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Biennial Report
2010-12

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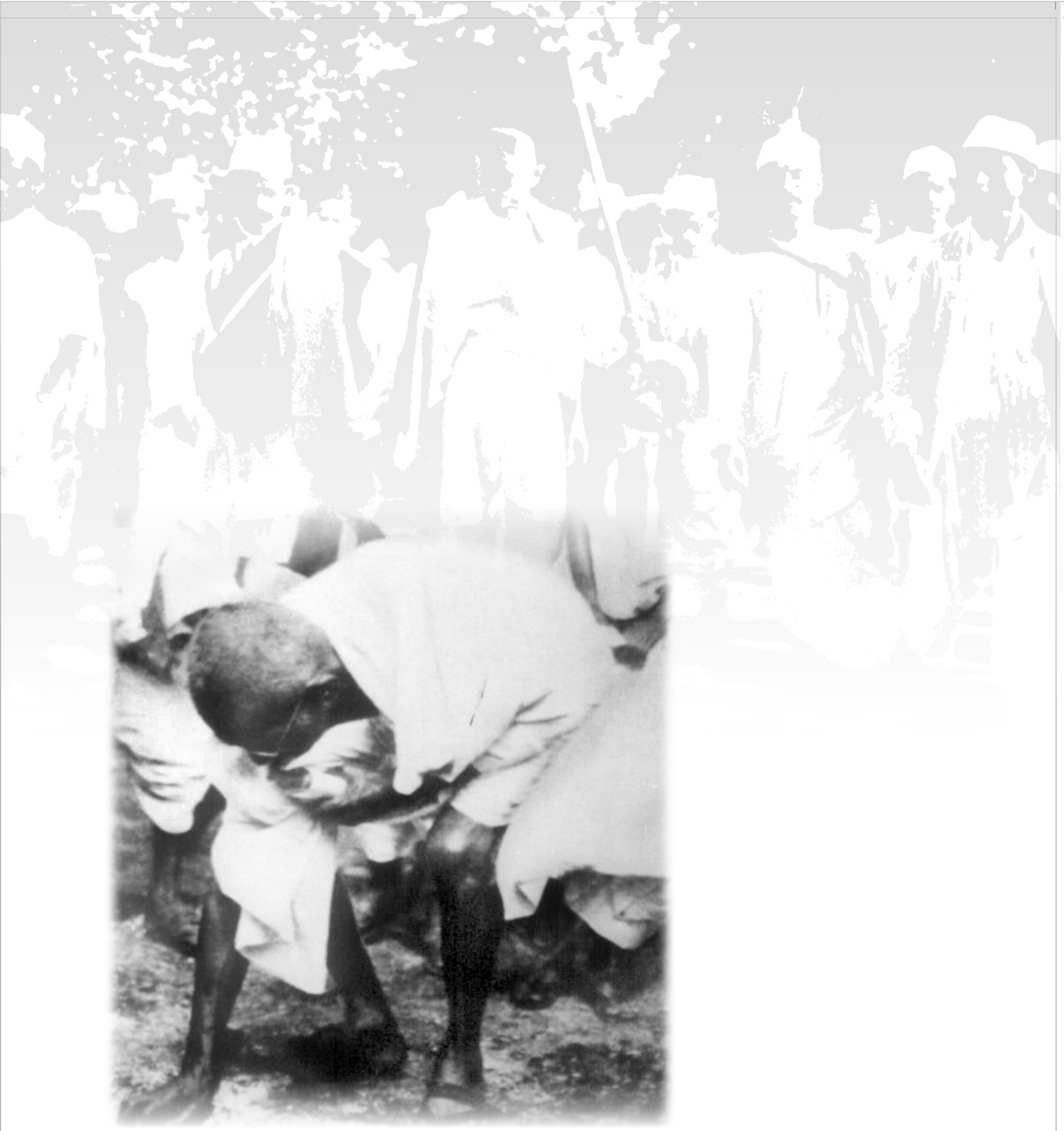


महात्मा गांधी, जिन्होंने ब्रिटिश साम्राज्य की जडों को हिला दिया और 6 अप्रैल, 1930 को दांडी समुद्री तट पर निडरता से नमक लेकर लोगों को प्रेरित किया।

The Mahatma who rocked the British Empire and galvanised the people by defiantly gathering salt at the Dandi seashore - 6th April, 1930.

''मैं नहीं चाहता कि इन प्रयोगशालाओं में कोई भी कार्यकर्ता सिर्फ अपनी आजीविका अर्जित करने के उद्देश्य से ही आये, मैं चाहता हूं कि हमारे युवा पुरुष और महिलायें जो यहाँ आयें उनमें हमारी समस्याओं के निवारण के लिये कार्य करने का उत्साह हो। वे ही इन संस्थानो को जीवन शक्ति देंगे। उनको यह एहसास होना चाहिये कि विज्ञान की सेवा सच्चे अर्थ में भारतभूमि की सेवा ही नहीं बल्कि संपूर्ण विश्व की सेवा है। विज्ञान की कोई सीमा नहीं होती।''

पंडित जवाहरलाल नहेरु

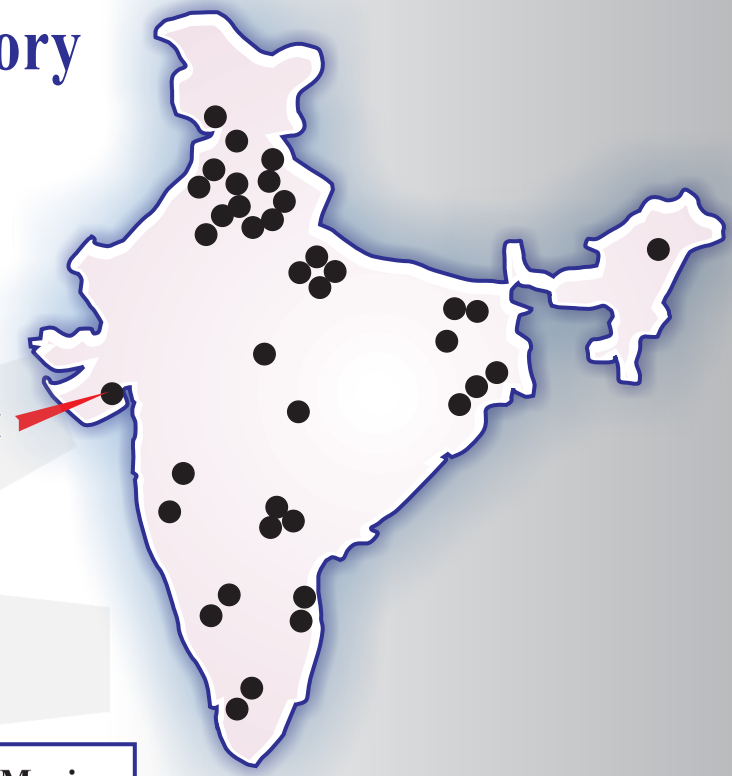
10 अप्रैल 1954 को दिये गये उदघाटन भाषण से उद्धृत

"I do not wish any worker to come to these laboratories merely with the aim of earning his living. What I wish is that our young men and women who come here should have a zeal for working out problems which would have great consequence. That would give vitality to these Institutes. They should realize that service to science is real service to India – no, even to the whole world; science has no frontiers"

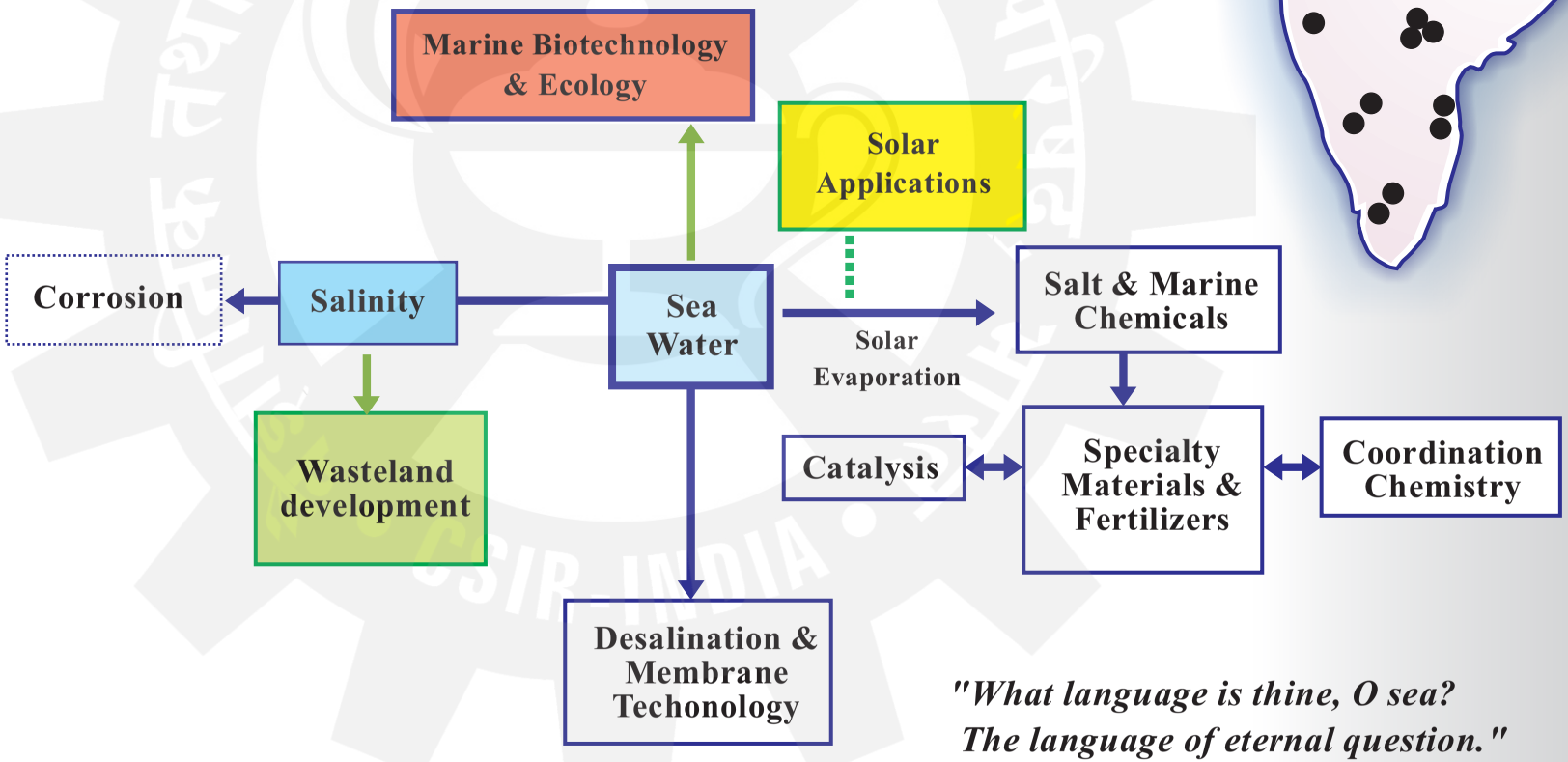
Pandit Jawaharlal Nehru

Extract from the Inaugural address on 10th April, 1954

CSMCRI: A CSIR Laboratory



CSMCRI AT A GLANCE



"What language is thine, O sea?
The language of eternal question."
(Stray Birds, Rabindranath Tagore)

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vul/kku ifj;ktukvk e fd, x, dk;k d ek/;e l 29 Nk=k u ih-,pMh- dh fMxh çkIr dh vkj o lHkh vc vPN LFkkuk ij dk;jr gA to&Mh ty vo'kÔk l to&vi{k;uh; lykfLVd fodflr dju d ç;klk d fy, lLFkku d 'kk/kdrkvk dh ,d Vhe dk bl oÔ jlk;u ,o mojd e=ky; lh-vkb-ih-b-Vh- jk"Vh; ijLdkj çkIr gvkA db vU; dk çfrf"Br Qykf'ki] ijLdkj vkj fof'k"Vrk çkIr gb vkj e mu lHkh dk c/kkb nrk gA ejk fo'kÔ /kU;okn lg;kx dk;k e lyXu mu xeuke uk;dk vkj depkfj;k d fy; g] tk cgn egRoi.k Hkfedk, fuHkkr g ij 'kk;n gh og vfHkeY;u çkIr dj ikr g ft ld o gdnkj gA e viu io depkfj;k d çfr vkHkkj 0;Dr djrk g ftUgk u foxr oÔk e viuk ;kxnku fn;k rFkk gekj fodkl dh uho j[khA e] gee foÜokl 0;Dr dju d fy, gekj fgr/kkjdk] çk;k tdk vkj 'kHkfprdk d çfr vkHkkj 0;Dr djrk gA

पी के घोष

if"irk dekj ?kkÔ

Foreword

I have great pleasure in presenting the Report for the period 2010-12. The year-wise balanced scorecards are provided immediately following this foreword. As compared to 2009-10, the grant from CSIR was 13% higher at Rs 34.30 crore in 2010-11 and it grew further to Rs 39.79 crore in 2011-2012. Our External Cash Flow climbed to a record Rs 13.00 crore in 2010-11 but declined the following year.

As Pandit Jawaharlal Nehru had exhorted us during his inaugural address on April 10, 1954, we have held the conviction that our R&D efforts must be of "great consequence" to the Nation and beyond. Our hollow fibre membrane knowhow was licensed to M/s Uniqflux and the modules have passed the stringent USEPA protocol for water purification devices. The technology for thin film composite SISOMSO RO membrane was also licensed to the same Party. Indigenous production of these membranes has profound implications for water purification and desalination in our country and it is hoped that more entrepreneurs will avail the technology. As part of our green initiative, we developed and licensed knowhow to M/s Heubach for production of synthetic hydrotalcite from a waste stream. M/s TATA Chemicals became the second licensee of our knowhow for co-production of sulphate of potash and magnesia from bittern and the demonstration trials were completed successfully. The knowhow for production of zeolite-A from low grade bauxite was licensed to M/s Credo Mineral Industries Ltd. and the licensee and GMDC have since formed a JV to set up a 10,000 TPA plant in Kutch. Several other technologies besides these were licensed. We also received Expressions of Interest from Gujarat and Orissa State Governments to enter into technology transfer agreements for seaweed cultivation by SHGs in these states. I am pleased that scientists are attempting to move up the learning curve in technological excellence. As an illustration, the consistency of RO membrane and module performance improved significantly this year.

The institute initiated several big projects during this period including setting up of a 0.75 TPD SOP test bed integrated with co-production of ammonium sulphate and ultrapure magnesia funded by DST, and a 2000 sq. m. TFC RO membrane test bed funded by CSIR. Business models will need to be created to ensure that these facilities not only serve their short term purpose but are self sustainable beyond the duration of the projects. The CSIR-MoES multi-institutional NMITLI project on marine microalgal biodiesel was also initiated during this period and a 200 km test drive of a TAVERA was undertaken successfully last March with B100 biodiesel extracted from *chlorella* microalga raised in our salt farm. Additionally, funding was received from MNRE to scale up the production of *Jatropha* tissue culture plants to propagate elite clones in large numbers. A CSIR-funded project was also initiated to conduct nation-wide trials with seaweed sap in partnership with agricultural institutes, and it is hoped that the project will help promote the use of sap in agriculture in a big way. A study to generate baseline data as part of EIA of the Dholera special investment zone project of the government of Gujarat also deserves special mention. Formal training of our staff in project execution and management is required as we undertake such large projects. Scientists also devoted time towards framing of Network projects under the 12th Plan as part of a pan CSIR effort. We hope to concentrate increasingly on renewable energy, fertilizer, water, clean technology, environment and affordable health in the coming years. We also hope to build on the leads developed during the previous plan periods, e.g., the patented bioactive extract from *S. brachiata* which was reconfirmed to possess anti-TB activity.

This year the Institute reached the important landmark of a half century of U.S. patents over a decade (2002-2012), an indication of our sustained innovativeness. We are especially pleased that several of these inventions have been licensed for commercialization over the years. We also successfully opposed an infringing patent application which, consequently, was disallowed by the Indian Patent Office last year. On the other hand, there was opposition in Israel to

one of our own patents which is being dealt with. Clearly, our patents have begun making an impact. The annexure provides details of the Indian and international patents granted and filed during the period of this report. We are especially pleased that our inventions around production of solar salt were awarded U.S. patents upholding our belief that one can invent even in what are considered to be mature technologies.

The establishment of AcSIR by CSIR has been a historic event and many students pursuing research in our institute are now registered for their Ph.D. under the Academy. The Institute was able to sustain the high standard of research it has set for itself. Our publications in SCI journals with published impact factor data climbed to 188 in 2010-2011 with average impact factor (AIF) of 2.441, and in 2011-2012 the AIF crossed 3 (3.096) for the first time. This can be attributed to the high standard of recruitments, growing number of bright research scholars, and excellent infrastructure – all of which have enabled problems to be addressed with greater scientific rigour. The centralized instrumentation services, for example, were valued at Rs 18.60 crore (based on CSIR-approved rates) for the period 2010-2012, indicative of the growth in research intensity and reliance on modern analytical tools. Today we also have a world class molecular biology laboratory and a bio-safety committee to monitor the important research being undertaken there. While we are proud of the quality of our research, it will be our endeavour to sharpen constantly its focus and relevance. For example, research on modeling and simulation is being used extensively in the design of solar devices. There are many such examples today of basic and applied research underpinning technology development.

The Institute has always prided itself on its outreach activities. A 6000 LPH seawater RO plant was set up in Narayan Sarovar, Kutch and the production cost of water was estimated to be 11 paise/L by WASMO. The total number of brackish water RO plants supplied to Norwegian Church Aid increased to 25 and today 50,000 Afghans in Faryab Province are benefited by the project. 100 units for desalination of sub-soil brine using waste heat of diesel engine were fabricated with funding from the Gujarat Industries Commissionerate and 5 community scale plants were installed in masjids in 24 Parganas, West Bengal to treat arsenic-contaminated groundwater. Our institute was assigned the responsibility of coordinating the exhibition of CSIR water technologies during CSIR Technofest and the pavilion received the Gold Award. Most significantly, the success of the DST-funded water projects in Rajasthan resulted in the sanction of 10 more plants which are under fabrication. Our effort to propagate improved solar salt technologies for the benefit of marginal producers is also being duly recognized. A new model salt farm in Markannan, Tamil Nadu was established and more projects are in the anvil. It is heartening that all the tourist buses in Sasan Gir lion sanctuary have switched to our B100 *Jatropha* biodiesel and boards have been put up at Gir to educate the public on this joint initiative of the Gujarat Forest Department and the Institute

The Institute, along with nominated scientists in Brazil, planned the first Brazil-India workshop on Bio-energy which was held in Bhavnagar last year. This was followed by a second workshop in Sao Paulo in April this year which too was planned by us. The workshops were held under the auspices of the Indo-Brazil Scientific Council and DST.

The media continued to take keen interest in our developments and many technologies, inventions and research findings were featured in newspapers and magazines, including MIT's Technology Review. Information on our activities is also being disseminated at the grassroots level through weekly broadcasts by AIR Rajkot as part of a 16 episode series.

Arising out of the research work undertaken in projects, 29 students received their Ph. D. degrees and they are all well placed. A team of researchers from the institute received the CIPET National Award this year from the Ministry of Chemicals & Fertilizers for the efforts to develop biodegradable plastic from biodiesel residues. Many others have received prestigious fellowships, awards and distinctions and I offer my congratulations to all of them. My special thanks to the many unsung heroes and staff members in the support functions who play a crucial role and yet rarely get the appreciation they deserve. I express my gratitude to past staff members who have contributed over the years and laid the foundation for our growth, and to our stakeholders, sponsors and well wishers for reposing faith in us.

Pushpito K. Ghosh

lrfyr Ldkj dkM - (2010-2011)

CSIR }kjk lforfjr fuf/k (2010 – 2011 d foÙkh; o"k) – :- 34.30 djkM] NMITLI dk feyk djA
cká udn çokg (2010 – 2011 foÙkh; o"k) :- 13.00 djkM NMITLI dk NkM djA

tu'kfDr llk/ku ¼31 ekp, 2011½ 264 LFkkb depkjh ,o 247 vLFkkb depkjh] ftle oKkfud Qykl@ 'kk/k lg;kxh v/;rk] ifj;ktuk lgk;d@,ifUVl 'kkfey gA

,pvkjMh

14 vul/kku Nk=k dk Ph. D. dh mikf/k l lEekfur fd;kx;kA 24 ,e- ,l- lh-@ ,e-Vd-fMtV'kuA

(i) Mk- dey'k ilkn dk CSIR ;x lkbfUVLV ¼dfedy lkbUll {k=½ l lEekfur fd;kx;kA
(ii) Mk- oHko v thr e=h dk p;u jeu fjlp Qykf'ki Vfux gr gvkA
(iii) Mk- ch- >k- dk p;u Qyk ,u-,-,-,l-¼ÝfUV;j lkbUll ¼ekyhD;yj ck;ykth ,o ck;kVDukykth {k=½
(iv) Mk- ¼Jherh½ vkj- vkb- dj'kh dk ifrf"Br efgyk oKkfud lEekfur fd;kx;k ¼bfUM;u lklk;Vh vkQ dfeLV ,o ck;kykftLVl {k=½
(v) Mk- ,-,l-egrk dk rhu yxkrkj ijLdkj ckehu fjdojh 'kk/k i= ij IIChE }kjk lEekfur fd;kx;kA
(vi) Mk- ih-d- ?kk"k dk ykbQ Vkbe vphoeUV ,okM] ,td'ku ,ofjlp; bfUM;u dfedy dkmfUly }kjk inku fd;kA
(ix) lh-,l-,e-lh-vkj-vkb- dk xkYM ,okb }kjk lEekfur fd;kx;k] "Fkhe iofy;u vku okVj" & vk;ktd CSIR – VDukQLV 2010A

vul/kku lk= - 193 oKkfud tuyke idkf'kr; vklr bEiDV QDVj 2.351 (viy 2010 – ekp 2011)

iVUVl – Qkby fd; x;: Hkkjrh; & 8; fon'kh & 8; Lohdr% Hkkjrh; & 8 fon'kh & 39 ¼3 ;-,l- iVUVl lfgr½

çk|kfxdh gLrkrj.k – 5

1. lYQVfoghuhdj.k rduhd }kjk 95% 'kð de lkfM;e lkYV ,o ikVkf'k;e DykjkbM cuku dh ifØ;kA ell vuh'k dehdYl] Hkkkouxj A
2. mPp 'kðrk;Dr vk|kfxd Lrj d lkj ued d mRiknu d fy, fdQk;rh ifØ;k d fy, rduhdh tkudkjhA ell Mh-lh-,e-Jhjke dkUlkfyMVM fyfeVM] ub fnYyhA
3. ikyh lYQku @ ikyh ,Øhykukb Vkby dk mi;kx dj d gkyk Qkbcj ijk fuLinu f>Yyh cukuk vkj mue ifjoru ykukA ell ;uhD;¶yDl eEcjUl ,y- ,y-ih- ukfld] egkjk"VA
4. ¶yV 'khV ekbØkfQYV'ku ¼,e-,Q-½ vYVk fuL;nu ¼;-,Q-½ vkj iryh fQYe dEikftV ¼Vh- ,Q-lh-½ fjol vklekfll f>Yyh vkj lfiy ekM;y cuku dh e'khu cuku dh ifØ;kA ell ;uhD;¶yDl eEcjUl ,y- ,y-ih- ukfld] egkjk"VA
5. dk;j Fkyklkbuhu xhu d cuku d nkjku mRiUu vY;efu;e DykjkbM oLV e l flUFkVhd gkbMkVy lkbV cuku dh ifØ;kA ell g;cd dyj ikboV fyfeVM] vdy'oj A

fof'k"V lkekftd dk;

(I) Hkkjr ljdkj d v/;;u d fy, "i;kxkRed fof/k }kjk vf/kd ek=k e dkcu dk idMdj to b/ku vkj :ikrj.k dh ifØ;k" ¼v/;k; lh-vkb-vkb- }kjk lpkfyr fd;kx;kg½ dh ikFkfedrk d ek/;e l bldk 'kk"k.kA
(ii) ikVk'k ,o vkj- vk- f>Yyh ik|kfxfd;k d fodkl d fy; jk"Vh; fofuek.k ifrLi/kkRedrk ifj"kn }kjk vk;kftr cBdk dh J[kykA
(iii) jktLFkku d fy; 5 lkj mtk lpkfyr vkj- vk- lykVA ¼FORRAD d lkFk lg;kx e vkj dkdk dkyk QkmM'ku }kjk foÙkh; lgk;rk½A
(iv) ub ued DyLVj fodkl ij iktDV ¼vxfj;k fgr j{kd ep d lkFk lg;kx ,o xtjkr bMLVht vk;Drky; }kjk foÙkh; lgk;rk ifj;ktuk½A

egRoi.k ehfM;k dojt

1. Hkkjr e tVkQk ik/k }kjk lykfLVd dk fuek.kA VkbEl vkQ bfM;k – 9 viy] 2010A
2. l[k [kku dk gkbftfud fuek.k & lk; mtk }kjkA VkbEl vkQ bfM;k 10 viy] 2010A
3. Hkkouxj l fufer "/ky jfgr pkd" f'k{kdk dh enn d fy;A & VkbEl vkQ bfM;k 13 viy] 2010A
4. oKkfudk u X;uku lkYV iu dk;drkvk dh l;kl c>ku dh fof/k fodflr dhA VkbEl vkQ bfM;k 16 viy] 2010A
5. xtjkr&thjk dh inkokj c< ldrh gA VkbEl vkQ bfM;k 9 tu] 2010A
6. tYn gh Hkkjr e dkj gjh b/ku d fodYi ij pyxhA VkbEl vkQ bfM;k 11 tu] 2010A
7. len dk Hkfe dk migkj & ,d lenh 'koky dk fodkl to mojd d :i eA VkbEl vkQ bfM;k 17 tu] 2010A
8. ikuh dk 'kð djue lh- ,l- ,e- lh- vkj- vkb- dk lQyre i;klA VkbEl vkQ bfM;k 8 tykb] 2010A
9. lh- ,l- ,e- lh- vkj- vkb- u ued d vk;kMhu dh ek=k vkdyu dh fof/k fodflr dhA il VLV vkQ bfM;k & 15 tykb] 2010A

BALANCED SCORECARD (2010-2011)

Allocation from CSIR (2010-2011 financial year) ₹ 34.30 crores including NMITLI
External Cash Flow (2010-2011 financial year) ₹ 13.00 crores excluding NMITLI

Manpower Resources (March 31, 2011) 264 permanent staff and 247 temporary staff comprising scientist fellows /research associates /research fellows / project assistants /apprentices

Human Resource Development

14 Research scholars were awarded Ph.D; 24 M. Sc./M. Tech. dissertation

(i) Dr. Kamalesh Prasad selected for CSIR Young Scientist Award (Chemical Science)
(ii) Dr. Vaibhav Mantri selected for Raman Research Fellowship training
(iii) Dr. B. Jha – Fellow, NAAS (Frontier Sciences; Mol. Biol & Biotechnology)
(iv) Dr. (Mrs.) R. I. Kureshy - Distinguished Women Scientist Award, Indian Society of Chemists & Biologists
(v) Dr. A. S. Mehta – Three simultaneous awards from IIChE for paper on bromine recovery
(vi) Dr. P. K. Ghosh - Lifetime Achievement Award (Education & Research), Indian Chemical Council
(vii) Gold Award Winner "Theme Pavilion on Water" CSIR Technofest 2010
(CSMCRI was honored to have the opportunity to coordinate this multi-laboratory effort)

Papers: 193 papers in SCI Journals with Impact factor of 2.351 (April 2010-March 2011)

Patents – (April 2010 to March 2011)
Filed: Indian 08 Foreign 08 **Granted:** Indian 08 Foreign 39 (including 3 US patents)

Technology transfer – 5

1. Process of preparation low sodium salt & KCl from bittern and potassium chloride of 95% purity through desulphatation technique. **M/s Anish Chemicals, Bhavnagar.**
2. Knowhow for the cost effective process for the production of high purity industrial grade solar salt. **M/s DCM Shriram Consolidated Ltd., New Delhi**
3. Process of preparation of hollow fiber ultra-filtration membranes using polysulphone/ polyacrylonitrile and their modification. **M/s Uniqflux Membranes LLP, Nasik, Maharashtra**
4. Process of preparation of flat sheet microfiltration (MF), ultra-filtration (UF), and thin film composite (TFC) reverse osmosis membrane and spiral module making machine. **M/s Uniqflux Membranes LLP, Nasik, Maharashtra**
5. Process of preparation of synthetic hydrotalcite from aluminium chloride waste generated in the plant for manufacture of copper phthalocyanine green. **M/s Huebach Color Pvt. Ltd., Ankleshwar**

Societal/Significant Initiatives

(I) Preparation of chapter for GOI on "Practical means of large scale carbon capture in diffuse form through energy crops and the prioritization of bio-fuels and conversion processes through carbon balance studies (the chapter has been vetted by CII)
(ii) Series of meetings organized by National Manufacturing Competitiveness Council revolving around potash and RO membrane technologies
(iii) 5 Solar powered RO plants for Rajasthan (in collaboration with FORRAD and funded by Coca Cola Foundation)
(iv) Project on new salt cluster development (in collaboration with Agaria Hith Rakshak Manch and funded by Gujarat Industries Commissionerate)

Important media coverage

1. India develops plastic from the Jatropha plant - Times of India, 9 April 2010
2. Dry food on solar dryer in hygienic way - Times of India, 10 April 2010
3. Dust free chalk from Bhavnagar to help teachers - Times of India, 13 April 2010
4. Scientists develop device to quench saltpan workers' thirst - Times of India, 16 April 2010
5. Gujarat's Jeera bowl may get bigger - Times of India, 9 June 2010
6. Soon, cars in India to have green fuel option - Times of India, 11 June 2010
7. Sea's gift to land: A weed cum bio fertilizer - Times of India, 17 June 2010
8. CSMCRI achieves milestone in water purification - Times of India, 8 July 2010
9. CSMCRI develops method to measure iodine content in salt - Press Trust of India, 15 July 2010

lrfyr Ldkj dkM - (2011-2012)

CSIR }kjk lforfjr fuf/k (2011 – 2012 d foÙkh; o"k e) – :- 39.79 djkM] NMITLI dk feyk dj cká udn çokg (2011 – 2012 foÙkh; o"k e) :- 8.33 djkM NMITLI dk NkM dj

tu'kfDr llk/ku ¼ekp 31, 2012½ 256 LFkkb depkjh ,o 192 vLFkkb depkjh] ftle oKkfud Qykl@ 'kk/k lg;kxh] v/;rk] ifj;ktuk lgk;d@,ifUVl 'kkfey gA

,pvkjMh

15 vul/kku Nk=k dk Ph. D. dh mikf/k l lEekfur fd;kx;kA 25 Nk=k dk ,e-,l-lh-@ ,e-Vd-fMtV'kuA

(i) AcSIR dk dk;Øe fof/kor 'k: djk;kx;k vkj 55 'kk/k Nk=k dk jthLV'ku bld vUrxr fd;kx;kg vkj f'k{kk dk; ixfr ij gA
(ii) Mk- vjfon dekj dk "jkeu fjlp Qykf'ki" ikIr gbA
(iii) Jh ghju jkoy dk "vUrjjk"Vh; Mhlyhu'ku ,lklh,'ku" Qykf'ki ikIr gbA
(iv) Mk- rtoUr flg] 'kk/k Nk= dk JSPS Qykf'ki ikIr gbA
(v) Mk- ih-d- ?kk"k] fun'kd] dk p;u Hkkjrh; oKkfud dkmfUly d Hkkjrh; v/;{k d :ie ikuh l lcf/kr nfo/kkvk d fodkl d fy, u,mik; vkj Hkkjrh; ,o ;jkfi;u l'kk/ku (New IMDG6 NPP2) d fy, fd;kx;kA
(vi) Mk- ih-d- ?kk"k dk p;u] "vljf{kr lkekftd ykxk d fy, xfBr ,l-,M Vh- ij dk; dj jg leg" d lnL; d :ie fd;kx;kA mDr leg dk xBu lykfux deh'ku d XII lyku vUrxr fd;kx;kgA
(vii) Jh fot; ih-f=ikBh ,o Jh egUn dekj dk gEckYV fjlp Qykf'ki & ikLV MkDVjy 'kk/k dk; d fy; ikIr gbA
(viii) Mk- vfouk'k feJk dk ";x oKkfud" dk lEeku ;-ih- dkmfUly vkQ ,l-,M Vh- }kjk ikIr gvkA
(ix) Jh ,e-vkj-xk/kh dk nkckjk buvkjxkfud dfedYl lD'kuy dehVh CHH dk p;jeu pukx;kA
(x) Mk- ,-d-flðkrk dk bfUM;u tujy vkQ upjy ikMDVl ,ofjlkjlt d ,MhVkfj;y okM e lfEefyr gku dk xkjo ikIr gvkA
(xi) fo'k"k Kkuo/kd if'k{k.k dk;Øe dk vk;ktu 7 – 11 ekp 2011 d nkjku mMhlk d ued mRikndk ,o ikUrh; ljdkj d vf/kdkfj;k d fy; vk;kftr fd;kx;kA

vul/kku lk=:

197 'kk/k i= oKkfud tuyk e idkf'kr g, ftudk vklr bEiDV QDVj 2.965 (viy 2011 – ekp 2012)

iVUVl: ¼viy 2011 – ekp 2012½

Qkby dh xb¼ Hkkjrh; & 15; fon'kh & 15; Lohdr¼ Hkkjrh; & 3; fon'kh & 32 ¼4 ;-,l- iVUVl lfgr½

çk|kfxdh gLrkrj.k – 4

1. Hkkjh {kkjh; eXuhf'k;e dkckuV cuku dh ifØ;kA ell vfer gkbikQkLQkbVl] Hkkouxj A
2. dPN e miyC/k yk xM ckDlkbV e l fMVtUV xM ft;kykbV & A dk fuek.k A ell ØMk feujy bUMLVht fyfeVM] vgenkckn] xtjkr
3. lenh fcVu l lYQV vkQ ikVk'k vkj eXuh'kh;k dh lefUor rjhd l iu¼ikflr d fy, ,d ifØ;kA ell VkVk dfedYl fyfeVM] ehBkij A
4. len e dlikQk;dl ,Yokjth dh [krh dk rduhdh Kku ¼vrj Tokjh; lenh ikuh e½A ell ejhu fyfDtjl] V;Vhdkjhu A

fof'k"V lkekftd dk;

1. 50,000 tVkQk fV'; dYpj ik/kk dh lfo/kk dk fodkl A (MNR 0.75 TDP }kjk foÙkh; lgk;rk)
2. ikVk'k VLV cM & FCO xM d lYQV vkQ ikVk'k vekfu;e lYQV ,o mPp Lrjh; eXuh'kh;k ,dhdr mRiknu d fy, ¼Mh-,l-Vh- }kjk foÙkh; lgk;rk½A
3. ekbØk ,Yxy tho b/ku ij cglLFkkxr NMITLI iktDV A lh-,l-vkb-vkj- & lh-,l-,e-lh-vkj-vkb- & ukMy i;kx'kkyk ¼ lh-,l-vkb-vkj- & feuhLVh vkQ vFk lkbUlt½A
4. tVkQk fV'; dYpj d 50000 dyhu ik/kk d fodkl dh lfo/kkA ¼,e-,u-vkj-b- }kjk foÙkh; lgk;rk½A

egRoi.k ehfM;k dojt

1. th-,e-] ;-,l-,uth foHkkx vkj lh-,l-,e-lh-vkj-vkb- dh to b/ku d fy; L;kgh lf/kA VkbEl vkQ bfM;k – 12 viy] 2011
2. Hkkouxj e Vojk lenh to b/ku ij pyrk gA VkbEl vkQ bfM;k & 30 eb] 2011A
3. lenh 'koky l bFkuky dk mRiknu dju dk i;klA nk fgUn & 30 eb] 2011A
4. ued mRiknu e yx Jfedk dh vk; c<ku d fy, ub rduhdA VkbEl vkQ bfM;k & 27 flrEcj] 2011A
5. ekbØk,Yxh l ck;kMh ty & ,d okLrfodrk cu x;kgA Mkmu V vFk & 30 ekp] 2012A

BALANCED SCORECARD (2011-2012)

Allocation from CSIR (2011-2012 financial year) ₹39.79 crores including NMITLI
External Cash Flow (2011-2012 financial year) ₹ 8.33 crores excluding NMITLI

Manpower Resources (March 31, 2012) 256 permanent staff and 192 temporary staff comprising scientist fellows /research associates /research fellows / project assistants /apprentices

Human Resource Development

15 Research scholars were awarded Ph.D ; 25 scholars did their M. Sc./M. Tech. dissertation

(i) The activities under AcSIR have begun and 55 research scholars are presently registered; course work has commenced
(ii) Dr. Arvind Kumar – Awarded Raman Research Fellowship
(iii) Mr. Hiren Raval – Awarded International Desalination Association Fellowship
(iv) Dr. Tejwant Singh (Research Scholar) – Awarded JSPS fellowship
(v) Dr. P.K. Ghosh, Director appointed as Indian Chair of Scientific Council for Water Related Challenges under New Initiative for the Development and Integration of Indian and European Research (New Indigo NPP2)
(vi) Dr. P. K. Ghosh, Director appointed as member of "Working Group on S&T for the Vulnerable Section of the Society" set up by the Planning Commission to identify projects under the XIIth Plan
(vii) Mr. Bijay P. Tripathi and Mahendra Kumar selected for Humboldt Research Fellowship for postdoctoral research
(viii) Dr. Avinash Mishra, Young Scientist award for the year 2011, Council of S&T, Utter Pradesh
(ix) Mr. M.R. Gandhi, renominated as Chairman of Inorganic Chemicals Sectional Committee CHD
(x) Dr. A.K. Siddhanta, Editorial Board, Indian Journal of Natural Products and Resources
(xi) An exposure training program for the salt manufacturers of Orissa and the State Dept. officials, Govt. of Odisha, 7 – 11, March 2011

Papers : 197 papers in SCI Journals with Impact factor of 2.965 (April 2011-March 2012)

Patents – (April 2011 to March 2012)
Filed: Indian 15; Foreign 15 **Granted:** Indian 03; Foreign 32 (including 4 US patents)

Technology transfer – 4

1. Process of preparation of heavy basic magnesium carbonate from bittern. **M/s Amit Hypophosphites, Bhavnagar**
2. Manufacture of detergent grade zeolite-A from low grade bauxite available from Kutch, Gujarat. **M/s Credo Mineral Industries Limited, Ahmedabad**
3. A process for the recovery of sulphate of potash and magnesia in integrated manner from sea bittern. **M/s Tata Chemicals Ltd., Mithapur**
4. Knowhow to cultivate *Kappaphycus alvarezii* in the sea (inter tidal water). **M/s Marinelixirs, Tuticorin**

Societal/Significant Initiatives

1. Facility for 50,000 *Jatropha* tissue culture plants from elite accessions (Funded by MNRE)
2. 0.75 TPD Potash Test Bed for integrated production of FCO grade sulphate of potash, ammonium sulphate and high purity magnesia (funded by DST)
3. Multi-institutional NMITLI project on microalgal biofuel with CSIR-CSMCRI as nodal lab (funded by CSIR-MoES)
4. Creation of facility for 50,000 *Jatropha* tissue culture plants from elite accessions (Funded by MNRE)

Important media coverage

1. GM, US Department of Energy and CSMCRI ink pact for bio fuel - Times of India, 12 April 2011
2. Tavera runs on marine biofuels in Bhavnagar - Times of India, 30 May 2011
3. Efforts on to produce ethanol from seaweed - The Hindu, 30 May 2011
4. New technology to boost earnings of saltpan workers - Times of India, 27 Sept.2011
5. Biodiesel from microalgae becomes a reality - Down to earth, 30 March 2012

çdjÆ
CHAPTER 1

jlk;u foKku
CHEMICAL SCIENCES

ued ,o lenh jlk;u
vdkcfud inkFk ,oe mRçj.k

Salt & Marine Chemicals
Inorganic Materials & Catalysis

ued o lenh jlk;u foHkkx

Mcy QkfVQkbM ued ¼Mh,Q,l½

eu"; d 'kjhj d fy, vkbju ,o vk;kMhu vko';d gA Øe'k% vk;kMhu ,o vkbju dh de ek=k yu l gb vk;kMhu vYirk fodkj (IDD) vkj ykg&vYirktU; vjDrrk (IDA) l ijh vkcknh d vkfFkd ,o lkekftd fodkl ij xHkhj gkfudkjd iHkko iMr gA ckt kj e db ikMDVl yk; x, g yfdu mu lHkh e fuEufyf[kr ,d ;k ,d l vf/kd dfe;k g% ¼i½ vi;klr fLFkjrk ¼ii½ vLohdk; jx ¼iii½ cnc ¼iv½ vf/kd dher

bLVhV;V nokjk io e fd, x, flFkfVd gkbMk Vylkb V e vk;kMV dk leko'k] dk; d vk/kkj ij Mcy QkfVfQd'ku ,tVl cuk, x,A tk fd b"Vre ifjfLFkfr;k e 3 o"k rd mRd"V lQnh;Dr rFkk LFkk;h jgr gA ued foHkkx l Hkh vkbju ,o vk;kMhu dh fLFkjrk d ckj e ifrif"V ekxh xbA ifØ;k dk 3 fd-xk-QkfVfQd'ku ,tVl gr Ldyvi fd;k x;k gA "vkbju ,o vk;kMhu ;Dr uohu Mcy QkfVQkbM ued ,o ml cuku dh ifØ;k" 'kh"kd l ,d iVV vth ¼lnHk % 0607/DEL/2012½ dk nt djk;h x;h gA Hkkouxj efMdy dkyt d lg;kxu e Mh,Qlh dh tfod miyC/krk dk ijh{k.k çxfr e gA

vR;Ur 'kð ued % lkYV D;kjh e lkyj iu% fØLVyhdj.k ifØ;k dk Ldy&vi

t lk fd gekjh fiNyh ckbu 'kfðdj.k o pH dVky d }kjk 'kð ued mRiknu dh mUur fof/k;k] vPNh x.koÙkk d ued mRiknu e lgk;d g ijUr bu fof/k;k l dN vYi v'kfð;k tk fd fo'k"k jlk;uk d mRiknu d fy, vuko';d g] ,lh v'kfð;k dk de ugh fd;k tk ldkA ,lk ,d vui;kx ckekbM dh vR;r de ek=k dk gA lkyj iu% fØLVyhdj.k fof/k l lkyj ued ikflr d ckj e {k= ieku ij v/;;u fd;k x;k g vkj ckekbM ,o vYi /kkfRod vk;uk ;Dr v'kfð;k dk vR;f/kd de Lrj ij ykdj yxHkx 100 MT ued dk mRiknu fd;k x;kA ¼lnHk % 05797/DDEL/2012½

lenh ikuh d ifrLFkkiu d fy, ikdfrd ued l:i.k] [kfut QkVhfQd'ku gr ykxr iHkkoh fof/k;k

len d ikuh dk fofo/k vui;kxk d fy, mu lHkh LFkkuk ij mi;kx gk ldrk g tk len d utnhd ugh gA mnkgj.k Lo:i fo'o e ,l db ik;kfxd lLFkku g tgk ij len d ikuh dk mi;kx fd;k tkrk g yfdu len dk ikuh vklkuh l miyC/k ugh gkrk gA len d ikuh dh vuiyC/krk dh dfBukb gekj CSIR – MoES vrxr NMITLI d lenh 'koky l to b/ku iktDV e fofHkUu Hkkxhnkj ik;kfxd lLFkkuk }kjk crkb x;h tk fd gekj bl i;kx dh ij.kk cuhA blh rjg l tk len l njLFk LFkkuk ij ejhu vDofjve j[k jg g blh nfo/kk e gA ckt kj e gkykfd db mRikn miyC/k g tk fd lenhikuh d ifrLFkkih d :i e i;kx e yku dk nkok djr g yfdu o lHkh mRikn cgr egx gkr gA geu ,d de ykxrokyh fof/k fodflr dh g ftld }kjk iklr ued dk rkt ikuh e feyk nu l lenh ikuh iklr gk tkrk gA bl ljpuk dk uke "lkfyM lh" fn;k x;k gA bl mRikn dk 0;fDrxr :i e ?kjy ejhu vDofj;e e i;kx dju d fy, Hktk x;k rFkk bld mRd"k ifj.kke ik; x,A blh idkj Chlorella variabilis lenh l{e 'koky d lo/ku d fy, Hkh bl fof/k l cuk, x, lenh ikuh dk i;kx fd;k x;k g ftld ifj.kke i.kr;k vifjofrr lenh ikuh t l ghfey gA

ge vkid }kjk Hkt x, ued ftll gekj ejhu erL;ky; d fy, df=e lenh ikuh cuk;k x;k mld fy, /kU;okn nr gA uedhu lenh ikuh cuku d fy, geu ued dk lefpr ek=k e lkn ikuh e feyk;kA erL;ky; dk ikuh l Hkj fn;k ,o ;g ik;k x;k fd lenh ikuh dh eNfy;k fiNy 2 eghuk l cgr vkjkenk;d fLFkfr e gA

duy ih d pVth ¼fjVk;M½
fnukd % 07/03/2012

ifØ;k e mi;Dr l'kk/ku l ,d vU; Qkey'ku & Mkb lh ,e,Q cuk;k tk ldrk g tk fd de [kfut ik"kd ;Dr ihu d ikuh d iu%[kfuthdj.k d fy, i;kx e fy;k tk ldrk gA "lenh ikuh d ifrLFkku d fy, ikdfrd ued l:i.k] [kfut QkfVfQd'ku gr ykxr iHkkoh fof/k;k" 'kh"kd l ,d vLFkkb iVV v th bfM;u iVV vkfQl e fnukd 29/11/2011 dk ¼lnHk % 3422/DEL/2011½ n t djk nh x;h gA

[kkj foyo.khdj.k l;= l iklr fu"dkflr ikuh d 'kfðdj.k d fy, ifØ;k vkj [kkuk idku d fy, iR;{k ued lek/kku d :i e mi;kx

gkykfd xkeh.k ifjo'k e Hkh ol rk foyo.khdj.k l;= dh iflfð dkQh c< xb g ijr voÓÔ¨ l lcfÄr çc/ku d lkeu foÓÔ :i l vn:uh Õ=k e cMh pukrh lkeu vk;h gA vxj lykV l iu%ikflr de g rk fu"dkflr ikuh dh ek=k cgr T;knk gk ldrh g ,o ;g fu"dkflr ikuh ft ldk ;fn VhMh,l 2100 ihih,e l vfÄd g] dk cfg%L=ko v;kX; gkxkA nljh vkj] tc fu"dkflr vf/kd g] fjtDV ikuh e VhMh,l Lrj c< tkrk g tk fd bl ikuh dk Òh fMLpkt d fy, vui;Dr cuk nrk gA ikuh dk cy ck"ihdjÆ ,d dfiVy bVfUlo vkj Åtk dh Âirokyk gkrk g ft ld dkj.k xkeh.k lfVx e bll cpk tkrk gA lkj ok"ihdj.k Åij dju d fy, ,d cgrj fodYi g] yfdu ;g egRoi.k g fd bl mí'; d fy, Hkfe miyC/k gk vkj tyok; d vudy gkA db LFkkuk e tgk lLFkku }kjk vkjvk l;= LFkkfir fd;k x;k g ogk xkeh.k foyo.khdj.k l;= dh lkbM l ikuh yu vkr g vkj ;g gekj fy, gvk g fd vxj mUg vfrfjDr [kkuk idku d i;ktuk d fy, ,d 'kð ued ikuh dk ?kky fn;k tk;] ;g fu"dkflr ikuh dh leL;k dk de dju e ennxkj gk ldrk gA fu"dkflr ckbu d 'kfðdj.k dh ;ktuk vkj bl vo/kkj.kk d ifj.kkek dk in'ku fd;k x;k ¼lnHk 0593/DEL/2012½A ;g ;ktuk vkjvk l;= dk mPp fjdojh ij lpkfyr dju d fy, ykHknk;d gkxhA

fofHkUu lclkby ckbu d ckbu 'kfðdj.k o pH dVky d }kjk 'kð ued mRiknu dh lkoHkkfedrk dk v/;;u

bl fjikV e 'kkfey dh x;h vof/k d nkjku ckbu 'kfðdj.k o pH dVky d }kjk vko';d Ca/Mg ryuk rFkk >99% 'kðrk ued mRiknu dh ,d mUur fof/k dk ; ,l iVV feykA fofHkUu lclkby ckbu d ckbu 'kfðdj.k o pH dVky d }kjk 'kð ued mRiknu dh lkoHkkfedrk dk v/;;u fd;k x;kA ifj.kke n'kkr g fd ckbu dh dkb Hkh ljpuk gk] mPp x.koÙkk dk ued] vk|kfxd vui;kxk d fy, v'kfð;k dh Lohdk; lhek d vu:i curk gA mUur fof/k l lHkh idkj d ckbu l Ca/Mg vuikr ~2 dk ued cu ldrk gA

lkyj lkYV oDl dk v) ;kf=dhdj.k

t lk fd fiNy f}okf"kd fjikV e crk;k g] lkyj yo.k dk; d v) ;kf=dhdj.k gr fof/k;k dk bLVhV;V d ik;kfxd yo.k dk; e ued dk iuk e l ckgj fudkyu d fy, fiNy nk yo.k l= e i;kx fd;k x;kA QyLo:i e tnjk dk fn; x, ued d iuk dk dke de fd;k tk ldk gA lkYV gkoLVj e Qjcny fd;k x;k ft ll NkV fØLVykb t j e Hkh bldk mi;kx fd;k tk ldA bll fiNy yo.k l= e ued dk mRiknu c<k gA ued d fudkyu l ydj ml dh <ykb rd] vxy ued fudkyu dh vof/k d nkjku] e'khuh dk; dk leko'k fd;k tk;xkA

ckbu dh ck"ihdj.k nj e j t d lgk;d lo/ku

uedhu ikuh d ok"ihdj.k e jxk d mi;kx e r th yku ij v/;;u 'k: fd;k x;kA ,l jxk dk puk x;k tk ckbu vFkok j t d dh fuf'pr lknrk ij ;k rk vklkuh l foylr gk tkr g] vFkok te tkr g vkj volkfnr gk tkr gA ok"ihdj.k i;kxk dk ,d lV 5 ihih,e ;Dr L;kgh dk 5.15°Be' lenh ikuh e feyk dj fd;k x;kA 4

fnuk d ckn ckbu d rkieku Øe'kk 47 fMxh lfYl;l vkj 41 fMxh lfYl;l ij ,d fo'k"k jx d lkFk fey g, ckbu dk] fcuk L;kgh fey g, ckbu dh ryuk e 25% vf/kd ok"ihdj.k dk irk pykA 6°C mPp rkieku dk iHkko ok"i nkc c<ku e gvk QyLo:i ok"ihdj.k r th l gvkA bl d ckn y?k Lrj ij ik;kfxd lkYV Qke e 4 °Be' len ikuh ydj fd, x,A ,lk ik;k x;k fd L;kgh fey g, ckbu d 25 °Be' ?kuRo rd igpu e 19 fnu yx tcfd fcuk L;kgh fey g, ckbu d 25 °Be'?kuRo rd igpu e 23 – 25 fnu yxA ,d fnypLi voykdu n[kk x;k fd iklr Ldf/kr ¼Coagulated½ j t d dk dN 'krk d rgr de ?kuRooky uedhu ikuh e i;kx fd;k tk ldrk g tk j t d d iujkofÙk dju d fy, l{ke gk ldrk gA

ued e ¶ykjkbM dh ek=k e deh d fy, ifØ;k

ell VkVk dfedYl fyfeVM d lkFk ,d ik;kft r ifj;k tuk d rgr exkfn] vÝhdk e ued dh x.koÙkk e l/kkj d fy, ,d ifØ;k ¶ykjkbM lkexh e deh ¼lnHk 1028/DEL/2012½ d lkFk fodflr dh xbA

ck;kMh t y d fy, lenh l{e 'kokyh; [krh d fy, lkj ued iuk dk mi;kx

"lenh l{e 'koky l to b/ku" cg lLFkkxr NMITLI ifj;k tuk d rgr ,d çfrHkkxh i;kx'kkyk lh, lvkbvkj vkj MoES }kjk l;Dr :i l lefFkr g] geu if'peh rV ij nk rVh; yxu dh igpku dh tgk lenh l{e 'koky d vLFkk;h eV c<rh n[kh x;hA bu eVl e ekbØkLikjk vkj ¶ykMkQkjk i tkfr;k ¼ATCC ifjxg.k l[;k Øe'kk ihVh, 12197 vkj 12199 ihVh,½ e[; :i l 'kkfey gA ;Qly d fy, vklku Fk vkj QyLo:i ft l ey :i l gDlu fudklh ij xj & /koh; lipid d] tk vkx tVkQk ry e cnyu d fy, dke e fy;k] rRi'pkr VkUl ,LVjhfQd'ku d }kjk QVh ,flM feFkkby ,LVj ¼ck;kMh t y½ e ifjofrr fd;k x;kA B20 ck;kMh t y lLFkku dh Vkojk okgu pyku d ijh{k.k e bLreky fd;k x;kA

Dykjyk ofj;kfcfyl ¼ATCC ifjxg.k l 12198 ihVh,½ dk] vjc lkxj l vyx] ekl dh [krh ,d gh ifj;k tuk d fgLl d :i e 'k: dh x;h FkhA 0;kid i;kx'kkyk i;kx] ik;kfxd lkYV Qke e [ky lkj ued iuk e [krh dk r; dju d fy, fd, x,A m l d ckn ued iuk e viy & tu] 2011 d nkjku ek/;e d :i e lenh t y dk mi;kx fd;k x;k gA i;kx'kkyk i;kxk u] ge xfe;k d ekl e e ck;kekl ¼40 – 45 fMxh lfYl;l½ d vkVk lVfyx d ek/;e l dYVho'ku dju d fy, ,d mi;Dr fof/k d fy, funf'kr fd;kA dYpj dh dy ek=k 432 ox ehVj d dy {k=Qy d lkFk 100 ?ku ehVj ¼1,00,000 yhVj½ FkhA 32.45 xke @ox ehVj @ fnu ¼'k"d vk/kkj½ d ,d vklr ck;kekl mRikndrk vkj 45 xke @ ox ehVj @ fnu ¼'k"d vk/kkj½ d vk/kkj ij vf/kdre mRikndrk 300 fdyk l[kh ck;kekl c<ku e l{ke g,A ck;kekl dk 30 yhVj B100 ekbØk ck;kMh t y r;kj dju d fy, bLreky fd;k x;kA ijh{k.k ck;kMh t y dk mi;kx Loxh; Jh foykljko n'ke[k] ekuuh; foKku vkj ik|kfxdh e=h }kjk >Mh fn[kkdj jokuk fd;k x;kA

ijh{k.k okgu dh lokjh d nkjku ek t n jg ,d i=dkj u viu vuHko d ckj e fy[kk ";g loknnkrk] Vkojk tk fd e=h }kjk >Mh fn[kkdj jokuk dh x;h] d ijh{k.k lokjh d nkjku ek t n FkkA bl dk vuHko fd lh vU; Mh t y okgu dh rjg] ,d lkekU; Mh t y b t u d cjkcj FkkA dnh; lfpoky; {k= d vklikl d nk fdykehVj rd Mkbo LeFk vkj fcuk fd lh 0;o/kku d Hkh FkkA" (Dinsa Sachan, "Biodiesel from microalgae becomes a reality", Down to Earth, March 30, 2012; www.downtoearth.org.in) (PCT/IN2012/000372 fnukd 28 eb, 2012). Okkgu ub fnYyh e ih; lh mRl tu ijh{k.k e Hkh lQy jgkA

ikVk'k @ eXuf'k;k l lcf/kr vul/kku ,o fodkl

ell VkVk dfedYl fyfeVM dk ik|kfxdh ykbll

ell VkVk dfedYl fyfeVM dk fn;k x;k ik|kfxdh ykbll tk fd iVV ,dhdr lYQV vkQ ikVk'k @ eXuf'k;k d fy, ,dhdr ifØ;k d fy, g mldk in'ku fd;k x;kA 3 TPD {kerk dk VLV cM tk fd foKku ,o ik|kfxdh foHkkx] Hkkjr ljdkj vkf'kd foÙk ikf"kr g] diuh d ifjlj ehBkij e yx jgk g ,o mldk fuek.k dk; py jgk gA

b ,l ,Qe 0.75 Vh ih Mh ,l vk ih VLVcM

tlkfdfiNyhfjikVemYy[kfd;kx;kg DST }kjk etj lh,l,elhvkjvkbe 0.75 TPD {kerk dk SOP VLV cM d lkFk lkFk Vhlh,y e Hkh SOP VLV cM LFkkfir fd;k tk jgk gA ;g jk"Vh; Lrj ij egRoi.k ifj;ktuk cgrj feêh vkj ikuh d ic/ku vkj Lon'kh lk/kuk vkj jktxkj ltud mi;kx d vykok LFkk;h df"k mRikndrk d ije y{; d lkFk Lon'kh mojd mRiknu ykxr ifrLi/kh fol&,&fol vk;kfrr ,lvkih cuku dh nf"V ls lpkfyr gA SOP VLV cM gekjh nkgjh mojd ifØ;k] 0.75 SOP ¼FCO xM½ vkj 0.3 TPD vfr'kð eXuf'k;k ¼ihlhVh iVV d fy, vkonu dk etjh n nh g½ d vk/kkj ij fd;k tk,xkA ell SNC – Lavalin bthfu;fjx bfM;k fyfeVM (SLEI) dk cfu;knh vkj foLrkj bthfu;fjx dke d fy, bthfu;fjx lykgdkj d :i e fu;Dr fd;k x;k gA o foLrr bthfu;fjx fMtkbu ftle ikbfix vkj midj.k vkj[k] midj.k yvkmV] ljpukRed fooj.k] midj.k fofun'k] fctyh vkj bLVeV'ku foLrkj] ikbfix foLrkj dk dke n[kxA gekj ik;kfxd lkYV Qke e 5000 ox ehVj {k= dk bl dk; d fy, fpfUgr fd;k x;k gA Levelling vkj rVc/k lfgr lkbV r;kjh dk dke ijk gk pdk gA Hk & rduhdh tkp dju d fy, ykM vlj vkj feêh dh {kerk ifrjk/kdrk dk vkdyu fd;k x;k gA ;g MVk vkx flfoy ljpukvk dh fMtkbfux d fy, bLreky fd;k tk,xkA lcLV'ku vkj e[; fctyh forj.k dn dh LFkkiuk dk dke ijk gk pdk gA

lHkh yc le; e feyuoky vkbVe dk vkn'k fn;k x;k gA dN egRoi.k midj.k g tl fd Calciners, i'kj centrifuges LFky ij igy lgh iklr fd;k x;k gA 'k"k midj.kk dh [kjhn flfoy fuek.k d lkFk feydj fu/kkfjr fd;k x;k gA

geu ljpuk fMtkbu vkj flfoy fuek.k dk; dh fuxjkuh vkj eY;kdu d fy, lykgdkj d :i e ell vkDVl dk fu;Dr fd;k gA ell vkDVl u ell SNC – Lavalin bthfu;fjx bfM;k fyfeVM (SLEI) d lg;kx ls l;= d 'kM d fMtkbu dk dke ijk dj fy;k gA l;= d 'kM dk fuek.k dk; vkn'k d ckn 5 – 6 eghu d le; e ijk gku dh lHkkouk gA l;= d H1, 2013 rd pky gku dh mEehn gA

SOP VLV cM d fy, dPp eky d L=kr dh leL;k dk lek/kku dju d fy,] gekj ik;kfxd lkYV Qke e bl lhtu e fefJr ued ¼12 Vu½ r;kj fd;k x;kA bld vfrfjDr jktyk ¼vejyh ftyk] xtjkr½ e vxkfj;k fgrj{kd ep d lkFk lh,l,elhvkjvkb ifj;ktuk d vrxr ued etnjk l mud ykHk dk/;ku e j[kr g, 25 Vu dkbukbV fefJr ued [kjhnk x;kA ued etnjk u lh,l,elhvkjvkb oKkfudk d rduhdh ekxn'ku d rgr fefJr ued r;kj fd;k FkkA dPN d xVj j.k l Hkh fefJr ued dh 0;oLFkk dh tk jgh gA fiNy ued ¼uedhu ikuh igy fQVfdjh d lkFk lkQ fd;k x;k Fkk½ d ekle d nkjku 25 Vu dPp dkuyk;V fefJr yo.k dh ifØ;k gr voHkfe fcVu dh 300 ?ku ehVj lc lkby dk dke e fy;k x;k gA fiNy ued ekle d nkjku mRikfnr 500 ?ku ehVj lc lkby fcVu rkykck e ljf{kr fd;k x;k g ftl eXuhf'k;e vkDlkbM dh ikflr d fy, vko';d dkuykbV feDLM lkYV d mRiknu d fy, bLreky fd;k tk,xkA len d ikuh d vck/k iokg d fy, ,d puy cukb xb g tk fd SOP VLV cM dh ikuh dh t:jr ijh djxhA

de lkfM;e ;Dr ued d ckj e foLrr tkudkjh dk LFkkukrj.k

lLFkku d vrjjk"Vh; Lrj ij fn; x, iVV ifØ;k tk fd fcVu l de lkfM;e ued cuku dh ifØ;k d ckcr g] dk ell vuh'k dfedYl] Hkkouxj d lkFk inf'kr fd;k x;k g rRi'pkr bl ik|kfxdh dk okf.kfT;d mRiknu gr gLrkrj.k fd;k x;kA

mPp cYd ?kuRo (0.5 – 0.7) ;Dr cfld eXuhf'k;e dkckuV cuku dh ifØ;k

mPp Fkkd ¼cYd½ ?kuRo (0.5 – 0.7) ;Dr cfld eXuhf'k;e dkckuV tk fd nok e mi;kx d fy, mi;Dr g] lkj ued dk;k e mRiUu fcVu l iklr dju dh ,d ifØ;k fodflr dh xb FkhA bl ifØ;k dk ell vuh'k dfedYl] Hkkouxj d lkFk inf'kr fd;k x;k vkj ik|kfxdh okf.kfT;d Lrj ij mRiknu dju gr LFkkukrfjr dh xbA

ub [kkt

0;kid rkieku ij dkuyk;V fo?kfVr mRikn ¼lhMhih½ l ikVf'k;e DykjkbM vyx dju d fy, ,d uohu nf"Vdk.k

dkuyk;V fefJr yo.k d ikuh e fo?kVu d rRi'pkr fo?kfVr mRikn dh xje yhfpx l ikVf'k;e DykjkbM ikIr fd;k tkrk gA blh rjg [kku l ikIr flYohukbV d 'kfðdj.k d fy, Hkh xje yhfpx fof/k dk i;kx fd;k tkrk gA xje yhfpx fof/k ,d cgr egxh vkj vf/kd Åtk [kirokyh fof/k gA blfy, lkfM;e DykjkbM l ikVf'k;e DykjkbM ikIr dju d fy, ,d odfYid nf"Vdk.k dh vko';drk egl l dh xb tkfd vkfFkd :i l 0;ogk;ijd gk vkj ft ll Åtk dh cpr Hkh gkA lkfM;e DykjkbM ,o ikVf'k;e DykjkbM dk fØLVyh; Bkl ?kuRo 1.98 vkj 2.18 xke @ leh³ (25°C) lcf/kr yo.k dh ,dy fØLVy MVk l gkuk ik;k x;kA bu fu"d"kk d vk/kkj ij vkx d i;kx bu nk yo.kk d bl de ?kuRo e vrj dh vo/kkj.kk d vk/kkj ij fd; x,A ,d 2.08 xke @ leh³ d ?kuRooky rjy xj ifrfØ;k'khy ek/;e bfFkyhu MkbDykjkbM ¼?kuRo½ 2.17 xke @ leh³½ d 90 Hkkx d lfEeJ.k }kjk r;kj fd;k x;kA ikVf'k;e DykjkbM vkj lkfM;e DykjkbM dk df=e Bkl feJ.k ,d vyx dhi e r;kj ek/;e l tkMk x;k ft l ijh rjg l Qyko d fy, vPNh rjg l fgyk;k x;k ,o iFkDdj.k d fy, j[kk x;kA fo'k"k :i l Åijh v'k l ,d= Bkl ikVf'k;e DykjkbM ik;k x;k tcfd uhp okyk v'k doy lkfM;e DykjkbM FkkA bl idkj nkuk v'kk dh dy fjdojh 100% ikb xbA

bl d ckn blh rjg d i;kx dkuyk;V fefJr yo.k d ikuh e fo?kVu l ikIr fo?kfVr mRikn l fd, x,A dkuyk;V fo?kfVr mRikn (CDP) vkj Bkl nkuk ijrk l ikIr ekbØkLdkih (SEM) vkj ljpuk fo'y"k.k ¼EDAX vkj vk;u ØkeVkxkQ½ d vk/khu FkA lij'ku n{krk] Åijh ijr lkexh d fy,] fo'k"k :i l de ikb xbA lHkkfor dkj.k dkuyk;V fo?kfVr ikMDV (CDP) e eXuhf'k;e dh deh gk ldrh gA mRlkgtud ifj.kke feyu l oreku e ikVf'k;e DykjkbM dk lkfM;e DykjkbM l vyx dju d i;kx ?kuRo vkj vkdkj e vrj d vk/kkj ij dju d fy, ixfr e g tkfd SEM Nfo;k l Li"V gkrk gA

dkbukbV fefJr ued l ikVf'k;e lYQV vkj vekfu;e lYQV d mRiknu dh ,dhdr ifØ;k

tcfd VLV cM e viukb x;h ifØ;k lYQV vkQ ikVk'k] vekfu;e lYQV vkj eXuhf'k;k d mRiknu dh t:jr ij tkj nrh g yfdu ;g egl l fd;k x;k fd ,d odfYid nf"Vdk.k r;kj gk tkfd ,d lgorh ljyhdj.k ifØ;k gk ,o ft ld }kjk eXuhf'k;k dk lgmRiknu ugh gkA bl idkj ,d ,dhdr ifØ;k d }kjk gh dPp eky d :i e fcVu l vekfu;k vkj gkbMkDykfjd vEy dk mi;kx dj r;kj fd;k x;k gA ifØ;k d nlj pj.k e 'kkfey g] dfY'k;e DykjkbM d lkFk ';kukbV ,o fcVu dh dfY'k;e DykjkbM l Mh&lYQV'ku] tcfd dfY'k;e dkckuV dh gkbMkDykfjd ,flM d lkFk dh ifrfØ;k l dfY'k;e DykjkbM vkj dkcu MkbvkDlkbM ikIr gkr gA dfY'k;e DykjkbM d lkFk ';kukbV ,M fcVu dh dfY'k;e DykjkbM l Mh&lYQV'ku l ikIr ftlle vekfu;k vkj dkcu MkbvkDlkbM d lkFk fØ;k dj vekfu;e lYQV foy;u ikoLFkk e rFkk ryNV d :i e dfY'k;e dkckuV ikIr gkrk g ¼elcx ifrfØ;k½A dfY'k;e dkckuV dk gkbMkDykfjd vEy d lkFk ifrfØ;k e fQj l mi;kx fd;k tkrk g tcfd dkcu MkbvkDlkbM dk elcx ifrfØ;k e mi;kx fd;k tkrk gA vekfu;e lYQV d iuçkfIr d fy, NkMdj] tgk Hkh vko';d g] lHkh vkij'ku ifjo'k rkieku ij fd, tkr gA ¼iVV vkonu l- 0600/DEL/2012½

ikVf'k;e d pfunk fu"d"k.k ifØ;k d ek/;e l fcVu l "lYQV vkQ ikVk'k" d mRiknu dh ifØ;k

lenh ty d ok"ihdj.k l ryNV d :i e mRikn ikIr dju ij vk/kkfjr ik|kfxfd;k e dkQh Hkfe {k= vkj lkj ok"ihdj.k d fy, vudy tyok; ifjfLFkfr;k dh vko';drk gkrh gA mi;Dr fu"d"kd dh lgk;rk l ikVf'k;e d pfunk fu"d"k.k }kjk bu leL;kvk l futkr fey ldrh gA ,d ifØ;k dh dYiuk vkj vo/kkj.kk d vk/kkj ij VkVfjd vEy dk mi;kx fcVu l ikVf'k;e d p;ukRed fu"d"k.k vkj lYQV vkQ ikVk'k vkj vekfu;e lYQV d mRiknu gr v/;;u fd, x,A ;g nf"Vdk.k lHkor% Hkkjr dh vko';drk dk ijk dju o xVj dPN d j.k e fcVu L=krk dk b"Vre mi;kx gr ,d 0;ogk; lek/kku dk i'k dj ldrk gA ¼iVV vkonu l- 0606/DEL/2012½

iVVM gfjr ckehu vfHkded d vui;kxk ij fujUrj v/;;u

ijk & ukbVk Vkybu l ijk ukbVk cfty ckekbM d fØLVyk dk 'kU; dkcfud fu"dklu d lkFk ifj'kð lÜy"k.k

nfor ckehu d fuek.k d le; NaBr – $NaBrO_3$ ¼2:1 d vuikr e½ e/;orh vif'k"V d :i e iklr gkrk gA ftldk iVV lLFkku }kjk fd;k x;k gA bldk mi;kx cftfyd ckehuhdj.k lfgr vud ckehuhdj.k vfHkfØ;kvk e fd;k tk pdk gA

blh rjg dh vfHkfØ;k e 0;kikfjd Lrj ij egRoi.k ijk ukbVk Vkybu dk :ikrj.k ijk ukbVk cfty ckekbM e fd;k x;k gA

oreku e 141 of'od ifrdrk lphcð g tk QkekL;fVdy fuek.k e bl vfr egRoi.k ;kfxd d fy, 0;kikj djr gA ;g ;ktuk flQydflu e/;orh d fuek.k dh ifjj{k.k & foifjj{k.k 0;g jpuk dk ukekfdr djrh g] tk ,yh&fyyh }kjk 1974 e bLreky dh xbA

;|fi ;g ifØ;k dN lkyk igy gekj }kjk vuefr iklr Fkh yfdu ble vkj l/kkj dh x tkb'k gA

PNBBR d vfHkfØ;k feJ.k ftle 2.5M PNBBr, 2.5 – 5.0M PNT bFkkbyhu MkbDykjkbM e ek tn g] l p;fur fge'khfrr (0 – 5 °C) fØLVyhdj.k fd;k x;k g tk fd ,d miyfC/k lkfcr gb vkj ftl l nk vxHkkxk e ykHk iklr gvkA bl ifØ;k l ckekuhdj.k vfHkfØ;k dk LoPNrk l i.k fd;k tk ldk rFkk vkxkeh in e ekrno dk iuh pØ.k fd;k tk ldkA

ijk NO_2– $PhCHBr_2$ dh v'kfð tkfd vfHkfØ;k feJ.k l 8 ink e mRiUu gb] dk PNBBr / PNT e no dk $NaBH_4$ l mipkfjr dj :ikrfjr fd;k x;kA ftl l no dk fpjLFkkb pØ.k dkcfud vif'k"V dk fu"dkf"kr dju d fy, fd;k x;kA

ijh ifØ;k e EDC ,d ek= foyk;d gA ftldh ifØ;k e [kir cgr U;ure gA PNT [kir d lki{k PNBBr dh foyfxr rFkk iuh ikflr dh lgyfC/k 98.30% jghA vfHkfØ;d dh mi;kx {kerk 98.26% jghA (RSC ,MokUl 2012, 2, 6645 – 6699)

ckekbM&ckeV ;Xe }kjk fo"kepØh; ;kfxdk dk tyh; ek/;e e ckehuhdj.k

,jkefVd fo"kepØh; ;kfxdk d p;fur ,dy ckehuhdj.k gr 2:1 vuikr e ckekbM & ckeV ;Xe d LoLFkku vEylfØ;.k }kjk ,d mi;Dr ckehuhded dh rjg] vf/kd i;kx e yk;k x;k gA ckekbM & ckeV ;Xe d LoLFkku vEylfØ;.k }kjk BrOH ,d fØ;k'khy fdLe mRiUu gkrh g tk fcuk fdlh mRijd d mi;kx l entyh; ifjfLFkfr;k e vud idkj d fo"kepØh; ;kfxdk dk ckehuhdj.k dju e l{ke gA byDVku vid"kh ifrLFkkih l lyXu fo"kepØh; ;kfxdk l yfC/k vf/kd iklr gkrh gA ¼bUM- b th- dfe- fjl- 2011, 50, 12271½

3 fo"ke pfØ; ,fju (H) + 2 Br^- + BrO_3^- $\xrightarrow{\text{tyh; MeCN 3H+, 5 – 10°C}}$ 3 ckek ;Dr fo"ke pfØ; ,fju + $3H_2O$

gfjr ckehu ctk;fyd @ f}rh;d ,Ydkgkyk d oj.kkRed vkDlhdj.k gr LoLFkku mRiUu mRijd

mi;Dr vkDlhdkjd d :i e ctkbfyd @ f}rh;d ,Ydkgy dk mud lxr ,fYMgkbM@ dhVkuk e o.kkRed vkDlhdj.k gr ckekbM & ckeV;Xe d lkFk mRijd ek=k e H_2O_2 (10%) dk ,d lkekU; vkDlhdkjd d :i e bLreky rFkk fodflr fd;k x;k gA

Br_2/BrOH Lih'kht ¼bldh mifLFkfr ijkcxuh LiDVkQkVkfefr; v/;;u l Kkr dh xb½ d LoLFkku fuek.k d fy, ckekbM @ ckeV ;Xe d 5:1 eky vuikr dk 15% vEy }kjk lfØ; dj vkDlhdj.k fØ;k dk iklr fd;k x;k gA

,fYMgkbM vkj dhVkuk dh mPp p;urk rFkk mPp yfC/k dk tyh; ek/;e e fcuk mRijd d lgkj iklr fd;k x;k gA ¼RSC ,MokUl 2012, 2, 2235½

eyHkr v/;;u

ckbu flLVe dk v/;;u

lenh ckbu dh ljpuk dk lkyj ok"ihdj.k d nkjku cnyr g, rkieku o ckbu ?kuRo ij vk/kkfjr dk;

22.4 °C rkieku ij] ?kuRo Qyu d lki{k lenh ckbu d vk;fud lxBuk dk lkfgR; e fjikV fd;k x;k g (IV International Symposium on salt The Northern Ohio Geological Society Inc. Ohio (1974) Vol. 2,351 – 58)A Hkkjrh; ekle ifjfLFkfr;k d vrxr ;gn[kk x;k g fd lenh ued d mRiknu d nkjku ckbu dk rkieku 25 – 35 °C rd cnyrk gA vr% ,lk egl l fd;k x;k fd Hkkjrh; ekle ifjfLFkfr;k dk /;ku e j[kr g, ckbu ljpuk d vkdM ink dju pkfg;A lenh ued d mRiknu d nkjku fofHkUu vk;u dh lknrk dk iHkko dk v/;;u ik;kfxd lkYV Qke e fd;k x;kA

lkfM;e DykjkbM foy;rk d vpj rkieku dk le>ku dk i;kl

lkfM;e DykjkbM d lcl iphnk x.kk e l ,d ikuh e ued dh ,d cM rkieku jt e ,d leku foy;rk gA bl ij idk'k Mkyuk ,d rduhdh utfj, l Hkh egRoi.k g] mnkgj.k d fy,] xe leaching d ek/;e l KCl dh iuçkflr] ued & ikuh legk d fodkl vkj fLFkjrk dk lkfM;e DykjkbM] ikVfl;e DykjkbM vkj vekfu;e DykjkbM d tyh; ?kky dh vR;r de lknrk l lrflr yoy rd xfr'khy idk'k fc[kju vkj thVk lHkkfor eki vk/kkj ij v/;;u fd;k x;kA DyLVj fLFkjrk dh tkp dju d fy, DyLVj vkdkj e ifjoru dh rkieku d lki{k fuxjkuh dh xbA

v/;;u e ik;k x;k fd vU; ekeyk dh ryuk e] lkfM;e DykjkbM & ikuh legk dk vklr vkdkj 20 – 70 °C rkieku lhek ij yxHkx fLFkj cuk jgkA DyLVj 0;ogkj dh 0;k[;k dju d fy, rkieku fuHkj foy;u lihM;rk ¼ftl /ofu ox vkj ?kuRo ekiu l fu/kkfjr fd;k g½] cgukfHkdh; NMR (^{1}H, ^{17}O, ^{35}Cl NMR) vkj FTIR l iklr lpuk dk i;kx e ykdj fd;k gA lrlr ued ?kky vkj 'kð ued dh NMR foLFkkiu vkj lrlr ued ?kky d OH [kM {k= dk 'kð ikuh dh ryuk e] vk;u ;Xe & ty vrjfØ;k dh egRoi.k tkudkjh gkfly dh xbA mPp fLFkjrk vkj tyh; lkfM;e DykjkbM e DyLVj vkdkj dh rkieku Lor=rk vkj foy;rk ij idk'k Mkyk x;kA (t-fQt-de- B, 2012, 116, 11712-11719)

25° ckbu ij no dk lkQ dju oky ,tV d iHkko dk v/;;u

ge igy gh lenh @ lclkby ckbu l cgrj lQnh ;Dr ued d mRiknu dh ,d mUur fof/k d ckj e crk pd g ftldk vrjk"Vh; iVV ¼EP 1928569 B1 fnukd% 16/03/2011½ fey pdk gA ,lk ik;k x;k fd ckbu dh lQkb d ckn Hkh ml dh ljpuk e vrj ugh iMrk g ,o cgrj lQnh ;Dr ued iklr gkrk gA lkQ fd, x, lenh o lclkby ckbu e dfedy v'kfð;k ij ued mRiknu d nkjku iHkkok dk fo'y"k.k fd;k x;kA ,lk n[kk x;k fd lkQ fd, g, lrlr ckbu dh l;ktu e ,Y;fefu;e dh ek=k 6 ihih,e l de gkrh g rFkk bld }kjk cuk, x, ued e ,Y;fefu;e dh ek=k 0.3 ihih,e l de gkrh gA

tfod ;kxt dk ftlle dh foy;rk ij iHkko

,fFky ,lhVV] fXyljky] vkblkikik;y ,Ydkgky] MkbfeFkkby Qkjekekb M] vkDlfyd vEy vkj ikik;y vehu dk ftlle d foy;rk ij 35°C ij tyh; lkfM;e DykjkbM ?kky e tkp dh xbA ,fFky ,lhVV l ftlle foy;rk e FkkMh ofð gb tcfd fXyljky feyu l foy;rk ij doy l{e ifjoru ik;k x;kA vkblkikik;y ,Ydkgky rFkk MkbfeFkkby Qkjeekb M feyku l ftlle dh foy;rk dkQh gn rd de gbA ikik;y vehu vkj vkDlfyd vEy u tyh; lkfM;e DykjkbM ?kky e ftlle foy;rk dk < 0.1% rd fxjk fn;k tkfd lHkor% bu tfod ;kxt d lkFk etcr gkbMktu lc/k gkuk gA vkDlfyd vEy ;Dr tyh; lkfM;e DykjkbM ?kky e ftlle foy;rk ij bu ,fMfVo dk iHkko ugh iMk tkfd n'kkrk g fd foy;rk e ,d gh y; e ofð gbA ?kky dk ?kuRo vkj /ofu ekiu dk Hkh v/;;u fd;k x;k vkj le,UVkfi; lihfM;rk (isentropic compressibility) bu Hkkfrd x.kk d vk/kkj ij iklr fd, x,] ?kky e vk;uk dh ty;ktu fo'k"krkvk dh tkp dh xbA

lkfM;e DykjkbM d fØLVyk dh vkdkfjdh ij dkcfud ;kxt d byDVkfud iHkkok dh tkp l;Dr ç;kxkRed ,oe dEI;Vjhdr v/;;u

i;kxkRed rFkk dEI;Vjhdr nkuk }kjk lkfM;e DykjkbM dh vkdkfjdh ij ;fj;k] Fkk;k&;fj;k] QkekekbM rFkk Fkk;k&QkekekbM d iMuoky iHkkok dk v/;;u fd;k gA vkDlk letkr ;kxt dk lkfM;e DykjkbM d fØLVyk dh vkdkfjdh ij ?ku l v"VQydh; fØLVyk e ifjoru dk Li"V iHkko Fkk tc fd Fkk;k letkr viHkkfor FkA bl fopkj.kh; fHkUurk dk lrgh vkf.odh fLFkj o|frdh foHko (molecular electrostatic potential surface, MESP) rFkk f=&vk;keh vkor lrgh ?kuRo fØ;kRed x.kuk (3D periodic surface density functional calculation) dk ykx dj tkp dh xb gA MESP fo'y"k.k crkrk g fd lkfM;e DykjkbM dh fLFkj o|frd lrg (111) d lkFk] vkDlk rFkk Fkk;k letkrk dh vU;kU; fØ;k d LFkku e fHkUurk FkhA ekMy CBS – QB3 x.kuk u] NaCl d lkFk bu pkj ;kxt dh vU;kU; fØ;kvk d LFkyk d fy, fLFkj o|frdh foHko fo'y"k.k dk leFku fd;k gA

vkor lrg lyXu Lyc ekMy inf'kr djrk g fd Fkk;k letkr] lkfM;e DykjkbM dh (111) lrg l ncy cf/kr jgr g rFkk ty d v.kbl rjg dh lrg ij bl c/ku dh rjQ ifrLi/kk dj ldr gA lkfM;e DykjkbM d fØLVyk d vkdkj ij leku vk.kfod ljpuk rFkk vk;ruoky letkrk dk byDVkfud iHkko dh egÙkk dk tkuu d fy, ;g igyk l0;ofLFkr v/;;u gA (fØLV- bt- dke-] 2010,12, 4168)

D;k ukbVkbykVkb, lhfVd vEy (NTA) l/kkued fØLVyk d fy, ,d vknr vkifjord d :i e dk; dj ldrk g \ dEI;V'kuy vkj i;kxkRed v/;;u l ,d tokc

;g dk; inf'kr djrk g fd NTA, io fjikV d foijhr l/kkued fØLVyk d fy, ,d vknr vkifjord d :i e dk; dj ldrk gA dEI;Vjhdr v/;;u crkrk g fd NTA ,d de lknrk Lrj ij jkd yo.k dh vkdkfjdh dk iHkkfor dj ldrk gA ;g flð fd;k tk pdk g fd lkekU; ?kuh; fØLVyk dh ryuk e bl yo.k d fØLVy ,d vPN eDr iokgh vfHky{k.k j[kr gA ,d U;u Åtkoky NTA d l:i.kh; leko;o rFkk bldh fo;kftr :i] tk l:i.kh; [kkt ikVkdky l ikIr gkr gA ,lk ekuk tkrk g fd o vk.kfod fLFkj o|frdh; foHko jklk;fudh; DokVe l 0;RiUu gkr gA ; leko;o NaCl d egRoi.k ryk ij NTA d vkØe.k gr LFkyk dk p;u djr gA (fØLV- xkFk- fMtk-] 2011, 11, 1675)

vk.kfod xfrdh rFkk DFT x.kukvk dk i;kx e ykdj] ty e KCl l{e fØLVyk d ?kyu dk v/;;u fd;k tk pdk g

vk.kfod xfrdh rFkk DFT x.kukvk dk mi;kx dj] foLrr Lrj ij KCl d l{e fØLVyk dk ty e ?kyu dk v/;;u fd;k tk pdk gA DFT v/;;u crkr g fd KCl $[(KCl)_6 (H_2O)_n$, n=1 – 15] l{e fØLVyk d tkyd l Cl^- vk;u vf/kd iHkkoh :i l bld dkuk dh ryuk e fdukjk l T;knk foLFkkfir gkr gA n= 4 ty v.kvk d lkFk fØLVy tkyd d fdukjk l Cl^- xeu d lkFk ?kyuk ikjHk gkrk gA ;g KCl v.k d vk;u dk iFkDdj.k 6 ty v.kvk d xPNk d lkFk vfriekf.kr gA KCl ?kyu xfrdh d vfHkyk{kf.kd y{k.k t l fd fØLVy d vuØfed :i l vk;u dk gVko] ty ;kftr vk;u rFkk ty v.kvk dh ?kyu dh ifØ;k d nkjku xfrdh; Hkfedk dk vkx fpjlEer vk.kfodh; xfrd fley'ku ft l GROMACS cy {k= d lkFk inf'kr fd;k x;k g] d }kjk v/;;u fd;k x;k gA MD ifj.kke fn[kkr g fd fdukj dh rjQ oky $K^+...Cl^-$ vk;u ;Xe fØLVy lrg (100) l igy ?kyr g rFkk ,d yc le; ieku ij lxr vk;uk e fo;kftr gk tkr gA KCl d 110 rFkk 111 lrg dh fdukjkokyh txgk l vk;uk d iFkDdj.k dk if{kr fd;k x;k gA ,d (100) KCl fØLVy tkyd dk li.k ?kyu bld lxr 110 rFkk 111 lrgk dh ryuk e /khek gkrk gA ,d f=th; forj.k oØ fn[kkr g fd ,d cgLrjh; ty d v.kvk dh ljpuk l{e fØLVy d pkjk rjQ gkrh gA vk;u ;Xe dk fuek.k Flicker Noise LiDVkLdkih dk i;kx e ykdj NaCl dk ikuh e ?kyu d v/;;u dk mPp lgefr d lkFk inf'kr fd;k x;k gA (t- dl;V- dfe- 2010, 31, 2948)

DokVe jlk;u x.kuk }kjk fofHkUu foyk;dk dk vcf/k C – O / Br – Br d lkFk vU;kU; fØ;kvk dk vUo"k.kA

;g v/;;u bl jkt dk mtkxj djrk g fd ckehu v.k dk vcf/kr ;Xek dh rjQ l Qke,YMhgkbM ehFkuky] 1, 4 – MkbvkDlu ,lhVku] MkbefFky bFkj] 1, 3- Mkb vkDlu d Sp^2 o Sp^3 vkDlhtu v.kvk ij fn'kkRed ;kx gkrk gA x.kuh; ifj.kke crkr g fd 1, 4 – MkbvkDlu rFkk ,lhVku d vkDlhtu v.kvk d lkFk vU;kU; fØ;kvk dh rjQ ckehu v.kvk dh fn'kkRedrk dk X – fdj.k fØLVy ljpuk fo'y"k.k l Hkh feyku fd;k x;k gA ;|fi ehFkuky e] ckehu d v.k fØLVyk d cyk }kjk iHkkfor gkr gA 1, 4 – MkbvkDlu dh ryuk e 1, 3 – Mkb vkDlu dh rjQ ckehu v.kvk dh igp] f=foe byDVkfud iHkkok }kjk T;knk iHkkfor gkrh gA nkrk v.k d lkFk ldfyr ckehu v.k d nljh rjQ mifLFkr /kukRed {k= (S – fNn) dh mifLFkfr o ifj.kke inf'kr djr g fd ble lr dk fuek.k gkrk gA t lk fd X – fdj.k fØLVy ljpuk }kjk if{kr fd;k x;k gA (fØLV-bUt- dke-2012, 14, 1833)

D;k ,dy ;kxt d lkFk jkd yo.k fØLVyk dh }r vkdkfjdh lHko g] tokc g gk] ckfcV;fjd vEy d lkFk

ckfcV;fjd vEy dk jkd yo.k fØLVyk d fy, ,d u; vknr vkifjord d :i e fn[kk;k x;k g ;g io e Xykbflu d fy; Hkh fn[kk; vulkj] ;g jkd yo.k fØLVyk dk }r vkdkfjdh inku djrk gA dEl;Vjhdr v/;;u inf'kr djrk g fd fuEu pH ij ckfcV;fjd vEy l fo"keyck{k }kn'kQydh; fØLVyk dh yfC/k iklr dj ldr g rFkk pH c<ku ij ;g v"BQydh; fØLVy T;kfefr dk oj.k djrk gA ;g v/;;u i;kxkRed v/;;u }kjk Hkh iekf.kr fd;k x;k gA Xykbflu d fy, tgk bldh mPp lknrk dh vko';drk iMrh g ogh ckfcV;fjd vEy fo"keyck{k }kn'kQyfd; NaCl fØLVy d lkFk ek= 0.08 – 0.2 Hkkj@ vk;ru lknrk ij Hkh iHkkoh gA rFkk bl otg l bl i;kxkRed vui;kxk gr mi;kx e yk;k tk ldrk gA ,d lfEefyr dEl;Vjhdr in'ku dh igp rFkk ckn e i;kxkRed iek.k l u, ;kxtk dk l'kyf"kr dju e i;kx e yk;k tk ldrk gA (,UX;- de- 2012, 124, 11441)

ckbu @ fcVu l eY;oku l{e rRok (Li o Sr) dh iuh ikflr ij 'kk/k

ckbu d ?kuRo e ofð d lkFk fyfFk;e lknrk e Hkh 38°Be' rd ofð gb A ;g vf/kdre 10 ihih,e ij gb gA tk len&ty dh lknrk dh 50 xuk FkhA LVkfU'k;e e 25°Be' rd ofð gb rFkk mld ckn lknrk de gk xbA ;g lYQV dh lknrk d c<u rFkk de ?kyu'khy $SrSO_4$ d vo{ki.k l gk ldrk gA

,lk gkuk ,d io fo'y"k.k d leku ik;k x;k tgk lclkby ¼mienk½ ckbu e] Sr dh ek=k] ftle dfY'k;e dh ryuk e lYQV dh ek=k de Fkh] mPp ikb x;hA uoy Li rFkk Sr p;fur fyxM dk l'yÔ.k dk; tkjh j[kk x;kA

DyFkjV ;kfxd VVk–2–0 u¶FkkbM dkcfud foyk;d e Li l c/ku djr ik;k x;k] yfdu tyh; ek/;e l viVd de FkkA

nfor yo.kk ¼vk;fud nok½ ij v/;;u

budh vf}rh; Hkkfrd jklk;fud o dYiukdkjh vfHkyk{kf.kd x.kk d dkj.k] fofHkUu ek/;ek e vk;fud nok ij vul/kku fd, x, gA bud lHkkfor vui;kxk l mtkxj fd;k x;k g&

1. vk;fud nok d feJ.k ftle 1 – C;fVy – 3 – efFky bfeMk tkfy;e vkfDVy lYQV o 3 – efFky – 1 – vkfDVy bfeMk tkfy;e Dykjkb M ie[k g d x.kk dk ty e v/;;u fd;k x;k gA

fe'ky & ofldy & fe'ky :ikrj.k ifØ;k dk Hkh if{kr fd;k x;k gA budh lrgh lfØ;rk] ikoLFkk 0;ogkj rFkk foy;u ljpuk dk pkydrkfefr] rukofefr (Tensionmetry), ¶ykjkfefr] xfrd idk'k idh.ku (DLS), ';kurkfefr] vkfoyrkfefr (Turbidometry), ijekf.ko; cy ekbØkLdkih (AFM) ikjxfer byDVku ekbØkLdkih (TEM) o H^1NMR vkfn rdfufd;k }kjk vfHky{ku fd;k x;k gA ofldy rFkk fe'ky foy;uk e idkf'kd

vip;u }kjk vfHky{ku fd;k x;k gA ofldy rFkk fe'ky foy;uk e idkf'kd vip;u }kjk LFkk;h Lo.k vfrl{e ¼uuk d.kk½ rFkk l{e ieku ij uuk ijr dk fofHkUu vkdkjk rFkk ifj.kkek e ikIr fd;k x;k gA (yXej, 2011, 27, 9261)

2. to cgydk d tyh; foy;u e vk;fud nok d iHkkok d fujrj vUo"k.k d nkjku] geu v/;;u fd;k fd xkykdkj ikVhu ckfou lhje ,Ycfeu (BSA) e ljpukRed ifjoru] budk 3 – efFky – 1 – vkfDVy bfeMk tkfy;e DykjkbM o 1 – C;fVy – 3 – efFky bfeMk tkfy;e vkfDVy lYQV d lkFk vr%fØ;k d ifj.kker% gkrk gA ;g vrfØ;k ok;@foy;u vr%i"B ¼vr% Qyd½ d lkFk lkFk li.k fudk; e vk;fud no dh fofHkUu lknrkvk ij Hkh Kkr dh xb gA ory Mk;Økble ekiu d lkFk lyXu fLFkj voLFkk ¶yvkjkll LiDVkLdkih }kjk vk;fud no d c/ku d ifj.kker% BSA d vdMyu dh tkudkjh ikIr dh xb gA cg rduhdh nf"Vdk.k l ikIr li.k ifj.kkek }kjk vk;fud no fofHkUu lknrkvk e BSA rFkk IL d e/; vU;kU; fØ;k dh fØ;kfof/k flð iod iLrkfor dh xb gA (t-fQt-de-B, 2012, DOI: 10.1021/jp303609h)

3. vehuk vEy ij vk/kkfjr vk;fud no lrgh lfØ;d dk l'yf"kr fd;k x;k gA lkekU; ifjoru d iHkkok d ldru ;k v/;;u gr L – Xykbyhu, L- ,ykuhu, L – oyhu, L – XyVkfed vEy rFkk L – ikyhu dk p;u fd;k x;k gA xyukd e deh rFkk to fuEuhdj.k dh lkFkdrk d fy, vehuk vEy e ,LVj leg dk lekof'kr fd;k x;k gA bl gr vehuk vEyk dk ,LVjhdju] ;k rk vkblkikfiy ;k vkblkC;fVy ,Ydkgky }kjk fd;k tkrk gA vehuk vEy ,LVj gkbMkDykjkbM rFkk SLS ¼lkfM;e ykfjy lYQV½ dk leku ek=k e ydj xe ikuh e ?kky fn;k tkrk gA vfHkfØ;k d i.k gk tku d ckn mifLFkr ty dk fuokr d vrxr fu"dkflr dj fn;k tkrk g rFkk AAILS ¼vehuk vEy ykfjy lYQV½ dk Mkb Dykjk ehFku e feykdj foyk;d fu"d"k.k }kjk fu"df"kr fd;k tkrk gA fofHkUu fo'y"k.kRed rduhfd;k }kjk AAILS dh ljpuk dk flð fd;k x;k gA vodfyr Ldfux o.kfefr }kjk $GluC_4Ls$ dk NkMdj lHkh AAILS d xyukd 30°C l uhp if{kr fd, x,A AAILS d lrgh x.kk d v/;;u }kjk Kkr fd;k x;k fd bldh lrg lfØ;rk] bld letkr vk;fud nok rFkk ikjifjd lrgh lfØ; dh ryuk e mPp dkfV dh gkrh gA ¼t-fQt-dfe- 8, 2011, 115, 13847½

mi;Dr d lkFk] ifrfuf/kRo AAILS d vui;kxk dh rjQ % (1) gkfudkjd 'koky Cye dk mUeyu rFkk (2) rduhdh; egRoi.k uuk ljpukoky n0;k tl fd CeO_2 d fu;f=r l'y"k.k ij vk/kkfjr 'kk/kdk; çdkf'kr fd;k x;kA ¼dellde 2011, 4,604) bl dk; dh >yd dk mYy[k upj bfM;k e Hkh fn[kkA

vdkcfud inkFk ,oe mRçj.k

inkFk

fuEuLrjh; dPN ckDlkbV l ft;kykbV&A ç{kkyu l td dk fodkl

dPN] xtjkr d fofHkUu [kfutk e fLFkr fuEu Lrjh; ckDlkbV ¼yEil½ jfedk feujy fjlkfll] vgenckn u çnku fd;k FkkA vf/kdre ,Y;feuk dk fudkyu d fy, p.k ckDlkbV }kjk] n'kkvk dk mPp fd;k x;kA bl çdkj çkIr lkfM;e ,Y;feuV foy;u l] ft;kykbV&A ç{kkyu l td] 30 fd-xk- çfr cp] cuk;k x;kA bl mRikn d x.k/ke] of'od mRikn d rY; ik; x;A yxHkx 15 fdxk ft;kykbV&A] ç;kx djuokyh ikVh dk fn;k x;kA 10,000 rFkk 50,000 Vhih, Lrjh; lkfM;e flfydV d vkrfjd mRiknu {kerk ij] fyxukbV b/ku d rkj ij ç;kx djd bl ifj;ktuk dk vkfFkd fo'yÔ.k fd;k x;kA ell ØhMk feujy bUMLVht fyfeVM] vgenckn dk fØ;kfof/k dh tkudkjh nh xb vkj th,eMhlh d lkFk m|e dh çk|kfxdh d 0;kolk;hdj.k d fy, ikVh çfo"V gbA

lhxkdkj dkcu uuk uyh cuku d fy, Dykfju jfgr iFk vkj bld CO_2, CH_4, CO vkj N_2 d fy, vf/k'kkÔ.k x.k/ke

VVk Dykjk bfFkyhu dkcu lkr d #i e] /kkfRod dkij vipk;d d #i e ç;Dr djd Dykfju jfgr fof/k }kjk lhxkdkj dkcu uuk ufy;k] lkE; n'kkvk e lQyrkiod cuk;h x;hA mRikn çkflr rFkk vkdkfjdh ij fofHkUu vfHkfØ;k ifjpkfydk d çHkko d v/;;u }kjk vfHkfØ;k dh n'kk; b"Vre dh x;hA bu lhxkdkj dkcu uuk ufy;k l irk pyk fd ; uuk ufy;k N_2 dh vi{kk CO_2 vkj CO d fy, mPp xg.k {kerk rFkk lkE; p;urk j[krh gA bUg foy;u rFkk xlk dh iu% çkflr d fy, u; vf/k'kkÔd inkFk d #i e ç;kx fd;k tk ldrk gA ¼tujy vkQ gtkjMl eVhfj;yl 2012, 227-228, 317-326½

fuEu Lrj puk iRFkj vkj ty pu l vo{kfir dyf'k;e dkckuV (PCC) vkj lfØ; dyf'k;e dkckuV (ACC) cukuk

fuEu Lrj puk iRFkj vkj tyk puk Øe'k% ell Jh d"uk bMLVht] ecb vkj ell vk'khokn ehujYl] ykdkij ¼dukVd½ l] PCC vkj ACC d cuku d lHkk0;rk v/;;u d fy,] fy; x;A bu puk d jklk;fud l;ktu dk fo'yÔ.k fd;k x;k vkj ik;k x;k fd bue ijijkxr pu dh ryuk e miyC/k puk de vkj v?kyu'khy vEy vf/kd gA dyf'k;e vkDlkbM d vf/kdre ifjoru d fy, lrkiu rki dk mPpre fd;k x;kA yxHkx ikp fdyk PCC vkj ACC cuk;k x;k vkj ikVh dk fujh{k.k d fy, fn;k x;kA bu ueuk d Hkkfrd jklk;fud x.k bl fof'k"Vrkvk d rY; ik; x;A

yxHkx ,dy folkfjr /kkr vkDlkbM uuk d.kk dk ty e l'yÔ.k

uuk ljpukRed inkFkk dh eki] vkdkj rFkk fn'kk vk/kkfjr çdk'kh;] fo|r] pEcdh;] mRçj.k o ;kf=d x.k vPNh rjg l ekye gA eki vkj vkdkj d fu;=.k d fy, bud cuku dh u;h fof/k;k dh 'kk/k ,d egRoi.k foÔ; gA ol rk bl dk; d fy, db vknd lgk;d rjhd fjikV fd; x; g yfdu eki vkj vkdkj d fu;r fu;=.k çklr dju d fy, vknd lgk;d bu vtyh; rjhdk e] foÔy vkj egx /kkr dkcfud ;kfxd ;k /kkr vknd ldy ioxkeh d #i e] vkj mPp rki ç;Dr fd;k tkrk gA bld dkj.k bldk vk|kfxd mi;kx ck/kd gk tkrk gA blfy, ,d ,l i;koj.k lxr rjhd dk fodkl <<uk t#jh g] ftle foÔy jlk;u vkj foyk;d dk ç;kx u gkA bld fy, Å"ek tyh; n'kkvk e] tyh; /kkr vekfu;e dkckuV ldy foy;u ioxkeh d #i e rktk cuk;k x;k vkj ikuh dk foy;u d #i e ç;Dr fd;k x;kA bld fy, uoy o lk/kkj.k rjhd dk fodkl uuk ljpuk d fu;r ekiu o vkdkj d fofHkUu /kkr vkDlkbM dk cuku e fd;k x;kA ty Å"eh; mipkj le;] rki vkj ioxkeh dh lknrk dk cnyu l eki vkj vkdkj ij fu;=.k ik;k x;kA ¼U; t- de 2011, 35, 1460-1465½

ij&vkDlk VkbVfu;e dkckuV ldy foy;u }kjk d{k rki ij] çkVkuVM iroky VkbVuV pnnjk dk l'yÔ.k

ir oky VkbVuV] viu ljpukRed rFkk Hkkfrd jlk;u vnHkr x.k/kek d dkj.k] vk;u fofue;] vf/k'kkÔ.k] çdk'k byDVkfud vkj mRçj.k d fy, egRoi.k x.k fn[kkr gA budk Li-cVjh] mRçj.k] lond] cDVhfj;k fojk/kh yiu vkj vkbfud vf/k'kkÔdk d fy, vk'kktud inkFk ekuk tkrk gA ijEijkxr #i l] {kkjh; /kkr ir VkbVuV dk ty Å"eh; n'kkvk e VkbVfu;e ioorh VkbVfu;e dk lkn NaOH e ydj vFkok mPp rki ij VkbVfu;e ioorh vkj Na_2CO_3 d feJ.k dk lrkfir djd cuk;k tkrk gA bld l'yÔ.k d fy, ,d uoy d{k rki fof/k fodflr dh xb gftle $[H_2Ti_2O_3H_2O]$ 96 eh²@xk fof'k"V lrg {k= d lkFk cuk;k x;kA bl fof/k e dkcfud v.kvk dk ç;kx ugh fd;k x;k vkj ml dh txg ,d vnHkr ty&?kyu'khy ij vkDlkVkbVuV ldy dk ,d ioorh d #i e ç;Dr fd;k x;kA l'yÔ.k dh lHkkfor fØ;kfof/k dk Hkh irk fd;k x;kA bl çdkj l'yfÔr VkbVuV l Pb^{2+} vkj feFkhfyu Cy dk fudkyu dh mRd"V {kerk ik;h x;hA ¼de dke] 2011, 47, 7731-7733½

ZnS DokVe rkjk dk l;kt Lykbl vkdkj e cuuk

ZnS d QkVk rFkk byDVk ped x.kk d dkj.k 0;kid v/;;u g, g vkj bl fofHkUu çdk'k byDVkfud midj.kk e ç;kx fd;k x;k gA ijk&ldfpr ZnS DokUVe rkj ~1.5 uuk ehVj pkMkb vkj oVtkbV ljpuk d lkFk cuku dh ,d uoy fof/k fodflr dh x;hA tyh; ftd vekfu;e dkckuV ldy foy;u] tyh; ikVf'k;e bFkhy tuFkV (XA) vkj Mdkukbd foy;u dk ydj ,d ljy ty Å"eh; fof/k }kjk l'yÔ.k fd;k x;kA W-ZnS d xky d.kk l rkj cuk; x; ftudh dk;fof/k e tMkok dk vudyu FkkA ; rkj Lo; ,df=r gkdj >dko d lkFk l;kt d Lykbl d vkdkj e cuA l'yÔ.k dh lHkkfor fØ;kfof/k dk Hkh irk fd;k x;kA ¼de dke] 2012, 48, 850-852½

CoAl-LDH d dkey jklk;f.kd fo?kVu l Co_3O_4 l{e ?ku

f}irh gkbMkDlkbM (LDH) mRçjd] iryh fQYe] uuk l?kVd] vk;u fofue; rFkk vkÔf/k lokgu d fy, lofofnr inkFk gA ,d vlk/kkj.k dkckYV dkckuV] CoAl-LDH d ,dy ioorh dk ydj ty Å"eh; fof/k }kjk cuk;k x;kA CoAl-LDH, eVy ukbVVl d ;fj;k d ty fo?kVu l çkIr fd;k x;kA fu;f=r vEy&{kkj mipkj dh uoy fof/k l mi fØLVfyr Al Qt dk vyx fd;k x;kA çkIr Co_3O_4 dh ljpuk vuk[kh ijrokyh Fkh ftl vkx ekbØk ?ku d vkdkj e fd;k x;kA bl dkckuV d lrkiu l Likbuy Co_3O_4 cuk ftle vlk/kkj.k mPp fo|r pkydrk çkIr gbA ¼Hk tk x;kA½

ikyhej efVDl e ;FkkLFkku uuk ljpukoky dkij dk l'yÔ.k

uuk fØLVy d x.k] mud eki] vkdkj rFkk lxBu l dkQh çHkkfor gkr gA /kkr uuk ljpuk dk l'yÔ.k vf/kdrj dkyk;My iFk ij vk/kkfjr gkrk g vkj eki rFkk vkdkj dk fu;=.k cg/kk dfix lnL; d puko ij fuHkj gkrk gA ,fulkVkfid okrkoj.k] tl fd iryh Bkl ikyhej fQYe [kn ikyhej d vipk;d rFkk LVfcykbftx lnL; d #i e ç;kx djd] geu bud vnj dkij d uuk fØLVyk d fodkl ij v/;;u fd;k gA ,lh fQYe mRçj.k] lond rFkk uuk diflVj e ç;kx dju d fy, midj.k cuku e mi;kxh gk ldrh gA

/kkr dkcfud <kpk

l;ktd ikyhejk d fMtkbu] l'yÔ.k vkj pfj=k dk egRo c<rk tk jgk g D;kfd bldk ç;kx xl vkj vU; v.kvk d HkMkjk d fy, pLr /kkrvk d #i e l{ke gA lLFkku bl {k= e dN le; l dk; dj jgk g vkj ,l /kkrvk dk fodflr dju d lrr ç;kl Hkkx Lo#i vud /kkr Cu(II) d /kkr dkcfud <kp cuk; x; vkj mudh ljpuk dk pfj=.k fd;k x;kA ble vehuk ,flM dk fyxM d #i e rFkk 4, 4'-ckbfifjMhu dh lr bdkb;k] $\{[Cu\text{-}(L\text{-}fllfV;V)(1,4\text{-}Bix)(H_2O)]\ H_2O\}_n$, $\{[Cu(L\text{-},likjVV)(1,4\text{-}Bix)_{0.5}].3H_2O\}_n$ (tgk *1,4-Bix = 1,4-bis* (behMtky *-1-yl* ehFkkby cthu) rFkk $\{[Cu(L\text{-},likjVV)(4,4'\text{-}Bpy)_{0.5}].H_2O\}_n$ dk ç;Dr fd;k x;kA fØLVy vkdMk d fo'yÔ.k l bu l;ktu ikyhejk dh 1-D, 2-D rFkk 3-D dMfyr ljpuk dk irk pykA bu ldyk d dk;jy çofr dk Bkl voLFkk lh Mh LiDVk rFkk rki fuHkj pcdh; x.k/kek }kjk fu/kkfjr fd;k x;kA ¼fØLV- xkFk- fMt-] 11(2011), 1631½

Å"eh; rFkk ty Å"eh; fLFkjrk of) d lkFk cM ieku ij MCM-41 dk l'yÔ.k

MCM-41 leku ÔVdk.kh; cyukdkj ~2-3 uukehVj 0;kl d fNnk l cu g, l0;ofLFkr ehlklj?kh inkFk g vkj budk lrgh {k= 700 l 1000 eh² @ xk dh lhek e gkrk gA ;g inkFk] /kukRed vknd CTAB dh ljpuk fun'kd lnL; d #i e ç;kx djd] ~ 100 l rkieku ij ty Å"eh; n'kkvk e dkQh le; ¼fnuk e½ rd j[kdj cuk;k tkrk gA bl inkFk dh lcl cMh deh] bldh {kh.k Å"eh; rFkk ty Å"eh; fLFkjrk gA bld fy, rhu fdxk cp Lrj ij] MCM-41 d çdkj d ehlk&lj?kh flfydk dk Å"eh; vkj ty Å"eh; fLFkjrk dh of) d lkFk] cuku dh fof/k fodflr dh x;hA

fu;f=r vkÔf/k ekpu

MCM-41 vkj vehukdkjh MCM-41 l buMkeFkklhu dk ekpu

buMkeFkklhu] fLVjk;My jfgr] tyu fojk/kh vkÔf/k] dk MCM-41 rFkk vehukdkjh MCM-41 l fu;f=r ekpu dk v/;;u fd;k x;kA MCM-41 l xfLVd pH ij 10 ?kV e 26% buMkeFkklhu ekfpr gb tcfd vk= pH ij 48% ekpu gvkA vehukdkjh MCM-41 l vk= pH ij 10 ?kV e 12% ekpu gvkA

fpVklu ekVekjhykukbV to uuk l?kVd l fu;f=r Dohfuu ekpu

vk;u fofue; }kjk cuk; x; J.khc) ekV ekVekjhykukbV vrHkfjr fpVklu uuk l?kVdk ij eyfj;k fojk/kh vkÔ/k] Dohuhu] yknh x;hA bUg ftyfVu dllye Hkjk x;k vkj mld ckn ;MjkfxV® L100 dk yi fd;k x;kA bl çdkj çkIr dllyk dk bu foVk vkÔf?k ekpu dk;liknu dk ijh{k.k cQj okrkoj.k e 37±5° l ij fd;k x;kA xfLVd no ij dkb ekpu ugh n[kk x;k tcfd vk= pH ij ekpu fn[kk vkj ;g Hkh ik;k x;k fd fpVklu vrHkkfjr enk e ekpu 'k) enk dh ryuk e rt FkkA bl fof/k e nk fofHkUu ekpu fof/k;k lfØ; g & igyh ;MjkfxV® L100 d yiu dh otg l rFkk nljh enk d dkj.k lA ¼t- ikyh- lk- ikV A ikyh de- 50 : 423-130, 2012½

lrgh vdkcfud uuk l?kVd % 5&¶ykjk;jkfly (5-Fu) d fy, gkugkj okgd

to ikyhej fpVklu (CS) dh lgk;rk l] 5-Fu dlj fojk/kh vkÔ/k d Na^+ enk ¼ek MMT½ dh vrlrgh xyjh e vrHkj.k d fy; v/;;u fd;k x;k bu&foVk vkÔf/k ekpu u fu;f=r iVu fn[kk;kA vkÔf/k d thukfoÔyiu d çHkko dk bu&foVk eY;kdu] ekuo fyEQklkbV dkf'kdk d dkeV ,l dYpj fof/k] l fd;k x;k ftll irk pyk fd enk vrHkfjr vkÔf/k l DNA dh {kfr dkQh de jghA bu&foVk vkÔf/k xfr] to forj.k] fgiVk&foÔkDr ekjdj ¼t l SGPT rFkk SGOT½ vkj yhoj VLVhD;yj fgLVkykuh pgk d lkFk tk ik;h x;h mle lykTek@Ård vkÔ/k Lrj ey vkÔ/k d edkcy] FkhjkI;fVd foMk d vrxr gh jgkA ;g dk; ohj uen lkmFk xtjkr ;fuoflVh d lg;kx e fd;k x;kA ¼;jkfi;u t- vkQ QkjekL;fVDl vkj ck;kQkjekL;fVDl 81 (2012) 91-101½

dlj fojk/kh vkÔf/k rFkk fu;f=r ekpu x.k d fy, ekUVekjhykukbV@cg ¼ε&dijkyDVku½ l?kVd

Na^+-MMT ¼ekUVekjhykukbV]Tmx–MMT½ d vrlrgh xyjh e VekfDlQhu dk vrHkfjr djd cg ¼ε&dijkyDVku½ (PCL) (Tmx–MMT/PCL,MPs) d lkFk l;ktu djd bldk v/;;u Lru dlj d ekfyd dhekFkjih d fy, fd;k x;kA bu&foVk vkÔ/k ekpu l fu;f=r ekpu iVu fn[kkA cu Tmx d pgk e bu&foVk vkÔ/k xfr u ;g fn[kk;k fd lykTek Tmx dk Lrj çhLVkbu Tmx d edkcy] fpfdRldh; foMk d vnj jgkA ;g v/;;u ohj&uen lkmFk xtjkr ;fuoflVh d lg;kxu e gvkA ¼;jkfi;u t- vkQ QkjekL;fVDl lkbl 47 (2012) 265-272½

tfod vkj vk|kfxd #i l egRoi.k vk;uk vkj v.kvk d fy, vk.kfod llj

vk.kfod lljk dk fodkl] ,d fojk/k /kkr vk;u d d'ky irk yxku d fy,] jlk;u 'kkL= e ,d mHkjrk {k= g D;kfd ,lh fof'k"Vrk fofHkUu jklk;fud] tfod vkj i;koj.kh; çfØ;kvk e egRoi.k gA lLFkku fjlp d bl {k= e lfØ; #i l 'kkfey g vkj fiNy dN oÔk d nkjku dkQh ;kxnku fn;k gA leh{kk/khu vof/k d nkjku fd; x; dk;k dh e[; fo'kÔrk, l{ki e uhp of.kr g%

,Vhih d fy, llj

;g crk;k x;k g fd vklkuh l l'yfÔr Zn(II) vfHkded] çkdfj;kfVd vkj ;dfj;kfVd dkf'kdkvk d fy,] ATP tk dkf'kdk d fodkl dh çfØ;k d nkjku *in situ* ¼Lo&LFkku½ mRikfnr gkrk g] l çfrorh c/ku d }kjk 0;ogk; vfHkjtudrk d #i e ç;kx fd;k tk ldrk gA ;g eyd foÔkDr ugh g ftll bldk v/;;u 'k) tyh; ;k tyh; HEPES cQj (pH = 7.2) ek/;e e fd;k tk ldkA ¼de- dke- 46 (2010) 9134½

yUFkukbM çfrnhIr l l j

fQuuFkkfyu vk/kkfjr ÔVnrh; fyxM vkj mud dk;jyVh fufgr yUFkkukbV l dy cuk; x;A bu l dyk u d{k rki ij yky mRl tu fn[kk;k vkj budk ATP _.kk;uk vkj QkLQV d p;fur c/ku d fy, ç;Dr fd;k x;kA ¼de- ,- ;jk- t-çl e½

Nd^{3+} d fy, l l j

Mk;tk leg fjikVjdk;h oky cuk; x; u; vk.kfod xkgh (L_1) }kjk] Nd^{3+} dh çfrorh igpku ,d n"çk; mnkgj.k t lh ik;h x;hA v/;;u l irk pyk fd ;g xkgh $[Nd^{3+}]_2L_1$, l dy cukrk g ft le igy $[Nd^{3+}]L_1$ ek/;fed l dy curk gA lHkh vU; yUFkukbM vk;uk dh çpjrk e p;fur $[Nd^{3+}]_2L_1$ cuuk] jx e ifjoru iku dk dkj.k gA ¼buvkjx- de- 49 (2010) 6909½

Hg^{2+} d fy, l l j

Mk;tk ek;Vh dk fjikVj dkjh t l ç;Dr djd ,d u;k 1,4,8,11&VVk, tklkbDykVVkMhdu (L) 0;RiUu cuk;k x;k ft le Hg^{2+} d lkFk fo'kÔ c/ku jgk tk jx ifjoru l lc) jgk rFkk vk[kk l n[kk tk ldkA xke&fuxfVo cDVhjh;e L;Vkekul l;fVMk d thfor dkf'kdkvk }kjk L d vfoÔkDr i)fr dk ijh{k.k fd;k x;kA iu½ ç;kxk u fn[kk;k fd ; eyd ekbØkvkxfuTe e fLFkr Hg^{2+} d irk dju d fy; vfHkj td lnL; d #i e ç;kx fd; tk ldr gA ¼buvkjx- dfe- 49 (2010) 11485½

, thu vk/kkfjr xkgh u Hg^{2+} vk;u d fy, t yh; ek/;e e vU; /kkr vk;uk dh ryuk e egRoi.k fo'kÔrk fn[kk;hA xkgh d Hg^{2+} d l;k tu u irk dju yk;d jx e ifjoru fn[kk;k vkj m l dk çfrnhIr çfrHkko fn[kkA bihfFkfy;y dkf'kdk ykbu KB 31 dkf'kdkvk e bl eyd dk ç;kx Hg^{2+} vk;uk d bDVB gku d çfrfcc d fy, fd;k x;kA ¼vkjx- yVj- 12 (2010) 5406½

CN^- d fy, l l j

nk behM tky vk/kkfjr xkgh ¼A rFkk B½ dk ç;kx djd lkfM;e lk;ukbM foy;u e CN^- vk;u dh fof'k"V igpku ik;h x;hA fn[k tku oky jx ifjoru gkbMk tu cf/kr ,MDV A·CN^- rFkk B·CN^- d cuu l lcf/kr FkA xkgh A dk CN^- l cf/kr dju ij j';kefVd çfrnhIr çfrHkko feyk vkj ;g eyd 1.42 µM CN^- lk;ukbM foy;u d cDVhfj;y dkf'kdkvk dk io&çdk'kh çfrfccr dju e ç;kx fd;k x;kA ¼vkjx- yVj- 12 (2010) 3406½

t yh; ek/;e e F^- d fy, l l j

vdkcfud F^- dh ikuh e vR;r l{e mifLFkfr dh igpku d fy, ,d u;k eyd cuk;k x;kA ¶ykjkbM dh bl eyd d lkFk igpku dh lonu'khyrk] ihu d ikuh] WHO }kjk Lohdfr Lrj l de ik;h x;hA ¼de- dke- 47 (2011) 11074½

foÔkDr vkj lØe.k /kkr vk;uk d fy, l l j

dfyDl[4] ,jhu 0;RiUuk d fofHkUu ljpukvk dk vk;ukQkj t lk rFkk ikbjhu ek;Vh dk ¶ykjkykj t lk ç;Dr djd J.khc) çnhIr vk.kfod l l j cuk; x;A 0;kid ijkl d /kuvk;uk vkj _.kk;uk d vk;u c/ku x.kk ij 'kk/k fd;k x;kA , lhVkukbVk;y DykjkQke e bul Hg^{2+}, Pb^{2+}, Cu^{2+} vkj Ni^{2+} l l dy cu tcfd THF-H_2O e doy Cu^{2+} l gh p;fur l dyu gk l dkA _.kk;uk e doy F^- u gh vrfØ;u fn[kk;k ft le vklkuh l jx ifjoru n[kk tk ldkA ¼buvkjx- de- ,DVk- 372 (2011) 126½

,d vU; J.kh dk dfyDl[4] ,jhu vk/kkfjr çnhIr jklk;fud l l j] ,ekbM c/ku lkbV vkj D;ukyhu ¶ykjk t fod çnhIr tud bdkb d lkFk] cuk;k x;kA bud vk;fud c/ku l irk pyk fd budk Hg^{2+}, Pb^{2+}, Fe^{3+}, Cu^{2+} vkj F^- d lkFk e tcr l dyu jgkA /kkr vk;u d l dyu u bDlhej ,eh'ku dk fodflr fd;k ft l dk J; /kkr vk;uk d l dyu ij vx vk.kfod vkjfcVy Åtkvk d ifjoru dk fn;k x;kA ¼U;- t-

de- 36 (2012) 988½

Ru(II)-ckbfijhMu ek;Vh dk çdk'ktud bdkb rFkk NS_2O_3 nuoky ijek.k oky N% lnL; eØkpØh; ek;Vh dk vk;ukQkj d #i e ç;kx djd J.khc) u; pedhy /kkr xkgh cuk; x;A bu J.khc) xkfg;k u Hkkjh /kkr vk;uk t l fd Hg^{2+} rFkk Pb^{2+} d lkFk etcr ldyu fn[kk; rFkk dN ekeyk e lØe.k /kkrvk t l fd Cu^{2+} rFkk Fe^{3+} d lkFk Hkh ldyu fn[kk;A bl çdkj cu ldyk d c/ku fLFkjkd (K_s) vkj l?kVu dk fu/kkj.k beh'ku vkj ^{1}H NMR vk;ru ekih vkdMk }kjk fd;k x;kA ¼ikyhgMu 43 (2012) 104½

,ydyh /kkr vk;uk d fy, llj

ØkmUl-4, ØkmUl-5 rFkk Ökmu-6 ek;Vh oky dfyDl ckmu ldj v.kvk d ifjokj dk vk;ukQkj d #i e l'yfÔr fd;k x;k rFkk fofHkUu ,ydyh vkj ,ydyh enk /kkr vk;uk d tyh; ek/;e e bud ryukRed ldyu rFkk vyxu {kerk dk eY;kdu fd;k x;kA bue l nk vk;ukQkjk u Na^+ rFkk K^+ d fy, mPp p;urk fn[kk;hA ifj.kkeh ldyk dh vk.kfod ljpuk rFkk mud c/ku fLFkjkd (K_a) dk fu/kkj.k Na^+ vkj K^+ d fy, fd;k x;kA ¼buvkjx- de- dke- 22 (2012) 85½

Pb (II) dk fo|r jklk;fud lonu vkj midj.k ueu dk fodkl

_.kkRed fLVfix okYVkfefr }kjk Pb (II) vk;u dh fo|r jklk;fud igpku dh x;hA Øfed ru fof/k l yM d mM tyh; foy;u l ueu r;kj fd; x;A bld ckn 0.1mM ejdjh yo.k feyk;k x;kA foy;u dk pH 4 j[kk x;kA

LoPN Lo.k byDVkM dk dk;h byDVkM] lyfVue dk lkFk dk byDVkM vkj Hg/Hg_2Cl_2 dk lnHk byDVkM t lk j[kdj] vip;u d nkjku bu rhuk ijijkxr byDVkMk d fo|r jklk;fud lVvi e] dk;h byDVkM ij 5 feuV d fy, -900 mV dk foHko yxk;k x;kA /kkjk d lki{k lknrk dk v'kkdu oØ 180 ldM ij cuk;k x;kA vip;u in nkgjku rFkk iumRiknu d ;kX; jgk vkj Pb dh ey lknrk l vPNh rjg çk#i dk fodkl yM d fo'yÔ.k d fy, çxfr e gA folj.k fu;f=r fof/k l] logu }kjk vip;u T;knk Pb^{2+} d vip;u l fu;f=r jgk ft l l vkdM dh ifj'k) rk T;knk gb rFkk fo'yÔ.k dh ek=k Hkh de jghA

vf/k'kkÔ.k

feFku HkMkj.k inkFk d #i e iVdkd 0;fRir dkcu

,d fd-xk- lfØ; dkcu cuku d fy, dPpk iVdkd fy;k x;k ft le lfØ; dkcu dk lrg {k= >2900 eh²@xk vkj feFku xg.k 30° l@35 ckj ij 200 lh-lh-@xk FkkA enk vkj lh,elh@LVkp dk c/kd t lk ç;Dr djd vkdkjoky inkFk t l fd cfgo/kh] [kfM;k] nku] fVfd;k vkj xkfy;k cuk;h x;hA [kfM;k vkdkjoky vf/k'kkÔd l 145 lhlh@xk feFku dk vf/kxg.k 0.51 xk@lh-lh- ifdx ?kuRo d lkFk feykA ukbVk tu okrkoj.k e 700° l ij iVdkd 0;fRir AC dk ck"ih; lfØ;.k feFku dk vf/kxg.k 35 ckj nkc ij 196 lh-lh-@xk gkdj ykHknk;h fl) gvk vkj lkFk gh vf/k'kkÔd vf/kd xfBr Hkh gk x;kA

feFku HkMkj.k inkFk d #i e beyh&cht dk dkcu (TSC)

KOH l jklk;fud lfØ;.k }kjk beyh d cht l dfÔ mi&mRikn lfØ; dkcu cuk;k x;kA 1 leh³@xk- mPp l{e fNn vk;ru okyk TSC, 1673eh²@xk lrg {k= d lkFk çklr fd;k x;kA feFku vf/k'kkÔ.k dh mPpre {kerk TSC d fy, 30° l vkj ,d ckj nkc ij 32.8 lh-lh-@xk rFkk 35 ckj ij 180 lh-lh-@xk feyhA ¼ck;k fjlkl] 2011, 6(1), 537-551½

dkcu MOF l?kVd [AC@CuBTC] }kjk of/kr feFku vf/kxg.k

Cu_3 (BTC)$_2$ d l'yÔ.k e Lo&LFkku lfØ; dkcu }kjk bldk l?kfVr MOF inkFk cuk;k x;kA 2% AC }kjk cuk; x; inkFk dk lrg {k= 1660eh²@xk] HK l{e fNn vk;ru 0.68 leh³@xk rFkk HK vklr fNn pkMkb 12.27Å FkkA bl l feFku vf/kxg.k 35 ckj nkc rFkk 30° l ij 165 leh³@xk FkkA ¼iVUV Qkby fd;k x;kA½

,Y;fefu;e VjFkyV [MIL-53 (Al)] ij 'kkÔ.k v/;;u

ty Å"eh; fof/k l l'yfÔr vkj foyk;d fu"dfÔr 'k)] ,Y;fefu;e VjFkyV [MIL-53 (AC)] /kkr dkcfud <kp dk vf/k'kkÔd d #i e xl&vf/k'kkÔ.k v/;;u d fy, ç;Dr fd;k x;kA vf/k'kkÔ.k {kerk dk Øe] $CO_2 > CH_4 > CO > N_2 > Ar > O_2$ FkkA CO_2 d fy, mPp p;urk rFkk fuEu m"ek vf/k'kkÔ.k l irk pyk fd ;g inkFk xl feJ.kk e l CO_2 d foyxu d fy, l{ke gA ¼t- vkQ ikjl efVfj;y] 2011, 18, 205-210½

MIL-53(AR) d tyh; foy;u e ukbVk cthu dh vf/k'kkÔ.k {kerk 610 fexk-@xk- Fkh tk ft;kykbV ¼267.2 fe-xk-@xk-½ vkj dkcfud enk ¼100 fe-xk-@xk-½ l vf/kd jgh] yfdu l'kkf/kr 0;kolk;h lfØ; dkcu ¼1443-53 fe-xk-@xk-½ l de FkhA ¼bMLVh ,M bthfu- de- fjlp] 2011, 50, 10516-10524½

LVkp vkj dkckfDly feFkkby lY;ykt d lkfM;e lkYV dk c/kd tlk ç;kx djd ty Å"eh; fof/k l cuk; x; MIL-101(Cr) dk nkunkj cuk;k x;kA bl ij 303 K ij CO_2 dh p;urk N_2 d lkFk 12.6% feyh tk Øe'kk feFku (5.96%) vkj CO (2.90%) d lkFk l vf/kd FkhA vf/k'kkÔd dh iuçkflr igy dh vi{kk de rki ij lHko ik;h x;hA bldk J; CO_2 d Hkkfrd vf/k'kkÔ.k dk fn;k x;kA ¼dfe- bUth- tjuy 2012, 195-196, 359-368½

lrkfir ZnAl f}lrgh gkbMkDlkbM (LDHs) }kjk tyh; foy;u l ckjV dk mPp 'kkfÔr fu"dklu

ckjV fu"dklu d fy, mPprj ckjV vf/kxg.k {kerkoky inkFkk dh t#jr gkrh g D;kfd ckjV dk T;knk vf/kxg.k ckjku dh foÔkDrk dk dkj.k gkrk gA dkckuV fufgr inkFkk dh vi{kk DykjkbM fufgr inkFkk u ey&l'yfÔr rFkk lrkfir] nkuk voLFkkvk e mPprj ckjV vf/kxg.k çnf'kr fd;kA 400° l ij lrkfir Zn_2Al-Cl LDH inkFk l ckjV dk vf/kxg.k 31 fe-xk-@xk ik;k x;k tk vktrd dh fjikVk e lcl mPp gA T;knk le; rd l[kku l VVk ckjV l ekuk ckjV _.kk;u dk Bkl voLFkk e ifjoru vrlrg e ik;k x;kA 4 xk lrkfir LDH inkFk] 100 fe-xk- B/L foy;u çfr yhVj d vuikr ij ckjV dk vf/kxg.k 97% igp x;kA 1 xk-@yh- 'kkÔd dk 5 fe-xk- B/L oky foy;u e ç;kx djd] ckjku dh lknrk 0.5 fe-xk-@yh- rd de dh x;h] tk WHO u Hkh crk;k gA 0;kid pH ijkl (4-10) e mPp vf/kxg.k {kerk d lkFk vf/k'kkÔd iuçkflr ;kX;] Hkh gA ¼bMLVh ,UM ,Uth- de- fjlp 50, 2011, 6943½

p;fur vkDlhdj.k mRçjd d #i e i;koj.k mipkj gr 0;fRir CoAl-CrO_4-LDHs

i;koj.k lxr #i l LDHs d lkFk 0;fRir inkFk dk mRçjd tlk ç;kx djd p;fur vkDlhdj.k fd;k x;kA J.khc) CoAl-LDHs vrlrg e] ukbVV ;k dkckuV _.kk;u d lkFk] lg&vo{ki.k vkj gDtkehu d ty&fo'yÔ.k }kjk] cuk; x; vkj mudk Cr fu"dklu d fy, v/;;u fd;k x;kA

lg&vo{ki.k l cu $CoAl_2$-N d fy, 45 fe-xk- Cr@xk- fo'kÔr;k vf/kd jgkA tert&C;Vkby gkbMkijkvkDlkbM vkDlhdj.k d lkFk ØkeV fofue; inkFk dk] ctkby ,Ydkgy d p;fur mRçfjr vkDlhdj.k d fy, v/;;u fd;k x;kA mRçjd ,Ydkgy d 1:20 Hkkj vuikr ij 23% ifjoru vkj 100% ctkby ,YMhgkbM dh p;urk d lkFk d{k rki ij l{ke ik;k x;kA ¼bM- ,UM ,Uth- de- fjlp 50, (2011), 13380½

vijrcn LDHs vkj oykjkbt 'u }kjk vudj.khr rkykch ueu l QkLQV dk fu"dklu

ZnAlZr f=&LDHs l QkLQV dk mPp vf/kxg.k vkj $NaAl_2$-LDH dh uuk&pnnjk e tyh; rFkk dkcfud nkuk ek/;ek e fLFkj fuyEcu dk bld igy d f}okfÔd fjikV e crk;k x;k gA ckn oky d fc[kjko dk tyh; ek/;e e cgrj fd;k x;k vkj mldh vijrcn fMxh 0.8 xk-@yh-] 125 xk-@yh- rFkk 6.15 xk-@yh- Øe'kk ty&Å"eh;] ;kf=d çdEid vkj ijk/ofud vijrcn LDH d lkFk jghA QkLQV d fu"dklu ij bld çHkko dk v/;;u fd;k x;kA 10 fe-xk- P@yh- d 25 feyh foy;u e 40 fe-yh- ijk/ofud fc[kfjr LDH feyku l QkLQV dk 100% vf/kxg.k fn[kkA rkykch ueu l 4 fe-yh- ijk/ofud fc[kfjr LDH dk 1 fe-xk-P@yh- foy;u e chdj e fNMdu l 75% QkLQV vf/kxg.k ik;k x;kA QkLQV cf/kr LDH d mojd e fu;f=r ekpu d fy, v/;;u fd;k tk jgk gA ¼çdk'ku gr çfÔr½

foÔekx mRçj.k

lhfj;k vkj lefj;e MkIM lhfj;k uuk d.kk dk fHkUu rki ij lxe l'yÔ.k vkj lkbDykgDthu dk mRçfjr ,ykbfyd vkDlhdj.k

lhfj;k (CeO_2) viu vud mi;kxk tl fd Bkl vkDlkbM b/ku tyk e vkDlhtu vk;u pkyd] vkDlhtu iEi] xl lond] ikfy'k inkFk] QkLQkj] Lopkfyr f=inh mRçj.k e vkDlhdj.k mRçjd vkj l{e jlk;u l'yÔ.k e] jkpd gkrk tk jgk gA lhfj;e (IV) d tyh; vekfu;e dkckuV ldy foy;u vkj lefj;e d ,d lk/kkj.k jklk;fud iFk }kjk mPp LQfVd lhfj;k vkj lefj;e MkIM lhfj;k uuk d.k mPp lrg {k= 368eh²@xk- d lkFk cuk;k x;kA fcuk fdlh dfix lnL; d d.kk dh LQfVd eki dh bthfu;fjx] vfHkfØ;k dh n'kkvk dk mPp djd 3 uukehVj l 15 uukehVj dh x;hA l'yfÔr inkFk dk mi;kx ,ykbfyd ;kfxdk d vkDlhdj.k l rRlc/kh dkckfuy ;kfxdk ¼bukUl½ dk cuku d fy,] mRçjd d #i e fd;k x;kA ¼t- vkQ fQ thdy dfeLVh C 2011, 115, 7628-7637½

ehlkljU/kh ftjdkfu;k QkLQV (m-ZrP) ipeu l?kuu }kjk D;ejhu 0;RiUu l'yÔ.k d fy, ,d n{k mRçjd

ipeu l?kuu l D;ejhu cuku d fy, m-ZrP dk Bkl vEy mRçjd tlk ç;Dr fd;k x;kA ijijkxr Å"eh; rFkk ekbØkoo çnhiu] nkuk fof/k;k l fQuky vkj bFkkby ,flVk ,LVj d l?kuu e mPp mRçjd {kerk fn[khA lHkh foLFkkfir fQukyk e m&,feuk fQuky u] de le; rFkk rki ij oy; lfØ; ,ehu leg gku d dkj.k] vf/kdre lfØ;rk 100% mRikn çkflr d lkFk fn[kk;hA m-ZrP lk/kkj.k fQuky d fy, Hkh lfØ; jgk vkj 57% 4&fQukby D;ejhu ijijkxr Å"eh; fof/k l feykA ¼,iykbM dVkfyfll A½ tujy 394(2011) 93-100½

Cr vrHkfjr ehlkljU/kh ftjdkfu;k QkLQV (Cr-m-ZrP) l vfr mPp ,ykbfyd vkj ctkbfyd p;fur vkDlhdj.k

Cr-m-ZrP l ,ykbfyd ;kfxdk dk mud ,yMhgkbM vkj fdVku ¼dkckfuy] buku½ e mRçfjr vkDlhdj.k d fy, mi;kx fd;k x;kA bl mRçjd dk mi;kx ,ykbfyd vkj ctfyd ;kfxdk d rRlc/kh dkckfuy ;kfxdk ¼buku½ d cuku d fy, fd;k x;kA mi;Dr nkuk vfHkfØ;kvk e mPp ifjoru ,o 100% p;urk feyhA lk/kkj.k iumRiknu vFkok iulfØ;.k }kjk lQyrkiod mRçjd dk db ckj iuç;Dr fd;k x;kA ¼de- dV- de] 2011, 09, 1447-1450½

ehlkljU/kh ftjdkfu;k QkLQV (m-ZrP) ij foyk;d jfgr voLFkk e ekbØkoo lgk;d fof/k l l{e jlk;uk dk l'yÔ.k

m-ZrP, 257eh²@xk- lrg {k= d lkFk cuku d fy, ,d ljy lfo/kk tud vkj rho ekbØkoo çnhiu (MWI) fof/k dk fodkl fd;k x;k ftle {kkjh; n'kkvk e ftjdkfu;e dkckuV ldy foy;u dk ftjdkfu;e ioxkeh d #i e rFkk CTAB dk ljpuk fun'kd lnL; d #i e ç;Dr fd;k x;kA l'yfÔr m-ZrP dh vEy mRçjd d #i e n{krk dk eY;kdu MWI dh n'kk e Dy tu&fLdfeMV l?kuu vfHkfØ;k rFkk fÝMy&Øk¶V ctkby'u] fcxuyh vkj ipeu l?kuu d fy, foyk;d jfgr voLFkk e Hkkjh v.kvk d lkFk fd;k x;kA ¼,lykbM dVfyll B] ,uok;jeuVy] 2011, 103, 378-387½

ukiky vkj l{e jlk;u cuku d fy, uuk vkdkjh lYQVM ftd QjkbV mRçjd (ZF)

lg&vo{ki.k fof/k l uuk vkdkjh mPp Øe e ZF cuk;k x;kA NH_3-TPD vkj fijhfMu 'kkfÔr DRIFT-IR l irk pyk fd lYQ'ku gku ij ftd QjkbV d Ykbl vEyh; lkbVk ij egRoi.k of) gbA ble chVk&ikbuhu dk 70% ifjoru vkj 88% ukiky dh p;urk feyhA ¼dVy- VM] çl e½

dkij mRçfjr foyk;d ;Dr voLFkk e vehuk l behuk dk ok;&vkDlhdj.k }kjk l'yÔ.k

dkij (o) mRçfjr vehuk l behu cuku dh ok;& vkDlhdj.k fof/k lkekU; n'kkvk e v/;;u dh xbA fofHkUu behuk vehuk] tl fd ctyhd] ,fyQfVd] pØh; ldMjh vkj foÔeh ,jkefVd lx/k l cuku d fy, ;g mRçj.k fof/k mi;kxh FkkA bl fof/k d ykHk ;g fd ble foyk;d eDr ok; vkDlhdkjd d #i e] vklkuh l çklr dkij mRçjd vkj vklkuh l mRiknk dk foyxu lekfgr gA fo'kÔ #i l ;g fof/k cthu behu cuku d fy, dkQh mi;kxh gA bl iFk l nkuk leferh; vkj pØh; behu ijijkxr #i l cuk; tk ldgA ¼vkj,llh ,Mokll 2013,2,5119½

H&β ft;kykbV mRçfjr LVkbjhuk dk tyh; ,jhyhdj.k

lkekU; n'kkvk e foÔekx H&β ft;kykbV mRçjd d lkFk LVkbjhu dk fofHkUu ,jhuk d lkFk gfjr tyh; ,jhyhdj.k fd;k x;kA mRçjd u 100% rd tyh; ,jhyhdr mRikn dh p;urk lk;DykgDtu foyk;d e çnf'kr dhA d{k rki ij lk/kkj.k<x l [kfut vEy d lkFk mRçjd dk iulfØ; fd;k tk ldkA igy fjikV fd;x; fof/k;k l bl fof/k d fuEu ykHk g & (i) ijek.k n{krk vkj fdlh mi&mRikn dk u cuuk (ii) vklkuh l dke djuk (iii) fofHkUu ,jhu d lkFk vfHkfØ;k djuk tl fd ,fulky] fQuky] ulFkky vkj ;gk rd fd foÔekxh ,jhu (iv) vklkuh l mRçjd vkj mRikn dk vyx djuk (v) H&β ft;kykbV /kkr vk/kkfjr mRçjdk l lLrk (vi) H&β ft;kykbV dk db ckj iu%ç;Dr fd;k tk ldk ftle lfØ;rk e dkb fo'kÔ udlku ugh gvkA ¼;jkfi;u t-vkjx- de- 2012,3520½

Y-ZrO_2 vk/kkfjr Bkl mRçjd }kjk vk.kfod O_2 l LVkbjhu dk bikDlhdj.k

l{e jlk;uk vkj vkÔf/k;k d fy, LVkbjhu vkDlkbM ,d egRoi.k dkcfud ek/;e gA Co vkj Fe lg&vk;uk l MkIM fd;x; J.khc) lYQV jfgr vkj lYQV d lkFk bVhfj;k&ftjdkfu;k (Y-ZrO_2) dk eY;kdu vk.kfod O_2 d lkFk DMF foyk;d e LVkbjhu d mRçfjr bikDlhdj.k d fy, fd;k x;kA lHkh mRçjdk u LVkbjhu vkDlkbM vkj ctyMhgkbM] nk e[; mRikn fn;A Co&MkIM mRçjd u 120° l- ij LVkbjhu dk egÙke ifjoru 61% vkj 80% p;urk d lkFk vkB ?kV d ckn fd;kA Å"eh; iutfur mRçjd u FkkMk de ifjoru (54%) fcuk p;urk dk çHkkfor fd; rhu vfHkfØ;k pØk rd fn[kk;kA ¼,iykbM dV A ½ tujy] 383 (2010)161½

lYQVM ftjdkfu;k Bkl vEy mRçjd l fMiuku dk l'yÔ.k

fMiuku] α-β vlrlr fdVku] eny lnL; lykfLVlkbtj rFkk lx/kk e ç;Dr gkrk gA lky- ty fof/k l cuk; x; uuk&LQfVd lYQVM ftjdkfu;k mRçjd }kjk foyk;d eDr voLFkk e ,lhVkfQuku d Lo&l?kuu }kjk bl cuk;k x;kA 650° l ij lrkfir bl mRçjd u fMiuku dh vf/kdre p;urk 92% ,lhVkQhuku d 68% ifjoru d lkFk 170° l ij lkr ?kV e fn[kk;hA ;g mRçjd ikp ckj iuç;Dr fd;k x;kA ¼t-vkQ lky ty Vd 61,275-280,2012½

cthu l fQuky d gkbMkDlhyhdj.k d fy, lrkfir CuZnAl f=&LDH iupØh; mRçjd

,d in ecthu l fQuky cuku d gkbMkDlhyhdj.k d fy, n{k fof/k dk fodkl djuk dkQh le; l pukrhi.k jgk gA ble de mRikn cuku d lkFk&lkFk vlxr foyk;d dk ç;kx vkj mRçjd dk iuç;kx dkQh ef'dy gkrk gA bu ef'dyk dk nj dju d fy, lrkfir LDH dk v'kr% Cu l foLFkkfir fd;k x;k g] iupØh; mRçjd d #i e ç;kx fd;k rFkk dkcfud foyk;dk d ç;kx dk ofpr fd;k gA mRçjd u 65° l ij 1.36% fQuky 100% p;urk d lkFk fn;kA ¼,iykbM Dy lk;Ul 53 (2011) 297½

,ydfuy ,jkefVDl dk ekbØkoo lgk; leko;ou

ekbØkoo lgk; bLVkxky l ,uhFkky d {kkj vk/kkfjr leko;ou dk v/;;u MgAl vkj Ni:Al LDH dk Bkl {kkj mRçjd d #i e ç;kx djd fd;k x;kA MgAl d ijek.kfod vuikr 4.0 ij 99% ifjoru] 86% VkUl

p;urk d lkFk ¼bLVkxky % mRçjd Hkkj vuikr = 2:1] T= 140° l-] 90 feuV] DMF½ feykA DFT x.kuk l irk pyk fd bu ,ydfuy ,jkefVDl dk ifjoru] ,jkefVd oy; ij yx foLFkkidk ij fuHkj djrk g rFkk lfØ; lkbVk d PKa l bl rjg dh vfHkfØ;kvk e fu;f=r gkrk gA ¼Hk tk x;kA½

foukby ,LVj vkj çkihu d gkbMkQkjfeyhdj.k d fy, Rh-TPPTS ldy vrHkkfjr ÔVdk.kh; ehlhljU/kh flfydk (HMS)

HMS d ehlkljU/kk e LoLFkku vrHkfjr RhCl $(TPPTS)_3$ (TPPTS = m&VkblYQkuVk VkbfQukby QklQhu) mRçfjr foukby ,LVj d gkbMkQkjfeyhdj.k e 100% ifjoru vkblk& ,yMhgkbM d mPp p;urk d lkFk çklr gvkA gkbMkQkjfeyhdj.k d nkjku cu ,flfVd vEy u Rh ldy dk dkckDlhyV ldy cukdj vlfØ; fd;kA ¼,iykbM dV A % tujy 409-410 (2011) 99-105½

blh çdkj çkiyhu d mRçfjr gkbMkQkjfeyhdj.k e 99% ifjoru ,yMhgkbM d 100% p;urk d lkFk foÔekxh Rh-HMS mRçjd l feyk ftl N ckj iuç;Dr fd;k x;kA ¼,iykbM dV A % tujy 2012, 415-416, 124-131½

,yMhgkbMk d foyk;d eDr p;fur l?kuu gr fpVklu mRçjd

fpVklu dk mRçjd d #i e ç;Dr djd glVuky vkj ctyMhgkbM d l?kuu l foyk;d eDr voLFkk e tlfeuyMhgkbM cuk;k x;kA mRçjd dk lcl vPNk dke giVuky % ctyMhgkbM d 1:4 vuikr ij fn[kkA ekMfyx v/;;uk l xfr fu;=d in dk irk yxk;k x;kA ¼t-eky- dV A % de 339 (2011) 86-91½

LDH çklr inkFk d Bkl {kkj mRçjd l ck;k Mhty cuku dh gfjrj fof/k

rkfir lrgh f} LDH Bkl {kkj mRçjd l Vkl&,lVhfjfQd'ku }kjk fofHkUu f=&Xyhljkb M ryk ¼[kk|] v[kk| vkj id g,½ dk olk vEy feFkkby ,LVj (FAME) e ifjofrr fd;k x;kA feFkuky % ry d vk.kfod vuikr 5.6:1 rFkk T= 60° l ij > 95% FAME 5 ?kV e feykA lfØ;rk d fcuk fdlh gkfu d bl mRçjd dk pkj ckj iuç;Dr fd;k x;kA çklr Xyhljky > 97% 'k) ik;k x;kA vfHkfØ;k dk lQyrkiod ,d fdykxke Lrj ij lu&¶ykoj ry ij mPp fd;k x;kA bl çdkj çklr ck;kMhty dk Hkkfrd x.k/ke ekud DIN d rY; ik;k x;kA ¼ck;kfjlkl VDukykth] 109 (2012) 57½ ¼iVUV Qkby fd;k x;k % 0371/DEL/2011, 14 Qjojh 2011; PCT/IN2012/000092, 10 Qjojh] 2012½

cgdk;h LDH 0;RiUu mRçjd l dldM vfHkfØ;k }kjk uohdj.kh; l foeku b/ku

foeku d fy, no ,Yduk dk n{k #i l fo'kÔr;k b/ku tlk ç;kx fd;k tk ldrk gA lY;ykt l no ,Yduk cuku dk ykHk ;g g fd ;g [kk| ij dkb vlj ugh Mkyrk gA Pd ;Dr MgAl LDH, fofHkUu Pd ek=k d lkFk lgvo{ki.k fof/k l cuk;k x;kA tyfoyk;d e bu inkFkk vkj bud rkfir #ik dk cgdk;h mRçjd tlk ç;kx djd ,d ik= e Qj¶;jy dk ,lhVku d lkFk ,yMky l?kuu gkbMktuhdj.k fd;k x;kA mPp dh xb lHkh n'kkvk e 5% Pd ;Dr lrkfir LDH u 83% C_{13} mRikn p;urk d lkFk 100% ifjoru çnf'kr fd;kA ¼Hk tk x;k½

ck;kekl l jlk;u

,EcjfyLV&15 Bkl vEy mRçjd l ÝDVkl dk 5&gkbMkDlh feFkkby Qj¶;jy e futyu

ck;k vk/kkfjr fjQkbujh ldyk e 5&gkbMkDlh feFkkby Qj¶;jy (5-HMF) ckjg eyHkr v.kvk e l ,d igpkuk x;k gA bl lkekU;r% vEy mRçjd l ÝDVkt d futyu l cuk;k tkrk gA bl vfHkfØ;k dk v/;;u 0;olkf;d mRçjd ,EcjfyLV&15 l fd;k x;k] ftle 70±5% mRikn ¼0.1 xk ÝDVkl] 0.1 xk ,EcjyhLV&15, DMF e 120° l ij rhl feuV½ feykA vfHkfØ;k pØ d lkFk mRikn e yxkrkj deh ik;h x;hA ç;Dr mRçjd dk lY¶;fjd vEy dh fofHkUu lknrk ¼0.5 l 2 M½ l iulYQkuV fd;k x;kA iulØh;

mRçjd l dkQh mPp çkflr (93%) feyh] tk bl mRçjd fof/k l lcl Åph jghA ey ,EcjfyLV&15 dk bl lY¶;fjd vEy l lYQkuV dju l] iupØ.k dk; liknu cgrj jgkA vfHkfØ;k d ckn pH de gk x;k tcfd mRçjd dh lfØ;rk mu vfHkfØ;kvk e {kh.k gk x;h ftudk çkjfHkd pH 6 l vf/kd FkkA DMSO foyk;d e iupØ.k d nkjku pH e dkb fo'kÔ ifjoru ugh ik;k x;k vkj 7 pØk rd lfØ;rk e dkb deh ugh gbA

jkgfM;e fofu;fer NaETS-10 vkj NaETS-4, foÔekxh mRçjd l gkbMk,ehukfefFkyhdj.k

Rh-NaETS-10 vkj Rl-NaETS-4 mRçfjr vkyhQhuk d gkbMk,ehukfefFkyhdj.k l 100% ifjoru ,ehuk d mPp p;urk d lkFk feykA ; nkuk mRçjd f}rh; ,ehu tl fd ekjQkyhu vkj ik;jkyhMhu d lkFk dkQh çHkkoh FkA Rh-ETS-10 u 1&gD thu vkj ekjQkyhu d lkFk n&,ehu dh 47% p;urk fn[kk;h tcfd ik;jkyhfMu vkj fiijhMhu d lkFk 48% p;urk FkhA mRçjd lfØ;rk vkj p;urk e fcuk fdlh gkfu d l{ke #i l iupfØr fd;k x;kA

p;fur l{e jlk;uk d l'yÔ.k d fy, /kkr vk/kkfjr uuk d.kh; foÔekxh mRçjd

2&fQukby bFkkuky 0;olkf;d egRo dk lx/k jlk;u gA fpVklu ij Pd dk v/;;u LVkbjhu vkDlkbM d gkbMk tuhdj.k l 2&fQukby bFkkuky cuku d fy, fd;k x;kA i.k&ifjoru mPp p;urk d lkFk ik;k x;kA ¼MkyVu VkUl 41 (2012) 2910-2917½

lekx mRçjd

f=&lYQkuVM fVl ¼ckb&fQukby½ QklQhu (BiPhTs) d Ru ldy l mRçfjr tyh; f}#ih gkbMk tuhdj.k

(BiPhTs) d ty&?kyu'khy Ru ldy u fofHkUu vlrlr gkbMkdkcuk d gkbMk tuhdj.k e lk/kkj.k n'kk e mPp p;urk d lkFk n{k lfØ;rk çnf'kr dhA ,d lk/kkj.k fof/k foyxu l mRçjd dk vklkuh l iu¼çklr fd;k x;k vkj iupØ.k ç;kxk u fn[kk;k fd pkj ckj yxkrkj lkbDykgDtu d fy, lfØ;rk vkj p;urk mPp cuh jghA ¼dV lkbl ,M Vd ¾ DOI : 10, 1039/C2Cy20172K½

ty&?kyu'khy fyxM f=&lYQkuVM fVl ¼ckb&fQukby½ QklQhu (BiPhTS) d Co ldy l mPp ,Ydhuk dk gkbMkQkjeyhdj.k

fofHkUu Hkkj LFkkukUrj.k çkRlkgdk ¼lg&foyk;d] vknd] lkbDykMDlVhu vkj lfØ; dkcu½ dh vuifLFkfr vkj mifLFkfr e mPp ,ydhuk d gkbMkQkjeyhdj.k d fy, ty ?kyu'khy BiPhTS d Co ldy dk mRçjd dh rjg ç;kx fd;k x;kA CTAB, feFkkbyVM β&lkbDykMDlVhu ;k lfØ; dkcu dh mifLFkfr e bl mRçjd u 1&vkDVhu dk gkbMkQkjeyhdj.k mPp ifjoru (95%) vkj ,YMhgkbM dh p;urk (85-95%) d lkFk fd;kA ¼,iykbM dV A ¾ tu- 413-414 (2012) 273-279½

dk;jy mRçj.k

fofHkUu dkcfud ifjoruk d fy, n{k dk;jy mRçjdk dk fMtkbu vkj fodkl] vlefer mRçj.k dk ân; g dk;jy d vfre mRiknk dk vkÔ/k] dfÔ jlk;u] Lokn ,o lx/k e 0;kid mi;kx gkrk gA dk;jy d vfre mRiknk vkj dk;jy fyxM d mPp eY; dk /;ku e j[kr g, fuEu iupØh; mRçjd fMtkbu fd; x; vkj mudk ç;kx vlefer LVhdj vfHkfØ;k] lkbukbM d fofHkUu lkrk l ,YMhgkbM dk lk;uhdj.k vlefer oy; [kkyu dh vfHkfØ;k] ,ehu vkj ty U;DykQkby d lkFk jlehd bikDlkbM dh xfr d vyxu vkj vkfyfQuk dk vlefer gkbMkQkjeyhdj.k d fy; fd;k x;kA

iupØh; eØkpØh; Cr(III) lyu ldyk }kjk bikDlkbM d AKR/ARO l buuf'k;k 'k) β&,ehuk ,Ydkgy cukuk

=;h ukbVktu l lec) nk dk;jy lyu bdkb;koky dk;jy eØkpØh Cr(III) lyu ldy J.kh e cuk; x;A ; ldy dkQh lfØ; Fk vkj fofHkUu jlehd Vkl vkj fetk bikDlkbM d ,fuyhuk d lkFk buuf'k;k p;fur AKR/ARO d{k rki ij g; vkj ftle ,Vh@flu β&,ehuk ,Ydkgy vkj buuf'k;k 'k) bikDlkbM >99% çkflr rFkk buuf'k;k çpjrk d lkFk jghA bld vfrfjDr iupØ.k dk Hkh ykHk jgkA ¼VVk gMu 67, (2011), 8300½

dk;jy eØkpØh; V(V) lyu ldyk e Økmu bFkj tl cu ueu }kjk ,yMhgkbMk dh buuf'k;k p;fur O-,lhVkby lkbuhdj.k@lkbukQkjeyhdj.k

dk;jy iupØh; eØkpØh; V(V) lyu ldy Vkbxky fydj d lkFk l'yfÔr fd; x; vkj vlefer lkbuhdj.k vfHkfØ;kvk e mRçjd tl ç;Dr fd; x;A bl mRçjd u KCN vkj NaCN tl de [kphy] v0kk"ih; lk;ukbM lkrk d lkFk mRd"V mRikn çkflr vkj ee 99% rd çnf'kr dhA bl mRçjd u ljf{kr lk;ukbM lkr bFkkby lk;ukQkjeV d lkFk lk;ukgk;fMu dkckuV mPp çkflr d lkFk fn;k vkj ee 97% rd feykA ¼VVk gMu 67. 2011, 7073½

bl mRçjd ¼10 v.k %½ dk TMSCN d lkFk fofHkUu N&ctkbyhehul l vlefer ;xu fd;k x;kA α&,ehukukbVkby yxHkx l[;kRed çkflr vkj 99% ee d lkFk] 2&feFkkDlh foLFkkfir N&ctkyhehu d lkFk feykA le; vkj rkieku] nl ?kVk vkj -40° l- Øe'kh FkkA ¼Hk tk x;kA½

APN jk/kd ek/;fed tl α&,feuk vEy vkj dk;jy 3&Mkb,ehu d l'yÔ.k d fy, C_2&lefer iupØh; vkjxuk mRçjd l buuf'k;k p;fur LVhdj vfHkfØ;k

vud iupØh; dk;jy ,ekbM vk/kkfjr vkjxuk mRçjd cuk; x; vkj fofHkUu lx/k vkj ,yhQfVd N&ctkgkbfMyhehul d lkFk bFkkby lk;ukQkjeV dk lkbukbV lkr tlk ydj vlefer LVhdj vfHkfØ;k dh x;hA bu mRçjdk l 95% çkflr rFkk 90% ee d lkFk ,ehuk ukbVkby feykA bl fof/k l (R)&fQukby,ykuhu rFkk (R)&3&fQukby çkiu&1, 2&Mk;kehu Hkh cuk; x;A ¼t- vkjx- de- 77 (2012) 4375½

J.khc) dk;jy eØkpØh; Mn(III) lyu ldy] ekukefjd rFkk Mkbefjd dk;jy eØkpØh; lyu fyxM vkj Vkbxky fydj d lkFk cuk; x;A dk;jy Mkbefjd eØkpØh; mRçjd ¼5 v.k %½ l buuf'k;k 'k) bikDlkbM mRd"V çkflr (> 99%) vkj ee (> 96%) d lkFk feykA ¼t- dVy- 286 (2012) 41-50½

vçdkf;r ,Ydhuk d bikDlhdj.k gr vpfyr Mkbefjd dk;jy Mn(III) ldy

(1 R, 2 R) – (-) Mkb,ehuklkbDykgDtu dkyj d lkFk NkV puy oky cM fNn eki dh flfydk vkj fydj $(CH_2)_3$-NH-eykehu&fiijthu½ d lkFk dk;jy Mkbefjd Mn(III) lyu ldy dk vpfyr fd;k x;kA bl mRçjd l db vkyhQhuk d buuf'k;k p;fur bikDlhdj.k l tyh; NaOCl d lkFk mPp TOF vkj buuf'k;k p;urk rRlEcfU/kr mRiknk d fy, feyhA bl fof/k dk mPp ruko fojk/kh vkÔf/k yoØkedkfye (ee 98%) dk ,d xke d Lrj ij cuku e ç;Dr Hkh fd;k x;kA ¼VVkgMu 68 (2012) 6812½

VkbVfu;e ,ehuk ,Ydkgy 0;RiUu f'kQ {kkj ldyk l gkbMktuijkDlkbM l lYQkbMk dk vlefer lYQkDlhdj.k

fofHkUu lfylyfMgkbM 0;RiUuk d lkFk (15, 25) (+)-2-,ehuk-1,2-MkbfQukbybFkuky½ d l?kuu l ,ehuk ,Ydkgy vk/kkfjr f'kQ {kkj cuk; x;A Lo&LFkku $Ti(Oi\text{-}Pr)_4$ d lkFk cu bu fyxMk d ldy dk io dk;jy lYQkbMk d vlefer lYQkDlhdj.k d fy, 30% H_2O_2 rFkk 0° l- ij 10 ?kV rd rRlEcU/kh dk;jy lYQkDlkbM cuku d fy, n{k #i.k ç;Dr fd;k x;kA ¼ifjoru 93%; ee 98% rd½A ¼t- eky- dV A: 361-362 (2012) 36-44½

iupØh; eØkpØh; Co(III) lyu ldyk d lkFk vlefer HKR

ty dk foyxu lnL; d#i e ydj ,d ine eY;oku buuf'k;k 'k) bikDlkbM vkj Mk;ky çklr dju d fy, jlfed vr d bikDlkbMk dh HKR cgr mi;kxh fof/k gA iupØh; dk;jy Co(III) eØkpØh; lyu ldy dk ç;kx jlfed bikDykjkgkbfMu] çkihu vkDlkbM] LVkbjhu vkDlkbM vkj Xykbflfly bFkj d HKR l buukf'k;k 'k) bikDlkbM vkj Mk;ky 42% ¼l)kfUrd çkflr 50%½ rFkk ee >99% cuku d fy, fd;k x;kA bl fof/k l dk;jy vkÔ/k v.k (R)&eDlhyhVkbu vkj (S)&çkiukyky vPNh çkflr vkj buukf'k;k p;urk d lkFk cuk; x;A ¼de- ;jk- t- 18 (2012) 5256½

Cu(II) eØkpØh; lyu vkj [H$_4$] lyu mRçfjr vlefer ukbVk,yMky vfHkfØ;k vkj bldk α 1 ,Mjhujft dxkgh ,xkfuLV (R) fQukbybQjkbu cuku e mi;kx

β&gkbMkDlhukbVk,Ydu cuku d fy, vlefer ukbVk,yMky vfHkfØ;k ,d l'kDr l'yÔ.k fof/k g vkj ;,Ydu to lfØ; ;kfxd cuku d fy, egRoi.k eyHkr gA dk;jy ekukefjd vkj Mkbefjd eØkpØh; lyu d db u; Cu(II) ldy Lo&LFkku [H$_4$] lyu fyxM d lkFk cuk; x; ftUgku d{k rki ij mPp çkflr (90%) vkj ee ~99% fn[kkbA 3&ehFkkDlhc tyMhgkbM d vlefer ukbVk,YMky vfHkfØ;k l bl fof/k l buuf'k;k 'k) (R)&fQukbybQjkbu ¼1&,Mjhujft d xkgh ,xkfuLV½ cuk;k x;kA ¼ACS dV (2011) 1529-1535; ,iykbM dV A ¼ 439-440 (2012) 74-79½

lh/k &,ehuk dk cuku d fy, fVu fofuef;r ft;kykbV mRçjd

fVu fofu;fer ft;kykbV fofHkUu dhVkuk vkj ,YMhgkbMk d ,ehu vkj VkbfeFkkby flykbyklk;ukbM d lkFk lh/kk α&,ehuk ukbfVy cuku d fy, foyk;d eDr voLFkk e n{k mRçjd ik;k x;kA d{k rki ij 10-120 feuV e α &,ehuk ukbVkby dh mRd"V çkflr ¼96% rd½ jghA ¼,iykbM dV A ¼ t 419-420 (2012) 22-30½

vkyhQhuk dk vlefer gkbMkQkjeyhdj.k

lfØ; ;kfxdk l ydj to fuEudj.kh; cgydk rd ç;Dr gkuoky buuf'k;k 'k) ,YMhgkbM dk cuku d fy, vlefer gkbMkQkjeyhdj.k ,d n{k fof/k d #i e /;ku vkdfÔr dj jgh gA dk;jy QkLQhu jfgr fyxM fMtkbu fd; x; vkj Rh(acac) (CO)$_2$ lØe.k /kkr ioxkeh d lkFk dk;jy mRçjd cuk; x; vkj bUg vkyhQhuk d vlefer gkbMkQkjeyhdj.k d fy, ç;kx dju ij mPp ifjoru (98%) mud Øfed dk;jy ,YMhgkbM d mPp ee (>99%) d lkFk lkekU; n'kkvk e feykA ¼Hk tk x;kA ½

/kkr f'kQ {kkj ldyk d buuf'k;kejk d Mh,u, e c/ku vkDlhdkjd fojk/kh vkj cDVhfj;k fojk/kh çofr;k d fy, dk;jy foHknu }kjk n<rk

Mh,u, c/ku vkDlhdkjd fojk/kh vkj cDVhfj;k fojk/kh çofÙk;k d fy, dk;jy f'kQ {kkj fyxM 'k) buukf'k;k #i e mud Ni, Cu vkj Zn ldyk d lkFk cuk; x; vkj mDr d fy, eY;kdu fd; x;A dkQ Fkkbel Mh,u, l mPp c/ku fLFkjkd 2 x 10^5 l 4.5x10^6 M^{-1} ik;k x;kA lHkh ldyk u lijvkDlkbM (56.99%) vkj gkbMkfDly (45-89%) ç{kkyu d fy, dkQh lfØ;rk fn[kk;hA iu% ldyk u xke (+) vkj xke (-) cDVhfj;k d fy, cDVhfj;k fojk/kh lfØ;rk fn[kkb yfdu o QQn d lki{k ugh FkA S&buuf'k;kej l Mh,u, vrfØ;.k] vkDlhdkjd fojk/kh vkj cDVhfj;k fojk/kh çofr;k d fy, vf/kd l{ke ik;k x;kA ¼LiDVk fde- ,DVk 81 (2011) 199-208½

dkQ Fkkbel Mh,u, vkj ckchu lhje ,Yc;feu (BSA) çkVhu d lkFk dk;jy V(V) u lfØ;rk fn[kkbA lkbVk foÔkDrrk] gi 2 dkf'kdkvk d v'kk e dk;jyVh l çHkkfor ik;h x;hA R&buuf'k;kej u mPprj c/ku fLFkjkd (51x10^6 M^{-1}) S&buuf'k;kej (01 x 10^4 M^{-1}) d lki{k çnf'kr fd;kA ¼;jk- t- eM- de- 2011, 46, 5074-5085½

cfty ckekbM dk ctkYMgkbM e lh/kk ifjoru

cftfyd ckekbM dk ctfYMgkbM e i;koj.k lxr vkDlhdkjd H_2O_2 }kjk tyh; ek/;e e ljy ,o p;fur ifjoru crk;k x;k gA bu n'kkvk e ctfYMgkbM dh vPNh çkflr feyhA çLrr fof/k n{k] p;fur] lkekU; voLFkk e H_2O_2 d lkFk mDr ifjoru d fy, jghA bu vkDlhdkjdk d fy, gkykfd ,fyQfVd ckekbMk d fy, bl fof/k u dke ugh fd;k yfdu nljh fof/k;k dh ryuk e dfBu vfHkfØ;k n'kkvk dh t#jr ugh gkrhA lk/kkj.k vfHkfØ;k n'kk vkj mRd"V mRiknk dh çkflr bl fof/k dk ljy vkj vkdÔd cukrh gA ¼flUFk- dkE;u- 2011, 41, 2712½

{kkj d fcuk cfty ,Ydyh bFkj cukuk

fcuk {kkj d cfty ,Ydyh bFkj cuku dh ,d lkekU; n{k vkj i;koj.k lxr fof/k fodflr dh x;hA $FeSO_4$ ctkbyvkDlhfifjMhfu;e fVQyV dk ,d vPNk foLFkkid ik;k x;kA bl fof/k e $FeSO_4$ dh rhu ckj iuçkflr çnf'kr dh xbA bl çdkj bl fof/k l jkpd vfre mRikn iku dk lQy ç;kx rFkk lkFk&lkFk lkekU; vkj lk/kkj.k vfHkfØ;k n'kk e gku d dkj.k ;g lcf/kr çpkyk d rkyey l;ktu d fy, mi;Dr gA ¼flUFk- dkE;u- 2011, 41, 720½

1,8 uQFkkbfjMhUl dk l'yÔ.k

I_2 vkj $InCl_3$ }kjk mRçfjr 1, 5 vkj 1, 8 uQFkkbfjMhul d fjft;k p;fur l'yÔ.k d fy, vfr n{k fof/k fodflr dh x;hA ;g fof/k foLFkkfir uQFkkbfjMhUl d ljy vkj 0;kogkfjd l'yÔ.k dk crkrh g vkj mRçjd d ljy lpkyu d dkj.k fo'kÔ ekxnf'kr gA ok; ;k ueh d çfr lonu'khy ugh gA mRçjd dk iuçklr djd n{krkiod ikp pØk rd iuç;kx fd;k x;kA ;g vkdkjh ueu] fofHkUu to lfØ; v.kvk e ik; tkr gA ¼flUFk- dkE;u 2011, 41, 1843½

NaOH mRçfjr behu l'yÔ.k ¼ vkYdkgy vkj vehu dk ok; vkDlhdj.kh tMu

vYdkgy vkj vehuk d ok; vkDlhdj.kh tMu l behu cuku gr ,d gfjr ,oe n{k fof/k dk fodkl fd;k x;k gA bl n'kk e vfHkfØ;k fcuk fdlh lØe.k /kkr] fyxM rFkk lg&foyk;d d gkrh gA fofHkUu vYdkgy ,oe vehu d tMu l behu cuku d fy; ;g ,d lkekU;] i;koj.k lxr fof/k gA ¼;jk- t- vkjx- dfe- 2012, 4457½

foLFkkfir behMktky [1,2 -a] fifjMhUl dk Å"eh; vkj ekbØkoo lgk; 'kh?k l'yÔ.k

behMktky [1,2 -a] fifjMhu 0;RiUu ,d egRoi.k v.kg tk 0;kid toh; lfØ;rk ¼ok;jyjk/kh] vYljjk/kh] cDVhfj;kjk/kh] QQnjk/kh] dyf'k;e puy ck/kd vkj lEekgd½ j[krk gA Å"eh; vkj ekbØkoo lgk; fof/k l mDr 0;RiUu ,ehuk fifjMhu vkj α&ckek β&dhVk ,LVj vfHkfØ;k }kjk LoPN n'kk e cuk; vkj çklr fd; x;A ekbØkoo fdj.ku }kjk mPp çkflr rFkk xfr ¼<2 feuV½ d lkFk vfHkfØ;k dh x;hA mDr nkuk fof/k;k l dh x;h ;g vfHkfØ;k igyh ckj fjikV dh x;hA ¼flUFkfll 2011, 635½

,dy fØLVy ,DlvkjMh }kjk ,d u; l'yfÔr ;kfxd dh ljpuk lfuf'pr dh x;hA bl fof/k d ;g ykHk g fd ble] de [kphyk miyC/k 0;olkf;d 2&,ehuk ckehukfijhMhu vkj α&ckek β&dhVk ,LVj fy;k x;k] rt vfHkfØ;k] ljy dk;] mPp çkflr rFkk mRikn 'kf) gA

çdk'k mRçj.k vkj çdk'k lfØ; v.k

iftr ikjfQfjuk ij çdk'k Hkkfrd v/;uu

5, 10, 15 fVlfQukby 20¼3,4&MkbgkbMkDlh fQukby½ ikjfQfjuk d iftr 0;ogkjk dk tyh; foy;u e pH vkj lknrk d lki{k v/;;u] fLFkj voLFkk vf/k'kkÔ.k vkj mRltu LiVkekih }kjk fd;k x;kA v/;;uk l irk pyk fd fo'kÔ lknrk ijkl e v.kvk e mRØe.kh; i tu fof/k jgh] vkj H&iftr v.k] nk fofHkUu pH ijkl ij FkA ¼t-fQth- de- B, 114 (2010) 8327½

çdk'k çfjr vrlrg byDVku LFkkUrj.k

QEVk ldM lØe.k vf/k'kkÔ.k LiDVkekih }kjk TiO_2 uuk d.k lrg ij $[(bpy_2ML)]^{2+}$ ¼tgk M = Os^{II} ;k Ru^{II}½ l vrlrg byDVku LFkkUrj.k fof/k dk v/;;u fd;k x;kA Ru^{II}/TiO_2 l ?kkrkd byDVku btD'ku çdk'kkÙkftr vÅ"eh; MLCT voLFkk l gvkA tcfd Os^{II}/TiO_2 l byDVku btD'ku f}&?kkrkd nkuk fof/k;k] vÅ"eh; rFkk Å"eh; MLCT voLFkkvk ¼e[;r½ ^{3}MLCT voLFkk½ l gvkA Hkkjh lØe.k /kkr Os l T;knk yEc fLiu d{k tMu Ru d lki{k gku dk dkj.k ^{3}MLCT voLFkk dh vf/kd n{k ?kurk dk crk;k x;kA ¼de- ;jk- t- 17, 2011, 1561½

vrlrg LFkkUrj.k fof/k dh xfrdh ij v/;;u

QEVk ldM lØe.k vf/k'kkÔ.k LiDVkekih }kjk çdk'k lfØ; l'yfÔr Ru^{II} ldy ¼$K_2[Ru(CN)_4(L)]$½ dk v/;;u vrlrg byDVku LFkkukrj.k dh xfrdh d fy,] uuk d.k TiO_2 vkj çdk'k mrftr Ru^{II} ldy ij fd;k x;kA lkYoVkØkfed 0;ogkj foyk;dk ;k foyk;d feJ.k e /kork cnyu ij fLFkj voLFkk vf/k'kkÔ.k vkj mRltu l irk pykA ,dy ?kkrkdh vkj lhfer iYl pkMkb ¼<100 fs½ dk byDVku btD'u ik;k x;kA byDVku d ihN dh vkj dh LFkkukUrj.k xfrdh dk lfuf'p;u {kj.k dh xfr l fd;k x;kA lkYoVkØkfed lond v.k d ç;kx l TiO_2 uukd.kk d lrg ij vfr rho ET&xfrdh dh ;g çFke fjikV gA ¼buvkjx de- 49 (2010) 4167½

lrg rF; ij v/;;u

bFkj fyd l pkj ifjf/k fQukby d çR;d oy; l lg l;kth cf/kr] nk C16&,Ydkby dfM;koky u; VVk fQukby ikjQkfju 0;RiUu cuk; x;] ftUgku ok; ty lrg ij cglrgh xPN ;k ifVdk; cuk;A LFkkb xky ifVdk; Hkh cuh tc bl mi;Dr Bkl lrg ij tek fd;k x;k vkj ; ifVdk;] ;gk rd fd] 'k"d voLFkk e Hkh] LFkk;h ik;h x;hA ekbdk&lrg ij te g; dkLV fQYek d fofHkUu ekbØkLdkfid Nfc;k u ;g lfuf'pr fd;k fd e/; d'ku vkj mHkj g, cn vroky uuk uyh] uuk NM cuA bu ldj ufy;k dk ifVdk cuu d ek/;fed tlk çLrkfor fd;k x;k tk ltu d nkuk rjQ d fo[kMu l gvkA ¼de ,f'k;u t- 2010, 5, 352; fFku lkfyM fQYe 519 (2011) 8066½

çdk'k mRçfjr inkFkk dk fodkl

TiO_2 yfir ,Øfyd pnnjk dk l'yÔ.k

fer0;;h çdk'k mRçfjr fj;DVj d fodkl ij dk; 'k# fd;k x;kA dokVt d LFkku ij fer0;;h ,Øfyd pnnj dk TiO_2 l] çdk'k mRçfjr lrg fodflr dju d fy, yfir fd;k x;k] vkj bldk ijh{k.k feFkkbyhu Cy fojtd d {kj.k d fy, fd;k x;kA lrg dk fcuk çHkkfor fd;] çdk'k&mRçjd yfir lrgu lkj çdk'k e fojtd v.k dk {kj.k fd;kA

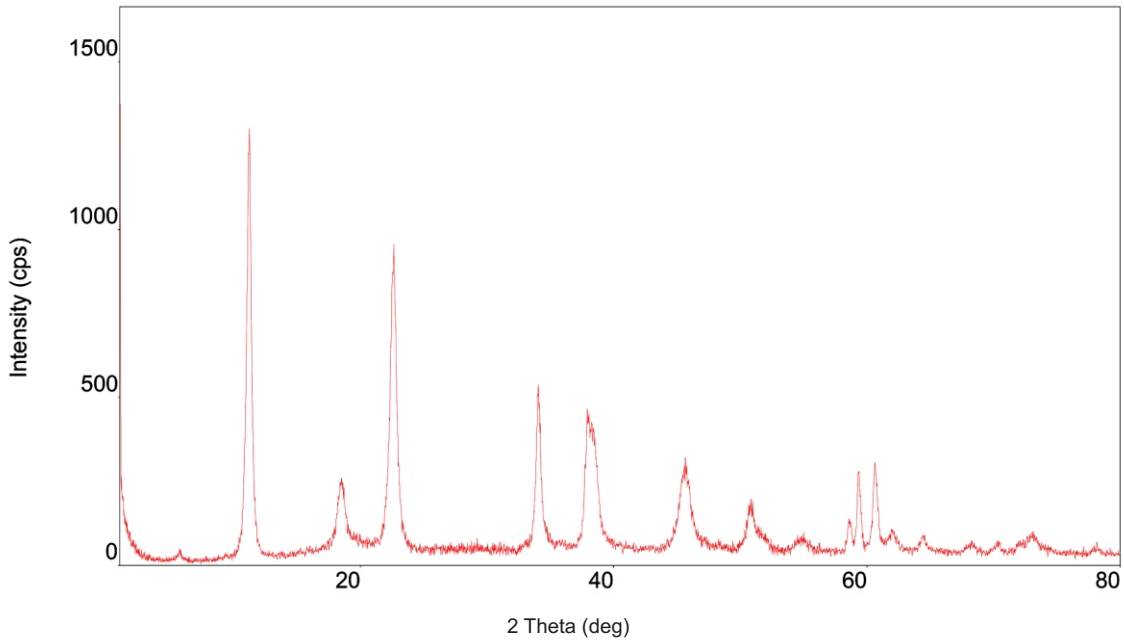
UV-LED lkr@ TiO_2 yfir DokVt uyh vk/kkfjr çdk'k mRçjdh; uyh; fj,DVj

UV-LED vk/kkfjr çdk'k mRçfjr fj;DVj d iodk; dh J[kyk e TiO_2 çdk'k mRçjd yfir DokVt uyh vkj UV-LED d }kjk ,d u;k fj,DVj fodflr fd;k x;k ftle {kfjr foy;u l çdk'k mRçjd dk vyx dju l ofpr fd;k x;kA feFkkbyhu Cy] eykpkbV xhu vkj jkMkehu&ch fojtdk d {kj.k d fy, bl fj;DVj dh çdk'k&mRçfjr lfØ;rk dk v/;;u fd;k x;k vkj ifj.kke l irk pyk fd mi;Dr lHkh fojtdk dk {kj.k ikp ?kV e gvkA bl v/;;u l irk pyk fd bl fodflr çdk'k mRçfjr fj;DVj l lQyrkiod vkjxfud ;kfxdk ;k fojtdk dk {kj.k de Åtk ij gk tkrk gA ¼de- buth- t- 2011, 169, 126-134; de- buth- t- 2011, 178, 40-49; bUM- bUth- dfe- fjl- 2011, 50, 7753-7762½

SALT & MARINE CHEMICALS

Double fortified salt (DFS)

Iron and iodine are essential elements for the human body. Iodine deficiency disorder (IDD) and iron deficiency anaemia (IDA) caused by insufficient intake of iodine and iron respectively have serious detrimental effects on the economic and social development of entire populations. Several products have been introduced in the market but they suffer from one or more drawbacks which can be stated as follows: (i) inadequate stability; (ii) unacceptable colour; (iii) foul smell; (iv) high cost. Building on the institute's previous work on iodate incorporation into synthetic hydrotalcite, double fortification agents have been prepared (PXRD given below) which show excellent whiteness and stability under ambient conditions for over 3 years. Feedback was also obtained from the Salt Department regarding stability of iron and iodine in the salt. Process has been scaled up to 3 kg scale for the fortifying agents. Patent application (0607/DEL/2012) entitled "Novel double fortified salt compositions containing iron and iodine and process of preparation thereof" has been filed. Bioavailability test of the DFS is in progress in collaboration with the Bhavnagar Medical College.



PXRD of iron fortifying agent (Iron- SHT)

Ultrapure salt: Scale up of solar recrystallization process in salt pans

Whereas our earlier innovations on brine clarification, pH control and morphology modification helped to reduce the commonly mentioned impurities in salt to ultra low levels, certain trace impurities could not be reduced to the levels required by user industries for specific applications such as production of specialty chemicals. One such application requires ultra low levels of bromide. Solar salt with solar recrystallization was studied at field level and about 100 ton of salt with highly reduced levels of all impurities including bromide and trace metal ions was produced. *(Patent Application No. 0597/DEL/2012)*

Solar recrystallization in salt pans

Analysis of recrystallized solar salt obtained in scale up studies

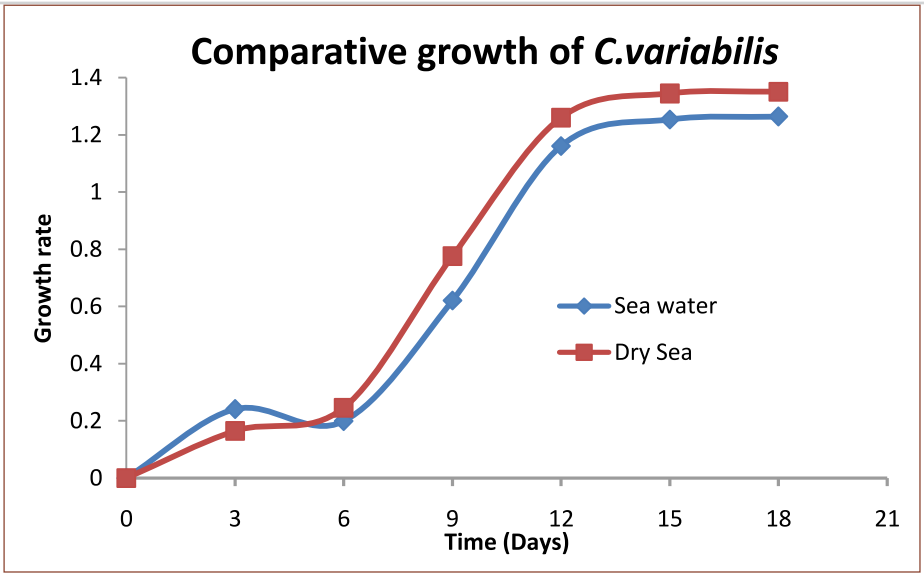
Constituents	Solar recrystallization in salt pan (unwashed)
NaCl (% w/w; dry basis)	99.7
Ca (% w/w)	0.03
Mg (% w/w)	0.02
SO_4 (% w/w)	0.07
Br (ppm)	< 10
Fe (ppm)	< 0.15
Al (ppb)	< 2.8
Cd (ppb)	< 1.3
Co (ppb)	< 0.7
Cr (ppb)	< 0.7
Pb (ppb)	< 4.2
Ni	< 1.5

Cost-effective natural salt formulations for seawater substitution and mineral fortification

Seawater may be required for diverse applications in locations which are not necessarily in the proximity of the sea. For example, many research laboratories across the world conduct research in seawater medium and struggle to obtain such water. Indeed, our motivation to address the problem arose from the CSIR-MoES multi-institutional NMITLI project on "Biofuel from marine microalgae" where several participating laboratories expressed difficulty in conducting their experiments due to lack of seawater availability. Those maintaining marine aquariums far removed from the sea also face a similar difficulty. There are several products available in the market, which claim to be seawater substitutes, but these are expensive. A cost-effective method was developed to produce a salt composition which is the exact replica of seawater constituents, which we have named *Dry Sea*. The product was sampled to an individual for conducting trials in a household marine aquarium and the results were found to be very encouraging. Similarly, studies were conducted with *Chlorella variabilis* marine microalga and the results were almost identical to that with pristine sea water.

"We thank you for sending us the salt for making the artificial sea water for our marine aquarium. We dissolved the required quantity of salt supplied by you in plain water to make salty sea water. The aquarium has been filled with the water and the sea water fishes seem to be very comfortable in the water since last two months." Col P K Chatterjee (Retd), Dated: 07/03/2012

Healthy growth of marine fauna in aquarium containing artificial seawater made from *Dry Sea*



Comparative growth of marine microalga, *Chlorella variabilis*, in natural sea water and medium prepared from *Dry Sea*

Through appropriate process modifications, it has been possible to make a second formulation - *Dry Sea MF* - which is suitable for remineralization of drinking water excessively depleted in mineral nutrients. A provisional patent application entitled "Cost-effective natural salt formulations for seawater substitution, mineral fortification and processes thereof" has been filed with the Indian Patent Office for these inventions *(Patent Application No. 3422/DEL/2011)*.

Process for the purification of saline reject water of desalination plant and its direct use thereafter as salt solution for cooking purpose

Although desalination plants have become increasingly more popular - even in rural settings - the management of residues has proved a major challenge, especially in inland areas. If recovery from the plants is low, there can be a large volume of reject water which would be unfit for discharge if its TDS exceeds 2100 ppm. On the other hand, when recovery is high, the TDS level in the reject water rises further making it still more unsuitable for discharge. Forced evaporation of the water as practiced in some prior art is capital intensive and energy consuming and best avoided in rural settings. Solar evaporation is a better alternative to the above but it is important that land be available for this purpose and the climate be favorable. In many of the locations where the institute has set up RO plants, villagers come to fetch the water from the site of desalination plants and it occurred to us that if they can additionally be provided with a pure salt water solution for cooking purposes, it may help them and also mitigate the problem of discharge. A scheme was devised for purification of reject brine and proof of concept demonstrated. The scheme would also make it possible for RO plants to operate at high recovery *(Patent Application No. 0593/DEL/2012)*.

Demonstration of the universality of the brine clarification-cum-pH control process for preparation of pure salt: Study of different subsoil brines

During the period covered by the present report, US patents were granted for the innovations of brine clarification and brine clarification-cum-pH control for the production of salt having >99% purity and also with desired Ca/Mg ratio. A study was undertaken to ascertain the universality of our claim that this treatment improves the purity of salts from all types of sub-soil brines. Data on the quality of salt produced from subsoil brines from the inland belts of Gujarat are provided in the following table.

Specifications of salt produced through internationally patented clarification-cum-pH control process

Description	Constituents (dry basis, %w/w)				
Sub-soil brine source	**NaCl**	**Ca**	**Mg**	**SO_4**	**Moisture & insoluble**
Rajula	> 99.3	0.09	0.04	0.25	< 1.0
LRK	> 99.2	0.11	0.05	0.30	<1.5
Bhavnagar	> 99.5	0.09	0.05	0.25	<1.0

The above results indicate that irrespective of the chemical composition of brine, the salt produced is of high quality with permissible impurities for its industrial applications. The innovative process of salt production has helped in maintaining Ca / Mg ratio 2 in all the cases.

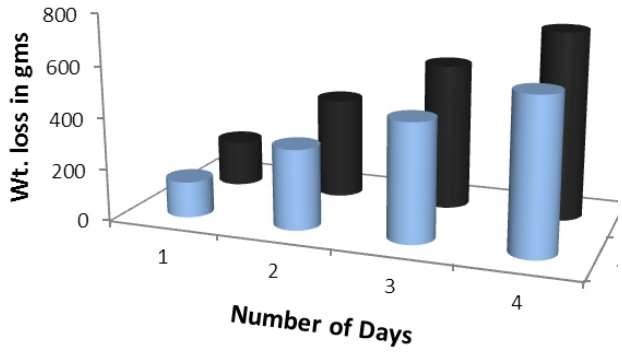
Semi mechanization of solar salt works

As reported in the earlier biennial report, semi mechanization process was employed in the experimental salt farm during the last two seasons for salt harvesting. This reduced the drudgery of labour involved in the harvesting of salt. The salt harvester was further modified for its easy operation in small scale crystallizers and, as a result, salt production increased 50% during the last season. The harvester-cum-loader which has now been designed will be introduced during the next salt harvesting season.

Mechanically harvested solar salt (left) heaping of salt at stacking platform (right)

Dye-assisted enhancement of evaporation rates in brines

Studies were initiated on use of dyes to accelerate the evaporation of brine. Those dyes were chosen which can be either decolorized readily after completion of the task or preferably, dyes which coagulate and settle down beyond a certain dye concentration and brine concentration. A set of evaporation experiments was carried out with 5 ppm of a suitable ink in 5.15° Bé sea brine. After 4 days the brine with a special dye showed 25% more evaporation than the control brine without ink and the brine temperatures in the two cases were 47 and 41°C, respectively, for experiments and measurements otherwise conducted in identical manner. The 6 °C higher temperature would raise the vapour pressure leading to faster evaporation. Experiments were thereafter conducted in the mini fields at experimental salt farm using 4° Bé seawater. It was observed that density rose to 25° Bé in 19 days for the brine with ink whereas in the absence of ink the time required was 23-25 days. An interesting observation was that coagulated dye obtained under certain conditions could be re-dissolved in dilute brine which may enable us to recycle the dye for a given initial dye concentration and defined initial and final brine densities.



Evaporation ponds containing brine with and without special dye (left);
Plot showing higher loss of weight (right) in dye-based system (black) compared to control (blue)

Process for reduction in fluoride content of salt and soda ash

Under a sponsored project with M/s Tata Chemicals Ltd, a process for improving quality of salt, produced in Magadi, Africa was developed, with reduction in fluoride content. A process for production of high purity soda ash from trona mineral was also developed with reduced fluoride content *(Patent Application No. 1028/DEL/2012)*.

Potash/magnesia-related R&D

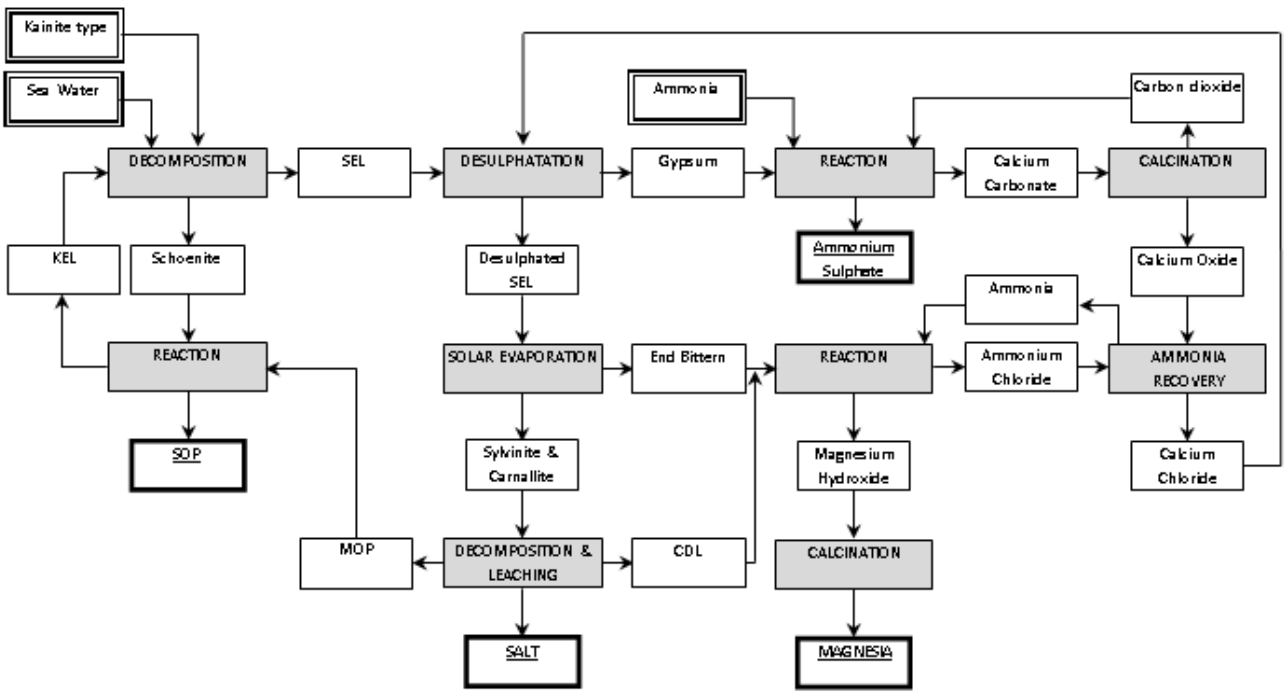
Technology licensing to M/s Tata Chemicals Limited

The know-how for the patented integrated sulphate of potash (SOP)/magnesia (MgO) process was demonstrated to M/s Tata Chemicals Limited and technology licensed. A 3 TPD test bed is presently under construction in the company's premises in Mithapur with part funding from the Department of Science & Technology, Government of India.

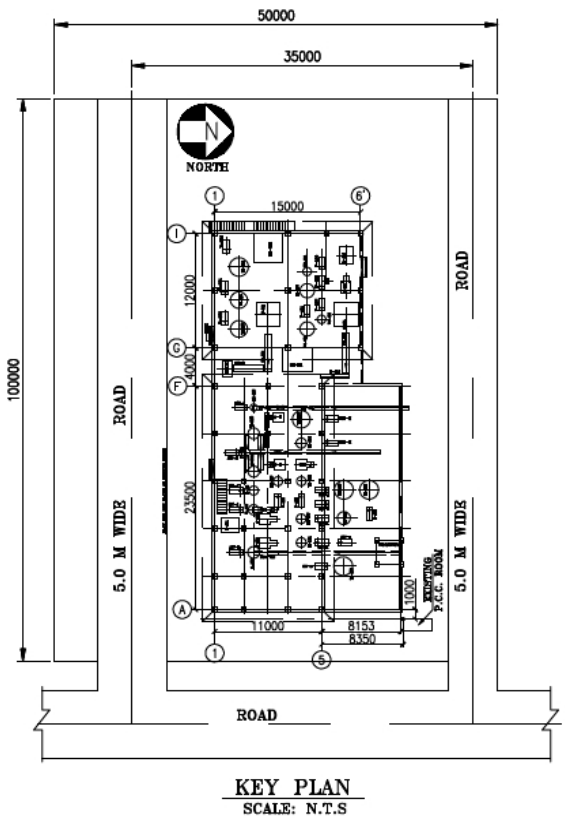
0.75 TPD SOP test bed at experimental salt farm (ESF)

Alongside the test bed being set up at TCL, a 0.75 TPD SOP test bed was also sanctioned by DST for installation at CSMCRI, as mentioned in the previous report. This nationally important project is driven by the vision to make indigenous SOP fertilizer production cost competitive vis- à-vis imported MOP with the ultimate aim of better soil and water management and sustainable agricultural productivity besides utilization of indigenous resources and job creation. The test bed will be based on our dual fertiliser process (see process flow diagram below), producing 0.75 TPD SOP (FCO grade), 0.75 TPD ammonium sulphate (FCO grade) and 0.3 TPD ultra-pure magnesia (PCT application cleared for patentability). M/s SNC-Lavalin Engineering India Limited (SLEI) was appointed as Engineering Consultant to carry out basic & detail engineering of the project. They have completed detail engineering design (given below) covering complete piping & instrumentation diagram, equipment layout, structural details, equipment specification, electrical & instrumentation detail, piping detail, etc. 5000 m^2 area at our experimental salt farm has been earmarked for the test bed. Site preparation work, including leveling & embankment has been completed. Geo-technical investigation has been done to assess load bearing capacity & resistivity of the soil. These data were further used for designing of civil structures. Installation & commissioning of substation & main power distribution centre has been completed.

INTEGRATED PROCESS FOR PRODUCTION OF SULPHATE OF POTASH, AMMONIUM SULPHATE & ULTRAPURE MAGNESIA USING SEA BITTERN-BASED MIXED SALT & AMMONIA AS ONLY INPUT



Schematic of integrated process of sulphate of potash, ammonium sulphate and magnesia



(left) Key plan and (right) Photographs of activities for preparation of SOP test bed at ESF

All the long delivery items have been ordered. Some critical equipment, viz., calciners, pusher centrifuges have already been received at site.

Equipment procured for SOP test bed at ESF

Procurement of balance equipment is scheduled in tandem with civil construction.

We have engaged M/s Auctors as Structure Design Consultant for monitoring and evaluation of the civil construction work. They have completed detail designing of the plant building in collaboration with M/s SLEI. Construction of the plant building is likely to be completed in 5-6 months' time, after award of order. The plant is expected to be commissioned by H1, 2013.

To address the problem of raw material sourcing for the SOP test bed, we prepared mixed salt (12 MT) at our experimental salt farm this season. We also procured 25 MT mixed salt from Rajula (Amreli distt., Gujarat), as part of CSMCRI's project with Agaria Hitrakshak Manch to benefit the marginal salt workers. Agarias prepared mixed salt under the technical guidance of CSMCRI scientists. Mixed salt is also being arranged from Greater Rann of Kutchh. 300 m^3 of subsoil bittern produced during the last salt season (the brine was treated with alum prior to salt production) was processed for the recovery of about 25 ton of crude carnallite. 500 m^3 of bittern produced during the last salt season has been preserved in storage ponds and this too will be used for the production of carnallite required for initiation of the SOP/MgO process. A sea water intake channel has been constructed to cater to the test bed's water requirement.

Production of kainite mixed salt at ESF

Average analysis of crude kainite type mixed salt produced at ESF

Constituents	% (w/w)
KCl	18.5
NaCl	19.4
$MgSO_4$	34.8
$MgCl_2$	5.8

Transfer of low sodium salt know how

Process for preparation of low sodium salt from bittern through the institute's internationally patented process was demonstrated to M/s Anish Chemicals, Bhavnagar, and the technology was transferred for commercial production.

Process for preparation of high bulk density (0.5-0.7) basic magnesium carbonate

A process for preparation of high bulk density (0.5-0.7) basic magnesium carbonate, suitable for use in pharmaceutical formulations, using bittern generated in solar salt works, was developed. The process has been demonstrated & the technology was transferred to M/s Anish Chemicals, Bhavnagar, for commercial production.

New innovations

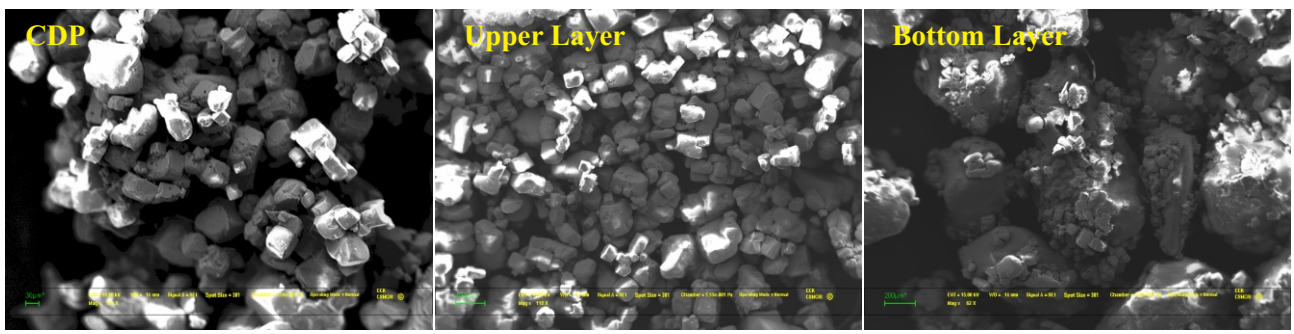
A novel approach for ambient temperature separation of KCl from carnallite decomposed product (CDP)

KCl is produced from carnallite mixed salt through its decomposition with water followed by hot leaching of the decomposition product (KCl + NaCl). Similar hot leaching operations are also required for purification of mined Sylvinite. The hot leaching process is very energy intensive & requires substantial capital investment. Thus there is a genuine requirement to develop an alternative approach for separation of KCl from NaCl which is economically viable and energy saving. The true densities of the KCl and NaCl crystalline solids were found to be 1.98 and 2.18 g/cm^3 (25°C) from the single crystal data of the respective salts. Based on these findings, further experiments were conceptualized to separate the two salts exploiting this small density difference. A non-reactive liquid medium, having density of 2.08, was prepared by blending 10 parts of ethylene dichloride (density: 1.252 g/cm^3) and 90 parts of ethylene dibromide (density: 2.17 g/cm^3). Artificial solid mixture of KCl and NaCl was added to the prepared medium in a separating funnel, shaken well for thorough dispersion and allowed to rest for phase separation. The solid collected from the upper fraction contained exclusively KCl while that from the lower fraction was solely NaCl. Yields of the two fractions added up to 100% recovery.

Subsequently similar experiments were carried out utilizing CDP obtained from decomposition of carnallite. CDP & solids obtained from both the layers were subjected to microscopy (SEM) & composition analysis (EDAX & ion chromatogram). The separation efficiency, as observed from the composition analysis, was poor, particularly for upper layer material. Probable reasons might be the presence of minute amount of magnesium in CDP. Presently experiments are in progress to separate potassium chloride from sodium chloride based on difference in true density & size, and encouraging results have been obtained as would be evident from the SEM images.

Average analysis of CDP, upper layer and bottom layer

Material	Analysis Method	KCl (%)	NaCl (%)
CDP	EDAX	59.02	27.41
	Ion Chromatogram	63.8	17.8
Upper Layer	EDAX	79.31	1.55
	Ion Chromatogram	70.3	15.2
Bottom Layer	EDAX	28.48	61.37
	Ion Chromatogram	25.8	72.45



SEM micrographs of CDP & solids obtained from upper and bottom layers

Integrated process of production of potassium sulphate and ammonium sulphate from kainite mixed salt

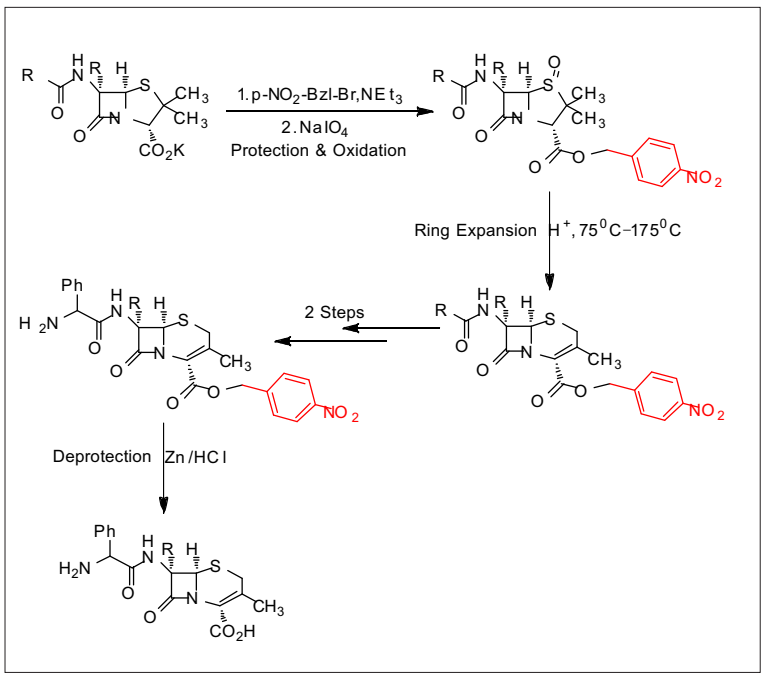
Whereas the process to be adopted in the SOP test bed entails production of sulphate of potash, ammonium sulphate and magnesia, it was felt that an alternative approach should be devised which dispense with the production of magnesia with concomitant process simplification. Thus an integrated process has been devised using bittern, ammonia and hydrochloric acid as the only raw materials. The process comprises, among other steps, the desulphatation of schoenite end liquor with calcium chloride, the said calcium chloride, along with carbon dioxide, being obtained from the reaction of calcium carbonate with hydrochloric acid. The gypsum formed on desulphatation is reacted with ammonia and carbon dioxide to produce ammonium sulphate in solution form and calcium carbonate as precipitate (Merseberg reaction). The calcium carbonate is re-utilized in the reaction with hydrochloric acid while the carbon dioxide is utilized in the Merseberg reaction. Except for ammonium sulphate recovery in solid state, where required, all operations are carried out at ambient temperature *(Patent Application No. 0600/DEL/2012).*

Process for production of sulphate of potash from bittern through selective extraction of potassium

Evaporite based technologies require considerable land area & favourable climatic conditions for solar evaporation. Selective extraction of potassium with the aid of suitable extractant addresses these concerns. A process was conceived and proof of concept studies undertaken to demonstrate selective extraction of potassium from bittern using tartaric acid and the production of sulphate of potash (SOP) and ammonium sulphate. This approach potentially can offer a viable solution, for optimum utilisation of the bittern sources in the Greater Rann of Kutch to meet India's requirement. *(Patent Application No. 0606/DEL/2012)*

Continuing studies on applications of patented green bromine reagent

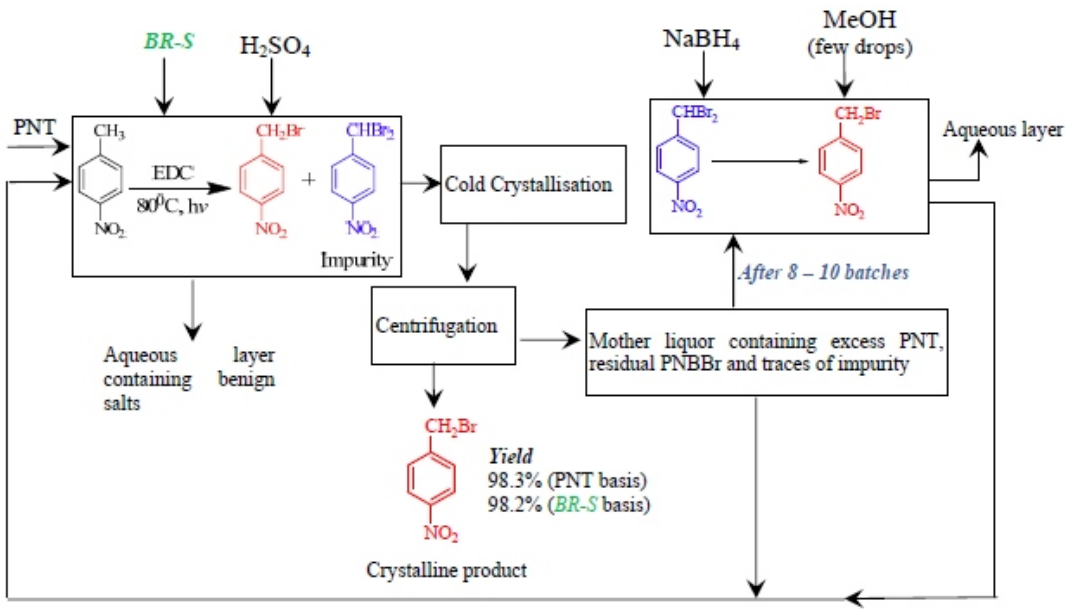
Clean synthesis of crystalline *p*-nitrobenzyl bromide from *p*-nitrotoluene with zero organic discharge



2:1 NaBr-$NaBrO_3$ obtained in crude form from the intermediate of liquid bromine manufacture as patented by the institute has been utilized in a number of bromination reactions including benzylic bromination. One such reaction of considerable commercial importance is the conversion of *p*-nitrotoluene (PNT) into *p*-nitrobenzyl bromide (PNBBr). There are presently 141 global suppliers listed for this very important compound employed in pharmaceuticals manufacture. The scheme on the right shows the protection-deprotection strategy employed by Eli Lily in 1974 towards the synthesis of Cephalexin intermediate.

Although the process was licensed by us a few years ago, there was scope for further improvement. Selective cold (0-5°C)

crystallization of PNBBr from the reaction mixture containing ca. 2.5 M PNBBr along with 2.5-5.0 M PNT in ethylene dichloride (EDC) was found to be a winning move which led to gains in two fronts. It allowed the bromination reaction to be carried out cleanly and also enabled direct recycle of the mother liquor in the subsequent batch. *Para* NO_2-Ph-$CHBr_2$ impurity, which built up gradually in the reaction mixture over 8 batches, was converted into PNBBr/PNT through treatment of the mother liquor with $NaBH_4$, helping thereby to recycle the liquor perpetually and eliminate organic waste. EDC was the sole solvent in the entire process and its losses were minimal. The combined yield of isolated and recoverable PNBBr was 98.30% with respect to PNT consumed. The reagent utilization efficiency was 98.26% (*RSC Advances 2 (2012) 6645).*



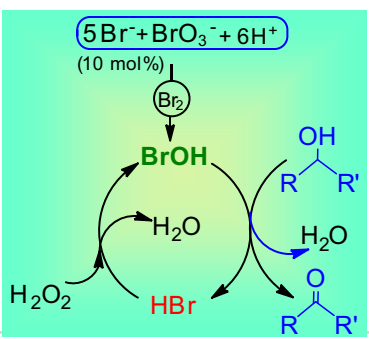
The scheme showing clean synthesis of crystalline *p*-nitrobenzyl bromide from *p*-nitrotoluene with zero organic discharge

Bromination of heterocycles using bromide-bromate couple in aqueous medium

Selective mono-bromination of aromatic heterocyclic compounds through *in-situ* acid activation of 2:1 bromide/bromate couple as a benign brominating reagent was explored. The *in-situ* acid activation of bromide:bromate couple generates the reactive species BrOH and it is proved to be efficient for bromination of various heterocycles under mild aqueous conditions without use of any catalyst. Heterocycles having electron rich substituents provided good yields (*Ind. Eng. Chem. Res. 50 (2011) 12271).*

$$3\ \text{Heteroarenes (H)} + 2\,Br^- + BrO_3^- \xrightarrow[3H^+,\ 5\text{-}10\ ^oC]{\text{aq .MeCN}} 3\ \text{Heteroarenes (Br)} + 3\,H_2O$$

Green bromine: *In situ* generated catalyst for selective oxidation of benzylic/secondary alcohols



A process for selective oxidation of benzylic/secondary alcohols to the corresponding aldehydes/ketones with catalytic amount of bromide-bromate (10 mol%) couple and H_2O_2 as benign oxidant was developed. The oxidation reactions were achieved through acid (15 mol%) activation of 5:1 mole ratios of bromide/bromate couple for *in situ* generation of Br_2/BrOH species (established by UV-vis spectrophotometric studies). High selectivity and yields of aldehydes/ketones were obtained under aqueous conditions without recourse to any catalyst *(RSC Advances, 2 (2012) 2235).*

BASIC STUDIES

Study of brine systems

Change in the ionic composition of sea brine during progressive solar evaporation as a function of brine density at varying temperature ranges

The ionic composition of sea brine as a function of density at 22.4 °C is reported in literature ("IV International Symposium on Salt" The Northern Ohio Geological Society Inc. Ohio (1974) Vol. 2, 351-58). During solar salt production the brine temperature is found to vary between 25 – 35 °C under Indian climatic conditions. Hence it was felt necessary to generate data on the composition of brine under ambient conditions prevailing in India. Accordingly, the change in concentration of various ions during the progressive solar evaporation of sea brine was investigated at the Experimental Salt Farm and the data are presented in the following table.

Major ionic composition [in % (w/v)] of sea brine during progressive solar evaporation as a function of brine density (Temperature range: 25 – 35 °C)

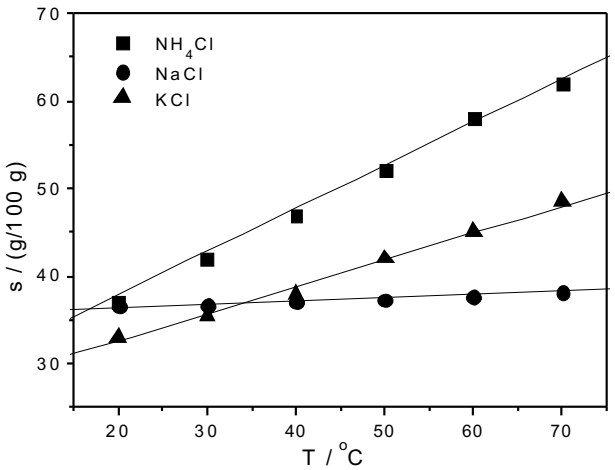
SR. No.	Specific Gravity	°Bé	Volume in liter	Ca	Mg	SO_4	Cl	Na	K
1.	1.038	5.31	20.0	0.11	0.18	0.49	2.81	1.54	0.06
2.	1.043	5.98	18.700	0.12	0.21	0.54	3.16	1.70	0.07
3.	1.048	6.62	16.200	0.13	0.23	0.60	3.41	1.87	0.07
4.	0.052	7.17	13.860	0.15	0.27	0.66	3.90	2.14	0.08
5.	1.064	8.73	12.100	0.17	0.32	0.79	4.54	2.46	0.08
6.	1.075	10.12	10.100	0.20	0.38	0.92	5.50	2.97	0.12
7.	1.085	11.36	8.100	0.15	0.45	0.96	6.52	3.57	0.14
8.	1.095	12.58	7.250	0.15	0.48	0.99	7.12	3.91	0.16
9.	1.104	13.66	6.400	0.15	0.56	1.02	8.04	4.37	0.18
10.	1.114	14.84	5.500	0.14	0.62	1.07	8.75	4.74	0.19
11.	1.125	16.12	4.950	0.13	0.70	1.15	9.72	4.94	0.20
12.	1.132	16.91	4.600	0.13	0.74	1.19	11.52	6.37	0.22
13.	1.138	17.58	4.240	0.12	0.77	1.23	12.06	6.67	0.23
14.	1.146	18.47	3.960	0.11	0.83	1.24	12.68	6.98	0.24
15.	1.157	19.71	3.580	0.10	0.91	1.30	13.15	7.16	0.26
16.	1.165	20.59	3.300	0.09	0.96	1.38	13.83	7.55	0.27
17.	1.181	22.2	2.920	0.08	1.06	1.45	15.29	8.34	0.28
18.	1.194	23.56	2.630	0.07	1.15	1.52	17.04	9.34	0.30
19.	1.207	24.89	2.430	0.05	1.23	1.61	17.94	9.82	0.32
20.	1.214	25.56	2.230	0.04	1.25	1.62	18.79	10.36	0.32
21.	1.222	26.33	1.860	0.04	1.43	1.88	19.22	10.40	0.37
22.	1.223	26.42	1.700	0.03	1.50	1.90	19.64	10.54	0.39
23.	1.228	26.90	1.150	0.03	2.23	2.73	19.22	8.92	0.97
24.	1.242	28.23	0.725	0.005	4.44	1.39	26.91	8.72	1.70

Attempt to explain the temperature invariance of NaCl solubility

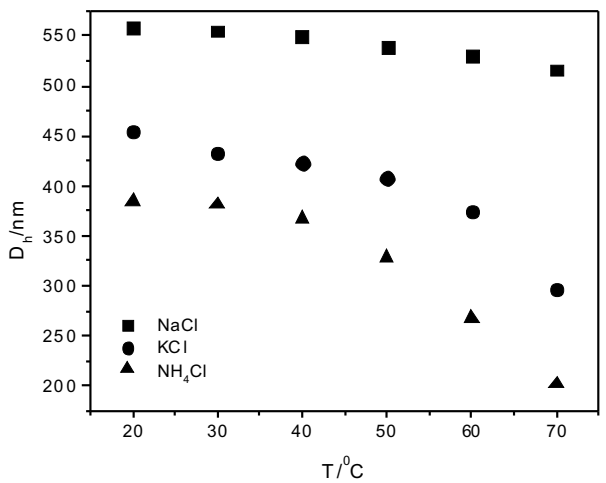
One of the most intriguing properties of NaCl is the near constant solubility of the salt in water over a large temperature range. To shed light on this phenomenon which is important from a technological perspective also, e.g., the recovery of KCl through hot leaching, the growth and stability of salt–water clusters were experimentally studied in aqueous solutions of NaCl, KCl and NH_4Cl from very dilute to near saturation conditions employing dynamic light scattering and zeta potential measurements. In order to examine cluster stability the changes in the cluster sizes were monitored as a function of temperature.

Compared to the other cases, the average size of NaCl-water clusters remained almost constant over the studied temperature range of 20-70°C.

Information obtained from the temperature-dependent solution compressibility (determined from speed of sound and density measurements), multinuclear NMR (^{1}H, ^{17}O, ^{35}Cl NMR) and FTIR were utilized to explain the cluster behaviour. Comparison of NMR chemical shifts of saturated salt solutions with solid state NMR data of pure salts, and evaluation of spectral modifications in the –OH stretch region of saturated salt solutions as compared to that of pure water, provided important information on ion pair–water interactions and water structure in the clusters. The high stability and temperature independence of the cluster sizes in aqueous NaCl shed light on the temperature invariance of its solubility *(J. Phys. Chem. B, 116 (2012) 11712)*.



Aqueous solubility of NaCl, KCl and NH_4Cl as a function of temperature.



Hydrodynamic diameter of the corresponding salt-water clusters as a function of temperature

Effect of clarifying agent on brine composition at 25 °Bé

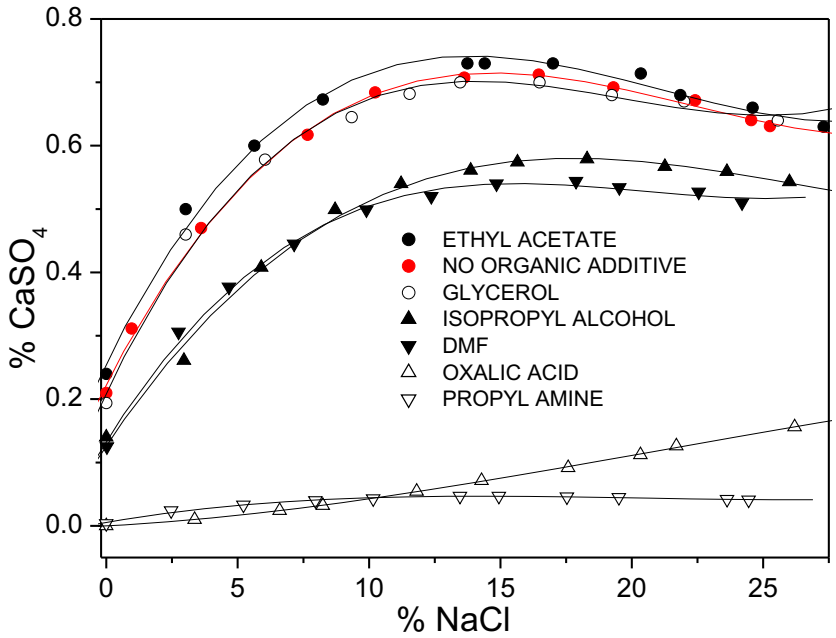
We have earlier reported the development of an innovative process for the recovery of high purity solar salt with improved whiteness from sea/subsoil brines which has been granted international patents (EP 1928569 B1 dated: 16/03/2011). It is observed that though there is no change in the composition of brine even after its clarification, the salt produced is of superior quality with improved whiteness. With a view to study the effect of chemical impurities in the treated brine, both sea and subsoil brines charged in the crystallizers for salt production, were analyzed. The analytical results are given in the following table.

Sample Details	Saturated subsoil brine	Saturated sea brine
Density ^{0}Bé	25.1	25.1
Ca^{2+} % (w/v)	0.10	0.05
Mg^{2+} % (w/v)	1.34	1.21
Cl^- % (w/v)	19.52	18.72
SO_4^{2-} % (w/v)	0.79	1.79
KCl % (w/v)	0.71	0.71
Al (ppm)	< 6	< 6

It was observed that there is no change in the composition of saturated brine except that the brine with clarification analyzed Al content in traces (< 6 ppm). However, the solar salt produced from the clarified brine contained ⩽ 0.3 ppm Al.

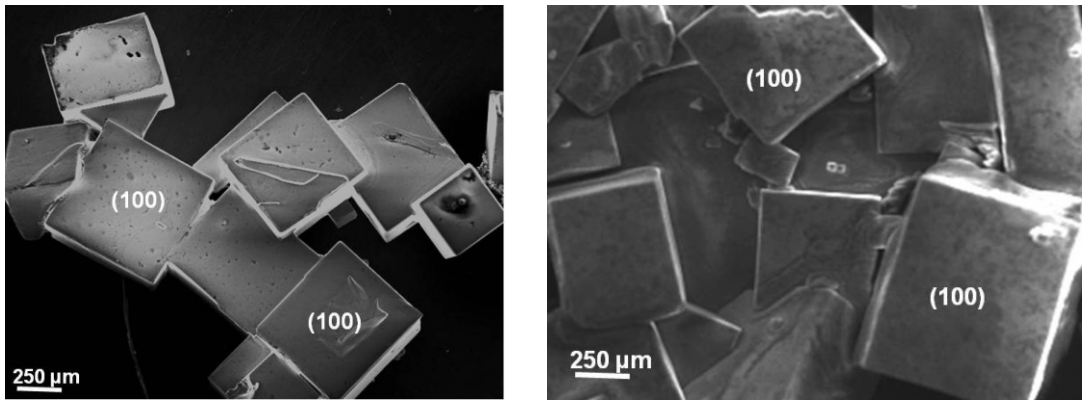
Effect of addition of organic additives on solubility of gypsum

Effect of organic solvents, such as ethyl acetate (EA), glycerol (GLY), isopropyl alcohol (IPA), dimethyl formamide (DMF), oxalic acid (OA) and propyl amine (PA) on the solubility of gypsum ($CaSO_4 \cdot 2H_2O$) in aqueous NaCl solutions at 35°C has been examined. Addition of EA slightly increased gypsum solubility whereas only a little alteration on solubility was found with the addition of glycerol. IPA and DMF decreased the gypsum solubility significantly and to nearly same extent. Gypsum solubility dropped to a marked extent i.e., <0.1 % in the NaCl solutions containing PA and oxalic acid which is probably due to strong hydrogen bonding interactions with these organic additives. These additives did not shift the solubility maximum of $CaSO_4 \cdot 2H_2O$, except in the case of solutions containing oxalic acid which showed a monotonic rise in solubility with NaCl concentration. Solution densities and speed of sound measurements were also carried out, and isentropic compressibilities were derived using these physical properties. Hydration characteristics of ions in solutions were examined.



$CaSO_4 \cdot 2H_2O$ solubility at constant organic solvent concentration (10%) but varying NaCl concentration at 35 °C. (●) EA; (●) No organic additive; (○) Gly; (▲) IPA; (▼) DMF; (Δ) OA; and (■) PA

Probing the influence of electronic effects of organic additives on the morphology of sodium chloride crystals: A combined experimental and computational study



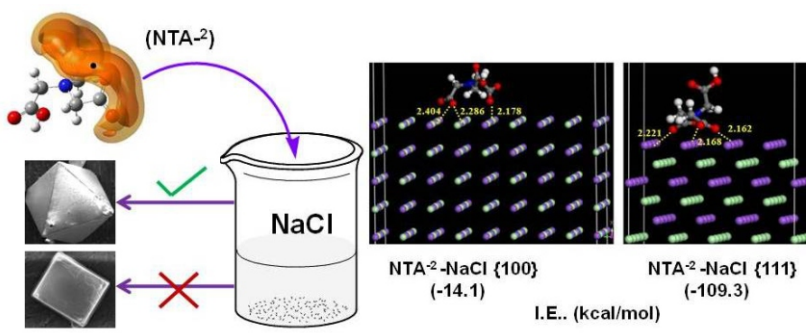
(a) (b)

Ex-situ SEM image of NaCl crystals grown from thioformamide solution (a); *ex-situ* SEM image of NaCl crystals grown from thiourea solution (b)

The influence of urea, thiourea, formamide and thioformamide on the morphology of sodium chloride was studied both experimentally and computationally. The oxo analog additives had pronounced effect on the morphology of sodium chloride changing from cubic to octahedron crystals whereas the thio analogs were ineffective. This striking difference was examined employing molecular electrostatic potential (MESP) surface and 3D periodic surface density functional calculations. MESP analysis showed that the sites of interaction for oxo and thio analogs would be different with the electrostatic polar {111} surface of sodium chloride. The model CBS-QB3 calculations supported the electrostatic potential analysis for the sites of interaction of these four additives with NaCl. Periodic surface calculations performed with slab models suggest that the thio analog binds weakly to {111} surface of NaCl (< 10.0 kcal/mol) and water molecules can possibly compete towards binding with such surfaces. This is the first systematic study to unravel the importance of electronic effects towards the habit of sodium chloride crystals with additives of similar molecular structures and volume *(Cryst. Eng. Comm., 12 (2010) 4168).*

Can nitrilotriacetic acid (NTA) act as a habit modifier for rock salt crystals? An answer from computational and experimental studies

This work has demonstrated that NTA can act as a habit modifier for rock salt crystals contrary to the earlier report. The computational studies revealed that the dissociated forms of NTA are responsible for the habit modification of NaCl. The experimental studies showed that NTA can influence the morphology of rock salt at small concentration levels. The salt crystals were confirmed to have superior free-flow characteristics compared to the normal cubic salt crystals. The lowest energy conformers of NTA and its dissociated forms obtained from conformational search protocols were considered to derive molecular electrostatic potentials (MESP) quantum chemically to predict the preferred sites of attack of NTAs on the important planes of NaCl *(Cryst. Growth Des., 11 (2011) 1675).*



Dissolution of microcrystals of KCl: DFT calculations and molecular dynamics

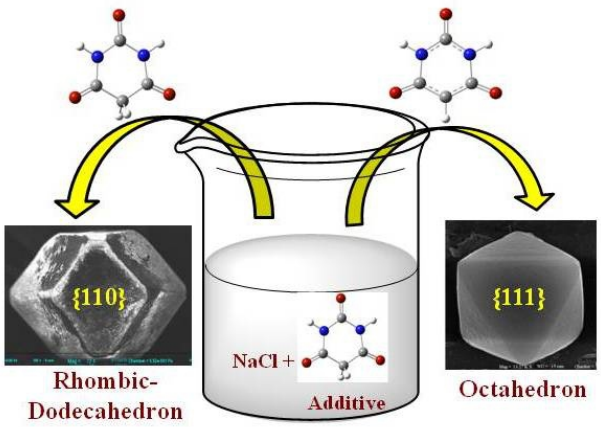
The study of the dissolution phenomena of potassium chloride microcrystal in water has been extended using DFT calculations and molecular dynamics studies. DFT studies reveal that the departure of Cl^- is more pronounced from the edge positions compared to the corner sites of the KCl [$(KCl)_6(H_2O)n$, n = 1-15] microcrystal lattice. The dissolution initiates with the movement of a Cl^- from the edge of the crystal lattice (5.19 Å) with n = 4 water molecules in agreement with the separation of ions from KCl molecule. This separation is more evident with the cluster of 6 water molecules (6.12 Å). The characteristics of KCl dissolution dynamics, such as the sequential departure of ions from the crystal, the hydrated ions and the dynamical role of water molecules during dissolution process were further studied by classical molecular dynamics simulations performed with GROMACS force field. The MD results show that a corner K+…Cl- ion-pair solvates first from the {100} crystal surface and dissolves into respective ions at longer time scales. The separation of ions from the corner sites of KCl {110} and {111} surfaces was also observed. The complete dissolution of {100} KCl crystal lattice is slower compared to its corresponding {110} and {111} surface. The radial distribution curves showed a multi-shell structure of water molecules around the microcrystal. The formation of ion-pairs shows an agreement to the study of dissolution of sodium chloride in water using Flicker Noise Spectroscopy (FNS) *(J. Comput. Chem., 31 (2010) 2948).*

Investigation of the non-bonded C–O/Br–Br interactions with various solvents by quantum chemical calculations

This study has explored the directionality of bromine molecule addition to the lone pairs at the sp^2 and sp^3 oxygen atoms of methanol, 1,4-dioxane, acetone, dimethyl ether, 1,3-dioxane and formaldehyde. The calculated results show that the directionality of bromine molecules towards interaction with the oxygen atoms of 1,4-dioxane and acetone is in accord with the observed X-ray crystal structure analysis. However, in the case of methanol, the approach of the bromine molecule seems to be influenced by the crystal forces. The influence of stereoelectronic effects towards the approach of the bromine molecule to 1,3-dioxane is more prominent than that of the 1,4-dioxane system. The existence and magnitude of the positive regions (s-hole) on the other side of the bromine molecule complexed with the donor molecule seem to facilitate the bridge formation as observed in the X-ray crystal structures *(Cryst. Eng. Comm., 14 (2012) 1833).*

Is dual morphology of rock-salt crystals possible with a single additive? The answer is yes, with barbituric acid

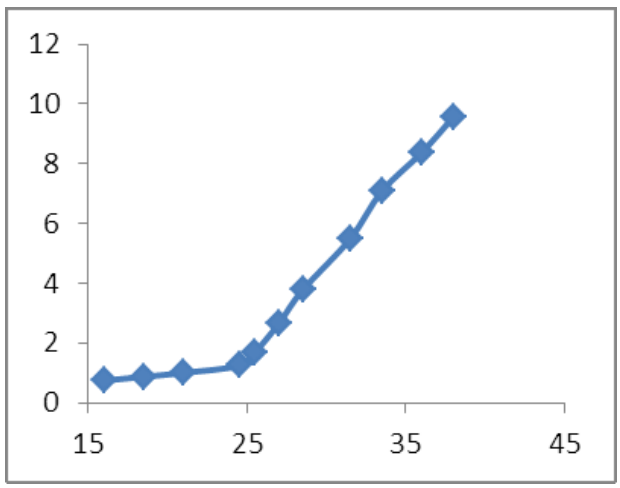
Barbituric acid is shown to be a new habit modifier for rock-salt crystals. It gave dual morphology of rock-salt crystals as shown previously for glycine also. The computational studies predicted that the barbituric acid can yield rhombic dodecahedron crystals at lower pH values and that with increasing pH value octahedron crystals are preferred, which was corroborated by the experimental studies. Unlike in the case of glycine wherein a high concentration of the additive was required,



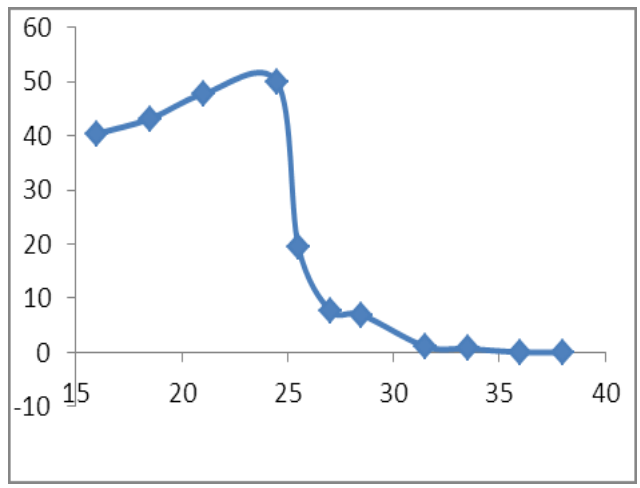
barbituric acid was effective at inducing rhombic dodecahedron NaCl crystals even at 0.08–0.2% w/v concentration and may thus be useful for practical applications. The combined approach of computational predictions followed by experimental corroboration is useful to design new additives *(Angew. Chem. Int. Ed., 124 (2012) 11441)*.

Studies on recovery of valuable trace elements (Li & Sr) from brine/bittern

As the previous analysis of brines of different density (°Bé) were inconclusive, forced evaporation studies on sea brine of initial density 16 °Bé was done and mapping of Li and Sr concentration (ICP-OES) at different densities were done as shown in the figures given below.



Plot of Li ion concentration (ppm) vs density (°Bé)



Plot of Sr ion concentration (ppm) vs density (°Bé)

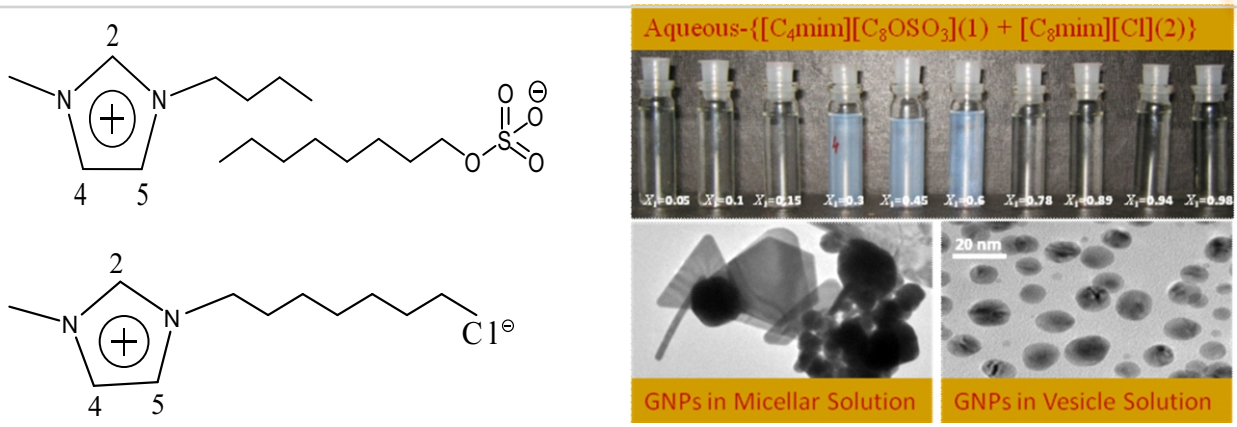
With increasing density of brine, the lithium concentration increased monotonically up to 38 °Bé. The maximum concentration achieved was 10 ppm, i.e., 50-fold increase over the concentration in seawater. The strontium concentration increased up to 25 °Bé and then decreased sharply as shown in the figure. This is ascribed to the build-up of sulphate concentration and consequent precipitation of poorly soluble $SrSO_4$. These observations are consistent with a previous analysis showing high content of Sr in subsoil brine which has lower sulphate content than sea brine. Syntheses of novel Li and Sr selective ligands were also continued. The clathrate compound, tetra-2-O-naphthoide, was found to bind Li^+ in organic solvents but uptake was low from aqueous medium.

Studies on liquid salts (ionic liquids)

Due to their unique physicochemical properties and designer characteristics, we have embarked on investigations on ionic liquids in different media, and explored their potential applications.

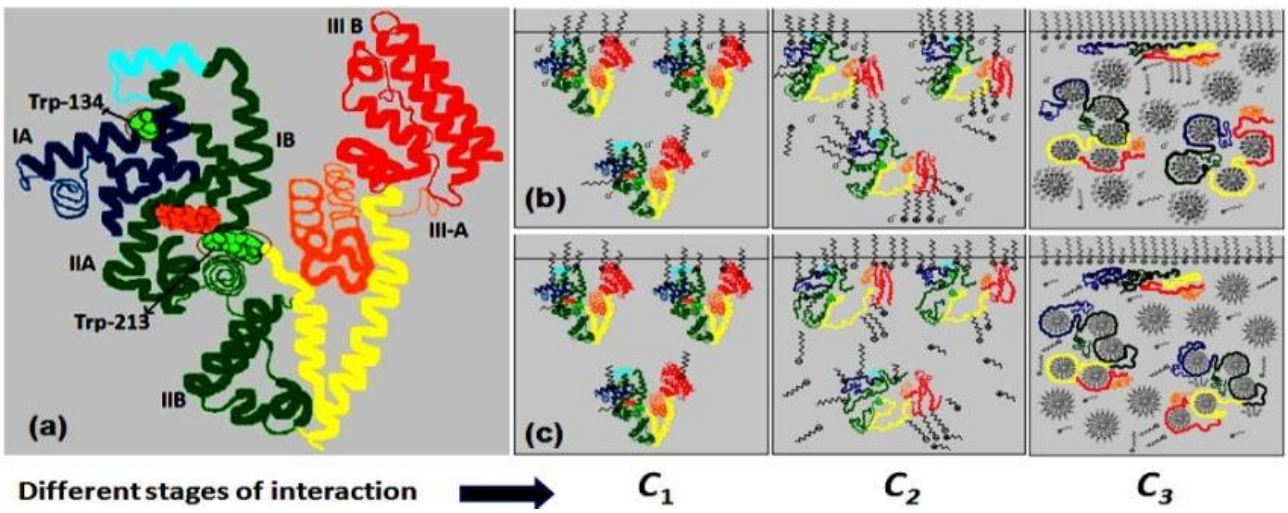
(1) The properties of a mixture of ionic liquids, namely 1-butyl-3-methylimidazolium octyl sulphate and 3-methyl-1-octylimidazolium chloride, in water were studied. Micelle-vesicle-micelle (MVM) transitions were observed. Their surface activity, phase behaviour and solution structures were characterized using conductometry, tensiometry, fluorimetry, dynamic light scattering (DLS), viscometry, turbidity, atomic force microscopy (AFM), transmission electron microscopy (TEM) and ^1H NMR techniques. Using a photo-reduction technique, formation of stable gold nanoparticles (GNPs) and microscale nanosheets of different shapes and sizes in the micellar and vesicular solutions were observed *(Langmuir, 27 (2011) 9261)*.

(2) In continuation of investigations on effect of



(left) Molecular structures of the ILs used and (right) phase behavior of aqueous mixed ILs solutions and gold nanoparticles prepared therein

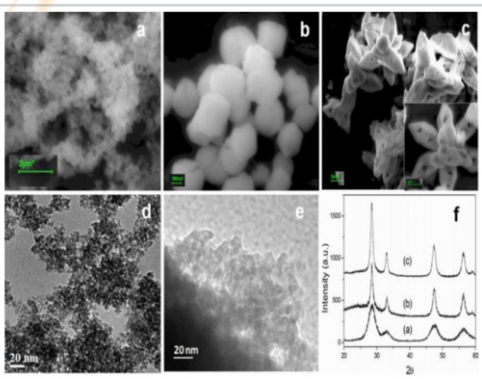
ionic liquids on biopolymers in aqueous solution, we studied the structural changes of a globular protein, bovine serum albumin (BSA), in different IL concentration regimes, and the different stages of interactions are shown in the scheme *(J. Phys. Chem. B, 116 (2012) 11924).*



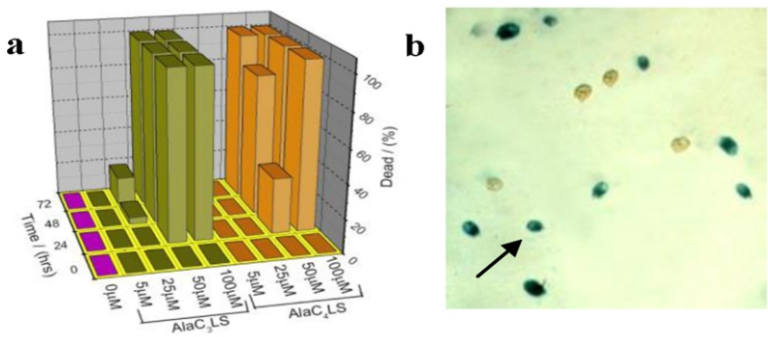
Schematic of (a) Native BSA; (b) BSA + [C_8mim][Cl]; and (c) BSA + [C_4mim][C_8OSO_3]. C_1 signifies the *cac* below which IL ions begins to interact with the BSA at the interface via electrostatic interactions and forms BSA-IL (monomer) complexes; C_2 correspond to BSA-IL (aggregate) complexes driven by both electrostatic and hydrophobic interactions; and C_3 shows the BSA-IL (micelle) complexes and free micelles.

as a consequence of interaction with 3-methyl-1-octylimidazolium chloride ([C_8mim][Cl]) and 1-butyl-3-methylimidazolium octylsulfate ([C_4mim][C_8OSO_3]) at different IL concentration regimes at air/solution interface as well as in the bulk. Circular dichroism measurements combined with steady state fluorescence spectroscopy provided valuable insights into the unfolding of BSA as a consequence of IL binding. The complementary results obtained from the multi-technique approach proved useful in proposing a mechanism of interaction between ILs and BSA

(3) Amino acid-based ionic liquid surfactants (AAILSs) were synthesized. L-glycine, L-alanine, L-valine, L-glutamic acid and L-proline were chosen to probe the effect of simple variations. Since incorporation of an ester group in the amino acid has been reported to decrease the melting point and increase biodegradability significantly, esterification of amino acids was carried out with either isopropyl alcohol or isobutyl alcohol. Equimolar amounts of amino acid ester hydrochlorides (AAECls) and SLS were then dissolved in hot water. After the completion of reaction, water was removed



Synthesis of CeO_2 nanoparticles using AAILSs



Mitigation of harmful algae *Amphidinium cartarae*, a toxic phytoplankton

under vacuum and AAILSs were extracted by addition of dichloromethane.

The structures of AAILSs were confirmed using various analytical techniques. Differential scanning calorimetry revealed melting temperatures <30 ^{0}C for all the AAILSs except $GluC_4LS$. Study of the surface properties revealed the superior surface activity of AAILSs over analogous ILs and conventional ionic surfactants. Additionally, applications of representative AAILSs towards (i) mitigation of harmful algal blooms and (ii) controlled synthesis of nanostructured materials of technological importance – such as CeO_2 – were demonstrated (*J. Phys. Chem. B, 115 (2011), 13847; ChemSusChem., 4 (2011) 604*). The work was featured in *Nature India*.

doi:10.1038/nindia.2011.69; Published online 16 May 2011

Research highlight

Versatile surfactants

Researchers have successfully produced new amino-acid-derived ionic liquid surfactants that could prevent the harmful growth of marine algae. The surfactants could also aid the synthesis of nanomaterials and biomolecular devices.

Algal growth has adverse effects on fishing, tourism and human health. Biosurfactants such as glycolipids and lipoproteins can counter algal growth, but are difficult and expensive to produce. In recent years, ionic liquid surfactants have emerged as promising alternatives because of their high water solubility and ability to self-assemble. However, some ionic liquid surfactants are loaded with halogen atoms, which, if released, can be potentially harmful to the surrounding environment.

The researchers used natural amino acids such as glycine, alanine, valine, glutamic acid, proline and sodium lauryl sulphate to produce eco-friendly amino-acid ionic liquid surfactants (AAILSs). They then exposed the AAILSs to Amphidinium cartarae, a toxic marine alga, to test their ability for preventing algal bloom. Results showed that very low concentrations of AAILSs were sufficient to kill algae without any detrimental effects on the surrounding environment.

The surface tension of the AAILS solutions reached the value of natural seawater within 36 hours, which indicates rapid and complete biodegradability. The very high biodegradability of AAILSs ensures that they disappear quickly after halting algal bloom. In addition to checking algal growth, the surfactants also helped shape nanostructures such as spheres, cubes and star-shaped structures from cerium ammonium carbonate solution.

"The AAILSs are highly water-soluble, biodegradable and non-toxic, which makes them potential candidates for drug-delivery applications," says lead researcher Arvind Kumar from the Central Salt and Marine Chemicals Research Institute, Gujarat. He adds that these AAILSs have a higher surface activity than conventional surfactants.

INORGANIC MATERIALS & CATALYSIS

Process developments: Marine chemicals / Specialty inorganic chemicals

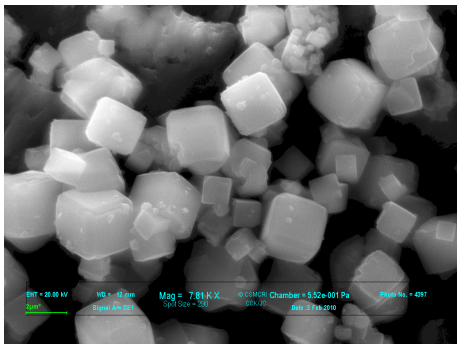
Synthetic hydrotalcite

An exploratory work on preparation of synthetic hydrotalcite (SHT) utilizing waste streams of M/s Heubach Color Pvt. Ltd., Ankleshwar – a leading manufacturer of organic pigments was carried out. A process was developed for preparation of SHT using effluents generated at client's manufacturing facility such as aluminium chloride and ammonium carbonate produced in their phthalocyanine pigment plant. Magnesium part of the product was taken from the bittern - mother liquor left out after recovery of salt from brines.The process was further scaled up from lab scale to pilot scale (30 g to 5 kg) and the specifications matched well with the bench mark product meeting international standards. Process demonstration was given on 5 kg scale. A plant with detailed design was made by the engineering consultant of the M/s Heubach in consultation with the scientists from CSIR-CSMCRI. The plant was inaugurated by the Mr. Rainer Heubach, Chairman of the company on 10th October 2012. The plant has a production capacity of 1000 tons per annum and produces the product that matches international specifications. The product has been imported to meet the requirement hitherto.

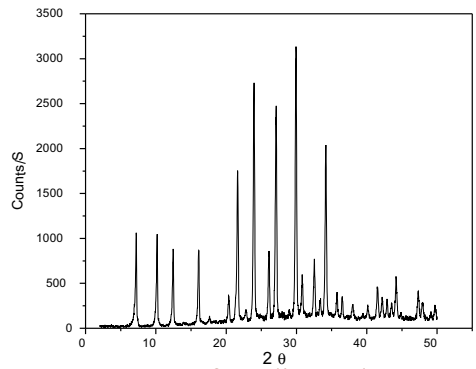
Inauguration of the plant by the Mr. Rainer Heubach, Chairman, M/s Heubach, Gemrany (inset is the reaction vessel)

Development of zeolite-A detergent builder from low grade Kutchh bauxite

Low grade bauxite lumps of different mines located in Kutchh, Gujarat, were supplied by M/s. Reminco Mineral Resources, Ahmedabad. The powdered bauxite was used to optimize the conditions of maximum leaching of alumina. The sodium aluminate solution thus obtained was used to produce zeolite-A detergent builder on 30 kg/batch. The properties of this product matched those of global products. 15 kg of product was provided to the party for testing at user end. Economic analysis of project on 10,000 & 50,000 TPA scales having in-house production capacity of sodium silicate and using lignite as fuel was done. The know-how was licensed to M/s Credo Mineral Industries Limited, Ahmedabad and the party has now entered into a joint venture with GMDC for commercialisation of the technology.



SEM image of zeolite-A detergent builder from low grade bauxite



XRD pattern of zeolite–A detergent builder from low grade bauxite

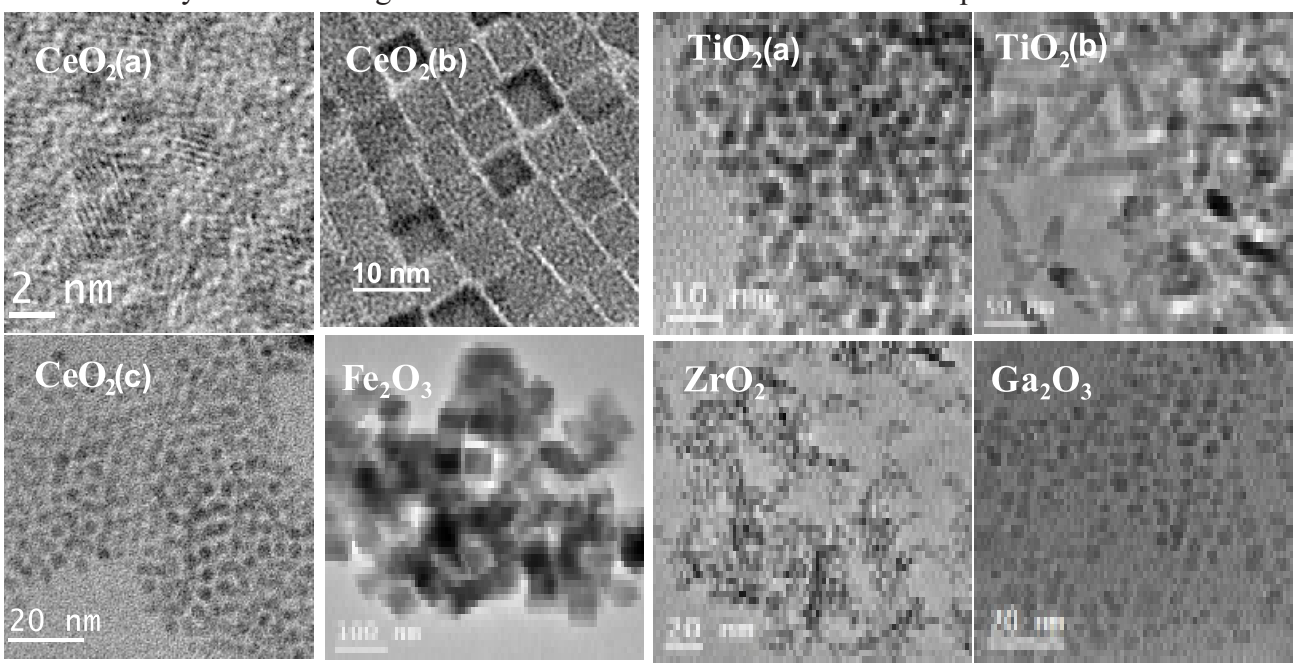
Production of precipitated calcium carbonate (PCC) & activated calcium carbonate (ACC) from low grade limestone and burnt lime

Low grade limestone and burnt lime were supplied by M/s. Sri Krishna Industries, Mumbai and M/s. Ashirwad Minerals, Lokapur (Karnataka), respectively, to undertake the feasibility study of producing PCC & ACC. The samples were analyzed for their chemical composition and it was found that the available lime is less, and acid insoluble is high compared to conventional limestone. Calcination temperature was optimized for maximum conversion to calcium oxide. About 5 kg each of PCC and ACC was produced and supplied to the party for testing at their end. Their physicochemical properties were found comparable with those of IS specifications.

Materials Research

Synthesis of nearly monodispersed metal oxide nanoparticles in water

The size, shape and dimension dependent optical, electrical, magnetic, catalytic and mechanical properties of nanostructured materials are well established. Innovations around new synthetic strategies for size and shape control are an important topic in frontier scientific research. Numerous surfactant assisted methods have been reported in the literature for this purpose. But to achieve precise control of size and shape in surfactant-assisted

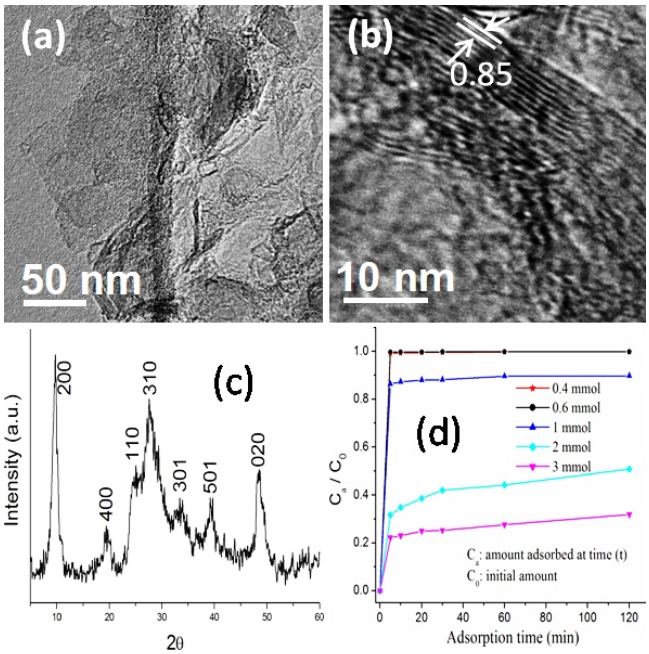


TEM images of various metal oxide nanoparticles prepared in water

non-hydrolytic methods, noxious and expensive organometallic compounds or metal-surfactant complexes are used. Organic solvents, surfactants and high temperature are also required. These hinder their application in industry. It was, therefore, imperative to develop an eco-friendly method, which makes use of innocuous chemicals and reaction medium (solvent). Towards this end, a novel, simple and versatile approach for the synthesis of variety of metal oxide nanostructures with controlled size and shape was developed, using water as solvent and freshly prepared aqueous metal ammonium carbonate complex solution as precursor under hydrothermal conditions. The variation of hydrothermal treatment time, temperature and concentration of precursor permitted control over particle size and shape *(New J. Chem., 35 (2011) 1460).*

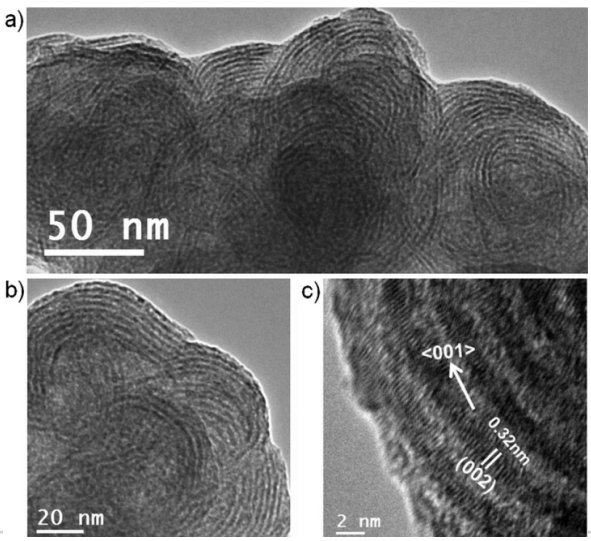
Room temperature synthesis of protonated layered titanate sheets using peroxo titanium carbonate complex solution

Owing to their unique structural and physiochemical properties, layered titanates show interesting ion exchange, absorption, photoelectronic and catalytic properties and are considered promising materials in Li-batteries, catalysis, sensors, and anti-bacterial coatings, and also as ionic absorbents. Traditionally alkali metal layered titanates are synthesized under hydrothermal conditions using a titanium precursor in concentrated NaOH or by calcining the mixture of titanium precursor and Na_2CO_3 at higher temperature. A novel room temperature method was developed for the direct synthesis of protonated layered di-titanate sheets ($H_2Ti_2O_5.H_2O$) with specific surface area of 96 $m^2\ g^{-1}$. The procedure avoids organic molecules and uses instead a unique water-soluble peroxo titanium carbonate complex as precursor. The probable mechanism of synthesis was also identified. The synthesized titanates showed excellent removal of Pb^{2+} and methylene blue *(Chem. Commun., 47 (2011) 7731).*

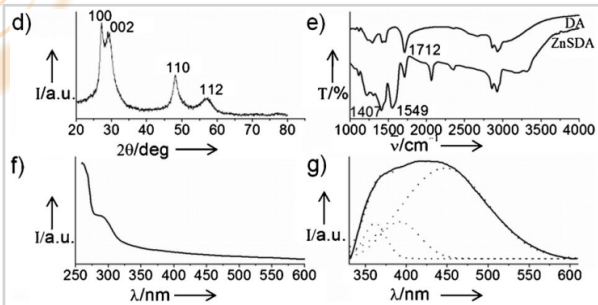


TEM images, XRD pattern and rate of removal of Pb^{2+} of the synthesized layered titanate at room temperature

Onion slice shaped assembled ZnS quantum wires



Zinc sulfide (ZnS) has been studied extensively for its unique photoluminescence and electroluminescence properties and has been widely used in different optoelectronic devices. A novel synthetic strategy was developed for ultra-narrow ZnS quantum wires with ~1.5 nm width and having wurtzite structure. The synthesis involved a simple hydrothermal procedure employing aqueous zinc ammonium carbonate complex solution, aqueous potassium ethyl xanthate (XA) and decanoic acid solution. The wires were formed through an oriented attachment mechanism from W-

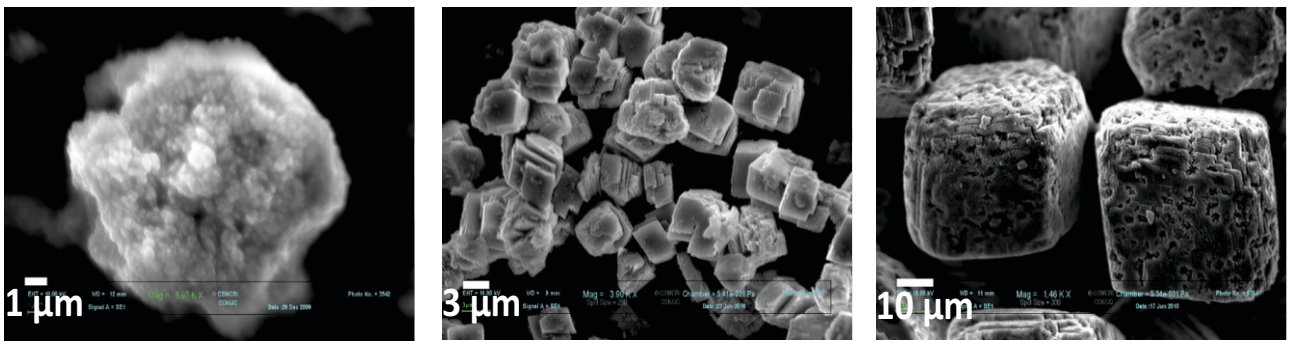


ZnS spherical particles. Further, the wires were found to bend and self-assemble into an onion slice shape. A probable mechanism of its formation was proposed *(Chem. Commun., 48 (2012) 850)*.

TEM and HRTEM images (a-c), XRD pattern (d), FT-IR spectra (e), UV-vis absorption spectrum (f), and (g) photoluminescence spectrum of the ZnS wires

Co_3O_4 micro cubes through soft-chemical decomposition of CoAl-LDH

Layered double hydroxides (LDHs) are well known materials as catalysts, thin films, nano composites, ion-exchangers and drug carriers. An uncommon cobalt carbonate was synthesized hydrothermally using CoAl-LDH as unitary precursor, the latter being obtained through urea hydrolysis of metal nitrates. A novel strategy was adopted to remove the co-crystallized aluminum phases through a controlled acid-base treatment protocol. The obtained cobalt carbonate had a unique layered structure which further assembled into microcubic morphology. Calcination of this carbonate resulted in a Co_3O_4 spinel having unusually high electrical conductivity *(Communicated)*.

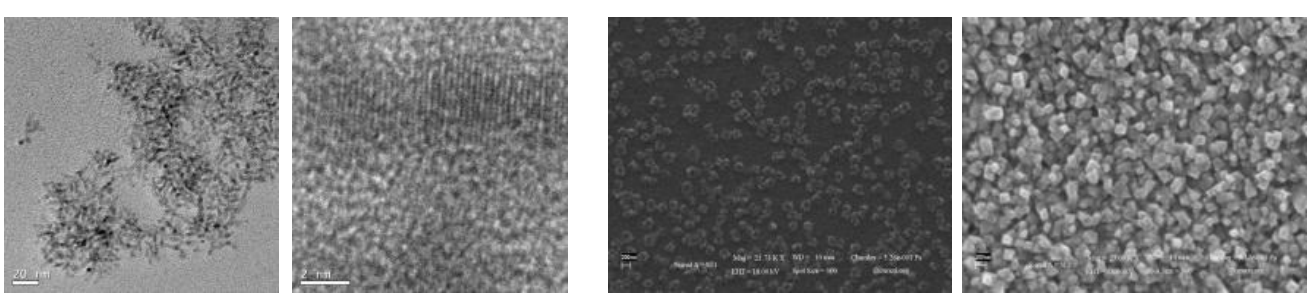


Co_3O_4-commercial Co_3O_4-UH Co_3O_4-LDH-decomp

SEM images of different Co_3O_4 materials

In-situ synthesis of copper nanostructure in polymer matrix

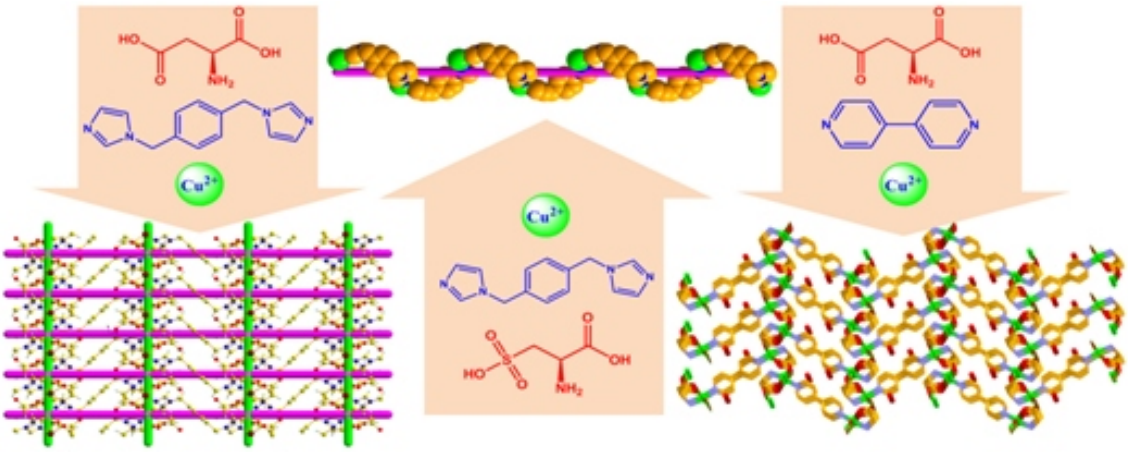
Properties of nanocrystals are strongly influenced by their size, shape and assembly. The synthesis of metal nanostructures is mostly based on the colloidal route and the size and shape control are often controlled through the choice of capping agents. We studied the growth of copper nanocrystals inside anisotropic environments such as thin solid polymer films using polymer itself as a reducing as well as stabilizing agent. The composite thin films may be useful for device fabrication towards catalysis, sensor as well as nano capacitor applications.



TEM images of a copper - polymer thin films SEM images of a copper - polymer thin films

Metal-organic framework

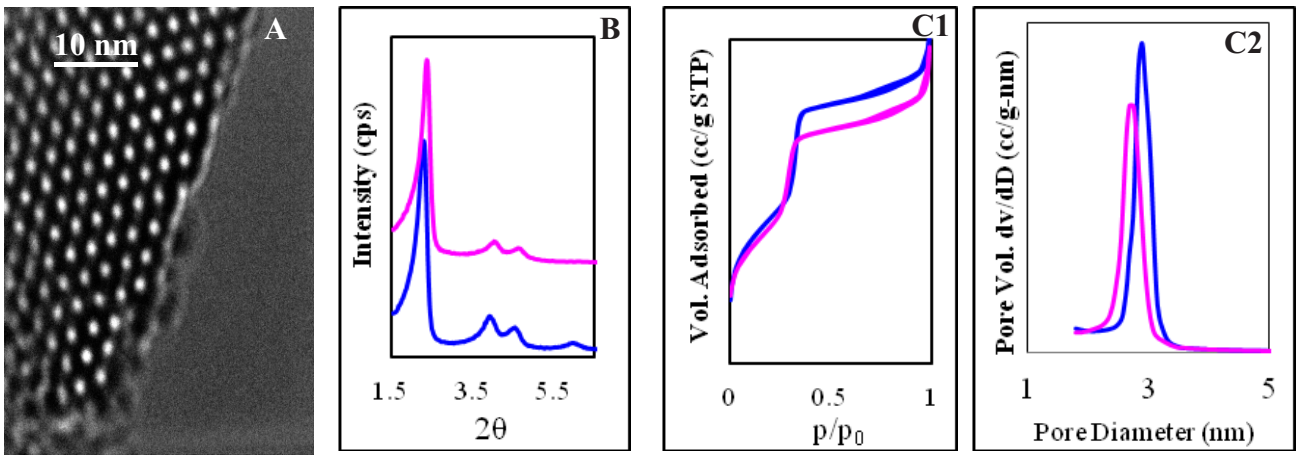
Design, synthesis, and characterization of coordination polymers continue to be of growing relevance because of their potential application as smart materials for storage of gas and other small molecules. The institute has been working in this area for some time and as part of our continuing effort, a number of metal organic frame work (MOF) materials of Cu(II), using amino acids as ligand and 4,4'-bipyridine as bridging unit, were synthesized and structurally characterized. These included {[Cu-(L-cysteate)(1,4-Bix)(H_2O)] H_2O}$_n$, {[Cu(L-aspartate)(1,4-Bix)$_{0.5}$].3H_2O}$_n$ (*1,4-Bix = 1,4-bis(imidazol-1-ylmethyl)benzene*) and {[Cu(L-aspartate)(4,4'-Bpy)$_{0.5}$].H_2O}$_n$. Analysis of crystal data revealed 1-D, 2-D, and 3-D helical structures of the coordination polymers. The chiral nature of complexes was established through solid state CD spectral studies and temperature-dependent magnetic properties of these complexes. *(Cryst. Growth Des., 11 (2011) 1631).*



(1) (2) (3)

Large scale synthesis of MCM-41 with improved thermal and hydrothermal stability

MCM-41, an ordered mesoporous material with uniform hexagonally arranged cylindrical pores of ~2-3 nm diameter and surface area in the range of 700 to 1000 m^2/g is normally synthesized under hydrothermal condition at ~100 °C for very long period of time (in days) using cationic surfactant, CTAB as structure directing agent. The major drawback of the material is poor



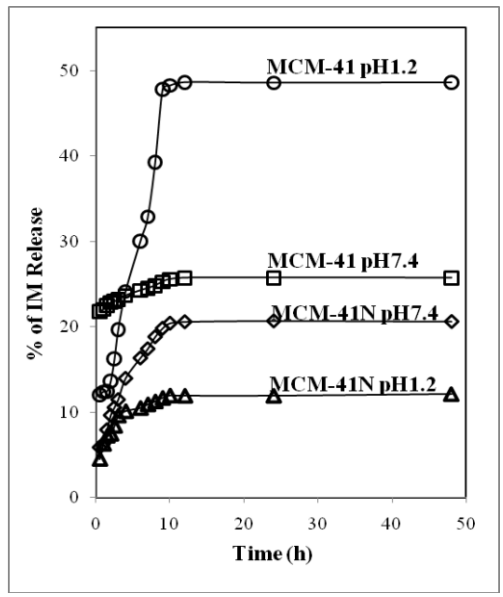
TEM image of MCM-41 sample calcined at 600 °C (A), powder X-ray diffraction patterns (B), nitrogen adsorption isotherm (C1) and BJH pore size distribution (C2) of MCM-41 calcined at 600 °C (blue) followed by hydrothermal treatment (100 °C, 24 h in water; pink)

thermal and hydrothermal stability. A methodology has been developed for the synthesis of MCM-41 type mesoporous silica with improved thermal and hydrothermal stability at room temperature on 3 kg batch scale.

Controlled drug release

Release of indomethacin from MCM-41 and amino functionalized MCM-41

Controlled release of indomethacin (IM), a non-steroidal anti-inflammatory drug, from MCM-41 and amino functionalized mesoporous silica was studied. At gastric pH, 26 % of the indomethacin was released within 10 h from MCM-41 whereas 48 % was released at intestinal pH. For amine functionalised MCM-41 (MCM-41N), the release was 12 % after 10 h under intestinal pH condition.



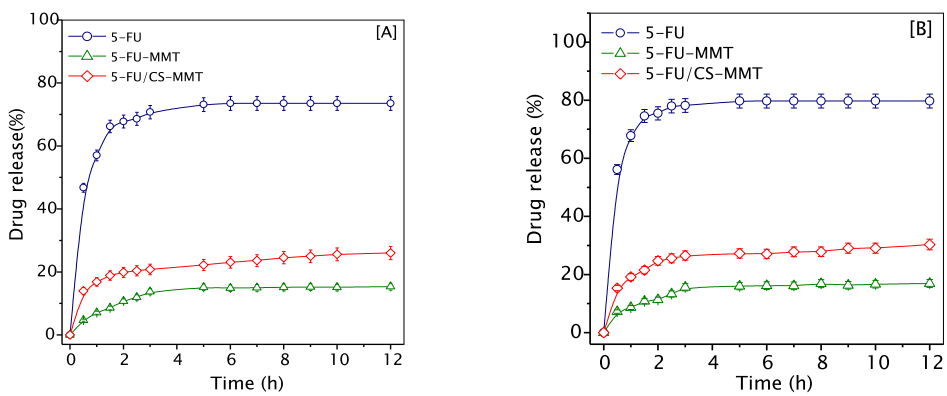
In vitro release behaviors of Indomethacin in physiological pH

Controlled release of quinine on chitosan–montmorillonite bio-nanocomposites

Series of chitosan (CS) intercalated montmorillonite (MMT) nanocomposites prepared via ion-exchange route were loaded with the antimalarial drug, quinine (QUI). These were filled into gelatin capsules followed by coating of Eudragit® L 100. The capsules thus obtained were tested for *in vitro* drug release performance in the sequential buffer environments at 37 ± 0.5 °C. No drug release was observed in the gastric fluid whereas under intestinal pH condition release was observed and, further, it was faster from the chitosan intercalated clay compared to pure clay. In this system two different release mechanisms are in action, i.e., one due to the Eudragit® L 100 coating and the other due to clay (*J. Polym. Sci. Part A: Polym. Chem., 50 (2012) 423)*.

Layered inorganic nanocomposites: A promising carrier for 5-fluorouracil (5-FU)

The intercalation of 5-fluorouracil (5-FU), an anticancer drug in interlayer gallery of Na^+-clay (Montmorillonite, MMT), with the assistance of biopolymer (chitosan, CS) was studied. *In vitro* drug release showed controlled release pattern. The genotoxic effect of drug was evaluated *in vitro* in human lymphocyte cell culture by comet assay, and results indicated significant reduction

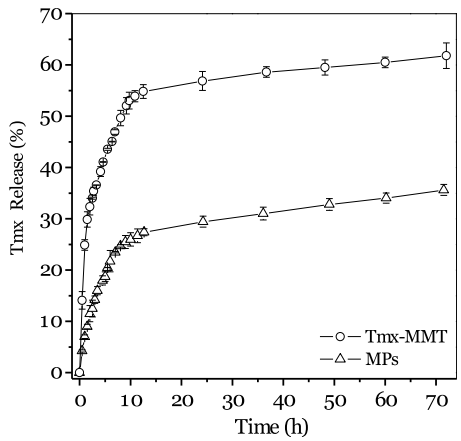


In *vitro* drug release profiles of 5-FU in (A) pH 1.2 and (B) pH 7.4 at 37 ± 0.5 °C

in DNA damage when drug was intercalated with clay. *In vivo* pharmacokinetics, bio-distribution, hepatotoxicity markers, e.g., SGPT and SGOT, and liver/testicular histology in rats showed that plasma/tissue drug levels were within therapeutic window as compared to pristine drug. The work was undertaken in collaboration with Veer Narmad South Gujarat University, Surat (*Eur. J. Pharm. Biopharm., 81 (2012) 91).*

Montmorillonite/poly-(ε-caprolactone) composites for anticancer drug and controlled release property

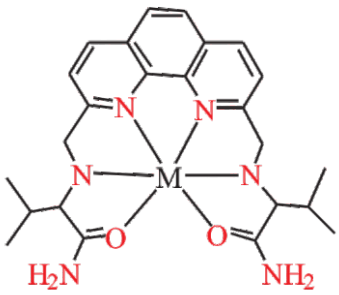
Intercalated tamoxifen (Tmx) in the interlayer gallery of Na^+-MMT (Montmorillonite (Tmx–MMT), further compounded with poly-(ε-caprolactone) (PCL) (Tmx–MMT/PCL, MPs), was studied for oral chemotherapy of breast cancer. *In vitro* drug release profiles showed controlled release pattern. *In vivo* pharmacokinetics of formulated Tmx in rats (conducted by Veer Narmad South Gujarat University, Surat) showed that plasma Tmx levels were within therapeutic window as compared to pristine Tmx (*Eur. J. Pharm. Sci., 47 (2012)265).*



In vitro release profiles of Tmx in simulated intestinal fluid (pH 7.4) at 37 ± 0.5 °C

Molecular sensors for biologically and industrially important ions and molecules

The development of molecular sensors for efficient detection of a specific metal ion is an emerging area in chemistry because such specificity is critical in various chemical, biological and environmental processes. The institute is actively involved in this area of research and has contributed significantly during the last few years. Highlights of the further work undertaken during the reporting period are described briefly below.

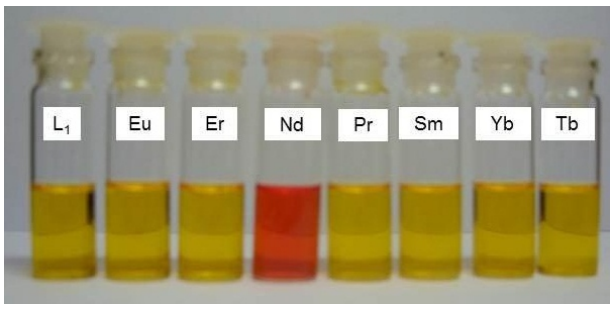


M =La^{3+}, Eu^{3+}, Tb^{3+}, Lu^{3+} and Y^{3+}

Sensor for ATP: It was demonstrated that an easily synthesizable Zn(II)-reagent could be used as a viable staining agent for Prokaryotic and Eukaryotic cells through the reversible binding to ATP, produced in situ during the cell growth process. This reagent was nontoxic and studies could be performed in pure aqueous or aqueous HEPES buffer (pH = 7.2) medium *(Chem. Commun., 46 (2010) 9134).*

Lanthanide fluorescent sensor: Phenanthroline based hexadentate ligand and their lanthanide complexes possessing chirality were synthesized. The complexes exhibited a red emission at room temperature and were used for the selective binding of phosphate and ATP anions *(Chem. Eur. J., in press).*

Sensor for Nd^{3+}: A rare example of a reversible recognition of Nd^{3+} by a newly synthesized molecular receptor (L_1), having a diazo group as the reporter functionality, was found. Studies revealed that this receptor eventually forms a



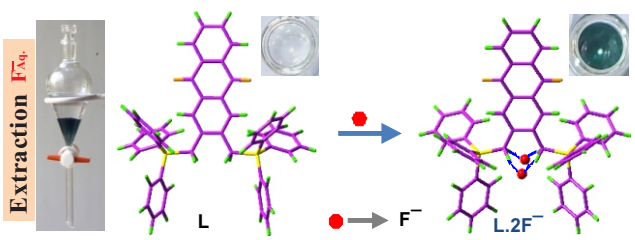
$[Nd^{3+}]_2L_1$ complex, via intermediate formation of $[Nd^{3+}]L_1$. Selective formation of $[Nd^{3+}]_2L_1$, in the presence of excess of all other lanthanide ions, caused a detectable change in color, as shown in the associated figure *(Inorg. Chem., 49 (2010) 6909)*.

Sensor for Hg^{2+}: A newly synthesized 1,4,8,11-tetraazacyclotetradecane derivative (L), functionalized with a diazo moiety as the reporter functionality, was found to bind specifically to Hg^{2+} with an associated change in color that could be visually detected. The nontoxic nature of L was checked with the living cells of a Gram negative bacterium, *Pseudomonas putida*. Further, experiments revealed that these reagents could be used as staining agents for the detection of Hg^{2+} present in this microorganism *(Inorg. Chem., 49 (2010) 11485)*.

An azine-based receptor showed remarkable specificity toward the Hg^{2+} ion in aqueous media over other metal ions. Coordination of the receptor to Hg^{2+} induced a detectable change in color and a *turn-on* fluorescence response. This reagent was used for imaging the accumulation of Hg^{2+} ions in Epithelial cell line KB 31 cells *(Org. Lett., 12 (2010) 5406)*.

Sensor for CN^-: Specific recognition of CN^- in sodium cyanide solution was achieved using two imidazole-based receptors (A and B). Visually detectable color changes were associated with the formation of hydrogen bonded adducts, $A{\cdot}CN^-$ and $B{\cdot}CN^-$. Ratiometric fluorescence response was achieved for receptor A on binding to CN^-, and this reagent was used for imaging bacterial cells pre-exposed to 1.42 μM CN^- solution *(Org. Lett., 12 (2010) 3406)*.

Sensor for F^- in aqueous media: A new reagent was developed for visual detection of ultratrace quantity of inorganic F^- present in water. The detection sensitivity of fluoride with this reagent is less than the WHO permissible level in drinking water (*Chem. Commun., 47 (2011) 11074)*.

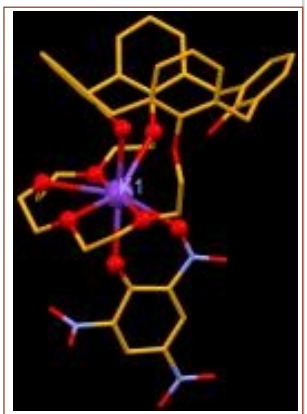


Sensor for toxic and transition metal ions : A series of fluorescent molecular sensors were synthesised incorporating calix[4]arene derivatives in various conformations as ionophore and pyrene moieties as fluorophore. Their ion-binding property with a wide range of cations and anions was investigated. In acetonitrile-chloroform, they formed complexes with Hg^{2+}, Pb^{2+}, Cu^{2+} and Ni^{2+}, whereas in THF-H_2O complexation took place selectively with Cu^{2+}. Among anions, only F^- exhibited interaction, with an easily discernible colour change *(Inorg. Chim. Acta, 372 (2011) 126)*.

Another series of calix[4]arene-based fluorescent chemosensors containing amide as binding site and quinoline as fluoregenic unit were synthesized; their ion-binding study revealed strong complexation with Hg^{2+}, Pb^{2+}, Fe^{3+}, Cu^{2+} and F^-. Complexation with metal ion induced development of excimer emission which was ascribed to modulation of frontier molecular orbital energies upon complexation of metal ions *(New J. Chem., 36 (2012) 988)*.

A series of new luminescent metalloreceptors were synthesized incorporating Ru(II)-bipyridine moiety as fluoregenic unit and six membered macrocyclic moiety containing NS_2O_3 donor atoms as ionophores. This series of receptors exhibited strong complexation with heavy metal ions such as Hg^{2+} and Pb^{2+} and also transition metal ions like Cu^{2+} and Fe^{3+} in a few cases. Binding constants (K_s) and composition of the complexes formed were determined from emission and ^1H NMR titration data *(Polyhedron, 43 (2012) 104)*.

Sensors for alkali metal ions: A family of calix-crown hybrid molecules incorporating crown-4, crown-5 and crown-6 moieties as ionophore was synthesized and their competitive complexing and extracting ability towards different alkali and alkaline earth metal ions in aqueous media was evaluated. Two of these ionophores exhibited high selectivity towards Na^+ and K^+. Molecular



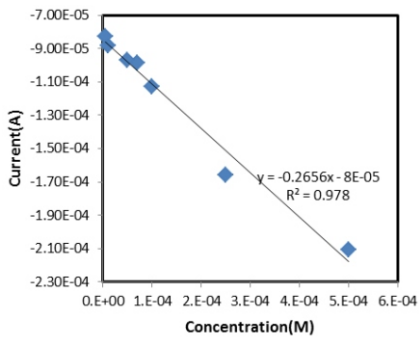
Calix [4]arene crown-5 K^+.pic complex

structures of the resulting complexes and also association constants (K_a) for the binding of Na^+ and K^+ were determined *(Inorg. Chem. Commun., 22 (2012) 85)*.

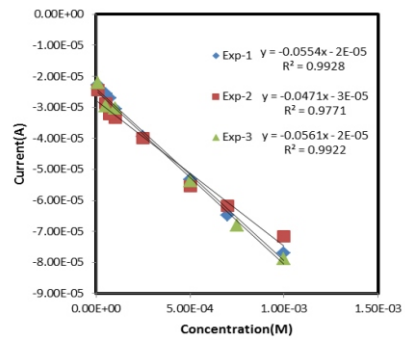
Electrochemical sensing of Pb(II) and development of prototype device

Electrochemical detection of Pb(II) ion using anodic stripping voltammetry was carried out. The samples were prepared by progressive dilution method from mM aqueous solution of lead. 0.1 mM mercuric salt was further added. The pH of working solution was maintained at 4. -900 mV potential was applied to working electrode for 5 min during reduction in a conventional three electrode electrochemical setup, using a clean gold electrode as working electrode, platinum as counter electrode and Hg/Hg_2Cl_2 as reference electrode. A calibration curve of concentration was plotted against current at 180 second. The reduction step was repeatable and reproducible and correlated well with the initial concentration of Pb. The development of first version of prototype for lead estimation is in process.

The convection controlled reduction of Pb^{2+} led to reduction of higher amount than in diffusion controlled mode which in turn gave more accuracy to the data besides lowering the detection limit.



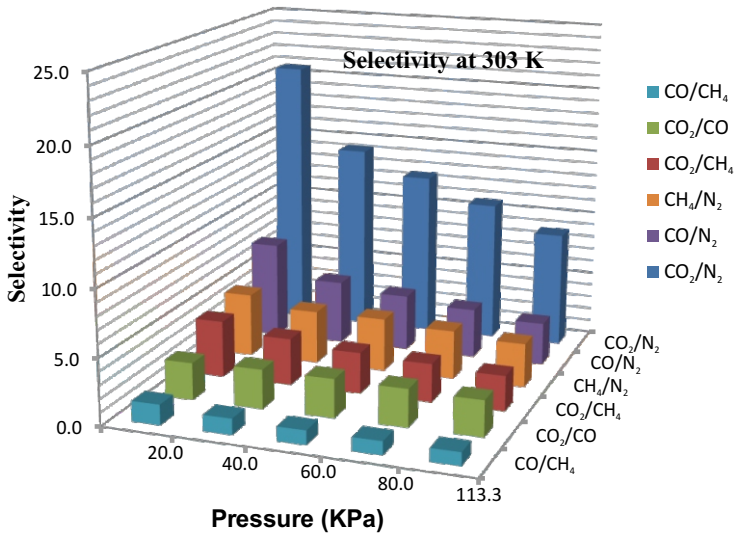
Calibration plot for reduction of Pb^{2+} ion along with 10^{-4} M Hg^{2+} (for amalgamation) under convection controlled condition in ASV experiment on gold electrode



Calibration plot for reduction of Pb^{2+} ion under convection controlled condition in ASV experiment on gold electrode (lead concentration 10^{-3} M to 10^{-5} M with 10^{-4} M Hg^{2+})

A dechlorination pathway for synthesis of horn shaped carbon nanotubes and its adsorption properties for CO_2, CH_4, CO and N_2

Horn shaped carbon nanotubes were successfully synthesized by a dechlorination pathway under mild reaction conditions using tetrachloroethylene as carbon source and metallic copper as reducing agent. The reaction condition was optimized by studying the effect of various reaction parameters on the yield and product morphology. These nanotubes showed abundant surface functionality. Adsorption studies indicated high uptake capacity as well as high equilibrium selectivity of CO_2 and CO over N_2. Thus the product has potential as a new adsorbent material for the separation and recovery of gases *(J. Hazard. Mater., 227–228 (2012) 317)*.

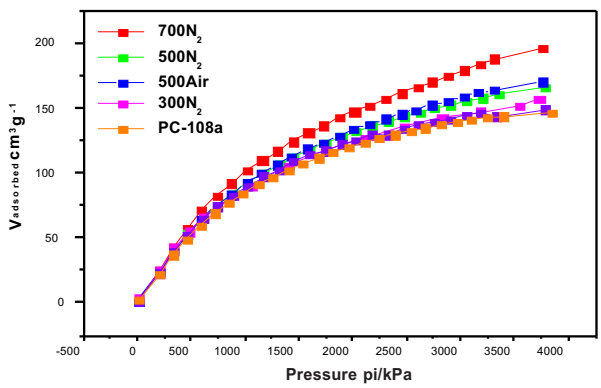


Selectivity of different gases in horn shaped carbon nanotubes

Adsorption

Petcoke derived carbon as methane storage material

Raw petcoke was used to prepare 1 kg of activated carbon (AC) having surface area >2900 m^2/g and methane uptake 220 cc/g at 30 °C/35 bars. Preparation of shaped bodies such as extrudates, chalk sticks, granules, tablets, pellets was undertaken using clay & CMC/starch as binder. The chalk stick type adsorbent body gave methane uptake of 145 cc/g with packing density of 0.51 g/cc. Steam activation of AC derived from petcoke at 700 °C under nitrogen atmosphere was beneficial as it improved methane uptake to 196 cc/g at 35 bars besides giving a more compact adsorbent.



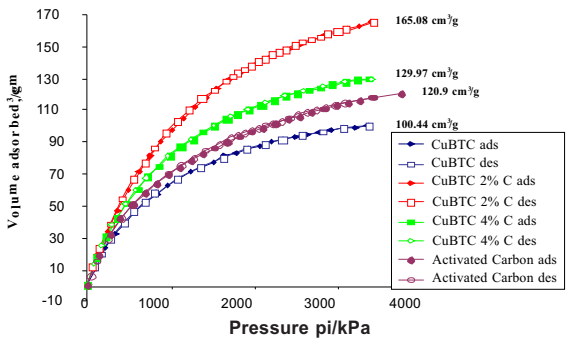
Methane adsorption capacity of steam activated petcoke derived activated carbons

Tamarind seeds carbon (TSC) as methane storage material

Activated carbon from tamarind (*Tamarindus indica*) seeds, an agro-byproduct, was prepared by chemical activation with KOH. TSC having micro-pore volume as high as 1.0 cm^3/g with surface area 2673 m^2/g was obtained. The highest methane adsorption capacity obtained for TSC was 32.8 cc/g at 1 bar and 180 cc/g at 35 bars and 30 °C *(Bio Resources, 6 (2011) 537)*.

Enhanced methane uptake by carbon-MOF composites [AC@CuBTC]

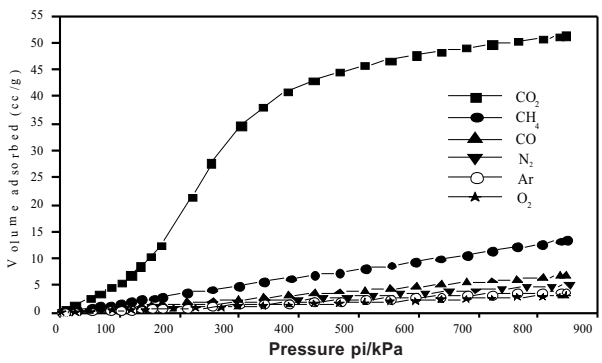
Activated carbon-$Cu_3(BTC)_2$ composite MOF material was prepared by incorporating *in situ* activated carbon during the synthesis of $Cu_3(BTC)_2$. The AC@Cu-BTC prepared with 2% AC gave surface area of 1660 m^2/g, 0.68 cm^3/g HK (Horvath-Kawazoe) micropore volume and HK median pore width of 12.27 Å. The methane uptake was 165 cm^3/g at 35 bars and 30 °C *(Patent filed)*.



Methane sorption on CuBTC, activated carbon and AC@CuBTC composites

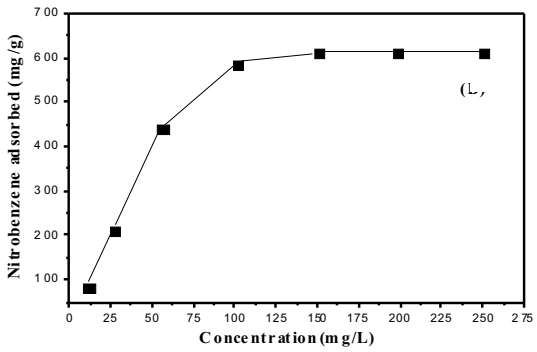
Sorption studies on aluminium terephthalate [MIL-53(Al)]

Aluminum terephthalate, MIL-53(Al), metal organic framework synthesized hydrothermally and purified by solvent extraction was used as an adsorbent for gas adsorption studies. The order of adsorption capacities was CO_2> CH_4> CO> N_2> Ar>O_2. The high selectivity and low heat of adsorption for CO_2 suggests that MIL-53(Al) is a potential adsorbent material for the separation of CO_2 from gas mixtures *(J. Porous Mater., 18 (2011) 205)*.

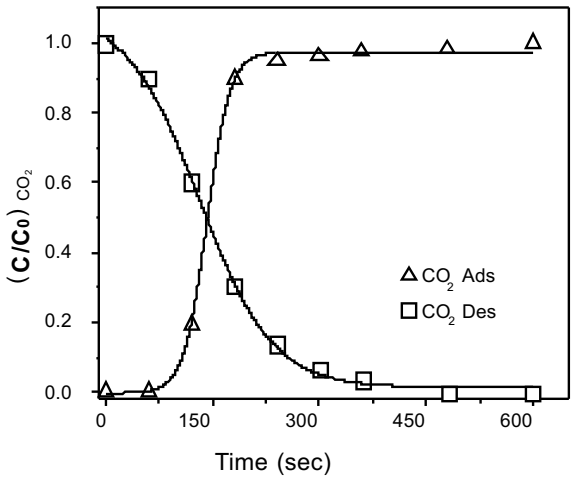


Adsorption isotherms for CO_2, CH_4, CO, N_2, Ar and O_2 on MIL-53(Al) at 303K

The adsorption capacity of nitrobenzene from aqueous solution on MIL-53(Al) was 610 mg/g, higher than zeolites (267.2 mg/g) and organoclays (100 mg/g), but, lower than modified commercial activated carbons (1443.53 mg/g) *(Ind. Eng. Chem. Res., 50 (2011) 10516).*



Adsorption isotherm of nitrobenzene (from aqueous phase) on MIL-53(Al) at 303 K

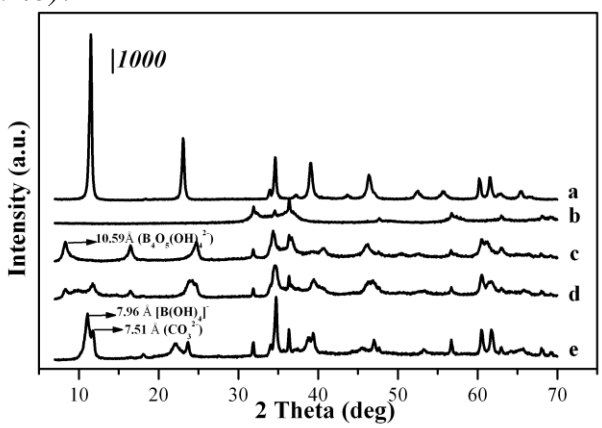


CO_2 adsorption-desorption breakthrough curves from binary gas mixture on MIL-101(Cr)

MIL-101(Cr), synthesized by hydrothermal method was granulated using starch and sodium salt of carboxyl methyl cellulose as binder. The selectivity of CO_2 over N_2 in MIL-101(Cr) was 12.6 at 303 K, more than those for CO_2 over CH_4 (5.69) and CO (2.90). The regeneration of adsorbent was feasible at a relatively low temperature. This was attributed to physical adsorption of CO_2 *(Chem. Eng. J., 195-196 (2012) 359).*

High sorptive removal of borate from aqueous solution using calcined ZnAl layered double hydroxides (LDHs)

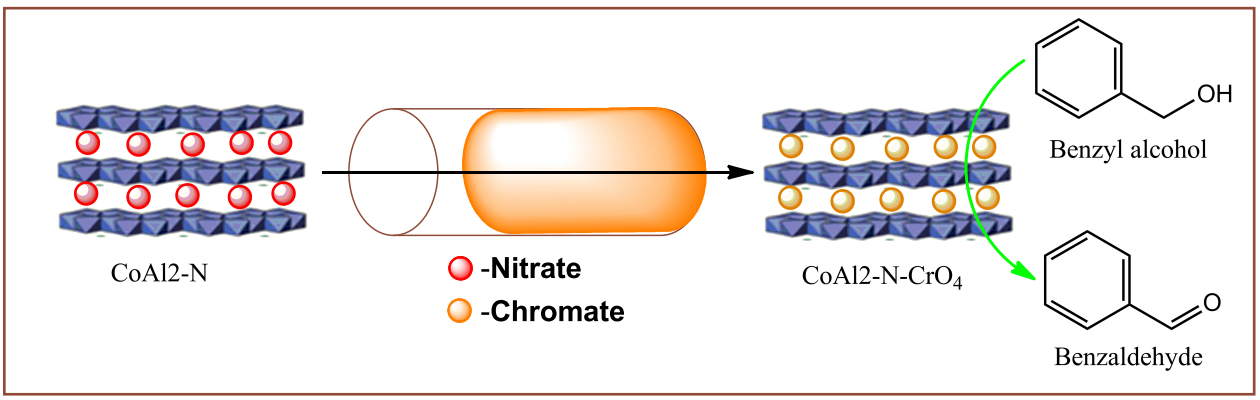
Materials with higher borate uptake capacity are desired for borate remediation as high intake of boron causes acute boron toxicity. Chloride-containing LDH materials in both as-synthesized and calcined form showed higher borate uptake than carbonate-containing forms. A maximum borate uptake of 31 mg B/g was achieved for the 400°C heat-treated Zn_2Al-Cl LDH material, this being the highest uptake reported so far for any LDH material. Interestingly, solid state transformation of tetraborate to monoborate anion ($[B_4O_5(OH)_4]^{2-} \rightarrow [B(OH)_4]^-$) occurred in the interlayer on drying for longer time (see PXRD given). At a ratio of 4 g Zn_2Al-Cl-CLDH per liter of 100 mg B/L solution, the uptake of borate reached 97 %. Using 1g/L of sorbent for a solution containing 5 mg B/L, the boron concentration reduced below 0.5 mg/L as recommended by the WHO. Besides having high uptake capacity over a wide range of pH (4-10), the adsorbent was shown to be recyclable *(Ind. Eng. Chem. Res., 50 (2011) 6943).*



Powder X-ray diffraction (PXRD) profile of (a) Zn_2Al-Cl-LDH, (b) Zn_2Al-Cl-CLDH, (c) 'b' after borate uptake in wet state (d) 'c' after drying for one week (e) 'c' after drying for one month

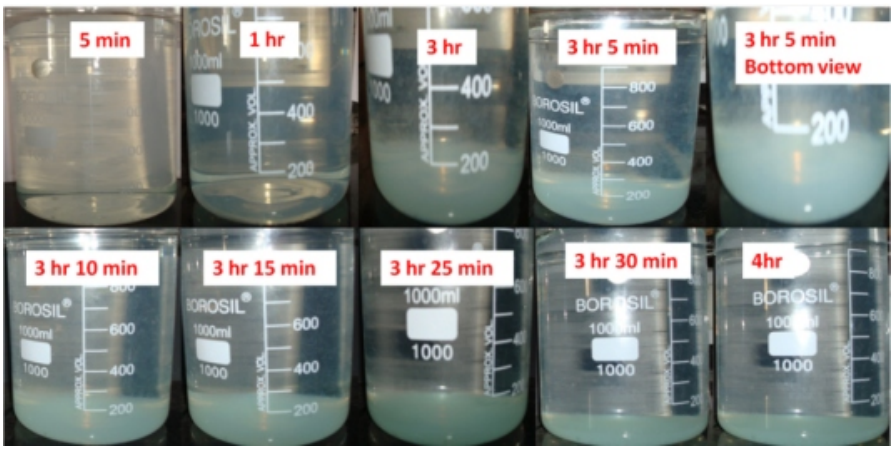
CoAl-CrO_4 LDHs derived from environmental remediation as selective oxidation catalysts

A combined approach of using layered double hydroxides (LDHs) for environmental remediation followed by use of the derived material as a catalyst for selective oxidation was demonstrated. A series of CoAl LDHs with nitrate or carbonate anion in the interlayers were synthesized by coprecipitation and hexamine hydrolysis and studied for chromate removal.



An uptake of 45 mg Cr/g was observed for CoAl2-N prepared by co-precipitation, this value being significantly higher than 15 mg Cr/g for the corresponding carbonate sample. The chromate-exchanged material was studied for selective catalytic oxidation of benzyl alcohol using *tert*-butyl hydroperoxide as oxidant. 23 % conversion with 100 % selectivity for benzaldehyde at room temperature was obtained using a catalyst/substrate weight ratio of 1:20 *(Ind. Eng. Chem. Res., 50 (2011) 13380)*.

Phosphate removal in simulated model pond using delaminated LDHs and valorisation



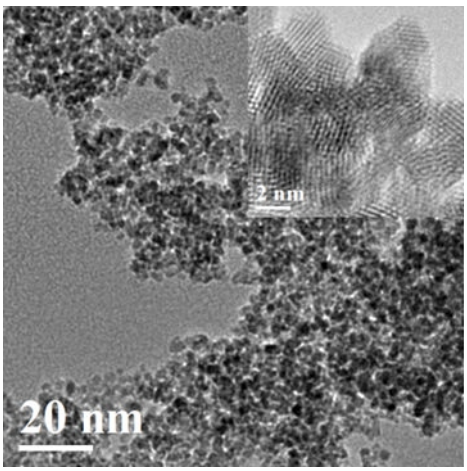
Photograph of model pond system (10mgP/L) at different time intervals

The high uptake of phosphate by ZnAlZr ternary LDHs and a process for delaminating NiAl2-LDH into nano sheets as stable suspension in both aqueous and organic medium was disclosed in the previous biennial report. The dispersibility of the latter in aqueous medium was improved and the values of delamination degree were 0.8, 1.25 and 6.15 g/L for hydrothermal, mechanical shaker and ultrasonic delaminated LDH, respectively. Thereafter a study was undertaken of their efficacy for the removal of phosphate. The phosphate uptake results showed 100 % uptake upon adding ratio of 40 mL/L of ultrasonically dispersed LDH suspension into 10 mgP/L solution.

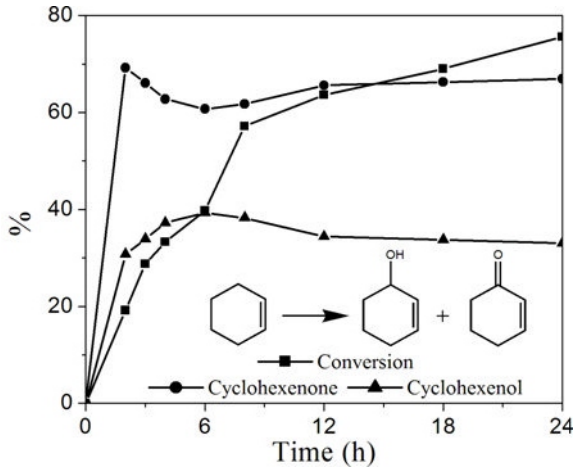
The phosphate uptake in a 'model pond' system showed 75 % uptake using 4 ml of ultrasonically dispersed LDH suspension sprayed into one litre of 1 mgP/L solution. The phosphate-bound LDH is being studied as a controlled release fertilizer *(Communicated)*.

Heterogeneous Catalysis

Facile low-temperature synthesis of ceria and samarium doped ceria nanoparticles and catalytic allylic oxidation of cyclohexene



TEM & HRTEM (inset) of CeO_2 NPs synthesized under reflux



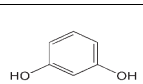
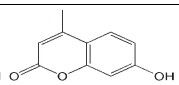
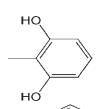
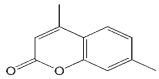
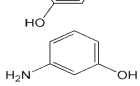
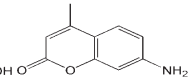
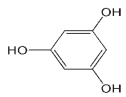
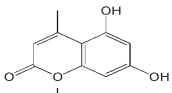
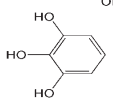
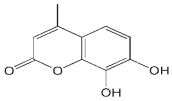
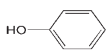
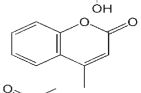
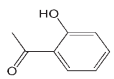
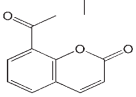
Reaction profile for allylic oxidation of cyclohexene

Ceria (CeO_2) is attracting interest for its diverse applications as oxygen ion conductor in solid oxide fuel cells (SOFCs), oxygen pumps, gas sensor, polishing material, phosphor, oxidation catalyst in automotive three-way catalysts, and in fine chemical synthesis. A simple chemical route for the synthesis of highly crystalline ceria and samarium doped CeO_2 nanoparticles (NPs) with high surface area (368 m^2/g) was developed using aqueous ammonium carbonate complex solution of cerium (IV) and samarium. The crystallite size of the particles could be engineered from 3 nm to 15 nm by optimizing the reaction conditions without using any capping agent. The synthesized materials also served as catalysts in the oxidation of allylic substrates to corresponding carbonyl compounds (enones) *(J. Phys. Chem. C, 115 (2011) 7628).*

Mesoporous zirconium phosphate: An efficient catalyst for the synthesis of coumarin derivatives through Pechmann condensation reaction

Mesoporous zirconium phosphate (m-ZrP) was used as a solid acid catalyst for the synthesis of coumarins via Pechmann condensation reaction. It showed high catalytic activity for the condensation of phenols and ethyl acetoacetate in both conventional heating as well as under microwave irradiation. Among the substituted phenols, *m*-amino phenol is more reactive and resulted in 100% yield in short time at low temperature due to the presence of ring activating amine group. The m-ZrP was active even for simple phenol and 57% yield of 4-methyl coumarin was obtained by conventional heating method *(Appl. Catal. A: Gen., 394 (2011) 93).*

Pechmann condensation of different phenols and EAA over m-ZrP

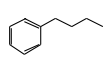
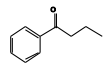
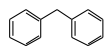
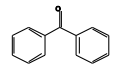
Entry	Substrate	Product	Time (h) and temperature (°C)	Yield (%)
1			4 and 160	94
2			4 and 160	91
3			0.5 and 110	100
4			4 and 160	95
5			4 and 160	90
6			4 and 160	56
7			4 and 160	85

Resorcinol : EAA, 1:2; catalyst, 15 wt% with respect to resorcinol.

Ultra high selective allylic and benzylic oxidation over Cr incorporated mesoporous zirconium phosphate

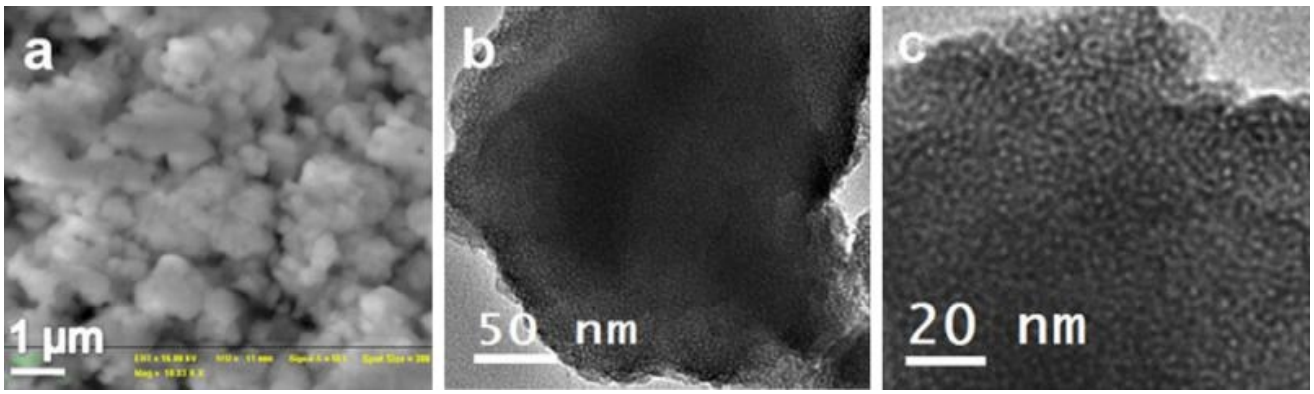
Chromium incorporated mesoporous zirconium phosphate (Cr-mZrP) was used as a catalyst for the oxidation of allylic compounds to their corresponding aldehydes and ketones (carbonyls, enones) and for oxidation of allylic and benzylic compounds to their corresponding carbonyl compounds (enone) and resulted in 100 % selectivity for all the substrates studied with good conversion. Through a simple re-generation or re-activation step, the catalyst was successfully re-used several times *(ChemCatChem, 3 (2011) 1447).*

Selective oxidation of allylic & benzylic compounds

Substrate	Product	Conversion (%)	Selectivity (%)
		91, 88	99
		60	100
		67	100
		76	100
		63	100
		71	100
		34	100

Microwave assisted synthesis of fine chemicals in solvent-free conditions over mesoporous zirconium phosphate

An easy, convenient and rapid synthetic procedure for the preparation of mesoporous zirconium phosphate (m-ZrP) having surface area 257 m^2g^{-1} by microwave irradiation (MWI) under basic conditions was developed. Zirconium carbonate complex solution was used as zirconium precursor and cetyltrimethylammonium bromide (CTAB) as structure directing agent. The efficiency of synthesized m-ZrP as acid catalyst was evaluated under MWI for Claisen-Schmidt condensation reaction, and other industrially important acid catalyzed reactions like Friedel-Craft benzylation of benzene, Biginelli, and Pechmann condensation, involving bulkier molecules under solvent-free conditions *(Appl. Catal. B: Environ., 103 (2011) 378).*



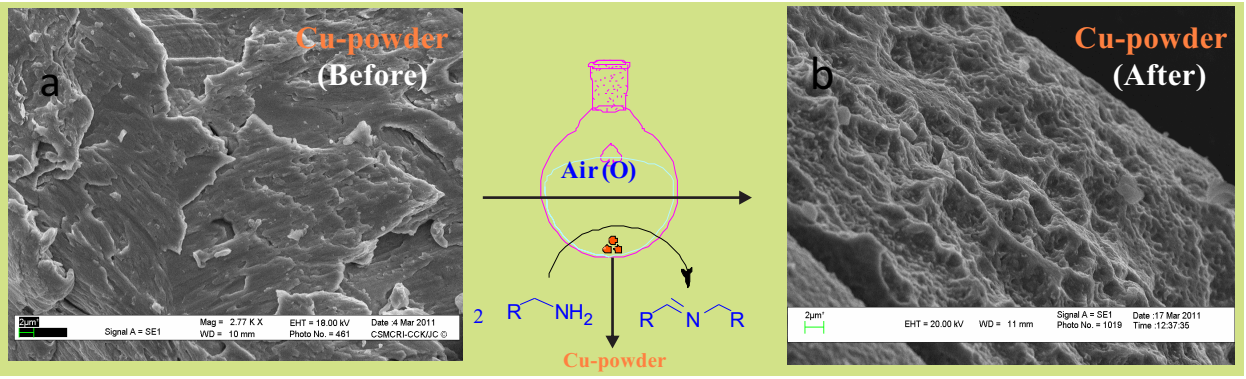
SEM (a) and TEM (b and c) of m-ZrP

Nanosized sulfated zinc ferrite as catalyst for the synthesis of nopol & fine chemicals

A nanosized highly ordered mesoporous zinc ferrite ($ZnFe_2O_4$; ZF) was synthesized via co-precipitation method. The NH_3-TPD and pyridine sorption DRIFT-IR studies revealed the significant enhancement in Lewis acidic sites of the zinc ferrite on sulfatation. It gave 70 % conversion of β-pinene with 88 % selectivity to nopol *(Catal. Today, in press)*

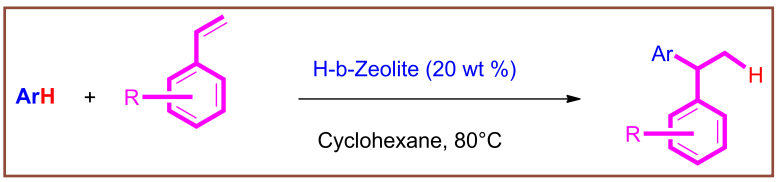
Copper (0) catalyzed aerobic oxidative synthesis of imines from amines under solvent-free conditions

Copper (0) catalyzed direct synthesis of imines from amines under mild aerobic conditions was studied. This catalytic system was applicable for the synthesis of various imines from benzylic, aliphatic, cyclic secondary and hetero aromatic amines. Solvent-free condition, air as oxidant, ready availability of copper catalyst and easy isolation of products were significant advantages of the present protocol. It was especially useful for benzyl imine synthesis. Both symmetrical and cyclic imines could be conveniently prepared by this route *(RSC Adv., 2 (2012) 5119)*.



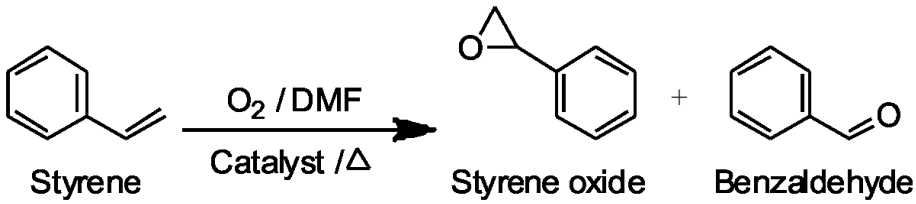
H-*β*-Zeolite catalysed hydroarylation of styrenes

The hydroarylation of styrenes with various arenes and heteroarenes using H-β-zeolite as a green and recyclable heterogeneous catalyst was developed under mild reaction conditions. The catalyst showed high selectivity (up to 100%) of desired hydroarylated products in cyclohexane as solvent under the conditions studied. The catalyst could be reactivated by simple treatment with mineral acid at room temperature for better catalytic activity. The method had the following advantages over previously reported procedures for the hydroarylation of styrenes: i) atom efficiency and no by-product formation, ii) easily handled (open atmosphere), iii) variety of arenes could be used as substrates (reactions with anisoles, phenols, naphthols and heteroarenes is also possible), iv) separation of the catalyst and product was easy, v) H-β-zeolite catalyst is inexpensive in comparison with metal- based catalysts, and vi) the catalyst could be reused several times without appreciable loss of activity *(Eur. J. Org. Chem., (2012) 3520)*.



Epoxidation of styrene with molecular O_2 over Y-ZrO_2 based solid catalysts

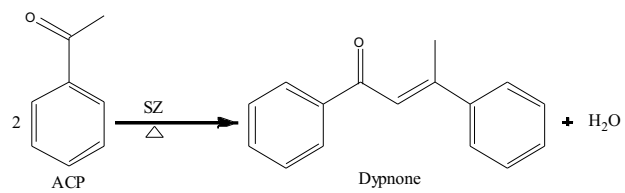
Styrene oxide is an important organic intermediate for fine chemicals and pharmaceuticals. A series of non-sulfated and sulfated yttria-zirconia (Y-ZrO_2) doped with Co and Fe as co-cations were evaluated for the catalytic styrene epoxidation using molecular



oxygen in presence of DMF as solvent. All catalysts yielded styrene oxide and benzaldehyde as two major products. Sulfated Co-Y- ZrO_2 catalyst resulted in the maximum styrene conversion of 61% with 80% selectivity at 120 ºC after 8 h. Thermally regenerated catalyst showed slightly lower conversion (54 %) without affecting the selectivity for three reaction cycles *(Appl. Catal. A: Gen., 383 (2010) 161).*

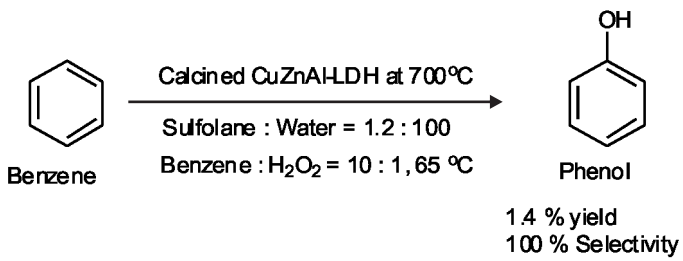
Synthesis of dypnone over sulfated zirconia solid acid catalyst

Dypnone, α-β unsaturated ketone, is useful as softening agent, plasticizer and perfumery base. It was synthesized by the solvent free self-condensation of acetophenone in presence of nano-crystalline sulfated zirconia catalyst prepared by sol-gel method. The catalyst calcined at 650 ºC, showed maximum dypnone selectivity of 92% with 68% acetophenone conversion at 170 ºC after 7 h. The catalyst was reused up to five cycles. *(J. Sol-Gel Sci. Technol., 61 (2012) 275).*



Calcined CuZnAl ternary LDH as recyclable catalyst for hydroxylation of benzene to phenol

A long-standing challenge has been to develop an efficient process for the hydroxylation of benzene to phenol in a single step. Besides low yields, there have been other formidable difficulties particularly with regards to catalyst reuse and use of unfriendly solvents. Some of the hurdles could be overcome using Zn-containing calcined LDHs (oxides) partially substituted with copper as recyclable catalyst and avoiding organic solvents. The catalyst gave 1.36% yield of phenol with 100% selectivity at 65 °C *(Appl. Clay Sci., 53 (2011) 297).*



Microwave assisted isomerization of alkenyl aromatics

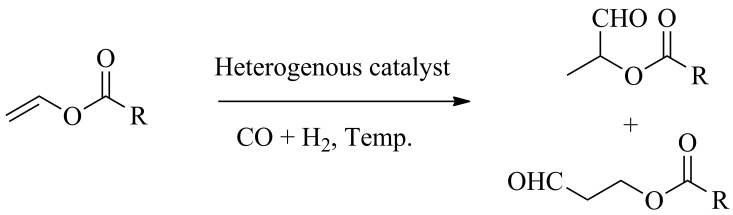
Microwave assisted base-catalyzed isomerization of estragole to anethole was studied over MgAl and NiAl layered double hydroxides as solid base catalysts. The catalyst with Mg/Al atomic ratio of 4.0 gave 99% conversion with 86% *trans* selectivity (substrate to catalyst weight ratio=2:1; T=140 °C; t= 90 min; DMF). DFT calculations revealed that the conversion of these alkenyl aromatics was dependent on the substituents attached to the aromatic ring and governed by the *pKa* of the reactive sites in such systems *(Communicated)*.

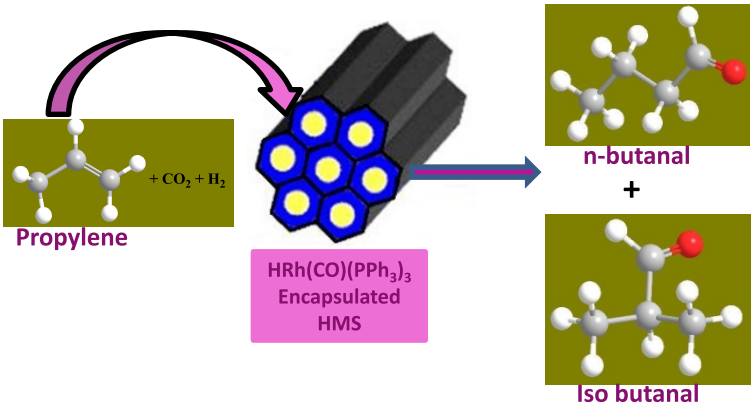
Rh-TPPTS complex encapsulated hexagonal mesoporous silica (HMS) for hydroformylation of vinyl esters and propene

$RhCl(TPPTS)_3$ (TPPTS = *m*-trisulphonato triphenyl phosphine) *in situ* encapsulated into the mesopores of HMS catalyzed hydroformylation of vinyl esters and gave 100% conversion and high selectivity to iso-aldehyde. The formation of acetic acid during

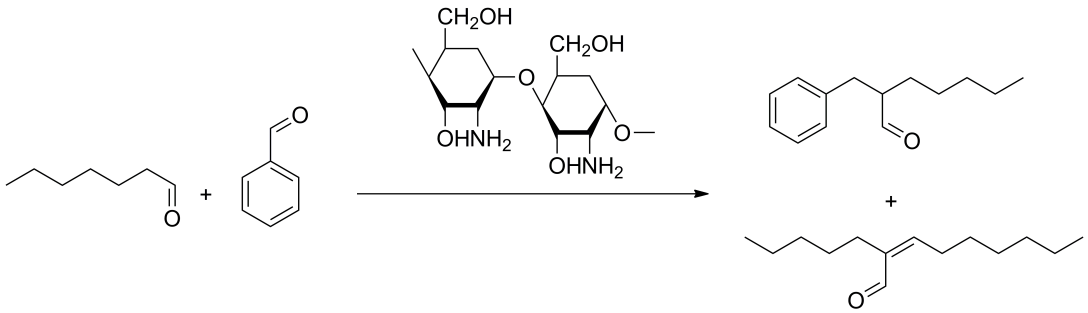
hydroformylation deactivated the Rh-complex by forming carboxylate rhodium complex (*Appl. Catal. A: Gen., 409–410 (2011) 99).*

Similarly, catalytic hydroformylation of propylene gave 99% conversion and 100% selectivity to aldehydes using the heterogenized Rh–HMS catalyst that was successfully recycled six times (*Appl. Catal. A: Gen., 415–416 (2012) 124).*





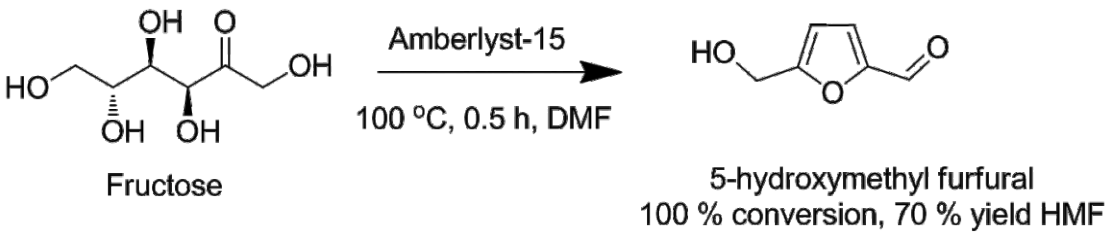
Amino functionalized chitosan as a catalyst for selective solvent-free condensation of aldehydes



Rh-impregnated on amine functionalized chitosan was used as catalyst for solvent-free synthesis of jasminaldehyde via condensation of heptanal with benzaldehyde. The best performance of the catalyst was at 1:4 ratio of heptanal:benzaldehyde. Modeling studies helped to identify the rate determining step (*J. Mol. Catal. A: Chem., 339 (2011) 86).*

Biomass to chemicals: Dehydration of fructose to 5-hydroxymethyl furfural over Amberlyst-15 as solid acid catalyst

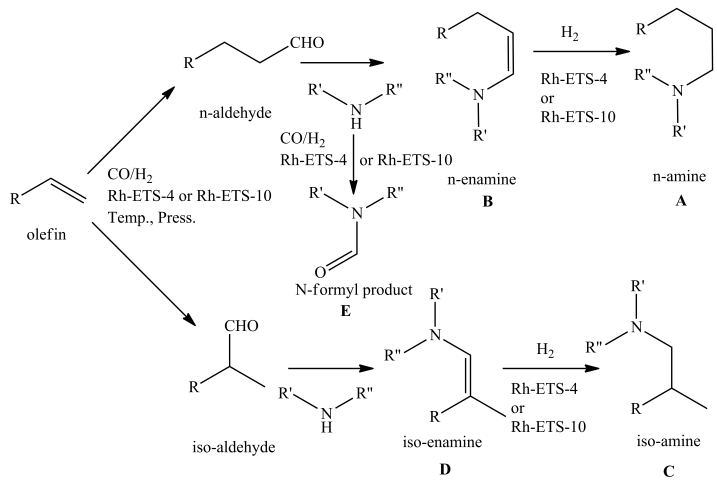
5-hydroxymethyl furfural, commonly called as HMF, is one of the identified twelve building block molecules in a bio-based refinery complex. It is commonly produced through dehydration of fructose over acid catalysts (see scheme). The reaction was studied using



Amberlyst-15, a commercial catalyst, which showed 70 ± 5 % yield (0.1 g fructose, 0.1 g Amberlyst-15, in DMF at 120 °C for 30 min). A continuous decrease in the yield was noted with number of cycles. An attempt was made to resulfonate the spent catalyst with different concentrations of sulphuric acid (0.5 to 2 M). A very high yield (93%) was obtained for the reactivated catalyst, highest known for this catalytic system. Sulfonating the as-received Amberlyst-15 using 2 M H_2SO_4 showed better recycle performance A decrease in the pH was observed after the reaction while the activity of the catalyst was poor for those reactions whose initial pH was greater than 6.0. When DMSO was used as solvent, no significant change in pH occurred while recycling and there was no loss in the activity for up to seven cycles.

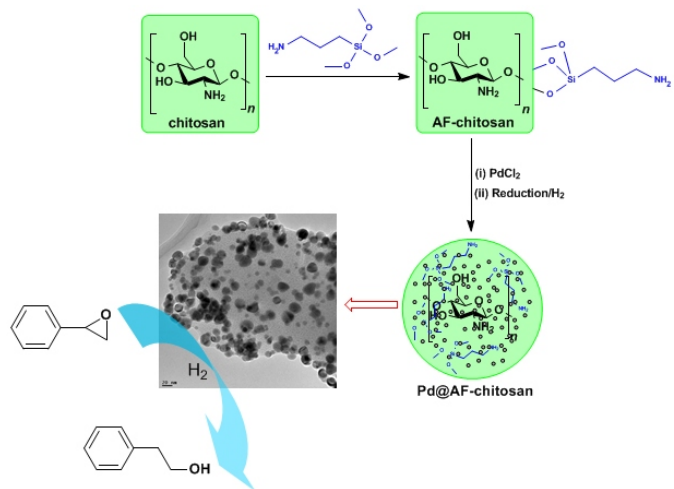
Rhodium exchanged NaETS-10 and NaETS-4 as heterogeneous catalyst for hydroaminomethylation

Rh-NaETS-10 and Rh-NaETS-4 catalyzed hydroaminomethylation of olefin gave 100% conversion with high selectivity to amines. Rh-ETS-4 and Rh-ETS-10 were more effective with secondary amines like morpholine and pyrrolidine. Using Rh-ETS-10, 1-hexene with morpholine gave selectivity of 47% to n-amine and with pyrrolidine and piperidine gave 48% selectivity to n-amine. The catalyst was recycled effectively without much loss in its activity and selectivity



Supported metal nanoparticles as heterogeneous catalysts for selective synthesis of fine chemicals

2-phenylethanol is an aroma chemical of commercial importance. Palladium-on-chitosan was studied for hydrogenation of styrene oxide to 2-phenyl ethanol. Total conversion with high selectivity was observed (*Dalton Trans., 41 (2012) 2910).*



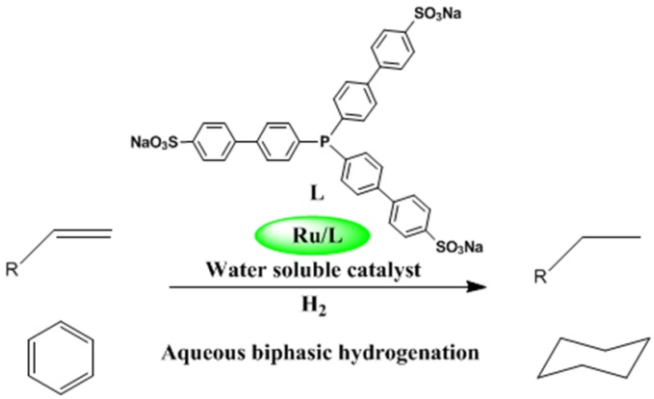
Tin exchanged zeolite as catalyst for direct synthesis of α-amino nitriles

The Sn-exchanged zeolite was an efficient catalyst for the direct synthesis of α-amino nitrile from various ketones and aldehydes with amine and trimethyl silylcyanide (TMSCN) under solvent free condition. Excellent yield of α-amino nitrile (up to 96%) was achieved within 10–120 min at RT *(Appl. Catal. A: Gen., 419–420 (2012) 22).*

Homogeneous catalysis

Aqueous biphasic hydrogenation catalyzed by ruthenium complex of trisulfonated tris (biphenyl)phosphine (BiphTS)

The water-soluble ruthenium complex of BiphTS exhibited efficient activity for hydrogenation of various unsaturated hydrocarbons with high selectivity under mild conditions. The catalyst was easily recovered from the product by a simple phase separation and recycling experiments showed that both activity and selectivity to cyclohexane remained high in four consecutive runs *(Catal. Sci. Tech.; DOI:10.1039/c2cy20172k)*.

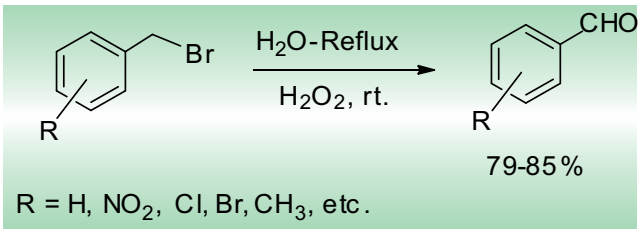


Cobalt complex of the water-soluble ligand trisulfonated tris(biphenyl)phosphine (BiphTS) for hydroformylation of higher olefins

The water-soluble cobalt complexes of BiphTS were used as catalysts for hydroformylation of higher olefins in the absence and presence of various mass transfer promoters (co-solvents, surfactants, cyclodextrins and activated carbon). In the presence of CTAB, methylated - cyclodextrin or activated carbon, the Co/BiphTS system allowed the hydroformylation of 1-octene with high conversion (95%) and aldehyde selectivity (85-90%) *(Appl. Catal. A: Gen., 413-414 (2012) 273)*.

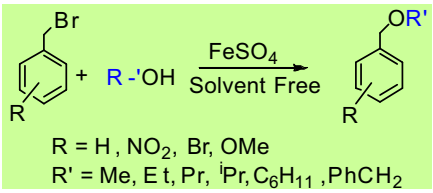
Direct conversion of benzyl bromides to benzaldehydes

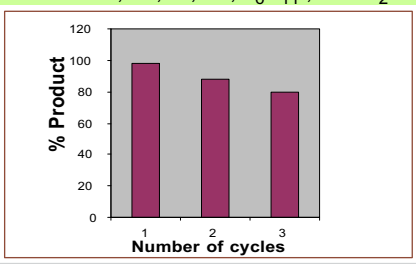
The facile and selective conversion of benzylic bromides to benzaldehydes using H_2O_2 as a benign oxidizing agent in aqueous medium is described. Under these conditions good yields of benzaldehydes were obtained. The present method describes an efficient, selective, and environmentally friendly method for the conversion of benzylic bromides to benzaldehydes in water under mild conditions. Although the present system does not work for the aliphatic bromides, it eliminated the harsh reaction conditions employed in earlier procedures for these oxidations. Simple reaction conditions and excellent yields of the products make this method a facile, and attractive protocol *(Synth. Commun., 41 (2011) 2712)*.



Synthesis of benzyl alkylethers without base

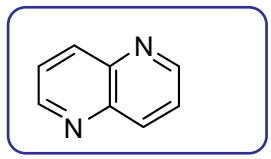
A simple reagent system has been developed for the synthesis of benzyl alkyl ethers under mild, efficient and environment-friendly conditions without use of base. $FeSO_4$ is shown to be a good substitute to benzyloxypyridinium triflates and its recyclability up to three runs was demonstrated. Therefore, the usefulness of the present method to obtain interesting final products, together with the mild and simple reaction conditions makes it well suited for the generation of combinatorial libraries (*Synth. Commun., 41 (2011) 720)*.

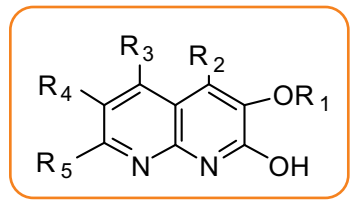




Synthesis of 1,8-naphthyridines

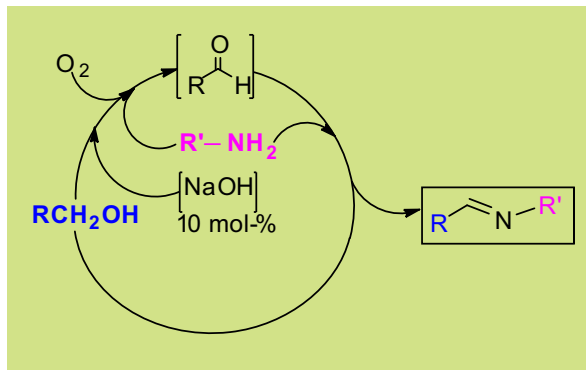
Highly efficient method has been developed for the regioselective synthesis of 1,5- and 1,8-naphthyridines catalyzed by I_2, and $InCl_3$. The procedure allows for an easy and practical synthesis of substituted naphthyridines and is attractive because of easy handling of the catalyst (no sensitivity toward air or moisture). Catalyst can be recovered and reused up to 5 cycles efficiently. Such motifs as synthesized in this study are found in various bioactive molecules *(Synth. Commun., 41 (2011) 1843)*.





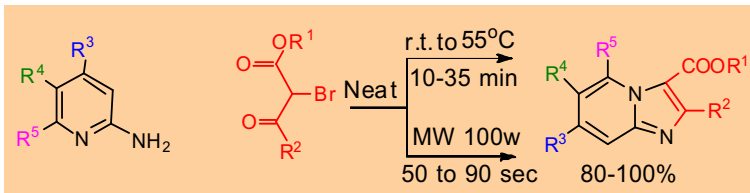
NaOH-catalysed imine syntheses: Aerobic oxidative coupling of alcohols and amines

A green and efficient protocol for imine synthesis through oxidative coupling of alcohols and amines was developed. The reaction occurred under aerobic conditions without the need of any transition metal, ligand or co-solvent. The reaction can be applied to a variety of alcohols and amines and offers an environmentally friendly, general method for the synthesis of imines *(Eur. J. Org. Chem., (2012) 4457)*.

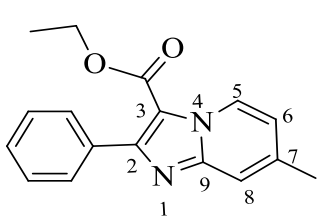


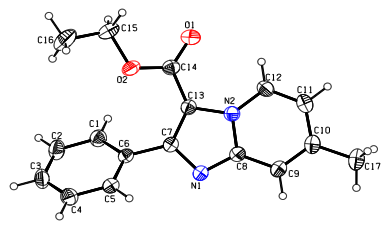
Thermal and microwave assisted rapid synthesis of substituted imidazo[1,2-a]pyridines

Imidazo[1,2-*a*]pyridine derivatives are an important class of molecules that exhibit a diverse range of biological activities (antiviral, antiulcer, antibacterial, antifungal, calcium channel blocker and as a hypnotic). Thermal and microwave-assisted rapid synthesis of highly substituted imidazo[1,2-a]pyridine derivatives by the recation of amino puridines and alpha pyridines and alpha-bromo-beta-ketoesters under neat conditions was achieved (Scheme). Reactions carried out under microwave irradiation gave higher yields in rapid reaction time (<2 min).



The structure of one of the synthesized new compounds was confirmed by single crystal XRD (See Figure). The advantages of present protocol include the use of commercially available and inexpensive 2-aminopyridines and α-bromo-β-ketoesters, rapid reaction simple workup, high yields and product purity (*Synthesis, (2011) 635*).



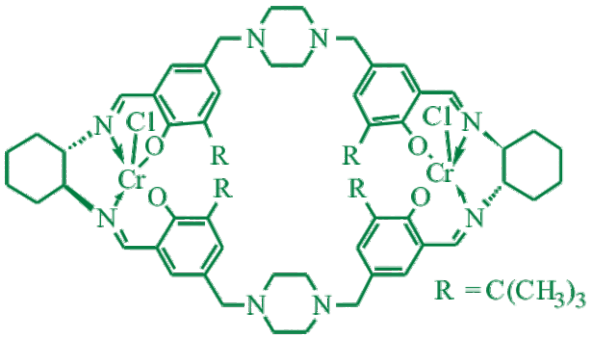


Chiral Catalysis

Design and development of efficient chiral catalysts for various organic transformations is at the heart of chiral catalysis. Chiral products have wide applications in pharmaceuticals, agrochemicals, flavors and fragrances. Keeping the importance of the end products and high cost of chiral ligands in mind, following recyclable catalysts were designed and used for asymmetric Strecker reaction, cyanation of aldehydes with different sources of cyanide, asymmetric ring opening reaction, kinetic resolution of racemic epoxides with amines and water as nucleophile and asymmetric hydroformylation of olefins.

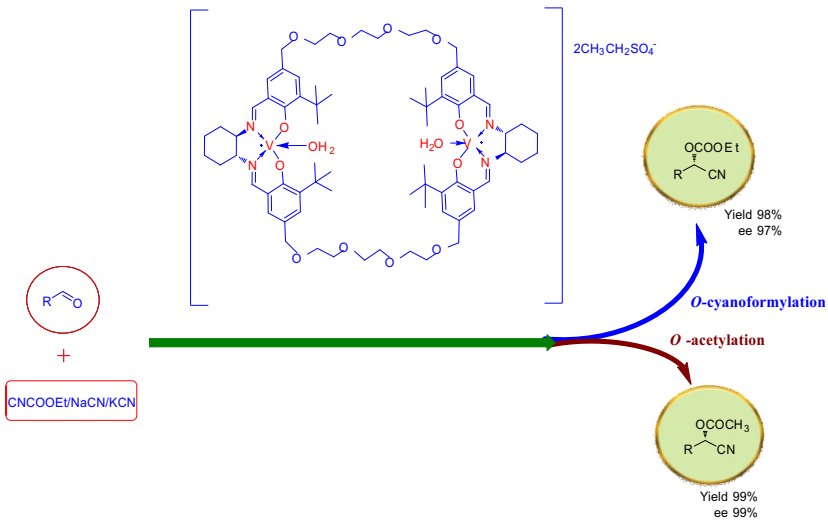
Synthesis of enantiopure *β*-aminoalcohols via AKR/ARO of epoxides using recyclable macrocyclic Cr(III) salen complexes

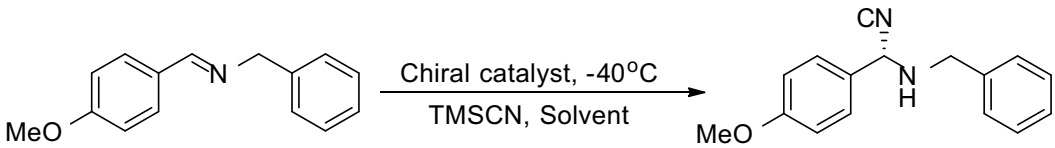
A series of chiral macrocyclic Cr(III) salen complexes bearing two chiral salen units linked through tertiary nitrogen were synthesized. These complexes were highly active and catalyzed the enantioselective AKR and ARO of various racemic *trans* and meso epoxides with anilines at room temperature giving chiral *anti/syn* *β*-aminoalcohols and enantio-pure epoxide with >99% yield and enantiomeric excess (ee) with added advantage of catalyst recyclability (*Tetrahedron*, *67 (2011) 8300).*



Enantioselective *o*-acetyl cyanation/cyanoformylation of aldehydes using catalysts with built-in crown ether-like motif in chiral macrocyclic V(V) salen complexes

Chiral recyclable macrocyclic V(V) salen complexes having trigol linker were synthesized and used as catalysts in asymmetric cyanation reactions. These catalysts demonstrated excellent performance (product yields and ee's up to 99%) with KCN and NaCN as inexpensive nonvolatile cyanide sources. The catalytic system also performed well with ethyl cyanoformate as a safer source of cyanide to give cyanohydrin carbonate in high yield and up to 97% ee *(Tetrahedron, 67 (2011) 7073).*

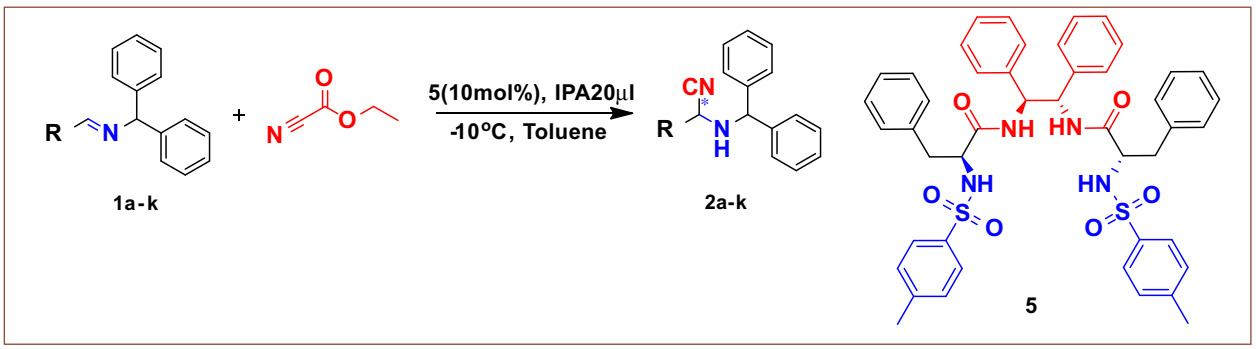




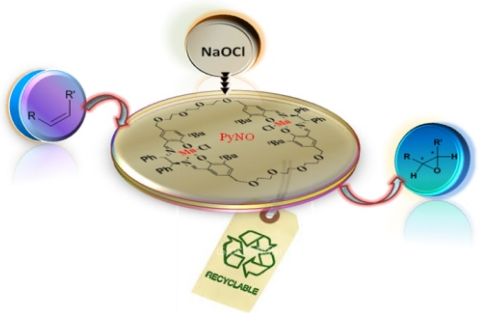
The macrocyclic V(V) salen complex was also used as catalyst (10 mol%) for asymmetric addition of TMSCN to various *N*-benzylimines. α-Aminonitrile was obtained in near-quantitative yield and 99% ee in case of 2-methoxy substituted *N*-benzylimines. The time and temperature were 10 h and -40 ^{0}C, respectively *(Communicated)*.

C_2-symmetric recyclable organocatalyst for enantioselective Strecker reaction for the synthesis of α-amino acid and chiral 3 diamine- an intermediate for APN inhibitor

Several recyclable chiral amide-based organo-catalysts of the structure 5 were synthesised and used for the asymmetric Strecker reaction of various aromatic and aliphatic N-benzhydrylimines with ethyl cyanoformate as cyanide source. These catalysts gave α-aminonitriles upto 95% yield and 99% ee. This protocol was extended for the synthesis of (*R*)-phenylalanine and (*R*)-3-phenylpropane-1, 2-diamine *(J. Org. Chem., 77 (2012) 4375)*.

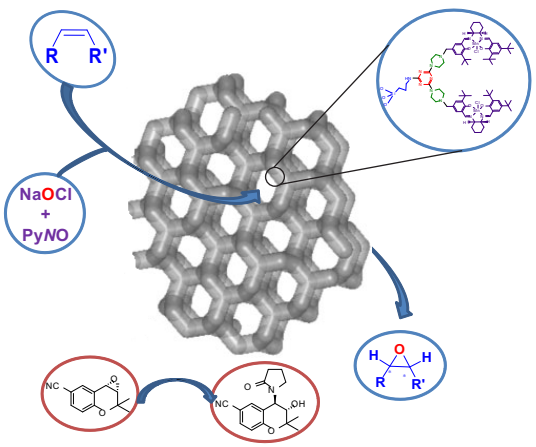


A series of chiral macrocyclic Mn(III) salen complexes with monomeric and dimeric chiral macrocyclic salen ligands with trigol linker were prepared. With the chiral dimeric macrocyclic catalysts (5 mol %) enantio-pure epoxides were achieved in excellent yields (>99%) and *ee* >96% *(J. Catal., 286 (2012) 41)*.

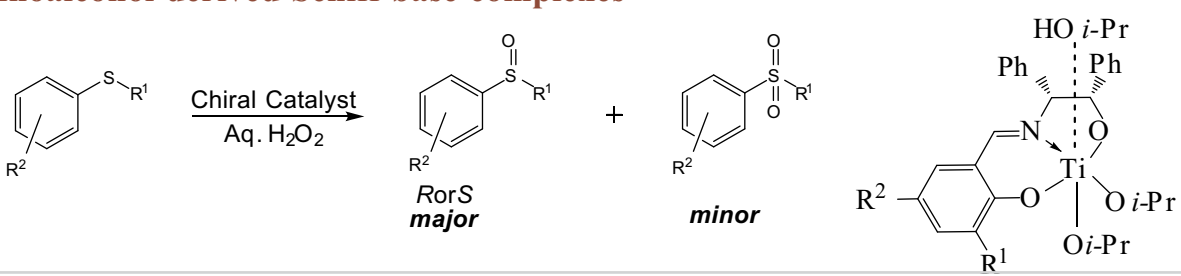


Immobilized dimeric chiral Mn(III) salen complex for the epoxidation of non-functionalized alkenes

The chiral dimeric Mn(III) salen complex was immobilised with *(1R,2R)*-(-)-diaminocyclohexane collar on short channel large pore sized silica through a linker, {$(CH_2)_3$-NH-melamine-piperazine}. The enantioselective epoxidation of several olefins with aqueous NaOCl gave high turnover frequency (TOF) and enantio-selective formation of products. This protocol was also used to synthesise (*S*)-Levchromakalim (ee, 98%) and antihypertensive drug at 1 g scale *(Tetrahedron, 68 (2012) 6812)*.



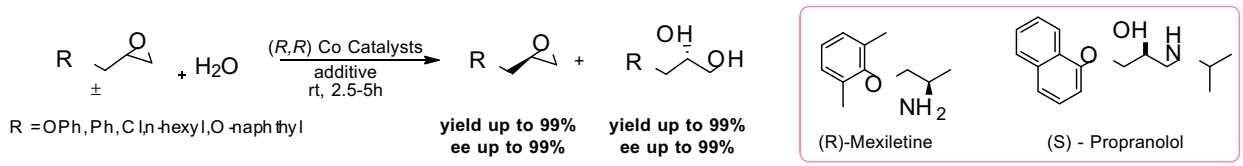
Asymmetric sulfoxidation of sulfides with hydrogen peroxide using titanium aminoalcohol derived Schiff base complexes



Aminoalcohol based Schiff bases were synthesized by condensation of (1*S*,2*R*)(+)-2-amino-1,2-diphenylethanol with various salicylaldehyde derivatives. The *in situ* generated complexes of Ti(O*i*-Pr)$_4$ with these ligands were used for asymmetric sulfoxidation of pro-chiral sulfides with 30% H_2O_2 at 0 °C in 10 h (conversion, 93%; *ee* up to 98%) (*J. Mol. Cat. A: Gen., 361–362 (2012) 36).*

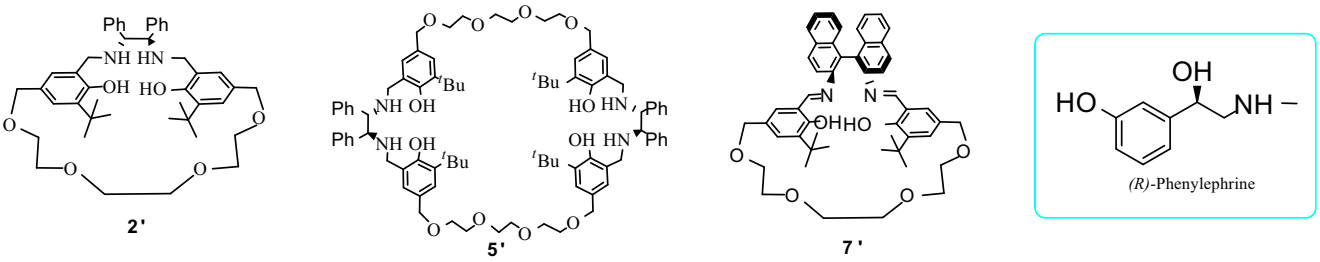
Asymmetric hydrolytic kinetic resolution (HKR) with recyclable macrocylic Co(III)-salen complexes

HKR of racemic terminal epoxides is a useful strategy to achieve valuable enantio-pure epoxide and diol in a single step using water as a resolving agent. Recyclable chiral Co(III) macrocyclic salen complexes were used in HKR of racemic epichlorohydrin, propene oxide, styrene oxide and glycidyl ethers to give enantio-pure epoxide and diol in >42% yield (theoretical yield is 50%) with enantiomeric excess >99%. With this protocol chiral drug molecules (*R*)-mexiletine and (*S*)- propranolol were synthesized in good yield and enantio-selectiviy *(Chem. Eur. J., 18 (2012) 5256).*



Cu(II)-macrocylic salen and [H$_4$]salen catalyzed asymmetric nitroaldol reaction and its application in the synthesis of α1-adrenergic receptor agonist (*R*)-phenylephrine

The asymmetric nitroaldol reaction is a powerful synthetic tool for the synthesis of *β*-hydroxy nitroalkanes that are important building blocks to prepare biologically active molecules. Several new chiral Cu (II) complexes were generated *in situ* with chiral monomeric and dimeric macrocyclic salen and [H$_4$]salen ligands that gave *β*-nitroalcohols in excellent yields (98%) and ee ~99% at RT. This protocol was used for the synthesis of enantiomerically pure (*R*)-phenylephrine (α1-adrenergic receptor agonist) via asymmetric nitroaldol reaction of 3-methoxybenzaldehyde *(ACS Catal., 1 (2011) 1529 ; Appl. Catal. A: Gen., 439-440 (2012) 74).*

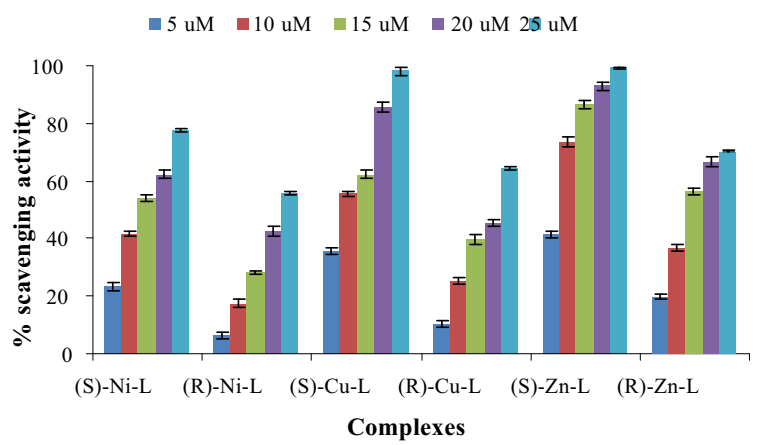


Asymmetric hydroformylation of olefins

Asymmetric hydroformylation has been attracting much attention as a potential synthetic tool for the preparation of enantiomerically pure aldehydes which have wide applications ranging from biologically active compounds to biodegradable polymers. Chiral non phosphine ligands were designed and used for the preparation of chiral catalysts with Rh(acac)(CO)$_2$ as transition metal precursor in asymmetric hydroformylation of olefins that gave high conversion (98%) to respective chiral aldehydes with high enantiomeric excess (>99%) under mild reaction condition *(Communicated).*

Chiral discrimination asserted by enantiomers of metal-Schiff base complexes in DNA binding, antioxidant and antibacterial activities

Chiral Schiff base ligands in their enantiomerically pure form and their Ni, Cu, and Zn complexes were synthesized and were screened for DNA binding, antioxidant and antibacterial activities. The complexes showed higher binding affinity to calf thymus DNA with binding constant ranging from 2.0 x 10^5 - 4.5 x 10^6 M^{-1}. All complexes exhibited remarkable superoxide (56-99%) and hydroxyl scavenging (45-89%) activities. Further, the complexes showed significant antibacterial activities against gram (+) and gram (-) bacteria; but were not active against fungus. Conclusively, ***S*** enantiomers of the complexes were found to be relatively more efficient for DNA interaction, antioxidant and antibacterial activities than corresponding ***R*** enantiomers (*Spectro Chim. Acta, 81 (2011) 199)*.



Superoxide scavenging activity of metal-Schiff base complexes

The chiral V(V) Schiff base complexes showed interaction with calf thymus (CT) DNA and bovine serum albumin (BSA) protein. The influence of chirality was also observed in cytotoxicity assay of Hep 2 cells. (*R*)-enantiomer exhibited higher binding constant (5 ± 1x 10^6 M^{-1}) as compared to (*S*)- enantiomer (8 ± 1x 10^4 M^{-1}) *(Eur. J. Med. Chem 46 (2011) 5074)*.

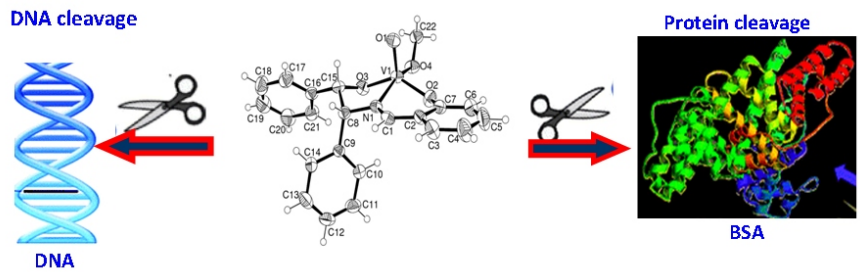


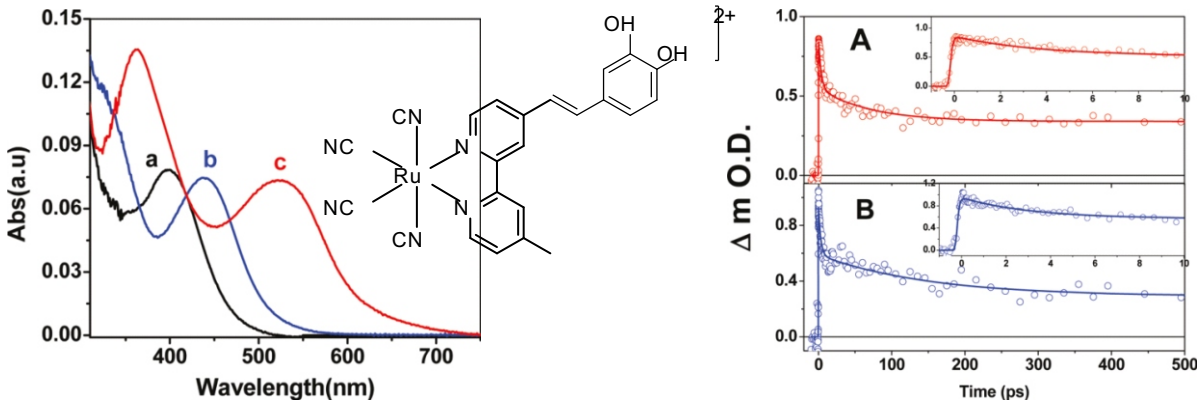
Photo catalysis and photoactive molecules

Photophysical study on aggregated porphyrins

The aggregation behavior of 5,10,15-trisphenyl-20-(3,4-dihydroxy phenyl) porphyrin in aqueous solution has been studied as a function of pH and concentration with the help of steady state absorption and emission spectroscopy. Our studies revealed that, for a particular concentration range, molecules undergo a reversible aggregation process and form J- and H-aggregates at two different pH ranges *(J. Phys. Chem. B, 114 (2010) 8327)*.

Photo-induced interfacial electron transfer

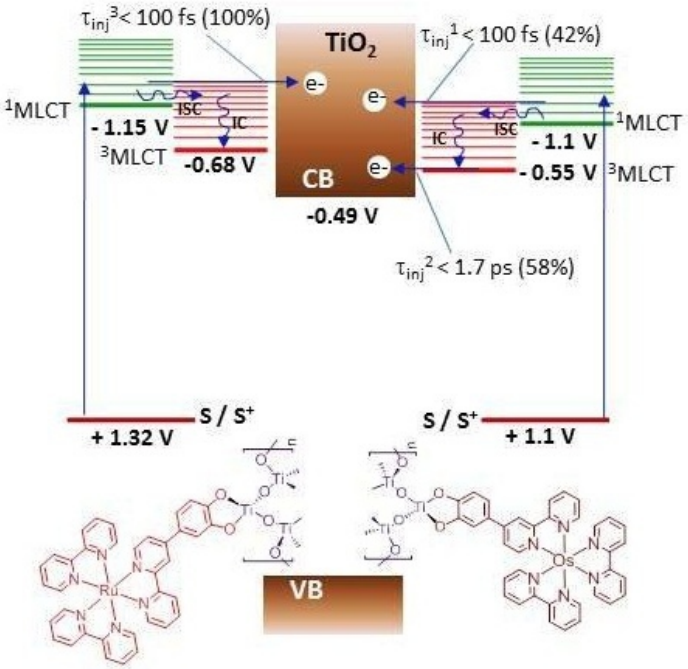
The interfacial electron-transfer process on a TiO_2 nanoparticle surface was studied using $[(bpy)_2ML]^{2+}$ (where M = Os^{II} or Ru^{II}) by femtosecond transient-absorption spectroscopy. In the case of Ru^{II}/TiO_2 system, single-exponential electron injection takes place from photoexcited nonthermalized MLCT states. However, in the case of Os^{II}/TiO_2 system, electron injection takes place biexponentially from both nonthermalized and thermalized MLCT states (mainly ^{3}MLCT states). Larger spin–orbit coupling for the heavier transition-metal osmium, relative to that of ruthenium, accounts for the more efficient population of the ^{3}MLCT states *(Chem. Eur. J., 17 (2011) 1561)*.



Solvent sensitivity of the MLCT absorption band of complex 1 in (a) water, (b) methanol, and (c) dimethyl sulphoxide Transient decay kinetics of 1/TiO_2 (a) in panel A with λ_{max} = 540 nm (b) in panel B λ_{max} = 1000 nm. Insets: decay kinetics in shorter time scale

Study on dynamics of the interfacial electron transfer process

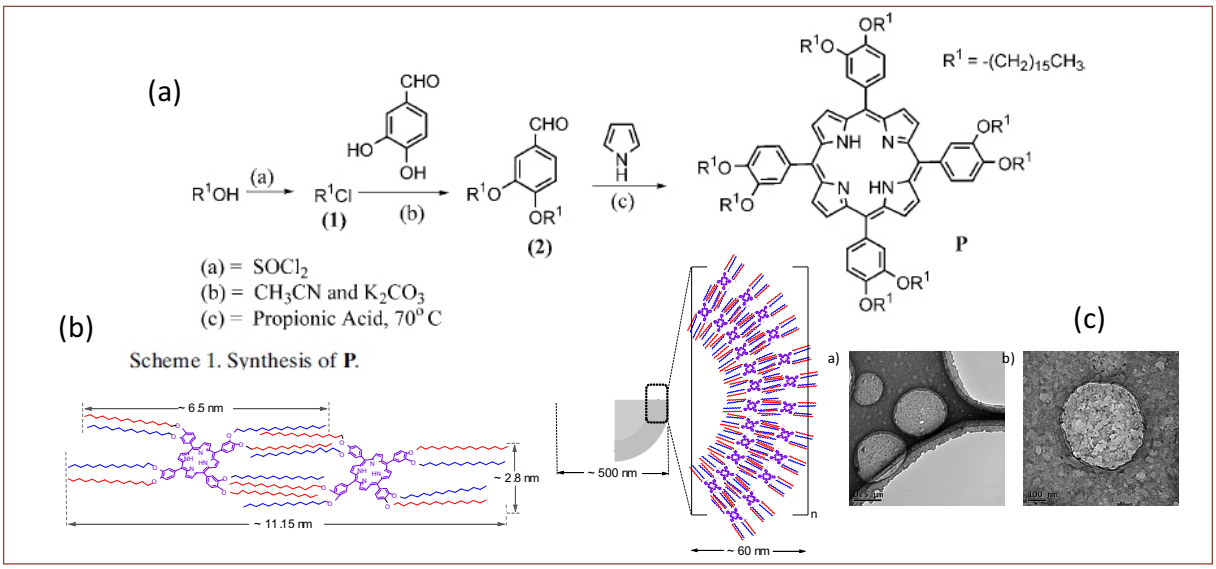
A photoactive ruthenium(II) complex, ($K_2[Ru(CN)_4(L)]$ (as shown in the accompanying figure), was synthesized and a study undertaken on the dynamics of the interfacial electron transfer between nano-particulate TiO_2 and the photoexcited states of the Ru^{II} complex using femtosecond transient absorption spectroscopy. Steady-state absorption and emission studies revealed a strong solvatochromic behavior in solvents or solvent mixtures of varying polarity. A single exponential and pulse-width limited (<100 fs) electron injection was observed. Back electron transfer dynamics was determined by monitoring the decay kinetics. This is the first report on ultrafast ET dynamics on TiO_2 nanoparticle surface using a solvatochromic sensitizer molecule *(Inorg. Chem., 49 (2010) 4167)*.



Scheme showing the photoinduced electron injection from the thermalized and non-thermalized triplet states of the Ru(II)- or Os(II)-polypyrydyl based dye molecules to the conduction band of the nanoparticulate TiO_2

Study on surface phenomena

A newly synthesized tetraphenyl porphyrin derivative, having two C_{16}-alkyl chains covalently bound to each of the four peripheral phenyl rings through ether linkage formed even in dry condition. Various microscopic images of the cast film deposited on mica surface confirmed close ended nanotube/ nanorod type formation with necking and bulging. These multilayer clusters or vesicles at the air-water surface. Stable spherical vesicles were also formed upon deposition on appropriate solid surface. These vesicles were found to be stable narrow tubes are presumably intermediates in vesicle formation through fission at either side of the bulge (*Chem. Asian J., 5 (2010) 352; Thin Solid Films, 519 (2011) 8066*).



(a) Cartoon representation of the proposed orientation (a) in bilayer formation (b) of the shell wall of Pas multi-lamellar (n>1) vesicular formation following self assembly process; (b) TEM image of LB monolayers of **P** deposited on carbon coated Cu grid at 30 mN/m pressure (Magnification; 80 KV x 6000) and (c) HRTEM of the vesicle formed in the at LB monolayers of P (Magnification; 100 KV x 20000).

Development of photocatalytic materials

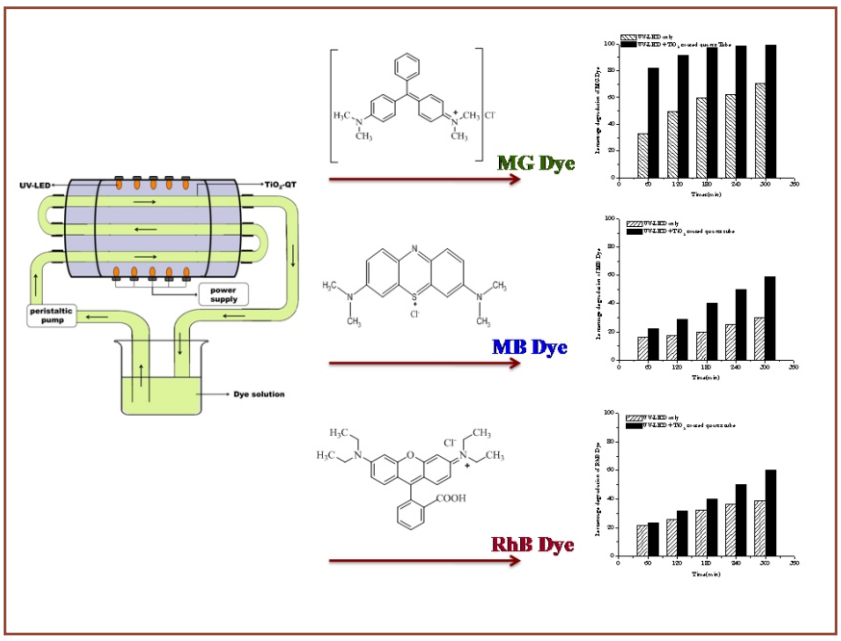
Synthesis of TiO_2 coated acrylic sheet

Work on developing a cost effective photocatalytic reactor was initiated. In place of quartz, an acrylic sheet was coated with titania and the photocatalytic surface was tested for degradation of methylene blue dye. Solar light helped degrade the dye molecules without affecting the surface.

TiO_2 coated acrylic sheet | Before solar irradiation | After solar irradiation

TiO_2 coated acrylic sheets for the degradation of methylene blue dye

UV-LED source/TiO_2 coated quartz tube based photocatalytic tubular reactor



In continuation of earlier work using UV-LED based photocatalytic reactor, a new photocatalytic reactor using TiO_2 photocatalyst coated quartz tube and UV-LED was developed that avoided the separation of photocatalyst from the degraded solution. The photocatalytic activity of this reactor was studied for the degradation of dyes such as methylene blue (MB), malachite green (MG) and rhodamine B (RhB). Degradation occurred in 5 h. This study established that photocatalytic degradation of organic dyes can occur even at low power *(Chem. Eng. J., 169 (2011) 126; ibid 178 (2011) 40 ; Ind. Eng. Chem. Res., 50 (2011) 7753).*

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CHAPTER 2

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MEMBRANE SCIENCES

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Pressure-driven Membrane Separation Processes
Electro Membrane Processes

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iryh l;Dr f>Yyh ¼Vh ,Q lh½ vkjvk f>Yyh vkj ekM;y Kku dk VklQj

ikyh,ekbM Vh,Qlh çfrorh jlkdÔ.k f>Yyh rFkk lfiy ekM;y cuku dh tkudkjh dk SSI bdkb] ell ;fu¶yDl dk ykbll fd;k x;kA bl çk|kfxdh dk 1 eh pkMkb x 100 eh yEckb d Lrj ij v/k&Lopkfyr dkfLVx rFkk dkfVx bdkb;k }kjk mPp fd;k x;kA

Vh ,Q lh eEcu çfof/k e iu% l/kkj

TFC f>Yyh cuku d Øe e] TFC f>Yyh cuku d eyfof/k e] ikyh lYQku (PS) casting vk/kkj ,o ikyh ,ekbM dkVhx vk/kkj e nk egRoi.k ifjoru fd; x;A ftldh otg l f>Yyh d dk; {kerk ,o cuku dh ifØ;k e mUufr gbA bll f>Yyh cuku e vPNh lxfr rFkk x.koÙkk e l/kkj gvkA

ikyh lYQku cuku d vk/kkj e] dkfLVx jkyj d LFkku ij CyM dkfLVx yxk;k x;kA ftll fuEu egRoi.k miyfC/k;k gb

(I) PS foy;u der vk;ru dk fuLdkfÔr gkukA

(ii) fdukjk ij ihN dh rjQ PS Lrj dk u cuuk] ftld QyLo:i lfiy ekM;y cuku dh dfBukb;k dk nj fd;k x;kA

(iii) TFC f>Yyh dh ijr dh ekVkb e fu;=.k d QyLo:i TFC d x.k LoHkko e Hkh méfr gbA SEM fp= l CyM dkfLVx l cuh f>Yyh e vf/kdrj fNnrk dk irk pykA vf/kd fNnrk d dkj.k ikuh d pyu e de #dkoV gb vkj mRikndrk c<hA Vh,Qlh dkfVx e l/kkj d fy;] ulV ikyh,ekbM dh lrg dk lgk;d@xkbfMx jkyjk d lid e rjr yk;k x;kA ftll ikyh,ekbM dh lrg ,d leku u cu ldhA l/kkj bl çdkj fd;k x;k fd lrg D;kfjx gku rd fdlh Hkh jkyj d lid e u vk ldhA bll T;knk ,d leku rFkk nkÔjfgr lrg cuh ftld QyLo#i dk;liknu e lxfr jghA

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lfiy ?kko f>fYy;k tk0;kolkf;d #i l cph tkrh g] dh n<rk l cf/kr cyukdkj ljpuk gkrh g tgk f>Yyh QhM rFkk fjDr LFkkuk d lkFk lfiy Øe e fNfnr ufydk;Dr dUn d pkjk vkj yiVh gkrh gA f>Yyh rUr dh vkj d fdukjk rFkk ofyr f>Yyh d nk lfØ; vk/k Hkkxk dh vkj cUn gkrh g tk fd QhM Lilj d lkFk ty d çokg dk tk fd vyo.khdr fd;k tkrk g dk miyC/k djokrh gA QhM ty f>Yyh ekM;y d ,d flj l ço'k djrk g rFkk tc nlj cUn okYo l nkc mRiUu gkrk g rk vyo.khdj.k dh çkflr gkrh gA ikjxE; ty fNfnr ufydk l xtj tkrk g tcfd lkfnr yo.k ty ekM;y d vU; flj l ckgj vk tkrk gA 'k# l vUr rd d vko';d cfu;knh <kp dk bu&gkml lfiy ekM;y cuku d fy; LFkkfir fd;k x;k] bu miØek e 'kkfey g %& (i) vYVklkfud ofYMx dk mi;kx dj mRikn vrjkyd dk fNfnr mRikn ty ufydk e fLFkjhdj.k; (ii) jkfyx e'khu dh nk Hk tkvk d chp mRikn ty ufydk dk ck/kuk; (iii) vk/kh yckb d lkFk nljh vk/kh lfØ; lrg dh vkj f>Yyh iÙkh ¼2.3 ehVj½ dk ekMuk rFkk dUn e QhM vrjkyd e vUrfufgr djuk; (iv) ofyr f>Yyh iÙkh dk mRikn vUrjkyd ifÙk;k d e/; e j[kuk; (v) f>Yyh d rUr Hkkx d Åijh fdukjk d lkFk foU;kl vkoj.k e lltd ç;Dr djuk rFkk fNfnr mRikn ty ufydk d pkjk vkj cyukdkj #i e ijh 0;oLFkk dk ?kekuk; (vi) io&fu/kkfjr ç;Dr nkc ij pytyh; jkyj d uhp yphyh lltd d lkFk n<rk l ck/kdj lfiy ljpuk dk yiVuk; (vii) lltd d leku llk/ku d fy, pkchl ?kVk d fy, n<rk l cfU/kr ofyr ljpuk dk fujUrj ?kekuk; (viii) nkuk fdukjk ij lekdru rFkk

fdlh Hkh {kj.k d fy, ok; ijh{k.k; (ix) vfUre <Dduk dk mi;Dr ¼ihohlh vFkok flfydku½ l fLFkj djuk rFkk ihohlh Vi d lkFk vfUre <Ddu dkyj dk yxHkx vkofjr dju d fy, yiVuk; (x) ,Qvkjih n< yiu; vkj (xi) lj{kd d lkFk ikyhbFkkbyhu ufydk e i.kr½ ekM;y dk ck/kuk rFkk ukedj.k djukA

ç;Dr lltd fuEu ijh{k.k d vk/kkj ij p;fur fd;k x;k & foÔghu rFkk [kk| ued] foyk;d ;Dr] cgkoghu rFkk mPp&l?ku] vknrk d çfr vlonu'khy] njh d ckn lV dju ij py] ikyhlYQku rFkk ikyh,ekbM iry yiu d çfr vfØ;] 'k"d fQYe yphyh g] llk/ku d ckn e'khfux lHko gkA dN e[; Hkkx tk fd ekM;y e mi;kx gkr g lLFkk d dk;'kkyk e cuk; tk jg gA

v'kð ifrjk/kd {kerk dk c<ku d fy, Vh ,Q lh lrg dk l/kkj

TFC eEcu dh v'kð ifrjk/kd {kerk c<ku d fy,] lrg ifjoru fd;k x;k] ftle tyLugh ikyhej (-COOH/-SO_3H) xi ;Dr dk vyx – 2 ifjfLFkfr;k e tek;k x;kA

lrg l/kkfjr Vh,Qlh f>Yyh d v'k) çfrjk/kd {kerk e l/kkj dk J; (a) lrg dk [kjnjkiu de gkuk rFkk (b) lrg dk tyLugh gkuk] gk ldrk g] ftl Øe'kh ,,Q,e rFkk lid dk.k }kjk n[kk tk ldrk gA

mPp tyçokg ,o fuEu dV&vkQ d PS – HF ikyhlYQku gkyk Qkbcj cukuk

yxHkx 90 kDA vkj mll vf/kd v.kHkkj dV vkQ oky PS vk/kkfjr gkykQkbcj dh drkb dh n'kk; igy fodflr dh xb Fkh vkj bl tkudkjh dk ykbll Hkh fy;k x;k FkkA bl dk; dk vkx c<kr g, çfof/k çkpyk d gj&Qj l fuEu (10-60 kDA) MWCO d HF eEcu cuk; x;A ¶yDl c<ku d fy; ifjo'kh rki ij Qkbcjk dk mi;Dr foyk;dk d lkFk 10-12 ?kV d fy; j[kk x;kA

fefJr vkO;g ih-,l- [kk[ky rUr f>Yyh dk fodkl

mPprj gkbMkfQfyd iðfr rFkk vko'k d lkFk [kk[ky rUrvk d fodkl d pyr Øe e] ikyhbFkj lYQku ¼ih-b-,l-½ [kk[ky rUrvk tk fd /kuk;u fofue; jthu vk/kkfjr ikyh LVkbjhu &Mkbfoukby cthu dkikyhej d lkFk gkrk g] dk ih-b-,l- rFkk jthu d lkFk Likbuhx Mki dk mi;kx dj cuk;k tkrk gA rUrvk dk ty tkfd dej d rki ij vH;rj [kkl d lkFk & lkFk ckgjh tyh;Dr ek/;e nrk g] dk mi;kx dj dkrk tkrk gA e[; mí'; f>Yyh e vko'k vfHkyk{kf.kd dk idV djrk g rFkk f>Yyh d iokg rFkk vLohdk; dk c<krk gA

jthu d fgLl dk c<ku ij f>Yyh iokg d lkFk&lkFk vk.kfod Hkkj dV & vkQ oY; e Hkh deh ¼pkj x.kk½ gkrh gA jthu fefJr f>Yyh e NaCl d vLohdk; e dkb fofHkUurk ugh ikb xb ij Na_2SO_4 vLohdk; e 21% dh ofð gbA ;g vf/kdrj rUr d _.kk;u vko'k dk c<ku d ifj.kke Lo:i gkrk gA f>Yyh dk iokg vkj vLohdk; lkUnrk c<ku ij ?kV x;kA f>Yyh d vkdkfjdh fo'y"k.k dk Ldfux byDVku ekbØkLdki d }kjk fd;k tkrk gA jthu d d.k dk vklr vkdkj 10 – 12 ekbØk ehVj ik;k x;kA

ikyh bFkkbyhu Xykbdky] (PEG 35K) ckfou lhje ,YC;feu rFkk ,x ,YC;feu d v/;;u l irk pyk fd feJ f>Yyh e jftu dh ek=k c<ku l ¶yDl çkflr dk vuikr c<k tk n'kkrk g fd ;g ey eEcu l T;knk çfrjk/kh gA 6% jthu ;Dr f>Yyh d fy, dy 15 – 20% ,Q-vkj-vkj-oY; e c<krjh if{kr gkrh gA

[kk[ky rUr f>Yyh tk fd 24 – 82% lhek e Na_2SO_4 vLohdk; dk n'kkrk g rFkk NaCl d 10% l Hkh de dk dN fuf'pr vudy ifjfLFkfr;k e djhcu 90 fdyk Mh, d ,e-McY;-lh- vk- d lkFk ikyhlYQku ;-,Q-f>Yyh d ukoy lrgh :ikUrj.k d }kjk if{kr fd;k tkrk gA :ikrfjr f>Yyh dh ,e- MCY;-lh-vk- oY; 280 – 1150 Mk- dh lhek e gkrh g tk fd :ikUrj.k ifjfLFkfr;k ij fuHkj djrh gA ;g lkQ n'kkrk g fd bu rUrvk dk de vk.kfod Hkkj d dkcfud ;kfxdk dk ykoj vkijfVx nkc dh ryuk e dke e fy;k tk ldrk gA ;g Hkh if{kr fd;k x;k fd :ikrj.k rUr dh gkbMkQhfyflVh dk vkj c<krk g rFkk blfy, eyhurk ifrjk/kh x.k dk c<krk gA

ikyhMkb feFkkbyflykDlu ijoikj'ku f>Yyh dh vfrl{e ljpuk rFkk iFkDdj.k x.k

ih-Mh-,e-,l- ijoikj'ku f>fYy;k VjfeuVM ikyhMkbfeFkkby flykDlu rFkk ikyhfeFkkby& gkbMkflykDlu d lkFk iUMUV gkbMkbM ¼ih-,p-,e-,l-½ dh fØ;k }kjk cuk;h tkrh gA f>Yyh d in'ku dk ijoikj'ku i;kx d }kjk tye cUthu] MkbDykjkfeFku rFkk feFkuky d mi;kx }kjk c<k;k x;kA

cukb xb lkQ f>fYy;k e l] f>Yyh tk DykjkQke vFkok Vkybu dk foyk;d d :i e mi;kx }kjk cukb xb mudh dkcfud p;ukRedrk ,u&gDlu dk foyk;d d :i e mi;kx dj cukb f>Yyh l mPprj FkhA ,u&gDlu d mi;kx }kjk cukb xb f>Yyh d fy, lkif{kd iokg mPprj ik;k x;k tk bldh <hyh cgyd uuk ljpuk d ifr lgefr crkrh gA

eEcu ljpuk vkj çokg d chp lc/k dk le>u d fy; fofHkUu ekVkb;k] 0.2 l 150 ekbØkehVj] dh eEcu cukb vkj v/;;u dh xbA n-gDlu e 10% ¼Hkkj@Hkkj½ cgyd foy;u d ck"iu dkfLVx }kjk cuh LoPN PDMS eEcu dh vklr ekVkb 150 ekbØkehVj Fkh tcfd lj/kh likV] iryh eEcu cuku d fy; ç;kx fd;k x;kA SEM l lrg dh vkdkfjdh] likV ij iryh yfir PDMS fQYe e LQfVd fn[khA ;g XRD vkj DSC MVk l Hkh lefFkr gvkA fQYe ekVkb dh deh l PDMS lrg dk lid dk.k ¼ty½ Hkh de ik;k x;kA LoPN PDMS fQYe dh cgyd uuk ljpuk dk fMckb pu ekMy e fQV fd;k tk ldkA

eEcu vklou }kjk mfPN"V ty l vekfu;k foyxu

J.khc) vleferh; ljpuk okyh ikyhfoukbyhMhu ¶ykjkbM gkyk Qkbcj f>Yyh cukb xb rFkk vk|kfxd vif'k"V ifjr vekfu;k d fu"dklu e tkph xbA NMP e PVDF vkj bFkhyhu Xykbdky fefJr] ikjn'kh drkb Mki l vlefer HF eEcu cukb x;hA Mki dk] nkgj dkruoky l] N_2 d okrkoj.k e fd;k x;kA

gkyk Qkbcj f>Yyh dk ikjkflVh] Fkhdul gkbMkQkchflVh] ty p;ukRedrk] thVk ikVUlh;y rFkk ikj lkbt d :i e y{kf.kr fd;k x;kA Mkihx foy;u u f>Yyh ljpuk rFkk f>Yyh x.k e egRo dk iHkkfor fd;k ftll f>Yyh dk dk; liknu c<kA gkyk Qkbcj ,e-Mh- ekMYl d lkFk 0.06 ehVj^2 {k= f>Yyh dk 1000 feyhxke ifr yhVj lkUnrk rd tkpk x;kA vekfu;k fu"dklu nj rFkk ty iokg vekfu;k QhM lkUnrk l Lor= ik;k x;k vkj 90% rd foyxu çklr gvkA

n'kh dkVhx bdkb d mi;kx }kjk lh-,l-vkb-vkj- & lh-,l-,e-lh-vkj-vkb- ij mPp ieku e fufer uukfuL;nu f>Yyh dh ljpuk rFkk in'ku

,jkefVd ikyh,ekbM dh ljpukokyh Vh,Qlh vkj vk eEcu d vleku] Vh,Qlh uukfuL;nu eEcu dh ljpuk ,jkefVd ikyh,ekbM dh gkrh g tk cg/kk ,fyQfVd Mk;kehu] lkekU;r% ikbijkthu vkj Vkbfelk;y DykjkbM dh 0;RiUu gkrh gA ,jkefVd Mk;kehu dk ,fyQfVd Mk;kehu l foLFkkfir dju l cgydh ljpuk dk uVod vkj T;knk [ky tkrk gA bl çdkj eEcu <hyh iMh] tgk eEcu dk v.kHkkj dV vkQ 300-600 Da rd fu;f=r djd] bl mPp Lrj ij cuk;k x;kA 50-1000 ihih,e oky ,UVhck;kVhd ¼,eihflfyu½ d l'yfÔr mfPN"V ty dk 1440 eki d bl eEcu l cu lfiy ekM;y l mipkfjr fd;k x;kA ,UVhck;kfVd dh lknrk QhM vkj ijfe;V e HPLC l irk dju ij Kkr gvk fd ijfe;V e ,UVhck;kfVd y'kek= Fkk vFkkr fjtD'ku mRd"V ik;k x;kA ty fudk;k e c<rh ,UVhck;kfVd dh pukfr;k dk n[kr g, bl v/;;u dh Hkfo"; e dkQh egRo dh lHkkouk gA

ihu d ikuh d jkxk.kuk'ku d fy, ukoy cgyd

eØkikjl lg ikyhej cgyd chM ij flYoj ykfMx vk/kkfjr jkxk.kuk'kd cgyd cuk; x;A mud thok.kjk/kh ifØ;kvk dk ty e eY;kdu] fofHkUu lkUnrk d thok.k lo/ku tl b-dkykb] ch-lcVhfyt ih-vkjhfxuklk rFkk ,l-vkjh;l d lyV rFkk VLV V;c ifØ;k d mi;kx l fd;k x;kA {k=h; ty e 95% l 99% lhek e thok.k dh ifr'kr deh ikb xbA

o|r f>Yyh çfØ;k,

vUrj cgyd f>Yyh çfØ;kvk e l/kkj

vUrj cgyd f>Yyh cuku d fy; ,d ub cgyd xyu&feJ e'khu ¼feDlVMj½ dk fMtkbu rFkk Vyj&eM fd;k x;kA ml ;= e flXek iÙkh d lkFk fj,DVj ¼çfr?kkrd½ Hkh g] ftldh {kerk N fdykxke lkexh ¼inkFk½ fefJr vfHkfØ;k dju d vykok ;= ,d vdyk ip bDlVMj d lkFk tMk gvk g ftldk ckgj fudkyu d <x e pky dju d ckn ;= vfHkfØ;k djd cgyd dk fefJr dju d ckn fi?kyh gb voLFkk e ckgj fudky nrk gA mld ckn ml ;= e db jpuk lfo/kk dk ykx fd;k x;kA mPp fi?kyu dh ';kurk d vykok foy;u ,oe rjy vfHkdkj.k d lkFk lkFk ml ;= dk 200° l rkieku rd vklkuh l lHkkyk tk ldrk gA bl ;= e ,lh0;oLFkk dh xbg fd l tkrh; rjy d vfrfjDr tkM dk fu;f=r fd;k tk ldA tlk fd fefJr vfHkfØ;k d nkjku ,dyd dk buflV cgydhdj.k gkrk gA

f}&/koh; f>Yyh dk fodkl

f}&/koh; f>Yyh dk fuek.k ,d rjy feJ.k d }kjk tk Mkbfouk;y cftu vk/kkfjr jftu p.k dk feJ.k Fkk ,oe ihohlh ml feJ.k e c/kd Fkk] d iryh yi dk ijr nj ijr rjhd l dkp dh Fkkyh ij cuk;k x;kA mld ckn f>Yyh dk ihbih,l vk/kkfjr vrj cgyd /kuk;u ,oe _.kk;u ,Dlpt f>Yyh d lkFk id dj ,d ikp ly tkMh o|r vikgu bdkb r;kj dh xbA fofHkUu yo.k foy;uk dk vEy vkj {kkj e cnyu d fy; iupØ.k ekM e ycLrj ij ç;kx fd; x;

lhbMhvkb flLVe dk Lopkyu

bl fjikV d nkjku gekj ykbl lh }kjk lhfer l[;k e vfr'k) ty dh bdkb;k cph xb vkj fcØh c< jgh gA bl ;fuV e iu%l/kkj fd;k x;k rFkk vkij'ku i.k Lopkfyr fd;k x;kA bld ckj e ,d ç;kxdrk u fy[kk g fd "l'kkf/kr ty dh x.koÙkk e fcuk le>krk fd; g,] vU; blh çdkj d 0;olkf;d ekMyk dh ryuk e vkid ekMy dh dher dkQh vk'p; tud gA okLro e vkid ekMy dk çokg nj fo[;kr ekMyk l Hkh T;knk gA ;g lh,l,elhvkjvkb dh nh xb fof'k"Vrk l feyrk gA ;g bdkb gekj foHkkx d 30 'kk/kNk=k dh t#jrk dk ijh dj jgh gA vHkh rd ge dkb 0;kogkfjd ef'dy ugh gvk g" ¼çk- ,l- ehuk{kh] xk/khxke #jy ;fuoflVh] rfeyukM] 12 tykb 2012½

mPp çkflr d bMh&vkjvk ldj foyo.ku flLVe

Hkkjr e Hkh vkj vk eEcu vk/kkfjr ?kjy ty foyo.ku@'kf)dj.k ty mRikn dh çkflr] QhM ty dh 10 vkj 20 çfr'kr rd gh nHkkX;o'k gk ikrh g tk dy ?ky g, yo.k ij fuHkj djrh gA ty vHkko dh nf"V l] foyo.ku d nkjku bru {kh.k ty mRikn dh çkflr ,d fodV leL;k gA ty x.kork l fcuk le>krk fd, g, [kkj ty l mPp ty mRikn dh çkflr gr ,d bMh&vkjvk Lkdj çfof/k fodflr dh xb gA Lkdj çfof/k e bMh bdkb dk mPp TDS {k= ¼flLVe dk çfrjk/k de vkj bl çdkj n{krk T;knk½ e vkj vkjvk eEcu dk de TDS {k= e eEcu ij de ykM gku d fy;] pyk;k x;kA ty mRikn d iu%[kfutu ij fu;=.k gr bMh&vkjvk flLVe d fodkl ij dk; çxfr e g] ¼Hkkjrh; iVV ,lyhd'ku l 1418/DEL/2012; fMlfyu'ku] 282(2011)104½

xkgdk d fy, vo/kkj.kk v/;;u dk çek.k

lkfM;e gkbMkDlkbM dh cfg% çokgh /kkjk l iu%çkflr dh lQyrk d orkr dk tkjh j[kr g,] tlk igy of.kr g] vUoÔ.kkRed o|r vikgu v/;;u vU; egRoi.k vk|kfxd /kkjkvk ij fd, x,A vR;f/kd

VhMh, l oky foj t d dh cfg% çokgh ikVh }kjk çnku dh xb /kkjk dk ijh{k.k fd;k x;kA o|r vikgu d iu% çokfgr #i dk mi;kx djd] cfg% çokgh /kkjk e DykjkbM rRo dk vkjfHkd 60,000 ihih,e DykjkbM l ~95% rd de fd;k x;kA ;g ,d vFki.k dk; g D;kfd ;g vR;f/kd foyk;dokyh vk|kfxd tyh; /kkjk d fy, o|r vikgu fØ;k d lQy ç;kx dk vkjvk d v leku] çnf'kr djrk gA

,d m|kxifr l çklr jklk;fud çfØ;k e fey Xykbdk lkbM f} l ;Xe d lo/ku ij v/;;u fd;k x;kA o|r vikgu çfØ;k dk ç;kx djd lof/kr 75% Xykbdk lkbM çklr gvkA lQy ijh{k.k d i'pkr ikVh vkj lh,e lhvkjvkb] Hkkouxj d chp ,d ,evk; ij gLrk{kj g,A

fM¶ykfjMlu d fy, Lon'kh jftu dh fo'yÔ.kkRed [kkt

Qyvkjkb M vo'kkfÔr Lon'kh vk/kkfjr fNfnr ,ØkbyV ¼,e ,e , & b th Mh ,e ,½ dk v/;;u fo'kÔ rkj ij Qyvkjkb M dk ihu d ikuh l fu"dklu d fy, fd;k x;kA vuØfed çfrfØ;k l ,fue'ku vkj QkLQkefFkfydj.k d }kjk jflu dk fØ;kRed djd ,feukfeFkkbyQkLQkfud vEy çdkj dk jflu çklr fd;k x;k mld ckn Al^{3+} dk #ikrj.k $Al_2(SO_4)_3$ d 'kk/ku d }kjk fd;k x;kA byDVku ekbØkLdkih }kjk ;g irk fd;k x;k fd fØ;kRed jflu dk cgokj NkV fNnk e gvk g] vkj fd lh fu;fer vkdkj d vdkcfud d.kk d cM fNn ugh FkA

ljpuk }kjk ;g Kkr gvk fd Al^{3+} dh ek=k fofue; {kerk ¼~7eq çfr yhVj½ l cgr T;knk ykMM FkhA Al^{3+} jflu dk lfØ; çtkfr gku dk dkj.k gkbMkvkD lkbM vkj vkD lkbM gk ldrk gA lkfM;e Qyvkjkb M foy;u ,oe ,Y;fefu;e Hkfjr jflu d lkFk mipkfjr orko djd Qyvkjkb M dk v/;;u fd;k x;kA

,Y;feuh;e ykMM jflu dk Qyvkjkb M d lkFk mipkfjr dju d ckn Li"V fØLVyh; fcUn n[kk x;k tk fd Øk;kykbV d lkFk feyrk FkkA Qyvkjkb M mipkfjr ,Y;feuh;e jflu dk lkfM;e Bkl voLFkk ,u ,e vkj LiDVk Hkh lkfgR; e çdkf'kr Øk;kykbV LiDVk d leku ik;k x;kA NaF mipkfjr F^- d lkFk] ijhf{kr Na^+ vk;u d] viVd dk MVk ,d leku ik;k x;kA

gfjr ç.kkyh }kjk fo|r jklk;fud çfØ;k d fy, vR;f/kd fLFkj ldjh _.kkRed fofue; f>Yyh dk tyh; ek/;e e fuek.k

dkcfud&vdkcfud ldj _.kkRed fofue; f>fYy;k dk nk Øeoky ,d vklku rjhd l fodflr fd;k x;kA ioorh _.kkRed fofue; flfydk dk fuek.k fd;k x;k rFkk ,- b- ,l- ih- ikyh foukby ,Ydkgy ldjh _.kkRed f>Yyh dk lky&ty rjhd l cuku e ç;kx fd;k x;kA bue l ,d _.kkRed fofue; f>Yyh e mPp vk;u fofue; {kerk ¼1.36 mequi@xke½ mip;u (0.94) d lkFk gh vk;fud pkydrk (7.61 mS/cm) FkhA fo|r ijklj.kh v/;;uk u f>Yyh d bfPNr de n0;eku vojk/k rFkk rY;kdh fNn f=T;k (2.31-5.28Å) dk crk;k gA ¼ikyhej dfeLVh] 1 (2010) 1302½

feFkuky vçHkkfor mPp vkof'kr] fLFkj rFkk ikjc/kd cgyd fo|r vi?kV; f>Yyh

,d uohu ikj c/kd dkjd 4-4'-fcl ¼4& vehukfQukD lh½ ckbfQukby-3, 30 Mkb lYQkfud {kkj (BAPBDS) dk l'yÔ.k fd;k x;k rFkk lYQkukekbM dMh }kjk lYQkuVM ikyh bFkj lYQku dk ;Fkkor ikj c/kd e ç;kx fd;k x;kA vkof'kr ikj c/kd dkjd dk bLreky /kukRed fofue; f>Yyh d dkj.k f>Yyh dh fØ;kRed rk e gb fd lh Hkh fodfr dk jkdrk gA cgrj BAPBDS rRookyh lcl mi;Dr f>Yyh mPp vk;u fofue; {kerk (1.47 mequiv./g) rFkk çkVku pkydrk (2.64×10^{-2} S/cm) n'kkrh gA ft ldh ty vrxg.k (22.85%) {kerk rFkk feFkuky ikjxE;rk (0.65×10^{-7} cm^2/s) de gkrh gA

çnf'kr ikj c/ku çfØ;k mPp fØ;kRed ikj c/ku ,jkefVd cgyd f>Yyh d fodkl e ,d 0;; çHkkoh lk/ku fl) gk ldrh gA tk fd fofHkUu b/ku ly rFkk fo|r f>Yyh çfØ;k d mi;kx e 0;olkf;d egxh f>fYy;k dk mi;Dr LFkkukiUu gk ldrh gA ¼tujy vkQ efVj;y dfeLVh] 20 (2010) 8036½

Xyklh dkcu byDVkM dk flYoj uukd.k ,oe dkbVklu }kjk l'kkf/kr djd] ikuh e l vklfud dk /kukRed o|r jlk;u fo'yÔ.k

Xyklh dkcu byDVkM dk flYoj uukd.k ,o dkbVklu l l'kkf/kr djd iYl fMQjfU'k;rk ,ukfMd LVfix okYVehVjh fof/k l vklfud dk tkpk x;kA f>Yyh }kjk vklfud d çokg dk irk yxk;k x;kA ,d cgrjhu jfpr uukljfpr byDVkM r;kj fd;k x;kA ftldk jf[kd n[kko ,oe irk yxku dh lhek ,d vjc dk nlok Hkkx l ydj lkok Hkkx rd g (10–100 ppb) vkj mPp lonu'khyrk (0.309 μA ppb^{-1}) ,oe irk yxku dh lhek 1.20 ppb (16.2 nM) gA ;g ihu d ikuh e vklfud dh ek=k l cgr de gA fo'o LokLF; lxBu d vulkj ihu d ikuh e vklfud dh ek=k ,d vjc dk nlok Hkkx (10 ppb) gkuh pkfg,A dk; liknu dk ijh{k.k okLrfod ty d ueu dk ydj fd;k tk;xkA ¼byDVk dfedk ,DVk] 72 (2012) 157½

o|r lgk;rk l ckbikyj f>Yyh }kjk ikuh d fo;ktu ij /kkr ,YdkvkDlkbM dk çHkko

ckbikyj f>Yyh dk foy;u <ykb fof/k }kjk ijr nj ijr cuk;k x;kA ,d leku foy;u gku d dkj.k nkuk ijrk d chp vPNk fpidko gkrk gA iryh f>Yyh cuku d fy, vyx vyx /kkr ,YdkvkDlkbM M(OR)n dk ç;kx fd;k x;kA tgk M = Si, Ti ;k Zr vkj R = $(CH_2)_n$ CH_3 g] budk mi;kx nk ijr _.kk;u fotkrh; vkj /kuk;u ltkrh; lYQkuVM ikyh ¼bFkj lYQku½ d chp d ijr dk cuku d fy, fd;k x;kA /kkr ,YdkvkDlkbM e mRçjd lfØ;rk gku d dkj.k ckbikyj f>Yyh dk fu"iknu ikuh dk fo;ktu dju d fy, vPNk gk x;k ,oe flfydk ;Dr ckbikyj f>Yyh dk çn'ku 0;olkf;d miyC/k ckbikyj f>Yyh dh ryuk e vPNk jgkA ¼byDVkfdfedk ,DVk] 66(2012) 325½

fojk/kh to nfÔr dkcfud vdkcfud ldj f>Yyh d }kjk ikuh dk 'kk/ku

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REVERSE OSMOSIS AND RELATED POLYMERIC MEMBRANES

Thin film composite (TFC) RO membrane and module knowhow transfer

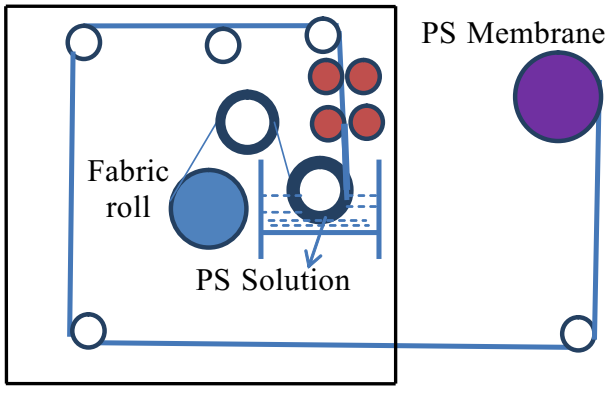
Knowhow for manufacturing polyamide TFC reverse osmosis membrane and spiral modules was licensed to M/s Uniqflux, an SSI unit. The technology has been demonstrated at the scale of 1 m width x 100 m length using semi-automated casting and coating units.

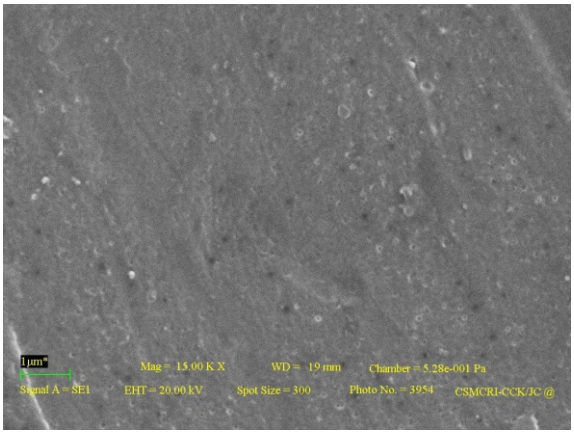
Further improvements in TFC membrane process

In continuation of the work on TFC membranes, two important modifications in polysulfone (PS) support casting and polyamide coating on PS support were made. These led to better consistency in membrane production and improved quality of membranes.

In the preparation of PS support membrane roller casting was replaced with blade casting. The major advantages which were realised include: i) elimination of dead volume of PS solution, ii) elimination of formation of PS layer along the edges on the backside of the membrane which posed difficulty while making the spiral module, and iii) greater control over the thickness of the PS membranes and, consequently, in the TFC membrane properties also. SEM images revealed greater porosity of the membranes produced through blade casting method. The higher porosity translates to reduced hindrance to water transport resulting in higher productivity.

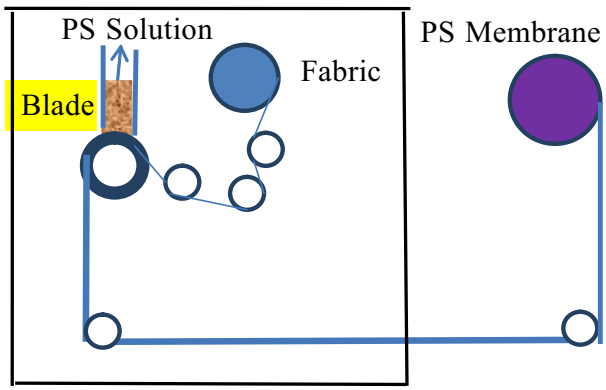
Roller (Earlier) Casting

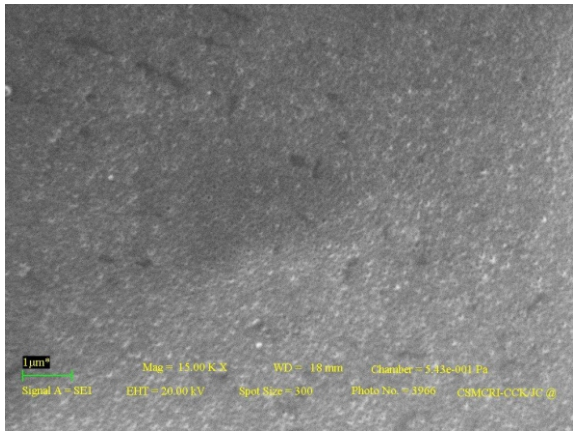




Roller casting of PS support membrane (left) and the SEM image (right)

Blade PS Casting





Blade casting of PS support membrane (left) and the SEM image (right)

Regarding the improvement made in TFC coating, the nascent polyamide layer was in contact immediately with the supporting/ guiding rollers. This was resulting in the formation of a non-uniform polyamide layer. Modifications were made in such a way that the polyamide layer did not come in contact with any roller until the curing step. This has resulted in the formation of a more uniform and defect free polyamide layer and hence greater consistency in the performance. The table below shows the average performance of the TFC membranes prepared according to the two protocols.

TFC membrane performances

Water type	New protocol		Earlier protocol	
	Flux, $Lm^{-2}h^{-1}$	%SR	Flux, $Lm^{-2}h^{-1}$	%SR
Brackish water	55 ± 2	97.5 ± 1	55 ± 5	94 ± 2
Domestic water	28 ± 2	94.0 ± 1	20 ± 6	86 ± 2
Sea water	60 ± 5	96.0 ± 1	35 ± 5	90 ± 2

Improvements in infrastructure and process of module rolling

Spiral wound membranes such as those sold commercially are tightly packed cylindrical structures where a membrane is wrapped around a centre perforated tube in a spiral fashion along with feed and permeate spacers. The membrane is sealed at the edges on the fabric side and gap between two active halves of the folded membrane is provided with a feed spacer that allows flow of the water that is to be desalinated. The feed water enters the membrane module from one end and desalination occurs when pressure is generated through closure of the valve at the other end. The permeate water travels out through the perforated tube whereas the concentrated brine comes out of the other end of the module. The complete infrastructure required end-to-end was established to enable all of the operations to be carried out in-house for fabrication of the spiral modules. These operations include: (i) fixing of product spacer onto perforated product water tube using ultrasonic welding; (ii) holding product water tube in between the two arms of the rolling machine; iii) folding the membrane leaf (2.3 meters) at a half length with active layer facing to the other half and inserting feed spacer in the centre; iv) placing the folded membrane leaf in between the two product spacer leaves; v) applying adhesive in an envelope configuration along the edges on top of the fabric part of the membrane and winding the entire set-up in a cylindrical form around the perforated product

water tube; vi) wrapping up the spiral structure with a flexible adhesive tape tightly under hydraulic roller at a pre-determined applied pressure; viii) allowing the tightly rolled structure to rotate continuously for 24 hours for even curing of the adhesive; ix) trimming at both the edges and air testing for any leakage; x) fixing the end caps with suitable (PVC/silicon) sealant and wrapping with PVC tape to cover the end cap collar appropriately; xi) FRP hard coating; xii) labelling and packing of the finished module in polyethylene tube along with preservative. The adhesive used was selected based on the following criteria: non-toxic and food grade; free of solvent, non pourable and highly viscous; non-sensitive to moisture; starts to set after a delay; inert for polysulphone and polyamide thin coating; dried film is flexible; machining is possible after curing.

Pictures shown below are of the machinery used for rolling, majority of which were fabricated indigenously based on the requirements indicated by the institute. Some important components utilised in the module are being fabricated in the institute's workshop.

DUSTFREE DRY AIR GENERATOR

SPIRAL MEMBRANE ELEMENT HARD WRAPPING MACHINE

SPIRAL MEMBRANE ELEMENT TRIMMING MACHINE

SPIRAL MEMBRANE ELEMENT ROLLING MACHINE

SPIRAL MEMBRANE ELEMENT AIR TESTING MACHINE

ULTRASONIC WELDING MACHINE

SPIRAL MEMBRANE ELEMENT HARD WRAPPING CURING MACHINE

PRODUCT AND FEED WATER SPACER SIZING AND CUTTING MACHINE

DOMESTIC SPIRAL MEMBRANE ELEMENT ROLLING MACHINE

ADHESIVE APPLICATOR

MOLDS FOR 4040 AND 8040 SPIRAL MEMBRANE ELEMENTS END CAP

DOMESTIC SPIRAL MEMBRANE ELEMENT TRIMMING MACHINE

Machineries and inner components required for making spiral membrane modules, some of which are being fabricated in the institute's workshop

Spiral modules of 2012, 4040 and 8040 size were rolled with improved perfection and the performance data are shown below (courtesy M/s Uniqflux Membranes LLP, Pune).

Performance of indigenous spiral membrane modules

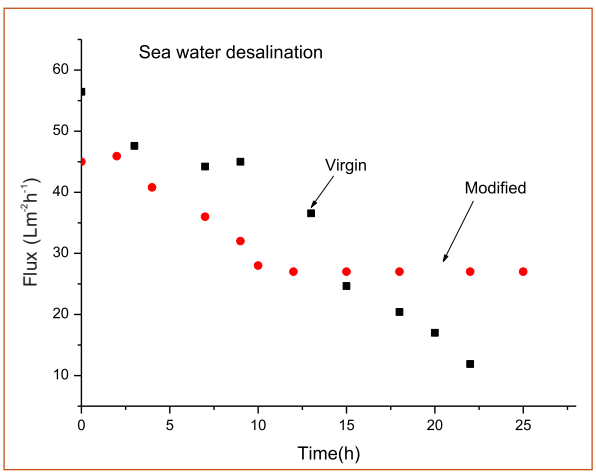
Model No	Active membrane area, m^2	Feed water, ppm.	Operating pressure, psi	SR, %	Flux, Lit./h
2012	0.9	800	100	89	10
4040	7.2	4000	300	93 to 98	300
8040	36	4000	350	93 to 98	1200

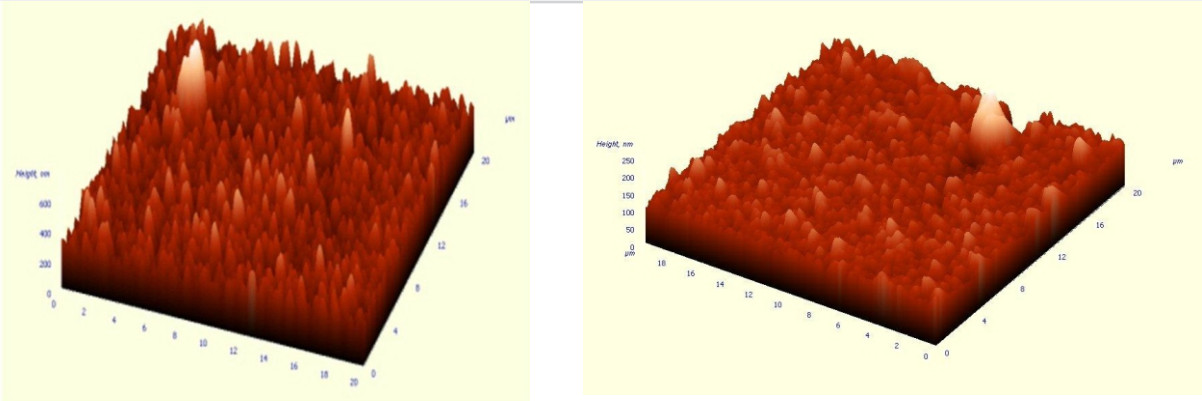
Surface modification of TFC membrane to increase fouling resistance

In order to increase the fouling resistance of the TFC membranes, a thin layer of cross-linked hydrophilic polymers containing hydroxyl and charged functional group like -COOH/-SO_3H

Surface roughness (AFM) and contact angles of the TFC membrane

Membrane characteristic	Virgin TFC	Modified TFC
AFM average roughness, nm	182	68
AFM RMS roughness, nm	221	81
Contact angle	66	44





AFM images of virgin (left) and modified TFC (right) membranes

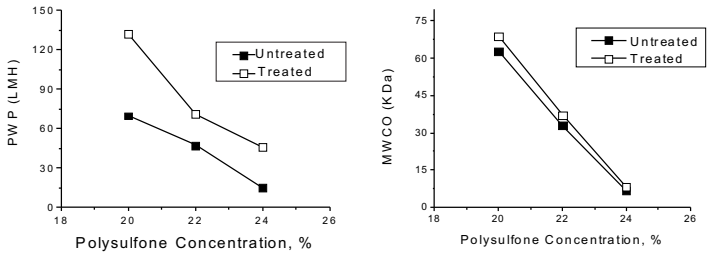
were deposited under different conditions. The flux vs. time plot for virgin and surface modified TFC membranes is shown for sea water desalination. The improved fouling resistance of the surface modified TFC membranes may be attributed to a) decrease in surface roughness and b) increase in surface hydrophilicity as seen from AFM and contact angles (CA) data, respectively.

Preparation of PS hollow fiber (HF) membranes with high water flux and lower cut-off values

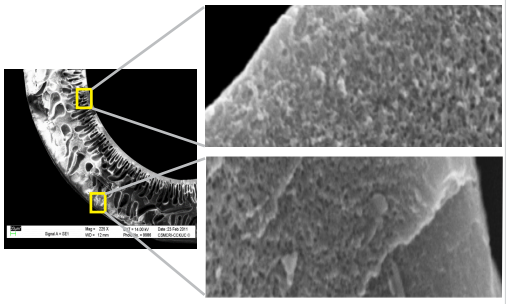
The conditions for spinning PS based hollow fibers for molecular weight cut off (MWCO) values of about 90 kDa and above were developed previously and the knowhow licensed for the same. In continuation of the above effort, HF membrane with lower (10-60 kDa) MWCO were spun through alterations in the process parameters. The fibers were then treated with appropriate solvents for 10-12 h at ambient temperature to raise the flux. The performances of different membranes are shown in the table below.

Performance of virgin and solvent treated PS HF membranes

Hollow fiber code	Flux ($Lm^{-2}h^{-1}$)		Water content (%)		MWCO (kDa)	
	Virgin	Treated	Virgin	Treated	Virgin	Treated
PS2020	70	132	74	51	100	100
PS2220	47	71	70	49	32	37
PS2420	15	24	64	53	6	8
PS2440	32	54	71	61	8	12
PS2460	38	66	73	60	8	9
PS2480	76	141	71	67	14	28



Variation of flux and MWCO with variation of PS concentration in polysulphone hollow fibers



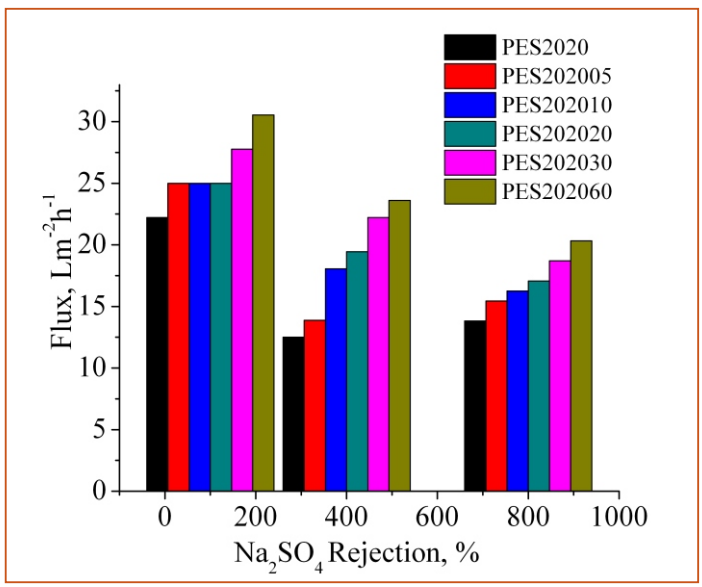
Porous microstructure of PS hollow fibers with 10-60 kDa MWCO and enhanced flux

Development of mixed matrix PS hollow fiber membranes

In continuation of the development of hollow fibers with higher hydrophilic nature and charge, polyethersulphone (PES) hollow fiber membranes containing polystyrene-divinyl benzene copolymer–based cation exchange resin (R) were prepared using the spinning dope containing PES and the resin (PES-R). The fibers were spun using water as the bore former as well as the outer gelling medium at room temperature. The main objective was to impart charge on the membranes and to enhance their flux and rejection. The performance of the blend HF membranes is shown below. Increase in the resin content decreased the membrane flux with concomitant reduction (four times) in the molecular weight cut-off value. The resin blended membranes exhibited no difference in the rejection of NaCl, but Na_2SO_4 rejection was higher by 21%. This is attributed to the increase in the negative charge of the fibers. The flux and rejection of the membranes decreased with increase in salt concentration.

Performance of PES-R HF membranes studied with dextran and PEG solutions

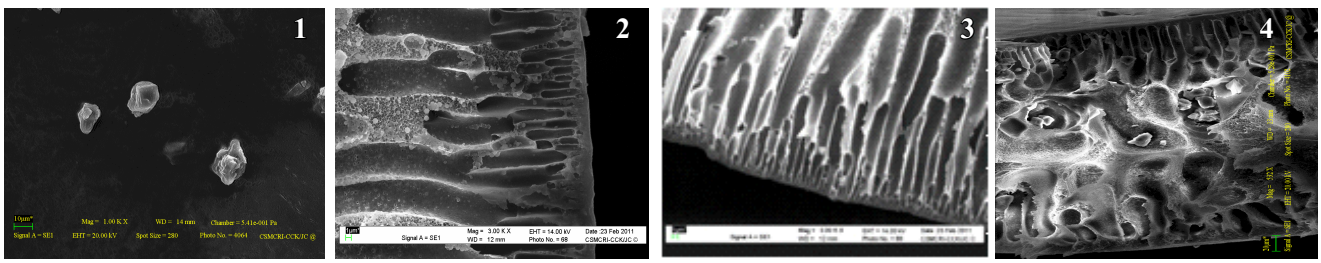
Membranes	Spinning dope Composition (wt/wt)				PWP, $Lm^{-2}h^{-1}$	MWCO, KDa
	PES	PVP	DMF	CER		
PES 2002	20	2	78	0	75.50	40.99
PESR 200201	20	2	78	1	60.84	27.71
PESR 200202	20	2	78	2	36.52	23.44
PESR 200203	20	2	78	3	21.22	18.67
PESR 200206	21	2	78	6	15.96	10.02



Variation of flux and rejection of PES-R HF membranes with aqueous Na_2SO_4 feed of different concentrations

Morphological analysis of the membranes was carried out by SEM. The average particle size of the resin was found to be 10-12 µm.

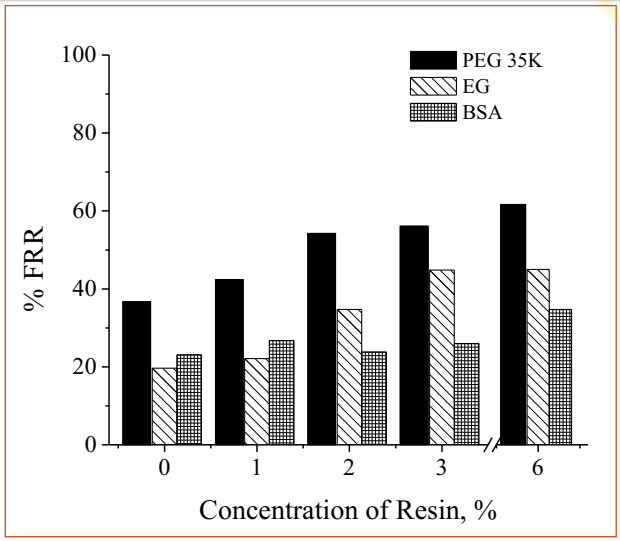
Based on studies conducted with polyethylene glycol (PEG 35K), bovine serum albumin (BSA) and egg albumin (EG), it was observed that the flux recovery ratio (FRR) increased with increase in resin content in the blend membranes, suggesting that these are more resistant to fouling than the virgin membrane. An overall 15-20% enhancement in



Scanning electron microscopic images of polyethersulphone-resin blend fibers:
(1) R, (2) PES2002, (3) PES-R200206, (4) PES-R200220

the FRR value was observed for the membranes containing 6% resin.

Hollow fiber membranes which exhibit Na_2SO_4 rejections in the range of 24-82% and NaCl rejection of <10% were obtained by novel surface modification of the conventional polysulfone UF hollow fibres having MWCO of about 90,000 Da. The MWCO of the modified membranes were as low as 280-1150 Da depending on the modification conditions. It may be feasible in future to use these fibers for the separation of low molecular weight organic compounds at low operating pressures. The modification procedure also helps increase the hydrophilicity of the fibers making these more fouling resistant.

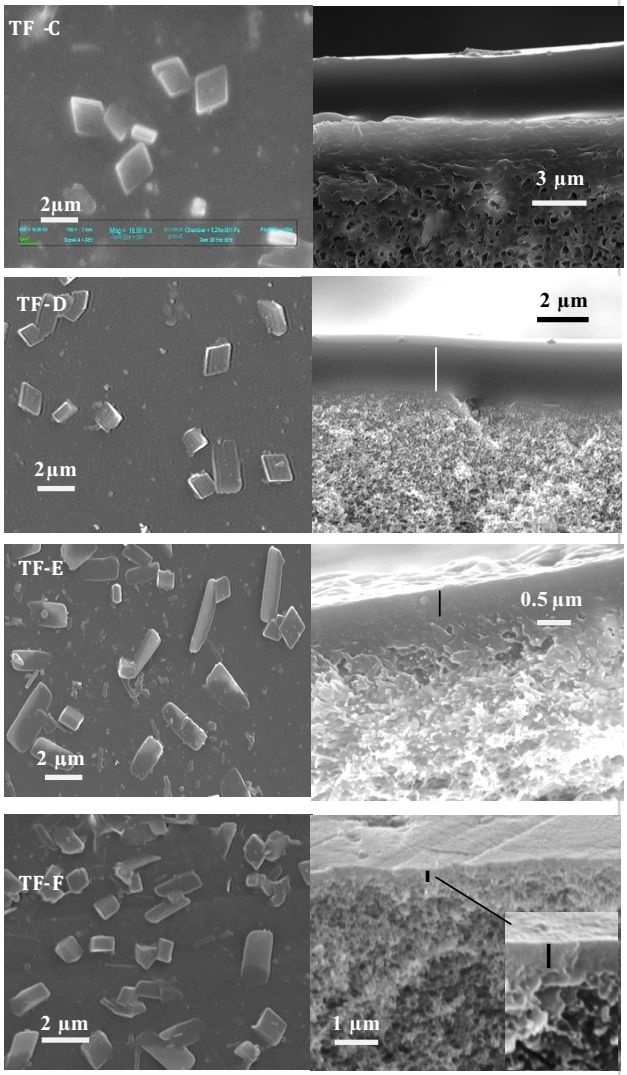


FRR of virgin and modified PS hollow fiber membranes

Nanostructure and separation properties of polydimethylsiloxane pervaporation membranes

Polydimethylsiloxane (PDMS) pervaporation membranes were prepared from the reaction of hydroxyl terminated PDMS (PDMS-OH) with pendant hydride (PHMS). The performances of the membranes were evaluated from the pervaporation experiments carried out using a ternary mixture of benzene, dichloromethane and methanol in water. Among the neat membranes prepared, the membranes prepared using toluene or chloroform as solvents had higher organic selectivity than those prepared using n-hexane as solvent. However, the flux was higher for the latter indicating a loose polymer structure.

In an attempt to understand the relationship between the membrane structure and flux, the membranes of different thickness varying from about 0.2 to 150 micrometer were prepared and studied. The neat PDMS membrane prepared by evaporation casting of the 10% (w/w) polymer solution in n-hexane had an average thickness of 150 micrometer while a porous support was used for preparing the thinner membranes. The surface morphology as seen by SEM images showed crystalline domains in the thinly coated PDMS film over the support. This was also supported by XRD and DSC data. The contact angle (water) of the PDMS surface was also found to reduce with the decrease in the film thickness. The polymer nanostructure of the neat PDMS film could be fit to the Debye chain model.



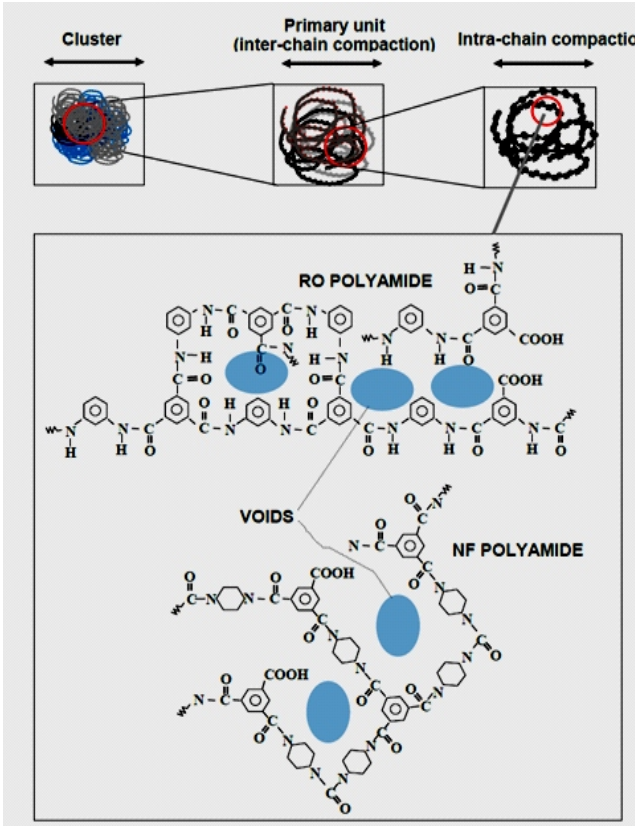
Surface and cross sectional SEM images showing differences in surface morphology of membranes with decrease in film thickness

Removal of ammonia from wastewater through membrane distillation

A series of asymmetrically structured polyvinylidene fluoride (PVDF) hollow fibre membranes were fabricated and tested for the removal of ammonia from simulated industrial wastewater. Asymmetric hollow fibre membranes were prepared from a transparent spinning dope comprising a mixture of PVDF and ethylene glycol in NMP. The spinning dope was extruded under nitrogen environment through a double orifice spinneret. The HF membranes were characterised in terms of porosity, thickness, hydrophobicity, water permeability, zeta potential and equivalent pore size. Doping solution was found to significantly affect the microstructure and properties, which in turn affected membrane performance. Hollow fibre MD modules with membrane area of 0.06 m^2 were assembled and tested with solution containing up to 1000 mg/L ammonia. Ammonia removal rates and water fluxes were independent of its concentration in the feed and up to 90% removal was achieved.

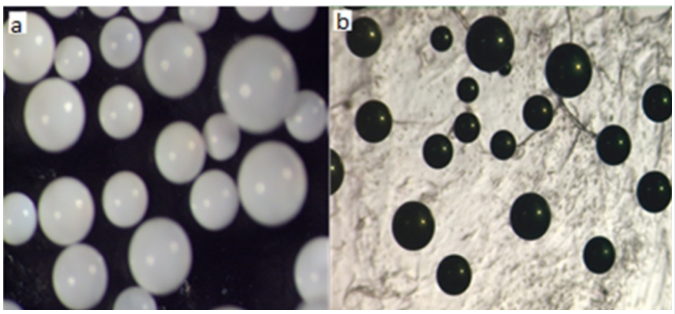
Structure and performance of nanofiltration membrane prepared in a large-scale at CSIR-CSMCRI using indigenous coating unit

Unlike TFC RO membranes which have aromatic polyamide structure, TFC nanofiltration membranes contain aliphatic-aromatic polyamide structure derived from aliphatic diamines – most commonly piperazine – and trimesoyl chloride. The substitution of aromatic diamine with aliphatic diamine results in a more open network polymeric structure. Such loose membranes, wherein the molecular weight cut-off of the membranes was controlled between 300 and 600 Da, were made on large scale. Synthetic waste water samples containing 50-1000 ppm of an antibiotic (ampicillin) were treated using 1440 size spiral modules fabricated from the above membranes. The antibiotic concentrations in feed and permeate were analyzed by HPLC and only traces of the antibiotic was found in permeate, i.e., the rejection was excellent. The study is likely to gain importance in the coming years considering the growing threat of antibiotics in water bodies.



Novel polymers for disinfection of drinking water

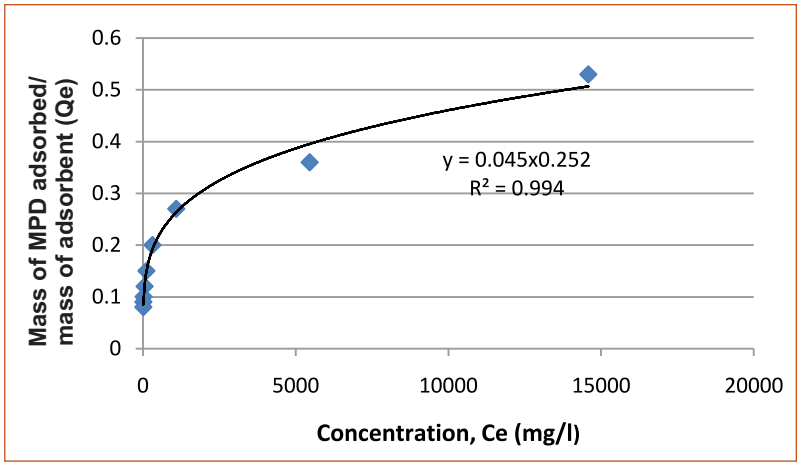
Several disinfecting polymers based on silver loading on macroporous copolymer beads were prepared. The optical micrographs of copolymer beads before (left) and after (right) silver loading are shown. Their antibacterial activities were evaluated by plate & test tube methods using different concentrations of bacterial cultures like *E. coli, B. subtilis, P. aeruginosa*, and *S. Aureus*. Percentage bacterial reduction in field water was observed to be in the range of 95 to 99%.



Effluent treatment and waste management

Adsorptive removal of *m*-phenylene diamine (MPD) using activated carbon

m-Phenylene diamine (MPD) is used in the manufacture of thin film composite (TFC) RO membrane in polyamide thin film formation by interfacial polymerization. The used MPD solution has to be discarded as effluent, as it has got very high propensity for oxidation and cannot be reused for the next batch of production. A study of adsorption of MPD over granular activated carbon at different loading of adsorbent for a given MPD concentration and different concentration of MPD solution for a given adsorbent quantity has been done. Kinetics of adsorption at different temperatures was also carried out. It is found that granular activated carbon is efficient in the removal of MPD from aqueous solution. Scale-up study and development of breakthrough curves are underway.



Adsorption isotherm: Varying quantities of adsorbent exposed to 2% MPD solution

Rejuvenation of terminally fouled sea water reverse osmosis (SWRO) membrane

TFC RO membranes have wide spread application in desalination and water reuse. Typical membrane life is around 3-5 years when good pre-treated feed water is provided. At the end of life, TFC RO membrane modules are discarded and replaced with new membrane modules. It is known that terminally fouled SWRO membranes find alternative applications. The process for rejuvenating the membrane performance is to explore the option of recycling the TFC RO membrane module for value addition. It has been demonstrated on terminally fouled SWRO membrane modules of Nirma Ltd., Bhavnagar that up to 7 times increase in flow with 15% decline in selectivity was possible to make the membrane module fit for alternate applications e.g. brackish water reverse osmosis. The process involves removal of foulant layer by course of treatments involving sodium hypochlorite, sodium lauryl sulphate followed by sodium metabisulfite to nullify the presence of active chlorine in the module. Removal of foulant layer coupled with structural modification in TFC RO is the key to improve permeability on sustainable basis. Characterization of treated membrane revealed that the membrane becomes hydrophilic and less prone for bio-fouling with structural modification.

Experimental set up for rejuvenation

Rejuvenated TFC RO membrane modules

ELECTRO MEMBRANE PROCESSES

Improvements in interpolymer membrane process

A new polymer melt-mixing machine (mixtruder) was designed and tailor-made for preparation of interpolymer membranes. The machine has a reactor with sigma blades with the capability of reaction-mixing up to about six kg of material, and is attached to a single-screw extruder, which is switched to the extrusion mode to extrude out reacted and mixed polymer melt in form of strand. Several design features were implemented, enabling the machine to handle high melt-viscosity polymers (e.g. HDPE of blow-extrusion grades) with solvents and liquid reactants at temperatures up to 200 °C. Arrangements have been made for controlled and homogeneous addition of liquids, such as the monomers for *in situ* polymerization, during the mixing process.

Mixtruder, a reactive mixing-cum-extruder machine designed and manufactured for preparation of interpolymer material

Development of bipolar membranes

Bipolar membranes were prepared by layer-by-layer spray coating of heterogeneous membranes (AEM and CEM bilayer), from a liquid mixture containing divinylbenzene-based resin powder and PVC as binder, on a glass plate. These membranes were packed, along with PE-PS based interpolymer cation and anion-exchange membranes, forming a five-cell tri-plate electrodialysis (ED) unit. Experiments were conducted at lab-scale in recirculation mode for exploration of conversion of different salt solutions into corresponding acids and alkalis. The experimental results on conversion of sodium sulphate to sulphuric acid and sodium hydroxide, are given below. Similar results were obtained with potassium sulphate.

Conversion of sodium sulphate to sulphuric acid and sodium hydroxide by ED using bipolar membrane

Exp. No.	Pot /cell tri-plate (V)	Initial conc. Na_2SO_4(N)	Acid stream		Alkali stream		Conversion (%)
			Conc. H_2SO_4 (N)	Purity (%)	Conc. NaOH (N)	Purity (%)	
1	6.0	0.5	0.3258	79.02	0.3341	85.4	93.4
2	8.0	0.5	0.3702	77.51	0.4242	90.43	91.8
3	8.0	0.5	0.3856	83.58	0.4132	87.85	93.8
4	8.0	1.0	0.5157	74.32	0.6264	84.56	91.4
5	8.0/7.0	2.0	0.6941	57.86	0.9232	79.31	82.5

Automation of CEDI system

A limited number of ultrapure water units were sold by our licensee during this period and sales are picking up. The unit was further improved and the operation was made fully automatic. The following feedback was received from a user: "*The cost of your model is extremely surprising when compared to other commercial models of same type without compromising the quality of treated water. In fact, the rate of flow of your model is higher than that of the popular model. It meets all the specifications given by CSMCRI. Nearly this unit catering the needs of 30 research scholars of our department. So far we have not faced any practical difficulty.*" (Professor S. Meenakshi, Gandhigram Rural University, Tamil Nadu, 12 July, 2012)

High recovery ED-RO hybrid desalination system

Reverse osmosis (RO) membrane-based domestic water desalination/purification units have gained wide acceptance even in India. Unfortunately, the recovery of product water from these units varies between 10 and 20% depending on total dissolved solid (TDS) of the feed water. Such poor recovery of product water during desalination is a serious problem in view of scarcity of water. An ED-RO hybrid process was developed for high recovery of product water from brackish water without compromising on water quality. In the hybrid process, ED unit was operated in high TDS region (low system resistance and thus high efficiency), and RO systems was operated in low TDS region to avoid load on membrane. Work is in progress for development of a system (ED-RO.M) for controlled on-line re-mineralization of the product water (*Indian Patent Application No. 1418/DEL/2010; Desalination, 282 (2011) 104*).

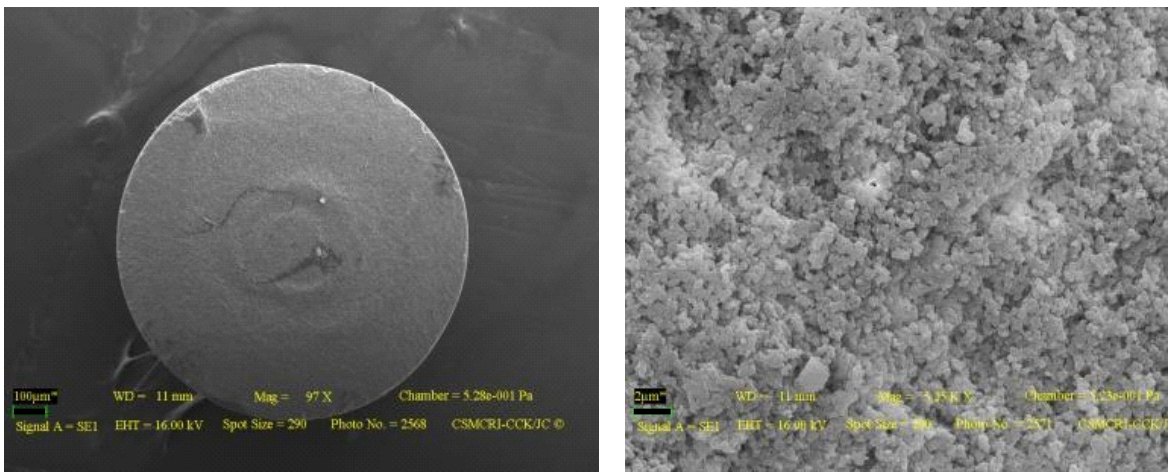
Proof of concept studies for clients

After demonstrating recovery of sodium hydroxide from effluent streams through ED, reported earlier, studies were carried out on other important industrial streams. A trial was conducted on a viscous dye effluent of high TDS supplied by a party. By conducting ED experiments in recirculation mode, the chloride content in effluent stream having 60,000 ppm TDS could be reduced by ~95%. This work is significant as it demonstrates successful application of ED process for extremely high-TDS industrial aqueous streams where RO will not function.

Studies were also conducted on enrichment of glycoside bioconjugates from a chemical process stream provided by an entrepreneur. Using the ED process an enrichment of 75% for glycoside was obtained. Subsequent to the successful trial, an MOU was signed with the party for benefit sharing once the process is commercialized.

Analytical investigation of indigenous resin for defluoridation

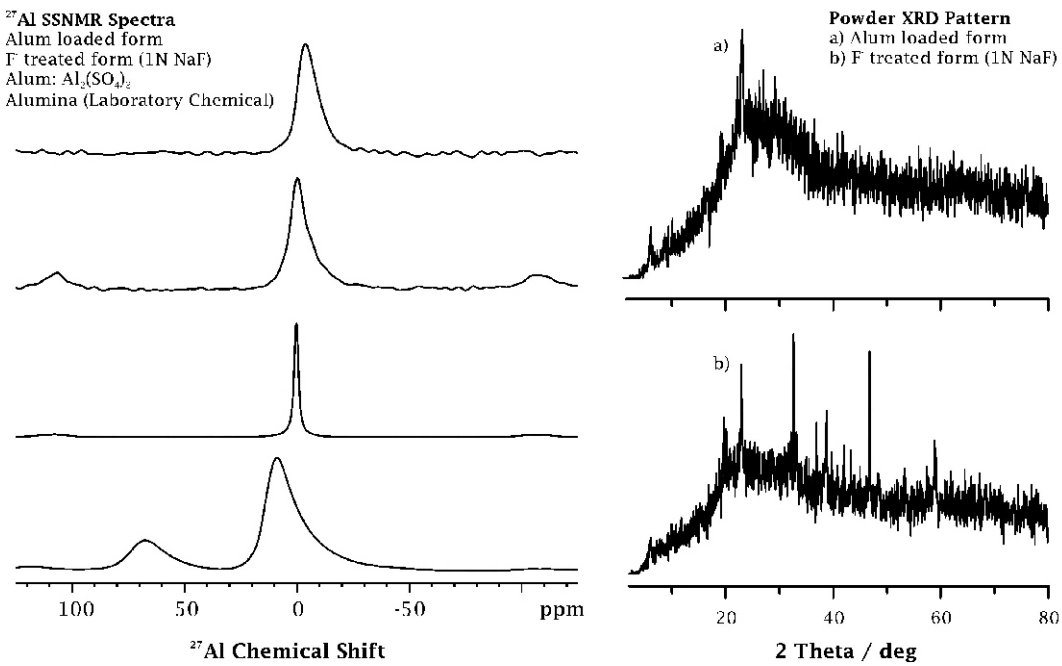
Detailed studies were performed on fluoride uptake of indigenous acrylate (MMA-EGDMA) based porous, specialty resins developed for fluoride (F^-) removal from drinking water. The functionalization of the resin was performed by sequential reactions of amination and



Electron microscope images of cross-section of Al loaded resin at low (left) and high (right) resolution. Absence of µm pores can be observed and sub µm pores were abundantly visible. Al loading was observed as a uniform coating

Elemental composition of the resins

Resin forms	Ca	Na	F	Al
Amine	158	96	0	1310
Phosphomethylated	394	212	0	2090
Na Form	16200	31900	0	898
Al Form	1110	278	0	217000
F- form	1220	55800	27200	114000



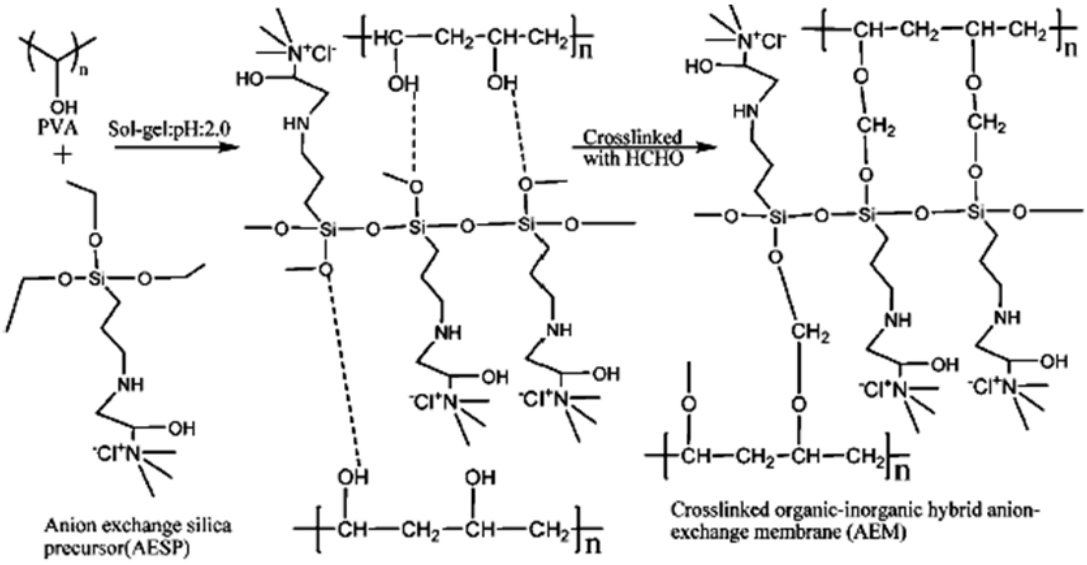
Left panel shows solid-state NMR spectra showing increase in order upon NaF (1N) treatment which was also confirmed by XRD measurement as shown in right panel

phosphomethylation, to obtain aminomethylphosphonic acid type resin, followed by further conversion to Al^{3+} form by treating with $Al_2(SO_4)_3$. The electron microscopy of the functionalized resin revealed homogeneously distributed small pores without the presence of any macro-pores or of any regularly shaped inorganic (metal hydroxide) particles.

The elemental composition of the resin indicated that the amount of Al^{3+} ion loaded in the resin was far higher than the exchange capacity (~7 eq/liter). The active species in the resin appears to be hydroxides and oxides (polymeric) of Al^{3+}. Fluoride uptake was studied by treatment of the Al loaded resin with NaF solution. The X-ray diffractogram of Al loaded resin after F^- treatment showed crystalline peaks, which could be matched with cryolite (Na_3AlF_6). The ^{23}Na solid-state NMR spectra of the F^- treated Al-resin also resembled published spectra of cryolite. The data conform to the observed uptake of Na^+ ions, along with F^- on NaF treatment.

A green method for the preparation of highly stable hybrid anion-exchange membranes in aqueous media for electrochemical processes

Organic-inorganic hybrid anion exchange membranes (AEM) were developed using a simple, two-step method. An anion-exchange silica precursor (AESP) was synthesized and used to prepare AESP-PVA hybrid anionic membrane by the sol–gel method. One of the membranes had the required properties of high ion exchange capacity (1.36 mequiv./g) and permselectivity (0.94), and acceptable ionic conductivity (7.61 mS/cm). Electro-osmotic studies revealed desirable low mass drag and equivalent pore radius of 2.31–5.28 Å of the membrane (*Polymer Chem., 1 (2010) 1302)*.

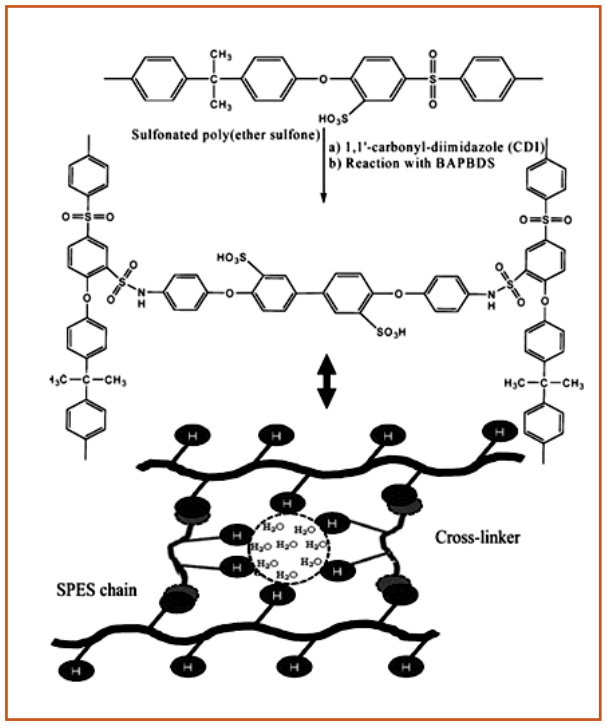


Scheme for synthesis of hybrid anion-exchange membranes using anion-exchange silica precursor

Highly charged, stable and cross-linked polymer electrolyte membranes impervious to methanol

A novel cross-linking agent, 4,4'-bis(4-aminophenoxy)biphenyl-3,30-disulfonic acid, (BAPBDS) was synthesized and used for *in situ* cross-linking of sulfonated poly(ether sulfone) via sulfonamide linkage. The use of charged cross-linking agent prevented any deterioration in the membrane functionality due to the cross-linking of the proton exchange membranes (PEMs). The most suitable membrane, at an optimized BAPBDS content, exhibited high ion-exchange capacity (1.47 mequiv./g) and proton conductivity (2.64×10^{-2} S/cm) with low water

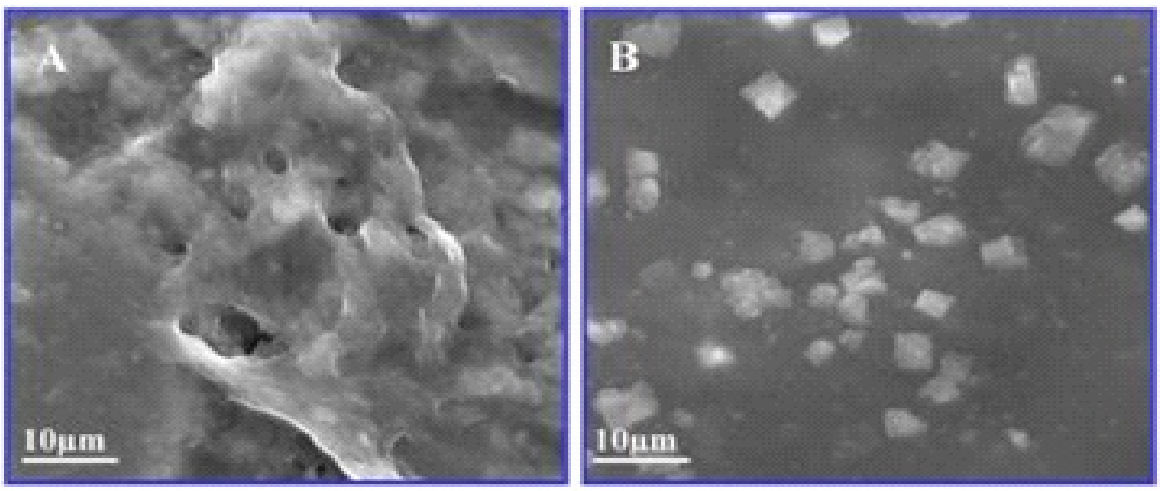
uptake (22.85%) and methanol permeability (0.65×10^{-7} cm^2/s). The reported cross-linking process may be a cost effective tool for the development of highly functionalized cross-linked aromatic polymer membranes as suitable substitute for costlier commercial membranes for diversified fuel cell and electro-membrane applications *(J. Mater. Chem., 20 (2010) 8036)*.



The schematic structure of cross-linked sulfonated poly(ether sulfone)

Anodic stripping electrochemical analysis of As(III) in water samples employing glassy carbon electrode modified with chitosan film embedded with nano-particulate silver

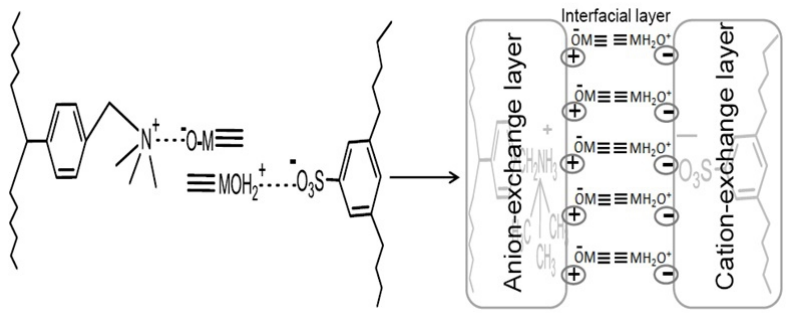
A glassy carbon electrode (GCE) was modified with nanoparticulate silver incorporated in chitosan for the detection of As(III) by differential pulse anodic stripping voltammetry (DPASV). Diffusion of As(III) across the membrane was explored. An optimally designed nanostructured electrode displayed wide linear detection range (10–100 ppb), high sensitivity (0.309 μA ppb^{-1}) with 1.20 ppb (16.2 nM) detection limit. This is much less than the arsenic level in drinking water (10 ppb) specified by the World Health Organization (WHO). Performance will be tested using actual feed water samples (*Electrochimica Acta, 72 (2012) 157)*.



SEM images of (A) film of chitosan and (B) hybrid silver nanoparticles/chitosan membrane

Effects of metal alkoxides on electro-assisted water dissociation across bipolar membranes

A bipolar membrane (BPM) was prepared by a layer-by-layer solution casting method (in the same solvent to achieve good adhesion between the layers). Thin films of different metal alkoxides ($M(OR)_n$, where M is Si, Ti or Zr, and R is $(CH_2)_nCH_3$, were used as interfacial layers sandwiched between a heterogeneous anion-exchange layer and homogeneous cation-exchange layer of sulfonated poly (ether sulfone). The catalytic activity of the metal alkoxides improved the water dissociation performance of the BPMs.

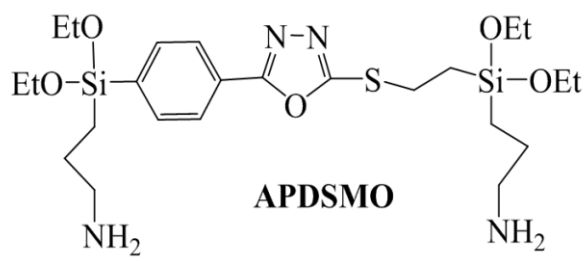


Schematic representation of a BPM with a M OH as the IL

The silica containing BPM (BPM–SiOH) performed better than commercial products (*Electrochimica Acta, 66 (2012) 325*).

Anti-biofouling organic-inorganic hybrid membrane for water treatment

Biofouling is a critical problem in membrane filtration processes. An anti-biofouling organic-inorganic hybrid membrane was developed through incorporation of silica, functionalized with an antimicrobial compound (substituted 1,3,4-oxadiazole), into the organic phase by acid catalysed sol-gel chemistry in aqueous media, followed by formal cross-linking. The monomer, APDSMO, was synthesized by Barbier-Grignard reaction. Prepared membranes exhibited high thermal, mechanical and chemical (solvent and chlorine) stability. The ion-exchange capacity, water content, and surface charge density values of hybrid membrane also confirmed their acidic nature. Antimicrobial properties of hybrid membranes



APDSMO

were tested against waterborne fungi (*Aspergillum niger*) and coliform bacteria (*Escherichia coli*). One of the membranes with high APDSMO content exhibited an MIC value of 9 mg ml^{-1} preventing the bio-film formation on the membrane surface (*J. Mater. Chem., 22 (2012) 1834*).

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CHAPTER 3

tfod foKku
BIOLOGICAL SCIENCES

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lenh 'koky vul/kku

Wasteland Research & Plant Biotechnology
Seaweed Research

ctjHkfe vul/kku

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tfod (rg)] dkf;d (rp) rFkk i;koj.kh; (re) l;ktu x.kkd d eY; 14 p;fur ik/k legk e fofHkUu y{k.kk e dk;kfUor fd; x;A lk/kkj.kr% tfod l;ktu x.kkd dk eY; mud lekukUrj dkf;d ,o i;koj.kh; l;ktu x.kkd eY; l vf/kd ik;k x;kA vR;f/kd lR;kfir tfod rFkk dkf;d l;ktu x.kkd d eY; ;n'kkr g fd fofHkUu y{k.kk dk vkil e bu nkuk Lrj ij mPpdkfV dk l;ktu gA lHkh i;koj.kh; l;ktu x.kkd eY; dN ik/kk e vlR;kfir rFkk dN e udkjkRed ik; x; ftll ;g irk pyrk g fd bu ik/kk e fofHkUu y{k.kk e vkil e i;koj.k dk çHkko de FkkA

F1 ldfjr ik/kk l 0;RiUu LrHk dyek dh of) ,o mit dk fu"iknu@ijh{k.k

fofHkUu mRd"V rFkk p;fur ekr ik/kk d ,dy ldj.k }kjk fodflr tVkQk ddl e ldfjr ik/kk dk mudh nk yxkrkj ihf<;k d fy, ijh{k.k fd;k x;kA bu mRd"V ldfjr ik/kk dk LrHk dyek }kjk ouLifr çtuu djd bUg Hknkoy e ,d vyx Hkfe e ekulu d nkjku jkfir fd;k x;kA bll igy yxHkx 1500 LrHk dyek dk uljh e mRiUu djd uoknfHkn ik/kk dh çkjfHkd of) dk ijh{k.k fd;k x;kA dy v/;;fur vkB lek;ktuk e l nk lek;ktuk IC 565733 x IC 565734 rFkk IC 565735 x IC 565739 e 'kÔ N% lek;ktuk dh ryuk e J"B of) rFkk vf/kd 'kk[kk, FkhA yxHkx 74% ldfjr ik/kk (F1) u viu fufn"V ekrik/kk dh ryuk e Qyu LFkkiuk çfr'kr e of) fn[kk;hA lek;ktu IC 565735 x IC 565739 u çfr i"iØe 21 Qyk dh LFkkiuk rFkk çfr ik/kk 180 xke cht mit n'kk;hA bu ik/kk dk çk;kfxd Hkfe e çFke oÔ jki.k gku d dkj.k vf/kdrj ik/k 40 xke l 80 xke rd gh cht n ik;A dN F1 ldfjr ik/kk u 108.92 l 178.47 xke rd cht Hkh fn; tcfd bUgh F1 d ekrik/kk u 89.56 l 104.75 xke rd cht fn;A

tVkQk ldfjr ik/kk dk fu"iknu

NMITLI ifj;ktuk d vrxr crk; x; mRd"V ik/kk d ldj.kk dk fu"ikfnr fd;k x;kA F1 vf/kdre cht vdj.k ¼80 çfr'kr½ rFkk uotkr ik/kk dk vfLrRo ¼75.1 çfr'kr½ lek;ktu RR-AP-Papum-1105-C-1 X RRL-NL-MON -1105-C-1e ik;k x;kA çkjfHkd uoknfHkn ik/kk dh voLFkk e lcl vf/kd Åpkb RRL-ASM-Kurbi-1205-C-5 X CSMCRI-OR-GUJ-Banas-C-1 e ikb xb tcfd vf/kdre 'kk[kk, ,o LrHk ?kjko lek;ktu NBPGR -SKNJ-2(Elite) X CSMCRI-OR-GUJ-Banas-1205-C-1 ldj.k uotkr ik/kk e ik;k x;kA çFke oÔ d nkjku of) fu"iknu e lokf/kd Åpkb ¼108.50 leh½ ldj.k RRL-ASM-Kurbi-1205-C-5 X CSMCRI-OR-GUJ-Banas-1205-C-1 e ikb xb tcfd lHkh lek;ktuk e U;ure ikni Åpkb ¼98.83 leh½ rFkk LrHk ?kjko ¼31.25 feeh½ RRL-ASM- Kurbi -1205 - C-5 X RRL-ASM-Golag-1105-C–1 ldj.k e ikb xbA lokf/kd 'kk[kk, (4.92) rFkk ikni Qyko ¼138.17 leh½ RRL-ASM-Kurbi-1205-C-5 X CSMCRI-OR-Ganj-1205-C -5 e vkdk x;k tcfd NBRI - J - 18 (Elite) X RRL - NL - MON - 1105 - C-1 rFkk NBRI - J - 18 (Elite) X CSMCRI-OR-GUJ-Banas-1205 - C–1 ldj.k bUgh y{k.kk d vk/kkj ij U;ure fu"iknd ik; x;A lcl vf/kd LrHk ?kjko ¼57.42 feeh½ ldj.k RRL-AP- Papum-1105 C-1 X CSMCRI-OR-GUJ-Banas- C-5 e ik;k x;kA lHkh F1 ik/kk dk dPpk lpuk lxg mud lcf/kr ekrik/kk d lkFk djd vkuUn dfÔ fo'ofo|ky; dk J"Brk fo'yÔ.k d fy, Hktk x;kA

ryukRed ldj.k çcyrk rFkk ih<h ldj.k çcyrk

fo'yÔ.k dk of) y{k.kk d fy, lHkh chl lek;ktuk e dk;kfUor fd;k x;kA lcl vf/kd ikni Åpkb d fy, ryukRed ldj.k çcyrk (21.51%) rFkk 'kk[kkvk d fy, (50.00%) nk lek;ktuk Øe'k% RRL-AP-Papum-1105-C-1 X RRL-NL-MON-1205-C-1rFkk RRL-ASM-Kurbi-1205-C-6 X CSMCRI-OR-Ganj-1205-C-5 e ikb xbA vf/kdre ldj.kh; çcyrk ikni ?kjko (8.79%) rFkk LrHk Qyko (21.09%) d fy, Øe'k% NBRI-J-18 (Elite) X CSMCRI-OR-Guj- Banas-1205-C-1 rFkk RRL-AP-Papum-1105-C-1 X RRL-ASM -Golag-1105-C-1 e vfdr dh xbA ldj.k RRL - ASM - Golag -1105-C -1 X CSMCRI -OR-Ganj -1205-C-5 u lokf/kd ldj.k çcyrk (7.79%) ikni Åpkb d fy, n'kk;h tcfd bl x.k dk 'kk[kkvk dh l[;k d fy, ldj.k RRL-ASM-Kurbi - 1205-C–6 X CSMCRI-OR-Ganj-1205-C-5 (39.02%) u fn[kk;kA LrHk ?kjko (15.80%) d fy, lokf/kd ldj.k çcyrk NBRI-J-18 (Elite) X CSMCRI-OR-Guj-Banas-1205-C-1 u fn[kk;hA lHkh lek;ktuk u Qyko d fy, udkjkRed eY; fn[kk;A

lfydkfu;k ck;kekl dk vkdyu vkj mle fofHkUu lkbVk ij ued dh lknrk

lfydkfu;k ck;kekl mit vkj mle ued ek=k d fu/kkj.k d fy, ikp l?kfur LFkyk ¼lrkUij] eFkyk] uhxkyk] foDVj vkj nho½ tgk ij fdlh Hkh çdkj d vU; çc/ku ugh fd; x,] ij lo{k.k vkj fo'yÔ.k dk dke fd;k x;kA ik/kk dh l[;k 1,00,000 ¼foDVj½ l 33,10,000 ik/k çfr gDVj ¼lrkUij½ ikb xb] tcfd vklr 8.35 yk[k ik/k çfr gDVj ik;k x;kA fofHkUu lkbVk ij l[k ck;kekl dh ek=k e Hkh 1.15 l 4.05 Vu çfr gDVj dh fofHkUurk ikb xb tcfd vklr 2.15 Vu çfr gDVj ik;k x;kA fofHkUu LFkyk e l lcl de l[kk ck;kekl lrkUij ¼1.46 Vu çfr gDVj½ vkj lcl T;knk uhxkyk ¼3.22 Vu çfr gDVj½ e ik;k x;kA ik/kk dh l[;k vkj çfr bdkb {k= l[k ck;kekl mRiknu d chp dkb egRoi.k lc/k (-0.04) ugh ik;k x;kA tcfd ik/kk dh l[;k vkj çfr ik/k d l[k otu d chp udkjkRed lc/k ¼lglc/k x.kkd =-0.53½ d ldr feyr gA cht dk çfr'kr dy l[kh ck;kekl d vk/kkj ij 7.2 ik;k x;k tcfd vklr 4.7% ik;k x;kA cht ry dk çfr'kr 25.2 l 34.6% tcfd vklr 32.5% ik;k x;kA l[k ck;kekl l çklr ued dk çfr'kr ¼okuLifrd ued vkj lykuh lkYV½ 9-27% ik;k x;k tcfd vklr ek=k 16.6% ikb xbA uhxkyk e okuLifrd ued dh lcl T;knk ¼829.6 fdykxke çfr gDVj½ ek=k ikb xbA

lyhdkfu;k ckdh;kVk d dPp fu"dklu ij Vhch çfrjk/kh lfØ;rk dk iu% v/;;u

lyhdkfu;k cdh;kVk dh tMk l dPp tyh; fu"dklu dk fofHkUu voLFkk l ikp ckj ,df=r dj] cuk;k x;k FkkA vDVcj 2009 l ekp 2010 rFkk tuojh l vçy 2012 d nkjku bldk v/;;u fd;k x;kA ueu dk lh-Mh-vkj-vkb- dk ekbØkcDVhfj;e Vhch d H37Rv çHkn d çfr lfØ;rk d fy, Hktk x;kA T;knkrj u FkkM cgr gn rd Vhch çfrjk/kh lfØ;rk fn[kkbA dPp inkFk e Vhch- çfrjk/kh lfØ;rk dk lfuf'pr dju d fy,] tk ueu lh,lvkbvkj&lhMhvkjvkb e lfØ;rk fn[kk; mudk lh,lvkbvkj&beVd dk Hktk x;k yfdu lfØ;rk ugh fn[khA vc ;g dk; egkRek xk/kh lLFkku] efMdy lk;Ul lokxke d lg;kxu e gk jgk gA

lyhdkfu;k ckdh;kVk dk lyykt

lyhdkfu;k ckdh;kVk dh tM] ru] ,oe ru dh fpll l geu lyykt dk mðj.k fd;k gA

iklr fd, x, iR;d dPp lyykt ueuk l geu ,YQk vkj chVk lyyktk dk vyx fd;kA dPp lyykt dh mit ru l lcl vf/kd Fkh tcfd bldh mit ru dh fVll l lcl de Fkh tcfd vkj Lyykt t dh inkokj dk Øe ?kVr mRiknu e bl idkj Fkk %& tM > LVe > LVe fVllA lyykt ueu dk ,QVh&vkbvkj] lhih@,e,,l]13 lh,u,evkj] ,DlvkjMh] Vhth, rFkk ,lb,e }kjk fo'yf"kr fd;k x;kA lyhdkfu;k ckdh;kVk l iklr lyyktk dh ryuk ¼e[; :i l ,YQk lyykt½ okVeku fQYVj iij ucj 4 l dh xbA ¼uV- çkM- dE;- 5 (2010) 603½

vk.kfod tho foKku

tVkQk dk ekbØkçkikx'ku

bu foVk çkix'ku Dykuy çkix'ku dk odfYid rjhdk gA mld viu Qk;n gA tl fd ,d ckj mÙke thukVkbi d dYpj tuj'ku d ckn lky Hkj ik/k çkIr fd; tk ldr gA bl vof/k d nkjku mÙke thukVkbi d 6000 dypj cuk; x; vkj mudk lcdypj fd;k x;kA bl i)fr dk vkj fodflr dju gr ç;kx fd; tk jg gA tl dypj nj e of)] dfydkvk dh l[;k e of)] bu foVk ik/kk dh yckb e of) ,Dl foVk vkj bu foVk #Vhx i)fr 'kkfey gA yxHkx 400 ik/k bl çfØ;k l cukdj d yxk; x; gA bld vykok mÙke thukVkbi d 179 ik/k Hknkoy e Hkh yxk; tk pd gA mud ljokboy vkj mit ij utj j[kh tk;xhA ifÙk;k dk bDllykUV tlk ç;Dr djd Ca 1500 dYpj LFkkfir fd; x;A dYpjk@lykUVyVk dh fQMYVh vkj ekl&Ldy VV Vkbi çkikx'ku d eY;kdu gr ftukfed DNA dk lgk;d dfy;k rFkk ifÙk;k d dYpjk l fudkyk x;kA mPp ykxr fV'k dypj d 0;kogkfjd vuç;kx e ck/kd g vkj blfy; ,Dl foVk #Vhx i)fr dk çkFkfedrk nh xb gA bl i)fr dk vkj fdQk;rh dju gr de ykxr d jlk;uk dk mi;kx fd;k x;kA bl ç;kl d vrxr ckUMM lØkt # 9.14@fy ek/;e dh txg] de ykxr dh lØkt dk mi;kx fd;k x;k ¼nkjkyk lØkt ft ldh ykxr # 3.60 gkrh g½A de ykxr d ek/;e d mi;kx l dy ykxr e 55-60 çfr'kr dVkrh dh tk ldrh gA ckUMM vxj ¼LiDVkde # 3600@fdyk½ lh,l,elhvkjvkb vxj l egxk gA de ykxr d vxj d çk;kfxd çHkko dk tkpu d fy; dYpj dk ckUMM vkj lh,l,elhvkjvkb vxj ij mxk;k x;kA bl ç;kx l ;g ldr çkIr gkrk g fd de ykxr dk vxj ¼lh,l,elhvkjvkb½ ckUMM vxj d led{k gA

tVkQk ruko lfg".krk dk c<kuk

tVkQk ddl o{kkjki.k e dkyj jkV Hkkjh ud'kku dk dkj.k curk gA ekbØkQkfeuk feVh tfur ,ukekfQd] ,ldkekbflVhl dod g] feVh cht ;k e tcku Ård e ekbØkLdfyjkfV;k bukdye d #i e jgrk g vkj ik/k dod foÔ phaseolinone d mRiknu vkj dod Ård d mRiknu l lM ;k ej tkr gA lyflfyd vEy ik/kk e ç.kkyhxr vf/kxg.k çfrjk/k dk c<ku d fy; tkuk tkrk gA lyflfyd vEy d fofHkUu lknrk ¼0.25, 2.5, 5.0 feyh½ dk cká #i e ,do.kh; ik/k dh tM dk mipkfjr fd;kA ,UVhvkDlkbM ,Utkbe] malondialdehyde (MDA) vkj çkyhu lknrk ij bldk çHkko ,d] rhu vkj ikp fnuk d ckn n[kk x;kA lijvkDlkbM fMLeFkkVl e rhu lknrk le; d lkFk /khj&/khj of) n[kh xb g] tcfd catalase (CAT) e igy vkj rhlj fnu gh of) n[kh xbA çkyhu vkj ,eMh lkexh Hkh rhu lknrk e igy vkj rhlj fnu of) gbA j?kh; çokgRo Lon vkj l{kyÔd nj lyflyd vEy mipkj d lkFk of) gb gA blfy, lyflfyd vEy dk ,l,vkj c<ku d fy, lfØ; fd;k tk ldrk gA tVkQk ddl e lfg".krk fodkl d fy, geu tVkQk ddl l jkxtuu lcf/kr (JcPR-10a) ¼NCBI vfHkof) l[;k JN566052½ l fudkyh gA bldk vkiu jkfMx Ýe 483 bp gA fo'yÔ.k ij JcPR-10a fMb;l ,feuk ,flM l;= 43%, 42% vkj 39% d Mal d(PR110) MtPR10-1 vkj CaPR-10/VvPR10.2 igpku d lkFk nr gA tkfrofrd fo'yÔ.k l irk pyrk g fd *JcPR*-10a MkbdkV] CaPR-10 d djhc g] tk nkuk dod vkj ok;jy çfrjk/k e ,d egRoi.k Hkfedk fuHkkr gA bld 568 bp dk thukfed Dyku ¼NCBI ifjxg.k l[;k JN639632½ e 185 bp dk buVku g] tk vU; PR-10 thu d leku gA *JcPR-10a* NaCl] lyflfyd vEy feFkkby tlekuV vkj *M. phaseolina* l fu;fer gkrk gA

JcPR-10a jhdkEchuV b dkykb e NaCl d lkFk cgrj of) n[kh xb g] tcfd jhdkEchuV dkf'kdkvk d fodkl dk KCl] efuVky] lkjchVky] feFkkby tlekuV vkj lyflfyd vEy u de fd;kA JcPR-10a çkVhu b dkykb dkf'kdkvk e overexpressed djr g] JcPR-10a çkVhu u RNase vkj DNase xfrfof/k;k pH(4-9) rd fn[kkbA JcPR-10a jhdkEchuV çkVhu *Macrophomina* d fodkl dk jkdrk gA dod fodkl fMLd d 2-3 feyhekyj {k= e fgpdr ik; x; FkA JcPR-10a tVkQk e ruko lfg".krk d #i e vPNh rjg l vU; ;ktuk dkyj lx/k }kjk eØkQkfeuk vfr lonu'khy bthfu;j d fy, ,d egRoi.k in d mEehnokj d #i e lok dj ldr gA

ok;jl lØfer vkj xj lØfer tVkQk e ,e,l & ,,Q,yih dk mi;kx dj efFkfydj.k dk v/;;u

efFkfydj.k lonu'khy cg#irk ij vk/kkfjr ok;jl lØfer vkj xj lØfer jrutkr ik/kk d ,e ,l&, ,Q ,y ih l iÜotuu lc/kh v/;;u fd;k x;k gA oreku v/;;u e] ok;jl lØfer ik/kk e Øe'k% 57% vkj 29% efFkfydj.k vkj efFkfydj.k cgyhdj.k cg#irk ikb xb g] tcfd xj lØfer ik/kk e Øe'k% 54% vkj 25% efFkfydj.k cg#irk ikb xbA bl çdkj ;g ik;k x;k fd lØfer ik/kk e iÜotuu lc/kh ifjoru T;knk gkr g tl fd ck;kfVd LVl d dkj.k efFkfydj.kA

xjfoÔy jrutkr d fy, fof'k"V ekd (SCAR) dk fodkl

xj foÔy vkj foÔy jrutkr d fy, vkj , ih Mh ekdj dh lgk;rk l fof'k"V SCAR ekdj dk fodkl djuu d ç;kl fd; x,A foÔkDr vkj xj foÔy fdLek d fy, fof'k"V ekdjk e l] pkj ekdjk dk p;u fd;k x;k] mudk Dyku djd mudk vuØe irk fd;k x;kA mud fy, çkbej cuk; x, bu çkbejke l NT-JC/SCAR I/OPQ15-F vkj R foÔkDr vkj xj foÔy e Hkn djuu e l{ke FkkA bl d vykok] >Bh igpku dk nj djuu d fy, eYVhlyDl ih lh vkj dk fodkl nrDNA ITS vkj SCAR çkbej l fd;k x;kA fof'k"V SCAR ekdj xj foÔy fdLe d p;ukRed [krh d fy, x.koÙkk fu;=.k e] ç tuu vkj vk.kfod ekufp=.k e ennxkj gkxkA

jrutkr d dyhu telykTe dk fofHkUu ekdjk }kjk vk.kfod y{k.ku

l=g dyhu telykTe dk çe[k vkj,ihMh ekdj ç.kkyh l vkuof'kd lc)rk dk v/;;u fd;k x;kA tkMhokj ryuk djuu ij NBRI-05-J vkj CRIDAJL-06 d chp mPpre cg#irk ikb xbA oreku v/;;u ijh{k.kk d rgr telykTe dh fofo/krk çnku djrk g vkj ldj.k vkj QTL ekufp=.k d fy, mi;Dr telykTe d p;u e lgk;d gkxkA fofHkUu Hkkxkfyd {k=k l ,d= 23 mPp mitoky jrutkr ik/kk (vfHkof)) d chp vk.kfod lc)rk dk fo'yÔ.k vkj , ih Mh vkj ,l ,l vkj ekdj l fd;k x;kA vkj , ih Mh fo'yÔ.k d ek/;e e 54% cg#irk ikb xbA vfHkof) d chp vkj , ih Mh l 0.911 vkuof'kd lekurk ikb xb] blh çdkj ,l ,l vkj ekdj l Hkh 0.90 vkuof'kd lekurk ikb xbA nkuk vkj , ih Mh vkj ,l ,l vkj fo'yÔ.k e SKNJ9 u vU; vfHkof) l vf/kdre lekurk çnf'kr dhA nkuk ¼vkj , ih Mh vkj ,l ,l vkj½ e 23 vfHkof) u ,d nlj l vPN lc/k fn[kk;A vkj , ih Mh fo'yÔ.k }kjk KUMBHARIA dk vU; vfHkof) l vyx ik;k x;kA vkj , ih Mh vkj ,l ,l vkj MUMkxke e CP9, CP13, CP17, SKNJ1 vkj SKNJ7 vfHkof) ,d nlj d lkFk leg g] tcfd KGR 'kÔ ikp vfHkof) l lkQ vyx gk x,A vkj , ih Mh vkj ,l ,l vkj MUMkxke e vfHkof) SKNJ9, SKNJ10 vkj SKNJ11 u ,d NkV leg dk xBu fd;k g] tcfd KOTESHWAR vkj AMBAJI nkuk ,d vkj NkV leg dk xBu fd;k gA KUMBHARIA tk fd vU;k vfHkof) l fHkUu ik;k x;k] ç tuu dk;Øe l ldj mRiknu d fy, bLreky fd;k tk ldrk gA

jrutkr e yo.krk d lkFk tM Hkkfrd] to jklk;f.kd vkj vk.kfod ifjoru

jrutkr d dyhu telykTe ¼lhih-9½ e yo.krk d lkFk tM 'kkjhfjd] to jklk;fud vkj vk.kfod ifjoruk dk v/;;u] vdjk dk fodkl djd fd;k x;kA yo.krk dh fofHkUu ek=kvk l pkchl ?k.Vk d fy, mipkfjr jrutkr vdjk dh tMk o ifÙk;k d Ård d ij thuke e Mh ,u , d efFkfydj.k vkj efFkfydr Mh ,u , e cg#irk d v/;;u dk ç;kl fd;k x;kA tMk ,o ifÙk;k e Øe'k% 70.% vkj 59% Mh,u, e efFkfydj.k d efFkfydr Mh ,u , e Øe'k% 99% vkj 91% cg#irk ikb xbA vuipkfjr ik/kk d lkFk ryuk d vk/kkj ij] yo.krk dh fofHkUu [kjkdk l mipkfjr ik/kk dh tMk e efFkfydj.k vkj cg#irk dh çfr'kr dk Øe Øe'k% 50 fe ek < 100 fe ek < 75 fe ek < 25 fe ek vkj 25 fe ek <75 fe ek < 100 fe ek < 50 fe ek ik;k x;kA blh çdkj yo.krk dh fofHkUu ek=kvk l mipkfjr ik/kk dh ifÙk;k e efFkfydj.k o cg#irk dh çfr'kr dk Øe Øe'k% 50 fe ek < 75 fe ek < 100 fe ek < 25 fe ek vkj 100 fe ek < 25 fe ek < 75 fe ek < 50 fe ek ik;k x;kA

xtjkr d rVh; {k=k e lfydkfu;k vkcknh vkj vkuof'kd fofo/krk dk fo'yÔ.k

lfydkfu;k e vkuof'kd fofo/krk dk fo'yÔ.k vkj , ih Mh vkj vkb ,l ,l vkj ekdj l dju d fy, xtjkr d rVh; {k=k ¼lrkUij] nho] vokfu;k] ?kk?kk] tkQjkckn] uhxyk] eFkyk] u0ikV] Hkkouxj vkj foDVj ikV½ l ueu fy, x,A 30 ik/kk d fy, vkdkfjdh; o.ku ¼ck;kekl] ru dh Åpkb] tM yckb] ruk vkj tM dh rktk vkj l[kk ck;kekl] spike vkj 'kk[kkvk dh yckb vkj l[;k½ nt fd;k x;k gA vk.kfod fo'yÔ.k e 20 vkj , ih Mh vkj 15 vkb ,l ,l vkj çkbejk dk mi;kx fd;k x;kA vkuof'kd lekurk efVDl vkj vkj , ih Mh vkj vkb ,l ,l vkj MUMkxke e dN Lrj dh vkuof'kd fofo/krk ikb xbA nkuk vkj , ih Mh vkj vkb ,l ,l vkj fQxjfçUV MVk d MUMkxke e rhu leg fn[krg tkfd ,d nlj l vyx gA

rVh; yo.kh; enk e thok.koh; lenk;k dk eVk thukehd v/;;u

rVh; yo.kh; enk e thok.koh; lenk;k d eVk thukehd v/;;u dju gr fofHkUu rVh; LFkkuk ¼ljruij] fefFkyk] foDVj] ikV] fuuxkyk vkj nho½ rFkk yo.knfHkn ik/kk ¼lfydkfu;k] lMk rFkk byjkil½ l ey lyXu thok.k ;Dr ¼jkbtkLifjd½ rFkk enk dk ,df=r fd;k x;kA Hkkfrd&jklk;fud vfHky{k.kk dk fo'yÔ.k dju d fy, Fkkd rFkk ey lyXu thok.k ;Dr enk ¼jkbtkLifjd½ ueuk dk fy;k x;kA

ble enk ueu dk pH 8.06 l 8.53 rd ifjofrr gvkA ;g enk dkQh yo.kh; rFkk bldh o|r vi?kV; pkydrk 7.5 l 21.2 dS m^{-1} dh ijkl e gkrh gA rFkk vkx ;g Hkh çf{kr fd;k x;k fd Fkkd enk dh o|r vi?kV; pkydrk de gkrh gA ;g crkrk g fd ; ikni] enk l yo.kk dk iFkd dju e enn djr gA

enk ueuk e dkcfud dkcu l?kVd lkekU;r% 0.37 l 1.05 çfr'kr ifjofrr gkrk gA ey lyXu thok.k ;Dr enk e dkcu dh lknrk] Fkkd enk dh ryuk e mPp gkrh gA

Fkkd enk rFkk ey lyXu thok.k ;Dr enk e dy ukbVktu l?kVd dh ek=k 0.03 l 0.08% rd ifjofrr gkrh gA vkx ;g Hkh çf{kr fd;k x;k fd ey lyXu thok.k ;Dr enk e N l?kVd] Fkkd enk dh ryuk e cjkcj ;k mPp gkrk gA

dkcu&ukbVktu vuikr 9.3 l 15.8 d e/; ifjofrr gkrk g rFkk Fkkd enk rFkk ey lyXu thok.k ;Dr enk e fo'kÔ çf{kr ugh gvkA

eVk thukehd fof/k l yxHkx 53 /kukRed ¼iu%;kxt½ 16S rRNA iu;kxt dkyu dk çklr fd; gA rFkk vuØfed vu#irk fo'yÔ.k l irk pyrk g fd 50% Dyku] oflfyl çtkfr l fudVrk çnf'kr djr g tk ;g crkrk g fd lMk dh ey lyXu thok.k ;Dr enk e ofldYl çtkfr dk ckgY; gA

lfydkfu;k cfd;kVk ij fV'; dYpj v/;;u

[kr e c<r o;Ld ik/kk dk p;u djd tuj'ku d fy; v/;;u fd;k x;kA yxHkx 3-15 dfydkvk dh çkflr gb çfr ,d dYpj ,e ,l ek/;e d ftle ch,ih Mkydj dYpj tujV fd; x;A dfydkvk dk tc #fVx ehMh;k ,e,l vkj vkbch, e yxk;k rk ek= 20% #fVx dh çkflr gbA ek/;e e vkj l/kkjdj #fVx dk 50% rd c<k;k x;kA

gk;ikdkVk;y] tM vkj MBy dk ç;kx dj] tM ,o dyl dYpj tujV fd; x;A lHkh mi;kx fd; x; ,Dl lykUV l tM ,o dyl çklr fd; x; ij mudh fodkl xfr cgr /kheh FkhA MBy l vPN tM dYpj çklr g; mRiUu tM vkj dyl l to lfØ; ?kVd dk v/;;u fd;k tk;xkA fofo/k ,Dllykuv l lh/k vkj bUMk;jDV jh tuj'ku dk ç;kl Hkh fd;k x;kA MBy d dyl l 60 fnu e dfydk dh çkflr gbA

'kk[kk dh fljk ,o ukM dk mi;kx djd igyh ckj lfydkfu;k cfd;kVk d l{e io/ku dh ljy ,o rt fof/k ik= LFkkfir dh xbA 8 i;kxk e l BA (4.44, 13.3 ,o 35.52 μM) l ifjof/kr 'kk[kk ilkj gvk tcfd BA+NAA vkj BA+2, 4-D d 15 i;kxk d l;ktu e l lcl vf/kd ifrfØ;k ifr'kr 5.37 μM NAA dh mifLFkfr e n[kh xb vkj blfy; bl i;kx d l;ktu dk vkx d v/;;u d fy; bLreky fd;k x;kA

NaCl d i;kx l 'kk[kk ifrfØ;k d ifr'kr e egRoi.k ofð gbA BA+NAA+NaCl d 30 i;kxk d l;ktuk e 'kk[kk ilkj e BA o ued d i;kx d lkFk /khj&/khj ofð gbA

BA (8.9 μM) + NAA (5.37 μM) + NaCl (500 mM) d

l;ktu l vPN 'kk[kk ilkj d lkFk ub l{e'kk[kk, cuh vkj blh rjg dk ifj.kke BA (13.3 µM) + NAA (5.37 µm) + NaCl (250 mM) d l;ktu l Hkh n[kk x;k tk ldr djrk g fd NaCl l{e io/ku d fy; vko';d gA PGR l;ktu 2.46 µM IBA & 0.46 µM Kn oky tM ij.k ehfM;k e mPp yo.k ek=k (250 ,o 500 mM NaCl) l tM mRiUu gbA bu ifj.kkek l ;g vueku yxk;k x;k fd NaCl lfydkfu;k cfd;kVk d l{e io/ku d fy; vko';d gA (bM- Øki- çkM- 35 (2012) 313)

bl v/;;u e ,d ljy o rho l{e io/ku ikVkdky fodflr fd;k x;k tk bl yo.kknfHkn e dk;kRed thu vfHk0;fDr fo'y"k.k ,o bl ikni l iFkd fd;x, db u, thuk d vk.kfod dk;k dk le>u e lgk;rk djxkA ;g fodflr ikVkdky vk|kfxd :i l egRoi.k fof'k"V ,Dl lul d io/ku ,o lj{k.k e lgk;rk djxk ,o lkFk gh rVh; yo.kh; ctj Hkfe d LFkk;h ic/ku e enn djxkA

PGPR dh mifLFkfr l exQyh d yo.k vojk/kdrk e l/kkj

fofHkUu idkj d yo.kvojk/kh thok.k t l Agrobacterium tumefaciens strain JG – 02, Zhingulliuella Strain JG-03, Brachebacterium Saurastrense Strain JG – 06, Vibno strain JG – 07 Breuibacterium Casei strain JG – 08, Haererohalobacter Strain JG – 11, lfydkfu;k d tMk l fudky x; gA bu thok.kvk dk mud ued lfg".k {kerk d fy, yo.k dk fofHkUu ek=k ¼1% l 2% NaCl½ rd Nutrient media vkj 2 – 4% NaCl yo.k dk NRb media l tkp fd;k x;kA bu thok.kvk d 16SrRNA thu Øe dk DQ – 45896 (JG -02), EU 937748 (JG 03), EU 937750 (JG – 06) EU 937751 JG (07), EU 937752 (JG 03), EU 937750 (JG 06) EU 937751 JG (07) EU 937752 (JG – 08) vkj EU 937754 (JG -11) dk NCBI e tek fd;k x;kA bu lHkh PGPRs e JG – 06 dk thul Brachebacterium] ,d ukoy brachybacterium Saurastrrense (Int. J. Syst. Evoi Microbiology, 61 (2011) 2799) uked thok.k iLrkfor fd;k x;k gA bu lHkh thok.kvk u ikni ofð fu;ked y{k.k t lk IAA lhMjkQkj vkj ACC deaminase d ifr lfØ;rk fn[kk;h gA bu lHkh thok.kvk dk exQyh dh yo.k vojk/kdrk c<ku d fy, tkp fd;k x;kA ifj.kke crkr g fd JG 06, JG 08 vkj JG 11 lcl vPN yo.k vojk/kh thok.k ik; x;A exQyh ikni tk 0 mM vkj 100 mM NaCl dh ek=k e mxk; x; Fk mud tfod n0;eku ru vkj tM dh yEckb T;knk ik;h x;h ftue PGPR thok.k dk j[kk x;k FkkA dkf;dh d vulkj] thok.kvk d lkFk j[k x; iknik d ruk e T;knk ikuh vkj de Electrolyte leakage ik;k x;k gA yo.k d ifr exQyh dk v/;;u bl thok.kvk d lkFk to jklk;fud ifØ;k l Hkh fd;k x;kA bu thok.kvk d lkFk j[k iknik e K^+ / Na^+ dk vuikr vkj ukbVktu vo'kkf"kr dju dh {kerk T;knk ik;h x;h] rFkk ikyhu ?kyu'kfDr 'kdjk vkj fyfiM {k; de ik;k x;k vehuk vEy rFkk vkDlhtu cuku dh {kerk T;knk ik;h x;h] vi{kkdr ftud PGPR thok.k ugh j[k x; FkA ¼t-lykV xkFk jxy] 31 (2012) 195½

lfydkfu;k cfd;kVk d cht ljf{kr ikVhu dh ik"kdh; lHkk0;rk

lfydkfu;k d cht ikVhu l Hkjij gkr gA vkj bud uotkr ru dk gj lykn d :i e [kk;k tkrk gA cht ljf{kr ikVhu d fofHkUu foyk;dk dk i;kx djd] vuØfed fu"d"k.k fof/k }kjk foHkkftr fd;k tkrk gA ftle vklfor ty albumin d fy;] NaCl (1M) Globulin d fy;] NaOH (0.1 N) Glutelin d fy; vkj E tO H (70% v/v) prolamina d fy; crkj foyk;d bLreky fd;k tkrk gA Globulin 54.75 ifr'kr, albumin 34.30 ifr'kr vkj Glutelin 8.70 ifr'kr ij cht ljf{kr ikVhu dk cukrk gA foHkkftr ikVhu dk 2D Mk;xuy SDS – PAGE vkj MALDI – TOF Mass Spectrometry }kjk igpkuk x;k A Globulin dk Hkkx] lkr Inter – Molecular disulphide linked poly peptide pair vk.kfod Hkkj = 63.5, 62.5, 54.7, 53.0, 43.2, 38.5 vkj 35.1 kDa dk cuk gvk gA tk fd {kkjh; vkj vEyh; miox l f?kjk gvk gA nk vk;keh ty (Gel) yxHkx 32 fu'kku n'kkr gA ftudk lefo|rfoHko fcn vkj vk.kfod Hkkj 4.93 l 11.6 vkj ~ 5.2 l ~ 109.4 kDa d chp jgrk gA ikVhu d fu'kku dk MALDI – TOF MS Peptide Mass fingerprint }kjk fo'y"k.k n'kkrk g fd 19 ifr'kr ikVhu mikipe dh ifØ;k e 'kkfey g] 16 ifr'kr ldru dh ifØ;k e vkj 15 ifr'kr fofuekud ikVhu dh ifØ;k e 'kkfey FkA ilVkbM n0;eku fQxjfçUV fo'y"k.k }kjk vrj vkj vkrj vk.kfod disulfide linkage globulin fraction e mifLFkr Fk]

,lk lkfcr gkrk gA Sulfur rich ikVhu dk ik"k.k eY; vf/kd gkrk gA blfy, disulfide lfydkfu;k cfd;kVk dk ,d vkgkj vuij.k lHkk0; lkr cukrk gA ¼t- ,fx- QM dfe- 60 (2012) 4320½

yo.k lfg".krk d fy, SbGSTU ¼XyVkfFk;ku&,l&Vkl&Qjt½ thu dh rEckd e vfHk0;fDr

Tau ox XyVkfFk;ku VklQjtt (GSTU) thu ikni fof'k"V thu g] tk vtfod rukok }kjk ifjr gkdj vkDlhMfVo {kfr d fo:ð ik/kk dh j{kk dju d fy, egRoi.k gA 5'RACE dk mi;kx dj GST thu fudkyk x;kA 5'RACE dk mi;kx dj GST thu gykQkbV ,l- cfd;kVk (s.brachiata) l iFkd] Dyku] vuØfer fd;k x;k rFkk bldh ikVhu ljpuk dk iokueku fd;k x;k FkkA SbGST thu dh vfHk0;fDr dk v/;;u VklkfØlV ikQkbfyx }kjk fofHkUu vtfod ruko ifjfLFkfr;k rFkk ikni ofð fu;ked mipkfjr ;Fkk yo.k] 'khryrk] l[kk] ,-ch-,- (ABA) vkj lfyflfyd vEy d lkFk le; vUrjky fcUn rFkk lkUnrk fcUn e fd;k x;kA SA mipkfjr d vfrfjDr lHkh ruko ifjfLFkfr;k e SbGST thu dk vfHk0;fDr mPp&fu;kfer FkhA cht vdj.k ifr'kr] GST ,Utkbe ijh{k.k] rktk otu] rFkk vU; ofð ekinMk ¼tM dh yEckb] ru dh yEckb rFkk iÙkk dk {k=Qy½ dk v/;;u fd;k x;k rFkk ifj.kkek l ldr feyrk g fd Vkl tfud rEckd e SbGST thu dh mPp vfHk0;fDr yo.k ruko e cht vdj.k rFkk fodkl dk c<krk gA yo.k rukok e Vkl tfud Øek d in'ku dk eY;kdu fd;k x;k FkkA vkj GST thu ;Dr mPp&vfHk0;fDroky rEckd d ik/kk u txyh idkj d ik/kk dh ryuk e T;knk cht vdj.k rFkk mÙkj thfork fn[kkbA bu ifj.kkek l ;g if"V gkrh g fd SbGST thu dh vfHk0;fDr fofHkUu rukok }kjk gkrh g rFkk tll ox SbGST thu dh mPp & vfHk0;fDr Vkl tfud rEckd e vtfod rukok dh lfg".krk e egRoi.k Hkfed fuHkkrk gA SbGST thu yo.k rukok e Li"V :i l vfHk0;Dr gkdj cht vdj.k rFkk fodkl dk c<krk gA ¼eky- ck;ky- fjl- 38 (2011) 4823)

,d uoy vufHkt yo.k ifjr lfydkfu;k thu SbSI-1, E.Coli e yo.k rFkk l[kk lfg".krk inku djrk g

io e geu vud vufHkt thu vuØe d lkFk lfydkfu;k cfd;kVk l ESTs d foyxu rFkk vfHky{k.k iLrr fd; gA fjol ukFku fo'y"k.k dN vufHkt thuk dk yo.kh;rk d ifr vijX;y'ku vkj MkmujX;y'ku vufØ;k dk crkrk gA bue l dN thuk dk i.k yEckb e cuk;k x;k g] rFkk mud fØ;kRed fo'y"k.k dk Hkh tkpk x;k gA bl v/;;u e] geu vf}rh; vufHkt] yo.kifjr thu SbSI–1 ¼lfydkfu;k cfd;kVk yo.k ifjr-1½ dk mldh fØ;kRed liek.krk gr p;fur fd;k gA

SbSI – 1 ¼thu cd accession l[;k JF 965339½ dk i.k yEckb rd cuk;k x;k g] rFkk l[ko yo.kh;rk e mldh fØ;kRed liek.krk dk foLrkj l vfHkyk{kf.kd fd;k x;k gA SbSI – 1 thu 917 bp yEch g o yxkrkj 437 bp 3' UTR rd rFkk ORF {k= 480 bp ij g tk 159 ,ehuk vEyk oky ikVhu dk dkfMr djrk gA bl ikVhu dk vk.kfod Hkkj 18.39 fdyk MkYVu rFkk pI 8.58 gA okLrfod le; PCR fo'y"k.k] yo.k] l[kk] B.Mk rFkk rkih; ruko e mPp vuy[ku vfHk0;fDr dk idV djrk gA ;|fi l[k l vf/kdre vfHk0;fDr iklr dh xb gA SbSI – 1 dk ORF {k=] pET 28a okgd e Dyku dh xb rFkk BL 21 (DE 3) b-dkykb dkf'kdkvk e LFkkukUrfjr fd;k x;k gA ruko dh mifLFkfr e doy okgd dh ryuk e SbSI – 1 iufu;kftr b- dkykb dkf'kdkvk dh yo.kh;rk rFkk l[k dh fLFkfr e lgu'khyrk inf'kr djrh gA ¼eky- ck;ky- fjl- 39(2012) 1943½

lenh 'koky vul/kku

vkfFkd #i l egRoi.k lenh 'kokyk dh [krh d cM Lrj ij 0;kogkfjd dfÔ çk|kfxfd;k d fodkl ij lLFkku u vul/kku dfUnr fd;k gA lenh 'koky dh [krh dk lkeF;i.k nf"CV l n[kk tk jgk gA [kk| dh to fofo/krk] VDlkukeh] lenh 'koky] tho foKku vkj mi;kxh vul/kkuk ij Hkh v/;;u fd;k x;k gA

to fofo/krk ,oe dfÔ

rfeyukM rV e lenh 'koky dh to&fofo/krk

uVod ifj;ktuk ¼,u MCy ih 018½ d ,d Hkkx d :i e rfeyukM rV dh 'koky fofo/krk dk v/;;u fd;k tk jgk gA lenh 'koky fofo/krk dk vkdyu dju d fy, ,Uukj l ydj dU;kdekjh rd vkj eUukj dh [kkMh d }hik e ,d 0;kid lo{k.k fd;k x;k gA dy 42 LV'kuk dk p;u fd;k x;k A e[; Hkfe d vrTokjh; rV e lenh 'koky fofo/krk 4.0 ehVj xgjkb e nt dh xb gA v/;;u dk nk;jk 10 ehVj dh xgjkb rd fy;k x;k gA

lenh 'koky i tkfr;k d fMft Vy QkVkxkQ mud viu ikdfrd fuokl LFkku e fy, x, gA bld vykok {k= rV dh LFkykdfr dh fjdkfMx] fuokl LFkku dh idfr] ouLifr dh cgrk;r vkfn l lcf/kr ukVl r;kj fd, x, gA bl v/;;u e dy 282 'koky dh i tkfr;k bdëk dh xb vkj mudh igpku dh xb g] ftue l 80 i tkfr;k DykjkQk;Vk] 56 fQvkQk;Vk vkj 146 i tkfr;k jkMkQk;Vk l lcf/kr gA fnypLi ckr ;g g fd bue l 33 i tkfr;k dk fo'k"k :i l eUukj }hik dh [kkMh l ,d= fd;k x;k gA ek/;fed L=krk vkj MVk ldyu l bl {k= d fy, dy 277 i tkfr;k dk irk pyk gA lHkh ,df=r çtkfr;k d gjcfj;e 'khV tujV fd; x; A

vkfFkd :i l egRoi.k lenh 'kokyk dh [krh

dlikQk;dl ,yojth dh i;kxkRed virVh; [krh ikd [kkMh] Hkkjr d nf{k.k ioh rV ij 'k: dh xb FkhA 2010-2011 d nkjku 170 jk¶Vl ½2 eh × 2 eh vkdkj½ e dlikQk;dl ,yojth yxk;k x;k vkj mUg virVh; {k= ¼rV l 1.2 fdeh njh vkj 8 ehVj dh xgjkb½ e j[kk x;k FkkA bld lkFk ryukRed v/;;u dju d fy, 30 jk¶Vl rVorh {k= ¼0.5 ehVj xgjkb½ e j[k x, FkA ikjfEHkd rkj ij 22.5 fdxk rktk otu cht lkexh ifr jk¶Vl d nj l iR;kjkfir fd;k x;k FkkA 'koky d Qly dh dVkb 45 fnu d fodkl d ckn dh xb FkhA ,d vklr ck;kekl 219 fdykxke rktk otu ifr jk¶Vl dh nj l virVh; {k= dh [krh l vkj 127.5 fdykxke rktk otu ifr jk¶Vl rVh; {k= dh [krh l iklr fd;k x;k FkkA lky 2011-2012 d nkjku 95 iR;kjkfir jk¶Vl ½2 eh × 2 eh½ virVh; {k= vkj 10 jk¶Vl rVh; {k= e j[k x, FkA ,d vklr ck;kekl 195 fdxk rktk otu ifr jk¶Vl dh nj l virVh; {k= dh [krh l iklr fd;k x;k FkkA fd, x, i;kx l ;g flð gkrk g fd virVh; {k= dh [krh e ck;kekl dk mRiknu rVh; {k= dh ryuk e vf/kd gkrk gA

v/;;u d nkjku dh xb fVlif.k;k bl idkj g%

1 xfe;k d nkjku lenh 'koky fodkl ¼viy l tu½ ifrdy i;koj.k dh fLFkfr dh otg l de gkrk gA

2 mÙkj ioh ekulu vof/k ¼uoEcj l tuojh½ d nkjku] virVh; [krh v'kkr ygj vkj mPp ikuh /kkjk dh otg l tkf[ke Hkjk g] blfy, ;g lykg nh tkrh g fd cht lkexh lxg.k d fy, o{kkjki.k dk de djA

3 fdukj d fudV ikuh e 'koky xftx dh ?kVuk; Qjojh vkj ekp d eghuk e xHkhj gkrh gA blfy,] Hkfo"; e Qly dh inkokj dk lkdkj dju d fy, Qly dh pjkb vkj ckn d udlku dk de dju d fy, fo'k"k mik;k dh vko';drk gA

4 flrEcj & vDVcj d eghu e] ux.; cnyko d lkFk rVh; vkj virVh; nkuk {k=k l vf/kdre ck;kekl gkoLV fd;k x;k FkkA

lky 2011-2012 d nkjku xkflyfj;k Mjk dh [krh FkkuhFkjkb e dh xb FkhA ikjfHkd lykfVx 3.0 fdykxke rktk otu ifr jk¶Vl dh nj l dh xb Fkh rFkk mld ckn bl 140 jk¶Vl e foLrfjr fd;k x;k FkkA 9.5

fdyk rktk otu ck;kekl ifr jk¶Vl dh vklr l lenh 'koky Qly 45 fnu dh vof/k d fodkl d ckn dkVk x;k FkkA

xkflyfj;k ,nfyl Hkkjr e vxj d fy, dPp eky dk ,d ie[k L=kr gA lky 2010 vkj 2012 d nkjku xkflyfj;k ,nfyl dh [krh 25 jk¶Vl ¼1.5 eh × 1.5 eh vkdkj½ ft le vyxh 800 xke@ jk¶Vl rktk otu d nj l iR;kjkfir dh xb FkhA 'koky dh gkofLVx 60 fnu d vrjky e dh xb FkhA lky 2010-2011 d nkjku 'koky dh 4 ckj gkofLVx dh xb ftue l vf/kdre ck;kekl 6.170± 0.730 fdykxke ifr jk¶Vl d nj l tuojh 2011 d nkjku iklr fd;k x;kA ft ldk nfud fodkl nj 3.5% ifr'kr FkkA vi{kkdr mPp ck;kekl 2011-2012 d nkjku iklr fd;k x;k FkkA bl lky d nkjku 5 ckj gkoLVhx dh xb ftue l vDVcj 2011 d nkjku vf/kdre ck;kekl 18.89 ± 10.68 fdykxke rktk ctu ifr jk¶Vl dh nj l iklr fd;k x;k vkj vf/kdre nfud ofð nj ifr fnu 6.2% nt dh xb FkhA ,l fQfyQkeh dk çfronu djkxhuu d ,d lkr e gA ,l fQfyQkeh d fodkl vkj ck;kekl mRiknu e ekleh cnyko dk v/;;u] 2 lky rd 2010-2012 d nkjku [krh dh cMk fof/k viukdj fd;k x;k FkkA tykb 2010 d nkjku 50 ckl d jk¶Vl ¼1.5 eh × 1.5 eh vkdkj½ 300 xke@ jk¶Vl rktk otu dh nj l iR;kjkfir fd, x, FkA 'koky dh gkofLVx 30 fnu d vrjky e dh xb FkhA lky 2010-2011 d nkjku 'koky dh 7 ckj gkofLVx dh xb ftue e l vf/kdre ck;kekl 4.42± 1.25 fdykxke ifr jk¶Vl dh nj l fnlcj 2010 d nkjku iklr fd;k x;kA ft ldk nfud fodkl nj 8.71 ifr'kr FkkA blh rjg Qly dh rhu gkofLVx 2011-2012 d nkjku dh xb ftue vf/kdre ck;kekl 5.82± 2.37 fdykxke ifr jk¶Vl vkj 7.5 ifr'kr nfud fodkl nj d lkFk uocj e iklr fd;k x;kA uoEcj & fnlEcj] ,l fQfyQkfe d vf/kdre fodkl dh vof/k gA toHkkj çkflr vkj çfrfnu mRiknu xfr ij yo.krk] ?kfyr vkDlhtu] QkLQV rFkk ukbVV dk xgjk çHkko iMkA

xkflyfj;k lfydkfu;k dk vPNh x.koÙkk;Dr vxj dk ek/;e ¼510 ±25 xke leh&2 dh ty rkdr vkj lYQV lkexh 0.45± 0.06%½ crk;k x;k FkkA ijd agarophyte d llk/ku d :i e viy 2011 e jk¶Vl iðfr dk mi;kx djd xkflyfj;k lfydkfu;k dh [krh 'k: dh xb FkhA igy i;kl e] 7 jk¶Vl ¼1.5 ehVj × 1.5 ehVj vkdkj½ 1500 xke rktk otu@jk¶Vl dh ikjfHkd ck;kekl d lkFk iR;kjkfir fd;k x;k FkkA lenh 'koky Qly dk 45 fnu dh vof/k d fodkl d ckn dkVk x;k Fkk vkj dy 5 ckj gkoLV fd; x;A mPp toHkkj 13.54± 1.466 fdyk xke rktk otu ifr jk¶Vl uoEcj e ik;k x;k Fkk tcfd nfud ofð nj ifr fnu 4.2% FkkA

ÅÙkd lof/kr vkj txyh idkj d tyhfnyk vlhjklk dh [krh d fodkl nj dk ryukRed v/;;u

o"k 2006-2008 dh f}okf"kd fjikV e ikjfHkd ifj.kkek d vk/kkj ij ;g ik;k x;k fd mÙkd lof/kr tyh fnyk vlhjklk tefyx tk ikjcnj] xtjkr l ,df=r fd, x, Fk mud fodkl nj txyh idkj d tyhfnyk vlhjklk ,joknh] ¼rfeyukM½ l ,df=r fd, x, Fk mudh ryuk e nk xuk ik;k x;k tcfd [krh nkuk txg fuycu iRFkj dh [krh fof/k }kjk fd;k x;k FkkA MkVk dh iujkofr n[ku d fy, nkuk telykTe dk mi;kx djr g, nk nk jk¶Vl e [krh dh x;h rFkk Qly dk 180 fnu dh vof/k d ckn dkVk x;k FkkA çklr ifj.kkek l ;g Kkr gvk fd ÅÙkd lof/kr telykTe }kjk iklr fd;k x;k ck;kekl] txyh idkj d telykTe l iklr ck;kekl l 3-4 xuk vf/kd FkkA bl i;kx d 3 l 4Qly d fy, tkjh j[kk tk,xkA

th vfjjklk [krh e ,fiQkb;fVte

bfiQkbVl ik/key d thog tk vYxk dh ckgjh lrg ij fpid dj vrfj{k] ik"kd rRok] vkj idk'k d fy, vYxk l ifrLi/kk djr gA ekleh ,fiQkb;fjte ,d ,lk QDVj g tk 'koky dh [krh vkj db vtfod QDVjk dk cjh rjg çHkkfor djrk gA th vfljklk bfiQkbVl dh vf/kd l[;k dk vkdf"kr djrh gA ,d o"k d fy, uoEcj 2009 l vDVcj 2010 d chp lheV Cykd e jk¶Vl fof/k viukdj ftyhfM;yk vfljklk dh [krh e ,fiQf;fVl dh vkcknh dk v/;;u fd;k x;kA io fof/k e dy 23 vf/kthfod 'koky n[k x;] ftue l 10 itkfr;k gjh 'koky] vkj 5 itkfr;k Hkjh 'koky vkj 8 itkfr;k yky 'koky l lcf/kr FkhA ckn dh fof/k e dy 24 vf/kthfod 'koky n[k x;] ft le l 10 itkfr;k gjh 'koky] 3 itkfr;k Hkjh 'koky vkj 11 itkfr;k yky 'koky l lcf/kr FkhA bul th vfjjklk dh [krh ij dkQh çHkko iMk A

lenh 'koky vkj cDVhfj;y d chp ijLij fØ;k

lenh 'koky cDVhfj;y d chp ijLij fØ;k lenh 'koky d fodklkRed tho foKku d ,d fnypLi igy g vkj lex lenh 'koky d fodkl vkj mld ilkj l lcf/kr ck;kVk dh ikfjfLFkfrd Hkfedkvk dk le>u d fy, egRoi.k gA thok.k tyh; ikfjfLFkfrdh r= e vke fuokfl;k dh rjg lenh 'koky d nkuk cká vkj vkrfjd ÅÙkdk ij fpid jgr g vkj lenh 'koky d vklikl d okrkoj.k e mud }kjk mRiUu dh xb dkcfud dkcu dh ,d cMh jkf'k ij QhM d :i e bLreky djr gA oreku v/;;u e vyx vyx 'koky dh fofHkUu itkfr;k xkflyfj;k vkj vYok l bihQk;fVd vkj ,Mk Qk;kfVd cDVhfj;k dk vyxko vkj LØhfux bud i;kx'kkyk dYpj e lenh 'koky d fodkl ij mudh Hkfedk dk LFkkfir dju d fy, fd;k x;k FkkA bl v/;;u d fu"d"kk l irk pyk g fd , cDVhfj;k 'koky d ljpukRed fodkl vkj ofð e ,d egRoi.k Hkfedk fuHkkr gA vYolh d lnL; ifjHkkf"kr flFkfVd ehfM;k e ,Dl tfud ek/;e e j[ku ij viuh fof'k"V Qkfy,y Fkyl vkdkfjdh dk [kk nr g ijUr tc dYpj ehfM;k e thok.k Mky tkr g rk ; viuh lkekU; Qkfy,t Fkyl vkdkfjdh iklr dj yr gA ¼,DokfVd ck;ykth] 12 (2011) 13½ blh rjg thok.k xkflyfj;k Mjk e Hkh dyh ij.k djd mld fodkl e Rofjr ofð djr gA ¼,Qb,e,l ekbØk ck;kyk- vkj bdkyk- 76 (2011) 381)

dPN dh [kkMh d }hik l nt dh xb ub dkfM;e Lihjfyl itkfr

to fofo/krk d v/;;u e u, vkokl d vUo"k.k l ub itkfr;k dh tkudkjh iklr dju dk volj feyrk gA fiNy f}okf"kd fjikV e dPN dh [kkMh d }hik l 93 fof'k"V lenh 'koky itkfr;k dh lpuk nh xb g ftue l 14 Hkkjr d fy, ub itkfr;k FkhA oreku fjikV e geu vHkh rd vuof.kr itkfr;k d :i e dkfM;e Lifyl dh igpku dh if"V ljpukRed vkj i tuu o.k d vk/kkj ij dh gA bld vykok QVh ,flM dh :ij[kk vkj thu vuØe.k }kjk Hkh bldh if"V gkrh gA itkfr dh fof'k"V igpku bld Ýknl d dMfyr idfr vkj ;fVlYl e cky vkj oLrhcyj cky fu'kku d vHkko dh idfr e fufgr gA ;g itkfr] Hkkjr e ikb tkuokyh lcl ych itkfr;k e l ,d g] e/; eb l 'k: tue bldh Åpkb 25-30 leh nt dh xb FkhA bl çtkfr d db vU; pkfjf=d fo'kÔrkvk ij Hkh vul/kku fd; x;A

xkiukFk d vYok vk;Vk d thou pØ d v/;;u ¼ ,M ,Mfed çtkfr

fiNy f}okf"kd fjikV e geu xtjkr rV d lenh 'koky to fofo/krk ij dke dju dh lpuk nh g rFkk 198 itkfr;k dh lph nh xb FkhA bl v/;;u l ;g Li"V gk x;k Fkk fd Kkr itkfr;k e l dN d forj.k dh lhek lhfer g vkj bl rjg bl {k= d fy, LFkkfud gk ldr gA rF; ;g g fd LFkkfud oky itkfr ekuo ifjr ifjoru dh piVe g vkj bldk/;ku e j[kr g,] rRdky lj{k.k fn, tku dh t:jr gA vYok vk;Vk] fFkoh et folky{eh et tk'kh et d".kefr }kjk eyr¼ xkiukFk rV l of.kr fd;k x;k g fd ;g ,d lonu'khy itkfr gA vyx tk doy xkiukFk l 30 fdeh nf{k.k e g ogk ikdfrd okl d fxjkoV dk ,d egRoi.k [krjk cuk gvk gA bl idkj vYok vk;Vk d thou bfrgkl d iVu dk le>uk egRoi.k gk tkrk gA v/;;u e bufoVk dh fLFkfr d rgr bl itkfr e ckb¶yftyV tLikl }kjk u, idkj d vyfxd thou bfrgkl dk irk pyk gA tLikl dh udkjkRed QkVkVkdfVd vkok tkgh nt dh xb vkj jkb tkfM;y dkf'kdk d vxnr e i;kx'kkyk dYpj e igyh dkf'kdk foHkk tu d ckn c<ko n[kk x;kA bu ?kVukvk dk ch tk.k fuiVku vkj vdj.k dh lHkkouk dk c<ku dk ikfjfLFkfrd :ikrj ekuk tkrk gA 5 leh yckb dh tefyxftudh vkdkfjdh enj ÝkUM l d leku Fkh pkj llrkg d Hkhrj fodflr fd, x, dYpj dMh lu fuEu idkj Fkh 24 ± 1 fMxh lfYl;l rkieku] m tky lQn ¶ykjklV yi d uhp v/kj e 12:12 ot idk'k vkj v/kj e j[kk x;k FkkA bl v/;;u u tL;kl d df=e bMD'ku rFkk dfÔ dh lHkkouk dk çnf'kr fd;k gA ;g lj{k.k dk ,d lk/ku çnku dj ldrk gA vk.kfod Lrj ij ITS vkj rbcl thu Øe u oxhdj.k fofHkUurk fuf'pr fd;kA

i;kx'kkyk ifjfLFkfr;k e xVyfi;k fQfyfluk (Lamouroux) lh-vxk/k e VVk Likj fodkl

oreku e yky 'koky thul xVyfi;k ftue l 90 l vf/kd itkfr;k 'kkfey g mue th fQfyfluk dk dkQh okf.kfT;d eY; gA bldk ijijkxr :i l] db ,f'k;kb n'kk e mi;kx fd;k tk jgk g tgk rktk vYxy Fkykb dk LFkkuh; Lrj ij ,d #fpdj [kk| vkbVe d :i e foi.ku fd;k tkrk gA bl 'koky dh mi;kfxrk] bld ,VhvkDlhMV leð x.k] l{e ik"kd rRok dh miyC/krk vkj vkgkj e Qkbcj dh mPp lkexh d dkj.k gA bld vykok gky gh e ble mPp nok mi;kxh ;kfxdk dh Hkh igpku dh xb gA 3,6 ,ugkbMkxyDVkl dh vf/kd ek=k vkj de fpifpikiu oky lYQVM ikyhldjkbMl djkxhuu cuku dk bl vYxk l fjikV Hkh fd;k x;k gA tkiku e xVyfi;k fQfyfluk dh [krh ouLifr ilkj d ek/;e l dju dk i;kl fd;k tk pdk gA vk[kk ikV rV l flrEcj 2011 ,d= fd; x,] th fQfyfluk d VVk Likj d fodkl dk v/;;u fd;k x;k FkkA

feFkkbyhdj.k lonu'khy io/ku cg:irk (MSAP) i)fr }kjk Kkr mYok jfVdyVk d ikVklykLV tfur ik/kk d chp i'ptuu lEcU/kh fofo/krk

ikVklykLV dk iutuu lenh 'kokyk dh fofo/k itkfr;k d fy, lfpr fd;k x;k gA fofHkUu ekjdkVkbik e çkVklykLVk dk iutuu bihtfUVd fofHkUurk d QyLo#i ik;k x;kA feFkkbyhdj.k lc/kh vkdyu }kjk irk yxk fd ikdfrd ik/kk e Mh,u, d fofHkUu LFkkuk ij feFkkbyhdj.k dh fLFkfr dk nj ¼%½ bl idkj Fkk% 32.43% fcuk feFkkbyhdj.k] 24.32% gehfeFkkbyhdj.k vkj 20.27% feFkkbyhdj.k Mh,u, d nkuk fljk d vkrfjd lk;Vkflu ijA tcfd cg:fir fMLd tl fn[ku oky ik/kk e rRLFkkuh; feFkkbyhdj.k dh fLFkfr dk nj (%) Øe'k% bl idkj Fkk% 27.02, 32.43 vkj 14.86% A v/;;u l irk pyk fd vkdkfjdh dk lc/k Mh,u, d feFkkbyhdj.k d çdkj l gA iu% ;g Hkh n[kk x;k fd 30° l ij lkekU; fQykeUVlo FkkYyh l fMLd Vkbi dh Å"eh; fLFkjrk mPp FkhA ¼ej- ck;kVduk- 2012; doi 10, 1007, & 1020-012-9434-7½

xkflyfj;k Mjk d vkblkekfQd xfeVkQkbV ¼uj vkj eknk½ ,o LikjkQkbV d ofð nj vkj vxkjkt dh fo'k"krk, rFkk mudk ekdj d lgk;rk l p;u

fiNy f}okf"kd fjikV e Hkkjrh; rV l xkflyfj;k Mjk ¼lh-vxk/k½ t vxk/k dk cgrj x.koÙkk d vxkjkt ¼1% ty> 1900 xk-l-eh-&2½ d mRiknu d fy, lfpr fd;k x;k Fkk tk to ik|kfxdh vui;kxk d fy, mi;Dr gA vU; m".kdfVc/kh; lenh 'koky dh rjg bld lhfer forj.k vkj NkVh me d dkj.k bld okf.kfT;d mi;kx d llk/kuk d lo/ku d fy, t:jr egll dh xb tk bldh [krh d ek/;e l bld mRiknu dk c<ku dk ifjr djrk gA xkflyfj;k Mjk d rhuk thou pj.kk d ofð nj vkj vxkjkt dh fo'k"krkvk d lkFk mud tovk.kfod ekdj lgyd p;u dk v/;;u fd;k x;k gA VVkLikjkQkbV e vxkjkt dk mRiknu vf/kd ik;k x;k tcfd vf/kdre ofð nj eknk xfeVkQkbV e nt dh xbA ;g v/;;u ituu dk;Øek d fy, Hkh Qk;nen gk ldrk gA ¼,DokdYpj 318, (2011) 389½

Hkkjrh; lenh 'koky l'kk/kuk l çkdfrd mRikn ,oe 0;RiUu

lkxj l MXl ij MoES dk;Øe e lrr Hkkxhnkjh

lenh 'koky itkfr;k ,d= dh vkj igpkuh xb gA ftle l 13 nckjk yh xb vkj ,d ub çtkfr gA

74 eFkuky vkj tyh; vd@v'k lhMhvkjvkb dk Hkt vkj ACTREC ecb dk Hkt x;A

20 vd d ueu lhMhvkjvkb }kjk lfØ; lfpr fd; x; ¼,.VhgkbijyhfifMfed] ,.VhgkijXykblfed] QQnjk/kh] thok.kjk/kh] ,.VhfViuklkey] ,UVhybleuh,y] dlj fojk/kh½ vkj ACTREC u 4 ueu ,.Vhdljdfy; lfØ; ik;A

bu itkfr;k d okmpj ueuk gcfj;k fjikftVjh lnHk d fy, ,uvkbvk d fy, Hktk x;k gA LVh;fjx lfefr rFkk MoES dk dk; i.kgku dk çfronu Hktk x;kA

Hkkjrh; lenh 'kokyk e fyfiM gkbMkijvkDlkbM dk vkdyu

fyfiM gkbMkijvkDlkbM ¼,yih,pvkl½ dk fofHkUu thok d vkDlhMfVo ruko e to jklk;fud ldrd d :i e tkuk tkrk gA gj] Hkj vkj yky 'kokyk e ,yih,pvk,l dh ikjfHkd Lrjk dk fu/kkj.k gkbMkijkDlh ,pih,ylh feJ.k dk mi;kx dj QkDl ij[k fof/k }kjk fd;k x;k gA tkp e fofHkUu i tkfr;k d chp ,yih,pvk,l dh vyx vyx ek=k ikb xb tcfd ,yih,pvk,l dh ek=k oreku v/;;u e vi{kkdr de fn[kkb nh gA rktk otu d vk/kkj ij gj vYxk e bldh fofo/krk 12±6.2 µg/g ¼dkfM;e ljle½ l 31.5±2.8 ekbØk xke@xke ¼vYok yDVdk½ d chp] yky vYxk e 5.7±1.6 ekbØk xke@xke ¼xkflyfj;k dkVhdVk½ l 46.2±6 ekbØk xke@xke ¼lkdkuhek fQfyQfe½ d chp tcfd Hkj vYxk e 4.6±4.4 ekbØk xke@xke ¼fMdfV;kVk cV;jfl;kuk½ l 79±5.0 ekbØk xke@xke ¼lxkle Vjfuee½ d chp nt ikb xbA bl gk;MkijvkDlkbM u dy olk d ,d ekeyh v'k dk ifrfuf/kRo fd;k budh ek=k 0.04% ¼,l LokRth½ l 1.1% ¼,l Vjfuee½ d chp ikb xbA ijkDlhdj.k dh lonu'khyrk dk eY;kdu fof'k"V eØkvyxy ÅÙkdk d fy, fyfiM ijvkDlhMft chfyVh eku ¼,l,yih½ }kjk fd;k x;kA ¼t- Qk;dky 2012 doi -101111@J 1529-8817, 2012, 01208 x½

Hkkjrh; lenh ty l miyC/k ljdkfuek lkbukbvkbMl rFkk fQyhQke l djkxhuu

Hkkjrh; lenh ty l miyC/k yky 'koky lDjkuhek lkbukbvkbMl l djkxhuu dk fu"d"k.k fd;k x;kA ftlee[;r djkxhuu ,o FkkMh ek=k e ioorh djkxhuu ik;k x;kA bl çdkj 'koky dh ;g çtkfr iota djkfxuu ¼dkckgkbMV ikyhej 87 (2012) 1657 - 1662½ dk ,d l{ke lkr gA mi;Dr d vulkj ljdkfu;k fQyhQke dh [krh dk ç;kl fd;k x;kA gkykfd 'koky l djkxhuu dh ek=k mPp feyh] yfdu ekbØkdkyk;M e 1-djkxhuu d vykok vU; djkxhuu 0;RiUu feykA ¼upjy çkMDV dE;u- 6 (2011) 1327½

lenh 'koky vd l ik/kk d fodkl djuoky jxyVjk (PGR) dh igpku vkj ek=k fu/kkj.k

dlikQkbdl vYojth dh rkth Qly l fudy vd dk ell vDokxh çkboV fyfeVM d lkFk Qkfy;j Qgkj d #i e 0;olk;hdr fd;k x;k gA bldh {kerk ij çHkko Mkyuoky çkpkyk dk le>u d fy, v/;;u dh 'k#vkr dh x;h gA vd d dkcfud lrdk fcuk ØkeVkxkfQd foyxu fd; g,] vd e ektn PGR dh igpku ,oe ek=k fu/kkj.k d fy; VMe ekl LiDVkfefr ,d l'kDr lk/ku gA bll 23.97 ihih,e IAA] 27.9 ihih,e GA_3] 7.94 ihih,e fdfVx vkj 23.97 ihih,e ftfVu çklr gvkA HPLC l iu% ek=kRed if"V dh xbA fçtjofVo d lkFk j[ku e PGR dh lknrk e ,d lky rd dkb Qd ugh iMkA Hkj 'koky lkxhle Vufjee vkj yky 'koky xkflylfj;k bMfyl dk Hkh fo'yÔ.k fd;k x;k] ftle Øe'k% IAA vkj ftfVu 13.2 rFkk 11.40 ihih,e igy e rFkk ckn oky e 9.11 ihih,e IPA ¼bUMky çkfi;kfud vEy½ IAA dh txg] 14.24 ihih,e ftfVu vkj 23.14 ihih,e GA3 feykA mDr Hkj 'koky e GA_3 dh txg fxCcjfyu GA_9 ¼ek=k fu/kkj.k fcuk½ feykA ¼t- ,fx- QM- dfe- 58 (2010) 4594½A ek= ;gh 'kfDro/kd ugh gk ldrk g vkj vU; to lfØ; l?kVd dh ryk'k tkjh g tk vd dh Qkfy;j Qgkj dh {kerk dk vf/kd çnku dj ldrk gA

n'kh mRiUu vxj (SAgar) l tktkck dYpj d ç;kx

tktkck dYpj dh of) ij SAgar d çHkko ij v/;;u fd;k x;kA SAgar ¼7 xk@yh-½ lgk;d ,e,l ek/;e e dYpj dk mxk;k x;k vkj dkef'k;y vxj d lkFk ,d fu;f=r ç;kx fd;k x;kA 45 fnuk d bukdy'ku d ckn dyh dh yEckb dk ekik x;kA ,DllykV dk of) nj leku ik;k x;k tcfd SAgar e ifÙk;k ych vkj xgj jx dh FkhA dfy;k d iYyok dh l[;k Hkh SAgar e c<uoky ,DllykVk e T;knk FkhA ¼4 iYyo@,DllykV d lki{k 2 iYyo@,DllykV dkef'k;y ueu d lkFk½

xkflykfj;k Mjk l fudy vxkjkt (SAgarose) dk eY;kdu] y{k.ku ,oe ekun.M

xkflyfj;k Mjk l vxkjkt fudkyu dh uoy fof/k d fodkl dk igy çfrofnr fd;k x;k gA bldk iVV vkonu l lj{k.k Hkh gvk gA ,d fdxk ¼'k"d 'koky½ d mPp Lrj rd bl mRiknd dk vkx Hkh 'k) dju gr v/;;u tkjh j[kk x;kA ,d HkyhHkkfr Kkr dkef'k;y mRikn d lki{k mRikn dk mPp dju d fy; ekun.M

cuk;k x;k vkj leku ifj.kke 20-30% de ek=k d inkFk d lkFk ty cuku e çkIr gvkA db ukeh 'kk/k legk d vudy QhMcd fn; vkj mRikn dk eY;kdu gr ed bfM;k dk Hktk tk jgk gA mPp vfUre mi;kx gr t#jh egRoi.k fof'k"Vrkvk d fy; lfo/kk; dh tk jgh gA vPNh x.kork d vxj d fy; vk'kktud to lk/ku d #i e] Hkkjrh; ty l ,xkQkbV ink dju d fy; 'kk/k tkjh gA ¼t- ,ly- Qk;dky] 22(2010) 623; 23(2011) 183½

thok.k çfrjk/kh x.kk d lkFk vxkj vk/kkfjr flYoj uukd.kk rFkk uukdEikftV fQYe dk l'yÔ.k rFkk vfHky{k.ku

xflyfj;k M;jk l vxkj l'yfÔr fd;k x;k ftle flYoj uukd.kk dk vkdkj 6 ,u ,e xkykdkj vkdfr e FkkA Mh-,l-lh- rFkk ,Dl-vkj-Mh- u yxHkx cjkcj fØLVyh; rkfydk dk crk;k ¼lh-vkb-Mh-,l-lh- 0.73½A , d.k vxkjkt fQYe e lforfjr Fk vkj cDVfj;k dkmUV d fjTD'ku e log3 d lkFk] mRd"V cDVhfj;y lfØ;rk fn[kk;A ¼ck;kfjlkl VDuky- 107 (2012)295½

tyh; ?kyu'khy vxkjkl & ldjV

ty e ?kyu'khy vxkjkl & ldjV dk lÜy"k.k fd;k x;k rFkk fofo/k rduhdk l fo'yÔ.kkRed y{k.ku fd;k x;kA ;g ikuh d feJ.k ¼675 ihih,e½ ;k ?ku&voLFkk e Lokn e dMok ugh Fkk tcfd 'kð ldkjV vu:i fLFkfr e dMok ik;k x;kA gkykfd vHkh bld lki{k feBkl d eY;kdu dh t#jr gA ty e ?kyu'khy ehBk vxkjkl&ldkjV ;kfxd lHkkfor Hkktu&;kxt d :i e mi;kxh gk ldrk gA ¼dkckgkbMV ikyhejl 88 (2012) 1118½

gkbMkQkfcd ck;kdeifVcy jfLl;k

lenh 'koky dh [krh d fy; jfLl;k dh dkQh t#jr gkrh gA Qkbdkdkyk;M 'koky l gh jLlh cuku d fy; v/;;u fd;k x;kA inkFk [kn gh ty&lxkgh Fkk vkj xk¶V lg&cgydhdj.k }kjk ty&fojk/kh cuk;k x;kA gkbMkQkfcd ck;kdeifVcy jfLl;k dk mi;kx djr g; rfeyukM d FkkuhFkjkb e dlikQk;dl dh ik;kfxd [krh [ky len dh n'kkvk e dh xbA jfLl;k u lenh okrkoj.k e dke fd;k vkj 'koky dh of) lkekU; jghA ¼çkfo/kku iVV vkonu çkl l e½

lkfM;e & vfYtuV vk/kkfjr u, eyk;e Li&l{ke ty r= dk lÜy"k.k

lkfM;e vfYtuV d lkFk vkFkk&vehukcUtkbd vEy ¼vk,ch,½ ,o eVk & vehukcUtkbd vEy ¼,e,ch,½ dh jklk;fud ifØ;k l fpifpik ,o dikuorh ,ekbM 0;Riéik;k x;k gA ;g jklk;fud ifØ;k 1- ,fFky – 3 – [3 – (MkbfeFkkby vehuk) ikikby] & dkckMhbekbM gkbMkDykjkbM ¼b-Mh-lh-½ dh mifLFkfr e dh x;hA bl ,ekbM 0;Riék dk r= & o.ku ,QVh&vkbvkj ,o [13] lh ,u,evkj LiDVkeVh d tfj; bldh jpuk dh if"V dh x;hA bl eyk;e dkey ty dh [kkfl;r ;gg fd ;g ue vkykMu l iokgh rjy inkFk e :ikrfjr gk tkrk gA ¼lk¶V eVj 8 (2012) 1837½

QkbdkdkykbM 'koky l çfrfnflroky cgydk dk l'yÔ.k

vkfYtfud vEy (ALG) vkj pkj vyx&vyx nk vehuoky ;kfxd tl gkbMkthu (HY), ,Fkhyhu Mk;kfeu (EDA), 1,6-gDlu Mk;kfeu (HAD) vkj 1,4- lkbDykgDlu Mk;kfeu (CHDA) dh vfHkfØ;k }kjk vkj ckn e çkdfrd Økl fydj tfuf;u }kjk çfrfØ;k djd ikuh e /kyu'khu u;k çfrnhflroky 0;RiUuk dk ekbØkoo&fofdj.k }kjk fuek.k dju dh fof/k fodflr dh xbA ,Fkhyhu Mk;kfeu d 0;RiUu e vPNh çfrnhflr ik;h xb tk Øklfyd dju d ckn rhu xuk gk xbA nlj ,ekbM 0;RiUuk e çfrnhflr x.k ugh ik;k x;k ij bl Øklfyd dju d ckn çfrnhflr x.k fn[kkA ¼dkckgkbM fjlp 346 (2011) 527½ lcf/kr v/;;u e çfrnhflr cgydk dk cuku d fy; U;fDy;kcl lkbVkflu dk vxkjkt vkj d&djkxuhu ij xk¶V fd;k x;kA leku lknrkoky 'k) lkbVkflu foy;u dh ryuk e bfe'ku rhork c< xbA bld mi;kxk dh lHkkouk ij dk; gkxkA ¼dkckgkbMV ikyhej 87(2012) 1971½

dkbVklu ikyh;jkfud ,flM d ih,p mÙkjnk;h Qyu;kX; ;kxkRikn dk ekbØkoo lgk;d l'y"k.k

,d ljy ekbØkoo lgk;d fof/k dk i;kx djd lij Qyu ;kX;] ih,p mÙkjnk;h vkj v?kyu'khy ;kxkRikn ¼tl lh,p&ih,e, vkj lh,p&ihth,½ dk l'y"k.k fd;k x;k] ftld fy, vEy e ?kyu'khy dkbVklu ¼lh,p½ rFkk {kkj e ?kyu'khy ikyh eU;jkuhd ¼ih,e,½ vkj ikyh xyjkuhd ¼ihth,½ ,flM dk mi;kx fd;k x;kA ifrfØ;kvk dk ikjifjd ry ghfVx fof/k dk mi;kx djd Hkh fd;k x;k FkkA ekbØkoo ghfVx 100 °C ij 5 feuV d fy, dju ij v?kyu'khy ;kxkRikn dh lcl cMh çkflr (95 – 97%) gkrh g] tk lcl vf/kd Qyu dk vuikr (2700 – 3000%) n'kkr gA ;kxkRikn dk ,QVh&vkbvkj rFkk lhih&,e,,l ^{13}lh ,u,evkj rduhd }kjk y{k.ku fd;k x;kA ¼dkckgkbMV ikyhej] 83 (2011) 1402½

jkMehu & vYthuV chM

jkMehu ch 0;Rié d Lijkydve :i dk vyftuV cdcku e Mkyk x;kA l'kkf/kr cgyd l foÔkDr vkj to lfØ; Hg^{+2} vkj Cr^{3+} vk;uk dk tyh; ek/;e e ¼1 mM HEPES CkQj½ e irk yxk;k x;kA vYthuV dh ikuh foy;rk ,d ikuh ?kyu'khy vfHkded ikIr dju] tcfd dfYl;e dh mifLFkfr e ,YthuV dh ty cuku dh {kerk u ekrh fodflr dju d fy, dke fd;k bl dk ejdjh vk;u vFkok Økfe;e vk;u d lkFk iHkkoh <x l ckbM dju d dk; e bLreky fd;k x;k FkkA ejdjh vFkok Økfe;e vk;u d lkFk ,d çfrnhflr jx ifjoru] tk igpku dju ;kX; jx g mldh lgk;rk l budh igpku dh tk ldrh gA ¼dfedy dE;fud'ku 48 (2012) 1659½

lenh 'koky l dkje lonu fu"k/kh inkFk

dkje lonu dk jkdu oky cg:ih; inkFk dh yxkrkj [kkt d nkjku 75 eUukj dh [kkMh rfeyukM l ,df=r fd; x; 'kokyk dh LØhfux dh xbA Asparagopsistaxiformis vkj Spyridia hyproids d vd 'k:vkrh dkje lonu fu"k/kh i;kx e ldkjkRed ik; x;A bld vykok Asparagopsis taxiformis d vd u thok.kuk'kd xfrfof/k ,o Li"V {k= inf'kr fd;kA

ck;kfQYe cukuoky lenh thok.k l cká dkf'kdh; cgyd inkFkk (EPS) dk vyxko rFkk fu:i.k

ck;kfQYe cuku rFkk EPS ink dju dh {kerk d fy; cDVhfj;k LØhu fd;k x;kA Vibirio Parahaemolythicus, 16S rRNA thu (HM355955) vuØe.k ,o GC d lkFk feMh }kjk igpku x;A bldh {kerk dk EPS cuku d fy; puk x;kA EPS u vukdkj idfr d lkFk 67% ik;lhdkjh xfrfof/k] 250°C rd rkiLFkkb ,o pseudoplastic rheology inf'kr dhA ;g irk djuk g fd ,l EPS T;knk ek=k e vk|kfxd ç;kx d fy; cuk; tk ldr gA ¼ck;kQkmfyx 27(2011) 309½

WASTELAND RESEARCH

The earlier activities of wasteland research were mainly concentrated on cultivation of crop plants using seawater on sand and degraded saline lands along the coastal regions. Thereafter, the research activities were expanded to deal with cultivation of non-traditional oil yielding plants of industrial importance in marginal lands and sand dunes. In recent times, the emphasis was laid on utilization of wastelands (non saline category) by taking up agro-technology development of *Jatropha curcas*, a potential source of biodiesel. Another dimension of the research in recent years has been on molecular biology. The specific focus has been laid on molecular diversity in natural vegetation of Salicornia, biochemical and molecular aspects of salinity stress, isolation and characterization of genes from Jatropha related to biotic stress, and development of salt tolerant transgenic crops utilizing genes isolated from Salicornia.

Employing best agro-practices and superior germplasm to raise Jatropha plantation on wastelands

As a part of joint collaborative project on Jatropha with General Motors Corporation, US and US Department of Energy, which sought to perform a life cycle assessment and validate the economic and technical viability of Jatropha plantation on a large scale employing best practices, new sites at Bhadraval and Neswad in Bhavnagar district and Kanod in Panchmahal districts of Gujarat were identified and acquired in 2010-11 for plantation. The physical and chemical properties of soil including macro-nutrient composition in these sites were analysed. After clearing the existing sparse vegetation, undulations in the land were removed by ploughing and leveling for raising the plantations.

Physical characterization of soil

S. No	Location of the sites	Range of various parameters of soil physical properties						
		% concretion (in 0-40 cm)	Sand (%)	Silt (%)	Clay (%)	Texture	EC (ds/m)	pH
1	Neswad	16.3-20.9	71.9-80.3	11.7-15.8	7.2-12.3	Sandy loam	0.09-0.13	7.0-7.6
2	Bhadrawal	19.1-22.3	68.5-76.3	16.7-21.6	7.0-9.9	Sandy loam to Sandy clay loam	0.18-0.34	7.3-8.1
3	Kanod	2.1-4.8	25.8-29.9	11.9-16.3	57.9-58.1	Sandy clay loam	0.07-0.44	6.8-7.3
4	Chorvadla	2.2-55	57.5-76.2	14.7-30.0	9.0-17.8	Sandy loam to sandy clay loam	0.11-0.29	7.1-7.9

The newly transplanted Jatropha plants established well in the field at village Bhadraval and Neswad (Bhavnagar). 20 ha of land at village Kanod (Panchmahal) was also planted with Jatropha.

Chemical characteristics of soil

S. No	Location of the sites	Range of various parameters of soil chemical properties						
		Organic Carbon (%)	$CaCO_3$ (%)	CEC (meq/100g)	Total N (%)	Avail N (kg ha^{-1})	Avail P (kg ha^{-1})	Avail K (kg ha^{-1})
1	Neswad	0.22-0.36	4.0-5.8	30.5-38.9	0.014-0.031	143.1-185.0	1.24-6.64	146.7-281.3
2	Bhadrawal	0.38-0.47	14.8-19.8	28.1-43.8	0.038-0.045	142.0 -200.7	1.94-3.73	269.9-325.9
3	Kanod	0.55-0.81	2.8-3.8	37.7-49.3	0.05-0.069	103.5-251.1	2.9-14.5	185.9-201.6
4	Chorvadla	0.45-0.89	4.0-24.0	25.9-38.0	0.035-0.104	159.9-238.3	0.97-15.21	161.3-346.1

Yield performance of selected elite accessions

The institute has identified few accessions that have been found superior year after year. The Neswad plantation was established with these accessions in 2007 on shallow soiled rocky wastelands. During 2010-11, the average seed yield per plant was low (around 350g), as there was low fruit set probably because of higher intensity of rainfall during the flowering period resulted in washing off of the pollens. However, the yield got recovered in 2011-12. Independent experts (Dr. H.M. Behl, Coordinator Biofuels, Department of Biotechnology, New Delhi and Dr. Mohammad Arif, Senior Scientist from DRDO, Haldwani) were appointed by Ministry of New and Renewable Energy to

Highlights of Report of MNRE Expert after visit to CSMCRI's Nesvad Jatropha Plantation

Point #1:

"The very fact that the drooping branches cultivar had high fruit output makes it a desirable phenotype. It is strongly recommended that CSMCRI develops it as a distinct cultivar as this is distinct, uniform and has high yield.

The phenotypic trait of the other erect type was not distinct but was also relatively uniform. Since it has been found to be resistant to local conditions (reportedly also to sites at Berhampur, Orissa), it is also a good cultivar and should be clonally multiplied for plantation."

Point #9:

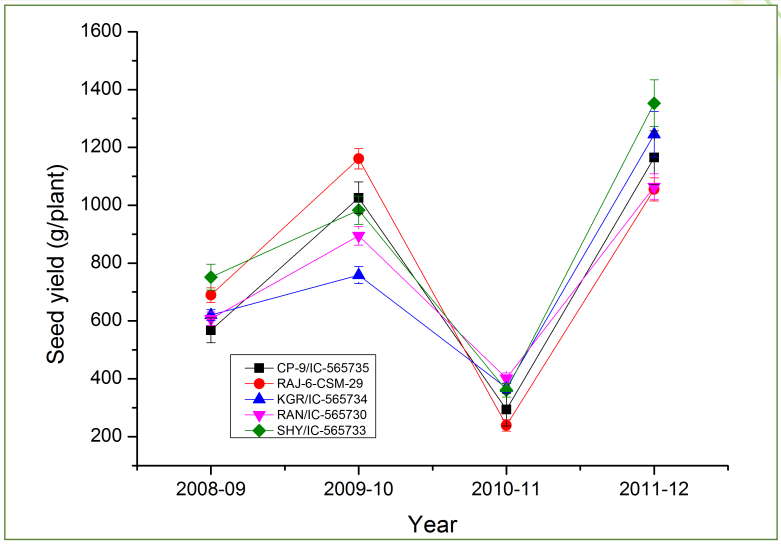
"The plots were healthy and as informed are minimally irrigated and only limited fertilization is done. Overall, it was a very successful trial and a good demonstration."

Dr.H M Behl
September 30, 2011

Drooping of branches due to weight of Jatropha fruits (right) and heavy fruiting (left) at Neswad plantation (Sep 2011)

visit our Neswad plantation in the fruiting season in 2011-12. Excerpts from the report are reproduced alongside. The figures show how the plants raised from elite cuttings have drooped due to the weight of the fruits. The year-on-year seed yield of the selected accessions is also shown.

At Orissa, the performance evaluation of the accession IC 565735 was continued. The seed yield dipped in 2011-12 due to lower rainfall. The mean oil content of seeds of the accession CP-9/IC-565735 from 2005-06 to 2011-12 is given below.

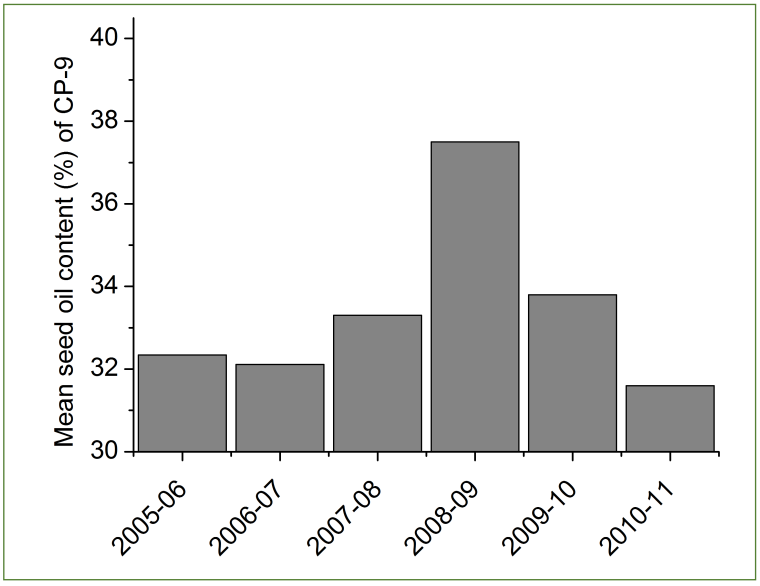


Performance of elite accessions of Jatropha at Neswad

Mean seed yield in kg/plant (N=10) at Orissa site

Year	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Seed yield	0.30	0.70±0.2	1.40±0.8	2.00±0.8	2.04±0.6	2.2±0.5	1.3±0.4

In Zanjmer (Bhavnagar, Gujarat), the accession IC 565739 (planted in 1999) proved to be high yielding under sand dunes. In 2008-10 the yield ranged from 5.2-5.55 kg/plant. However, during 2010-11 yield declined to 3.74 kg/ plant (Jatropha yields for the year 2010-11 were uniformly low across all places in Gujarat). In 2011-2012 the plants were affected by white ant attack leading to poor yield. However, control measures were taken thereafter.



Mean oil content of seeds of the accession CP-9/IC-565735 from 2005-06 to 2010-11

Mean seed yield of accession IC-565739 in different years at Zanjmer, Bhavnagar

Year	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Seed yield (kg/plant; average of two plants)	1.49	4.14	5.20	5.55	3.74	2.01*

* Due to white ant attack, the yield for the plants were drastically reduced; control measures were put in place

Elite germplasm (IC-565739) on sand dunes of Zanjmer, Gujarat

Agrotechnology

Manurial trials using Jatropha cake

Jatropha cake was exclusively used as manure in Jatropha plantation itself as a part of long-term trial. At Orissa, depending upon spacing and amount of cake applied to the plants, in both years in all the treatments, the yield per plant improved from 11 % to 60 % over control where no other fertilizers were applied. In 2010-11, the maximum seed yield of 1.74 kg/plant (equivalent to 2.9 t/ha) was obtained by application of 1.35 kg of Jatropha cake per plant (2.25t/ha) in 3m x 2m spaced plants, while an increased yield of 1.75 t/ha was obtained on increasing the amount of Jatropha cake and spacing. In the subsequent year, i.e., 2011-12, the yield was diminished uniformly at Orissa due to less rainfall.

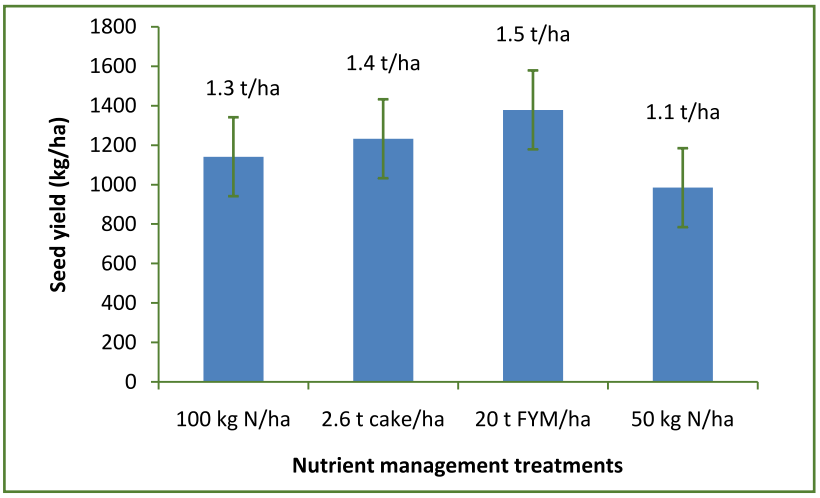
In another experiment at Gujarat, the application of Jatropha cake resulted in ca. 21% improvement in the seed yield against the treatment where equivalent amount of nitrogen (140 kg N/ha) contained in Jatropha cake was supplied through inorganic fertilizer in 2010-11.

Effect of Jatropha cake on seed yield per plant at Orissa

Treatments	Seed yield (kg/plant) 2010-11*	Seed yield (kg/plant) 2011-12*	Treatments	Seed yield (kg/plant) 2010-11*	Seed yield (kg/plant) 2011-12*
Spacing = 4m x 3m			Spacing = 3m x 2m		
T1(0 t/ha= 0 kg/plant	1.09	0.90	T1(0 t/ha= 0kg/plant)	1.20	0.86
T2 (0.75 t/ha = 0.9 kg/plant)	1.26 (15%)	1.00 (15%)	T2 (0.75 t/ha = 0.4 kg/plant)	1.33 (11%)	0.96 (12%)
T3 (1.5 t/ha = 1.8 kg/plant)	1.47 (34%)	1.04 (21%)	T3 (1.5 t/ha = 0.9 kg/plant)	1.36 (14%)	1.06 (24%)
T4 (2.25 t/ha = 2.7 kg/plant)	1.51 (37%)	1.09 (26%)	T4 (2.25 t/ha = 1.35 kg/plant)	1.74 (46%)	1.36 (60%)
T5 (3 t/ha = 3.6 kg/plant)	1.75 (60%)	1.31 (52%)	T5 (3 t/ha = 1.8 kg/plant)	1.70 (41%)	1.28 (49%)

NB: DOP : Jan 2003; No other chemical fertilizers applied in any of the treatments.
*Figures in parentheses indicate % increase in yield over control (T1)

In 2011-12, this experiment comprising application of 50% recommended dose of fertilizer (RDF) or 100% nitrogen nutrient to Jatropha through different sources (urea, cake and farm yard manure) on equivalent substitution basis was continued, albeit with a lower dose of N (100 kg/ha). The application of nutrients through Jatropha cake or farm yard manure was found at par and slightly better than the treatment applying nutrients solely through inorganic fertilizer. The highest seed yield of 1.5 t/ha was recorded in treatment receiving nutrients through farm yard manure, closely followed by the application of Jatropha cake. Soil enzymatic activity was found much better in organic amended soils as compared to urea fertilized soils.



Effect of different sources of nutrients on Jatropha seed productivity

Studies to characterize the nitrogen (N) mineralization of Jatropha residue during the decomposition in soil beneath or outside Jatropha canopy

A study was undertaken with the objective to characterize the nitrogen (N) mineralization of Jatropha residue during the decomposition in soil beneath or outside Jatropha canopy. Two laboratory incubation (94 days) studies (beneath and outside Jatropha canopy soil) had four Jatropha residue soil amendments (fruit shell, leaf, cake or control of soil only). The results showed that only Jatropha cake caused net N mineralization. Soil amended with leaf and fruit shell residues immobilized N during the first 64 and upto 94 days, respectively.

Soils outside of canopy **Soils inside of canopy**

Nitrogen mineralization in Jatropha residue amended soil [Lowercase letters denote statistically significant differences in N mineralization within each sampling day ($p<0.05$)]

Land amendments for successful establishment of plantations at Talegaon

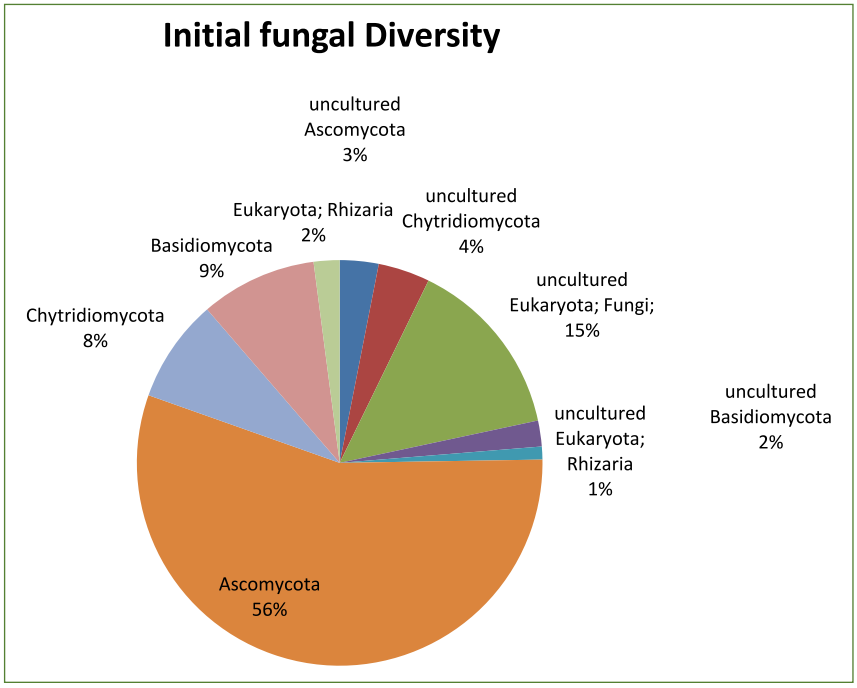
Jatropha plantation at General Motor's premises was established in 2008 with elite germplasm (CP-9, IC-565735 and PCM, IC-565731), which started flowering profusely in the reporting period. In the beginning, after studying the topography of land, soil profile, and physico-chemical properties of soil, it was found that *Jatropha curcas* cannot be cultivated on such prevailing land conditions. The reason for non suitability was the shallow soil depth (10-20 cm)

below which lay the parental rock. However, two models were proposed wherein, Jatropha could be cultivated after suitable land amendment. Model 1 comprised digging pits of suitable size with the help of appropriate machinery in 1 acre and filling the pits with soil brought from outside or scrapped from vicinity. Model 2 envisaged loosening of the strata to a certain depth by breaking the soft rocks with appropriate machinery and putting a layer of soil brought from outside in 1 acre area. Accordingly, Jatropha plantation employing the above models was carried out on 2 acres of area.

In a similar approach rather than bringing soil from outside, an innovative technique was developed under a CSIR sponsored Empowerment project to utilize the soil within the same piece of land to create an artificial rhizosphere for growing of Jatropha at Chorvadla site at Bhavnagar. The technique has been successfully implemented in 2010-11. Further, studies were initiated to determine the changes in soil microbial (fungal) diversity by metagenomic approach to confirm the effect of cultivation of Jatropha using good management practices under such rocky wasteland conditions. Initial soil fungal diversity of native soil was assessed by amplifying 18s rDNA sequence from the soil metagenome using 18s primers. Among 98 sequenced clones, 40 distinct species were identified by nucleotide blast analysis.

In the Jatropha plantation at Berhampur, Orissa, a diverse range of flora and fauna was observed. On the bark of some plants the rare lichens were also seen.

Working up on rocky land (left) transplanted plantation in 2008 (centre) and established plantation (2012)



Fungal diversity in the native soil at Jatropha experimental site based on 18s rDNA sequence

Jatropha plants attract variety of creatures and help in biodiversity growth (A and B- lichens, C-translucent spiny spider, D-green spotted beetle, E & F- butterfly)

Genetic Improvement of *Jatropha curcas* for adaptability and oil yield

The multilocational trial were continued under the NMITLI project and efforts were made to identify superior genotypes for future breeding programs from ca. 185 genotypes collected at Pan- India level representing different climatic conditions and soil types. After assessing the growth and yield performance of all these accessions, following 14 *J. curcas* accessions were shortlisted which performed better at most of the locations. Various parameters of these accessions were analyzed statistically.

Jatropha curcas accessions performing better across the locations

1	CSMCRI-GUJ-Banas-1205-C-1	8	FRI-HP-Shim-0306C-13
2	CRIDA-MP-Jhabua-02-03-JJ-06	9	FRI-HAR-Jhajj-1105-C-24
3	NBPGR-GUJ-SKN-0605-Hans	10	NBPGR-RJ-Rajsam-0905-C-15
4	AFRI-TN-Coimb-0206-C-6	11	NBPGR-UA-Paur-0306-C-9
5	AFRI-KER-Palak-0206-C-1	12	NBPGR-CHH-Bilas-0306-C-30
6	CRIDA-MP-Dhar-1105-C-4	13	RRL-AP-Papum-1105-C-1
7	CSMCRI-GUJ-Panchm-0106-C-7	14	RRL-MNP-Imph-1005C-1

Genetic Variability in various parameters of 14 shortlisted Jatropha accessions growing at CSIR-CSMCRI, Bhavnagar

	Seed yield (g/plant)	Test wt (g)	Seed coat wt (g)	Kernel wt (g)	Seed oil (%)
Mean	419.10	50.33	39.59	46.13	28.96
Maximum	391.33	55.21	52.82	47.18	32.17
Minimum	643.00	52.79	44.00	56.00	33.27
Standard Deviation	202.80	21.04	16.78	19.39	12.00
Genotypic Covariance	43366.43	458.93	295.09	395.65	152.47
Phenotypic Covariance	43752.38	468.65	298.75	399.32	153.06
Environmental Covariance	385.95	9.73	3.66	3.66	0.59
Genotypic Coefficient of Variation	49.69	42.56	43.39	43.12	42.63
Phenotypic Coefficient of Variation	49.91	43.01	43.66	43.32	42.72
Heritability (Broad Sense)	0.99	0.98	0.99	0.99	1.00
Genetic Advance	0.24	1.95	2.49	2.15	3.44

It was observed that all the accessions performed more or less uniformly for test weight and oil content. Variation was very high in seed yield as compared to other characters.Variance components for various traits presented in the table above revealed that the magnitude of phenotypic covariance was higher than the corresponding genotypic and environmental ones for all characters. Seed yield showed highest GCV (49.69%) and PCV (49.91%). Heritability estimates in broad sense ranged from 0.5 to 1.0 which reflected moderate to high predominance of heritable variation for all the traits. The highest heritability was recorded for seed oil content and very closely followed by seed yield, seed coat and kernel weight with the same value i.e.0.99.The genetic advance ranged as low as 0.24 for seed yield to 3.44 as highest for seed oil content. CV values were low (2.66-14.36) for all the characters for pooled performance of 14 accessions.

Genotypic (r_g), phenotypic (r_p) and environmental (r_e) correlation coefficients among different traits in 14 accessions were worked out. In general, the genotypic correlation coefficient value was higher than corresponding phenotypic and environmental correlation coefficients. Highly significant values for genotypic and phenotypic correlation coefficients among various traits indicated high degree of association of traits at both these levels. All the environmental correlation coefficients were non-significant and in some cases, values were negative indicating low influence of environment among various traits.

Growth and yield performance of hybrid lines derived from F1 cuttings

In order to develop Jatropha hybrids from single crosses, hybrid lines of *Jatropha curcas* were derived from identified Jatropha accessions and their performance was observed for two successive generations. Promising hybrid lines were multiplied through stem cuttings and transplanted in an isolated plot at Bhadraval during monsoon. Early seedling growth was assessed on approx. 1500 stem cuttings raised from various promising hybrid lines in nursery. Out of eight cross combinations, cuttings raised from hybrids lines namely IC565733×IC565734 and IC565735× IC565739 showed better growth and more branches as compared to other six combinations. Around 74% F1s showed increase in fruit set over their respective parents. Cross IC565735 × IC565739 showed the maximum fruits (21 numbers per inflorescence) and 180 g seed yield per plant. As it was the first year of plants performing in the field, most of the plants could yield between 40 g to 90 g of seeds. Few F1s ranged between 108.92-178.47 g whereas for parents it was between 89.56-104.75 g.

Performance of Jatropha hybrids

The performance of hybrids made in the elite genotypes selected under the NMITLI project was assessed. Maximum seed germination (80%) and survival of F1 seedling (75.01%) was recorded in cross RR-AP-Papum-1105-C-1XRRL-NL-MON-1105-C-1. In early seedling stage, height was more in RRL-ASM-Kurbi-1205-C-5XCSMCRI-OR-GUJ-Banas-C-1, whereas number of branches and stem girth were maximum in NBPGR-SKNJ-2(Elite)X CSMCRI-OR-GUJ-Banas-1205-C-1 cross seedlings. For first year growth performance in field, maximum plant height (108.50cm) was recorded in RRL-ASM-Kurbi-1205-C-5 X CSMCRI-OR-GUJ-Banas-1205-C-1 cross whereas cross RRL-ASM- Kurbi -1205 -C-5 X RRL-ASM-Golag-1105-C–1 exhibited minimum plant height (98.83cm) as well as stem girth (31.25mm) among all the crosses. Number of branches (4.92) and canopy diameter (138.17 cm) were highest in cross RRL-ASM-Kurbi-1205-C-5X, CSMCRI-OR-Ganj-1205-C-5. Crosses NBRI-J-18 (Elite) X RRL-NL-MON-1105-C-1 and NBRI-J-18 (Elite) X CSMCRI-OR-GUJ-Banas-1205-C-1 were lowest performers with respect to the same traits. Stem girth was maximum (57.42mm) in cross RRL-AP-Papum-1105C-1XCSMCRI-OR-GUJ-Banas-C-5. Plant wise raw data collected for all the F1s along with their respective parental plants were sent to Anand Agricultural University, Anand for heterosis analysis.

Relative heterosis and Heterobeltiosis were worked out for all 20 cross combinations for growth characters. Maximum relative heterosis for plant height (21.51%) was exhibited in the RRL-AP-Papum-1105-C-1XRRL-NL-MON-1205-C-1 cross and for number of branches (50.00%) by RRL-ASM-Kurbi-1205-C-6 X CSMCRI-OR-Ganj-1205-C-5. Maximum relative heterosis for canopy diameter (8.79%) was recorded in cross RRL-AP-Papum-1105-C-1 X RRL-ASM-Golag-1105-C-1and for stem girth (21.09%) by NBRI-J-18 (Elite) X CSMCRI-OR-Guj-Banas-1205-C-1. Cross RRL-ASM-Golag-1105-C-1 X CSMCRI-OR-Ganj-1205-C-5 showed maximum heterobeltiosis (7.79%) for plant height, whereas the maximum number of branches was observed in cross RRL-ASM-Kurbi-1205-C–6 X CSMCRI-OR-Ganj-1205-C-5 (39.02%). Cross NBRI-J-18 (Elite) X CSMCRI-OR-Guj-Banas -1205-C-1 recorded maximum heterobeltiosis (15.80%) for stem girth. All the crosses showed negative values for canopy diameter.

Estimation of Salicornia biomass and their salt concentrations at various salt marsh sites

Survey and analysis work was done to estimate the biomass production and the salt content in salicornia plants at five densified sites (Sartanpar, Methla, Nigala, Victor and Diu), without any other management practices. The plant population varied from 1,00,000 (Victor

Estimation of different parameters of *Salicornia brachiata* at different coastal salt marshes

Parameters	Mean values	Minimum value	Maximum value
Plant population/ha	835600	100000	3310000
Dry biomass (tonnes/ha)	2.15	1.15	4.05
Seed weight (kg/ha) (oven dried)	100.2	35.5	192.4
% seed wt from dry biomass(root+shoot)	4.7	0.08	7.2
1000- seed wight (g)	0.334	0.279	0.408
% oil in seed	30.6	25.2	34.6
Amount of oil (kg/ha)	32.5	14.0	66.5
% salt from biomass (root+shoot-seed)	16.6	8.9	26.6
Amount of salt produced from biomass (root+shoot-seed)(kg/ha)	385.4	127.6	829.6

port) to 33,10,000 (Sartanpar) plants/ha with mean value of 8.35 lakhs plants/ha, across different sites. The dry biomass also varied among the different samples from different sites ranging from 1.15 to 4.05 t/ha with an average of 2.15 t/ha. Among the sites, the least mean dry biomass was obtained at Sartanpar (1.46 t/ha), while the maximum dry biomass was obtained at Nigala site (3.22 t/ha). No significant correlation (-0.04) was observed between plant population and dry biomass production per unit area, while there were indications of negative correlation (correlation coefficient = -0.53) between plant population and individual plant dry weight. The amount of seed obtained from the total dry biomass was approx. 7.2% with a mean value of 4.7%, while the seed oil content ranged from 25.2 to 34.6% with a mean of 32.5%. The percentage salt (commercialized as vegetable salt *Saloni*) obtained from the dry biomass ranged from 9-27% with an average salt content of 16.6%. The Nigala site produced the highest quantity of vegetable salt (829.6 kg/ha).

Repeat studies on crude extracts of *Salicornia brachiata* for their anti-TB activity

Crude aqueous extracts were prepared from the roots of *Salicornia brachiata* collected during five different stages of growth of the shrub. The study was conducted during October 2009 to March 2010 and January to April, 2012. Samples were sent to CDRI for activity testing against the strain H37Rv of *Mycobacterium tuberculosis.* Most of the crude extracts showed anti-TB activity, albeit to lesser or higher extent. To confirm the anti-TB activity in the crude, the samples which showed activity in CSIR-CDRI were sent to CSIR-IMTECH but no activity was seen. The work is now being continued in collaboration with Mahatma Gandhi Institute of Medical Sciences, Sevagram.

Cellulose of *Salicornia brachiata*

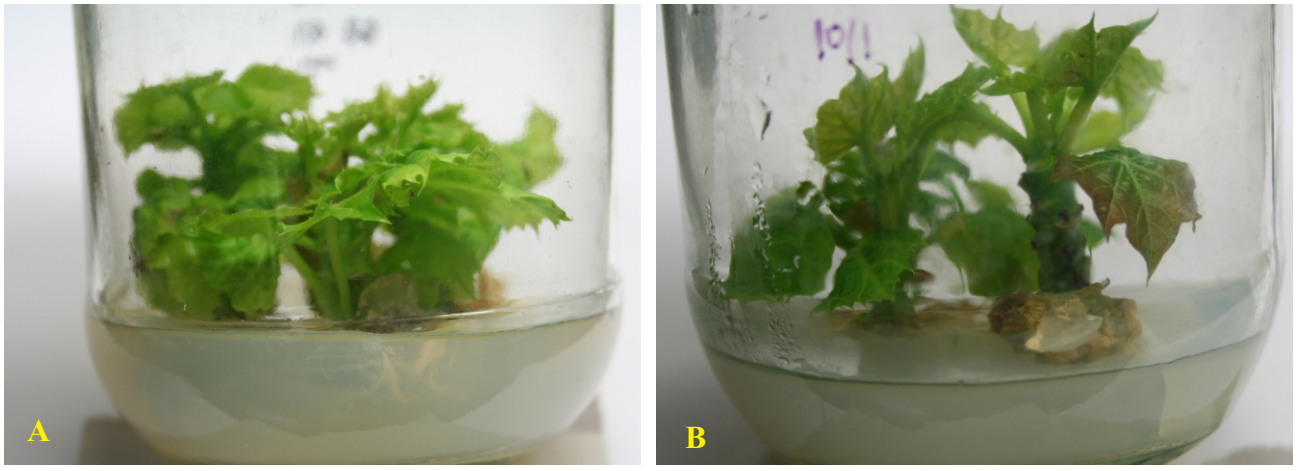
Cellulose was extracted from the roots, stems and stem tips of *Salicornia brachiata* Roxb. Each crude cellulose sample obtained was fractionated into α- and β-celluloses. The yields of crude cellulose from the stems and stem tips were greatest and lowest, respectively, while the yields of α- and β-celluloses were in the order, roots > stems > stem tips. The cellulose samples were characterized by FT-IR, CP/MAS, ^{13}C NMR, XRD, TGA and SEM. The data were compared with those of the celluloses (predominantly α-cellulose) isolated from Whatman filter paper No. 4 (*Nat. Prod. Commun., 5 (2010) 603)*.

PLANT BIOTECHNOLOGY

Micropropagation of *Jatropha curcas*

In vitro propagation is an alternative method to clonal propagation with its own advantages like continuous supply of rooted plantlets throughout the year, once axenic cultures are generated. During this period, ca.6000 cultures from elite genotypes of *J. curcas* L. were maintained. Further experiments are under progress to improve the growth of cultures and shoot elongation; and scale up the rate of multiplication, along with *in vitro* and *ex vitro* rooting percentage. Approximately 400 plants of elite genotypes were generated and planted in the field. Later 179 plants of elite genotypes were also transplanted at Bhadrawal site and survival and yield performances will be monitored in the field. Alternatively cultures were established using leaf as explants and ca. 1500 cultures were established. Genomic DNA was extracted from axillary bud and leaf regenerated cultures to assess the fidelity of cultures/plantlets and suitability of regeneration pattern for mass-scale true-to-type propagation.

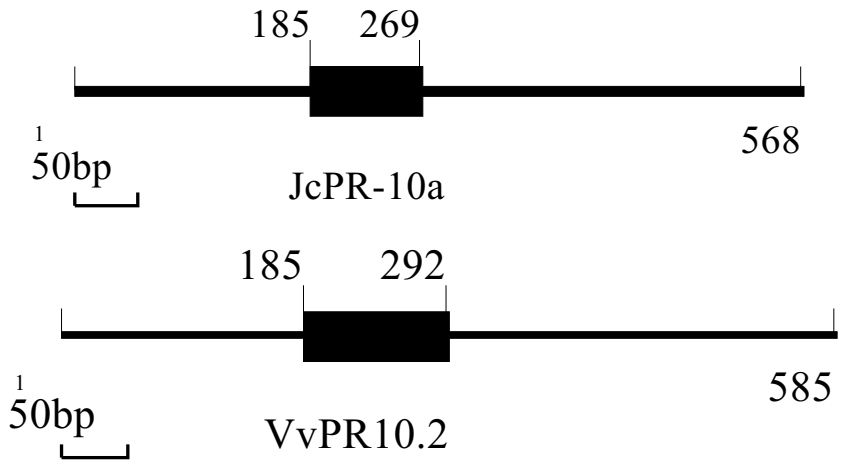
High cost is one of the major constraints in the practical application of tissue culture and hence emphasis was laid on *ex vitro* rooting methods. To economize the *in vitro* multiplication of *Jatropha curcas* L., attempts were made to replace the use of branded sucrose costing Rs. 9.14 per litre of medium with commercial grade sucrose (Daurala Sugar Works), costing Rs. 3.60 per litre of medium. This reduced approximately 55-60% of the cost for sucrose. Similarly, commercially available agar (Rs. 3600/Kg) was costly as compared to agar prepared in CSIR-CSMCRI. The medium supplemented with Spectochem and CSMCRI agar was used in culture, and performances of both CSMCRI and Spectrochem agar were found to be equivalent.



Cultures of *Jatropha curcas* growing in CSMCRI agar (A) and commercial agar (B)

Enhancing stress tolerance in Jatropha

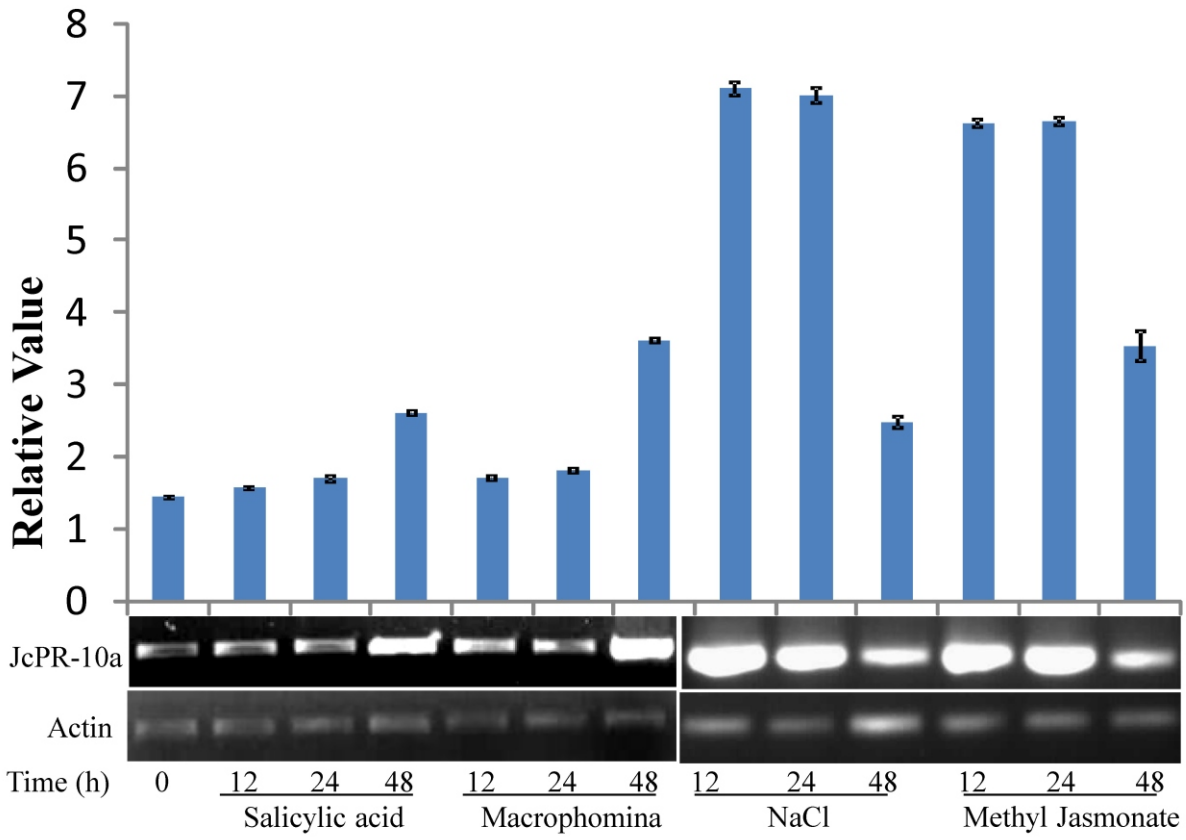
The collar rot caused by *Macrophomina* imparts heavy losses in *Jatropha curcas* plantations. *Macrophomina* is a soil borne, anamorphic, ascomycetes fungi. Microsclerotia in soil, seed or host tissue serve as inoculum and plants die/decay due to production of fungal toxin phaseolinone and production of fungal tissue that plug the host xylem vessels. Salicylic acid is known to enhance systemic acquired resistance in plants. Different concentrations of SA (0.25, 2.5, 5.0 mM) were exogenously applied to the roots of 1-year-old plants. Its effect on antioxidant enzymes, malondialdehyde (MDA) and proline content was observed after 1, 3 and 5 days of treatment. Superoxide dismutase (SOD) showed gradual increase with time in all the three concentrations of SA, whereas catalase (CAT) showed increase only for first and third



Diagrammatic presentation of the position of intron and exons of Jc-PR10a (*Jatropha curcas*), and VvPR10.2 (*Vitis vinifera*).The scale underneath each diagram represents 50 bp

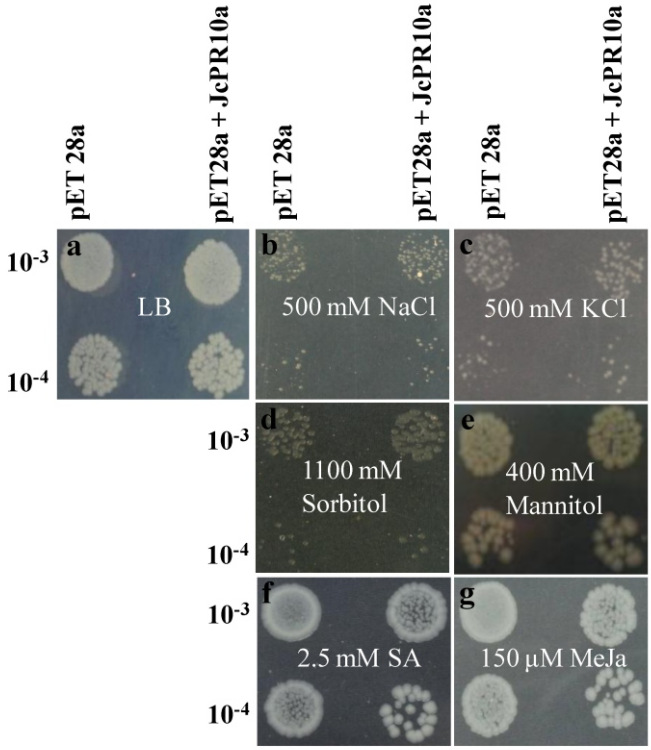
day. The proline and MDA content also increased on first and third day in all the three concentrations. The stomatal conductance, transpiration and photosynthetic rate increased with SA treatment, indicating that increase in the antioxidant enzymes caused by SA treatment had no adverse effects on the stomatal conductance and photosynthetic capacity of the *Jatropha*, therefore, SA signaling pathway can be activated for enhancing SAR in *Jatropha curcas*.

Towards, developing tolerance in *J. curcas*, we have isolated the cDNA of a pathogenesis related gene (JcPR-10a) from *Jatropha curcas* with an open reading frame of 483 bp (NCBI accession number JN566052). The deduced amino acid of

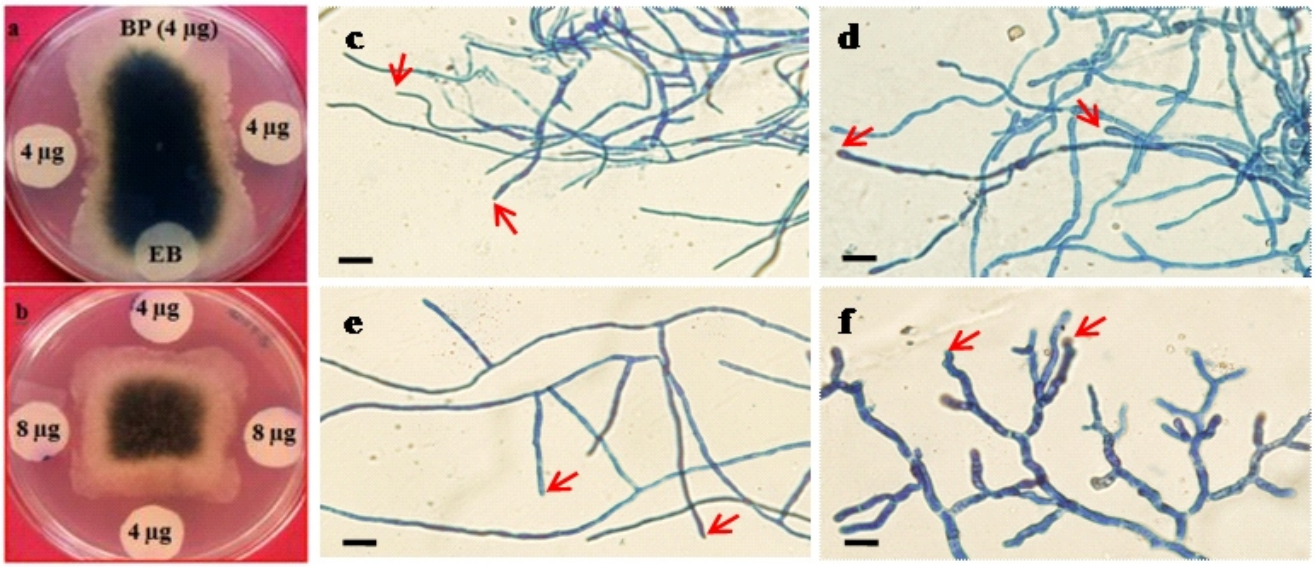


Transcript analysis of JcPR-10a gene under different stress treatments, 2.5 mM salicylic acid, Macrophomina fungus, 250 mM NaCl, 100 µM methyl jasmonate. Graphs over each radiograph show the relative value of JcPR-10a against the actin gene to show the quantitative increase in the expression levels

JcPR-10a on blast analysis showed homology to plant PR10 proteins, with 43%, 42% and 39% identity to Mal d(PR10), MtPR10-1 and CaPR-10/VvPR10.2, respectively. Phylogenetic analysis showed that JcPR-10a was clustered with dicots, close to CaPR-10, known to play an important role in both fungal and viral resistance. The 568 bp genomic clone (NCBI accession number JN639632) showed the presence of an intron at 185 bp, similar to other PR-10 genes. Transcript expression of *JcPR*-10a was upregulated in response to different stimuli such as NaCl, salicylic acid, methyl jasmonate and *M. phaseolina*. Transcript accumulation of a pathogenesis-related gene, *JcPR-10a*, with response to *Macrophomina* was demonstrated.



The growth analysis of *E. coli* cells containing pET 28a alone (left panel in each figure) and JcPR-10a recombinant plasmid (right panel in each figure) in LB medium (solid) with different supplements (a) LB only; (b) 500 mM NaCl; (c) 500 mM KCl; (d) 1,100 mM sorbitol; (e) 400 mM mannitol; (f) 2.5 mM salicylic acid; (g) 150 µM methyl jasomonate



JcPR-10a protein inhibits the growth of fungus *Macrophomina*. (a) 4 µg of JcPR-10a recombinant protein, boiled protein (BP) and protein elution buffer (EB) was used. (b) 4 and 8 µg of JcPR-10a recombinant protein was used. (c, e) Hyphal morphology of *Macrophomina* under control conditions at 24 and 48 h, respectively. (d, f) Hyphal morphology of *Macrophomina* on treatment with 8 µg recombinant protein at 24 and 48 h, respectively. Scale bar 100 µm

The JcPR-10a recombinant *E. coli* cells showed better growth in LB medium supplemented with NaCl, whereas growth of recombinant cells was inhibited in LB medium supplemented with KCl, mannitol, sorbitol, methyl jasmonate and salicylic acid. The JcPR-10a protein was overexpressed in *E.coli* cells, and was purified to homogeneity. It inhibited the growth of fungus *Macrophomina*. The fungal growth was found inhibited in 2-3 mm zone in proximity to the discs. JcPR-10a can serve as an important candidate to engineer stress tolerance in *Jatropha* as well as other plants susceptible to collar rot by *Macrophomina.*

Methylation studies of virus infected and non-infected *Jatropha curcas* using MS-AFLP

Epigenetic study based on methylation sensitive polymorphism has been studied using MS-AFLP of virus infected and non-infected *J. curcas*. The study revealed that *J. curcas* has ca. 57% and 29% methylation and methylation polymorphism, respectively, in virus infected, and 54% and 25% in non-infected plants. Thus, it was concluded that infected plants have high epigenetic changes such as methylation due to biotic stress.

Development of SCAR marker specific to non-toxic *Jatropha curcas L.*

The efforts were made to generate the specific SCAR marker for toxic and non-toxic *J. curcas* using RAPD. Among the markers specific for toxic and non-toxic varieties, four were selected, purified, cloned, sequenced, and primers designed, out of which one set of primers NT-JC/SCAR I/OPQ15-F and R was able to distinguish between the two varieties. The multiplex PCR was designed using the nrDNA ITS primers and SCAR primers to overcome the false identification. The specific SCAR markers generated have applications in quality control for selective cultivation of non-toxic variety and will be also helpful in breeding and molecular mapping studies.

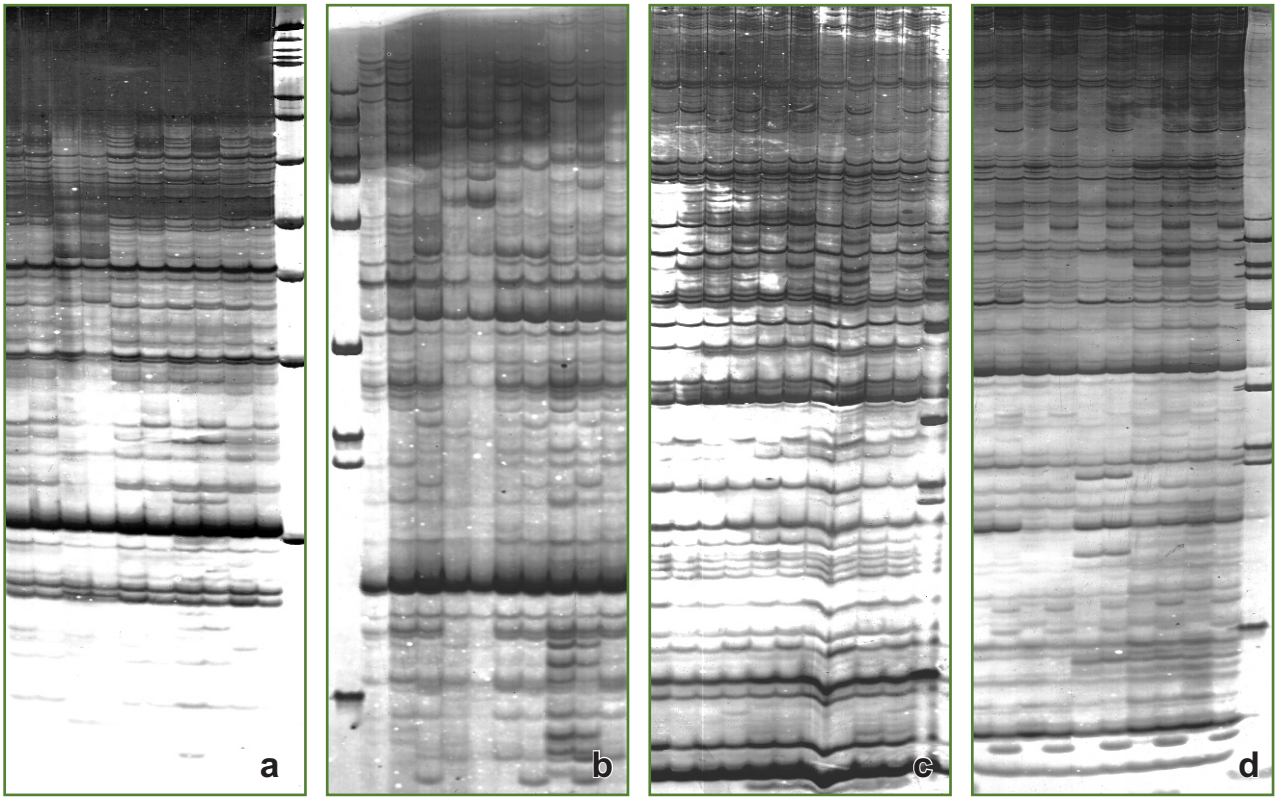
Molecular characterization of elite germplasm of *Jatropha curcas* using diffferent markers

Seventeen elite accessions from NMITLI germplasm were used for their genetic relatedness among themselves using dominant RAPD marker system. Among them, highest polymorphism was found between NBRI-05-J and CRIDAJL-06 when pairwise comparison was made. It paves the way for the selection of suitable germplasm and for generation of hybrids and QTL mapping.

Further, 23 high yielding plants of selected accessions collected from distinct geographical areas were analyzed by RAPD and simple sequence repeats (SSR). The overall polymorphism was found to be ca. 54% through RAPD analysis. The mean genetic similarity among accessions was found to be 0.911 through RAPD, which was supported by mean genetic similarity obtained through SSR markers (0.90). SKNJ9 showed maximum similarity to other accessions both through RAPD and SSR analysis. RAPD and SSR dendrograms generated using UPGMA for 23 accessions showed good correlation to each other. KUMBHARIA got separated from other accessions in the cluster analysis showing its distinctness from other accessions. In both dendrograms, the accessions CP9, CP13, CP17, SKNJ1 and SKNJ7 got clustered together, whereas, KGR got separated distinctly from rest of the 5 accessions. Accessions SKNJ9, SKNJ10 and SKNJ11 formed a minor cluster, while KOTESHWAR and AMBAJI formed another minor cluster both in RAPD and SSR dendrograms. KUMBHARIA which exhibited maximum divergence from the other accessions can be used for further breeding programs to produce hybrids with diversified characters.

Physio-biochemical and molecular changes in *Jatropha* associated with salinity

To study the physiological and biochemical/ molecular aspects in *J. curcas* associated with salinity stress, seedlings of an elite accession (CP-9) were generated on Hoagland medium. Attempts were made to study the methylation of DNA in whole genome and polymorphism in methylated DNA in root and leaf tissues of *Jatropha curcas* L. seedlings, subjected to different levels of salinity stress for 24 h. In root and leaf tissues ca. 70% and 59% methylation was observed, respectively; while 99% and 91% polymorphism was observed in methylated bands in root and leaf tissues, respectively. The percentage methylation was found in order of 50 mM < 100 mM < 75 mM < 25 mM and methylation polymorphism represented the order 25 mM < 75 mM < 100 mM < 50 mM in roots as compared to control. The percentage methylation was found in order of 50 mM < 75 mM < 100 mM < 25 mM and methylation polymorphism represented the order 100 mM < 25 mM < 75 mM < 50 mM in leaves as compared to control.

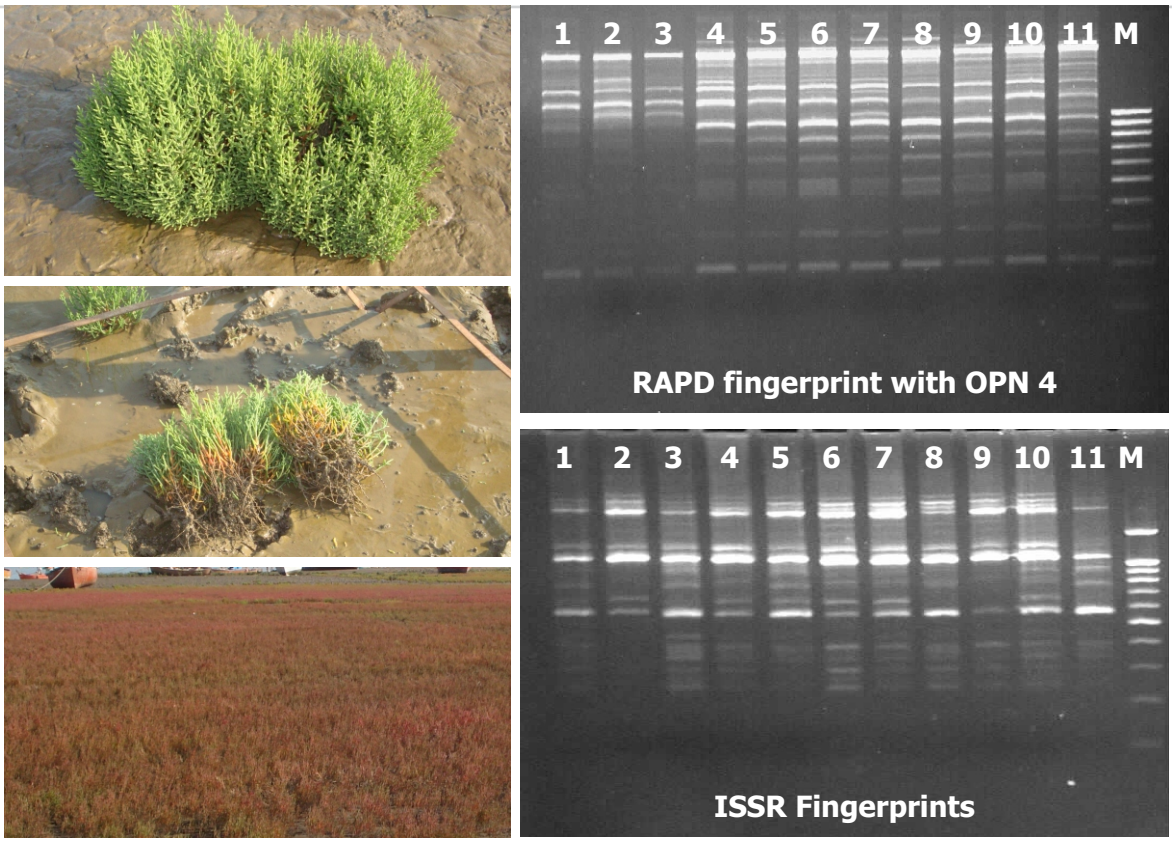


Differential expression in root (a, b) and leaf (c, d) tissues of salt treated *J. curcas* L. seedlings using different MSAP primers

Genetic diversity analysis of *Salicornia* populations along Gujarat coastal area

Diversity in *Salicornia* using different molecular markers (RAPD and ISSR), from Gujarat coastal regions (viz., Sartanpar, Diu, Avania, Ghogha, Jafrabad, Nigala, Methla, Newport Bhavnagar, and Victor port) were analysed. Morphological characters (biomass, shoot height, root length, fresh and dry biomass of shoot and root, spike length and number of branches) for thirty plants were recorded. For molecular analysis, RAPD and ISSR amplifications were performed with 20 RAPD and 15 ISSR primers, respectively.

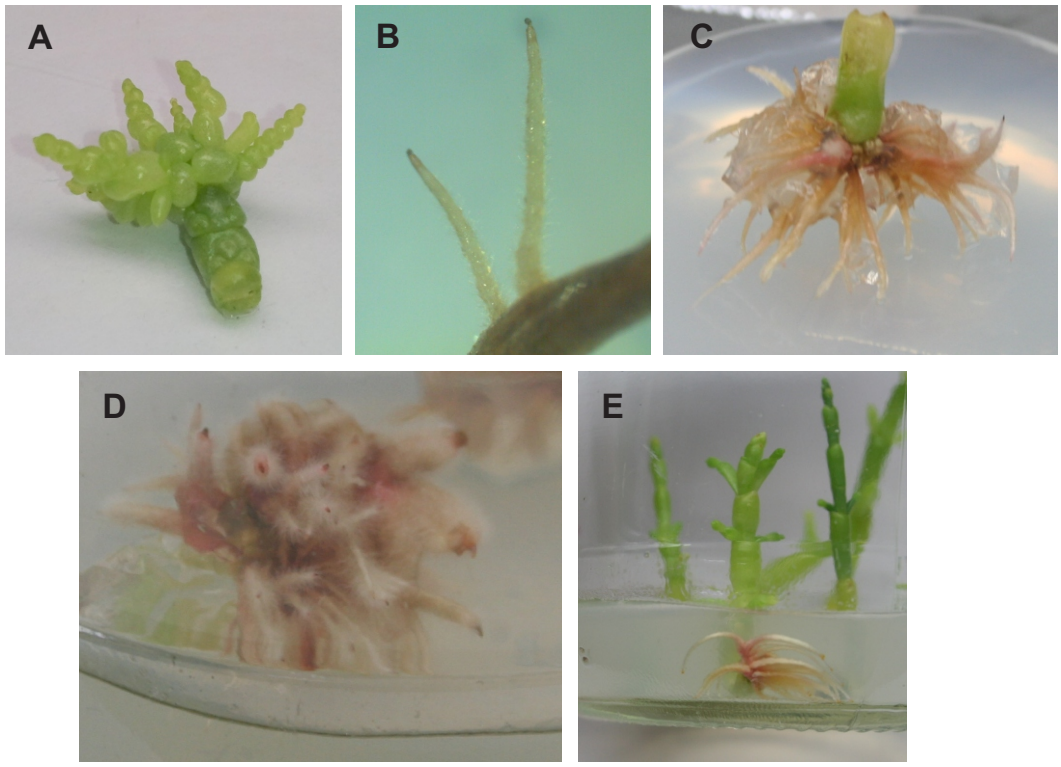
In genetic similarity matrix and dendrograms of RAPD and ISSR, certain level of genetic distance was observed. In both (RAPD and ISSR) dendrograms three groups were obtained showing un-clustering of the basis of fingerprint data.



RAPD and ISSR profiling of *Salicornia brachiata* from different locations

Tissue culture studies on *Salicornia brachiata*

Shoots were collected from mature plants growing in the field for the regeneration studies. Approximately, 3-15 multiple shoots were achieved per culture on modified MS medium



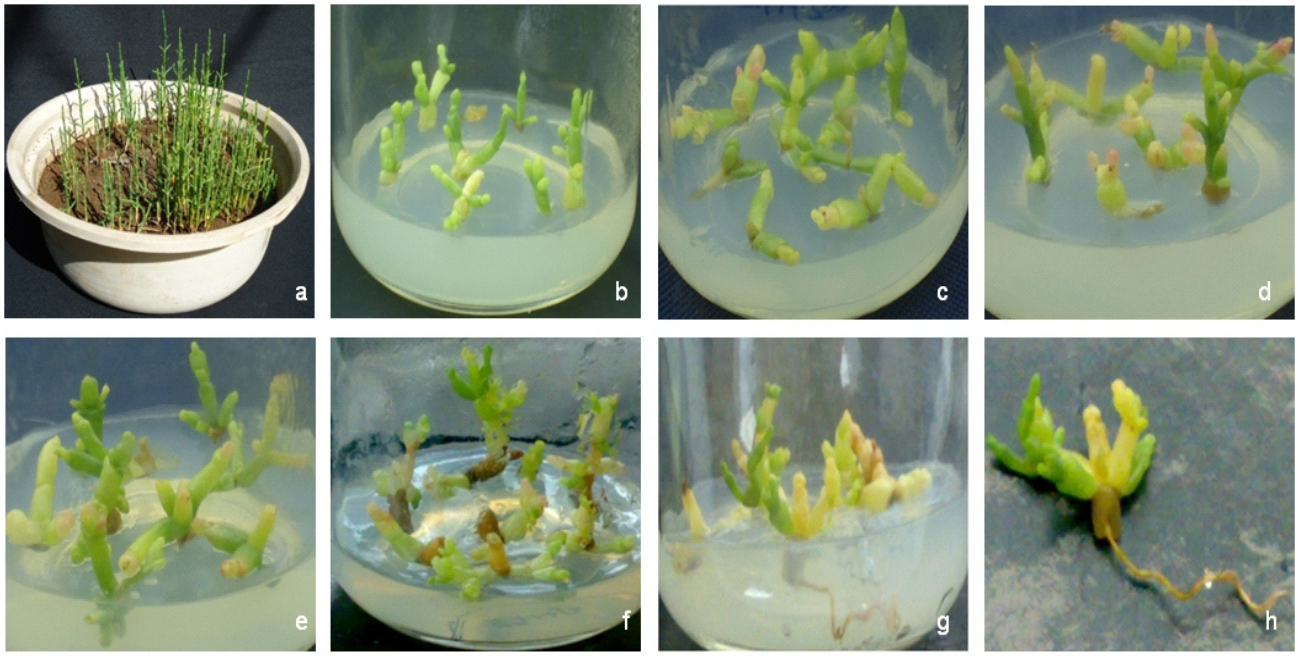
Multiple shoot bud induction (A), root initiation from root explants (B), root initiation from stem explants (C-D), well rooted shoots (E)

supplemented with BAP after two subcultures. Only 20% of elongated shoots could be rooted on MS media supplemented with IBA. Rooting percentage was enhanced up to 50% by improving the culture conditions.

Root and callus cultures were generated using different explants like hypocotyls, root and stem. All the explants resulted in roots and callus but the growth rate was very slow. Best root cultures were achieved from stem explant cultures. The generated root and callus will be used for studying bio active compounds. Direct and indirect regeneration from different explants were also tried. Callus of stem developed some shoot bud within 60 days of culture.

shoot response increased significantly with NaCl treatment. Among 30 treatments in the combination of BA + NAA + NaCl, shoot proliferation gradually increased with BA and salt treatment.

The efficient shoot proliferation was observed in the combination BA (8.9 µM) + NAA (5.37µM) + NaCl (500 mM) and similar result was also observed in the combination BA (13.3 µM) + NAA (5.37µM) + NaCl (250 mM) indicating that NaCl is required for the micropropagation. Rooting was observed in high salt treatments (250 and 500 mM NaCl) with root induction media containing PGRs combination of 2.46 µM IBA & 0.46 µM Kn (*Ind. Crop Prod.,35 (2012) 313*).



Micropropagation of *Salicornia brachiata*. (a) *S. brachiata* plantlets (3 months) used as explants; (b) 15 days, (c) 30 days, (d & e) 45 days and (f) 60 days old micropropagated plantlets in BA [8.9 µM] + NAA [5.37 µM]+ NaCl [500mM]; (g & h) rooting in IBA [2.46 µM] + Kn [0.46 µM]

Furthermore, a simple and rapid method for micropropagation of *S. brachiata* was established using shoot tips and nodes from the juvenile plants growing in pots. Among 8 treatments, BA (4.44, 13.3 and 35.52 µM) showed enhanced shoot proliferation, however, among 15 treatments (combinations of BA + NAA and BA + 2,4-D), the best response was observed with 5.37 µM NAA. Percentage of

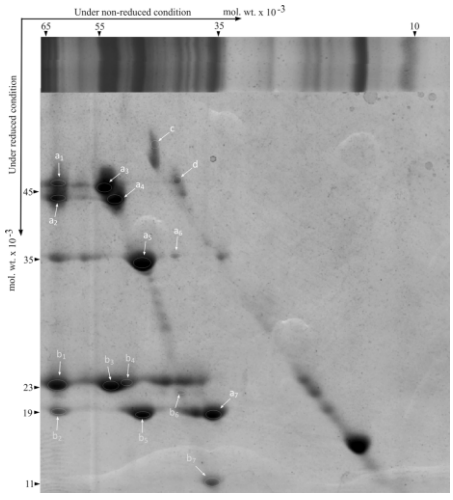
This protocol will facilitate functional gene expression analysis in this halophyte helping to understand molecular function of a number of novel salt responsive genes isolated from the same. The developed protocol will help for the propagation and conservation of industrially important elite accessions and also facilitate sustainable coastal saline wasteland management.

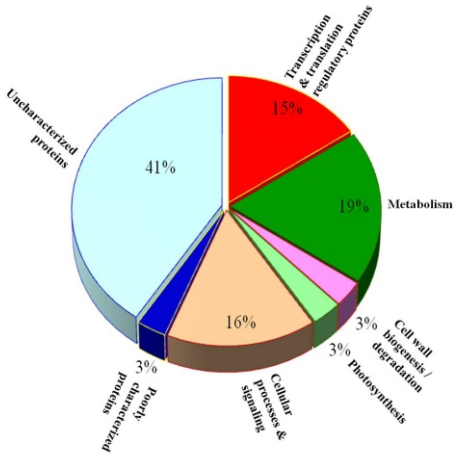
A novel salt-inducible *Salicornia* gene *SbSI-1* confers salt and desiccation tolerance in *E. coli*

Previously we have reported isolation and characterization of ESTs from *S. brachiata* with large number of unknown gene sequences. Reverse Northern analysis showed upregulation and down regulation of few unknown genes in response to salinity. Some of these unknown genes were made full length and their functional analysis was tested. In a further study, a novel unknown salt inducible gene SbSI-1 (*S. brachiata* salt inducible-1) was selected for the functional validation. The SbSI-1 gene (NCBI Acc No. JF 965339) was 917 bp long, and contained 437 bp 3′ UTR, and 480 bp ORF region encoding 159 amino acids protein with estimated molecular mass of 18.39 kDa and pI 8.58. The real time PCR analysis revealed high transcript expression in salt, desiccation, cold and heat stresses. However, the maximum expression was obtained by desiccation. The ORF region of SbSI-1 was cloned in pET28a vector and transformed in BL21 (DE3) *E. coli* cells. The SbSI-1 recombinant *E. coli* cells showed tolerance to desiccation and salinity stress compared to only vector in the presence of stress (*Mol. Biol. Rep., 39 (2012) 1943*).

Nutritional potential of seed storage proteins from *Salicornia brachiata*

Salicornia seeds are rich in protein and its tender shoots are eaten as salad greens. Seed storage proteins were fractionated by sequential extraction using different solvents, including distilled water for albumins, NaCl (1.0 M) for globulins, NaOH (0.1 N) for glutelins and ethanol (70% v/v) for prolamins. Globulins accounted for 54.75% of the total seed storage proteins followed by albumins (34.30%) and glutelins (8.70%). The fractionated proteins were characterized using 2-D-diagonal-SDS-PAGE and MALDI-TOF mass spectrometry. The globulin fraction, composed of seven inter-molecular disulfide-linked polypeptide pairs of mol. wt. 63.5, 62.5, 54.7, 53.0, 43.2, 38.5 and 35.1 kDa, encompassed a basic and an acidic subunit. Two-dimensional gels revealed approximately 32 spots, with isoelectric points and molecular masses ranging from 4.93 to 11.6 and ~5.2 to ~109.4 kDa, respectively. Protein spots were identified by MALDI-TOF MS peptide mass fingerprint analysis and further classified. Homology analysis demonstrated that 19% of the proteins were involved in metabolism, 16% were involved in signaling and 15% were regulatory proteins. Peptide mass fingerprint analysis confirmed the presence of inter- and intra-molecular disulfide linkages in the globulin fraction. Sulfur-rich proteins are of high nutritional value and disulfides make *S. brachiata* a potential source of dietary supplementation (*J. Agric. Food Chem., 60 (2012) 4320*).





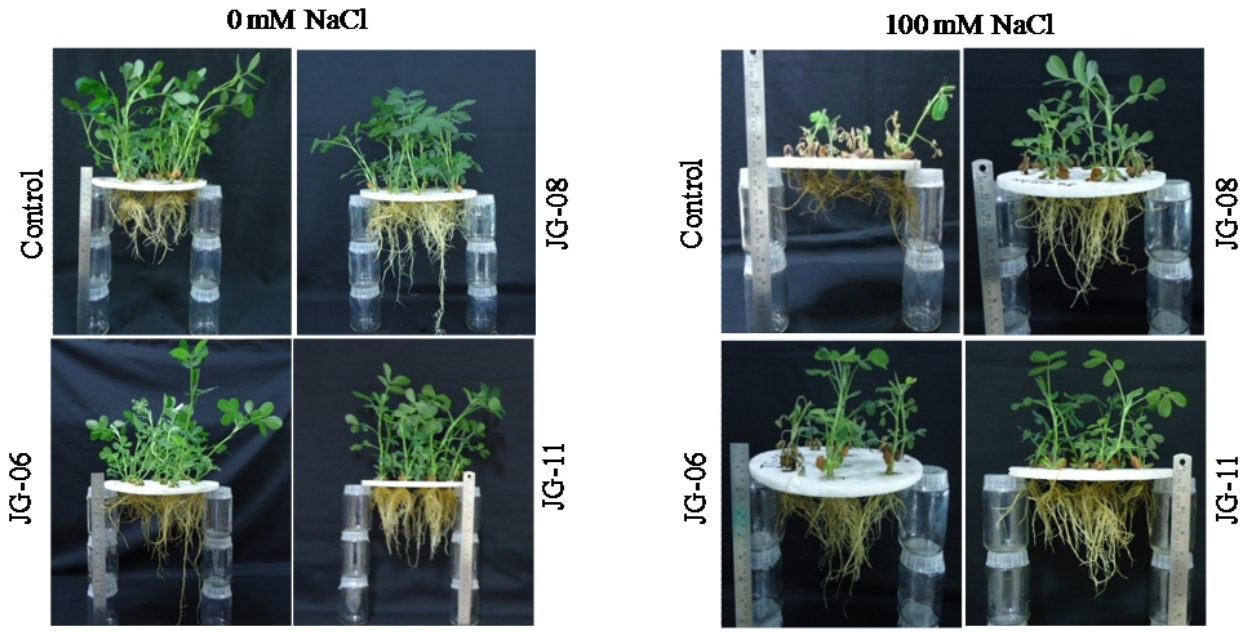
Total proteins spots resolved in 2D-SDS-PAGE identified by MALDI-TOF MS in salt soluble fraction globulin of seed protein of *Salicornia brachiata*

Metagenomic study of microbial communities in coastal saline soils

To study the metagenomics of microbial communities in coastal saline soils, rhizospheric and bulk soil were collected from halophytes (Salicornia, Suaeda and Aeluropus) from different coastal sites (Sartanpur, Methla, Victor, Ningala and Diu coast). The bulk and rhizospheric soil samples were analysed for basic physico-chemical characteristics. The pH of the soil samples varied from 8.06 to 8.53. These soils were highly saline and $EC_{2.5:1}$ ranged between 7.5 to 21.2 dS m^{-1}. Further it was also observed that rhizospheric soil had lower EC compared to bulk soil. Thus these plants help in removing salt from the soil. The organic carbon content of the soil samples varied between 0.37 to 1.05%; in general, rhizospheric soil contained higher concentration of C than bulk soil. Total nitrogen contents of rhizosphere and bulk soils varied from 0.03 to 0.08% and further it was observed that rhizospheric soil contained either equal or higher N concentration than bulk soil. The C:N ratio (carbon to nitrogen ratio) varied between 9.3 to 15.8 and no specific trend between rhizosphere and bulk soil could be observed. About 53 positive 16S rRNA recombinant clones were obtained from rhizophere of Suaeda using metagenomic approach and sequenced. Homology search revealed that 50 % clones showed close proximity with *Bacillus* sp. indicating that *Suaeda* rhizophere is dominated by *Bacillus* sp.

Improving the growth of groundnut under salinity stress in the presence of PGPRs

Different halotolerant PGPRs namely, *Agrobacterium tumefaciens* strain JG-02, *Zhinguelliuella* strain JG-03, *Brachybacterium saurashtrense* strain JG-06, *Vibrio* strain JG-07, *Brevibacteriumcasei* strain JG-08, *Haererohalobacter* strain JG-11 were isolated from the roots of *Salicornia brachiata*. These bacteria were screened for their salt tolerance capacity at different salt concentration from 1% to 20% on NaCl in nutrient broth medium and 2-4% in Nfb medium (*Plant and Soil, 356 (2012) 265*). The 16S rRNA gene sequences of these strains were submitted to the NCBI under the accession number DQ-458962(JG-02), EU-937748 (JG-03), EU-937750 (JG-06), EU-937751 (JG-07), EU-937752 (JG-08) and EU-937754 (JG-11). Among these PGPR strains, JG-06 is proposed as a novel species of genus *Brachybacterium* and hence named *Brachybacterium saurashtrense* (*Int. J. Syst.*

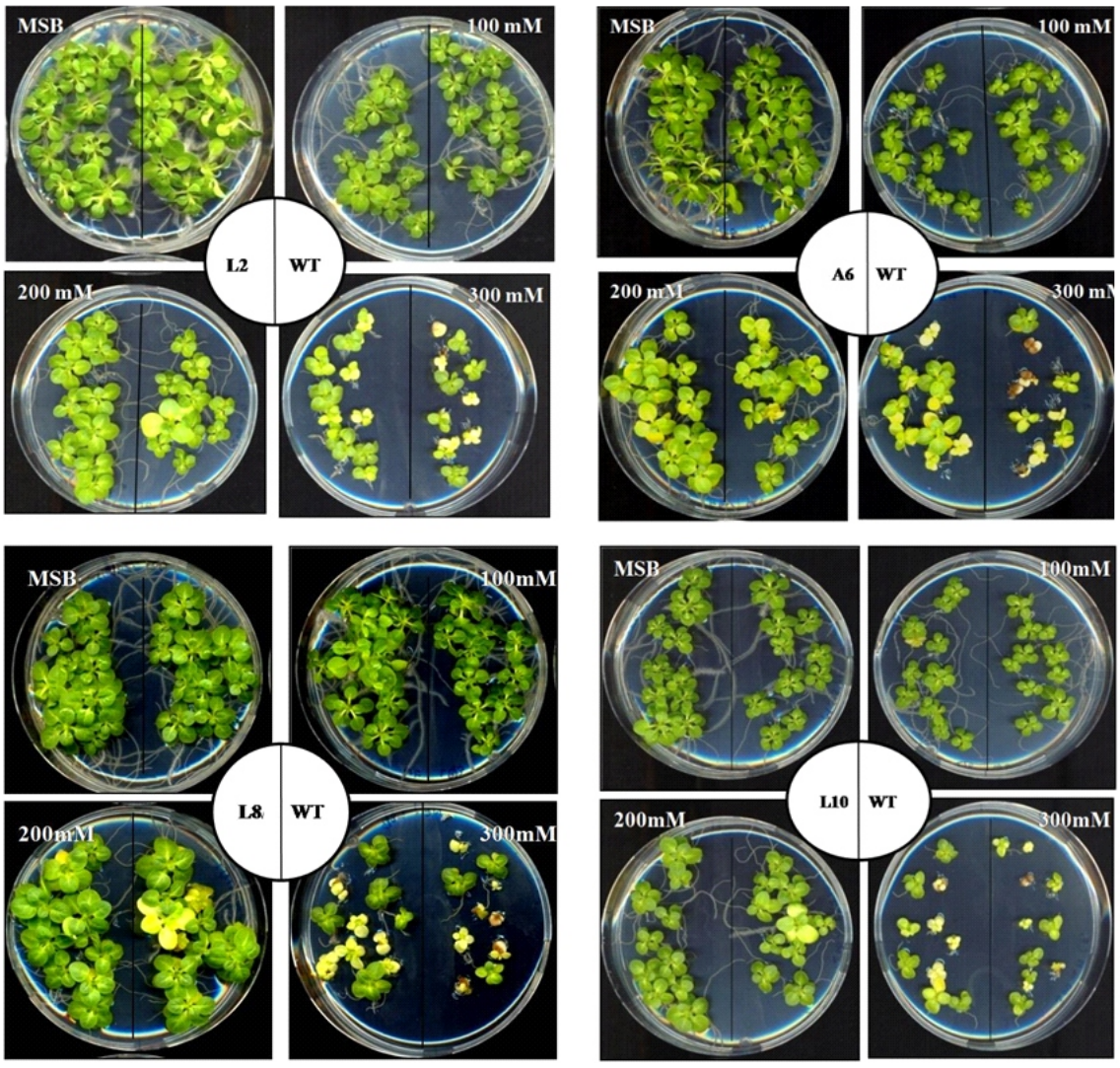


Twenty-one-day-old *Arachis hypogaea* seedlings grown in 1/2 MS liquid medium in the presence of different PGPR strains without NaCl and with 100 mM NaCl

Evol. Microbiol., 61 (2011) 2799). These bacteria revealed the growth promoting traits like indole-3-acetic acid (IAA), siderophore production and ACC deaminase activity. These PGPRs were tested for their ability to confer salt tolerance in *Arachis hypogaea*. JG-06, JG-08 and JG-11 showed growth promotion under salt. Plants inoculated with these bacteria showed increased biomass, higher shoot and root length as compared to uninoculated plant at both 0 mM and 100 mM NaCl. Physiologically, inoculated plant showed higher water content in shoot, and reduced electrolyte leakage in shoot and root. PGPR inoculated plants showed enhanced K^+/Na^+ ratio, increased uptake of phosphorous and nitrogen, reduced accumulation of proline, soluble saccharides, lipid peroxidation, higher protein, amino acid and auxin synthesis (*J. Plant Growth Regul., 31 (2012)195*).

Expression of *Sb*GSTU (Glutathione S-transferase) gene in tobacco for salt tolerance

Tau class glutathione transferases (*GSTU*) genes are plant specific, induced by different abiotic stress, and important for protecting plants against oxidative damage. *GST* gene was isolated using 5' RACE from *Salicornia brachiata*, cloned, sequenced and its protein structure was predicted. Transcript profiling of *SbGST* gene expression was studied under different abiotic stress conditions and plant growth regulator treatments, *viz*. salt, cold, drought, ABA and salicylic acid, with time period point and concentration point. The expression of *SbGST* gene was up-regulated in all stress conditions, except SA treatment. Seed germination percentage, GST enzyme assay,



Analysis of *SbGST* transgenics (T1) tobacco lines. Growth comparison of wild type (WT) and transgenic lines (L2, A6, L8 and L10) at 0, 100, 200 and 300 mM NaCl

fresh weight and other growth parameters (root length, shoot length and leaf area) were studied and results indicated that over-expression of *SbGST* gene in transgenic tobacco led to enhanced seed germination and growth under salt stress. Transgenic lines were evaluated for their performance under salt stress and tobacco plants over-expressing *SbGST* showed higher seed germination and survival compared to wild type. These results confirmed that expression of *SbGST* gene is up-regulated by different stresses and over-expression of *tau* class *SbGST* gene in transgenic tobacco plays a vital role in abiotic stress tolerance (*Mol. Biol. Rep., 38 (2011) 4823*).

SEAWEED RESEARCH

The seaweed research at the institute is focused on the development of practical cultivation technologies for large scale farming of economically important seaweeds, and their value addition. Seaweed farming is now viewed as being rife with potential. Additionally, studies being undertaken on biodiversity, taxonomy, seaweed biology and application research.

Biodiversity and Cultivation

Seaweed biodiversity of Tamil Nadu coast

As part of CSIR network project (NWP018), the study on seaweed diversity of Tamil Nadu coast was continued. An extensive survey was undertaken from Ennore to Kanyakumari, and the islands of Gulf of Mannar for assessment of seaweed diversity. Total 42 stations were selected. The intertidal seaweed diversity of mainland coast was recorded up to 4 m depth while in the islands the data were recorded up to 10 m depth. The digital photograph of each seaweed species in its natural habitat was taken besides recording field notes pertaining to topography of coast, nature of habitat, abundance of flora etc. In this study, total 282 seaweed species were collected and identified. Of this, 80 species belonged to Chlorophyta, 56 to Phaeophyta and 146 to Rhodophyta. 33 species were collected exclusively from the Gulf of Mannar islands. The compilation of data from secondary sources revealed total 277 species for this region. Herbarium sheets were generated for all the species collected.

Halimeda macroloba

Turbinaria decurens

Botryocladia leptopoda

Cultivation of economically important seaweeds

The experimental offshore cultivation of *Kappaphycus alvarezii* was initiated at Palk Bay, southeast coast of India. During 2010–2011, 170 rafts (2 m × 2 m size) were seeded and kept in offshore region (1.2 km from the shore with 8 m depth). Simultaneously 30 rafts were seeded and

placed in the onshore region (0.5 meter depth) for comparison. Initial seed material of 22.5 kg fresh wt/ raft was seeded. Seaweed crop was harvested after 45 days growth. An average biomass of 219 kg fresh wt/ raft was obtained in offshore region while the same for onshore region was 127.5 kg fresh wt/ raft. During 2011-2012, 95 seeded rafts (2 m × 2 m) were placed offshore while 10 rafts were placed in onshore waters. An average biomass of 195 kg fresh weight was harvested from the offshore region. The experiment proved that offshore cultivation is feasible and that it yielded conspicuously higher biomass than cultivation in onshore region. Some other observations made during the study are summarised below:

1. The seaweed growth during summer (April-June) is poor due to hostile environmental conditions.
2. During north-east monsoon period (November-January), the offshore cultivation is risky due to turbulent wave action and high water current. Therefore, it is advisable to minimize the plantation for the sake of seed material stocking.
3. The incidences of grazing in near shore waters are severe in the months of February and March. Therefore, special measures are required to minimize the grazing and subsequent loss of crop for realizing predicted crop yields.
4. In the months of September-October, the biomass harvested from near- and off-shore waters was the highest, with negligible variations.

The cultivation of *G. Dura*, a promising source

of agarose, was continued at Thonithurai (Palk bay) during 2011–2012. Plantation was done in 140 rafts, with an initial seeding of 3.0 kg fresh wt/ raft, and an average of 9.5 kg fresh weight biomass harvested after 45 days.

Gracilaria edulis is a prime source of raw material for agar in India. During 2010-2012, the alga was cultivated in 25 rafts (1.5 m × 1.5 m size) with 800 g fresh wt/ raft seedling weight. Harvests were done at 60 days intervals. During 2010-2011, 4 harvests were done of which the maximum was 6.170 ± 0.730 kg fresh wt/ raft obtained in January 2011, with corresponding daily growth rate of 3.5% per day. Relatively

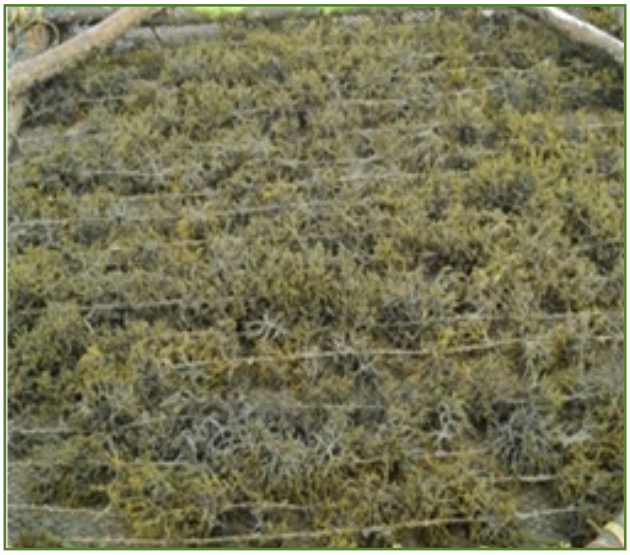
higher biomass was obtained during 2011-2012. 5 harvests were made, the highest yield being 18.89 ± 10.68 kg fresh wt/ raft in October 2011, corresponding to a daily growth rate of 6.2%.

S. filiforme is reported to be a source of carrageenan. Seasonal variation in growth and biomass production of the indigenous variety, cultivated by raft culture method, was studied

for 2 years during 2010-2012. 50 bamboo rafts (1.5 m × 1.5 m size) were seeded with an initial seedling weight of 300 g fresh wt/ raft in July 2010. The seaweed crop was harvested at 30

days intervals. During the year 2010-2011, 7 harvests were made with a peak biomass value being 4.42 ± 1.25 kg fresh wt/ raft and a daily growth rate of 8.71% in Dec. 2010. Similarly, 3 harvests were made in 2011-12 with a maximum biomass being 5.82 ± 2.37 kg fresh wt/ raft and a daily growth rate of 7.5% in Nov. 2011. Nov-Dec was the peak growth period. The biomass yield and daily growth rate were strongly influenced by salinity, dissolved oxygen, phosphate and nitrate.

Gracilaria salicornia is reported to contain agar of good quality (gel strength of 510 ± 25 g cm^{-2} and sulphate content of 0.45 ± 0.06%). To supplement the resource of agarophyte, cultivation was initiated (using raft method) in April 2011. At the first instance, 7 rafts (1.5 m × 1.5 m size) were seeded with an initial biomass of 1500 g fresh wt/ raft. Seaweed crop was harvested after 45 days growth period and total 5



harvests were done. Peak biomass obtained was 13.54 ± 1.466 kg fresh wt/ raft in November with corresponding daily growth rate of 4.2% per day.

Comparison of growth of tissue cultured and wild plant of *Gelidiella acerosa* under cultivation

It was reported based on preliminary experiments (biennial report of 2006-2008) that the germlings from tissue cultured *G. acerosa* collected from Porbandar (Gujarat) gave double the biomass yield of wild plants collected from Ervadi (Tamil Nadu). Suspension stone cultivation was adopted in both places. To confirm the consistency of data, 2 rafts each of both germplasm were seeded simultaneously and harvested after 180 days of growth period. The results indicated that the germplasm of tissue culture origin recorded 3 to 4 times higher biomass yield over wild plants. This experiment will be continued for another 3 to 4 harvests.

Biomass yield of tissue cultured and wild plants of *G. acerosa*

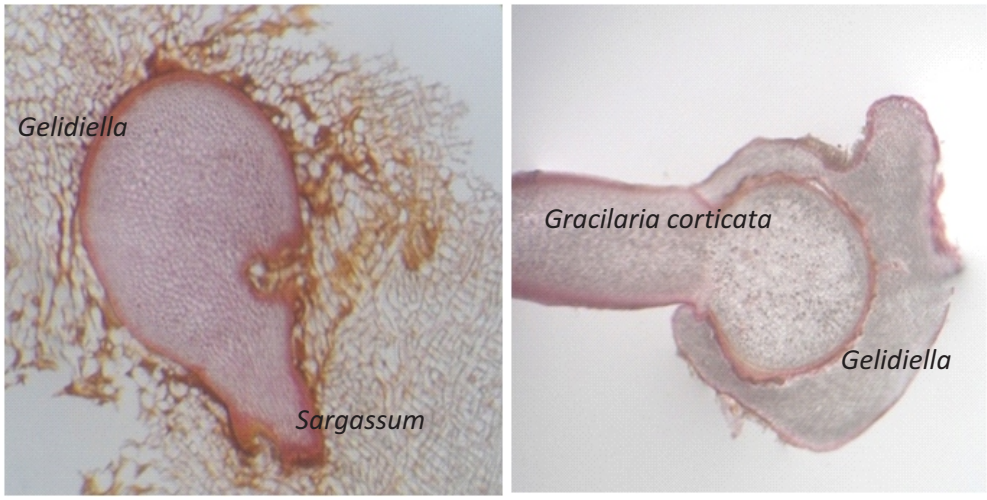
Germplasm	Number of stones seeded	No. of stones harvested	Biomass (g fresh wt/raft)	
			Seeded biomass	Harvested biomass
Wild plant	80	73	160	600-1100
Tissue cultured	80	74	160	3020-5625

Epiphytism in *G. acerosa* cultivation

Epiphytes are organisms of plant origin that settle on the external surface of host alga and compete with it for space, nutrients and light. Although seasonal, *Epiphytism* is one of the biotic factors that adversely affect seaweed cultivation in addition to a number of abiotic factors. *Gelidiella acerosa* attracts more number of epiphytes. A study was conducted between November 2009 and October 2010 to enumerate the epiphyte populations on cultivated *G. acerosa* in bottom culture (cement block culture) and raft methods. In the former method, total 23 epiphytic algae were observed, of which 10 species belonged to green algae, 5 to brown and 8 to red algae. In the latter method, total 24 epiphytic algae were observed, of which 10 species belonged to green algae, 3 to brown and 11 to red algae (see Table). These affected the growth of *Gelidiella acerosa* to a greater extent in cultivation.

Epiphytes on *Gelidiella acerosa*

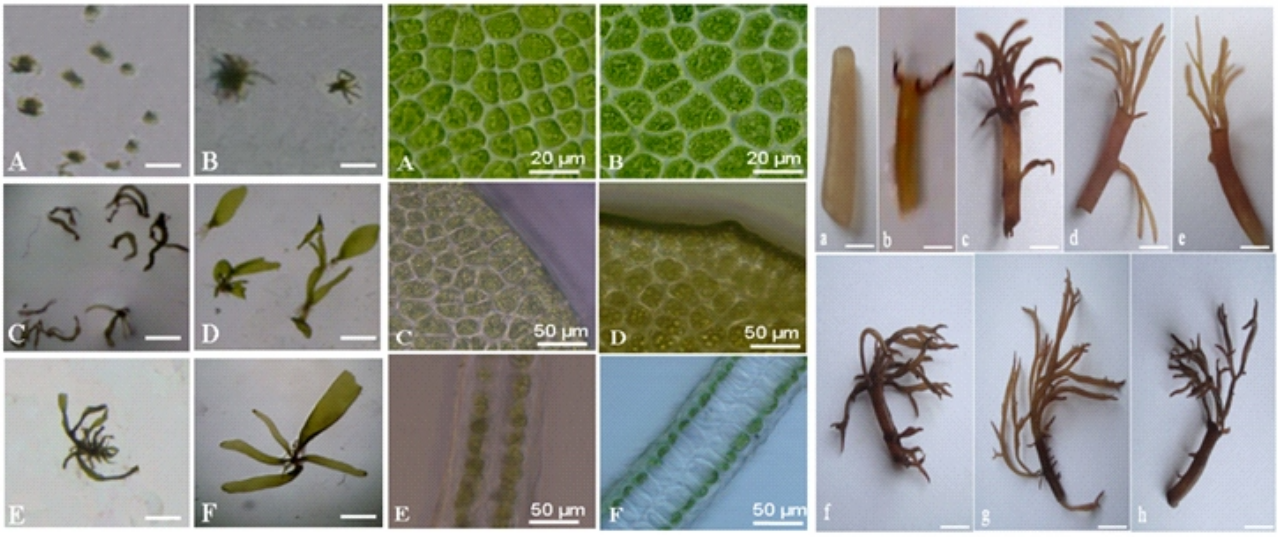
Culture method	No. of epiphytes recorded	No. of *Gelidiella* plants seeded	No. of *Gelidiella* plants recorded after one year
Bottom culture	23	393	33
Raft culture	24	650	337



Transverse section view of epiphyte on *G. acerosa*

Seaweed-bacterial interaction

Seaweed-bacterial interaction is an interesting aspect of seaweed developmental biology and is important for understanding the ecological roles of associated biota on overall seaweed development and its propagation. Bacteria are common inhabitants in aquatic ecosystem and reside on both external and internal tissues of seaweeds which release a large amount of organic carbon into the surrounding environment on which they feed. In the present study, isolation and screening of epiphytic and endophytic bacteria lodged in different species of *Ulva* and *Gracilaria* were undertaken. These seaweeds and bacterial extracts were subsequently co-cultured. The findings of this study revealed that these bacteria play an important role in morphogenesis and growth of the seaweeds. The members of Ulvaceae lost their typical foliose thallus morphology when cultured in axenic conditions but their natural morphology was restored upon inoculation of bacterial isolates to the culture medium (*Aquatic Biol., 12 (2011) 13*). Similarly they also accelerated the bud induction in *Gracilaria dura* thereby increasing their growth (*FEMS Microbiol. Ecol., 76 (2011) 381*).

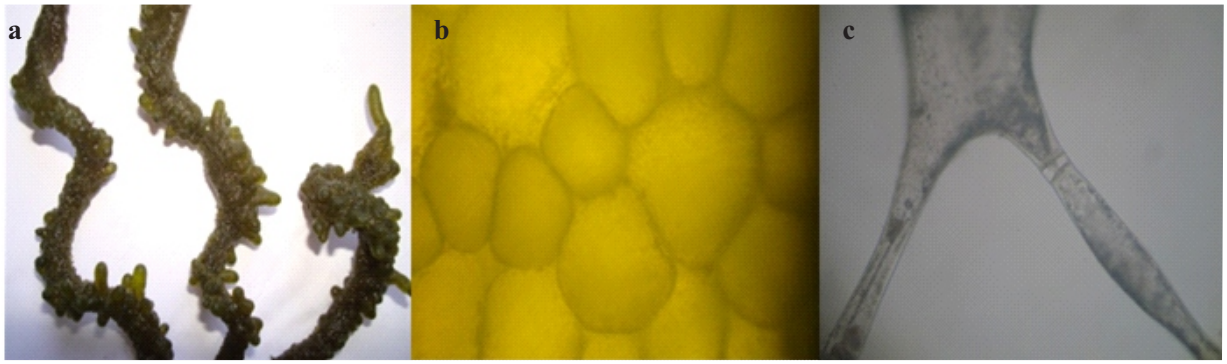


Morphogenesis of *U. fasciata* in axenic culture (left) and regeneration of new buds from individual fronds of *G. dura* grown medium supplemented with microbial protein (right)

Record of new species *(Codium spiralis)* from islands of Gulf of Kutch

Habit of Codium spiralis

The exploration of new habitat gives an opportunity to report unrecorded species in biodiversity studies. In the previous biennial report, 93 distinct seaweed species were reported from islands of Gulf of Kutch, of which 14 were new records to India. A hitherto unreported species, christened *Codium spiralis*, was discovered and confirmed to be new based on morphological, anatomical and reproductive characters, further supported by fatty acid profiling and gene sequencing. The unique feature is the spiral/ coiled nature of the fronds along with absence of hair or vestibular hair scars in the utricels. This species is one of the tallest from India, with plants attaining 25-30 cm height by mid May to early June. Several other characteristic features of this species were also investigated.



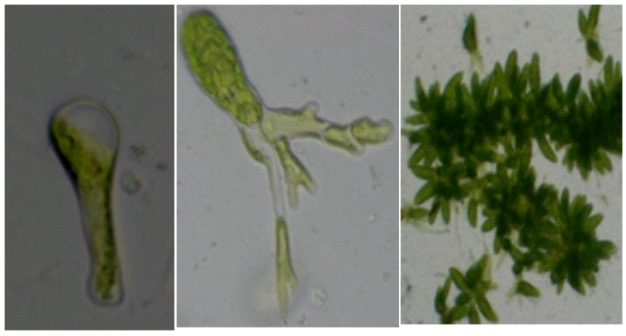
Spiral arrangement of assimilatory fronds (a), honey comb like organization of utricles (b) and presence of septum at the base of utricle (c)

Life cycle studies of *Ulva ovata* from Gopnath: An endemic species

In the previous biennial report we have reported our work on seaweed biodiversity along Gujarat coast, wherein, 198 species have been reported. From this study, it was evident that a few of the species have restricted range of distribution and thus could be endemic to this region.

Considering the fact that endemic species are more vulnerable to anthropogenic-induced alterations, urgent attention to conservation is required. *Ulva ovata* Thivy *et* Visalakshmi *ex* Joshi *et* Krishnamurthy, originally reported from Gopnath coast, is one such vulnerable species. Alang, which is merely 30 km south of Gopnath, poses a significant risk of habitat deterioration and understanding the life history of *U. ovata* was thus important. The study revealed new type of asexual life history by biflagellate zoospores in this species under *in-vitro* conditions. The zoospores recorded negative phototactic movement and the precursor of rhizoidal cell showed elongation after first cell division in laboratory culture. These events are considered ecological adaptations that enhance the prospect of spore settlement and germination. The germlings of about 5 cm length, having similar morphology as that of mother fronds, were developed within four weeks of culture at 24 ± 1°C under white fluorescent lamps with a 12:12 h light : dark photoperiod. This study demonstrated the possibility of artificial induction of zoospores and their culture. This may offer a means of its conservation. The *ITS* and *rbcL* gene sequencing ascertained its taxonomic distinction at the molecular level.

Habit of *U. ovata*



Different stages of spore germination

Tetraspore development in *Grateloupia filicina* (Lamouroux) C. Agardh under laboratory conditions

The red algal genus *Grateloupia* currently includes over 90 species, of which *G. filicina* has a considerable commercial value. It is traditionally been consumed in several Asian countries, where fresh algal thalli are locally marketed as a gourmet item. The utility of this alga lies in its rich antioxidant properties, presence of micro nutrients and high content of dietary fibre. Compounds of potential pharmaceutical importance have also been recently identified. The sulphated polysaccharide with higher content of 3,6-anhydrogalactose and low viscosity carrageenan is also reported from this alga. The cultivation of *Grateloupia filicina* has been attempted in Japan through spores. A study was initiated on tetraspore development employing *G. filicina* collected from Port Okha coast in September 2011.

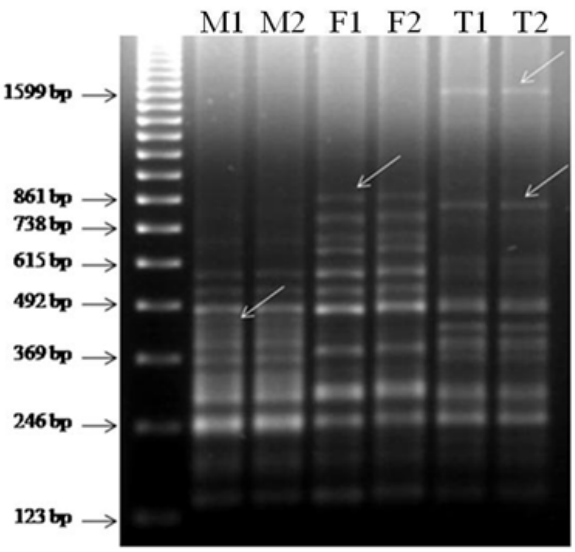
Various stages of tetraspore germination

Detection of epigenetic variations in the protoplast-derived germlings of *Ulva reticulata* using methylation sensitive amplification polymorphism (MSAP)

Regeneration of protoplasts into *de novo* plants was reported earlier for a large number of seaweed species. The regeneration of protoplasts into different morphotypes as a result of epigenetic variations was found. The loci assessed for methylation modifications in normal filamentous thalli showed a frequency of 32.43% as unmethylated DNA, 24.32% as a hemimethylated and 20.27% as a methylation of internal cytosine at both the strands. The corresponding methylation values for disk-type thalli were 27.02, 32.43 and 14.86%, respectively. The study revealed that the morphology was correlated with the type of methylation of DNA. Further, it was observed that the disk-type variant had higher thermal stability at 30°C over normal filamentous thalli (*Mar. Biotechnol., 14 (2012) 692)*.

Differentiation of protoplasts (a) into variant disk-type thalli (b) and normal filamentous thalli (c)

Growth and agarose characteristics of isomorphic gametophyte (male and female) and sporophyte of *Gracilaria dura* and their marker assisted selection



M: Male; F: Female and T: Tetrasporophyte

In the previous biennial report *Gracilaria dura* (C. Agardh J. Agardh) from the Indian coast was reported to produce superior quality agarose (1% gel >1900 gcm^{-2}) suitable for biotechnological applications. Like other tropical seaweeds, the limited distribution coupled with short lifespan constrained its commercial utilization necessitating the need for augmentation of the resource through cultivation. The characteristics of agarose and growth for three isomorphic life phases of *G. dura* with their bio-molecular marker assisted selection were studied. The tetrasporophyte gave higher yields of agarose whereas the female gametophytes gave highest growth rate. The study may be beneficial for breeding programs (*Aquaculture, 318 (2011) 389*).

Natural Products and Derivatives from Indian Seaweed Resources

Continuing participation in MoES programme on Drugs from the Sea

Seaweed species were collected and identified. Of these, thirteen were repeat collections and one was a new collection. 74 methanol and aqueous extracts/fractions were sent to CDRI and 56 to ACTREC, Mumbai. 20 extract samples were reported by CDRI to be active (antihyperlipidemic, antihyperglycemic, antifungal, antibacterial, antitrypanosomal, antileishmanial, anticancer) whereas ACTREC found anticancer activity in 4 samples. The seaweed species were also taxonomically identified and voucher specimen herbaria of these species were sent to NIO for repository references. The completion report was submitted to MoES and the Steering Committee.

Estimation of lipid hydroperoxide in Indian seaweeds

The lipid hydroperoxides (LHPOs) are used as biochemical indicator for oxidative stress in different organisms. The incipient levels of LHPOs were determined in selected green, brown and red macroalgae by the FOX assay using hydroperoxy HPLC mix. The LHPOs contents varied between the investigated species and showed relatively low values in the present study. Among the greens, it varied from 12 ± 6.2 µg/g (*Codium sursum*) to 31.5 ± 2.8 µg/g (*Ulva lactuca*), while in reds, from 5.7 ± 1.6 µg/g (*Gracilaria corticata*) to 46.2 ± 6 µg/g (*Sarconema filiforme*) and in browns, from 4.6 ± 4.4 µg/g (*Dictyota bartayresiana*) to 79 ± 5.0 µg/g (*Sargassum tenerrimum*) on fresh weight basis. These hydroperoxides comprised a minor fraction of total lipids, amounting to 0.04% (*S. swartzii*) to 1.1% (*S. tenerrimum*). The susceptibility of peroxidation was assessed by specific lipid peroxidazibility (SLP) values for macroalgal tissues (*J. Phycol., 48 (2012) 1362).*

Carrageenan from *Sarconema scinaioides* and *Sarconema filiforme* of Indian waters

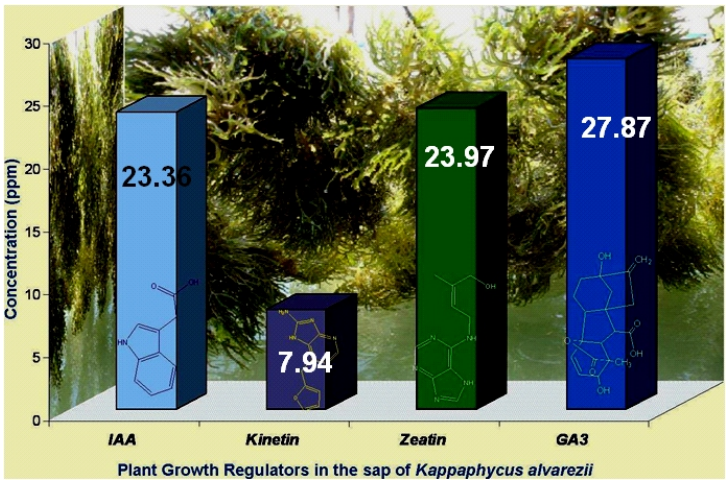
Carrageenan was extracted from the red seaweed *Sarconema scinaioides* found in Indian waters. Investigations revealed that the polysaccharide comprises predominantly ι- carrageenan and a small amount of its precursor ν-carrageenan. This Indian seaweed species is thus a potentially important source of iota-carrageenan (*Carbohydr. Polym., 87 (2012) 1657)*. As mentioned above, attempts were also made to cultivate *Sarconema filiforme*. Though the absolute amount of carrageenan from the seaweed was high, the phycocolloid contained other carrageenan derivatives besides ι-carrageenan *(Nat. Prod. Commun., 6 (2011) 1327)*.

Carrageenan content of cultivated *Sarconema filiforme*

Date of harvest	Carrageenan yield (%)	Moisture (%)	Sulphate (%)
07.08.2010	40.57	37.6	ND
26.10.2010	28.42	32.0	23.2
22.11.2010	33.67	30.0	ND
04.01.2011	33.16	28.0	22.5

Detection and quantification of plant growth regulators in seaweed sap

The sap expelled from the fresh harvest of *Kappaphycus alvarezii* has been commercialized by M/s Aquagri Pvt. Ltd. as a foliar spray. Studies were initiated to understand the factors influencing its efficacy. Tandem mass spectrometry of organic extracts of the sap, without recourse to chromatographic separation, was found to be a powerful tool for detection and quantification of plant growth regulators (PGRs) present in the sap. It was found to contain 23.4 ppm of indole 3-acetic acid (IAA), 27.9 ppm of



Qantification of plant growth hormones in *K. alverazii*

gibberellin (GA_3), 7.94 ppm of kinetin and 23.97 ppm of zeatin. Quantification was validated against HPLC data. The concentrations of the PGRs remained virtually unchanged after 1 year of storage with preservatives. Sap from the brown seaweed, *Sargassum tenerrimum*, and the red seaweed, *Gracilaria edulis*, were also analysed. IAA and zeatin were present to the extent of 13.2 ppm and 11.40 ppm, respectively, in the former, whereas the latter contained 9.11 ppm IPA (indole propionic acid) instead of IAA, 14.24 ppm of zeatin and 23.14 ppm of GA_3. *Sargassum tenerrimum* was found to contain gibberellin GA_9 (not quantified) instead of GA_3 (*J. Agric. Food Chem., 58 (2010) 4594*). These may not be the only stimulants present, and efforts are underway to detect other bioactive constituents which may have a role to play in imparting efficacy to the sap as foliar spray.

Jojoba culture experiments with indigenously produced agar (SAgar)

*S*agar on the growth of Jojoba cultures was studied. The cultures were grown on MS medium supplemented with *S*Agar (7 gl^{-1}) and a control experiment with commercial agar. The shoot length was measured after 45 days of inoculation. It was found that the growth rate of explants was identical, while leaves were longer and deeper in color in *S*Agar. The number of shoot buds were also more in explants growing on *S*Agar (4 buds/explant vs. 2 buds /explant with commercial sample).

Data of 50 days old primary cultures of Jojoba in CSIR-CSMCRI (SAgar) and standard (Spectrochem) agar samples under identical conditions

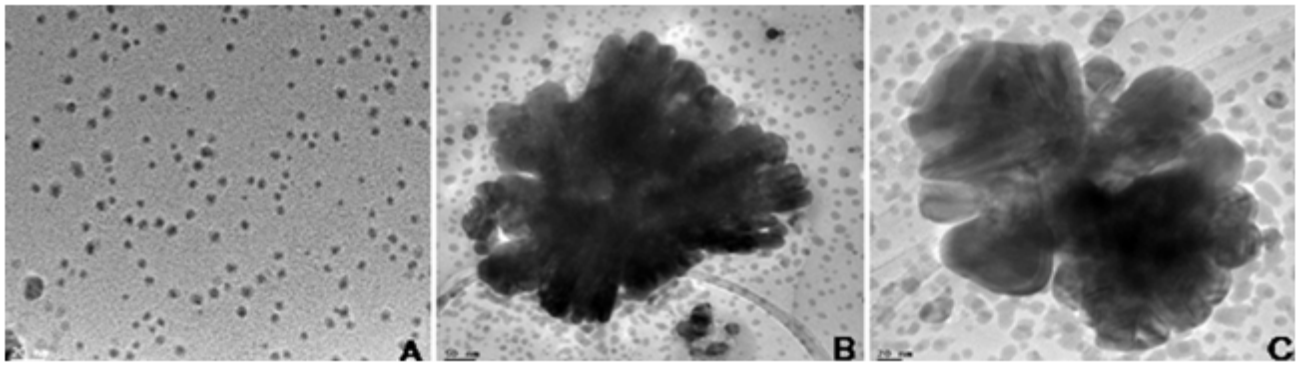
Type of Rope	CSMCRI Agar ($7gl^{-1}$)	Spectrochem Agar ($7gl^{-1}$)
Explant weight	363 mg	310 mg
Leaf Length	1.7 cm	0.8 cm
Colour of leaf	Dark green	Olive green
Shoot length	3.1 cm	3.9 cm
No of shoot buds	74% explant has 4 buds/explant	All (100 %) explant has 2 buds/explant

Evaluation, characterization and benchmarking of agarose (*SA*garose) extracted from *Gracilaria dura*

It has been reported previously that a novel process was developed for isolation of agarose from *Gracilaria dura*. The invention is protected by patent application. Studies were continued to further refine the product and scale it up to 1 kg (dry seaweed) scale. The product from scale up was benchmarked against a well known commercial product and similar results were obtained even while using ca. 20-30% lesser amount of material for gel preparation. Favorable feedback has been received from several reputed research groups and the product is also being sent to Merck India for evaluation. Facilities are being created to ascertain other important specifications essential for high end applications. Search is also underway for other agarophytes growing in Indian waters which may hold promise as bioresource for good quality agar (*J. Appl. Phycol., 22 (2010) 623*; *23 (2011) 183*).

Synthesis and characterization of *SA*garose-based silver nanoparticles and nanocomposite film with antibacterial property

Spherically shaped silver nanoparticles of 6 nm average size were synthesised using *SA*garose from *Gracilaria dura*. DSC and XRD showed approximately equal crystalline index (CI_{DSC} 0.73). These particles were well distributed in the agarose film and exhibited excellent bactericidal activity with log 3 reduction of bacterial count (*Bioresour. Technol., 107 (2012) 295)*



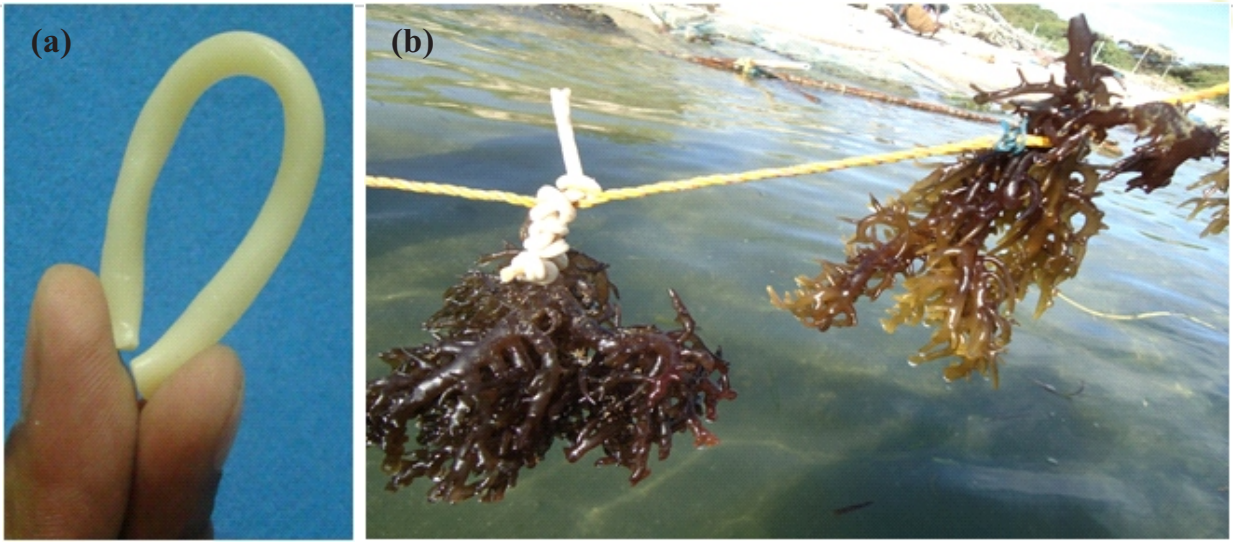
Transmission electron microscopy image of silver nanoparticles at (A) 25 (B) 60 and (C) 100°C

Synthesis of water-soluble agarose-saccharate (AGS)

AGS was synthesized and characterized by various analytical techniques. It did not have bitter aftertaste in 675 ppm solution form, or in the solid state, whereas pure sodium saccharate (SA) tasted bitter under the same conditions. Although assessment of relative sweetness requires to be rigorously ascertained, such a product may be of potential use as a food additive (*Carbohydr. Polym., 88 (2012) 1118*).

Hydrophobic biocompatible ropes

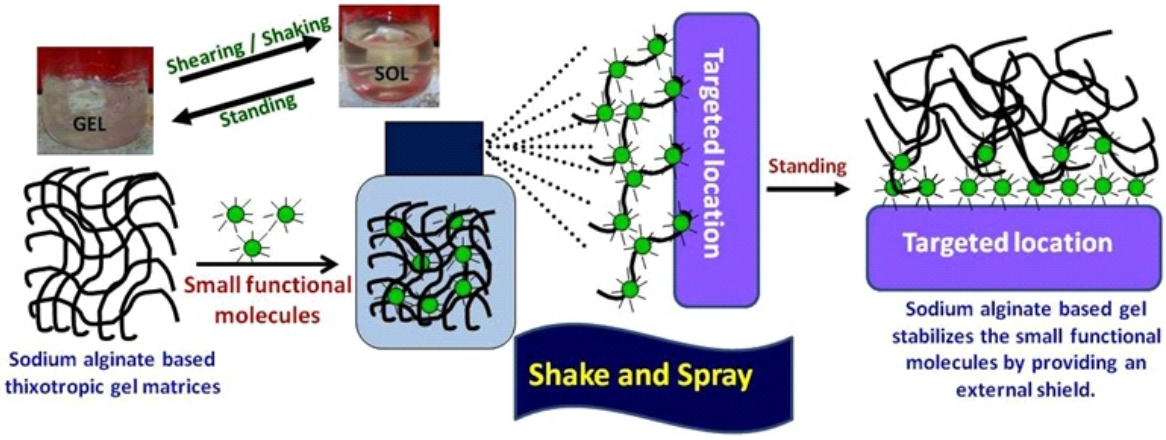
Seaweed cultivation requires a lot of rope. A study was undertaken to produce ropes from the seaweed phycocolloid itself. Whereas the material on its own was excessively water-sensitive, hydrophibicity could be introduced through graft co-polymerization. A few such ropes were used for the cultivation experiments of *Kappaphycus alvarezii* in the open sea conditions at Thonithurai, Mandapam. The ropes survived the seawater environment and the growth of the seaweeds was normal (*Provisional Patent application under process*).



Rope prepared from phycocolloid (a) and its evaluation in seaweed cultivation (b)

Synthesis of sodium alginate based sprayable new soft gel system

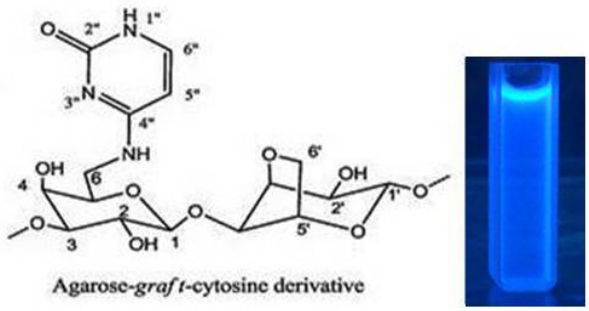
Chemical reaction of sodium alginate (Na-Alg) with *o*-aminobenzoic acid (OABA) and *m*-aminobenzoic acid (MABA) in the presence of 1-ethyl-3-[3-(dimethylamino)propyl]-carbodiimide hydrochloride (EDC) afforded an amide derivative capable of forming viscous hydrogel systems having thixotropic behaviour. Amide formation between Na-Alg and OABA or MABA was confirmed through FT-IR and ^{13}C NMR studies. The soft gel turned into a flowing liquid on gentle stirring (*Soft Matter, 8 (2012) 1837*).



Schematic representation of delivery of small functional molecules from the thixotropic alginate amide gel matrix

Fluorescent polymers prepared from seaweed phycocolloids

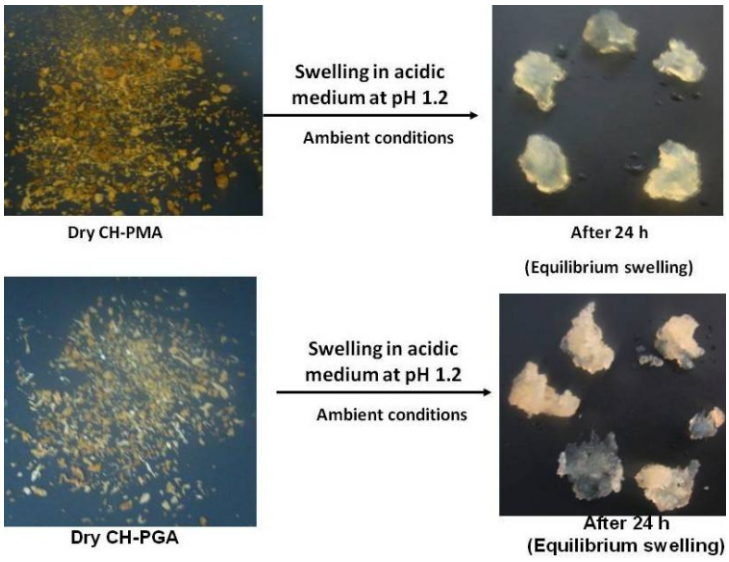
A facile microwave-induced method was developed for synthesizing water-soluble fluorescent derivatives of alginic acid (ALG) with four different diamines, hydrazine (HY), ethylenediamine (EDA), 1,6-hexanediamine (HDA) and 1,4-cyclohexanediamine (CHDA), followed by a cross-linking reaction with a natural cross linker, namely genipin. The ethylenediamine derivative of alginic acid



(ALG-EDA) exhibited strong fluorescence, which upon cross linking was enhanced threefold. The other amide derivatives were not fluorescent, but their respective crosslinked products were fluorescent (*Carbohydr. Res., 346 (2011) 527*). In a related study, the nucleobase cytosine was grafted on to the backbone of agarose and κ-carrageenan to obtain fluorescent polymers. The emission intensity was enhanced compared to that of pure cytosine solution of the same concentration. Possible applications will have to be explored (*Carbohydr. Polym., 87 (2012) 1971*).

Microwave assisted synthesis of pH-responsive swellable adducts of chitosan–polyuronic acids

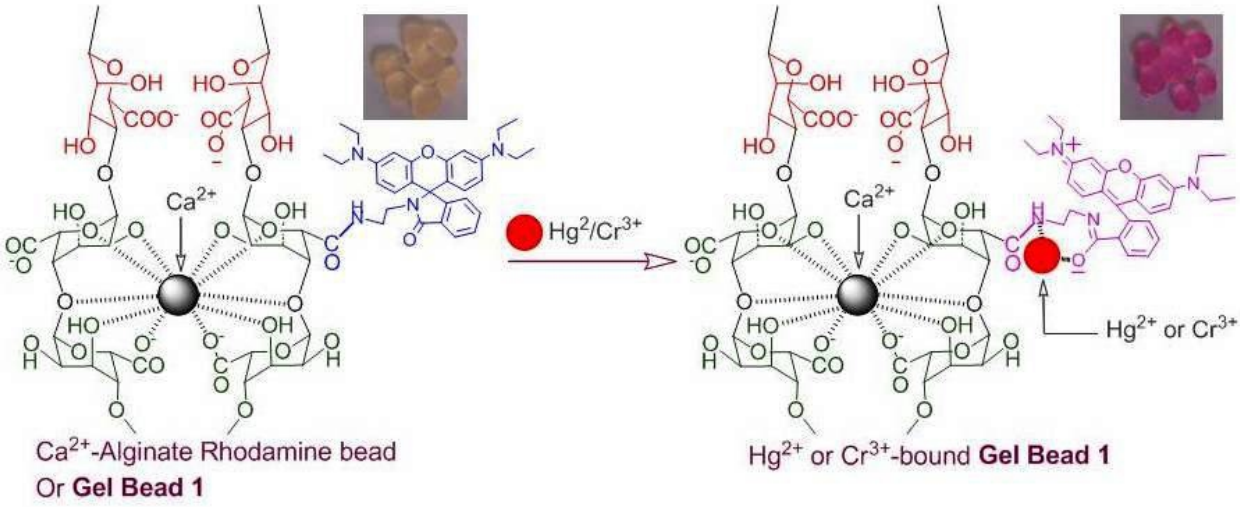
A facile method for synthesizing super-swellable, pH-responsive and insoluble adducts (e.g. CH–PMA and CH–PGA) of acid-soluble chitosan (CH) with alkali-soluble poly-mannuronic (PMA) and poly-guluronic (PGA) acids using microwave (MW) heating was demonstrated. The reactions were also carried out using conventional oil bath heating method. Microwave heating to 100°C for 5 min produced greatest yields (95–97%) and swelling ratios (2700–3000%) with these two acids. Adducts were characterized by FT-IR and CP-MAS ^{13}C NMR techniques (*Carbohydr. Polym., 83 (2011) 1402*).



Chitosan–polyuronic acid derivatives sweallable in acidic media

Rhodamine-alginate beads

Rhodamine B derivative, in its spirolactam form, was incorporated on to the alginate backbone. The modified polymer was used for recognition of toxic and biologically active



Schematic representation of detection of Hg^{2+} / Cr^{3+} by the alginate-rhodamine A conjugate

metal ions like Hg^{2+} and Cr^{3+} in neutral aqueous medium (1 mM HEPES buffer). The water solubility of alginate aided achieving a water soluble reagent, while gel forming ability of modified alginate in presence of Ca^{2+} was harnessed to develop beads. A visually detectable colour and fluorescence change of the alginate-rhodamine conjugate (GB 1) was observed upon binding of Hg^{2+} or Cr^{3+} (*Chem. Commun., 48 (2012) 1659*).

Quorum sensing inhibition mimicking substances from marine algae

In continuation of the research initiated on quorum sensing inhibition mimicking substances from marine algae, a large number of algae collected from Gulf of Mannar were screened. *Asparagopsis taxiformis* and *Spyridia hypnoids* extracts tested positive in preliminary experiments for quorum sensing mimic substances. Additionally, extract of the former showed antibacterial activity and display zone of clearance.

Isolation and characterization of extrapolymeric substance (EPS) from biofilm forming marine bacteria

Bacteria were screened for their biofilm formation and EPS production ability. *Vibrio parahaemolyticus* identified by 16S rRNA gene (HM355955) sequencing and GC coupled with MIDI, was selected for its capability to produce EPS. The EPS was amorphous in nature, imparting pseudoplastic rheology and having 67% emulsifying activity and temperature stability up to 250 °C. It remains to be seen whether such EPS can be produced in sufficiently large amount for biotechnological and industrial usage (*Biofouling, 27 (2011) 309*).

çdjÆ
CHAPTER 4

uohdj.kh; Åtk vuqla/kku
RENEWABLE ENERGY RESEARCH

uohdj.kh; Åtk vul/kku

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lh,lvkbvkj vkj MoES }kjk l;Dr :i l lefFkr "lenh l{e 'koky l to b/ku" cg lLFkkxr NMITLI ifj;ktuk d rgr ,d çfrHkkxh i;kx'kkyk d #i e] geu if'peh rV ij nk rVh; yxu dh igpku dh tgk lenh l{e 'koky d vLFkk;h eV c<rh n[kh x;hA bu eVl e ekbØkLikjk vkj ¶ykMkQkjk itkfr;k ¼ATCC ifjxg.k l[;k Øe'kh ihVh, 12197 vkj ihVh,12199½ e[; :i l 'kkfey gA ; Qly d fy, vklku Fk vkj QyLo:i ftl ey :i l gDlu fudklh ij xj &/koh; fyfiMl d] tk vkx tVkQk ry e cnyu d fy, dke e fy;k] rRi'pkr VkUl,LVjhfQd'ku d }kjk QVh ,flM feFkkby ,LVj ¼ck;kMhty½ e ifjofrr fd;k x;kA B20 ck;kMhty lLFkku dh Vkojk okgu pyku d ijh{k.k e bLreky fd;k x;kA

Dykjyk ofj;kfcfyl ¼ATCC ifjxg.k l ihVh, 12198½ dk] vjc lkxj l vyx fd;k x;k ftldh ekl [krh dh dkf'k'k blh ifj;ktuk e dh x;h FkhA 0;kid i;kx'kkyk i;kx] çk;kfxd lkYV Qke e [ky lkj ued iuk e [krh dk r; dju d fy, fd, x,A mld ckn ued iuk e viy&tu] 2011 d nkjku ek/;e d :i e lenh ty dk mi;kx fd;k x;kA dYpj dh dy ek=k 432 ox ehVj d dy {k=Qy d lkFk 100 ?ku ehVj ¼1,00,000 yhVj½ FkhA xfe;k d ekle e ck;kekl ¼40–45 fMxh lfYl;l½ d vkVk lVfyx d ek/;e l dYVho'ku djuk ljy ik;k x;kA 32.45 xke @ox ehVj @ fnu ¼'k"d vk/kkj½ dh vklr ck;kekl mRikndrk vkj 45 xke @ ox ehVj @ fnu ¼'k"d vk/kkj½ dh vf/kdre mRikndrk] 300 fdyk l[kh ck;kekl c<ku e l{ke g,A ck;kekl l 30 yhVj B100 ekbØk ck;kMhty (CVME) cuk;k x;kA ck;kMhty dk mi;kx dk ijh{k.k Loxh; Jh foykljko n'ke[k] ekuuh; foKku vkj ik|kfxdh e=h }kjk] >Mh fn[kkdj fd;k x;kA

ijh{k.k okgu dh lokjh d nkjku ektn ,d i=dkj u viu vuHko d ckj e fy[kk ";g loknnkrk] Vkojk tkfd e=h }kjk >Mh fn[kkdj jokuk dh x;h] d ijh{k.k lokjh d nkjku FkkA bldk vuHko fdlh vU; Mhty okgu dh rjg] ,d lkekU; Mhty btu d cjkcj FkkA dnh; lfpoky; {k= d vklikl d nk fdykehVj rd Mkbo LeFk vkj fcuk fdlh 0;o/kku d Hkh FkkA" (fnulk lpku] "Biodiesel from microalgae becomes a reality", Down to Earth, March 30, 2012; www.downtoearth.org.in) (PCT/IN2012/000372 fnukd 28 eb, 2012). okgu ub fnYyh e ih; lh mRl tu ijh{k.k e Hkh lQy jgkA

tVkQk tob/ku thoupØ eY;kdu dk v/;;u

thoupØ eY;kdu dh fn'kk e v/;;u dju d fy, dkcu vkj Åtk lryu dk fu/kkj.k dju d fy, 'k# fd;k x;kA tVkQk ik/kk dk ,d oÔ yxk; tku d ckn çtkfrokj l[kh ck;kekl vkj dy dkcu dk fdruk Hkkx çkjfHkd ouLifr dk gVku e vkj fdruk ck;kekl tVkQk yxku d mijkr ,df=r ck;kekl dk fu/kkj.k fouk'kdkjh ueuk vkj jklk;fud fo'yÔ.k }kjk fd;k x;k gA Hknkoy {k= ij n'kh ck;kekl e dy dkcu 3.05 Vu ij VDV;j Fkh ftle 2.33 Vu ij gDV;j tehu d Åij ouLifr l çklr gbA ,d oÔ d ckn Hknkoy e tVkQk dh of) vU; o{kkjki.k dh ryuk e dkQh vf/kd Fkh vkj lp;h dkcu tVkQk d tehu d Åij vkj uhp Hkkxk }kjk 0.6 Vu çfr gDV;j ik;k x;k bl çdkj ,d oÔ d ckn okrkoj.k l egRoi.k dkcu efix e lQyrk çklr gbA dkukM {k= e cgoÔh; gVk; x; ck;kekl e dy dkcu 1.62 Vu çfr gDV;j ekik x;k ftle 0.77 Vu çfr gDV;j tehu d Åijh ouLifr l çklr gb vkj tcfd cp g, 0.86 ck;kekl tehu d uhp FkA mlh tehu ij cgrj tVkQk ik/kk }kjk ,d gh oÔ e 0.80 Vu@gDV;j l[kk ck;kekl lfpr gvk vkj 0.3 Vu@gDV;j dkcu fu"dkflr çklr gvkA lkbV uloM ij ;g Li"V g fd dy dkcu ¼0.3 Vu@gDV;j½ d ekey e T;knk ud'kku ugh gvk tlk fd ogk ij foj y ouLifr FkhA tVkQk }kjk mlh tehu d VdM e 0.03 Vu@gDV;j dkcu çFke oÔ e çklr gvk vkj mldk v/;;u vkuoky oÔk e tkjh jgkA

; ,l tob/ku Myhx'ku dk nkjk

25 vDVcj 2010 d nkjku ;,l d to b/ku d çfrfuf/kRo e] ft le vefjdk d Åtk foHkkx ¼DOE½] vkj vU; jk"Vh; ç;kx'kkykvk] rFkk foÜo fo|ky;k] vkxk u rFkk vkdfjt u'kuy yckjVjh] ,uvkjb,y] rFkk ;y foÜofo|ky; d oKkfud@fo'kÔK 'kkfey Fk] lLFkku dh to b/ku dh xfrfof/k;k dh tkudkjh gr Hkkouxj dk nkjk fd;kA ;g fe'ku Jh Xyu lkUuVkx ck;kekl dk;Øe] l;Dr jkT; vefjdk] Åtk foHkkx dk;ky;] dh v/;{krk e fd;k x;k FkkA Mk duMl Oghyj] ç/kku vUoÔd ¼tujy ekVl½ Hkh Vhe d lkFk FkA fe'ku d lnL; lLFkku d fofHkUu lfo/kkvk l voxr g, mld ckn Hknkoy vkj uloM e fLFkr tVkQk o{kkjki.k lkbVk d fy, x; vkj nkjk fd;kA çfrfuf/k eMy d lnL; l{e çpkfjr uoLFkkfir Hknkoy d o{kkjki.k lkbV e vfHktkr ox tVkQk d ik/k yxk,A ; ik/k 2012 d vUr rd Qyu vkj Qyu 'k# dj fn;A

LDH 0;RiUu inkFk d Bkl {kkj mRçjd l Mhty cuku dh gfjrj fof/k

rkfir lrgh f} LDH Bkl {kkj mRçjd l Vkl&,lVhfj&fQd'ku }kjk fofHkUu f=&Xyhljkbm ryk ¼[kk|] v[kk| vkj id g,½ dk olk vEy feFkkby ,LVj (FAME) e ifjofrr fd;k x;kA feFkuky % ry d vk.kfod vuikr 5.6:1 rFkk T= 60° l ij > 95% FAME 5 ?kV e feykA lfØ;rk d fcuk fd lh gkfu d bl mRçjd dk pkj ckj iuç;Dr fd;k x;kA çklr Xyhljky > 97% 'k) ik;k x;kA vfHkfØ;k dk lQyrkiod ,d fdykxke Lrj ij mPp fd;k x;kA bl çdkj çklr ck;kMhty dk Hkkfrd x.k/ke ekud DIN d rY; ik;k x;kA ¼ck;kfjlkl VDukykth] 109 (2012) 57½ ¼iVUV Qkby fd;k x;k % 0371/DEL/2011, 14 Qjojh 2011; PCT/IN2012/000092, 10 Qjojh] 2012½

cgdk;h LDH 0;RiUu mRçjd l dldM vfHkfØ;k }kjk uohdj.kh; l foeku b/ku

foeku d fy, no ,Yduk dk n{k #i l fo'kÔr;k b/ku tlk ç;kx fd;k tk ldrk gA lY;ykt l no ,Ydu cuku dk ykHk ;g g fd ;g [kk| ij dkb vlj ugh Mkyrk gA Pd ;Dr MgAl LDH, fofHkUu Pd dk ek=k e lg&vo{ki.k }kjk cuk;k x;kA bl cgdk;h mRçjd tlk ç;kx djd ,d ik= e ty foyk;d e Qj¶;jy dk ,lhVku d lkFk ,yMky l?kuu&gkbMktuhdj.k fd;k x;kA mPp dh xb lHkh n'kkvk e 5% Pd ;Dr lrkfir LDH u 83% C_{13} mRikn p;urk d lkFk 100% ifjoru çnf'kr fd;kA ¼Hktkx;k½

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;g igy çfrofnr fd;k x;k g fd tVkQk toMhty&vo'kÔ dk ih,p, cuku e ç;Dr fd;k tk ldrk g tk feVVh e dN eghuk e tofo/kfVr gk tkrk gA bl fof/k dk 30-50 xk- cgyd çfr cp e cuku d fy; 10 yhVj rd mPp fd;k x;kA lLFkku dk uke ih,p, d fodkl dk; e yx vUrjk"Vh; e[; lLFkkvk dh lph e egRoi.k gvkA bl dk; d lLFkku d oKkfudk dk f}rh; jk"Vh; CIPET ,okM ¼Vhe ,okM½ çklr gvk rFkk bl iVUV vkonu l Hkh doj fd;k x;kA

tyh; bFkuky l b/ku xM bFkuky d iFkDdj.k d fy, gkyk Qkbcj f>Yyh rU=

Økl cf/kr ,l-vkb- & ih-oh-,- ikyhlYQku f>Yyh ijoikj'ku mi;kx gr cukuk ,d pukrhi.k dk; gA fu;f=r gkbMkykbfll iØe e ikjn'kh flfydk ikyhej (Si-O-C) fQYe cuk;h tk ldhA fQYe e mifLFkr flfydk d.kk d vkdkj dh lhek 2 l 5 uukehVj FkhA iryh Si-O-C fQYe gkyk Qkbcj fefJr f>Yyh fuek.k d fy, gkyk Qkbcj ij vkofjr dh xbA bl f>Yyh d mi;kx l ty dk] tyh; bFkuky l vyx fd;k x;kA ty d i.k fu"dklu d }kjk b/ku & xM ,Fkuky iklr gvkA tcfd mPp iFkDdj.k x.kd yxHkx 1000 l?ku f>Yyh d fy, iklr gvkA f>Yyh 1.5 fdyk@eh^2 @?kVk d mPp iokg d in'ku d lkFk de p;ukRedrk nrh gA

lkj Åtk

lkyj ihoh&Å"eh; gkbfcM

lkyj QkVkokYVkf;d ¼ihoh½ fjol vkLekl hl ¼vkj vk½ r= d fy, ih oh ekM;Yl yxHkx 60% dfiVy ykxr y yrk gA t lk igy çfrofnr fd;k x;k g] ekM;y l Åtk fuxr dk c<ku d fy; v/;;u dk] fuf"Ø; BMd }kjk ekM;y rki d fu;U=.k ij dfUnr fd;k x;kA fo'kÔr% B.Mk dju d fy, /kkr gkfly ijkfQu oDl] tk fd dN xyu lhek t lk fd çkoLFkk ifjoru eVhjh;y ¼ihlh,e½ ekM;y d jh;j ij gkrh g] ç;Dr fd;k tkrk gA V&VQ ih oh ihlh,e r= d mi;kx }kjk ij fnu d fuxr Åtk dk 1.55 x.kk rd rki Lo; fu;keu d lkFk c<k;k tk ldkA oreku e] bl fudyh m"ek dk PC-RO flLVe e ç;Dr dju ij dk; tkjh gA

vko';d ryk dk lk; m"eh; ty&vklou

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[ky e l [kkuk e¶r g ijr bl dh dN lhek, gA xkeh.k ?kjk e ;g rduhdh ogu ;kX; gku l iln dh tkrh g ft l l okfNr l [kku dk foLrkj rFkk [kk| mRiknk dk LoPNrk dh nf"V l l [kkr gA lh,lvkbvkj& lh,l,elhvkjvkb blh jkg ij lk; 'kkÔd d mi;kx }kjk vif'k"V d l [kku d lkFk ml mPp rFkk l{ke dju e dk; dj jgk gA lk; 'kkÔd dk egx mRikn t l lQjku] ,ijhdkV] vxj bR;kfn dk l [kku d fy; n[kk tk jgk gA ;gk iu% çk#i e u; dk; fd; x; g ftUgku l [kku dh {kerk dk dkQh c<k;k gA u; dk; e Lor% Vfdx rFkk Lor% ykfdx dh lfo/kk] gA dk;kfUor o vknrk fu;=d lkyukbM okYo tk fd vfre rFkk dfBu ueh dk gVku e vkrfjd rki rFkk vknrk dk foLrr çnf'kr dju e Mh lh QUl tk ih oh iuy l lh/k tM gkr g] gYd ,d#ih gok rki l [kkuoky çkQkby dk ij fnu e çkIr dj] dk iVUV fd;k tk pdk gA NkV ieku ij ?kjy pht l [kku d fy; Hkh çkVkVkbi fufer fd;k tk pdk gA ?kjy lk; 'kkÔd tk ,d&nk fdyk {kerk dk g rFkk lenk; t lh bdkb dk g] dk cuk;k rFkk fufer fd;k x;k gA

vk/kkçokg toHkkj xlhQk;j dk lLFkkiu

tVkQk fNyd t l toHkkj l çkM;lj xl cuku d fy; ,d 10 kw ¼o|r½ v/kkçokg okyk toHkkj xlhQk;j lLFkkfir fd;k x;kA çkM;lj xl ikoj ink dju d fy; ,d vkrfjd ngu btu dk pykrh gA dkcu ekukDlkbM] gkbMktu vkj ehFku l ;Dr bl xl dh dykfjfQd eY; mPp g vkj ok"i cuku d fy; xl&tyu ck;yj e ;g mi;Dr b/ku Hkh gA btu dh vo'kÔ m"ek dk toHkkj l [kku e ç;Dr fd;k tk ldrk gA

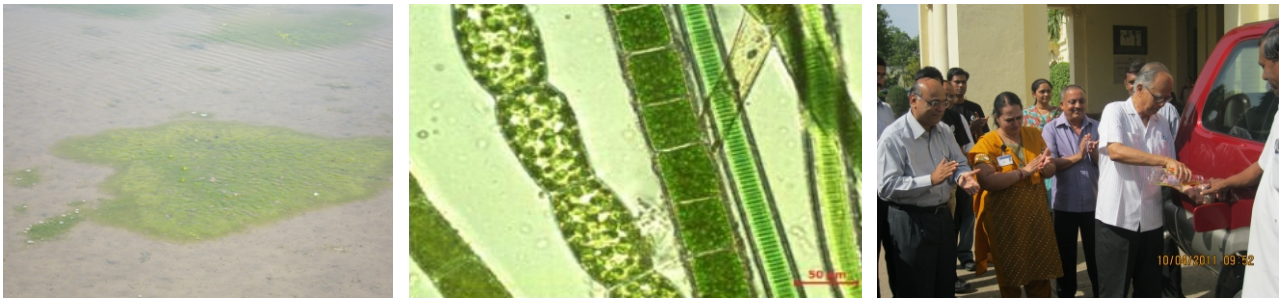
RENEWABLE ENERGY RESEARCH

Biofuels

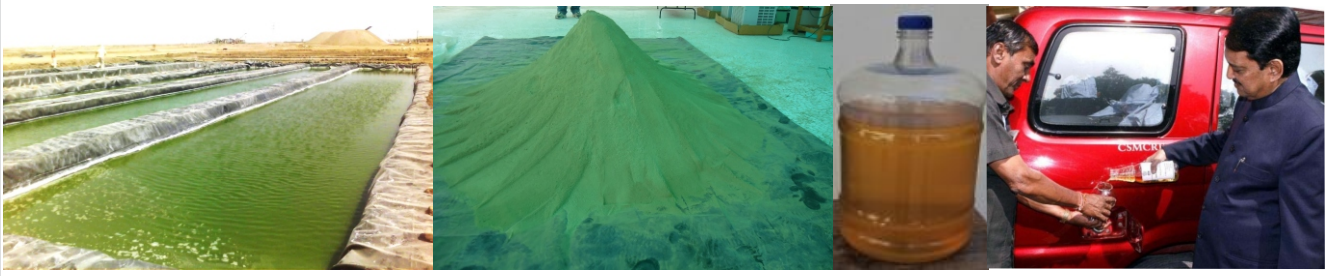
Biodiesel from marine microalgae

As a participating laboratory under the "Biofuel from Marine Microalgae" multi-institutional NMITLI project supported jointly by CSIR and MoES, two coastal lagoons were identified on the west coast where floating mats of marine microalgae were seen to be growing. The mats comprised mainly of *Microspora* and *Cladophora* species (ATCC Accession numbers; PTA 12197 and PTA 12199, respectively). These were easy to harvest and gave small amounts of non-polar lipids on hexane extraction. The lipids, after refining, were further converted into fatty acid methyl esters (biodiesel) through the transesterification process developed originally for Jatropha oil. B20 biodiesel was used in a test run of the institute's Tavera vehicle.

Mass cultivation of *Chlorella variabilis* isolated from the Arabian Sea was subsequently attempted under the same project. This species was granted ATCC accession number PTA 12198 for international filing of patent application. Extensive experiments were carried out in the laboratory and it was decided to explore cultivation in the open solar salt pans at the Experimental Salt Farm. Cultivation was thereafter carried out during April–June, 2011 using seawater as the medium. The total culture volume was 100 m^3 (100,000 L) with a total area of 432 m^2. Harvesting was found to be simple through spontaneous auto-settling of the biomass in summer season (40–45 °C). 300 kg of dry biomass was raised, with an average productivity of 32.45 $g/m^2/d$ and a maximum productivity of 45 $g/m^2/d$ on dry basis. The biomass was used for preparing 30 L of B100 microalgal biodiesel (CvME). A test run using the biodiesel was flagged off by the Late Shri Vilasrao Deshmukh, Hon. Minister for Science & Technology at CSIR Headquarters, New Delhi on 30 March, 2012. A journalist who



From left: Naturally floating microalgal mat in Diu; view under a microscope wherein *Microspora sp.* was dominant; Test Run of Tavera on 10th April 2011 with B20 biodiesel prepared from the mat



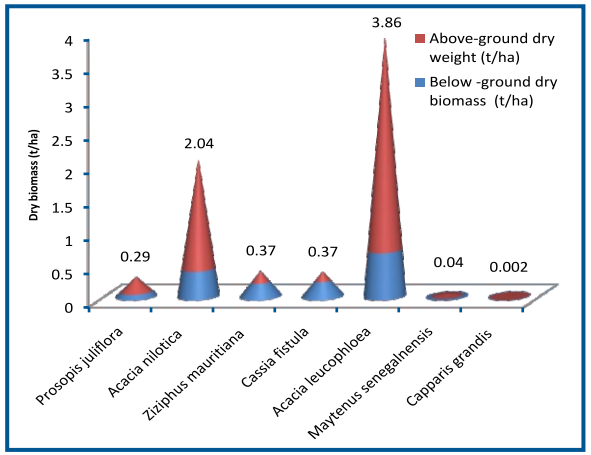
From left: Cultivation of *Chlorella variabilis* in salt pans; sun dried auto-settled biomass; B100 biodiesel prepared from extracted lipid; Topping up of the tank with the B100 marine microalgal biodiesel by Hon. Minister of Science & Technology, Late Shri Vilasrao Deshmukh, on 30 March 2012 which was followed by flag off of the Tavera for a 200 km test run, the first such test in the world.

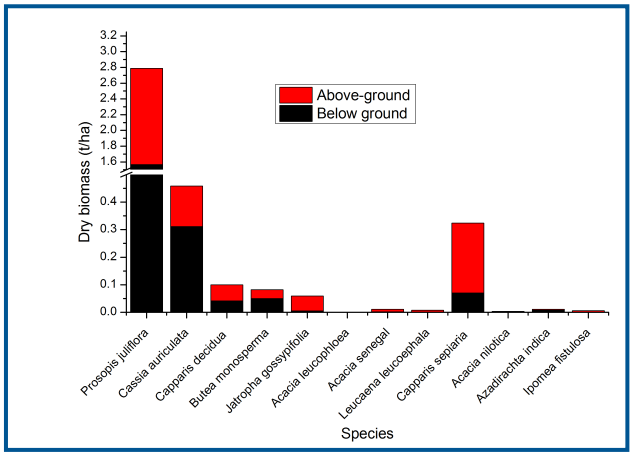
accompanied the vehicle during the test ride wrote thus: *"This correspondent took a test ride in the Tavera that was flagged off by the minister. The experience was equivalent to that of any other diesel vehicle, accompanied by a monotonous hum by a diesel engine. The two-km drive around the Central Secretariat area was smooth and without any hiccups."* (*Dinsa Sachan, "Biodiesel from microalgae becomes a reality", Down to Earth, March 30, 2012; www.downtoearth.org.in*) (*PCT/IN2012/000372 dated 28 May, 2012*). The vehicle also cleared the PUC emission test in New Delhi.

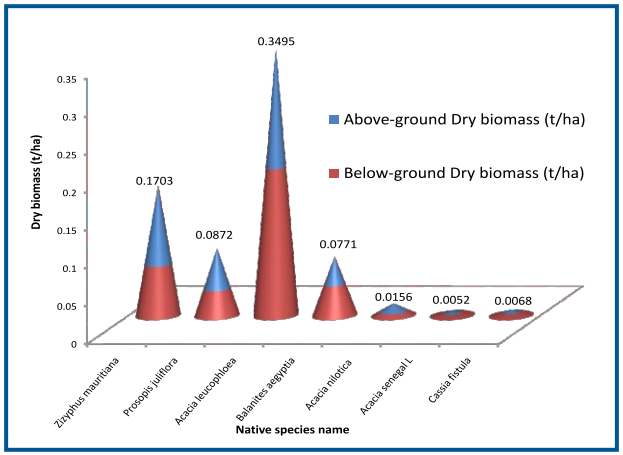
Life cycle assessment studies of Jatropha biodiesel

Studies towards life cycle assessment to determine carbon and energy balances were initiated. The species-wise dry biomass and total carbon displaced on account of uprooting the initial biomass of native vegetation (see next page) and the Jatropha dry biomass accumulation as well as carbon sequestration of Jatropha planted after 1 year was determined by destructive sampling and chemical analysis thereof. At Bhadrawal site, the total carbon in the native biomass amounted to ca. 3.05 t/ha of which 2.33 t/ha was from the above-ground vegetation. The growth of Jatropha in Bhadrawal (see picture) after one year was significantly higher than the other plantations and the cumulative carbon sequestrated by above and below ground parts of Jatropha was ca. 0.6 t/ha, thus being successful in mopping up significant carbon from atmosphere after one year. At Kanod, the total carbon in the perennial native biomass displaced amounted to ca. 1.62 t/ha of which 0.77 t/ha was from the above-ground vegetation, while the remaining 0.86 t/ha was attributable to below-ground biomass. Optimally grown Jatropha plants on the same land after 1 year accumulated 0.80 t/ha of dry biomass and sequestered 0.3 t/ha of carbon. At Neswad site, not much loss in terms of total carbon (0.3t/ha) occurred as there was sparse native vegetation. Jatropha grown in the same piece of land sequestered 0.03 t/ha of C in its biomass in the first year. The studies would be continued over the years.

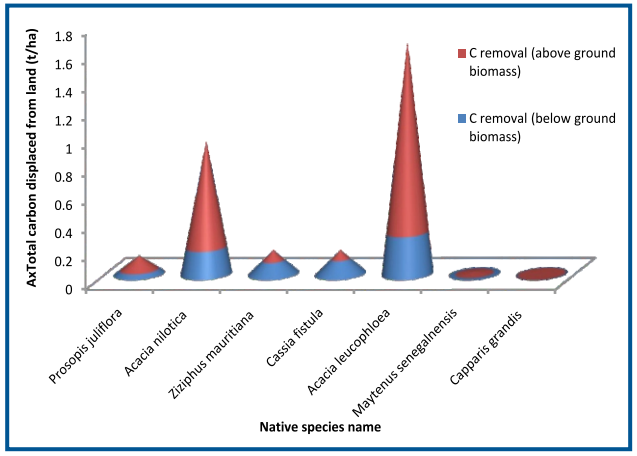
Plantation at Bhadrawal site after one year (Picture date: 19th August, 2011)

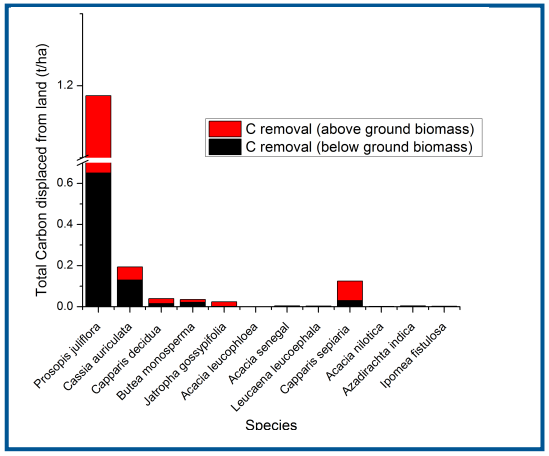


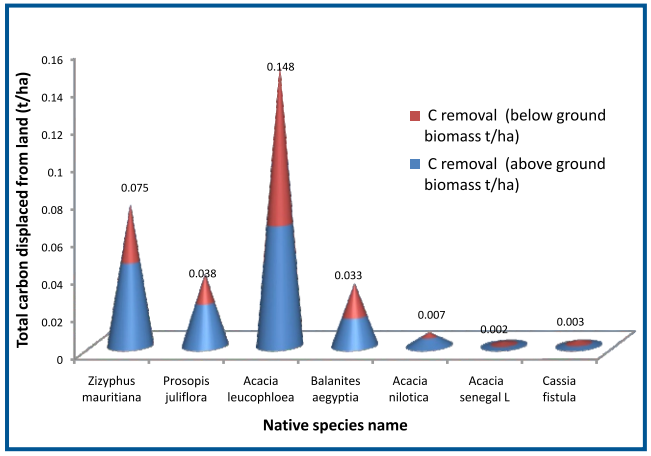




Initial species-wise biomass removed (t/ha) for Jatropha plantation at Bhadrawal (left), Kanod (centre) and Neswad (right) in Gujarat







Species-wise total carbon displaced (t/ha) on account of uprooting the initial native vegetation at Bhadrawal (left), Kanod (centre) and Neswad (right) in Gujarat

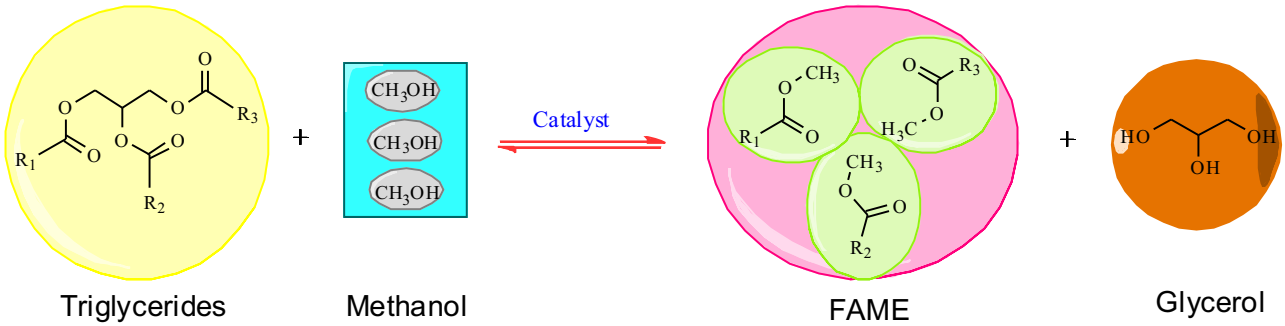
Visit of US biofuels delegation

During October 25th, 2010, a US biofuels delegation comprising scientists/experts from US Department of Energy (DOE) and various national laboratories and universities including Argonne National Laboratory, Oak Ridge National laboratory, National Renewable Energy Laboratory, and Yale University visited Bhavnagar to learn about the institute's activities in biofuels. The mission was headed by Mr. Glenn Sonntag, Office of the Biomass Program, United States Department of Energy. Dr. Candace Wheeler, Principal Investigator (General Motors) also accompanied the team. The members of the mission visited various institutional facilities following which a trip to the Jatropha plantations sites located at Bhadrawal and Neswad was made. The members of the delegation planted micro-propagated elite Jatropha saplings at the newly established plantation site of Bhadrawal. These plants started flowering and fruiting in 2012.

Visit of US biofuel mission to Jatropha field at Bhadrawal and planting the tissue culture raised plants by them (left); Grown up tissue cultured plants in 2012 (right)

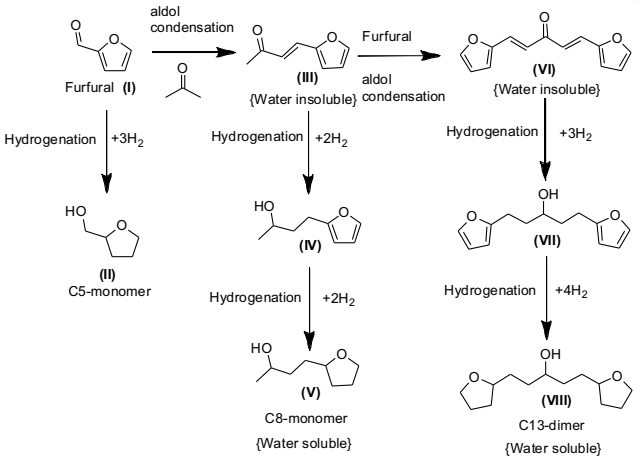
A greener process for bio-diesel synthesis using LDH-derived material as solid base catalyst

Different triglyceride oils (edible, non-edible and cooked) were converted to fatty acid methyl esters (FAME) through transesterification using heated layered double hydroxides (LDHs) as solid base catalysts. At methanol:oil molar ratio of 5.6:1 and T=65°C, FAME yield > 95 % was obtained within 5 h. The catalyst could be reused up to four cycles without significant loss of activity. The obtained glycerol showed > 97 % purity. The reaction was scaled up to 1 kg level. The physical properties of the obtained biodiesel matched well with the standard DIN values *(Bioresource Technology, 109 (2012) 57; Patent Application No. 0371/DEL/2011; PCT/IN2012/000092).*



Aviation fuel from renewable using cascade reaction over multifunctional LDH derived catalyst

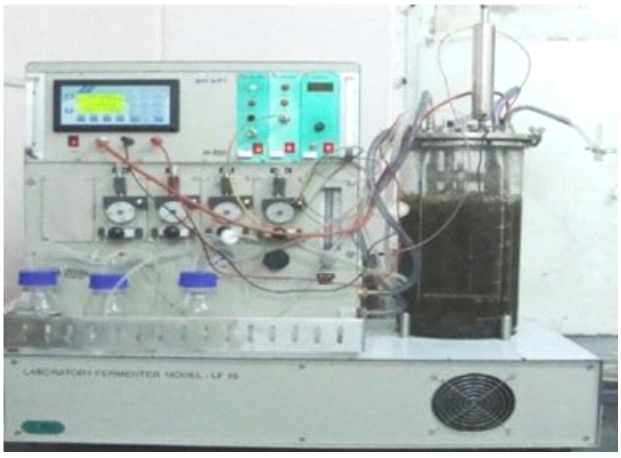
Liquid alkanes can be potentially used as fuels for aviation. Their production from cellulose has an advantage of non-interference with food. Palladium containing MgAl layered double hydroxides (LDHs) with varying palladium content were synthesized by co-precipitation. One pot sequential aldol condensation-hydrogenation of furfural with acetone (see scheme) was done using these materials as multifunctional catalysts employing water as solvent. Calcined LDH containing 5% Pd showed 100% conversion with 83% C_{13} product selectivity under optimized conditions *(Communicated)*.



Aldol condensation followed by hydrogenation of furfural

Value addition of biodiesel process through the production of PHA

It has been reported previously that Jatropha biodiesel residues may be utilised for production of polyhydroxyalkanoates (PHA) which biodegrade in the soil over a period of a few



Scale –up of PHA production in 10 L fermenter (left). Biodiesel residues were utilised and *Halomonashydrothermalis* (MTCC 5345) was employed as the bacterial strain. Dr. Sandhya Mishra receiving the CIPET national award (2011-12) on behalf of the team for technology innovation in green polymeric materials (right)

Current players in PHA-based resins (PolyHydroxyAlkanoates) « Bio-Pol Blog

« New bioplastics based on furan chemistry from biomass

Algae might just be the next big bio-resin – A point of view! »

Current players in PHA-based resins (PolyHydroxyAlkanoates)

There are now about 75,000 metric tons of annual capacity globally to produce PHAs (PolyHydroxyAlkanoate) from five companies: Telles (USA), Tianjin Green Bioscience/DSM (China), Bio-on (Italy), Tianan Biologic Material Co. (China); and BioMatera (Canada). Nine other companies are conducting developmental work on PHAs, some with pilot plants: Micromidas (USA), Meridian (USA), Biomer (Germany), PHB Industrial (Brazil), Bioplastech (Ireland), the Salt and Marine Chemical Research Institute (India), Mitsubishi Gas Chemical (Japan), Shenzen Obioer Technology (China), and Kaneka (Japan).

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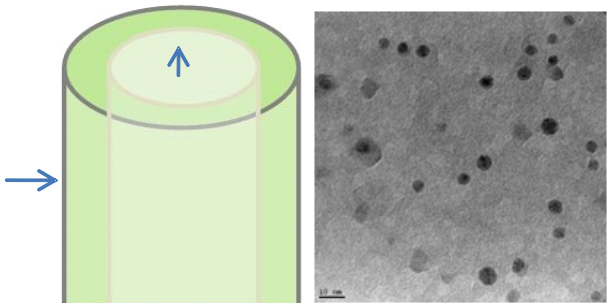
Source

months. The process was scaled up in a 10 L fermenter, producing 30-50 g of polymer per batch. The institute name features in a list of key organisations internationally who are engaged in development work on PHA. Scientists of the institute received the 2nd National CIPET award (team award) for the above work which is also covered by a patent application.

Hollow fiber membrane system for separation of fuel-grade ethanol from aqueous ethanol

The preparation of cross-linked Si-PVA-polysulphonemembrane suitable for pervaporation application has been a challenging task. Under controlled hydrolysis conditions, transparent silica-polymer (Si-O-C) films could be prepared. The silica particles present in the film were in the range of 2 to 5 nm only. Thin Si-O-C film was then coated on the hollow fiber to produce hollow fiber composite membrane. Using this membrane, water could be removed from alcohol-water mixture. Fuel-grade ethanol was obtained after total removal of water. While high separation factor of ~ 1000 for the denser membrane was obtained, the membrane exhibiting high flux of 1.5 $kg.m^{-2}.h^{-1}$ gave lower selectivity.

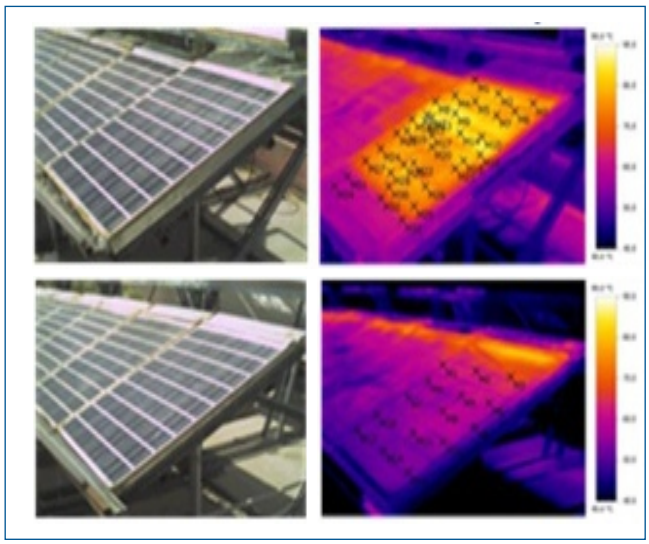


TEM of hollow fibre composite membrane

Solar energy

Solar PV-thermal hybrid

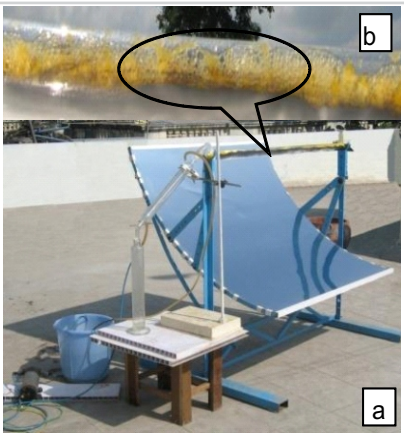
For a solar photovoltaic (PV) - reverse osmosis (RO) system, the PV modules take up almost 60 % of the capital cost. As reported previously, studies toward enhancement of the power output from the modules was continued with focus on control of the module temperature through passive cooling. Specifically, cooling was accomplished using metal embedded-paraffin wax as phase change material (PCM), incorporated at the rear of the modules. Using the V-trough PV-PCM system, the output power over the day could be enhanced, on average, 1.55 times with self-regulation of temperature. Presently, work is underway to make use of this extracted heat in PV-RO systems.



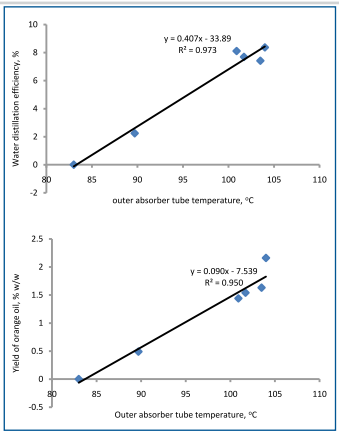
Original picture (left) and thermal images of PV modules (right) without (top) and with (bottom) PCM cooling

Solar thermal hydro-distillation of essential oil

The extraction of essential oils such as orange peel oil from fresh orange peels was carried out using hydro-distillation technique using a solar boiler developed in the institute. The experiment was carried out in the absorber tube of a square parabolic trough concentrator of 1.3 m^2 collector aperture area. 400–500 g of fresh peels was processed per batch and the limonene content in the crude oil was in the range of 86% to 90% while the maximum yield obtained was 2.16% (w/w).



(a) Experimental set-up for extraction of orange peel oil; (b) blown up image showing the attainment of reflux conditions in the absorber tube

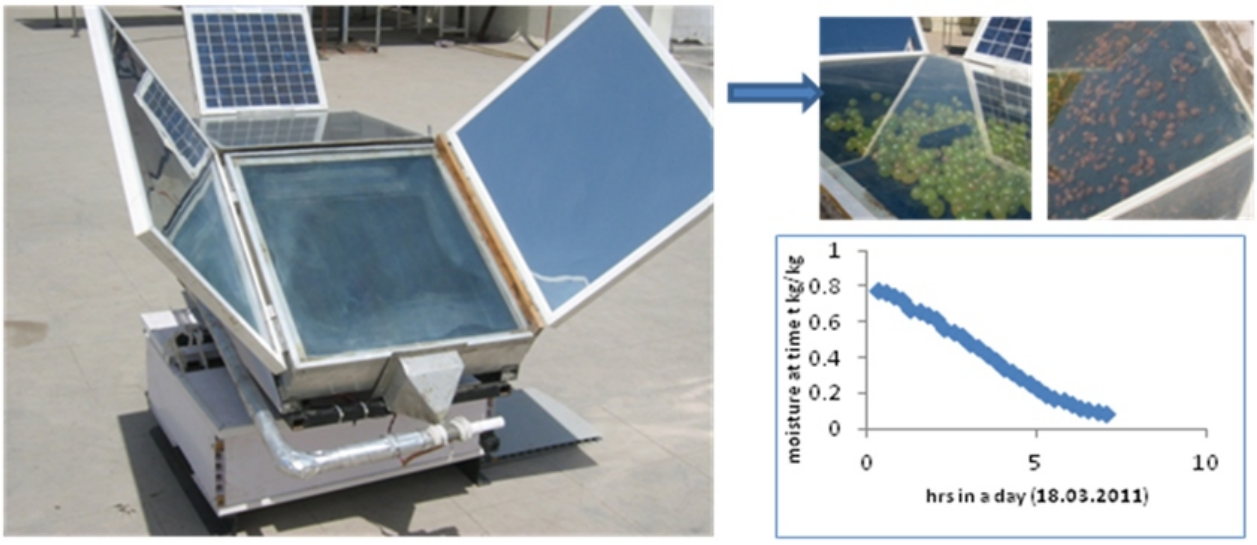


Plots of (A) water distillation efficiency and (B) oil yield as a function of the average outer absorber tube temperature

Extraction of sweet lime oil by steam distillation – a scaled up approach

Solar dryer for household applications

Drying in the open is free but it has its limitations. Rural households would like to have affordable technologies which give the desired extent of drying and dries food products in a hygienic manner. CSIR-CSMCRI is looking at ways of using a solar dryer to carry out residual drying requirements with efficiency and high throughput. Solar dryer designs to dry costly produce such as saffron, apricot, grapes, etc. are being looked at. Here again, there have been several innovations in design which has boosted the drying efficiency. These innovations like auto tracking and auto locking facilities, programmable humidity controlled solenoid valves to remove the "last and difficult to remove moisture", display boards to show inside temperature and humidity, DC fans directly connected to PV panel for a fairly uniform drying air temperature profile obtained throughout the day-have been patented and a prototype small scale household dryer has been fabricated. A household solar dryer of 1-2 kg capacity and a community type unit has been designed and fabricated in-house.



Solar drying experiment with grape

Installation of a downdraft biomass gasifier

A10 kW (electrical) downdraft biomass gasifier was installed for generation of producer gas from biomass such as Jatropha shells. The producer gas in turn drives an internal combustion engine to generate power. This gas –containing carbon monoxide, hydrogen and methane – has a high calorific value and is also a suitable fuel in the gas fired boiler for production of steam. Waste heat from the engine can be used for drying of the biomass.

Downdraft gasifier for generation of producer gas

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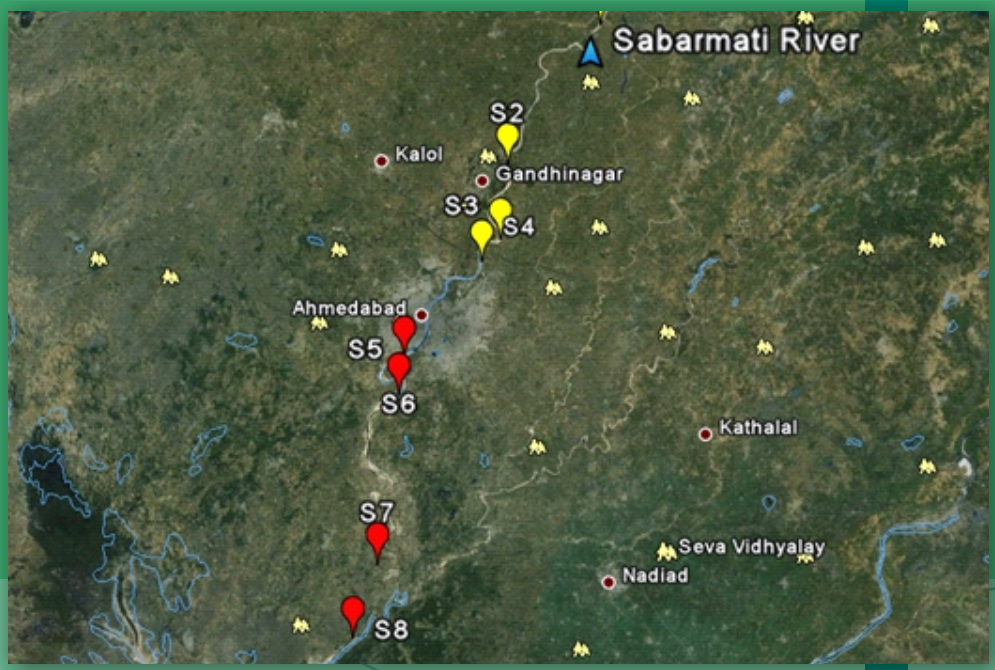
CHAPTER



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ENVIRONMENTAL RESEARCH

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dYilj ifj;ktuk d cl ykbu MVk lxg d dk; d vrxr [kHkkr dh [kkMh d rVh; ueu l lenh cDVhfj;k d 106 vkblkyVl dh igpku dh xbA fnypLi ckr ;g g dy 32 vkblkyVl] xjhekulh;k gkyhlk; d :i e igpku x,] tk igy Mk;fj;k jkfx;k d ey l fjikV dh xb FkhA tlk fd o idfr e gkykQhfyd g vkj mud ey lenh i;koj.k l g] yfdu o 'kk;n gh dHkh i;koj.k d ueuk l lfpr fd, x, gkA bl idkj] [kHkkr dh [kkMh dh lenh ty vkj ryNV d ueu e xjhekulh;k gkyhlk; dk cMh l[;k e vyxko djuk ,d mYy[kuh; [kkt g bld igpku dh if"V dju d fy, 16S rRNA d vk/kkj ij vuØe.k py jgk gA

o.kd fof'k"V ck;kekdj }kjk lenh dh ekbØk 'koky dk itkfr v/;;u

Lil ,lyhd'ku lVj ¼,l , lh½] bljk] vgenkckn d lg;kx l lnj lonu MVk l l{e 'koky dk irk yxku d ,Yxkfjne fodkl d fy, o.kd ck;kekdj vkj ekukLiflfQd 'koky d o.kØeh; itkfr ij v/;;u py jgk gA bl ifj;ktuk e 65 l vf/kd ekukLiflfQd l{e 'koky xtjkr vkj rfeyukM rVk l vyx fd;k x;k gA 35 l vf/kd ekukLiflfQd 'koky d fof'k"V o.kd ljpuk dk v/;;u fd;k x;k gA vkj ,d tgjhy Mkbuk¶ykthyV ,EQhfMfu;e dkLVh gycV 1957 dh ,DlkikfyldjkbM d y{k.k] vkj bld gkfudkjd 'koky (HABs) e lHkfor Hkfedk dk v/;;u fd;k x;k gA lh,lvkbvkj& lh,l,elhvkjvkb }kjk fodflr vk;fud no viektd }kjk gkfudkjd 'koky d f[kyu dh 'keu ij v/;;u fd;k x;k gA

lenh QkbVkIykUVk d o.kØeh; gLrk{kj d v/;;u

2011-12 oÔ d nkjku l{e 'koky dh fofo/krk d v/;;u gr fofHkUu i;koj.kh fLFkfr;koky dy lkr rVh; LFkkuk dk nkjk fd;k x;kA ikjcnj d ikl jM VkbM jdkM fd;k x;k FkkA Mkbuk¶ykthyV dh ryuk e Mk;Vedk xtjkr d rV ij iHkRo n[kk x;kA ekbØk 'koky d 25 l vf/kd fofHkUu i tkfr;k dk ,p-ih-,y-lh- d ek/;e l o.kd ljpuk dk v/;;u dju d fy, fodflr fd;k x;kA fof'k"V ekbØk'koky d vo'kkÔ.k ¼300 – 800 ,u,e½ vkj ijkoru (400 – 800 ,u,e) dk v/;;u fd;k x;kA

dkcfud foyk;d lgu'khy thok.k d mi;kx l dkcfud foyk;d dk fo?kVu

v/;;u l dkcfud foyk;d lgu'khy thok.k dh dkcfud foyk;d d fo?kVu dh {kerk dk irk pyk ftle 6 thok.kvk }kjk vlk/kkj.k :i l cUthu vkj Vkybu dk fo?kVu n[kk x;kA

,d 39313 rFkk ch- vklhVuhlMhfeuhl u lcl T;knk ek=k e cthu (50%) vkj Vkybu (58%) dk 96 ?k.V e 100 mg 1^{-1} dod fu"d"k dh gktjh e fo?kVu fd;kA clhyl Lih'kht ,d 39427, ekbØkdkdl yVh;l ,d 39532, ch- ykbduhQkjehl ,d 39762] clhyl ,Dohejht ,d 39881 rFkk clhyl Lih'kht 35-40% cUthu vkj Vkybu dk fo?kVu fd;kA bl idkj] ; l{e thok.k nf"kr LFky l fofo/k lxf/kr ;kfxdk dk gVku d dk; e mi;kxh mEehnokj cu ldr gA

,d {kkj&Lugh thok.k l tfod vknd dk mRiknu

,d {kkjh; thok.k Økuk cDVj lkdktkdh ¼ifjxg.k Øekd t-,u- 398668½ l tfod vknd dk mRiknu gekfyfVd] ik;lhdkjh xfrfof/k vkj lrg ruko eki fof/k }kjk tkpk x;kA tfod vknd e dy 'kDdj (73.3%)] vipk;h 'kDdj (1.464%), ikVhu (11.9%), ;jkfud vEy (15.98%) vkj lYQV (6.015%) ik;k x;k g] tk L;MklykfLVd fj;kykth v/;;u e de fpifpikiu fn[kkrk g vkj ry vkj gkbMkdkcu d lkFk egRoi.k ik;lhdkjd xfrfof/k dk in'ku djrk gA ,dy] f} ,o f= vkfyxk 'kdjk dk inf'kr dju okyh fuEu vkj e/;e jt d J[kyk dh pkfV;k MALDI TOF-TOFMS }kjk ldkjkRed vk;u ijkord ekM e ik;k x;k gA th-lh- & ,e- ,l-fo'y"k.k e ,dy 'kdjk d idkj dk ¼Hkkj@Hkkj½ dk irk pyk ftle Xydkt (14%)] eUukt (24%)] XyDVkl (14%)] tkbyl (20%) vkj vjfcukt (1.9%) gA rki fLFkjrk ¼260°C rd½ vkj lh-vkb- (0.456)] Vh-th-,- vkj Mh-,l-lh-fo'y"k.k fof/k }kjk fu/kkfjr fd;k x;k gA tfod vknd d vrfufgr x.k l ;g ry vkj gkbMkdkcu d ck;k jeMh;'ku d fy, ,d lHkkfor mEehnokj cu ldrk gA

tfod vknd thok.k dh feêh vkj lrh diM l ry fudkyu dh {kerk

tfod vknd dk mRiknu ,d {kkj&Lugh thok.k] Dycfl,yk itkfr djrk g] ble dy 'kDdj (52.4%)] vip;h 'kDdj (0.8787%)] ;jkfud vEy (18.65%)] ikVhu (13.6%) vkj lYQV (0.281%) 'kkfey gA tkfd L;MklykfLVd fj;kykth v/;;u d lkFk de fpifpikiu fn[krk g vkj ry vkj gkbMkdkcu d lkFk egRoi.k ik;lhdkjd xfrfof/k dk in'ku djrk gA ;g ,d mPp vk.kfod Hkkjokyk] mPp rkih; fLFkjrk fn[kku okyk tocgyd gA bl v/;;u e tfod vknd d Hkkfrd vkj jklk;fud x.kk dk ij[kk x;k vkj bld feêh vkj lrh diM l ry dk gVku dh {kerk dk vH;kl fd;k x;kA fofHkUu fMVjtV d lkFk tfod vknd dk feykdj mldh lxrrk] LFkkf;Ro vkj dk; d'kyrk Hkh n[kh x;h tgk diM /kku dh {kerk e l/kkj ik;k x;kA ;g tfod vknd diM /kku d lkcu e ;kxkRed d :i e Hkfo"; e vk|kfxd mi;kx e yk;k tk ldrk gA ¼dkckgkbM- ikyh- 89 (2012)1110½A bl l lcf/kr dk; Mkmu V vFk] Qjojh 1 – 15, 2012 if=dk }kjk idkf'kr fd;k x;kA

idk'k mRifjr vf/k'kk"kd IPCAs d mi;kx l ikuh vkj vif'k"V ty e l nokb;k dk {kj.k

lfØ; dkcu likV ij uuk ljfpr VkbVfu;k dk leUo; djd idk'k mRifjr vf/k'kk"kd (IPCAs) cuk;k x;k ftldk v/;;u bMkeFkflu] ,ekfDlfyu vkj ,flVkfeukQu lfgr fofHkUu nokb;k dh idk'k mRifjr fo?kVu dh tkp d fy; fd;k x;kA v/kj e fd, x, vf/k'kk"k.k v/;;u l vkb-ih-lh-,-,l- dk lHkh nokvk d ifr T;knk yxko ik;k x;kA nok d vf/k'kk"k.k dk iek.k VkbVfu;k vkDlkbM dh ek=k ij vk/kkfjr g vkj

lcl T;knk vf/k'kk"k.k 10 Hkkj% VkbVfu;e vkDlkbM e ik;k x;kA

lryu lerkih d v/;;u l irk pyk fd ;g yxE;j vf/k'kk"k.k ekMy dk ikyu djrk g tk ikjfHkd vf/k'kk"k.k Lrj ij fuHkj gA vf/k'kk"k.k xfrdh dk lMk&f}dkfV lehdj.k l tkMk x;k vkj mll irk pyk fd vf/k'kk"k.k ifØ;k vrd.k folj.k ij ijh rjg fu;f=r ugh gA 'k: d ih-,p- mRçjd dh ek=k iek.k vkj ikjfHkd ,flVkfeukQu dh lknrk dk idk'k mRifjr {kj.k ij vlj dk vH;kl fd;k x;kA vke rkj ij vkb-ih-lh-,- dh idk'kh; {kj.k xfrfof/k ek= VkbVfu;e vkDlkbM dh ryuk e cgrj ik;h x;hA nokbvk d UV d vlj d lkFk fy, x, idk'k mRifjr xfrdh v/;;u l ekye gvk dh {kj.k yXe;j & fgUlyoM ¼,y-,p-½ xfr dh d vulkj gkrk g vkj mldk vf/k'kk"k.k nj fLFkjkd idk'k mRifjr nj fLFkjkd l cgr T;knk ik;k x;kA bll irk pyrk g fd nj fu/kkj.k djuokyk ;g idk'k mRifjr gA 10 ifr'kr VkbVfu;e vkDlkbM vkb-ih-lh-,- mRçjd d idk'k mRifjr ifØ;k e iu%mi;kx djr g, irk pyk fd pkj idk'kh; {kj.k pØ d ckn mldh dk; {kerk e 4 – 5% deh gbA

bfenktkfy;e vk;fud nOkk dk gfjr 'koky mYok yDVdk ij fo"kkDr vlj % vkDlhdj.kh; ruko o Mh,u, ij vk?kkr

gky d o"kk e bfenktkfy;e vk;fud nOkk ¼ILs½ dk "gfjr foyk;d" d :i e vkdk x;k g lkFk gh bUg bud Hkkfrd o jklk;fud x.kk d dkj.k ,d odfYid vk|kfxd mMu'khy dkcfud foyk;d Hkh ekuk x;k gA ;|fi ¼ILs½ d ux.; ok"i ncko gku d dkj.k bud }kjk gku okyh ok; in"k.k dh vk'kdk de gkrh g yfdu budh ty e lkFkd ?kyu'khyrk gkrh g rFkk cgr l vkby tfod ifrfØ;k }kjk fo?kVu'khy ugh gkrA blfy, ILs d c<r g, vk|kfxd vf/kdkj l tyh; i;koj.k e bud fuLrkj d [krj c< jg gA bul tyh; ifjfLFkfr dh r= ij gkuoky udkjkRed iHkko Hkh c< jg gA 1-alkyl-3-methylimidazolium bromide [$C_n$mim]Br (n=4 l 16) }kjk tfur fo"kkDrrk dh dk; fof/k vkj bul gkuoky tfod iHkkok dh tkudkjh mYok yDVdk d lkFk fd;k x;k gA IL e Mkyu l bl 'koky dh dkf'kdh; thou {kerk vkj vfYdy leg dh dkcu dh yEckb d chp _.kkRed lglc/k ik;k x;kA ¼dfe- fjl- VkDlhdky; 24 (2011) 1882; t- ,lyk-Qkbdky] 2012 doi:10.1007/5 10811-012-9871-8½

ENVIRONMENTAL RESEARCH

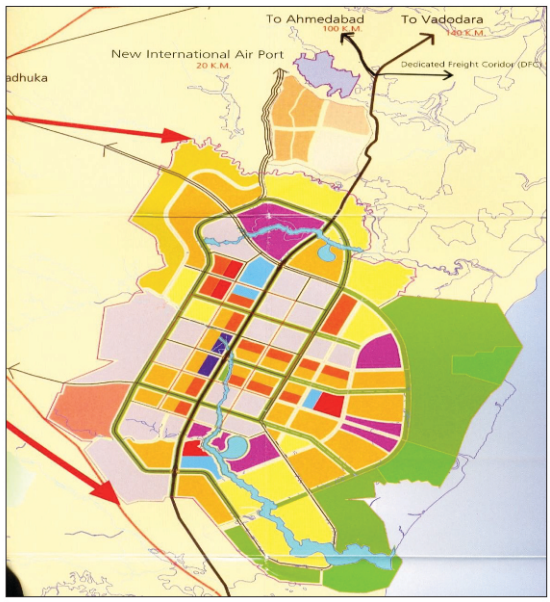
Assessment of ambient environmental quality for Kalpasar project

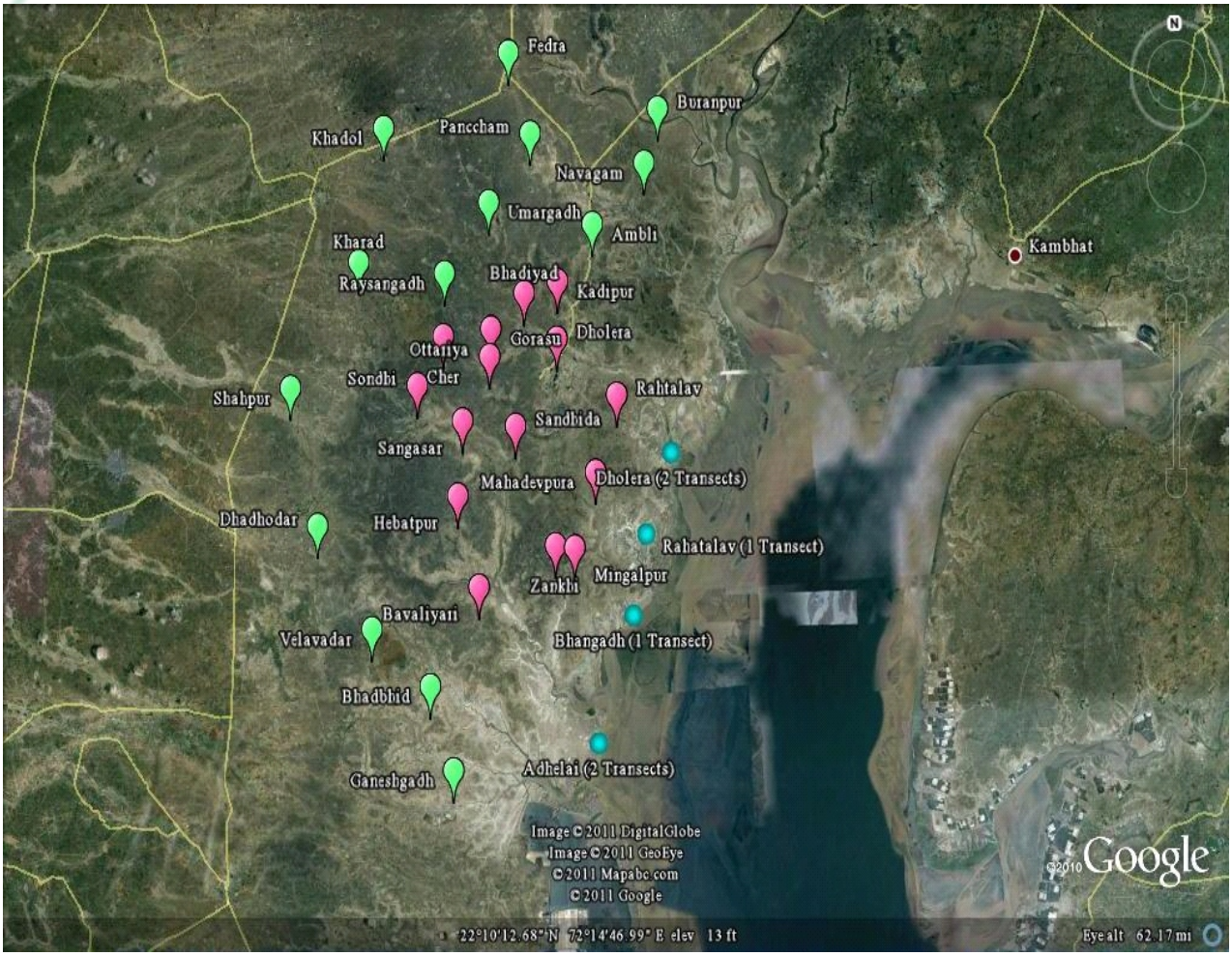
As a part of baseline data collection under Kalpasar project, the environmental parameters and social status in the region of interest were assessed. For this study, total 11 sampling stations were fixed along the Gulf of Khambhat in consultation with Kalpasar authority. Apart from this, the environment of six rivers (Sukhbhadar, Bhogavo, Sabarmati, Mahi, Dhadhar and Narmada) and an estuary (Narmada) were also covered. Three stations from each river/estuary were selected, and samples were collected covering all the three seasons, namely, post monsoon, winter and pre-monsoon. Suspended particulate matter (SPM) in ambient air was high at all the stations in pre-monsoon season – presumably on account of extreme dry weather and high wind velocity. PM_{10} was higher than the CPCB standard (100 $\mu g/m^3$) in the eastern side. Other parameters like SO_x, NO_x, CO and CO_2 were within permissible limits. Expectedly, ground water quality indicated high TDS and salinity towards the coast. High levels of fluoride, heavy metals, lower dissolved oxygen (DO) and high biochemical oxygen demand (BOD) were found in some resources. Creation of fresh water with proper environment management plans will no doubt improve ground water quality. Other than Dholera and Devla, soil quality of other stations was acceptable for agricultural applications. Low DO, high BOD, phenol, nutrient and heavy metal concentration, along with heavy load of pathogenic bacteria such as *Streptococcus feacalis,* indicated poor state of Sabarmati and Dhadhar rivers. Narmada and Mahi River waters were, however, of good quality. Coastal water quality was good except few stations where influence of domestic sewage (Vadgam) or industrial effluent (Hazira) were found. Notwithstanding the ship breaking activities, Alang was found to be relatively unpolluted. Socioeconomic status was also surveyed for 39 villages of 18 talukas in seven districts along the Gulf of Khambhat. Enhanced economic status and better infrastructural facility on eastern side of the Gulf improved the quality of life of the people. Satellite images were classified into different land use classes.

Collection of base line ambient environmental quality data for Dholera Special Investment Region (SIR)

Gujarat Industrial Development Board (GIDB) assigned a consultancy project on assessment of the environmental quality of Dholera SIR as a part of generating base line data for various environmental components like air, noise, ground water, and soil including coastal environment. The objective of the project was to make a relevant and reliable assessment of project impacts by comparing with base line situation. The baseline assessment included data on the relevant environmental characteristics of the study area, as well as information on any changes anticipated before the proposed project commences.

Total 29 stations were selected within 900 sq.km area covering Dholera SIR and surrounding areas together with area of proposed international airport. The base line environmental quality was assessed through field studies within the impact zone. Report preparation is under progress.

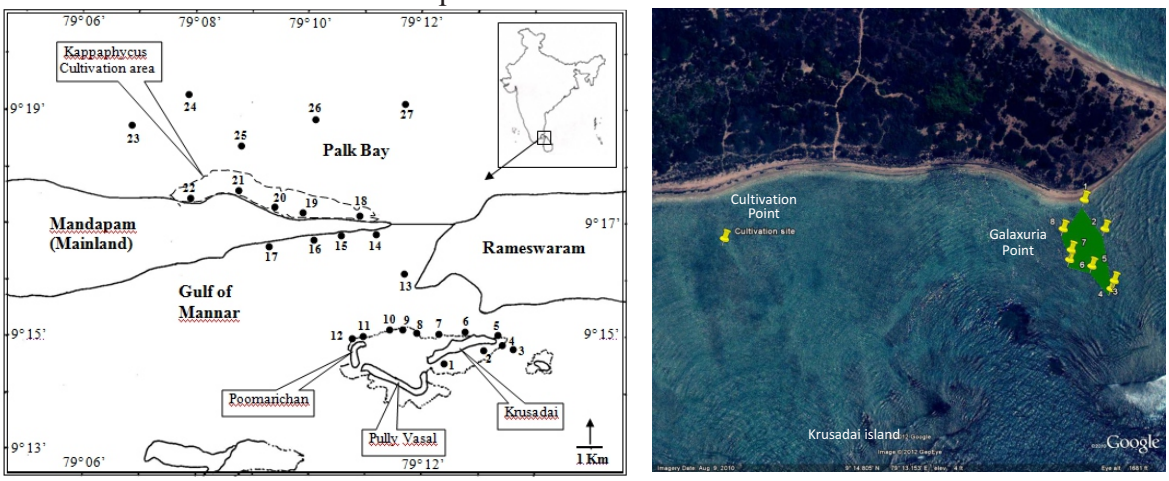




The map showing stations within the Dholera SIR region (•), peripheral of Dholera SIR (•) and coastal sampling stations (•)

Monitoring of *Kappaphycus* at Kurusadai Island

In view of the reported invasion of *K. alvarezii* mentioned in the earlier biennial report, extensive surveys were conducted in February & August 2011 to ascertain the invasion potential of *K. alvarezii* on *Acropora* sp. at Kurusadai Island and three other adjacent islands (Mandapam group of islands) in the Gulf of Mannar.

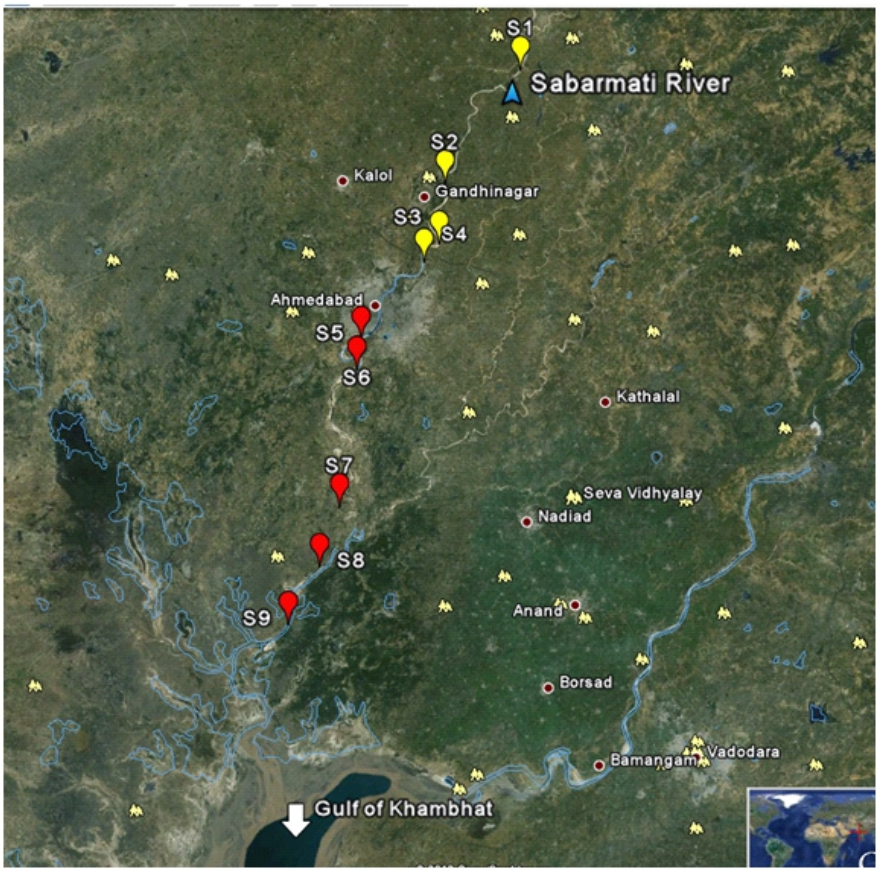


Kappaphycus occurrence at the Galaxuria point of the Krusadai Island. A) 27 locations were surveyed for occurrence of *Kappaphycus alvarezii*. B) Green colored polygon represents the sporadic growth of *Kappaphycus* at Galaxuria point

During the survey, it was observed that the canopy cover of the *Kappaphycus* in the Galaxuria point has increased marginally. The average cover was 214.62± 74.28 m^2, amounting to less than 0.0098% of the total coral reef area of the island surveyed during 2011.

Monitoring of pollution level in Sabarmati river

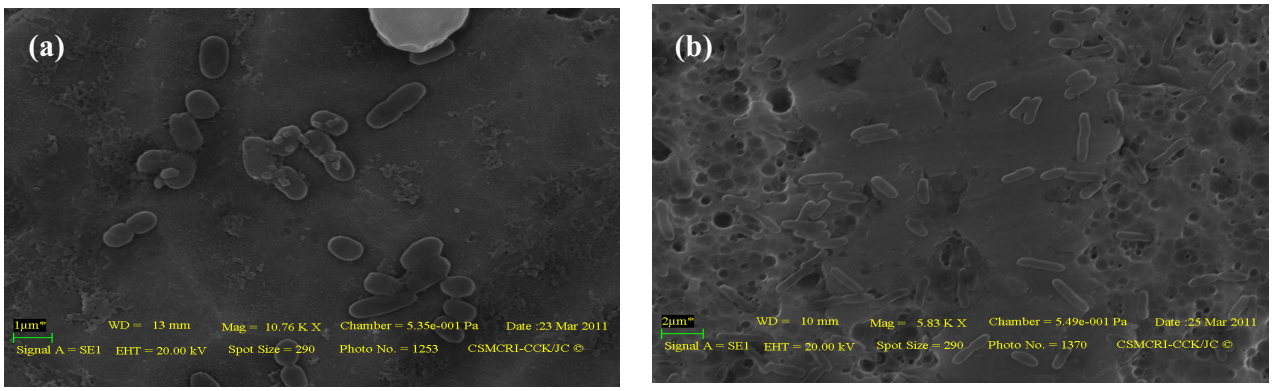
Sabarmati river is one of the major rivers of Gujarat and a life-line of Ahmedabad city. The institute conducted a study to assess the environmental quality of this river, covering nine sampling stations along 163 km stretch from village Mahudi in Gandhinagar district to Vataman in Ahmedabad district. The water samples were analyzed for various physicochemical parameters including suspended solids, turbidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrate, nitrite, ammonical nitrogen phosphate, silicate, phenol and microbiological parameters. The results indicated that as the river enters Ahmedabad city, the water quality deteriorates, whereas in upstream it was relatively unpolluted. Dark coloration of river water, foul smell, heavy load of suspended solids, and near absence of DO, were observed in the river stretch from the Ahmedabad city to Vataman. Same trend was observed for organic pollution, measured in terms of BOD, phenol and coliform count. The BOD levels exceeded CPCB norms (3 mg l^{-1}) by as much as 14 to 60 times. Moreover, the river stretch in this region was saprobic and eutrophicated, presumably due to discharge of various effluents resulting in depletion of oxygen. Very high microbial load in terms of total viable count and pathogenic bacteria such as *Vibrio*, *E. coli*, *Salmonella*, *Shigella*, and *Streptococcus* were also found in downstream reflecting the influence of anthropogenic activities and sewage pollution.



Sampling stations (S1 to S9) along Sabarmati river
(Stations marked in red indicates the polluted river stretch and yellow indicates relatively unpolluted stretch)

Evaluation of the ground water quality of Bhavnagar city for pathogenic bacteria

In order to investigate the health risk due to ground water pollution owing to the presence of pathogenic bacteria, 25 ground water resources of Bhavnagar city were monitored. Ground water samples from densely crowded areas were dominated by *Aeromonas* and *Acinetobacter* while those from residential areas were dominated by *Citrobacter* and *Serratia*. *Pseudomonas* was isolated from sites located adjacent to drainage areas. Multi drug resistant bacterial species were quite common. Majority of the isolates were resistant against vancomycin, cloxacillin, penicillin, ceftazidime and ampicillin. Indiscriminate use of antibiotics might be the possible reason for the development of multi drug resistant strains. High number of enteropathogenic bacteria was recorded in terms of MPN (most probable number) at 6 sites, reflecting the possible sewage contamination in drinking water. This study indicates that some of the drinking water resources of Bhavnagar contain substantial numbers of opportunistic bacteria warranting effective treatment prior to domestic use.



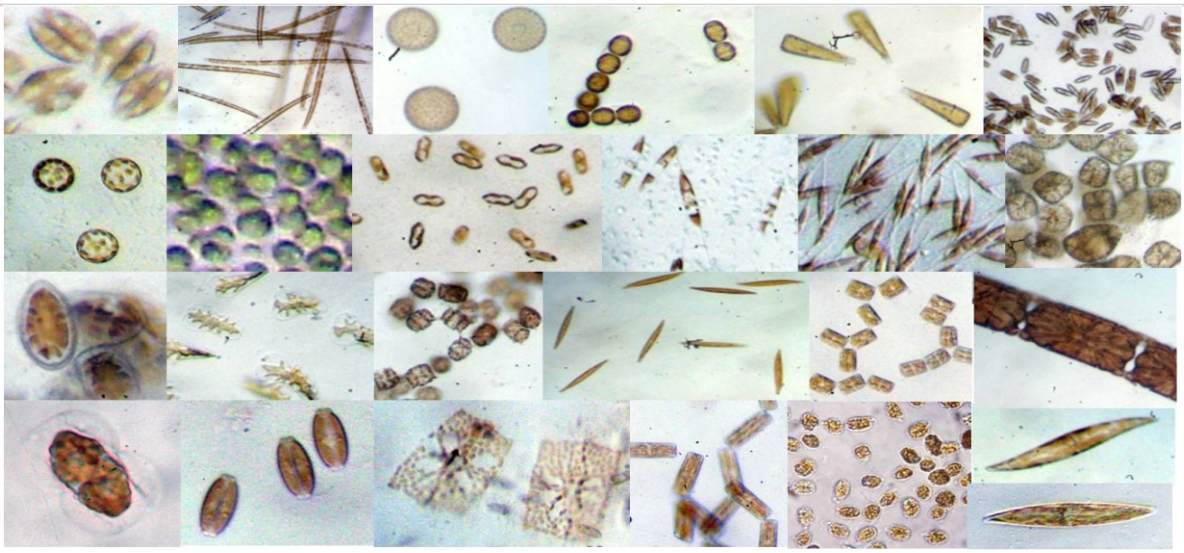
SEM micrograph of (a) *Citrobacter* and (b) *Aeromonas caviae* isolated from ground waters of Bhavnagar

Isolation and identification of *Grimontia hollisae* from water and sediments of Gulf of Khambat

As a part of base line data collection for Kalpasar project, a total of 106 isolates of marine bacteria were isolated and identified from coastal samples of Gulf of Khambhat. Interestingly, a total of 32 isolates were identified as *Grimontia hollisae*, previously reported from stool samples of diarrhoeal patients. As they are halophilic in nature, their origin belongs to marine environment; however, they were rarely reported from environmental samples. Thus, the presence of *G. hollisae* in seawater and sediment samples collected from Gulf of Khambat was a noteworthy finding. To reconfirm, identification based on 16S rRNA sequencing is underway.

Species specific pigment biomarker and spectral fingerprints study of marine microalgae

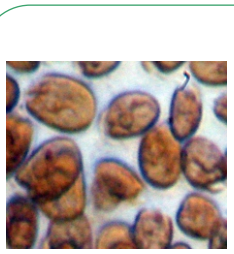
Under the Space Application Centre (ISRO, Ahmedabad) – CSMCRI collaborative project entitled "Pigment biomarkers and spectral fingerprints of monospecific algae for development of detection algorithms of algal blooms from remote sensing data", more than sixty five mono-specific phytoplankton cultures were isolated from Gujarat and Tamil Nadu coasts. Mono specific pigment compositions of more than thirty five cultures were studied. Isolation and characterization of exopolysaccharide secreted by *Amphidinium carterae* Hulburt 1957, a toxic dinoflagellate, and its probable role in harmful algal blooms (HABs) was studied. Mitigation of harmful algal bloom by ionic liquid surfactants developed by CSIR-CSMCRI was additionally undertaken.

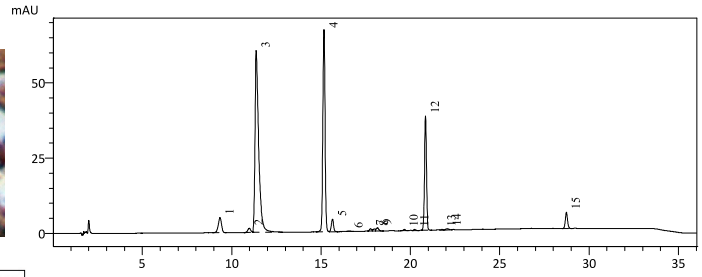


Some monospecific microalgal cultures

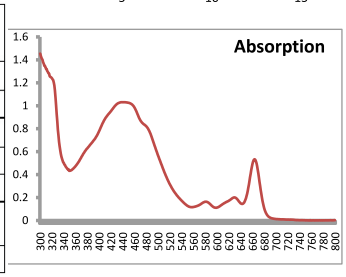
Studies of spectral signature of marine phytoplanktons

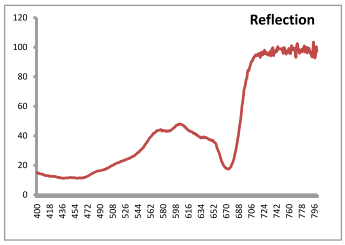
Total seven coastal sites were visited during the year 2011-2012 for micro algal diversity study. Red tide was recorded near the Porbandar coast. Diatoms dominated throughout the Gujarat coast as compared to dinoflagellates. More than 25 different species of microalgae were isolated and mono cultures were developed for studying pigment composition through HPLC. Absorption (300-800 nm) and reflection (400-800nm) for specific microalgal cultures were studied.





Peak No.	Pigment	Composition in %
1	Chlorophyll C3	3.297
2	MgDv	0.817
3	Chlorophyll C2	44.825
4	Peridinine	29.754
5	Peri-isomer	1.860
12	Dinoxanthin +Diadinoxanthin	15.063
15	Chlorophyll a	2.391

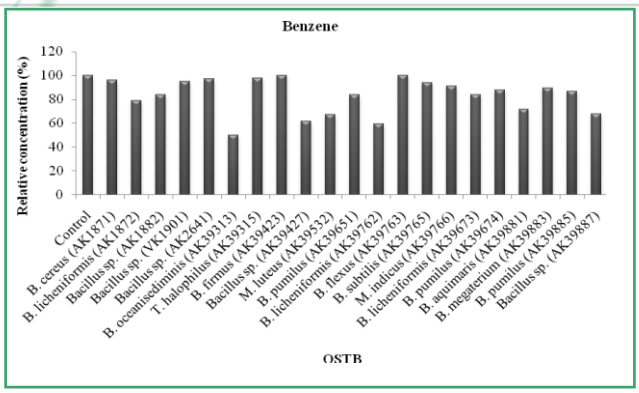


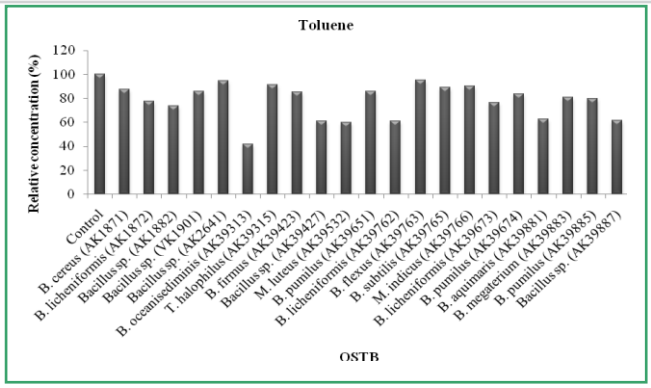


Pigment composition and spectral signature of a phytoplankton species

Degradation of organic solvents using organic solvent tolerant bacteria

Studies on bioremediation potential of organic solvent tolerant bacteria (OSTB) revealed that six isolates exhibited exceptional bioremediation of benzene and toluene. Isolate AK39313 and *B. Oceanisediminis* showed the highest degradation of benzene (50%) and toluene (58%) in 96 h in the presence of 100 mg l^{-1} yeast extract. *Bacillus* sp. AK39427, *Micrococcus luteus* AK39532, *B. licheniformis* AK39762, *Bacillus aquimaris* AK39881 and *Bacillus* sp. AK39887 showed degradation of benzene/toluene in the range of 35-40%. Thus, these isolates could be considered as the prospective candidates for bioremediation of a range of aromatic compounds from contaminated sites.





Degradation of benzene and toluene by organic solvent tolerant bacteria

Biosurfactant production by an alkaliphilic bacterium

Production of biosurfactant from an alkaliphilic bacterium *Cronobacter sakazakii* (Accession No.JN398668) was screened for haemolytic assay, emulsifying activity and surface tension measurement. Biosurfactant, comprising total sugars (73.3%), reducing sugars (1.464%), protein (11.9%), uronic acid (15.98%) and sulfate (6.015%), showed low viscosity with pseudoplastic rheological behavior and exhibited significant emulsification activity with oils and hydrocarbons. A series of low and mid-range mass peaks (m/z) corresponding to mono-, di-, tri- and oligo- saccharides were detected in the positive ion reflector mode of MALDI TOF-TOF MS. GC-MS analysis revealed the occurrence of monosaccharide

moieties (w/w) *viz*. glucose (14%), mannose (24%), galactose (14%), xylose (20%) and arabinose (1.9%). Thermostability (up to 260°C) and *CI* (0.456) were determined by TG and DSC analysis. Inherent properties of biosurfactant make it a potential candidate for bioremediation of oil and hydrocarbons.

Potential of bacterial biosurfactant to remove oil from soil and cotton cloth

An alkaliphilic bacterium, *Klebsiella* sp. strain RJ-03, produced a biosurfactant, comprising total sugar (52.4%), reducing sugar (0.8787%), uronic acid (18.65%), protein (13.6%) and sulphate (0.281%). It showed low viscosity with pseudoplastic rheological behaviour and exhibited emulsification activity with oils and hydrocarbons. It is a high molecular weight, thermostable biopolymer showing high thermal stability. This study demonstrated physico-chemical properties of biosurfactant and its importance with respect to remediation of oil from soil as well as cloth. Further, its efficiency, compatibility and stability with various laundry detergents along with their additive interaction with detergents improved the washing performance. It thus may have industrial utility as laundry detergent additive (*Carbohydr. Poly., 89 (2012) 1110*). A related work was featured in Down to Earth (February 1-15, 2012).

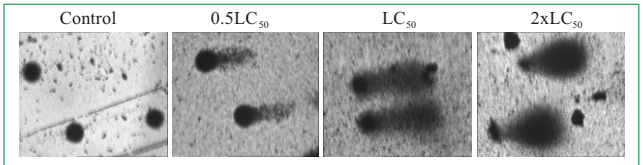
Degradation of pharmaceuticals from water and wastewater using photocatalytic adsorbents (IPCAs)

Nanostructured titania supported over activated carbon (AC), termed as integrated photocatalytic adsorbents (IPCAs), were investigated for the photocatalytic degradation of various pharmaceuticals including indomethacin, amoxicillin and acetaminophen. The IPCAs in dark adsorption studies had high affinity for all pharmaceuticals with the amount adsorbed increasing steadily up to 10 wt% TiO_2. Equilibrium isotherm studies showed that the

adsorption followed the Langmuir model, indicating the dependence of the reaction on an initial adsorption step. The pseudo-second-order equation correlated the adsorption kinetics well and further analysis indicated that the adsorption process was not controlled solely by intraparticle diffusion. The effects of initial pH, catalyst amount and initial acetaminophen concentration on the photocatalytic degradation rates were studied. Generally, the photodegradation activity of IPCA was better than that of bare TiO_2. Kinetic studies on the photocatalytic degradation of pharmaceuticals under UV suggested that the degradation followed the Langmuir-Hinshelwood (L-H) kinetics and the adsorption rate constant was considerably higher than the photocatalytic rate constant, indicating that the photocatalysis is the rate-determining step during the adsorption/ photocatalysis process. The reusability of 10% TiO_2 IPCA was slightly decreased (4-5%) after four photodegradation cycles.

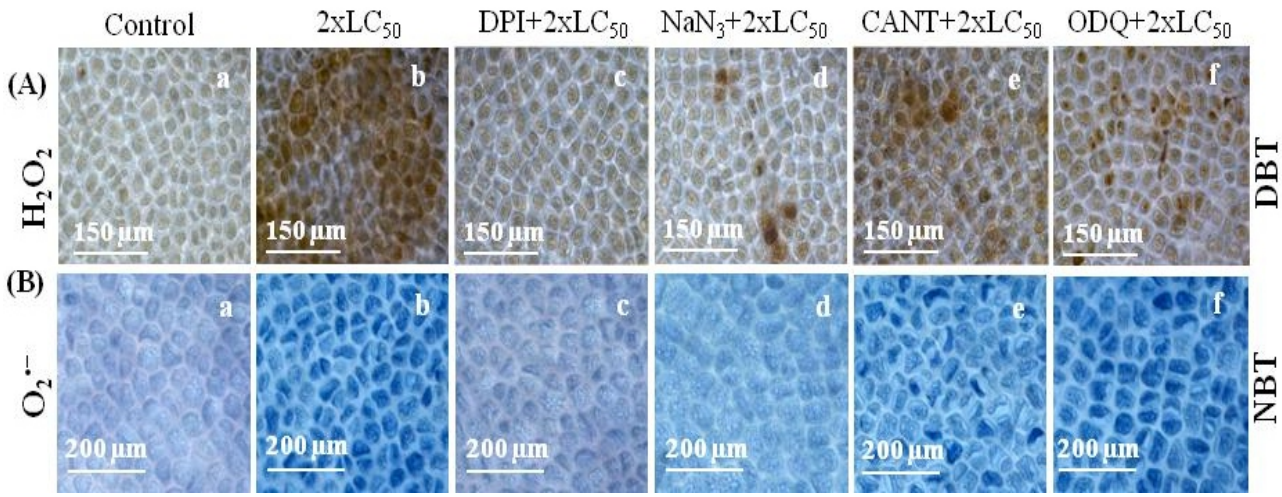
Toxic effects of imidazolium ionic liquids on the green alga *Ulva lactuca*: Oxidative stress and DNA damage

In the recent years, ionic liquids (ILs) have been mostly considered as "green solvents" and considered as alternate for industrial volatile organic solvents due to their unique array of physico-chemical properties. Although ILs can lessen the risk of air pollution due to their negligible vapour pressure, but they do have significant solubility in water and many of the ILs are non-biodegradable. Therefore, in view of growing industrial interest in ILs, concerns are being raised for their eventual release in the aquatic environment through industrial effluents and their possible negative impact on the structure and function of aquatic ecosystem. A study was conducted to gain insight into the mechanism of toxicity and biological effects of 1-alkyl-3-methylimidazolium bromide [$C_n$mim]Br (n=4 to 16) using green seaweed *Ulva lactuca*. The cell viability of this alga during IL exposure was found to be negatively correlated to the chain length of the alkyl group (*Chem. Res. Toxicol., 24 (2011) 1882; J. Appl. Phycol., 25 (2013) 369).*



Comet category	% DNA in Tail	Tail length (µM)	Number of comets			
			Control	0.5LC_{50}	LC_{50}	2xLC_{50}
0	0-5	4.2-8.4	48	16	10	1
1	5-25	8.5-24.8	9	15	4	-
2	25-45	25.0-38.7	3	29	3	3
3	45-70	39.0-55.8	-	-	37	7
4	>70	56.0-96.3	-	-	6	49

Comets showing tails of different length induced by various concentrations of ionic liquid [C_{12}mim]Br exposure in *Ulva lactuca*



Effect of pre-treatment by inhibitors on the production of reactive oxygen species in *Ulva lactuca* following exposure to the ionic liquid [C_{12}mim]Br at 2xLC_{50} concentration (A) H_2O_2 and (B) O_2^- radicals were detected with 3, 3-diaminobenzidine (DAB) and nitroblue tetrazolium (NBT) staining, respectively

çdjÆ
CHAPTER 6

fo'yÔ.kkRed lok, ,oe fof/k fodkl

ANALYTICAL SERVICES & METHOD DEVELOPMENT

fo'yÔ.kkRed lok, vkj i)fr fodkl

fo'yÔ.kkRed foKku çHkkx d rgr dUnhdr midj.k lfo/kk dk xBu oÔ 2002 e lLFkku d lHkh çe[k midj.kk dk ,d Nr d uhp yku vkj lLFkku d lHkh mi;kxdrkvk dk leku volj miyC/k djku d mí'; l fd;k x;kA viu xBu d ckn l gh] fo'yÔ.kkRed foKku çHkkx fo'yÔ.kkRed lokvk vkj lHkh ?kjy ifj;ktukvk d fy, ckf)d ;kxnku n jgk gA midj.kk d vfrfjDr le; dk mi;kx ckgjh ueuk] e[; #i l fofHkUu foÜofo|ky;k vkj 'kf{kd lLFkkuk d 'kk/k Nk=k gr fo'yÔ.kkRed lok, miyC/k djku e fd;k tkrk gA ckgjh mi;kxdrkvk d fy,] fo'yÔ.kkRed lok, Hkxrku d vk/kkj ij çnku dh tkrh g ¼fo'yÔ.kkRed lok 'kYdk dh nj lh, lvkbvkj }kjk vuekfnr dh x;h g½] rFkkfi bl Hkkxkfyd {k= d vul/kku ,o fodkl xfrfof/k;k dk c<kok nu d fy, ih,p Mh d Nk=k dk lkekU; nj ij 75% dh NV nh tkrh gA ;g dUnhdr lfo/kk dN midj.kk d lkFk 'k# dh x;h rRi'pkr lLFkku dh vko';drk d vulkj çfr oÔ u, midj.k tkM x; ,o oreku e dy 35 çe[k midj.k dk;jr gA lefir oKkfudk vkj rduhf'k;uk dk ,d leg bu midj.kk d j[kj[kko vkj lpkyu d vykok lLFkku d vul/kku ,o fodkl xfrfof/k;k d fy, vko';d uohu fo'yÔ.kkRed i)fr;k d fodkl dk;k e lfyIr gA

t lk fd Åij mYy[k fd;k g] fu;fer fo'yÔ.kkRed lokvk d vykok] ge fo'yÔ.kkRed fof/k;k d fodkl vkj cgrj ifj.kke d fy, ek tnk rjhdk d #ikrj.k e lfyIr gA bu dk;k d dN e[; rF; uhp fn, x, gA

ikoMj ,DlvkjMh }kjk lkopu yo.k dk fo'yÔ.k

vk;on e mi;kx vku oky lkopu yo.k d fofHkUu ?kVdk dk ikoMj ,DlvkjMh }kjk fo'yÔ.k fd;k x;kA çkoLFkk ijh{k.k d fy, JC-PDF ucj;Dr lp ep fo'yÔ.k fof/k }kjk 2 FkhVk jt 2° l 80° mi;kx fd;k x;kA e[; ?kVdk d vykok vU; l{e v'kf);k dk Hkh irk yxk;k x;kA

fefJr vkDlkbM ;Dr ueuk e çkoLFkk dk PXRD }kjk irk yxkuk

dEik tkbV eVfj;Yl d fHkUu fHkUu ueuk e mifLFkr /kkr rRok d vkDlkbM dk JC-PDF ;Dr lp ep fo'yÔ.k fof/k ikoMj ,DlvkjMh fo'yÔ.k }kjk irk yxk;k x;kA mDr eVfj;y e dkckYV] LVkfUl;e vkj yUFkue d vkDlkbM fofHkUu l;ktu o vuikr e ik; x;A

xtjkr e fofHkUu LFkkuk l fy; x; dÙk d nkrk e gkbMkfDly ,iVkbV çkoLFkk dk v/;;u

vkuUn i'k fpfdRlk egkfo|ky; l çkIr g, ueuk dh MUVy dYdyh dk PXRD o FTIR rduhd l ijh{k.k fd;k x;k vkj ;g irk pyk fd bu ueuk e e[; #i l ,iVkbV çkoLFkk gkrh gA ;g ;k rk gkbMkfDly ,iVkbV ;k dkckuV ;Dr gkbMkfDly ,iVkbV d #i e gkrk gA bu çkoLFkkvk e dkckuV rFkk çkVhu d ,ekbM-I vkj ,ekbM-II dk FTIR }kjk fo'yÔ.k fd;k x;kA ikoMj ,DlvkjMh vkj Vhth, d ifj.kkek l çkoLFkk dk fofHkUu rkiekuk ij Vkft lu }kjk dkfjyV fd;k x;kA 300° C ij çkoLFkk #ikrj.k 'k# gkrk gA 800° C ij dfY'k;e ;Dr çkoLFkk dk mnHko gkrk gA iu% rkieku de dju ij 'k) gkbMkfDly ,iVkbV ugh curh g vFkkr ;g #ikUrj.k vifjoruh; gA ,iVkbV çkoLFkk dk ,lb,e midj.k }kjk lrgh vkdkfjdh dk ijh{k.k fd;k x;kA MVy dYdyh e mifLFkr /kkfRod vkj dkcfud ?kVdk dk TEM }kjk ijh{k.k py jgk gA

ikoMj ,DlvkjMh }kjk ,evk,Q e bdkb dkf'kdk o ukbVkc thu ;Dr ,evk,Q dk fu/kkj.k

ikoMj ,DlvkjMh }kjk ,evk,Q e ukbVkc thu dh mifLFkfr o vuifLFkfr dk irk yxk;k x;kA midj.k 40Kv o 30mA ij 2 FkhVk jt 2° l 60°, LVi lkbt 0.02° 2 o çfr LVi 4 ldM le; mi;kx fd; x;A bdkb dkf'kdk ekuk fDyfud tk ukbVk c thu feyku ij VkbfDyfud #i e cny tkrh g dkf'kdk vk;ru 1256.7 l 1097.54 A°³ gk tkrk gA pH d cnyu ij Hkh ekukfDyfud dk VkbfDyfud e ifjoru fn[kkA

byDVku ekbØkLdkih ¼TEM½ }kjk eVfj;y x.k fooj.k

TEM fxM ij ueuk dk o|r jklk;fud fof/k }kjk LFkkiu djuk

pkyd cgydk dh jpuk o|r jklk;fud voLFkk ij fuHkj djrh gA ;g ifjfLFkfr ,D;,'ku o lflx gr cgr mi;kxh gA budh ljpuk o x.kk d ckj e foLrr v/;;u vHkh rd LFkkfir ugh gvk gA vr% TEM fxM ij o|r jklk;fud rjhd l eVfj;y dk LFkkiu dju gr ,d fodYi fodflr fd;k x;kA bl gr 300 e'k vkdkj dh ,d Lo.k fxM dk ofdx byDVkM o fxM ij ,fuyhu dk o|r cgydhdj.k dj bl jQjUl o dkÅUVj byDVkM d #i e ç;kx fd;kA fofHkUu o|r jklk;fud fLFkfr;k dk ikV';k&Mkbufed pØk }kjk ikfy,fuyhu fQYe dh vkdkfjdh dk TEM }kjk v/;;u fd;k x;kA

cgyd f>fYy;k dk ekbØkVkeh fo'yÔ.k

fØ;k'khy flyhdk d.k cgyd f>Yyh ij fdl çdkj l forfjr gkr g budk fooj.k TEM }kjk n[kk x;kA f>fYy;k dh ekVkb ekbØkehVj jt e jgrh g blfy, bldh lDlfux Øk;k&ekbØkVkeh rduhd }kjk djd TEM fy;k x;kA

mPp letu {kerkokyh TEM ljpuk,

fofHkUu çHkkxk }kjk çkIr ueuk dh mPp letu{kerk ¼gkbfjtkY;'ku½ ij TEM ljpuk, yh xbA

SEM ljpuk yu gr rduhd dk fodkl

fdlh Hkh ueu dh ik'o lrg dk fp=.k dfBu gkrk gA bl gr VyM ,lb,e LVc e ,d xi cukdj ueu dk fQVdj LØ yxk; x; vkj fQj ,lb,e }kjk vkdkfjdh yh xbA VkbVfu;e lyV ij fo|r fu#i.k }kjk LFkkfir ueu dk ,d LVc ij ,lb,e fy;k x;kA

mPp letu {kerk okyh ,lb,e ljpuk,

fofHkUu çHkkxk }kjk çkIr ueuk dh mPp letu ¼gkbfjtkY;'ku½ ij ljpuk, yh xbA

lrgh fo'yÔ.k gr ,,Q,e

f>Yyh dh nÔ.krk dk vkdyu

f>Yyh dk [kjnjkiu bldh nÔ.krk d vkdyu gr egRoi.k y{k.k gA ,,Q,e }kjk leh dkUVDV fof/k }kjk f>Yyh dk [kjnjkiu n[kk x;kA mDr nh xb f>fYy;k e APDSMO ¼flykDlu ekukej½ d ikfy dUM'klu }kjk lxg.k dk fn[kk;k x;kA lxg.k flfydk d lkFk c<rk tkrk gA ihoh, iryh f>Yyh dk [kjnjkiu Økl fydj dh vuifLFkfr e fuEure 0.03 ,e,e gkrk gA tcfd MO-3 d lkFk 0.254 ,e,e] MO-4 d lkFk 0.112 ,e,e vkj MO-6 d lkFk 0.05 ,e,e n'kkrk gA AODSMO d feyku l 'k# e [kjnjkiu (MO-3) c<rk g fQj ?kVrk g (MO-4, MO-6)

oflDyl dk fp=.k

1&feFkkby] 3&vkDVkby bfeMktkfy;e Dykjkb M vkj 3&feFkkby] 1&C;Vkby bfeMktkfy;e vkDVkby lYQV d 2mM tyh; vk;fud no dh lrgh vkdkfjdh e oflDYl dh xkykdkj vkdfr yh xbA oflDYl dk vkdkj 100-200 ,e,e ik;k x;kA

fØLVyhdr vkdkfjdh

NaCl o QkLQV yo.k }kjk jfpr fØLVyhdr ty dh ,,Q,e }kjk vkdkfjdh yh xbA

thok.k vkdkfjdh e ifjoru o.ku

thok.k dkf'kdk dh thok.kjk/kh fØ;k'khyrk d fy, thok.k fuyEcu dk ck;kfIMy cgydk d lkFk feykdj vkdkfjdh #ikUrj.k n[kk x;kA

#Fkfu;e ckbfifjfMy vk/kkfjr ,EQhQkbYl d ofIDyl vkj fjol ofIDyl dk fp=.k

$RuCl_3$ vkj ty fojk/kh yEch J[kyk d $C_{18}H_{37}$,-$C_{14}H_{29}$-$C_{10}H_{21}$ d o ckbfijhMhu 0;RiUu dh vfHkfØ;k }kjk ,EQhQkbYl cuk; x;A bue tyLugh #Fkfu;e dUnd o ty fojk/kh yEch dkcu J[kyk gkrh gA ; /koh; foyk;d tl ikuh e olhdYl cukr gA v/koh; foyk;dk tl Vkybu o lkDykgDlu e fjol ofIDYl cukr gA

yo.kk dk cgdUnh; ,u,evkj v/;;u

ikuh e NaCl DyLVj cukrk g tk vU; yo.kk d foijhr cM vkj LFkk;h gkr g ;g ,u,evkj }kjk irk yxk;k x;kA NaCl, KCl vkj NH_4, Cl d ^1H, ^{17}O o ^{35}Cl ,u,evkj LiDVk fHkUu&fHkUu rki ij ikuh e fy; x;A ^{35}Cl ,u,evkj }kjk NaCl d fy, dyLVj cM o LFkkb feyA tk ;g crkrk g fd NaCl e Cl.....H d etcr gkbMktu cU/k d dkj.k DyLVj e rkieku d lkFk LFkkbRo vk tkrk gA bu yo.kk dk lkfyM ^{35}Cl NMR fjdkM fd;k x;k vkj mud foy;u LiDVk l ryuk dh xb ft ll irk pyk fd tyh; NaCl e Cl^- vkj H^+ d chpetcr vUrfØ;u gA

Hkkjrh; jftu ij MUMhej d LFkkiu dk Bkl ,u,evkj }kjk fo'yÔ.k

ikuh d thok.kjk/kh cuku gr LVkbfju Mkbfoukby cthu dh ikfyej fcMl l cuh Hkkjrh; jftu ij MUMhej LFkkfir fd; x;A l'yÔ.k çde dk tkuu gr lkfyM LVV ,u,evkj mi;kx e fy;k x;kA ^{13}C LiDVk fy;k x;kA jftu e çfrLFkkiu dh fofHkUu fLFkfr;k e v.kvk d VdMk dk LiDVk n[kk x;kA DykjkfeFkkbyhdj.k gr cthu dh ijk fLFkfr gkrh gA ;g fo'yÔ.k LVkbfju o Mkbfoukby cthu l cuh /kukRed o _.kkRed vk;u fofue; f>fYy;k dh 0;k[;k gr mi;kx e fy;k tkrk gA bl le> dk mi;kx vkx lYQku'ku@DykjkefFky'ku dh lki{k vfHkfØ;k gr ljpuk lfØ; lc/k d fy; dj ldr gA

lh,uVh dkcu uukV;c dEiktkbV ikfylYQku f>Yyh dh ,u,evkj 0;k[;k

lh,uVh dk ikfylYQku d lkFk feJ.k ,u,evkj }kjk n[kk x;kA ikfylYQku lh,uVh dEiktkbV] 'k) ikfylYQku rFkk lh,uVh ikfylYQku feJ.k dk ,u,evkj fy;k x;kA lh,uVh ikfylYQku dEiktkbV e nk ub pkfV;k n[kh xbA ,d ,jkefVd o vU; ,fyQfVd Hkkx e tk ;g lfpr djrk g fd ;g dEiktkbV ljpuk gh gA

tyhdr ikfyldjkbM dk ,u,evkj }kjk ljpukRed l/kkj

NMRCOSY }kjk tyhdr ikfyldjkbM l ^1H o ^{13}C e dkfjy'ku }kjk tyhdj.k dk çde n[kk x;kA COSY o HSQC LiDVk dk 70° C ij cdj d ekMy ,Mokl II 50 MHz e BBO çkc }kjk n[kk x;kA

,u,evkj }kjk β&lkbDykMDlVhu (BCD) dh ,uu';kefjd p;ukRedrk

β&lkbDykMDlVhu ,d dk;jy ,u,evkj f'k¶V ,tUV g ftll vfeuk vEyk dh ,u';kefjd fj';kY;'ku çklr dh xbA BCD dh fHkUu lkUnrk ij vfeuk vEyk d ,u';kefjd feJ.k dk ^1H ,u,evkj LiDVk nt fd;k x;kA BCD d lkFk dkEiyDl dh c/ku fLFkjkd vkj fLFkjrk e vrj gku dh otg l ^1H ,u,evkj pkfV;k dk foHkktu n[ku dk feykA

Mh¶;tu ,evkjvkb }kjk ED f>Yyh d vk;u fofue; LFky d x.kk dk v/;;u

vk;u fofue; x.k rFkk f>Yyh dh çdfr dk fu/kkj.k vk;u fofue; LFky }kjk gkrk gA fHkUu ty dh ek=k e pkj bMh f>fYy;k d H_3O^+ d Mh¶;tu eY;k dk Mh¶;tu MRI }kjk ekik x;kA f>Yyh ij ty dh ek=k de dju ij Mh¶;tu eY; e deh n[kh xbA

ik/k d ru dk ,ukVkfedy ,evkjvkb v/;;u

jkxxLr ik/k d ru e ,ukVkfedy ifjoruk dk ,evkjvkb v/;;u dj mldh ryuk LoLFk ik/k l dh xbA A ¼LoLFk½ B ¼de LoLFk½ vkj C ¼lcl de LoLFk½ ruk dh ,evkjvkb Nfo yh xb gA ru C e >kbye {k= e çkVku ldr dh rhork e deh ikb xb ftll ;g ldr feyrk g fd jkxxLr gku ij >kbye dh ty c/ku {kerk de gk tkrh gA

Fe_3O_4 uukd.kk dk ,evkjvkb oÔE; v/;;u

Fe_3O_4 uukd.k viuh pcdh; x.k dh otg l foJke le; dk çHkkfor dj ,evkjvkb oÔE; çHkko mRiUu dj ldr gA ,l d.kk d oÔE; çHkko dk le>u d fy, 500MHz cdj l{e Nfo ,u,evkj LiDVkehVj ij mudh Nfo çkIr dh xbA fHkUu lknrkoky ikp Fe_3O_4 uukd.kk (A<B<C<D<E) dk r;kj dj mudh Nfo çkIr dh xbA ;g n[kk x;k g fd T_2 Hkkfjr Nfo;k e oÔE; çHkko vf/kd rth l c<rk gA T_1 Hkkfjr Nfo;k dh ryuk e uukd.kk dh lkUnrk d lkFk Nfo e oÔE; çHkko c<rk gA

,Vhvkj&vkbvkj }kjk ikyh,ekbM f>Yyh ij ikuh rFkk vYdkgky d 'kkÔ.k dk v/;;u

,Vhvkj&vkbvkj LiDVkLdkih vk/kkfjr fo'yÔ.kRed fof/k dk fodkl fd;k x;k ftll fjol vkLeklhl ikyh,ekbM f>Yyh e ty&feFkuky vkj ty&vkblkçkiuky ?kky e l ty vkj vYdkgky d 'kkÔ.k dk ekik x;kA f>Yyh e vYdkgky dh ryuk e ty dk 'kkÔ.k çkFkfed gA ?kky e vYdkgky dh lkUnrk c<u ij feFkuky dh ryuk e ty dh 'kkÔ.k p;ukRedrk 6 l 328 tcfd vkblkçkiuky dh ryuk e ty dh 'kkÔ.k p;ukRedrk 2 l 8% c<hA ikyh,ekbM d fy, ty xj&foyk;d gku dh otg l f>Yyh dh lrg ljpuk vçHkkfor jgrh gA nljh rjQ f>Yyh e vYdkgky 'kkÔ.k l ikyh,ekbM dh fof'k"V vkbvkj cUM rhork e deh gkrh g ftldk eryc ;g g fd f>Yyh dh lrg ljpuk e ifjoru gvk ftldh if"V AFM vkj SEM }kjk f>Yyh d [kjnjiu e ifjoru dk n[kdj gbA

vk;u ØkeVkxkQh }kjk lk/kkj.k ued e ckekbM vkj lYQV dk fu/kkj.k

AS II – HC vkblh LrHk d lkFk lk/kkj.k ued e ckekbM vkj lYQV dk vk;u ØkeVkxkQhd vkdyu fd;k x;kA flFkfVd ueuk e ,uk;uk dh ek=kRed çkflr dh vkj fHkUu dVk;u dk gLr{ki v/;;u fd;k x;kA flYoj dkfVt tk fd vkerkj ij mPp DykjkbM eVhDl dk gVku e mi;kx dh tkrh g] mld fcuk mi;kx fd, li.k ckekbM@lYQV dk fu/kkj.k fd;k x;kA ued e ckekbM vkj lYQV dh lkUnrk dk ≥ 4 rFkk 1±0 ihih,e Øe'k% ek=kRed fo'yÔ.k lHko gvkA lk/kkj.k ued e ckekbM vkj lYQV d ,d lkFk gku ij Hkh fo'yÔ.k fd;k x;k vkj nkuk ?kVdk dk fu/kkj.k ,d gh ØkeVkxkQh pky e fd;k x;kA 0;olkf;d #i l miyC/k yo.kk e ckekbM vkj lYQV dk fu/kkj.k bl fof/k l lQyrkiod fd;k x;kA

rRo fo'yÔ.k gr bUMfDVoyh ;fXer lykTek LiDVkehVj

/kkrvk dh l{e ek=k fu/kkj.k d fy, bUMfDVoyh lykTek LiDVkfefr rduhd dk ç;kx fd;k tkrk gA lLFkku d fofHkUu foHkkxk vkj ckgjh mi;kxdrkvk l çkIr fofHkUu çdkj d ueuk e rRo fo'yÔ.k d fy, bl ;U= dk çe[k mi;kx fd;k x;kA eyty çokg e Hkkjh@foÔkDr /kkrvk dh fuxjkuh] nok mRiknk e /kkr v'k) rkvk] tfod ueuk e l{e ikÔd rRo] feVh e /kkr vk;u] ft;kykbV e /kkr vk;uk dk vknku&çnku vkj çfrfØ;k e/;orh dh fuxjkuh e bl midj.k dk vuç;kx fd;k x;kA

rRo fo'yÔ.k gr ,Dl&j ¶ykfjlUl ¼,Dlvkj,Q½

,Dlvkj,Q LiDVkehVj l fofHkUu Bkl ueuk dk ek=kRed rRo fo'yÔ.k fd;k x;kA bld }kjk (1) vokfNr rRok dh v'kf) ;k dk fu/kkj.k (2) ft;kykbV o vU; lcf/kr çnkFkk e /kkr vk;uk dk vknku&çnku (3) dPph vkj mUur Dy dh jpukvk e vrj (4) feVh e Hkkjh foÔkDr /kkr fu/kkj.k (5) iphnk ueuk dk ekud&jfgr fo'yÔ.k (6) ¶ykjkbM gVku oky jlhu d mipkj vkj iu%çkflr d fofHkUu pj.kk e] /kkr vk;uk d vknku&çnku d v/;;u e fd;k x;kA

d.k vkdkj forj.k (PSD) fo'yô.k

flFkfVd gkbMkVy lkbV] Dy] ft;kykbV] flfydk] $CaCO_3$] ck;kekl l fu"dkfÔr ikyhlDjkbM vkfn dk 'xhyh eki i)fr' l d.k vkdkj forj.k fo'yô.k fd;k x;kA ell ;cd fyfeVM dh çokg /kkjk l çkIr flFkfVd gkbMkVy lkbV d PSD fo'yô.k gr ,d fof/k dk fodkl fd;k x;kA midj.k dk ekud lnHk l dyhcV fd;k x;k FkkA mRikn fodkl rFkk c< ieku ij mRiknu d nkjku d.k vkdkj dh gj dne ij utj j[kh xb vkj bldh çfØ;k cuku e vudyu vkj ekudhdj.k e bl fo'yô.k dh egRoi.k Hkfedk jghA ;g fo'yô.kkRed i)fr lex SHT l'yô.k çk|kfxdh idt d ykbl l dk ,d fgLlk jgh gA

lrg {k=Qy vkj lj/kh ekiu d fy; Hkkfrd&'kkô.k ;=

mRçjd vkj xl iFkDdj.k inkFk t l /kkr vkDlkbM] ft;kykbV] flfydk] dkcu uuk V;c] ftjdkuh;k] Dy vkfn inkFkk d nk çe[k çkpky] fof'k"V lrg {k=Qy vkj lj/kh d ekiu e] ;g ;= vkdMk çnku djrk jgkA mRçj.k rFkk iFkDdj.k çk|kfxdh e bl ijh{k.k }kjk cgrj inkFkk dk fodkl o fMtkbu dju e rdlxr lkp çkIr gkrh gA

Hkkj vkj mRikn igpku d fy, ,ylh&,e,l

;oh çdk'k fofdj.k dh mifLFkfr e Qhuky] DykjkQhuky] ukbVkcUthu] jkMkekbu] eykpkbV xhu vkj dkxk jM d çdk'k&mRçj.k iru dk le>u d fy, b,lvkb&,e,l dk 0;kid mi;kx fd;k x;kA b,lvkb&,e,l l lenh 'koky ck;kekl dk lyykt d iru dk fo'yô.k fd;k x;kA behMk>kfy;e vk/kkfjr vk;kfud rjy inkFk] fHkUu dkcfud o vdkcfud rFkk çkdfrd mRiknk d y{k.k o.ku e ,ylh&,e,l dk fu;fer mi;kx fd;k x;kA

lenh 'koky e ektn ik/kk dh of) fu;kedk dk ,ylh&,e,l }kjk fo'yô.k

io e gekj }kjk b,lvkb&,e,l dk vuç;kx lenh 'koky jl e ektn ik/kk dh of) fu;kedk dh igpku d fy, fd;k x;k FkkA ,l of) fu;ked ftudk fo'yô.k igy ugh fd;k x;k] mudh igpku o ek=kRed fo'yô.k gr bl fof/k dk foLrkj fd;k x;kA buMky&3&çkih;kfud vEy d fo'yô.k e fd;k x;kA

lenh cDVhfj;k d jl e N&,lkby&gkeklhjhu dk ,ylh,e,l@,e,l }kjk v/;;u

lenh cDVhfj;k d jl e N&,ekby&gkeklhjhu dh igpku gr b,lvkb&,e,l vkj ,e,l@,e,l }kjk v/;;u fd;k x;kA ,ylh&b,lvkb&,e,l ekinMk d vudyu d ckn ekud ueu dk ,ylh&,e,l ØkeVkxke mRiUu fd;k x;kA rri'pkr db çkdfrd jlk dk bl fof/k }kjk fo'yô.k fd;k x;kA

,ylh&,e,l }kjk ikyhMkbehFkkby lhyUl (PDMS) dk y{k.k o.ku

Økl yhdj dh lgk;rk l PDMS dk mi;kx dj f>Yyh r;kj dh tkrh gA nfÔr ikuh e l vkxfud inkFkk dk fQYVj dju e ; f>fYy;k lgk;d gA PDMS d vk.kfod Hkkj forj.k dk v/;;u dju d fy, ,ylh&,e,l vk/kkfjr ,d fo'yô.k fof/k dk fodkl fd;k x;kA ,lblh@thihlh ikjifjd fof/k vlkekU; #i l mPp vk.kfod Hkkj n nrh g ¼yxHkx ,d yk[k½A ifj.kkek dh o/krk d fy, ,ylh&,ihlhvkb&,e,l fof/k dk fodkl fd;k x;kA vudyu ij ge Hkkj ØkeVkxke çkIr gvk ftldk mi;kx fofHkUu vkjVh ¼fjVU'ku Vkbe½ ij LiDVk dh pkfV;k dk mRiUu dju d fy, fd;k x;kA nk vyx PDMS d fy, MkVk mRiUu fd;k x;kA 2900 vk.kfod Hkkj rd nkuk ;kfxdk d fHkUu cgydhdj.k Lrj d vulkj vk.kfod Hkkj çkIr g,A ,lblh@thihlh fo'yô.k d nkjku PDMS ,df=r ljpuk cuk yr g ftll ; mPp vk.kfod Hkkj fn[kkr gA vr% PDMS d vk.kfod Hkkj forj.k d fy, ,ylh&,ihlhvkb&,e,l ,d cgrj fof/k gA

bFkuky fo'yÔ.k d fy, gMLi l ¼thlh,p,l,e,l½ d lkFk thlh,e,l

to bFkuky dk fodkl lLFkku dh ,d çe[k ifj;ktuk gA fdf.or ek/;e l çkIr bFkuky d vkdyu gr thlh,p,l,e,l dh lgk;rk l ,d fof/k dk fodkl fd;k x;kA fd.ou dh ifjfLFkfr;k dk vudy cuku d fy, yxHkx 250 ueuk dk fo'yÔ.k fd;k x;kA vU; fd.ou mi&mRiknk d vkdyu d fy, bl fof/k dk mi;Dr l'kk/ku fd;k x;kA

dkckgkbMV d fo'yÔ.k gr thlh,e,l

fuEu ck"i'khy gku dh otg l dkckgkbMV dk thlh,e,l }kjk fo'yÔ.k ef'dy gkrk gA fdUr ;g fo'yÔ.k ck"i'khy] ,lhVV 0;RiUu }kjk lHko gA fo'yÔ.k gr vudy ifjfLFkfr;k cukdj yxHkx 125 ueuk dk fo'yÔ.k fd;k x;kA fofHkUu ikyhldjkbM bdkb;k dh ljpuk le>u e bl v/;;u dh lgk;rk feyhA bl fof/k dk ifjofrr dj feFkkbyVM dk vkdyu Hkh fd;k x;k] ftll ikyhldjkbM d fofHkUu ekukej d chp dk lc/k le>k tk ldA

olk;Dr vEyk d fy, thlh,e,l

olk;Dr vEyk d fo'yÔ.k gr ektnk fof/k e ifjoru dj rhl feuV e 36 olkeDr vEyk dk iFkd dj mudh igpku dj ek=kRed fo'yÔ.k fd;k x;kA fofHkUu lkrk l çkIr olk;Dr vEyk dh #ij [kk cuku e blh fof/k dk ç;kx fd;k x;kA

thok'e Mhty fefJr ck;kMhty d eki gr thlh,e,l

thok'e Mhty e fefJr olk;Dr vEy ¼ck;kMhty½ dk vkdyu ,d dfBu leL;k gA bld vkdyu gr thlh,e,l vk/kkfjr ,d fof/k dk fodkl fd;k x;kA bl mí'; d fy, VVkMhdu vkj ikfefVd vEy feFkkby bLVj dk ekud lnHk d #i e mi;kx fd;k x;kA

,pih,ylh }kjk Mx fMyhojh v/;;u

5&¶ykjk ;jklhy] 6&ejdlVkl;fju] VekDlhQhu] ,ehVhlVhyhu] ukfVlVhyhu] diflVkckbu] Dohuhu] fjQfEiflu] foVkfeu ch&12] vkj lkbDykQkLQekbM d iFkDdj.k vkj ek=k fu/kkj.k gr ,pih,ylh vk/kkfjr ,d fof/k dk fodkl fd;k x;kA ,ehVhlVhyhu dk dyhc'ku oØ ($R^2 \geqslant 0.0996$) cuk;k x;kA nok dh fu;f=r fjdkM d fy, Dy ,d egRoi.k ifj;ktuk g ftle bl dk; dk egRoi.k ;kxnku gA

Mki xyukd eki midj.k dk ?kjy fodkl

xyckUM lu dfedYl çk- yh- iknk] oMknjk l ge eke d ueu Mki xyukd eki gr çkIr g,A ?kjy ç;kl }kjk midj.k dk fodkl fd;k x;k ftll ueu dk lQyrkiod fo'yÔ.k fd;k tk ldkA

ANALYTICAL SERVICES AND METHOD DEVELOPMENT

Centralized instrumental facility under Analytical Science Division was created in 2002 with the aim to bring all the major instruments of the institute under one umbrella to provide equal opportunity to all the users of the institute to use the facility for their work. Since its formation, Analytical Science Division has been rendering analytical services and intellectual input to all the in-house projects. The spare times of the instruments have also been utilized to render analytical services to the outside users, mainly for Ph. D. students from various universities and academic institutions. For outside users, analytical services were provided on payment basis (rate for analytical charges were approved by CSIR), however for Ph.D. students 75% discount on normal rates was offered to promote R & D activities of this region. This centralized facility has started with a few instruments and subsequently every year new instruments have been added according to institute's requirement and at present there are 35 major instruments. A group of dedicated scientists and technicians are involved in maintenance and operation of these instruments and also to develop new analytical methods as and when required for institute's R & D activities.

The list of instruments available under centralized facility during the reporting period, and the number of samples analyzed with these instruments are summarized and given below. For the record, we have calculated the value of the service rendered during the year on the basis of normal charges as approved by CSIR.

In addition to providing analytical services, we were also involved in analytical method development and modification of existing methods for better results. Highlights of some of the work are given below.

List of instruments in the centralized facility under Analytical Science Division

S. No	Instrument	Make/model
1	FT-NMR (500 MHz)	Bruker, Avance II 500
2	FT-NMR (200 MHz)	Bruker, DPX-200
3	FT-IR	Perkin Elmer, GX- FTIR
4	FT-IR-Raman	Nicolet FT-IR, NXR FT-Raman
5	CHNS/O Analyser	Perkin Elmer, Series II, 2400
6	Inductive Coupled Plasma Spectrometer (ICP)	Perkin Elmer, Optima 2000
7	X-ray Fluorescence Spectrometer (XRF)	Bruker AXS, S4 Pioneer
8	Atomic Absorption Spectrometer (AAS)	Shimadzu, AA-680
9	Ion Chromatograph (IC)	Dionex DX-500
10	Single Crystal XRD	Bruker Smart Apex CCD
11	Powder XRD	Philips X'pert MPD System
12	Thermal Analysers (TGA, DSC, DMA)	Mettler Toledo
13	Surface Area Analyser	Micromeritics, ASAP 2010
14	Particle Size Analyser	Malvern Mastersizer 2000
15	Scanning Electron Microscope (SEM)	LEO 1430 VP
16	Transmission Electron Microscope (TEM, 200 KeV)	JEOL, JEM 2100
17	Tensiometer	Data Physics
18	Rheometer	Anton Paar, Haake
19	Spectrofluorimeter	Perkin-Elmer, LS-50B
20	Spectrofluorimeter (with life-time attachment)	Horiba Jobin, Fluorolog
21	Spectrofluorimeter	Edinberg, Model FLSP920
22	Spectrophotometers (UV-VIS-NIR)	Varian Cary 500, Shimadzu
23	Circular Dichroism (CD) Polarimeter	Jasco, J-815
24	HPLC (three)	Waters (Allience) and Shimadzu
25	GC	Thermo, Trace-GC Ultra
26	GC-MS (with head space analyzer)	Shimadzu, QP-2010
27	Total Organic Carbon Analyzer (TOC)	Elementar, Liqui TOC
28	Biodiesel Rancimat	Metrohm 873
29	Atomic Force Microscope (AFM)	NT-MDT, Model Ntegra Aura
30	Time Correlated Single Photon Counting instrument (TCSPC)	Edinburgh Instruments, OB920

Sample analyzed during April, 2010 – March, 2011

Name of the instrument	Total samples analyzed
FT-NMR [500 MHz]	H=1155, C=239, ^{31}P=13, others (NOESY, DEPT etc.) = 27; Solid: H=56, C=153, ^{31}P=23, ^{29}Si=35, others 146
FT-NMR [200 MHz]	H=3262, C=941, ^{31}P=22
FT-IR	2530
CHNS/O Analyser	622
Inductively Coupled Plasma Spectrometer (ICP)	972 (elements 5647)
X-ray Fluorescence Spectrometer (XRF)	107
Atomic Absorption Spectrometer(AAS)	523 (elements)
Ion Chromatograph (IC)	460
LC-MS	1419
Powder XRD	722
Single Crystal XRD	136 (132 solved)
Thermal Analyses (TGA, DSC, DMA)	TGA=659, DSC=332, DMA=38
Surface Area Analyser (BET)	253
Particle Size Analyser	170
Scanning Electron Microscope (SEM)	1636
Transmission Electron Microscope (TEM)	652
Tensiometer (Goniometer)	111
Rheometer	109
Spectrofluoremeter (Horiba and Edinburgh)	1780
Spectrophotometers (Varian and Shimadzu)	8143
CD Polarimeter	89
HPLC (Waters & Shimadzu)	3296
GC	543
GC-MS	2877
Total Organic Carbon Analyzer (TOC)	709
Atomic Force Microscope	174
Time Correlated Single Photon Counting Inst. (TCSPC)	161

For the record, we have calculated charges for analytical services rendered using all the instruments mentioned above on the basis of normal rate (as approved by CSIR) and the total amount is Rs.8,34,41,800/-

Sample analyzed during April, 2011 – March, 2012

Name of the instrument	Total samples analyzed
FT-NMR [500 MHz]	H=2069, C=677, ^{31}P=7, others (NOESY, DEPT etc.) = 70; Solid: H=26, C=72, ^{31}P=4, ^{29}Si=32, others 11
FT-NMR [200 MHz]	H=2120, C=558, ^{31}P=4, ^{29}Si=2
FT-IR	2133
CHNS/O Analyser	660
Inductively Coupled Plasma Spectrometer (ICP)	1871 (elements 11059)
Ion Chromatograph (IC)	984
LC-MS	850
Powder XRD	374
Single Crystal XRD	98 (88 solved)
Thermal Analyses (TGA, DSC, DMA)	TGA=621, DSC=362, DMA=83
Surface Area Analyser (BET)	283
Particle Size Analyser	69
Scanning Electron Microscope (SEM)	2420
Transmission Electron Microscope (TEM)	559
Tensiometer (Goniometer)	101
Rheometer	163
Spectrofluoremeter (Horiba and Edinburgh)	3619
Spectrophotometers (Varian and Shimadzu)	7900
CD Polarimeter	260
HPLC (Waters & Shimadzu)	7367
GC	1241
GC-MS	2830
Total Organic Carbon Analyzer (TOC)	601
Atomic Force Microscope	229
Time Correlated Single Photon Counting Inst. (TCSPC)	105

For the record, we have calculated charges for analytical services rendered using all the instruments mentioned above on the basis of normal rate (as approved by CSIR) and the total amount is Rs.10,24,44,000/-

Analysis of Sauvarchan Lavan (salts used in Ayurved) by powder XRD

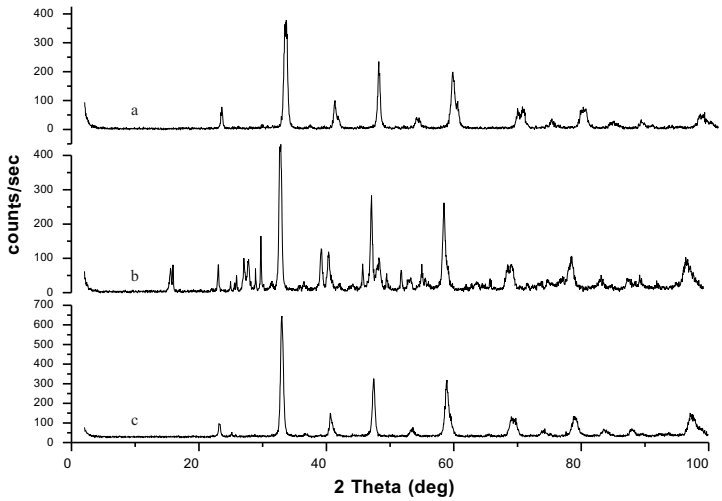
(Samples supplied by Central Council for Research in Ayurveda and Siddha)

Powder XRD analysis was carried out to ascertain the constituents of salts used in Ayurved (known as Sauvarchan Lavan). The measurements were carried out in the 2θ range 2° to 80° and search-match analysis using powder diffraction file database was performed to identify the phase(s) present. Apart from main constituents, some minor impurities were also identified and those were also confirmed from complementary evidences obtained from other analytical techniques (detailed results are not presented here because of the confidential nature of the report).

Phase identification in samples containing mixed oxides by powder XRD

(*Samples received from Nirma University)*

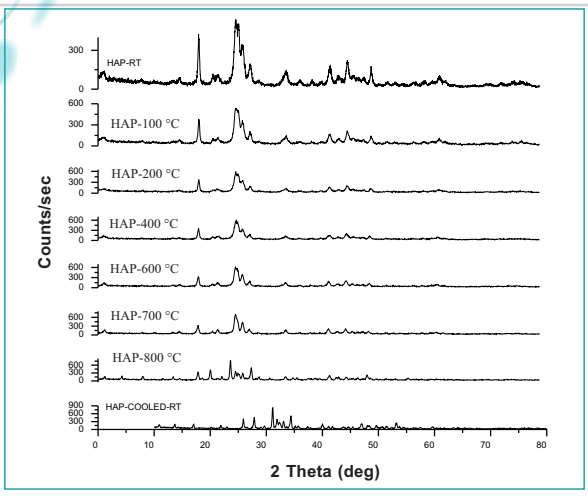
Powder XRD analyses of a series of composite materials containing oxides of various metals in different compositions were performed and the data were analyzed by search-match technique using powder diffraction file database. The materials comprised mainly oxides of cobalt, strontium and lanthanum in different combinations and ratios. Diffractograms of three samples are shown in the accompanying figure.



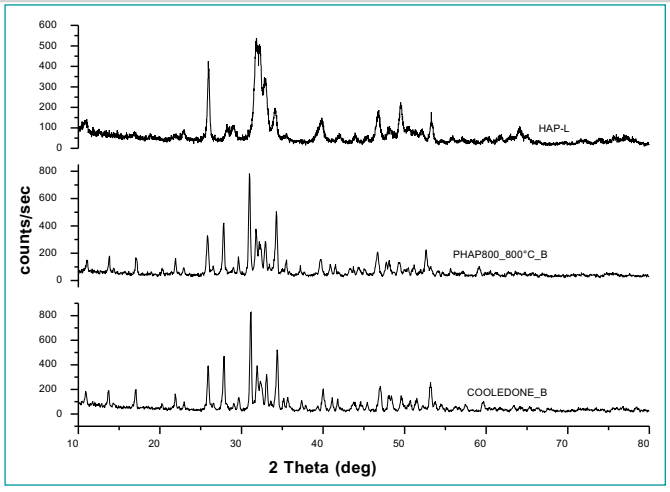
Powder XRD based phase identification of mixed oxides (a) $LaCoO_3$ (b) $LaCoO_3$ & $La0_{.6}Sr_{.4}CoO_3$ (c) $LaCoO_3$ & $SrCoO_2$

Study on ultrastructure of hydroxyl apatite (HAP) phase in the dental calculi of dogs from different regions of Gujarat

Samples for this analysis were obtained from the Surgery Department of Veterinary College at Anand. Constituents of surgically removed dental calculi of dogs of different breed, age and sex, from different regions of Gujarat, were identified using powder X-ray diffraction and FT-IR techniques. Powder XRD findings revealed that nano sized apatite phase was the main constituent present in the calculi of almost all the dogs. Apatite phases present were either hydroxyl apatite or carbonated hydroxyl apatite, and this was further confirmed by FT-IR measurements. In case of carbonated apatite, type (A or B) of substitution of carbonate ion could also be inferred from FT-IR. Presence of protein content in dental calculi was also confirmed from the presence of amide-I and amide –II bands in the FT-IR spectra. Thermo-gravimetric analysis was performed for all the calculi to complement the findings of XRPD and FT-IR. The phase transitions at different temperatures were also carried out with the aid of powder XRD to correlate the result with thermal analysis. In pure HAP at room temperature, pure hydroxyl apatite was present. Phase transformation began at 300 °C and calcium- containing multiple phases began appearing at 800 °C. Upon cooling to room temperature, pure hydroxyl apatite phase was not obtained, i.e., the transition was irreversible. The surface morphology of the apatite phase was also examined by SEM. Work is presently underway to examine the interwoven morphology of mineral and organic content of the dental calculi using TEM.



Diffractograms showing temperature dependent phase transitions in hydroxy apatite



Diffractograms showing irreversible phase transition HAP-L (HAP measured at RT is different from the measurement done at RT for the cooled one)

Determination of unit cell parameters of MOF and nitrobenzene loaded MOF by PXRD

Powder XRD measurements were performed for MOF in the absence and presence of different loadings of nitrobenzene. The instrument was operated at 40 KV and 30 mA in the 2θ range of 2 to 60°, step size of 0.02° 2θ and time per step = 4 second. Unit cell parameters were determined using the Treoer method available in Highscore Plus software.

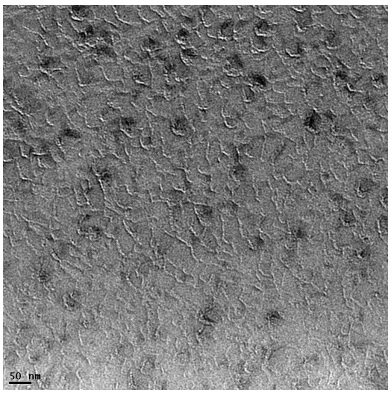
The unit cell structure of MOF was monoclinic whereas upon loading with nitrobenzene the structure changed to triclinic even at the lowest loading level of nitrobenzene. The unit cell volume was also raised. Curiously, the cell volume decreased from 1256.76 to 1097.54 $Å^3$ at higher loading. Change in pH also showed transformation from monoclinic to triclinic. The results are shown in the following Table. The observations have been rationalized.

Sample code	Crystal system	Unit cell parameters (a b c in Å, α β γ in °)	Unit cell volume ($Å^3$)
MIL-53 lt (Al)	Monoclinic	a = 10.53 α = 90.0 b = 16.89 β = 103.39 c = 6.398 γ = 90.0	1107.21
MIL-53-24 mg NB	Triclinic	a = 8.915 α = 65.198 b = 9.888 β = 70.626 c = 17.012 γ = 71.589	1256.76
MIL-53-36 mg NB	Triclinic	a = 6.37 α = 62.83 b = 11.19 β = 94.25 c = 18.628 γ = 111.03	1097.54
MIL-53-pH -11	Triclinic	a = 6.153 α = 60.45 b = 9.171 β = 82.27 c = 17.267 γ = 86.91	839.87

Transmission electron microscopy (TEM) for material characterization

Electrochemical loading of the sample over TEM grids

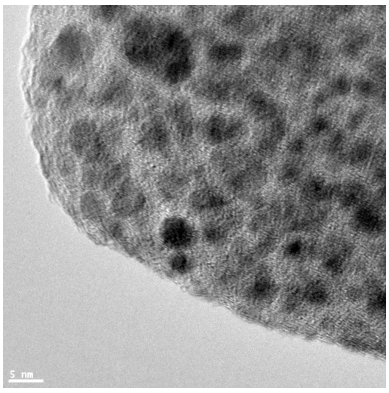
The conformation of the conducting polymers is function of its electrochemical state. This phenomenon is extensively utilized for various applications like actuation and sensing. The structure-property correlation of these materials is not fully understood, however. A method has been developed for electrochemical loading of material over TEM grid. The gold grid of 300 mesh size was used as working electrode and aniline was electropolymerized over the grid using tiny custom made reference and counter electrodes. The potentio-dynamic cycle was stopped at various electrochemical states and the morphology of the polyaniline film was investigated by TEM. Two such images are shown and the differences in their morphologies are discernible. This is an important step towards *in situ* monitoring of the conformation of the conducting polymer as a function of electrochemical state.



Morphology of polyaniline film *in situ* coated over gold TEM grid

Microtomy of polymer membranes

The distribution of functionalized silica particle dispersed in polymer membrane was imaged by TEM. The thickness of the membrane commonly falls in micrometer range. Hence it was sectioned using cryo-microtomy before TEM investigation. A representative image is given where the distribution of silica can easily be seen



Cross-sectional TEM image of polymer embedded with silica particles

High resolution TEM images

High resolution images (and also SAED, EDS and STEM) of a large number of samples from different disciplines were recorded and a few of the images are given below.

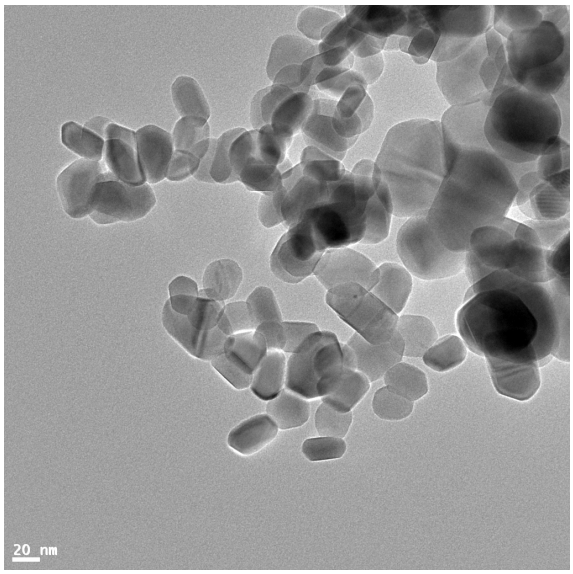
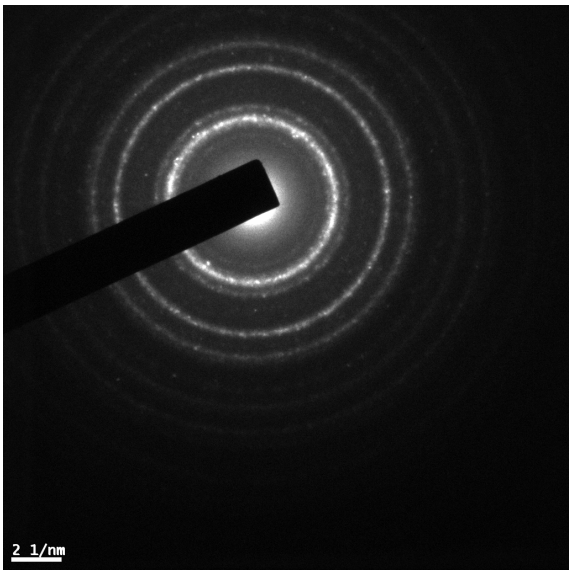


Image of Cu-Cr particles



Electron diffraction of Cu-Zr particles

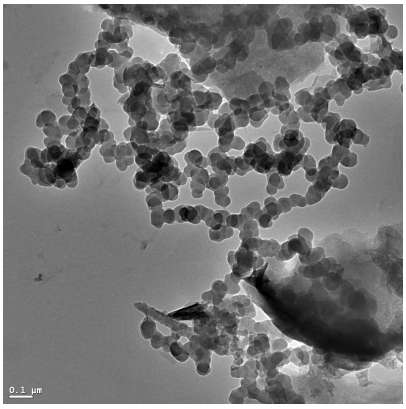
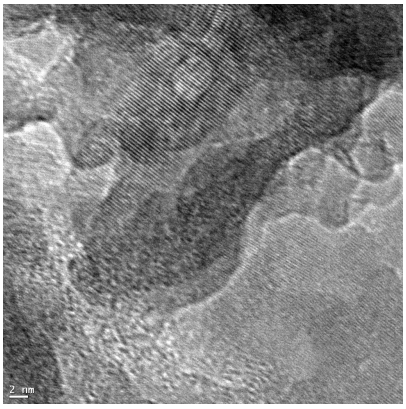
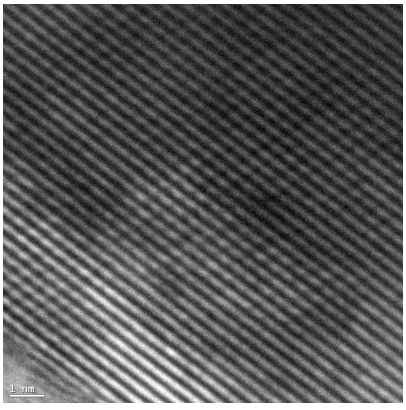


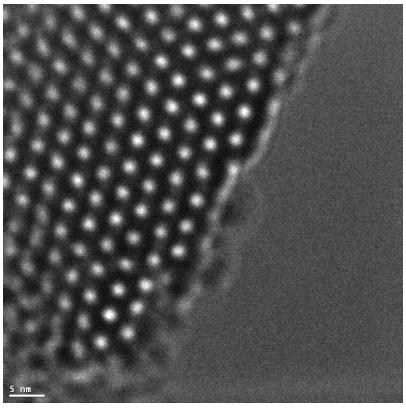
Image of biological sample (DNA)



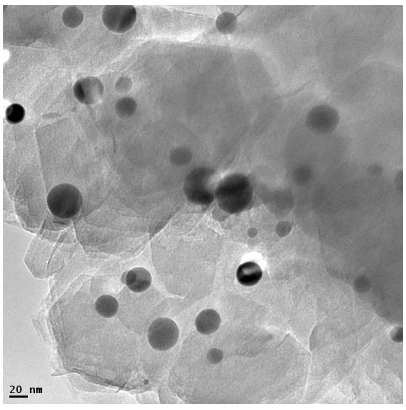
Lattice fringes of animals teeth



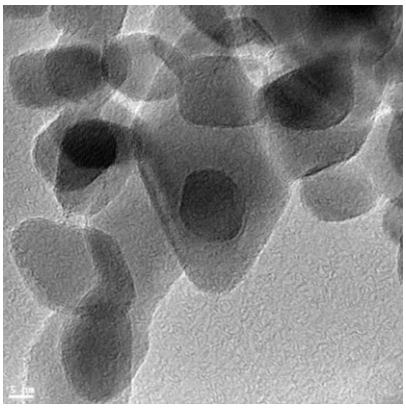
Mo supported on TiO_2



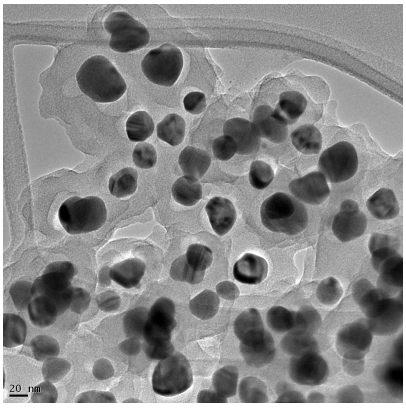
Hexagonal pores opening of mesoporus silica



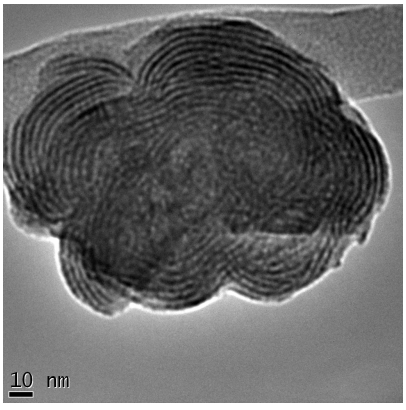
Palladium incorporated montmorillonite clay



Ag particle on titanium dioxide surface



Metal oxide dipped polymer



ZnS nanowires

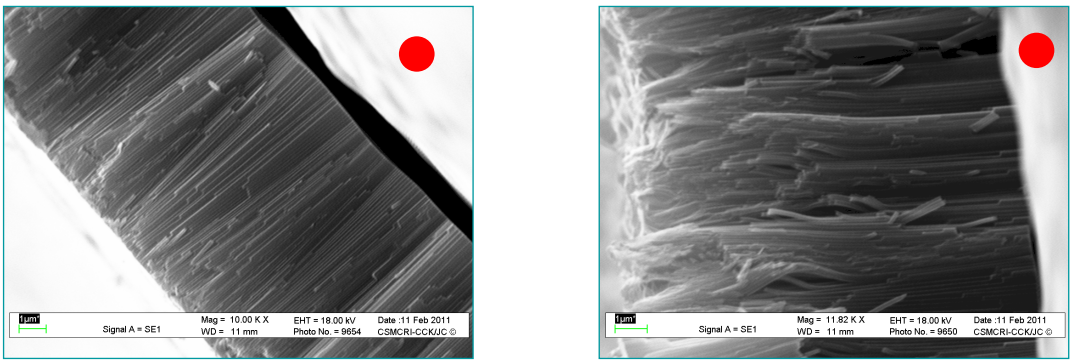
Scanning electron microscopy (SEM) for material characterisation

Technique developed for recording SEM images

Imaging of lateral portion of a thin sample is always difficult due to difficulties in mounting. To overcome the problem, tailored SEM stubs were designed having a groove in the center and a screw to tighten the sample within the groove as shown in the following images. The sample was electrodeposited over the titanium plate.

Optical image of a titanium plate sample mounted over the newly designed stubs

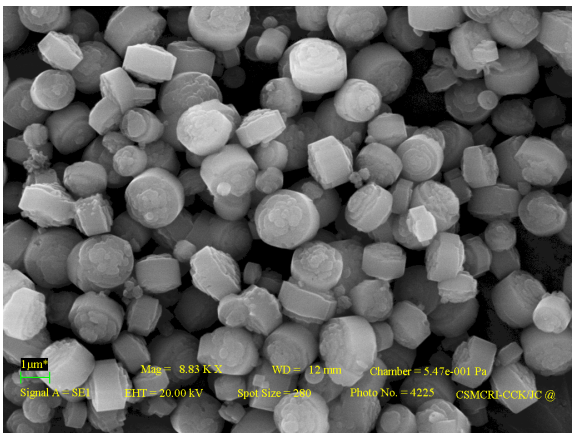
Selected images recorded in this fashion are shown below



Cross-section view, the red mark indicate the electrode (titanium) over which TiO_2 nanotubes were electrodeposited

High resolution SEM Images

High resolution images of a large number of samples from different disciplines were recorded and a few of the images are given below.



Zeolite-L sample

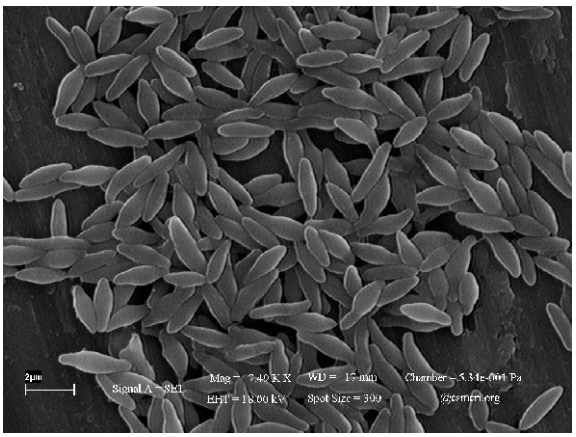
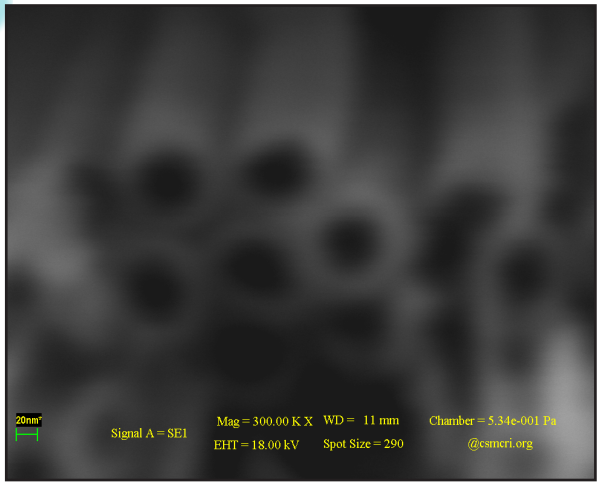
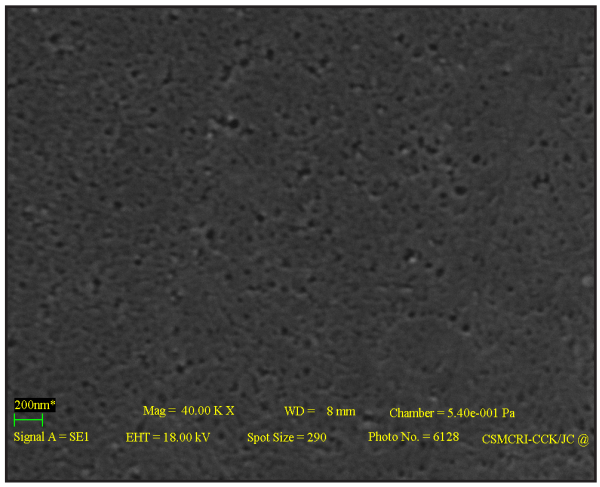


Image of bacteria

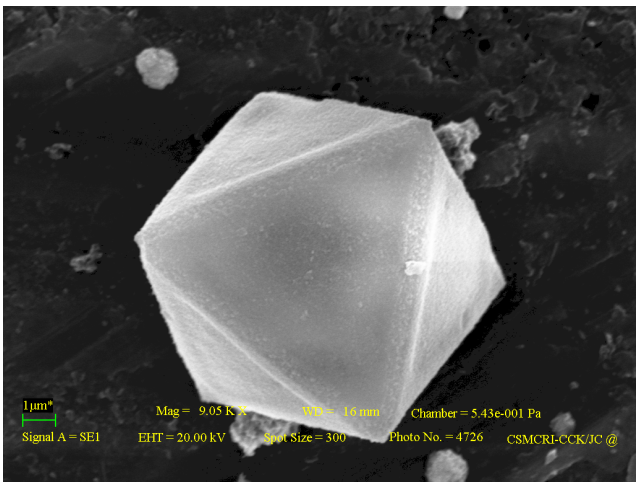


TiO_2 nanotubes (magnification 200K)

Niobium oxide (Niobate)



Membrane surface (200 nm range)

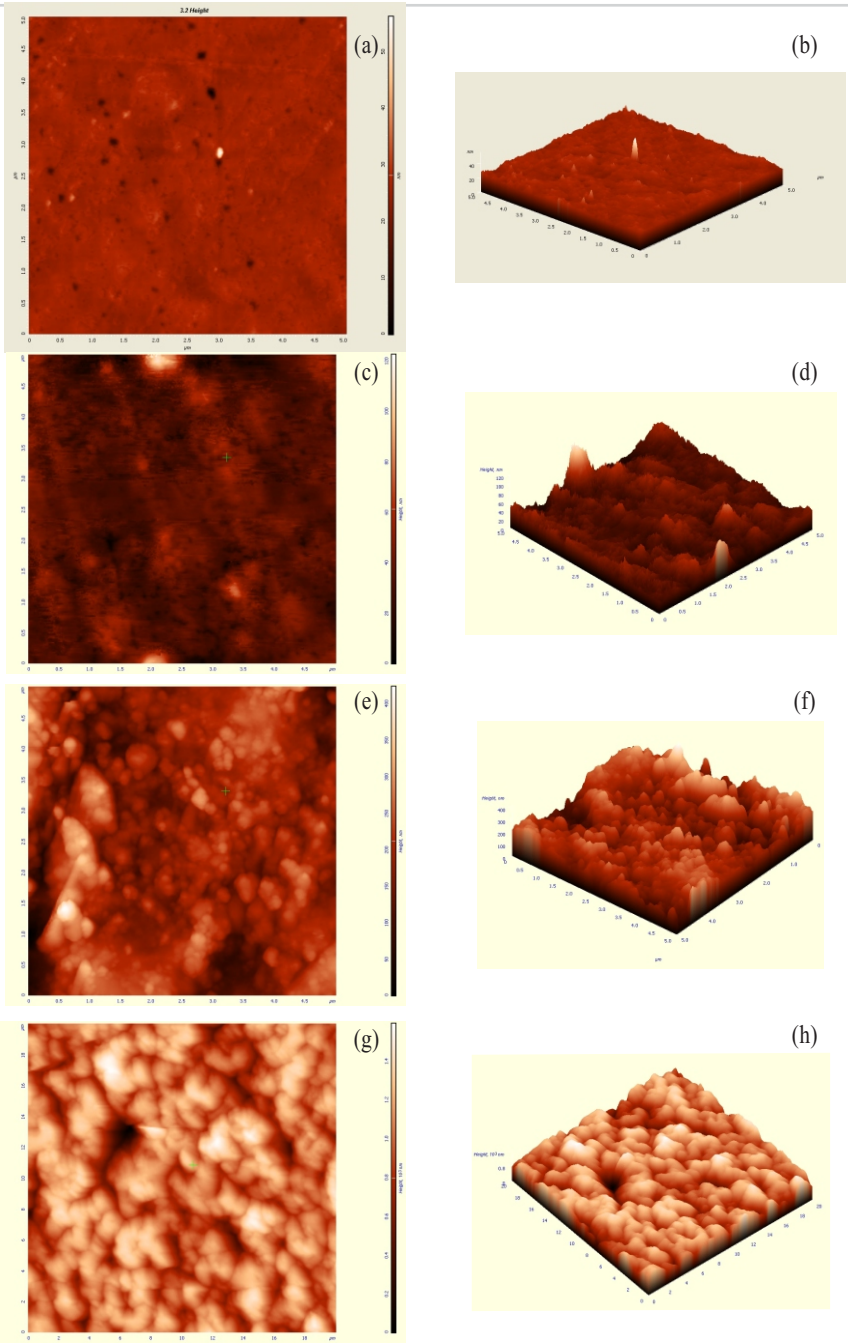


Copper triazolate (hydrothermal synthesis)

Atomic force microscopy (AFM) for surface characterization

Surface characterization of membrane for fouling study

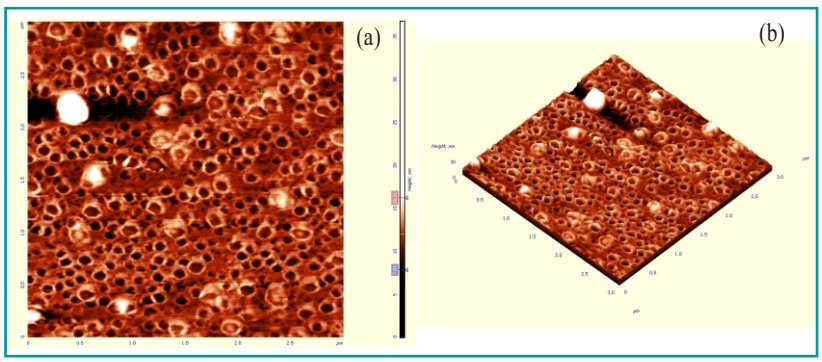
Surface roughness of membranes is an important property to study owing to membrane fouling. AFM is used to estimate roughness of the surface in semi-contact mode. The AFM images obtained (a to h, shown below) showed agglomeration of APDSMO (siloxane monomer) due to polycondensation, which further increased with silica content in membrane matrix. PVA thin film without any cross linking exhibited lowest surface roughness (0.03 mm; fig a and b), while the surface roughness observed for MO (2-mercaptoethane-5-phenyl-1,3,4-oxadiazole)-3, MO-4 and MO-6 hybrid membranes were 0.254 mm (fig c and d), 0.112 mm (fig e and f), and 0.05 mm (fig g and h), respectively. With incorporation of APDSMO, surface roughness increased initially (MO-3) but reduced subsequently for APDSMO loading beyond 30% (w/w) (MO-4, MO-6).



(a) Surface morphology of PVA thin film without crosslinking, (b) 3D view of PVA thin film without crosslinking (c-h) Surface morphologies and 3D views of various 2-mercaptoethane-5-phenyl-1,3,4-oxadiazole (MO) hybrid membrane

Imaging of vesicles

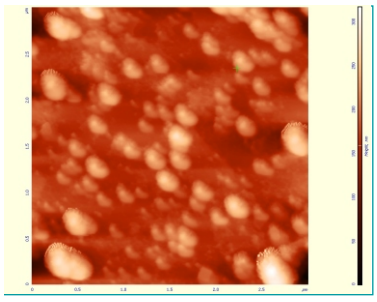
The surface morphologies of 2 mM solution of ionic liquids prepared from a mixture of 1-methyl, 3-octyl imidazolium chloride and 3-methyl, 1-butyl imidazolium octyl sulphate in aqueous solution were recorded. 2D (left) and 3D (right) AFM images of 3 µm x 3 µm frame revealed a typical spherical morphology of vesicles in the size range of 100-200 nm.



(a) Surface morphology of the 2 mM ionic liquids (b) 3D view

Characterization of vesicles and reverse vesicles of ruthenium bipyridyl based amphiphiles

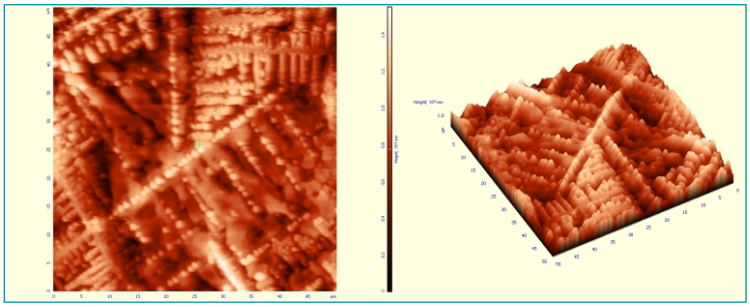
The amphiphiles were prepared through chemical reactions of $RuCl_3$ with bipyridine derivatives containing hydrophobic long chains of $-C_{18}H_{37}$, $-C_{14}H_{29}$, $-C_{10}H_{21}$. These complexes contain hydrophilic ruthenium core and long chain hydrophobic part. They form vesicles in polar solvent like water and reverse vesicles in nonpolar solvents like toluene and cyclohexane. These were characterised by atomic force microscopy. The surface topography of 3 µm x 3 µm frame 2D is shown in the image.



Vesicles of ruthinium bipyridyl based ampiphile

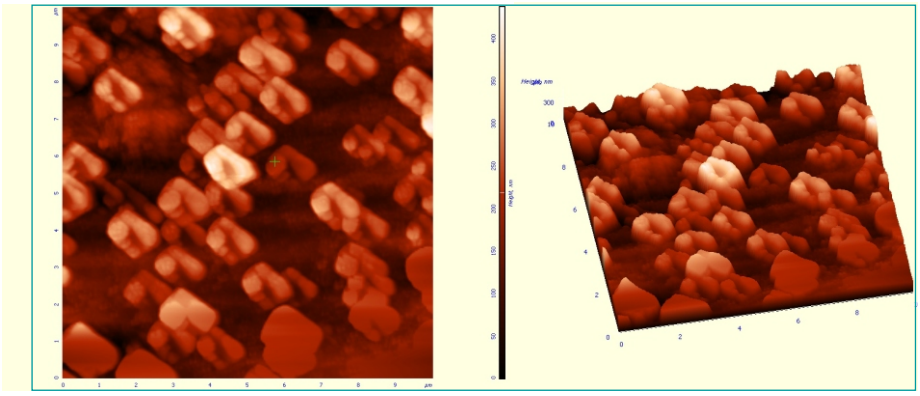
Crystalline morphology

The morphology of crystalline gel prepared from NaCl and phosphate salt were observed by AFM images of 50 µm x 50 µm frame. 2D (left) and 3D (right) images are shown in the accompanying figures.



Surface morphology of the crystalline gel and 3D view

Modification in bacterial morphology



Surface morphology of the bacteria and 3D view

Bacterial suspension was prepared after equilibration with biocidal polymers and the modification in morphology of the bacterial cell was observed after testing for antibacterial activity. AFM images of 10 µm x 10 µm frame 2D (left) and 3D (middle) showing surface morphology are given in the accompanying figures.

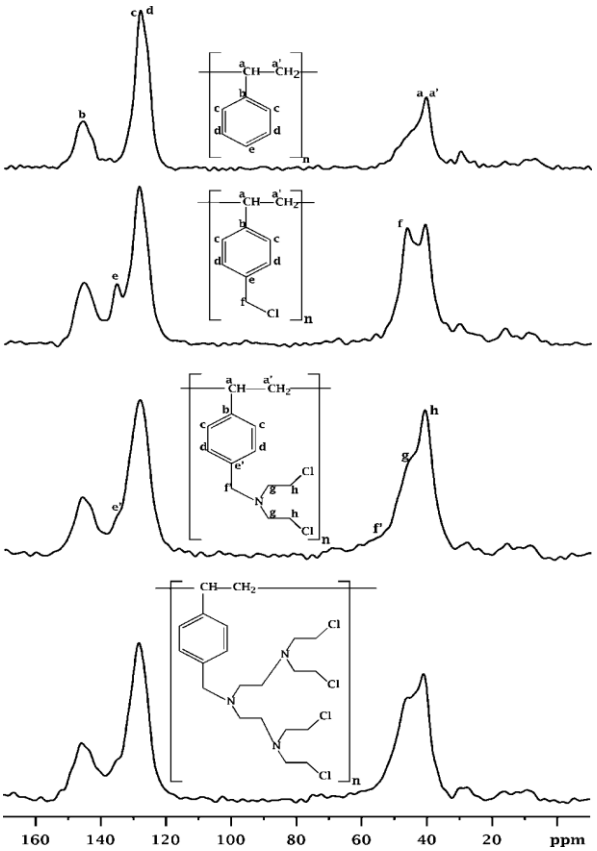
Multinuclear NMR study of salts

It is known that NaCl forms clusters in water. These were found to be big and very stable to temperature variation compared to other salts. This anomalous behavior of NaCl was probed by multinuclear NMR. ^{1}H, ^{17}O, ^{35}Cl NMR spectra of aqueous solution of NaCl, KCl and NH_4Cl were recorded at variable temperature. An anomalous variation was observed in ^{35}Cl NMR and the variation was larger for NaCl system which indicated the formation of strong Cl---H interaction in NaCl system. Thus, strong hydrogen bonding in NaCl system enhanced the cluster stability with temperature. The solid state ^{35}Cl NMR spectra of these salts were also recorded and compared with their solution spectra. These studies corroborated the presence of strong Cl^- and H^+ interaction in aqueous NaCl system.

Solid-state NMR investigation of dendrimers grafted on indigenous resins

Dendritic structure was grafted on indigenously prepared styrene-divinylbenzene (DVB) copolymer beads by forming two successive generations of di(chloroethyl)amine-type end group functionality for bacterial disinfection of drinking water. Solid-state NMR was employed to characterize the synthesis pathway. Sample was spun at 15 kHz to counter the resolution loss from spinning sidebands in ^{13}C spectra acquired after cross polarisation. Spectral appearance at various stages of the substitution was indicative of changes in the molecular fragments. Predominant site for chloromethylation was deduced to be the *para* position of the benzene ring. The molecular fragments along with assignment of relevant spectral peaks are described in the accompanying figure.

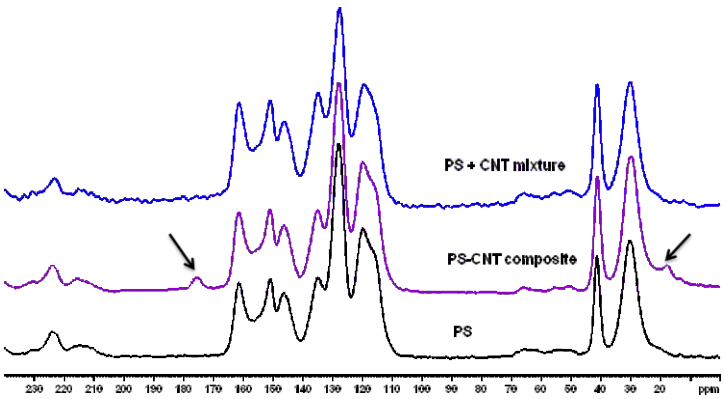
This knowledge was used to devise a method of characterizing cation and anion exchange membranes casted using styrene and divinylbenzene. This understanding can be further employed for determining relative degree of sulfonation/chloromethylation to explore structure activity relationships.



Solid-state NMR characterisation of dendrimer grafting on the styrene-DVB beads. Molecular fragments are drawn with corresponding ^{13}C CPMAS spectra along with the assignment

NMR study of carbon nanotube (CNT) composite polysulphone membrane

The interaction of polysulfone with CNT was observed in NMR. The solid state NMR spectra of polysulfone-CNT (PS-CNT) composite, pure polysulfone and CNT polysulphone mixture were recorded. Two new peaks were observed in CNT-polysulfone composite, one in aromatic region and another in aliphatic region which indicated the formation of a truly composite structure.



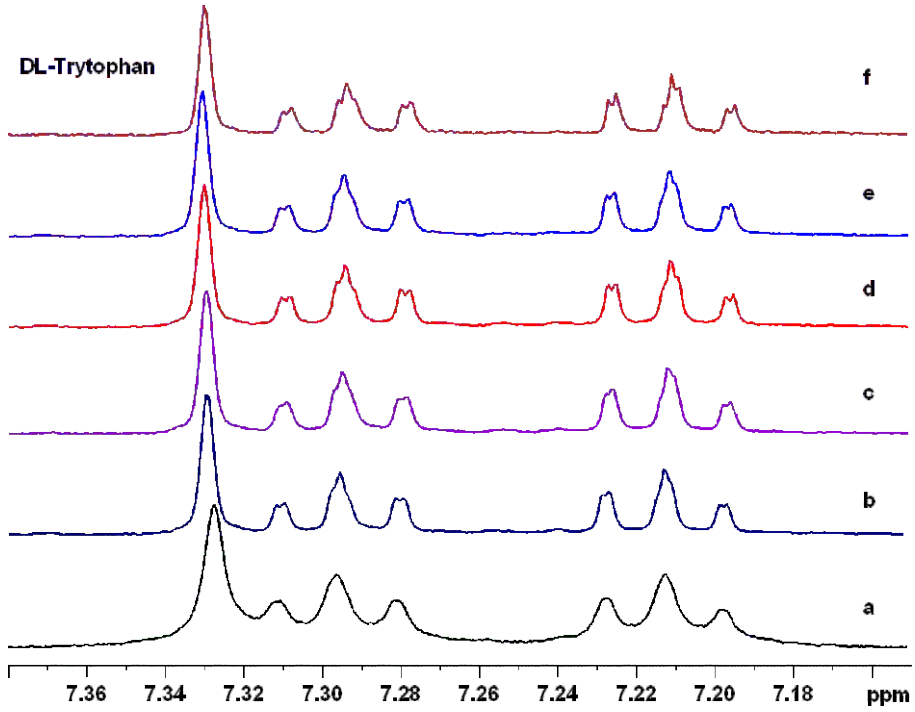
^{13}C NMR spectra of PS, PS-CNT composite and mixture of PS and CNT

Improved structural information of gelling polysaccharide using NMR spectroscopy

Correlation spectroscopy (COSY), displaying connectivity between ^{1}H nuclei at distance of three bonds, was employed for resolving assignment ambiguity of gelling polysaccharide. Correlation between pair of ^{1}H and ^{13}C nuclei were obtained using HSQC experiment where gradients were applied for enhanced sensitivity. The COSY and HSQC spectra of sol phase, at 70 °C, were acquired on Bruker Avance II 500 MHz spectrometer equipped with BBO probe.

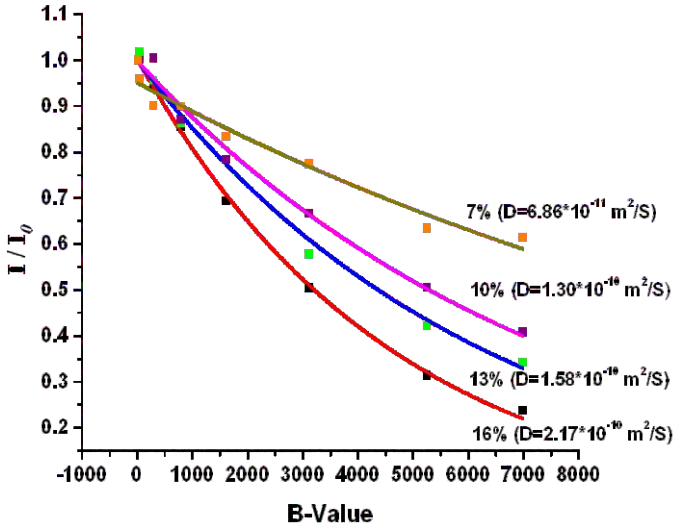
Enantiomeric selectivity of *β*-cyclodextrin (BCD) by NMR

The enantiomeric resolution of amino acids was achieved with *β*-cyclodextrin, a well known chiral NMR shift agent. The ^{1}H NMR spectra of enantiomeric mixture of amino acid at different concentration of BCD were recorded. The splitting of ^{1}H NMR peaks was observed because of difference in binding constant and stability of complexes of the two enantiomers with BCD.



^{1}H NMR spectra of D and L tryptophan mixture at different concentration of BCD, the concentration of BCD increases from a to f.

Study of the property of ion exchange site of electrodialysis (ED) membrane by diffusion MRI

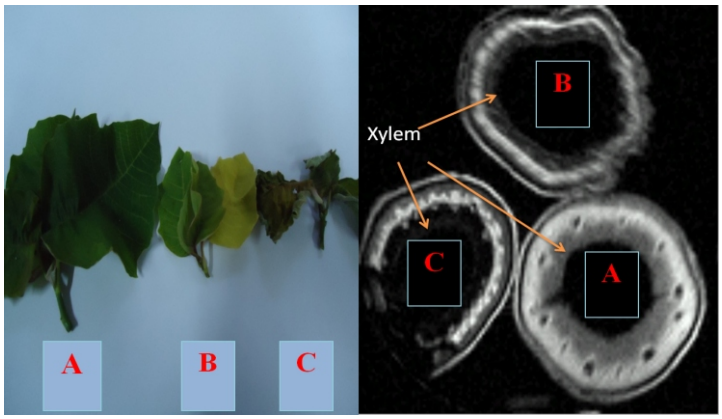


Ion exchange property and nature of the ED membrane are decided by the property of the ion exchange site. The diffusion values of H_3O^+ in four ED membranes having different water content were measured by diffusion magnetic resonance imaging (MRI). A decrease in diffusion value was observed on decreasing the water content in membrane.

Relative ^{1}H NMR intensity decay with B-value for ED membrane having different water contents and their corresponding diffusion values

Anatomical MRI study of plant stem

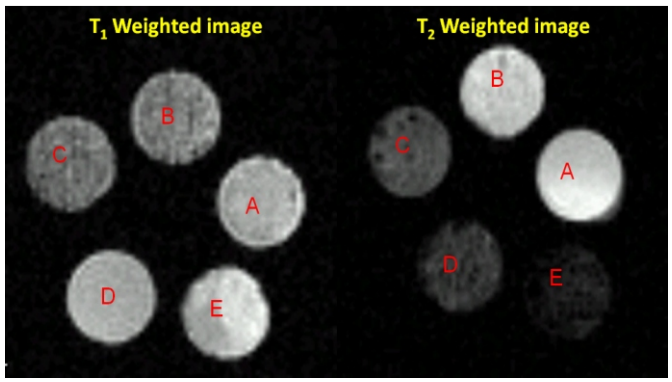
Anatomical changes in stem of diseased plant were studied by MRI and compared with healthy plant. MRI images of three stems: A (healthy), B (less healthy) and C (least healthy) were recorded. It was observed that the intensity of proton signal in xylem region was least for stem C indicating the reduction in water binding capacity of xylem due to disease.



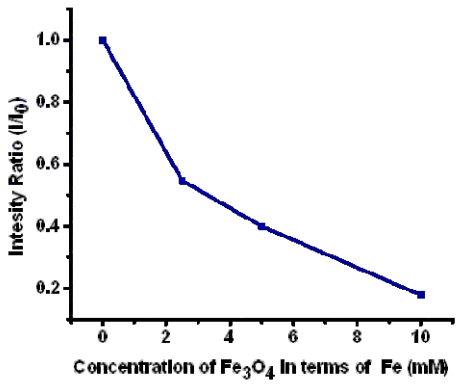
MRI image of plant stems having three different stages of disease

MRI contrast study of Fe_3O_4 nanoparticles

Fe_3O_4 nano-particles can generate MRI contrast by affecting the relaxation time because of their magnetic property. To understand the contrast properties of such particles, their MRI images were recorded on 500 MHz Bruker microimaging NMR spectrometer. Five samples of different concentration (A<B<C<D<E) of Fe_3O_4 nanoparticle were prepared and their images recorded. It was observed that the contrast in T_2 weighted images changed more vigorously as compared to the T_1 weighted images thereby suggesting that Fe_3O_4 nanoparticles work as T_2 contrast agent. The contrast in images increased with nanoparticle concentration.



T_1 and T_2 weighted images of Fe_3O_4 nanoparticle dispersed water phantoms



Variation of signal intensity with Fe_3O_4 nanoparticle concentration in T_2 weighted MRI image

Sorption study of water and alcohol on RO polyamide membrane by ATR-IR

An analytical method based on ATR-IR spectroscopy was developed and used to measure water and alcohol sorption from water-methanol and water-isopropanol aqueous solutions in the reverse osmosis polyamide membrane. Preferential sorption of water over alcohol was observed in the membrane. As alcohol concentration in the solution increased, the sorption selectivity of water over methanol increased from 6 to 328 while the selectivity of water over isopropanol increased from 2 to 8 (as alcohol %) for the membrane. However since water is non-solvent for polyamide, the membrane surface structure remains unaffected by its sorption. On the other hand, the sorption of alcohol in the membrane leads to decrease in characteristic IR band intensities of the polyamide implying a change in membrane

surface structure which is corroborated by the change in membrane surface roughness observed by AFM and SEM.

Determination of bromide and sulphate in table salt by ion chromatography (IC)

Ion chromatographic estimation of bromide and sulphate impurities present in table salt was accomplished with a AS 11-HC IC column. Quantitative recovery of the anions in synthetic samples was obtained and the interferences from different cations and anions were studied. Total bromide/sulphate was determined without any treatment with silver cartridge normally employed for high chloride matrix removal. Quantitative analysis was feasible for bromide and sulphate concentrations $\geqslant$ 4 and 10 ppm, respectively, in salt. Table salt containing bromide and sulphate together were analysed and the two constituents were quantified separately with a single chromatographic run. The method was successfully applied to the determination of bromide and sulphate in the commercially available salts.

Inductively coupled plasma (ICP) spectrometer for elemental analysis

Inductively coupled plasma (ICP) spectrometry is a technique for estimation of metal ions present in trace amounts. This instrument has been extensively used for the elemental analysis of various samples obtained from different departments of the institute and also from outside users. Among the many diverse applications, it was used for monitoring of heavy/toxic metal ions in effluent and also in samples of pharmaceutical products. Micronutrients in biological samples and metal ions in soil (after extraction) were also probed. Studies were also conducted to monitoring reaction intermediates and probe exchange of metal ions in zeolite samples.

X-Ray fluorescence (XRF) for elemental analysis

Quantitative elemental analyses of a variety of solid samples were undertaken with XRF spectrometer. It was utilized for (1) determination of metals of interest along with impurities of undesired elements; (2) the exchange of metal ions in zeolites and related matrices; (3) study of compositional differences between raw and upgraded/treated clays; (4) trace level analysis of toxic heavy metals in soils; (5) standardless semi quantitative elemental analysis of critical samples and (6) study on the exchange of ions in fluoride removal resin at various stages of treatment and regeneration.

Particle size distribution (PSD) analysis

"Wet measurement method" was applied to obtain PSD measurement of synthetic hydrotalcite, clay, zeolites, silica, precipitated $CaCO_3$, extracted polysaccharides from biomass, etc. A method was optimised for PSD measurement of synthetic hydrotalcite (SHT) obtained from certain effluent streams generated at M/s Heubach Ltd. The instrument was calibrated using Audit Standard Reference Material. During scale up and product development, the particle size was monitored at each step and the analysis was useful for optimization and standardization of the process. The analytical methodology constituted a part of the overall technology package on SHT synthesis licenced to the company.

Physisorption instrument for surface area and porosity measurement

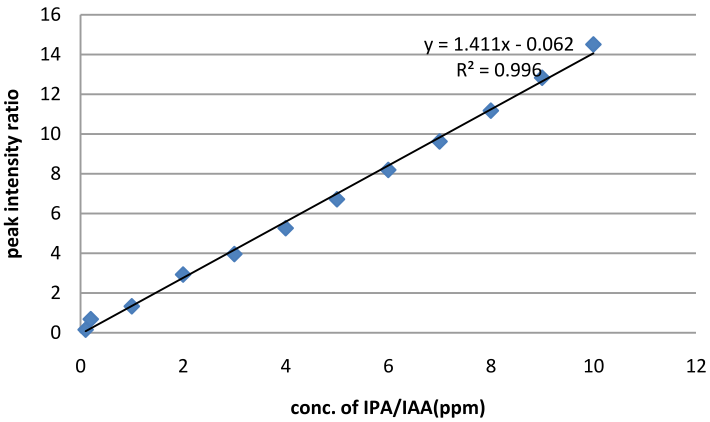
This instrument continued to provide data on two important parameters i.e. specific surface area and porosity of catalytic and gas separation materials like metal oxides, zeolites, silica, CNTs, zirconia, clay, etc. This characterization is important for design of superior materials for catalytic and separation technology.

LC-MS for mass analysis and product identification

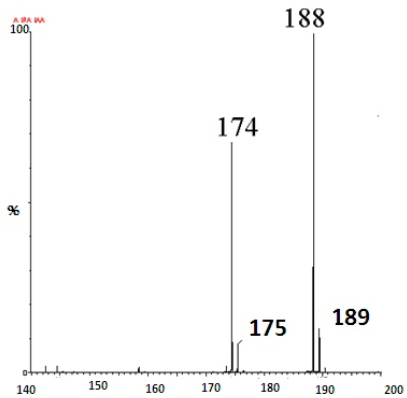
ESI-MS has been used extensively for understanding of the photocatalytic degradation pathway of phenol, chlorophenol, nitrobenzene, Rhodamine-B, Malachite green, and Congo Red in presence of UV-light irradiation. Biomass of seaweed was analyzed in ESI-MS for cellulose degradation study. LC-MS was also used regularly for characterization of imidazolium based ionic liquids and various organic and inorganic compounds and natural products.

Analysis of some plant growth regulators present in seaweed by LC-MS

ESI-MS was applied by us previously for identification of plant growth regulators (PGR) in seaweed sap. This method was extended for identification and quantification of other plant growth regulators not analysed previously. A typical calibration curve with indole-3-acetic acid as standard is shown in the accompanying figure which was used for the analysis of indole-3-butyric acid and indole-3-propionic acid. The mass spectrum of the latter is also shown.



Standard curve generated in ESI MS for indole-3-propionic acid using indole-3-acetic acid as internal standard



Mass spectra of indole-3-propionic acid using indole-3-acetic acid as internal standard

LC-MS/MS study of N-acyl–homoserine lactones in marine bacterial extract

ESI-MS and MS/MS were undertaken to identify N-acyl-homoserine lactones in marine bacterial extract. Well resolved LC-MS chromatograms were generated for standard sample after optimization of LC-ESI-MS parameters. Thereafter, a number of natural extracts were analyzed following this method.

Characterization of polydimethylsilanes (PDMS) by LC-MS

PDMS has been used for preparation of membrane with the help of cross linkers. These membranes help filter organics from contaminated water. An analytical method based on LC-MS was developed to study the molecular mass distribution of PDMS. The conventional method employing SEC/GPC gave unusually high molecular weight (around one lakh). To validate the result, LC-APCI-MS method was developed. On optimization, we got well resolved mass chromatogram which was used for generating mass spectra of peaks at different RT. Data were generated for two different PDMS. For both the compounds we got molecular weight corresponding to different degree of polymerization up to MW 2900. Since PDMS tends to form aggregated structure, these yield apparently very high molecular weights during SEC/GPC analysis. LC-APCI-MS is thus a better method to measure molecular weight distribution of PDMS.

GC-MS with head space (GCHSMS) for the analysis of ethanol

The institute has a major project on development of bio-ethanol. A method was developed with the help of GCHSMS for the estimation of ethanol obtained from the fermented medium. About 250 samples of this type were analyzed to optimize the conditions for fermentation. The method was also modified suitably for the estimation of other fermented byproducts.

GC-MS for the analysis of carbohydrates

Due to their low volatility, carbohydrates are difficult to analyze by GC-MS. However, such analysis is feasible through derivatization to volatile acetate. By setting the optimum conditions for this analysis, around 125 samples of this type were analyzed. The study helped to understand the composition of different polysaccharide units. The method was modified for the estimation of methylated carbohydrate monomers also, which helped to understand the linkage between the different monomers in polysaccharide.

GC-MS for fatty acid analysis (in FAMEs)

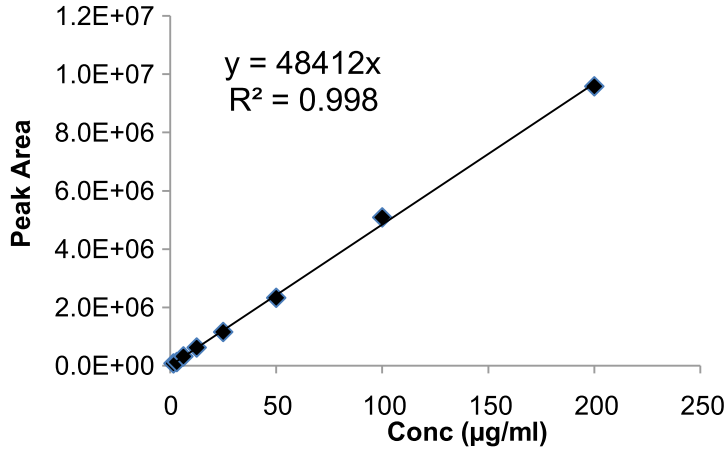
Modification of the existing method for fatty acid analysis was carried out, which enabled us to separate, identify and quantify 36 fatty acids (FAMEs) within thirty minutes. This method was applied in profiling of fatty acids obtained from various sources.

GC-MS measurement of biodiesel mixed with fossil diesel

Estimation of fatty acid methyl ester (biodiesel) mixed in fossil diesel is a difficult problem. A method was developed based on GC-MS for such estimation. Tetradecane and palmitic acid methyl ester were used as standard references for this purpose.

Drug delivery study by HPLC

HPLC-based methods were developed for the separation and quantification of 5-fluoro uracil, 6-mercaptopurine, temoxifin, amitriptyline, nortriptyline, capecitabine, quinine, rifampicin, vitamin B-12, rifampicin, and cyclophosphamide. The calibration curve prepared for the nortriptyline drug ($R^2 \geqslant 0.998$) is shown in the accompanying figure. The work has contributed significantly to an important project on use of clays for controlled drug release.



HPLC linearity chart for nortriptyline

Indigenously developed drop melting point measurement device

Samples of wax were received from M/s Gulbrandsen Chemicals Pvt. Ltd., Padra, Vadodara for their drop melting point measurements. A device was developed in-house for this purpose and could perform the analysis successfully.

çdjÆ
CHAPTER 7

lekt dh lok esa lh,l,elhvkjvkbZ

CSMCRI IN THE SERVICE OF SOCIETY

lekt lok e lh-, l-vkb-vkj-& lh-, l-,e-lh-vkj-vkb

lpuk & çlkj

ehfM;k }kjk lLFkku d 'kk/k ,o lekt&loh xfrfof/k;k dk HkyhHkkfr lou fd;k x;kA ifj.kker% budk mRd"V dojt gvkA

n'k e U;ure vFkok NkV ieku d {k= e mPp 'kðrk d lkyj lkYV VDukykth dh l[;k e rth l c<kÙkjh

dk;Øe d¨ 2008 – 10 e fØ;kfUor dj fujUrj n[kdj ;g fuf'pr fd;k x;k fd U;ure {k= d ykx bu rduhfd;¨ l çkIr Òkfrd ykHkk d vkuUn yAu; ued DyLVj fodkl dk;Øe dk blh nkjku çLrr fd;k x;k rFkk SEWA cuj d vUrxr 250, de vk;oky vxfj;kvk d fy, çf'k{k.k dk;Øe Hkh fd;k x;kA

VDukykth vixM'ku rFkk fcVu oY; ,Mh'ku e l/kkj }kjk jktyk {k= ij ekjthuy vxjh;kvk d }kjk ued d mRiknu dh x.koÙkk rFkk ek=k dk c<kuk

xtjkr jkT; d vejyh fty d jktyk {k= e ued DyLVj fodkl dk;Øe dk 2010 – 12 e rth l 'k: fd;k x;kA ble 20 ekjthuy ued ikUl dk 'kkfey fd;k x;k rFkk vxfj;kvk dk vk|kfxd fof'k"Vrk d ued mRiknu gr çf'kf{kr fd;k x;kA jktyk e x.koÙkk fu;=.k gr vPNh ç;kx'kkyk cukb xbA lclk;y ckbu dk Vi djd ued mRikndrk dk c<ku dk ç;kl fd;k x;kA

vxfj;kvk dk duhVh Vkbi fefJr ued dk cp g, fcVu l cuku d fy, çf'kf{kr fd;k x;kA nk vxfj;kvk u djhcu 25 Vu ,lk ued cuk;k rFkk efVfj;y dk vxy çØe e ,l-vk-ih- mRiknu d fy, ued Qke ij Hktk x;kA

jktLFkku d NkV ieku ij ued mRikndk d fy, vPNh x.koÙkkoky ued mRiknu ij çf'k{k.k

jktLFkku e ukok e ekMy lkYV Qke dh LFkkiuk igy crkb xb gA ftld vulkj 12 NkV ieku d ued mRikndk u viu lkYV ikUl iuxfBr fd;A ikp lkYV mRikndk u u; lkYV ikUl fufer fd; rFkk crk;k fd x; çof/kr ued mRiknu vH;kl }kjk vPN ifj.kke çkIr g,A lkYV foHkkx d mnkgj.k d :i e Hkkjr ljdkj d çf'k{k.k dk;Øe Qyknh rFkk ukok e fd; x;A

mMhlk e ued bUMLVh e c<kok

bld igy dh f}okf"kd fjikV] e ;g ik;k x;k fd mMhlk e ,d ekMy lkYV Qke] deh'kfux jkT; d NkV ieku d mRiknudrk d fy, ykHknk;d gA lekt u ;gk ij ued Qke LFkkfir fd,] o vPNh x.koÙkk d ued cuk jg gA ued mRiknu dk nkxuk l T;knk rd c<k;k x;k gA bl lQyrk dk n[kdj gEek {k= d 9 ued mRikndk u blh çdkj ued dh yfC/k e ofð fjikV dhA

gEek & ljyk & lekMh] ckyx] vLrjxk ¼mMhlk½ rFkk dkuVkb ¼if'pe cxky½ {k= d ued mRikndk d ykHk d fy, dk;'kkyk dk xBu fd;k x;kA

bl {k= d 100 ued mRikndk u bl dk;'kkyk ij mifLFkfr nt djokb gA ued mRikndk rFkk foHkkxh; dk;k d fy, lh-,l-vkb-vkj- & lh-,l-,e-lh-vkj-vkb u çf'k{k.k dk;Øek d çn'ku dk xfBr fd;k gA bl dk;Øe d nkjku Hkkouxj e gekj Lo; d çk;kfxd Qke rFkk vU; çdkj d ued dk; dk n[kk gA ued mRikndk u ued foHkkx] Hkkjr ljdkj rFkk lh,lvkbvkj&lh,l,elhvkjvkb d bl ç;kl dh eDr ç'klk dh ftll mUg vPNh x.koÙkk rFkk çkflr dk ued cuu dk lgh rjhdk feykA

mMhlk d rVh; {k= e ued mRiknu d lHkkfor {k=k dk lo{k.k

mMhlk d gEek e LFkkfir ekMy ued Qke dh lQyrk dk n[kr g, mMhlk ljdkj d m|kx foHkkx u ued mRiknu d lHkkfor {k=k d lo{k.k dk urRo dju dh e'kk tkfgj dh g tk jkT; dh okf"kd ekx dh jkf'k dk 3 yk[k Vu çfro"k rd igpk,A bld vulkj lHkh ued mRiknd {k=k u igy lo{k.k fd;k rFkk ued mRiknudrkvk u yfC/k rFkk x.koÙkk e l/kkj d fy, çf'k{k.k fy;kA db ued dkj[kkuk dk yf{kr ued mRiknu l nj lpkfyr fd;k tk jgk g rFkk o rduhdh :i l lkyj lkYV t lk fd ub ued mRiknd çfØ;k l gkrk g] l mRiknu d fy, çf'kf{kr fd;k x;kA db vfrfjDr {k=k Hknjd] ijh] txrflg ij] ckyklkj] dUnkikMk ftyk dk lo{k.k fd;k x;kA yxHkx 25000 ,dM ued;Dr tehu jkT; e ued mRiknu d fy, miyC/k g rFkk vxj bu ij {k=k dk HkyhHkkfr mi;kx fd;k tk, rk vuekurk djhcu 6 yk[k ,e-Vh- ued dk mRiknu fd;k tk ldrk g tk u doy vkt dh t:jrk dk ijk djxh cfYd vU; m|kxk dk Hkh ued vk/kkfjr bdkb;k LFkkfir dju d fy, vkdf"kr djxk rFkk jkT; e jktxkj d i;klr volj Hkh çnku djxkA lo{k.k dh vfre Mk¶V fjikV mMhlk ljdkj d m|kx foHkkx dk tek djok nh xb gA

rfeyukM e ued m|kx dk mUu;u

n'k e rfeyukM] ued mRiknu dk x tjkr o jktLFkku d ckn rhljk lcl cMk mRiknd gA jktLFkku rFkk mMhlk e LFkkfir ekMy lkYV Qke dh lQyrk dk n[kr g, ued foHkkx] Hkkjr ljdkj u rfeyukM d ejdk.ke {k= e rfeyukM o vkU/kçn'k d mRiknudrk d ykHkkFkh ekMy lkYV Qke dk LFkkfir dju dh e'kk tkfgj dh g txg dk p;fur rFkk LFkkuh; mRikndk d çf'k{k.k dk;Øek dk ekp 2011 e LFkkfir fd;k x;kA f'kykU;kl lekjkg dk foyije fty d dyDVj rFkk eftLVV rFkk foyije ¼Vh-,u-½ d ftyk m|kx dUn d egkçc/kd dh mifLFkfr e fpfUgr fd;k x;kA ued dk; d fuek.k dh vkipkfjdrk çxfr e g rFkk rfeyukM e vxy l= l ued mRiknu çfØ;k 'k: dj nh tk;xhA

lh-,l-vkb-vkj- & lh-,l-,e-lh-vkj-vkb- rFkk LokLF;

ty fe'ku

lkyj }kjk lpkfyr [kkj ty dh vkj-vk- bdkb dk jktLFkku d vtej fty e Hkkik dh <k.kh rFkk lkyokrk xko e LFkkfir fd;k x;kA ,d lenh ty ij vk/kkfjr vkj-vk- bdkb ftldh {kerk 6000 ,y-ih-,p- g] dk xtjkr jkT; d dPN fty d ukjk;.k ljkoj ij LFkkfir fd;k x;k gA mRiknu&eY; 11 il çfryhVj vkdk x;kA lLFkk e çf'k{k.k dk;Øe dk xBu fd;k x;k g ftle jktLFkku dh xkeh.k efgykvk dk vkj- vk- vyxhdj.k ,dkb;k d lpkyu rFkk n[kj[k dh i.k tkudkjh rFkk çf'k{k.k fn;k x;k gA

ljf{kr ihu d ikuh d fy, vklfud fu"dklu bdkb;k dh LFkkiuk

vklfud nj dju dk dk; bl fjikV d nkjku tkjh j[kk x;kA fofHkUu txg foLrr {k= lo{k.k }kjk] jthu vk/kkfjr 65 ?kjy vklfud fu"dklu bdkb;k dk if'pe cxky d elynkij] ?kk"kij rFkk e: MkMh xko d 34 ijxuk ¼,u½ e LFkkfir rFkk fufer fd;k x;kA ikp lenk; iekuk vklfud fu"dklu bdkb;k dk 250 yhVj çfr ?k.V dh mRiknu {kerk d lkFk vklfud ;Dr {k=k e LFkkfir fd;k x;k rFkk bdkb;k u bl {k= e 50 ifjokjk dk LoLFk ikuh dh t:jr dk ijk fd;kA

250 vklfud VLV fdVk dk ihu d ikuh e vklfud dk tkpu d fy, cuk;k x;k rFkk 18 eghu e yxkrkj bld lYQ thou dk n[kj[k fd;k x;kA 8 fdV dh vPN çn'ku l vk'oLr gkdj budk 8 ykHkdrk d lkFk ?kjy rFkk lenk; ieku ij vklfud fu"dklu bdkb;k dk ckVk x;kA fdV dh fo'kÔrk ;g g fd 'kYQykbQ T;knk g vkj de [kphyh gA

fofHkUu txgk d ykxk dk bdkb d lpkyu gr fo'kÔdj io mipkj fof/k dh t#jrk d fy, çf'kf{kr fd;k x;kA fn; x; ykxk dk tkp fdV dk ç;kx dju dk Hkh çf'k{k.k fn;k x;kA

ekjthuy lkyj lkYV dk; e ihu ;kX; ty dh iuçkflr d fy, vif'k"V m"ek dk mi;kx

vif'k"V m"ek l] tk Mh ty b tu e mienh; [kkj ty] tk lkyj lkYV dk;k e dke vkrk g] d mi;kx dju dk ;= fufer fd;k x;k gA vif'k"V m"ek d çHkkoh mi;kx dk n[kr g, m|kx deh'kujV] x tjkr ljdkj u lh-,l-vkb-vkj-& lh-,l-,e-lh-vkj-vkb dk dPN d NkV ju e ekjthuy ued dk;k e bdkb;k LFkkfir dju dh e'kk tkfgj dh gA bld vulkj 100 bdkb;k dk ,y-vkj-d-{k= ljUnuxj ft y e fofHkUu ued Qke e LFkkfir fd;k x;k rFkk bu bdkb;k dk çn'ku Hkh lrk"ktud nt fd;k x;kA vfUre fjikV dk vkb-lh-vkfQ] xk/khuxj e tek fd;k x;kA

fuEu vk; rVh; lenk; dk vkfFkd :i l etcr dju d fy, lenh; 'koky dh [krh djuk

2010 – 12 d nkjku] lkr fnuk e db çf'k{k.k dk;Øek dk jkeukFkije ¼vdkyekMe rFkk iecu½] iMdkfV ¼dkVbiVhue½ rFkk rUtkokj ¼prje rFkk iydMh½ ftyk e ykx fd;k x;kA yxHkx 100 ykHkkfFk;k u çf'k{k.k fy;k rFkk dlikQkbdl d [krh d lkekU; fu;ek dk lf{kIr e tkuk rFkk bld vkfFkd egRo ckt kj ekx dk] eY;oku mRikn l lh-,l-,e-lh-vkj-vkb }kjk fodflr rduhdh;k }kjk tkukA çf'k{k.k dk;Øe d nkjku] çf'k{k.k drkvk u çk;kfxd çn'ku ft le jk¶V dk fuek.k] L=kr inkFk d Vkbx rFkk jk¶V dk LFkkukUrj.k] ,dj d fy, jk¶V dh Vkbx] Qke dk çc/ku rFkk dVkb & NVkb dk vH;kl fd;kA çf'k{k.kdrk lenh 'koky d cpu l lcf/kr tkudkfj;k l Hkh voxr g,A

tkQjkckn rV ¼xtjkr½ ij dlikQkbdl dh [krh djuk

dlikQkbdl dh [krh d lkeF; dk rfeyukM e lkfcr dj pd g tgk ij db Lo; lgk;rk leg lfØ; :i l fiNy nl lkyk l 0;ofLFkr py jg gA bl lQyrk dh dgkuh u i;klr :i l bl vkj vU; jkT;k t l egkjk"V] mMhlk] vkU/kçn'k rFkk cgr u; xtjkr e #fp txkb gA eNyh foHkkx] xtjkr ljdkj u Qjojh 2012 e dlikQk;dl ,Yojth dh [krh d fy, tkQjkckn rV dh mi;Drrk dk fuf'pr dju d fy, v/;;u gr /;ku fn;k gA lo{k.k l irk pyk g fd nk lHkkoh txg ljd'oj egkno ¼,u 200 48.45', b 710 14.15"½ rFkk okjkgLo:i ¼,u 200 52.15; b 710 25.26"½ e djhcu 1000 jk¶Vl dh [krh d ieku d fy, mi;Dr gA

io lHkkouk v/;;u l jk¶V dh [krh dh lQyrk dk irk pyk vkj dy ck;kekl 6% l vf/kd mPp] çfrfnu of)nj l ifjofrr gvkA uyh tky rjhd u Hkh vPNk dke fd;kA ekulu d le; tc ygj dkQh rt pyrh g] rk toHkkj lhM HkMkj d :i e lj{k.k rFkk çc/ku d fy, :fp çnku djrk gA

dlikQkbdl lenh 'koky dh [krh dk LFkkfir dju d fy, mi;Dr txgk dk igpkuu d fy, uykj rFkk çdk'ke rV ¼vkU/kçn'k½ dk lo{k.k

[krhoky leg dlikQkbdl dh [krh dh çfØ;k dk nlj lenrVh; jkT;k e vklku v/;;u dk 'k: dju d fy, rFkk foLrr dju d fy, fd;k x;k bl çfØ;k e v'k d :i e ckgjh {k=k d LFkkfudk dh igpku rFkk dlikQk;dl lenh 'koky dh [krh d lHkkoh dk fy;k x;kA vkU/kçn'k d uykj rFkk çdk'ke ft y d 33 rVh; {k=k dk lo{k.k fd;k x;k rFkk 19 lHkkoh LFkkuk dk igpkuk x;kA

ctjHkfe df"k

lhekUr tehu ij tVkQk ik/kk dk LFkkfir djuk

tujy ekVl dkikj'ku] ;,l rFkk ;,l fMikVeUV vkQ ,uth d lkFk l;Dr le>krk fd;k x;kA ft ldk y{; io oÔk e igpku x; dV rFkk l{eçof/kr bykbV telykTe d mi;kx }kjk ekthuy Hkfe ij tVkQk djdl d 50 gDVj ik/kkjki.k dk çnf'kr djuk gA ;g Hkh y{; jgk g fd py jg [krh vH;kl dk vf/kdkf/kd tVkQk ry dh mRikndrk gr mUur fd;k tk,A bld i.k thoupØ d fo'y"k.k dk çLrko fd;k x;k gA

fjikfVx le; d nkjku u; mi;Dr txgk dk igpkuk x;k g rFkk mll lEcfU/kr ,tUlh;k }kjk vftr fd;k x;k gA eØk ikÔd l?kVdk d lkFk feVVh d Hkkfrd vkj jklk;fud x.kk dk i.k pfj=.k fd;k x;kA tujy ekVl] ryxko d iBkjh çkx.k e bykbV telykTe (IC 565735/CP-9 rFkk IC 565731/PCM) }kjk LFkkfir io ik/kk u dkQh Qy fn;A

mMhlk rFkk xtjkr e dyhu telykTe l tVkQk d cM ieku dh uljh dk c<kuk

tVkQk d egRoi.k dyhu l LrEHk dfVx d lkFk cM ieku dh uljh mMhlk e c<h g rFkk tM;Dr ik/kk dk 2010 rFkk 2011 e xtjkr jkT; d ipegy rFkk Hkkouxj ftty e 50 gDVj {k= e jkfir fd;k x;k gA u; :ikUrfjr tVkQk ik/kk dk {k= e lQyrkiod LFkkfir fd;k x;k gA u;h rFkk uohuhdj.k Åtk e=ky; ¼,e,uvkjb½ ub fnYyh d }kjk cuk; x; dk;jr oKkfud d legu ;g igpkuk fd lhih – 9 ¼vkb lh 565735½ ,d mÙke çn'ku okyk telykTe g rFkk bl jktLFkku e cg çtuu djokdj bldh vu'klk dh xb gA

fxj yk;l lupjh e py jgh VfjLV clk e to Mhty çk|kfxdh dk ifjfu;ktu

gky gh dh f}okf"kd fjikV d vulkj lLFkku u ou foHkkx] xtjkr ljdkj l ch 100 tVkQk to Mhty d ç;kx l ou e xkfM;k pyku dk djkj fd;k gA bldk vH;kl çn'ku lQyrkiod jgk rFkk lLFkk fujUrj lkQ ch 100 to Mhty dh vkifr u'kuy xhj yk;Ul lupjh xhj dk dj jgh g vkj ogk lHkh cl bl toMhty l py jgh gA

lyhdkfu;k toHkkj rFkk mudh ued lkUnrk dk fofHkUu ued nynyh {k=k e ekiu

lyhdkfu;k cfd;Vk rFkk lfydkfu;k dh [krh rFkk ck;kekl l ry rFkk ouLifr ued d fu"dÔ.k dk o.ku igy dh f}okf"kd fjikV e fd;k x;k gA bld vkx dk; lo{k.k rFkk fo'y"k.k dk; fd;k x;k tk toHkkj mRiknu d vuekiu rFkk ikp l?kfur txgk ¼ljrkuij] eFkyk] fuxyk] foDVj rFkk fno½ e mxuoky ik/kk e ued d d.kk dh miyfC/k fcuk [kk| vkj flpkb d gbA ik/kk dh vkcknh 100000 ¼foDVj ikV½ l 3310000 ¼ljrkuij½ çfr gDVj c<h ftldk vklr 8.35 yk[k çfr gDVj fofHkUu txgk d fglkc l ik;k x;kA l[k toHkkj Hkh txg&txg ij cny vkj vklr yfC/k 2.15 Vu çfr gDVj FkhA bu txgk e l lcl de l[kk toHkkj ljrkuij ¼1.46 Vu çfr gDVj½ ik;k x;k tcfd vf/kdre l[kk toHkkj mRiknu fuxyk txg ¼3.22 Vu çfr gDVj½ ij çf{kr gvkA ikni l?kurk rFkk l[k toHkkj mRiknu] çfr bdkb {k= d chp] dkb egRo ;kX; lEcU/k ugh çf{kr gvk tcfd ;gk _.kkRed lEcU/k ¼dkfjy'ku dkfQf'k;UV = - 0.53½ ikni l?kurk rFkk o;fDrd ikni l[k Hkkj d chp ik;k x;kA dy l[k toHkkj e l çfr'kr lhM dh çkflr 7.2 d lkFk vklr eY; 4.7 g tcfd lhM ry v'k dh lhek 25.2 l 34.6% d lkFk vklr eY; 32.5% gA çfr'kr ued ¼dkef'k;yh ouLifr ued d :i e lykuh uke l tkuk tkrk g½ l[k toHkkj d :i e 9 – 27% dh lhek d lkFk vklr ued v'k 16.6% çklr gvkA fuxyk txg ij lcl vf/kd ek=k e ouLifr ued ¼829.6 fdyk çfr gDVj½ dk mRiknu gvkA

rjy lenh [kjirokj ikni mÙktd ij cgl LFkkxr ;ktuk

dlikQk;dl l çklr rjy lenh [kjirokj n[kk x;k g fd] ;g fiNy o"kk e db foHkkxk }kjk fd; tk jg db ç;klk l ouLifr d mRiknu dk c<krk gA bld mí'; dk foLrr djr g, dlikQkbdl ,Yojth rFkk xlhyjh;k bMfyl l çklr lenh [kjirokj jl dh çHkkodkfjrk d fy, tkp uk fofHkUu çdkj dh ouLifr tl] eDdk] pkoy] Cydxke] xhuxke] lk;kchu] lhle] vky] xUuk rFkk xfll@ QkMj ij n'k d fofHkUu ,xk&bdkykftdy {k= rFkk fofHkUu jkT;k d df"k fo'ofo|ky;k rFkk vkb-lh-,-vkj- lLFkk d lkFk bl gr le>krk dj lh-,l-vkb-vkj-& lh- ,l-,e-lh-vkj-vkb] lh-,l-vkb-vkj- çk;kftr ifj;ktuk dk lg;kxu Hkh dj jgh gA bue 41 lLFkk, g tkfd n'k d 20 jkT;k dk vH;kl e lfEefyr djrh g rFkk bll çklr ifj.kke dkQh mRlkgtud gA bl vuç;kx d Mklt d vudyre d ckn bldk cM ieku ij fdlkuk d [krk

efd;k tk jgk gA

ih-,l-ch- fo'oHkkjrh dUn] cnoku efdlku d [kr e 3 ,dM e ,d ,d çfl ð vky dh çtkfr d¶jh dk mld vulkj mojd fn, rFkk fuEufyf[kr ekud idt d vH;kl if'pe cxky d yVjhfVd {k= e lxfBr dj fn,A vky dh çtkfr d }kjk lenh [kjirokj jl d fNMdko vuç;kx l vPNh çfrfØ;k feyh tk 35.56 Vu çfr gDVj Fkh vkj dVky lykUV l 26.6% vf/kd FkhA dN vukif{kr ç{k.k Hkh fjikV g,A tl fd BCKV ukfM;k dUn efdlku d [kr e okjk /kku dh [krh d ckj e ç/kku 'kk/kd ubl çdkj fy[kk % "gkykfd /kku dh Qly Hkkjh rQku ¼ukoLVj½ d nkjku çn'ku [kr e mxkb xb fQj Hkh Qly K li rFkk A li çkIr djr g, [kr e fxjh ughA ik/k lh/k [kM jgA"

fcgkj d ilk d jkÅ e fLFkr fdlku d [kr e çnf'kr ijh{k.k e fdlku u jl dk fNMdko ouLifr ijoky ¼Vkbdklu/kl Mkbvkbdk½ ij fd;k rFkk vk'p;tud :i l vPN ifj.kke çkIr g,A

vkVdek.M ¼fuyxhjh ftyk½ d vko';d ry fudkuy e yx LFkkuh; dkjhxjk dh enn ¼MSME DyLVj fodkl dk;Øe½

Hkkjr ljdkj d l{e] NkV rFkk e/;e bUVjçkbt t e=ky; d }kjk vko';d ry DyLVj fodkl dk;Øe dh 'k:vkr ,p-vk-ih-b- Qkm.M'ku d lkFk gb A

lh-,l-vkb-vkj- & lh-,l-,e-lh-vkj-vkb- d oKkfudk d lkFk ,p-vk-ih-b- d vf/kdkjh u uhyxhjh d {k=k dk n[kk tgk ij LFkkuh; ykx jktejh] ;dfylVl] eMhf'kuy tMhcVh bR;kfn l vko';d ry dk fu"dklu rFkk budh [krh djr FkA ry fu"dklu fof/k e l/kkj rFkk Åtk n{krk n[ku d fy; voljk dk irk fd;k x;kA

rVh; {k= dk yf{kr dj lenh ikuh d foyo.ku dju d fy, ?kjy lkyj vklou bdkb;k

Lkkyj vklou l eryc g fd og vklou tk lLrk] mi;kxdrk d fy, ljf{kr rFkk o;fDrd :i l ?kjy ifjfLFkfr e mi;Dr gkA ijEijkxr lkyj LVhy ok"ihdj.k rFkk l?kuu d lk/kkj.k flðkr ij dk; djrk g] ftl ikuh l v'kfð;k nj gk tkrh gA blfy, vk/kkfjr pukrh lkyj LVhy l mRiknu dk c<kdj djuk FkkA len ty d foyo.ku d fy; ;g fo'kÔ vkdÔd g D;kfd ?kjk e eEcu l foyo.ku djuk ef'dy gA lh-,l-vkb-vkj & lh-,l-,e-lh-vkj-vkb u vf/kdre fuxr 7.2 yhVj ty dk ,d ehVj² d mnHkklu {k= e fuEufyf[kr u; x.kk l c<kdj çkIr fd;k gA

- 0kk"ihdj.k dk c<ku d fy, lrgh {k= dk c<k;kA
- ukFk lkbV fj¶yDVj d mi;kx }kjk LVhy ij lkyj Åtk dk c<k;kA
- l?kud rFkk l?kud dh lrg d uhp çokfgr B.M ty dk yxkdj l?kuu dh {kerk dk c<k;kA
- jkf= vkdk'k fofdj.k dk mi;kx dj rFkk rkih; vojk/kd lkp tk jkf= e rFkk fnu d le; ty dk B.Mk j[krh gA
- ljy j[kj[kko d fy, ljy fLVy bVhjh;j dk çc/kA

dYilj ;ktuk dh vkj lh-,l-vkb-vkj- & lh- ,l- ,e-lh-vkj-vkb dk ;kxnku

;g gky e fjikV fd;k x;k fd lLFkk dk dYilj rduhdh ly] xtjkr ljdkj }kjk fofHkUu ;ktuk çfØ;k e] ;ktuk d lgh dk;kUo;u gr ijLdr fd;k x;kA ;ktuk dk d-Vh-lh-uke l d rgr lQyrkiod ijk dj fy;k x;k g rFkk [kkt dk ih-,e-th rFkk b-,-th tk 2012 e gvk Fkk] dk çLrr dj fn;k x;k gA

vdknfed rFkk vU; lLFkkvk d fy, fo'y"k.kRed lok,

lLFkk u fo'y"k.kRed lokvk dk vdknfed] ljdkjh lLFkkvk] e/;e] cM rFkk NkV Lrj d m|kx bdkb;k e fo'y"k.kRed nj e dN fj;k;r d lkFk fn;k gA

foKku e ;ok urRo ij lh-,l-vkb-vkj- dk dk;Øe ¼lh-ih-okb-,y-,l-½

fiNy nk o"k d nkjku lh-ih-okb-,y-,l- dk;Øek d vrxr 2011 d nkjku lLFkk e xtjkr ek/;fed f'k{k.k ckM foHkkx ¼th-,l-b-ch-½ rFkk dUnh; ek/;fed f'k{k.k ckM foHkkx ¼lh-ch-,l-b-½ d nloh dh ijh{kk e çFke vkuokyk dk ykHkkfUor fd;k x;k gA ç[;kr çkQlj tkgj lkgk] io Mk;jDVj] vkb-vkb-,e- vgenkckn 20–

21 tuojh 2011 d nkjku g, lh-ih-okb-,y-,l-d e[; vfrfFk FkA mUgku çfr;kfx;k dk viu thouiFk dk ftØ djr g, mRlkgo/kd Hkk"k.k fn;k FkkA nljk lh-ih-okb-,y-,l- dk;Øe 24–25 uoEcj 2011 e vk;kftr fd;k x;k ftle ç[;kr çkQlj vehrkc pêkik/;k;] oKkfud &,p] lUVj Qkj lyyj ,.M ekyhdyj ck;kyk th] gnjkckn e[; vfrfFk FkA v/;kid rFkk ekrk&firk tk Nk=k d lkFk dk;Øe e vk; Fk mUgku lh-,l-vkb-vkj-&lh-,l-,e-lh-vkj-vkb- }kjk vk;kftr bl dk;Øe dk dju d ç;kl dh dkQh ljkguk dh tk mRlkgo/kd rFkk ;okvk dk tkx#d djuokyk FkA rFkk mud lugj Hkfo"; d fy, bl jkLr dk puu e lgk;rk djuokyk FkkA

çkFkfed ,oe ek/;fed d Nk=k ,oe f'k{kdk gr oKkfud çf'k{k.k dk;Øe

gekj fu;fer vul/kku ,o fodkl xfrfof/k;k }kjk lLFkku Hkkouxj fty d çkFkfed] ek/;fed rFkk mPp ek/;fed fo|ky; d Nk=k rFkk LVkQ dk çf'k{k.k çnku djrk g tk oKkfud lkp dk tk gekjk lkekftd fe'ku dk;Øe g] dk c<krk gA Nk= rFkk v/;kid x.k bl çdkj d çf'k{k.k dk;Øek vFkok dk;'kyk e cM Lrj ij Hkkx yr gA bl çdkj dh dk;'kyk 14 vDVcj 2011 dk vk;kftr dh xb FkhA bl volj ij feLVj vfuy ekudj] Mk;jDVj] ug: foKku dUn] eEcb e[; vfrfFk FkA 72 Nk=k rFkk 10 v/;kidk u bl dk;'kyk e fgLlk fy;kA nljk çf'k{k.k dk;Øe tk çkFkfed rFkk ek/;fed v/;kidk d fy, Fkk] dk 5 l 7 ekp 2012 d nkjku vk;kftr fd;k x;kA Mk- ch- ,u- nkl] dydÙkk d [;kfrçkIr Hkkfrd'kkL=h] dk fo'k"k :i l bl volj ij vkef=r fd;k x;k FkkA ble fty d fofHkUu çkFkfed rFkk ek/;fed 'kkykvk d 50 v/;kidk u çf'k{k.k dk;Øe e fgLlk fy;k FkkA

fgUnh Hkk"kk e oKkfud iijk dk fy[ku dh dk;'kyk

fgUnh ly cgr T;knk lfØ; g tk gekjh jk"V Hkk"kk d fodkl d fy, lHkh oKkfudk rFkk ç'kklfud dfe;k dk fgUnh e xfrfof/k;k dk dju gr c<kok nrk gA blh dk;Øe d lEcU/k e ,d fnu "fgUnh Hkk"kk e oKkfud iij fy[kuk" foÔ; ij ,d dk;'kyk dk vk;ktu lLFkk d oKkfudk rFkk rduhdh LVkQ d Qk;n d fy, fd;k x;kA Mk- Mh-Mh-vk>k] oKkfud rFkk lykgdkj] fgUnh lykgdkj lfefr] Hkkjr ljdkj bl volj ij e[; vfrfFk FkA 53 oKkfudk rFkk rduhdh LVkQ u bl dk;'kyk e Hkkx fy;kA

vkj{k.k uhfr

vulfpr tkfr] vulfpr tutkfr] vU; fiNM ox rFkk fodykx 0;fDr;k d mRFkku rFkk dY;k.k d fy, ljdkj u vud dne mBk; g] ftle l ,d] jkT; d v/khuLFk lokvk e vkj{k.k dk feyuk gA bu lokvk e] Hkrio depkjh Hkh vkj{k.k dk ykHk ikIr djr gA

vulfpr tkfr] vulfpr tutkfr rFkk vU; fiNM ox gr vkj{k.k

jkT; dh jk; e] Hkkjrh; lfo/kku d vuPNn 16 d [k.M (4) e fiNM ukxfjdk d i{k e fu;fDr;k rFkk ink e vkj{k.k nu dk iko/kku g tk jkT; d v/khuLFk lokvk e i;kIr :i l ifrfuf/kRo ugh djr g blh vuPNn dk [k.M 4A, vulfpr tkfr o tutkfr d lnL;k d fy, inkUufr d ekey e vkj{k.k nu d fy, jkT; dk l{ke cukrk gA vuPNn 335 d vk/kkj ij l?k ;k jkT; d ekeyk l tM ink o lokvk gr fu;fDr d le;(i'kklu dh n{krk d j[kj[kko d lkFk] vulfpr tkfr o vulfpr tutkfr d lnL;k d ekeyk dk /;ku e j[kk tk;xkA vuPNn e dgk x;k g fd jkT; vulfpr tkfr o vulfpr tutkfr d lnL;k d i{k e l?k ;k jkT; l lEcfU/kr ink ;k lokvk d fdlh Hkh ox ;k oxk e inkUufr d ekeyk e vkj{k.k] fdlh Hkh ijh{kk e ikIrkdk e NV ;k eY;kdu d ekudk e deh dju gr iko/kku dk fuek.k djrk gA

lfo/kku }kjk inku dh xb 'kfDr;k dk mi;kx e ykdj] ljdkj u fofHkUu lokvk e vkj{k.k d fy, vulfpr tkfr] vulfpr tutkfr vkj vU; fiNM ox d lnL;k dk tk Øheh y;j e vkr g] dk miyC/k djku d vun'k tkjh fd;k g yfdu budk vkj{k.k dk ykHk ugh fey ik jgk gA

lh/kh Hkrh d ekey e lHkh legk d ink gr vulfpr tkfr] vulfpr tutkfr vkj vU; fiNM ox dk

vkj{k.k miyC/k g tc lh/kh Hkrh vf[ky Hkkjrh; Lrj ij [ky Lrjokyh ifr;kfxrk d vk/kkj ij gkrh g rk vulfpr tkfr] vulfpr tutkfr o vU; fiNM oxk d fy, vkj{k.k Øe'k% 15%, 7.5% rFkk 27% gkrk gA ;fn ;g ¼lh/kh Hkrh½ [kyh ifr;kfxrk d vykok vU; gkrh g rk Øe'k% 16.66%, 7.5% rFkk 25.84% vkj{k.k gkrk gA xi C rFkk D ink dh lh/kh Hkrh e lkekU; bykd ;k {k= l T;knk vH;kFkh vkr g] vulfpr tkfr rFkk vulfpr tutkfr d fy, vkj{k.k dk ifr'kr jkT; ;k dUn 'kkflr in'kk dh tul[;k d vuikr d lki{k lkekU; r% fu/kkfjr fd;k x;k g vkj bl ekey e vU; fiNM oxk d fy, vkj{k.k budk vuikr] jkT; @ dUn 'kkflr in'kk dh tul[;k dk /;ku e j[kdj fu/kkfjr fd;k tkrk g tkfd 27% l vf/kd ugh gk ldrk gA rFkk dy vkj{k.k vulfpr tkfr] vulfpr tutkfr rFkk vU; fiNM ox d fy, 50% dh lhek l T;knk ugh gk ldrk gA

ST rFkk SC dk xj p;u fof/k rFkk p;u fof/k }kjk lHkh lokvk dh inkUufr e vkj{k.k 15% rFkk 7.5% ij miyC/k gA p;u fof/k }kjk inkUufr d ekey e] SC rFkk ST xi 'A' d fuEure lkiku rd vkj{k.k dk ykHk ikIr djr g rFkk bud fy, vkj{k.k dh ek=k] bl ekey e olh gh gkrh g t lh fd xj p;u fof/k }kjk inkUufr e gkrh gA gkykfd ;fn dkb lh/kh Hkrh dk rRo gk tk 75 ifr'kr l vf/kd gk] rk ink ;k lokvk e gkuokyh inkUufr d ekey e vkj{k.k ugh fn;k tkrk gA inkUufr d ekey e] vU; fiNM ox dk dkb vkj{k.k ugh gA

;gk xi ^A^ d ink d fy, inkfUur e dkb vkj{k.k ugh g ft ldk vfUre oru 18,300/- ;k bll de ¼ifr l'kkf/kr orueku e½ g yfdu vulfpr tkfr @ tutkfr d vf/kdkjh tk viu {k= e dkQh ofj"B eku tkr g mudk fjDr d fy, cukb tk jgh p;u lph e inkUufr d fy, v;kX; ugh ekuk tkrk gA

ST rFkk SC, vH;kfFk;k dk fofHkUu NV rFkk fj;k;r inku gkrh g ft ll o lokvk e cgrj in'ku dj ldA mnkgj.k d fy, mUg Åijh vk; lhek e NV] ifr;kxh ijh{kk e cBu d fy, fu/kkfjr vk; lhek e NV d lkFk] vufxur ekd] ijh{kk 'kYd e dVkrh rFkk mi;Dr ekudk e NV vkfn ol gh] OBC vH;Fkh] fj;k;r t l rhu lky rd Åijh vk; lhek e NV] flfoy lok ijh{kk e vk; lhek e NV d lkFk lkr ckj ekd vkfn ikIr gkrh gA vukjf{kr fjDr;k d lki{k SC/ST/OBC vH;kfFk;k dh Lo; dh vyx l efjV lph cukb tkrh gA

;g lfuf'pr dju d fy, fd SC/ST/OBC d in doy bUgh l lEcfU/kr 0;fDr;k }kjk Hkj tk;x bl gr lh/kh Hkrh d ekey e fjDr;k dk fn&vkj{k.k ifrcfU/kr gA

SC/ST rFkk OBC d fy, vkj{k.k dh ek=k] fd lh xM@dMj e ink dh l[;k d vk/kkj ij fu/kkfjr dh tkrh gA gkykfd 14 ink l de j[kuoky NkV dMj] tgk bl flðkr d vk/kkj ij bu rhuk oxk dk vkj{k.k nuk lEHko ugh gA vkj{k.k lkotfud rFkk if'k{k.k dk;ky; Kkiu l[;k 36012/2/96 – Ett (Res) fnukd 02/07/1997 }kjk fu/kkfjr L– vkdkj d jkLVj dh rjg /k.ku d rjhd l fn;k tkrk gA tc vkj{k.k dk fu/kkj.k fd;k tkrk g rc ;g lfu'fpr fd;k tkrk g fd fd lh Hkh dMj e SC/ST rFkk OBC d fy, dy vkjf{kr ink dh l[;k] dMj d dy ink dh l[;k l 50% l vf/kd ugh gkA blh le;] fd lh Hkh dMj e lky dh dy fjDr;k d ryuk e vkj{k.k d fy, fpfUgr fjDr;k dh dy l[;k lky e 50% l vf/kd ugh gkA gkykfd] vkjf{kr fjDr;k <j dk ,d vyx o foHkfnr leg dh rjg gh j[kk tkrk g ft l ij 50% lhek ykx ugh gkrh gA

iR;d e=ky;@foHkkx e ,d milfpo] i'kklu dk bupkt vkj dkb vU; vf/kdkjh de l de ,d milfpo dk ,d lEid vf/kdkjh dh rjg] e=ky;@foHkkx d i'kklfud fu;=.k e vkuoky lHkh ifr"Bkuk o lokvk e ST rFkk SC l lEcfU/kr ekeyk d lki{k fu;Dr fd;k tkrk gA og SC rFkk ST i{k e vkuokyh fjDr;k e vkj{k.k rFkk vU; Lohdk; ykHk lEcfU/kr vkn'kk] fun'kk rFkk fu;Dr v/khuLFk vf/kdkjk dh vuikyuk gkuokyh ijLij ftEenkfj;k dk lfu'fpr djrk gA iR;d e=ky;@foHkkx d ikl flfoy gkrk g tk lEid vf/kdkjh d fu;U=.k e vkuoky e=ky;@foHkkx d vUnj ml iHkkoh :i l dr0;k l eDr dju e lgk;rk djrk gA foHkkxk/;{k d fu;U=.k e vkuoky dk;ky;k e Hkh] ST rFkk SC d ifrfuf/kRo l lEcfU/kr dk;k d fy, ,d lEid vf/kdkjh dk ukekfdr fd;k tkrk gA bl rjg d foHkkxk/;{k d vUrxr vkuoky dk;ky;k e] lEid vf/kdkjh d dr0;] e=ky;@foHkkx d vk/khu vkuoky dk;ky;k d lEid vf/kdkjh t l gh gkr gA

vU; fiNM oxk l lEcfU/kr ekeyk e vkj{k.k dk n[ku d fy, ,d vyx l iR;d e=ky;@foHkkx e lEid vf/kdkjh dk fu;Dr dju d fy, 6 – 3 – 1997 e vkn'k tkjh fd;k x;k gA

vkj{k.k l lEcfU/kr Hkkjr ljdkj }kjk tkjh fd, x; fun'kk e ;Fkkfpr ifjoru lfgr] lkotfud {k= d miØe] lkotfud {k= d cd lfgr] foÙkh; lLFkku }kjk eku tkr gA lkfof/kd vkj v/k&ljdkjh fudk;k d :i e Lok;Ùk fudk;k dk Hkh mlh rt ij viuh lokvk e vkj{k.k dk ykx djuk gkrk gA fun'k iHkko d fy, ektn g fd [k.M }kjk vkj{k.k d fy, vof/k rFkk 'krk lfgr fun'k gku pkfg, tcfd dÙnh; vunku lgk;rk l de l de 50% rd cBd rFkk fu;fer vk/kkj ij 20 0;fDr;k l T;knk dk jktxkj nuokyh Lo;loh lLFkkuk dk vunku nuk gkrk gA

vulfpr tkfr@vulfpr tutkfr rFkk vU; fiNM oxk d lenk;k d fgrk dh j{kk d fy, vkn'k tkjh fd;k g rFkk ;g lfu'fpr fd;k g fd mud vkjf{kr ink dk doy mUgh l lEcfU/kr oxk d vH;fFk;k }kjk Hkjk tk;xkA ;g fu/kkfjr fd;k g fd tgk bu oxk l lEcfU/kr vH;fFk;k dh l[;k lh/kh Hkrh e mudh vkjf{kr fjfDr;k dk Hkju d fy, i;kIr miyC/k ugh g] rk o ugh Hkjh tk;xhA ;fcuk Hkjh gb fjfDr;k] vkjf{kr fjfDr;k dh rjg] vkxkeh o"k e gku okyh lh/kh Hkrh e cdk;k jgxhA

tykb] 2008 e ljdkj u Qlyk fy;k fd vU; fiNM ox dh cdk;k vkjf{kr fjfDr;k dk ,d vyx rFkk fof'k"V leg dh rjg ekuk tk;xk tgk ij 50% dh mPpre lhek ykx ugh gkxhA

fun'k ektn g fd e=ky;k@foHkkxk vkfn dk ,d lEHko gn rd vulfpr tkfr rFkk vulfpr tu tkfr d vf/kdkjh dk p;u ckM ij] foHkkxh; inkUufr lfefr;k d xBu d fy, mud rgr vkuoky ink@lokvk e ukekfdr dju dk i;kl djuk pkfg,A fo'k"k :i l] ogk p;u ckM@foHkkxh; inkUufr lfefr dk pkfg, fd o ,d gh le; e 30 l T;knk fjfDr;k dh l[;k d fy, foLrr Lrj ij p;u djA

p;u ckM@foHkkfx; inkUufr lfefr e 'kkfey dju d fy, vulfpr tkfr ;k vulfpr tutkfr d vf/kdkjh dk [kktu d dkb vFkd i;kl dju pkfg,A

tgk Hkh] xi D ;k xi C d ink ;k lokvk e 10 ;k vf/kd fjfDr;k dh Hkrh d fy, p;u lfefr@ckM gkrk g ;k xfBr fd;k tkrk g] ogk vfuok; g fd mle l ,d lnL; bl rjg dh lfefr@ckM e vulfpr tkfr@tutkfr@vU; fiNM ox rFkk vYi l[;d lenk; l gkA p;u ckM@lfefr dk ,d lnL; tk pkg lkekU; J.kh ;k vYi l[;d lenk; ;k SC/ST/OBC l gk og ,d efgyk gkuh pkfg,A lfefr@ckM ij ,d efgyk lnL; dk lgfu;Dr djuk pkfg,A ;g Hkh lfu'fpr djuk gkrk g fd tgk fjfDr;k dh l[;k] fd; tk jg p;u d lki{k 10 l de g rk SC/ST/OBC] dk vf/kdkjh vYi l[;d lenk; dk vf/kdkjh ;k efgyk vf/kdkjh dk] bl rjg dh lfefr@ckM d rgr] <<u d i;kl ugh dju pkfg,A

lky d nkjku ;g fun'k iHkko e yk;k x;k fd SC vkj ST vf/kdkjh fcuk fdlh vkj{k.k dk ykHk mBk;] vukjf{kr fjfDr;k d fo:ð le;kftr dj xj & p;u fof/k }kjk inkUur dj fn; tkr gA

fodykx 0;fDr;k d fy, vkj{k.k

fodykx 0;fDr;k d vf/kfu;e 1995 (PWD vf/kfu;e) d /kkjk 33 ¼leku volj] lj{k.k dk vf/kdkj o i.k Hkkxhnkjh½ e iko/kku g fd mi;Dr ljdkj de l de rhu ifr'kr fjfDr;k dk fodykx 0;fDr;k ;k fodykx 0;fDr;k d leg gr LFkkfir djxhA ftle l ,d ifr'kr tk (1) vU/krk ¼v/kkiu½ ;k de nf"V (2) Jo.k 'kfDr âkl vkj (3) efLr"d i{kk?kkr ;k xeu fodykxrk l ihfMr 0;fDr;k d fy,] iR;d fodykxrk in d igpku d fy,] vkjf{kr fd;k tk;xkA /kkjk 32 e pkfg, fd ljdkj LFkkiuk e mu ink dk igpku e yk; ftUg fodykx 0;fDr;k d fy, vkjf{kr fd;k tk ldA PWD vf/kfu;e] 1996 e iHkkoh gvkA gkykfd ;g bl l igy uoEcj 1977 e vk;k Fkk] xi C rFkk D dh lh/kh Hkrh d ekey e bl fodykx 0;fDr;k d vkj{k.k d fy, ykx fd;k x;k Fkk 1989 e ;g xi C rFkk D ink e inkUufr d ekeyk e ;g vkx c<k;k x;k FkkA vf/kfu;e d ykx gku d lkFk fodykx 0;fDr;k d fy, vkj{k.k dk xi A rFkk B d igpku e rFkk lh/kh Hkrh e Hkh ;kX; fd;k FkkA

fodykx 0;fDr;k d fy, vkj{k.k dh ifØ;k dk l0;ofLFkr rjhd l dju d fy, fnlEcj 2005 e if'k{k.k rFkk dkfed foHkkx] Hkkjr ljdkj }kjk lefdr :i l bl fo"k; ij fun'kk dk tkjh fd;k FkkA bu fun'kk d vulkj] vc lh/kh Hkrh d ekeyk e iR;d xi d ink ij fodykx 0;fDr;k dk vkj{k.k miyC/k gA

inkUufr d ekey e] tc ;g miyC/k g rc inkUufr xi D d lkFk] xi D l xi C vkj xi C d p;fur ink ij gkrh gA vf/kfu;e e fn; vulkj] vkj{k.k dk ykHk] (i) vU/krk ;k U;u nf"V (2) Jo.k 'kfDr dk âkl (ii) xeu v;kX;rk ;k efLr"d i{kk?kkr l xflr 0;fDr dk feyrk gA bl iR;d J.kh dk 1% vkj{k.k dk iko/kku gA vfLFk fodykxrk ;Dr 0;fDr] xeu v;kX;rk ;k efLr"d i{kk?kkr dh J.kh e vkr gA

fodykx 0;fDr dk fofHkUu fj;k;r nh xb g tl fodykx 0;fDr dh Åijh vk; lhek e NV (a) 10 lky rd (SC/ST d fy, 15 lky vkj OBC d fy, 13 lky), xi C rFkk xi D ink dh lh/kh Hkrh d ekeyk e xi A rFkk xi B d ink dh lh/kh Hkrh d ekeyk e (b) 5 lky rd (10 lky SC/ST d fy, o 8 lky OBC d fy,) tgk Hkrh] [kyh ifr;kfxrk d vykok vU; l dh tkrh gA vkj [kyh ifr;kfxrk l xi A rFkk xi B d ink gr (c) 10 lky (15 lky SC / ST rFkk 13 lky OBC d fy,) rd dh NV dk iko/kku gA ogk in vkjf{kr Fkk ;k ugh bl rF; d ckotn Hkh mUg vk; lhek e NV inku dh tkrh gA rFkk inku fd;k x;k ;g in fodykx 0;fDr;k d fy, mi;Dr ekuk tk;xkA

,d mi;Dr bl vl{keokyh J.kh d 0;fDr;k dh i;klr miyC/k ugh gku ij ; fjfDr;k tk fdlh vl{keokyh J.kh d fy, vkjf{kr Fkh] dk fdlh vU; fodykx 0;fDr l ugh Hkjh tk ldrh gA ;k vU; fdlh i;klr dkj.k l ;g fjfDr;k ugh Hkjh xb g bu fjfDr;k dk vkxkeh lky dh Hkfr;k e vkjf{kr fjfDr;k d :i e cdk;k j[kh tkrh gA

vkxkeh lky dh Hkrh e] bu cdk;k vkjf{kr fjfDr;k dk ,d fodykxrk J.kh d fy, vkjf{kr dh Hkkfr gh ekuk tkrk gA ogk ; Hkrh ikjfEHkd lky e vkjf{kr gkrh g rFkk bUg blh rjg l Hkjk tkrk gA gkykfd] ;fn bl vkxkeh Hkrh e Hkh bl J.kh dk mi;Dr 0;fDr ugh feyu dh fLFkfr e bu fodykxrk dh rhu Jf.k;k e ikjLifjd cnyko djd] fodykx d vykok vU; 0;fDr l Hkj nh tkrh gA rc ;fn ,d fjfDr fodykx J.kh d fy, vkjf{kr fu/kkfjr g vkj Hkrh d ikjfEHkd lky e bl fjfDr dk Hkju d fy, blh fodykxrk dh J.kh okyk mi;Dr 0;fDr miyC/k ugh gku ij] igy vkxkeh Hkrh lky d fy, "cdk;k vkjf{kr fjfDr" cu tkrh gA

Hkrio lfudk d fy, vkj{k.k

1966 e nk lky dh vof/k d fy, Hkrio lfudk d fy, vkj{k.k dk ykx fd;k FkkA ;g le; nj le; vkx c<rk x;k rFkk vkt ;g Hkrio lfudk ¼dUnh; flohy lokvk rFkk ink e iu% jktxkj½ fu;e 1979 d :i e miyC/k gA bl fu;e d vulkj] v/k lfud cyk d lgk;d dekMV d Lrj d ink dh fjfDr;k dk 10 ifr'kr] xi C lokvk vkj ink e fjfDr;k dk 10% rFkk xi D lokvk e fjfDr;k dk 20%] dN fuf'pr 'krk ij Hkrio lfudk d fy, vkjf{kr gA Hkrio lfudk dk dUnh; flfoy lokvk@ink e fdlh Hkh fjfDr d fy, vk; lhek e NV dk iko/kku gA Hky gh og vkjf{kr gk ;k u gkA io lfudk d fy, tk igy l gh dUnh; ljdkj d v/khu ukdjh dj jg g mUg Hkh dUnh; ljdkj d v/khu mPp xM ;k dMj e nlj jktxkj d fy, NV dk ykHk nu dk fy[kk x;k gA ;gk ij Hkrio lfudk d fy, mud 'k{kf.kd vgrkvk@;kX;rkvk e Hkh NV dk iko/kku gA egkfun'kd ¼iuokl½] j{kk e=ky; d dUnh; ljdkjh ,tfl;k e vkn'kk d fØ;kUo;u ij utj j[krk gA Hkrio lfudk rFkk vfLFk fodykxrk d fy, vkj{k.k dk "{kfr t" dgr g rFkk SC/ST rFkk OBC d fy, vkj{k.k dk "m/ok/kj" vkj{k.k dgk tkrk gA ekxnf'kdk e crk;k x;k g fd dl "{kfr t" vkj{k.k dk "m/ok/kj" vkj{k.k d lki{k lek;kft r fd;k tkrk gA

fgUnh foHkkx

gekjk lLFkku] oKkfud vul/kku ,o fodkl d {k= e 'kk/kdk; djuoky vx.kh lLFkkuk e l ,d gA foKku ,o ck|kfxdh d fodkl dk y{; doy n'k dh Hkkfrd vko';drkvk dh ifr gh ugh cfYd mPp mí';k ,o ofÜod lenk; dh /kkj.kk l ,d cgrj llkj dk fuek.k dju dk Hkh gA bl y{; dh çkfIr d fy, foKku dk HkkÔk d lkFk tkMuk gkxkA tc rd foKku dk HkkÔk d lkFk ugh tkMx rc rd foKku ,o çxfr d lHkh ykHkk dk tu tu rd igpku e vleFk jgxA

blh y{; rd igpu d lí< ç;kl #i lLFkku dk okfÔd çfronu f}HkkÔh #i e r;kj fd;k tkrk gA jktHkkÔk uhfr lc/kh lo/kkfud dk;k ,o oKkfud ,o ck|kfxdh dk;k d ckj e fgUnh foHkkx }kjk oÔ 2010-12 d nkjku liUu dk; fuEuku lkj of.kr gA

jktHkkÔk çpkj çlkj

- fgUnh dk;kUo;u lc/kh xge=ky;] jktHkkÔk foHkkx }kjk çkIr okfÔd dk;Øe ¼2011-12 ,o 2012-13½ jktHkkÔk uhfr d vuikyu gr lHkh foHkkxk/;{kk dk çfÔr fd, x,A
- depkfj;k e jktHkkÔk d çfr tkx#drk ink dju rFkk jktHkkÔk dk mi;kx dju e mudk çkRlkfgr dju rFkk fgUnh e mRlkgi.k dk; dju gr 14 flrEcj fgUnh fnol d miy{; e oÔ 2011 ,o 2012 d nkjku 7 flrEcj l 14 flrEcj rd fgUnh llrkg euk; x;A llrkg d nkjku dEl;Vj ç'ukrjh] oKkfud 'kk/ki= ij vk/kkfjr fgUnh ikLVl çfr;kfxrk] dfork iBu] oknfookn çfr;kfxrk] fuc/k y[ku] rLohj D;k ckyrh g \] lkjk'k y[ku] dEl;Vj ij fgUnh Vkbfix ¼;fudkM e½] ç'ukÙkjh vkfn dk vk;ktu fd;k x;k vkj bu çfr;kfxrkvk d fotrkvk dk ijLdr fd;k x;kA
- oÔ 2011 ,o 2012 d nkjku foHkkxh; dk;k e fgUnh dk fo'kÔ ç;kx djuoky fuEufyf[kr depkfj;k dk uxn ijLdkj fn; x;A

oÔ 2011 :

- Jh fc , 'kek
- Jh jfo iVy
- Jh xkjoUn 'kDy
- Jh t;'k ijekj
- Jh , ,e pkgk.k
- Jh jfo iVy
- Jh xkjoUn 'kDy
- Jh t;'k ijekj
- Jh , ,e pkgk.k

oÔ 2012 :

- Jh fou;dekj tk;loky
- Jh ;K'k f=onh
- Jh t;'kdekj ekdk.kh
- Jh Hkjr ,e ijekj
- Jh /kut; dekj
- Jh fnid Bkdj
- Jh jfo iVy
- lJh ljyk lklk
- Jh t;'k ijekj
- Jh , ,e pkgk.k

- oÔ 2011-12 e fgUnh i=kpkj dk c<kok nu d fy; depkfj;k dk çfjr o çkRlkfgr dju gr çR;d frekgh e lcl T;knk i=fy[kuoky rhu depkfj;k dk ijLdr dju dk fu.k; fy;k x;k rnulkj fuEufyf[kr depkfj;k dk uxn ijLdkj çnku fd; x;A

Ukke	foHkkx	ijLdkj
Jh ;K'k f=onh ¼flrEcj 2011½	ç'kklu	# 1000/-
Jh Vh jkeckc	ç'kklu	# 1000/-
Jh jfo iVy	foÙk ,o y[kk	# 750/-
Jh jfo iVy	foÙk ,o y[kk	# 1000/-
Jh t;'kdekj ekdk.kh	flfoy	# 750/-
Jh xkjoUn 'kDy	ç'kklu	# 500/-

- fgUnh HkkÔk lc/kh ikLVl cuok; rFkk lLFkku e fofHkUu txgk ij çn'ku gr yxok; x;A

fgUnh çf'k{k.k

- ekp 2011 rFkk 2012 rd dk depkfj;k dk fgUnh Kku lc/kh jkLVj v|ru fd;k x;kA
- xge=ky; d vkn'kkulkj çoh.krk çklr depkjh@vf/kdkfj;k dk o;fDrd vkn'k tkjh fd;x;A
- fgUnh vk'kfyfi gr LFkkfud Lrj ij çc/k fd;k x;kA
- lenh 'koky QhYM LV'ku eUnie e u; Hkrh g, oKkfud dk fgUnh çf'k{k.k gr jkt HkkÔk foHkkx d yhyk lk¶Vo;j e Hkkouxj l vkuykbu jftLV'ku djok;k x;kA

fgUnh dk;'kkyk

- fnukd 29.06.2011 dk ç'kklu] foÙk ,o y[kk] HkMkj ,o Ø;] flfoy rFkk j{kk o çgjh vuHkkxk d depkfj;k d fy, dEl;Vj d fy, ;fudkM lgk;rk d ckj e vkb Vh foHkkx d depkjh Jh çekn edokuk u 0;k[;ku fn;kA nljk 0;k[;ku xxy VkUly'ku] VkUlfyVjV d ckj e ç'kklu foHkkx d lgk;d Jh ;K'k f=onh u fn;kA bl dk;'kkyk e dy 36 depkjh rFkk vf/kdkjh mifLFkr FkA
- lLFkku d oKkfud ,o rduhdh vf/kdkfj;k d fy, fgUnh foHkkx }kjk bl oÔ dh rrh; frekgh dh dk;'kkyk dk vk;ktu fnukd 07.07.2011 dk çkr% 10:30 ct lLFkku d lHkkxg e fd;k x;k FkkA lLFkku d oKkfudk ,o rduhdh vf/kdkfj;k d fy, vk;kftr bl dk;'kkyk dk foÔ; Fkk & fgUnh e foKku y[ku ,o ijLdkj ;ktuk,A bl foÔ; ij 0;k[;ku ,o ekxn'ku nu d fy, Hkty foHkkx] tk/kij d oKkfud ,o fgUnh lykgdkj lfefr d lnL; Mk nxknÙk vk>k dk vkef=r fd;k x;k FkkA bl dk;'kkyk e dy 53 oKkfud ,o rduhdh vf/kdkjh mifLFkr FkA
- fnukd 06.02.2012 dk nkigj 3:00 ct HkMkj ,o Ø; foHkkx e Vcy od'kki d #i e fd;k x;kA ftle HkMkj ,o Ø; foHkkx e fgUnh dh mi;kfxrk] HkMkj ,o Ø; vf/kdkjh] Jh l/kkU'k 'k[kj pk/kjh u foHkkx e fgUnh d mi;kx dk c<kok nu d fy, ekxn'kd 0;k[;ku fn;A
- lLFkku d fgUnh foHkkx dh vkj l lenh 'koky fQYM LV'ku] eUnie ¼rfeyukM½ e fLFkr depkfj;k@vf/kdkfj;k dk fgUnh e dk; dju d fy, çkRlkfgr dju gr ;fudkM LFkkiuk ,o fun'ku rFkk mi;kx foÔ; ij ,d dk;'kkyk dk vk;ktu fnukd 04.05.2012 dk fd;k x;kA vkb Vh foHkkx d rduhf';u Jh çekn edokuk u f}HkkÔh #i e ikoj ikbUV }kjk mDr foÔ; ij 0;k[;ku ,o ekxn'ku fn;kA
- fgUnh foHkkx }kjk bl oÔ dh rrh; frekgh dh dk;'kkyk dk vk;ktu lLFkku d oKkfudk ,o rduhf';uk d fy; fnukd 09.10.2012 dk 'kke 4:00 ct lLFkku d lHkkxg e fd;k x;k Fkk] ftld vrxr lLFkku d ofj"B ç/kku oKkfud] Mk oh ih ekgunkl u "lekt dh lok e lh,lvkbvkj&lh,l,elhvkjvkb" foÔ; ij 0;k[;ku fn;kA
- fnukd 26.10. 2012 dk vk;kftr "mi;kxh jlk;u vkj thou" iLrd d foekpu lekjkg e jkt HkkÔk foHkkx] xg e=ky;] if'pe {k= ¼dk;kUo;u½ d mifun'kd Jh foukn dekj 'kek dk fo'kÔ vfrfFk d #i e vkef=r fd;k x;k FkkA iLrd foekpu lekjkg l igy ,d dk;'kkyk dk vk;ktu fd;k x;k ftld vrxr "ç'kklu ,o foKku e ljy fgUnh dk ç;kx" foÔ; ij Jh foukn dekj 'kek u ljy HkkÔk e ekxn'ku fn;kA

rduhdh vuokn

- oÔ 2012 d nkjku ithdr iVUVk d lkjk'k dk fgUnh vuokn oclkbV ij j[ku gr fd;k x;kA
- lLFkku d f}okfÔd çfronu 2008-10 dk oKkfudk dh lgk;rk l fgUnh vuokn djd f}HkkÔh #i e r;kj fd;k x;kA lh,lvkbvkj LFkkiuk fnol d fy, bl çfronu dh lhMh r;kj dh xbA
- f}okfÔd çfronu 2010-12 dk oKkfudk dh lgk;rk l fgUnh vuokn fd;k x;kA
- ;fudkM buLVky'ku d ckj e f}HkkÔh ¼fgUnh&vxth½ ikoj ikbUV çLrfr r;kj dh xbA
- vkdk'kok.kh] jkt dkV }kjk çlkfjr fd; tkuoky jfM;k okrkyki dk fgUnh rFkk {k=h; HkkÔk] xtjkrh e vuokn fd;k x;kA

ç'kklfud vuokn

- VUMj ukfVl] ,evk; Qke] flfoy] LVkj ijpt] j{kk rFkk çgjh foHkkx] fo'yô.kkRed foHkkx d dk;ky; Kkiu rFkk Qke dk vuokn fd;k x;kA
- ç'kklu foHkkx l çkIr lHkh foHkkxk d fy; jcM dh ekgjk dk vuokn rFkk Vd.k fd;k x;kA
- vko';drkulkj VUMj ukfVl] ,evk; Qke] fofHkUu foHkkxk d l'kkf/kr@ifjofrr QkEl dk vuokn rFkk Vd.k dk; fd;k x;kA
- lHkh foHkkxk d QkEl dk ;fudkM e ifjofrr djd gkbij fyd ndj lhMh r;kj dh xbA

fujh{k.k

- fnukd 06.06.2012 dk jktHkkÔk foHkkx ¼if'pe {k=½] xge=ky;] ecb dh vul/kku vf/kdkjh] Jherh lk/kuk f=ikBh }kjk lLFkku dh jktHkkÔk dk;kUo;u çxfr dk fujh{k.k fd;k x;kA
- lLFkku dh jktHkkÔk dk;kUo;u lfefr }kjk çfrekl jktHkkÔk dk;kUo;u lc/kh ,d&,d foHkkx dk vkrfjd fujh{k.k fd;k x;kA

fgUnh cBd

- oÔ 2011 d nkjku pkj frekgh jktHkkÔk dk;kUo;u lfefr dh cBd fun'kd egkn; dh v/;{krk e liUu dh xb rFkk nk ckj uxj jktHkkÔk dk;kUo;u lfefr }kjk vk;kftr v)okfÔd cBd e lLFkku dk çfrfuf/kRo fd;k x;kA
- oÔ 2012 d nkjku pkj frekgh e jktHkkÔk dk;kUo;u lfefr dh cBd fun'kd egkn; dh v/;{krk e liUu dh xbA fnukd 26.10.2012 dh cBd e Jh foukn 'kek] mifun'kd] jktHkkÔk foHkkx ¼if'pe {k=½] xge=ky; dk fo'kÔ #i l vkef=r fd;k x;k FkkA

fo'kÔ dk;

- oÔ 2011 ;j vkQ dehLVh d miy{; e lLFkku d oKkfud }kjk Mh Mh vk>k d lg;kx l ,d iLrd fy[ku dk fu.k; fy;k x;k FkkA bld vul/kku e fopkjfoe'k gr fnukd 07.07.2011 dk Mk Mh Mh vk>k dk vkef=r fd;k x;k FkkA çLrkfor iLrd e ck;kMhxMcy lykfLVd] lkn; çlk/ku & tktkck Øhe] çkdfrd jx ¼Qkbdklk;uhu½] vk;kMhdr ued d fy, fo'yô.k dh ub i)fr] gfjr jlk;u] jtd.keDr pkd] gkykQkbu eEcu vkj mud fofu;kx] LoLFk thou d fy, i;koj.k vudy ck;kMhty tl foÔ;k dk lekfo"V dju d ckj e fopkjfoe'k fd;k x;kA
- fun'kd egkn; d vkn'kkulkj lLFkku e fiNy n'kd e g, vul/kku dk;k dk ,d ldyu fgUnh e çxV dju dk dk; 'k# fd;k x;kA
- fnukd 20 tuojh 2012 dk Hkkjrh; çk.kh lo{k.k] vneku ,o fudkckj {k=h; dUn] ikVCyj e fgUnh dk;kUo;u d ckj e jktHkkÔk vf/kdkjh] Jh fcfiu ,e 'kkg }kjk 0;k[;ku fn;k x;kA
- fnukd 25-29 Qjojh 2012 d nkjku fnYyh e vk;kftr foÜo iLrd ey e tkdj lLFkku d fy, mi;kxh lkfgR; ,d= fd;k x;k rFkk # 25,000/- d iLrdk dh lph r;kj djd xFkky; dk Hkth xbA
- lh,l,elhvkjvkb d LFkkiuk fnol 10 vçy 2011 d fy; f}HkkÔh fue=.k dkM] cuj r;kj fd; x; vkj dk;Øe lc/kh [kjhnh] eplTtk ,o vU; dk;k e lfØ; lg;kx fn;k x;kA
- lLFkku d nk vkrfjd foHkkxk ihMhblh rFkk lenh toçk|kfxdh ,o ikfjfLFkfrdh dk fujh{k.k fgUnh foHkkx }kjk fd;k x;kA
- ifjÔn d LFkkiuk fnol 26 flrEcj 2011 d volj ij f}HkkÔh vke=.k dkM] cuj r;kj fd; x; rFkk dk;Øe l lcf/kr vU; dk; liUu fd; x;A
- lhihok;,y,l 2011 d fofo/k dk;Øek d vrxr ijLdkj] Lefrfpgu vkfn dh [kjhnh dk dk; rFkk dk;Øe l lcf/kr vU; dk; liUu fd;k x;kA
- oKkfud rFkk vk|kfxd vul/kku ifjÔn dh viuh ç;kx'kkykvk }kjk "v/;kid çf'k{k.k rFkk vfHkçj.k vkj fo|ky;k ,o foÜofo|ky;k dk vxhdj.k ;ktuk" vrxr dUnh; ued o lenh jlk;u vul/kku lLFkku] Hkkouxj u Hkkouxj ftye fLFkr çkFkfed] ek/;fed rFkk mPprj ek/;fed 'kkykvk d foKku f'k{kd@çk/;kidk d fy; rhu vfHkçj.k dk;Øe dk vk;ktu fd;kA

- blh ;ktuk d vrxr çFke dk;Øe 15 Qjojh 2012 dk Hkkouxj ftyk d çkFkfed rFkk ek/;fed foKku f'k{kdk d fy; vk;kftr fd;k x;kA ftle f'k{kdk d fy, Doht Li/kk d lkFk e foKku d odhx ekMy dh çfr;kfxrk dk Hkh vk;ktu fd;k x;k FkkA Doht çfr;kfxrk e dy 28 çfrHkkfx;k e l 05 çfrHkkfx;k dk vfre Doht d fy, puk x;k rFkk foKku d odhx ekMy dh çfr;kfxrk e 20 çfrHkkfx;k u Hkkx fy;kA çR;d foHkkx d çFke fotrk dk çktDVj ekbØkLdki] f}rh; fotrk dk áeu Vkjlk ohFk 14 pUtcy ikVl vkj rrh; fotrk dk lV vkQ áeu ckMh flLVe d #i e buke ndj ijLdr fd;k x;kA bl volj ij Jh cyor ikj[k foKku uxjh] Hkkouxj }kjk lg;kx çklr gvkA
- mDr ;ktuk vrxr nljk dk;Øe 29 Qjojh 2012 dk E;fufliy Ldy d 60 fo|kfFk;k rFkk 40 f'k{kdk dk vfHkçfjr dju gr nk clk }kjk vgenkckn foKku uxjh dh ,d fnolh; eykdkr dk vk;ktu fd;k x;kA
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CSMCRI IN THE SERVICE OF SOCIETY

Information dissemination

The institute's research and societal mission activities were well received by the media. Excellent coverage was received as a result.

Media coverage for CSIR-CSMCRI activities

Proliferation of high purity solar salt technology in the marginal/small scale sector across the country

The programs implemented during 2008-10 were continuously monitored to ensure that the people in the marginal sector derive tangible benefits from the technologies. New salt cluster development programs were also introduced during this period and training programs were expanded to cover 250 marginal agarias under SEWA banner.

Training program in Sultanpur, Little Rann of Kutch

Improving the quality and yield of salt produced by the marginal agarias at Rajula region through technology up-gradation and improving their income through bittern value addition

(Left) Marginal agarias of Rajula region harvesting superior quality salt;
(Centre) QC laboratory set up in Rajula; (Right) Stack of kainite mixed salt

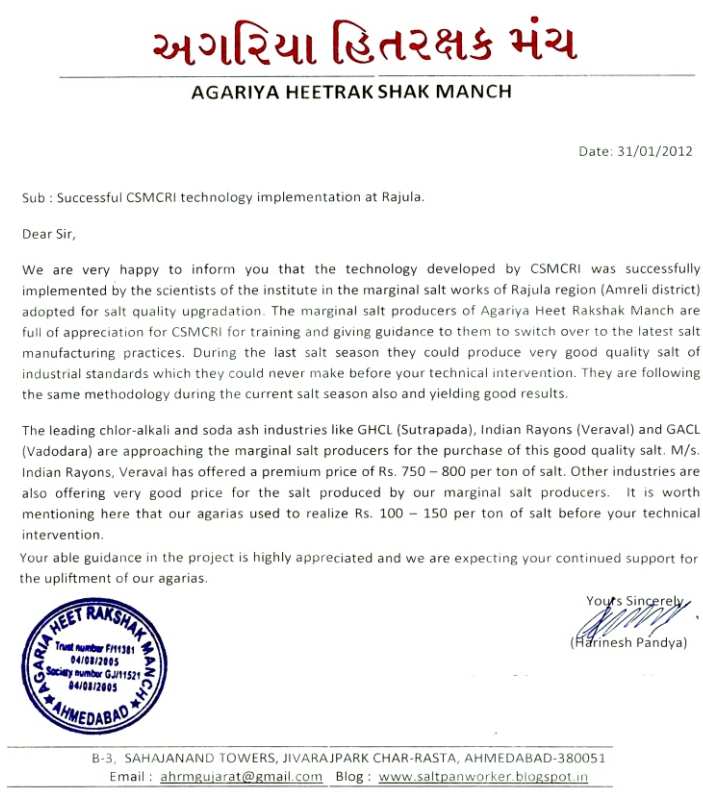
The salt cluster development program initiated at Rajula region of Amreli district in Gujarat was vigorously pursued during 2010–12. 20 salt pans were adopted and the agarias were trained to

Specification of salt at Rajula

Constituents	(% w/w)
Ca	0.09
Mg	0.06
SO_4	0.35
NaCl (on dry basis)	> 99
Insoluble	0.20
Moisture	< 1

Average analysis of mixed salt produced at Rajula

Constituents	(% w/w)
$CaSO_4$	0.3
$MgSO_4$	34.7
$MgClO_2$	1.3
KCl	20.2
NaCl	27.7



અગરિયા હિતરક્ષક મંચ

AGARIYA HEETRAK SHAK MANCH

Date: 31/01/2012

Sub : Successful CSMCRI technology implementation at Rajula.

Dear Sir,

We are very happy to inform you that the technology developed by CSMCRI was successfully implemented by the scientists of the institute in the marginal salt works of Rajula region (Amreli district) adopted for salt quality upgradation. The marginal salt producers of Agariya Heet Rakshak Manch are full of appreciation for CSMCRI for training and giving guidance to them to switch over to the latest salt manufacturing practices. During the last salt season they could produce very good quality salt of industrial standards which they could never make before your technical intervention. They are following the same methodology during the current salt season also and yielding good results.

The leading chlor-alkali and soda ash industries like GHCL (Sutrapada), Indian Rayons (Veraval) and GACL (Vadodara) are approaching the marginal salt producers for the purchase of this good quality salt. M/s. Indian Rayons, Veraval has offered a premium price of Rs. 750 – 800 per ton of salt. Other industries are also offering very good price for the salt produced by our marginal salt producers. It is worth mentioning here that our agarias used to realize Rs. 100 – 150 per ton of salt before your technical intervention.

Your able guidance in the project is highly appreciated and we are expecting your continued support for the upliftment of our agarias.

Yours Sincerely,

(Harinesh Pandya)

AGARIA HEET RAKSHAK MANCH
Trust number F/11381 04/08/2005
Society number GJ/11521 04/08/2005
AHMEDABAD

B-3, SAHAJANAND TOWERS, JIVARAJPARK CHAR-RASTA, AHMEDABAD-380051
Email : ahrmgujarat@gmail.com Blog : www.saltpanworker.blogspot.in

produce quality salt meeting industrial specifications. A well-equipped QC lab was also established at Rajula. An attempt is being made to raise the productivity of salt by tapping subsoil brine.

The agarias were also trained to produce kainite type of mixed salt from residual bittern. About 25 ton of such salt was produced by two of the agarias and the material was transported to the institute's salt farm for future processing in the SOP test bed.

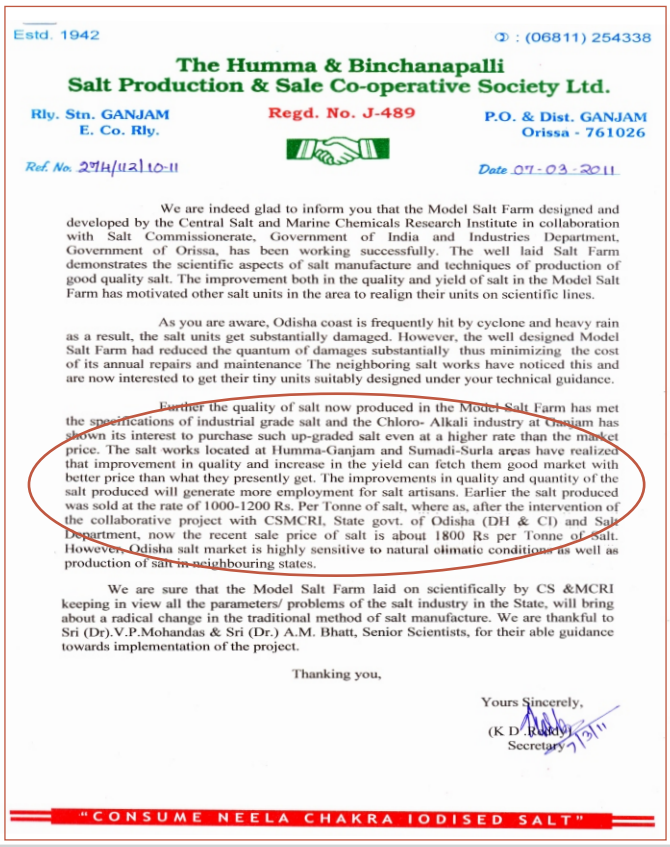
Training on good quality salt production for the small scale salt producers of Rajasthan

(Left) A salt works laid out as per the design of the model salt farm established at Nawa; (Right) Training programme in Rajasthan

The establishment of a model salt farm at Nawa in Rajasthan was reported previously. 29 small scale producers have re-aligned their salt pans accordingly. Five salt producers have constructed new salt pans and reported good results following the improved manufacturing practices. At the instance of Salt Deptartment, GoI training programs were organized at Phalodi and Nawa.

Upgrading salt industry in Odisha

The commissioning of a model salt farm in Odisha for the benefit of the small scale salt producers of the state was reported in the previous biennial report. The society in whose site the salt farm was established continues to produce good quality salt. The productivity was raised more than twofold by utilizing subsoil brine and improved methodologies of production. Seeing the success, 9 salt producers in Humma region have similarly reported enhancement in yield of salt. A workshop was organized for the benefit of the salt producers of Humma, Surla – Sumadi, Bolang, Astaranga (Odisha) and Kontai (WB) regions. About 100 salt producers from the above regions attended the workshop. An exposure training program was organized at CSIR-CSMCRI for the salt producers and departmental officials. Visits



Estd. 1942 ✆ : (06811) 254338

The Humma & Binchanapalli Salt Production & Sale Co-operative Society Ltd.

Rly. Stn. GANJAM, E. Co. Rly. | Regd. No. J-489 | P.O. & Dist. GANJAM, Orissa - 761026

Ref. No. 274/12/10-11 | Date 07-03-2011

We are indeed glad to inform you that the Model Salt Farm designed and developed by the Central Salt and Marine Chemicals Research Institute in collaboration with Salt Commissionerate, Government of India and Industries Department, Government of Orissa, has been working successfully. The well laid Salt Farm demonstrates the scientific aspects of salt manufacture and techniques of production of good quality salt. The improvement both in the quality and yield of salt in the Model Salt Farm has motivated other salt units in the area to realign their units on scientific lines.

As you are aware, Odisha coast is frequently hit by cyclone and heavy rain as a result, the salt units get substantially damaged. However, the well designed Model Salt Farm had reduced the quantum of damages substantially thus minimizing the cost of its annual repairs and maintenance The neighboring salt works have noticed this and are now interested to get their tiny units suitably designed under your technical guidance.

Further the quality of salt now produced in the Model Salt Farm has met the specifications of industrial grade salt and the Chloro- Alkali industry at Ganjam has shown its interest to purchase such up-graded salt even at a higher rate than the market price. The salt works located at Humma-Ganjam and Sumadi-Surla areas have realized that improvement in quality and increase in the yield can fetch them good market with better price than what they presently get. The improvements in quality and quantity of the salt produced will generate more employment for salt artisans. Earlier the salt produced was sold at the rate of 1000-1200 Rs. Per Tonne of salt, where as, after the intervention of the collaborative project with CSMCRI, State govt. of Odisha (DH & CI) and Salt Department, now the recent sale price of salt is about 1800 Rs per Tonne of Salt. However, Odisha salt market is highly sensitive to natural climatic conditions as well as production of salt in neighbouring states.

We are sure that the Model Salt Farm laid on scientifically by CS &MCRI keeping in view all the parameters/ problems of the salt industry in the State, will bring about a radical change in the traditional method of salt manufacture. We are thankful to Sri (Dr).V.P.Mohandas & Sri (Dr.) A.M. Bhatt, Senior Scientists, for their able guidance towards implementation of the project.

Thanking you,

Yours Sincerely,
(K D Reddy)
Secretary

"CONSUME NEELA CHAKRA IODISED SALT"

to our own experimental salt farm and various other salt works in and around Bhavnagar were arranged during the above program. The salt producers were appreciative of the efforts made by Salt Dept., Govt. of India and CSIR-CSMCRI in showing them the correct methods of salt production which has helped to improve the quality and yield.

Workshop for Odisha small scale salt producers

Survey of potential areas of salt production in the coastal belt of Odisha

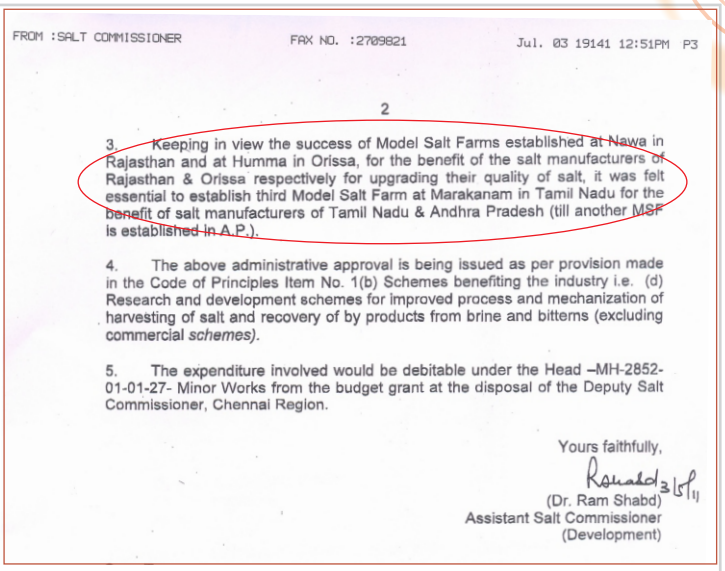
Looking at the success of the model salt farm established at Humma in Odisha, the industries department, Govt. of Odisha desired a survey of potential areas of salt production to meet the annual requirement of the state amounting to 3.0 lac ton per annum. Accordingly, all the salt producing areas were first surveyed and the salt producers were given training to improve the quality and yield of salt. Many salt factories were being operated far below the targeted salt production and they were technically trained to produce solar salt as per the latest salt manufacturing practices. Additional areas in Bhadrak, Puri, Jagathsinghpur, Balasore, and Kendrapada districts were surveyed. About 25000 acres of saline land is available for salt production in the state and if the entire area is fruitfully utilized, it is estimated that 6 lac MT of salt can be produced. This will not only cater to the current requirements but may help attract other industries to set up their salt based units. It will also help generate employment in the state. The final draft report of the survey was submitted to the Industries Dept., Govt. of Odisha.

Some of the potential sites surveyed at Odisha

Upgrading salt industry in Tamil Nadu

Tamil Nadu is the third largest producer of salt in the country after Gujarat and Rajasthan. Seeing the success of the model salt farms established at Rajasthan and Odisha, the Salt Dept., Govt. of India desired to establish a model salt farm at Marakanam region of Tamil Nadu for the benefit of salt producers of Tamil Nadu & Andhra Pradesh. The site was selected and a training program for the local salt producers was arranged in March 2011. The

foundation stone laying ceremony was marked by the presence of the Collector & Magistrate of Villupuram district and the General Manager, District Industries Center, Villupuram (TN). The formalities for the construction of salt works are in progress and the salt production activities will be initiated during the next salt season in Tamil Nadu.



FROM :SALT COMMISSIONER FAX NO. :2709821 Jul. 03 19141 12:51PM P3

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3. Keeping in view the success of Model Salt Farms established at Nawa in Rajasthan and at Humma in Orissa, for the benefit of the salt manufacturers of Rajasthan & Orissa respectively for upgrading their quality of salt, it was felt essential to establish third Model Salt Farm at Marakanam in Tamil Nadu for the benefit of salt manufacturers of Tamil Nadu & Andhra Pradesh (till another MSF is established in A.P.).

4. The above administrative approval is being issued as per provision made in the Code of Principles Item No. 1(b) Schemes benefiting the industry i.e. (d) Research and development schemes for improved process and mechanization of harvesting of salt and recovery of by products from brine and bitterns (excluding commercial *schemes).*

5. The expenditure involved would be debitable under the Head –MH-2852-01-01-27- Minor Works from the budget grant at the disposal of the Deputy Salt Commissioner, Chennai Region.

Yours faithfully,

(Dr. Ram Shabd)
Assistant Salt Commissioner
(Development)

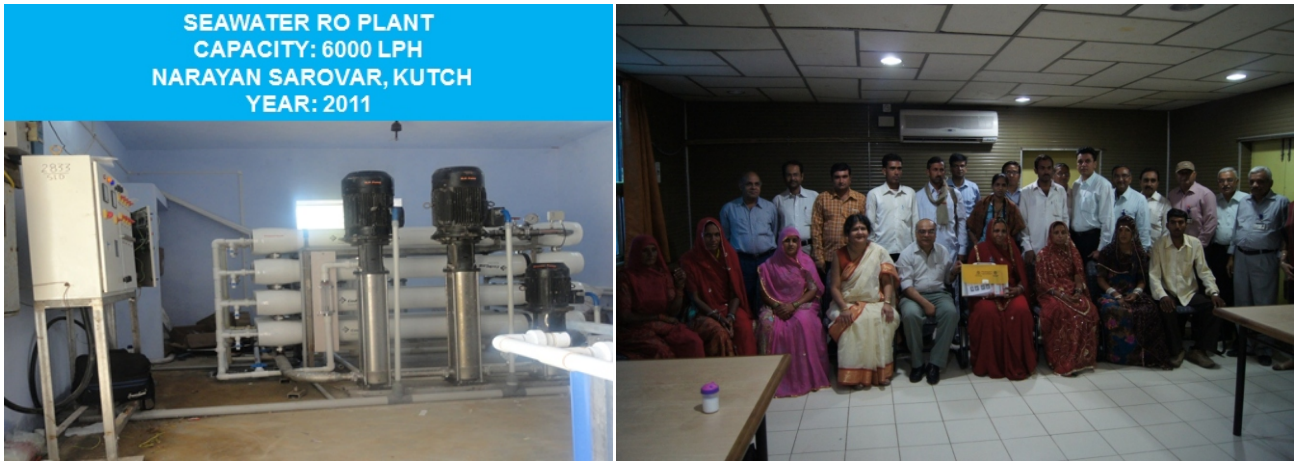
CSIR–CSMCRI and health

Water mission

Installation of new water purification plants

Solar powered brackish water RO plants funded by the Coca-Cola Foundation were installed in Bhopa ki Dhani & Solawata villages of Ajmer District in Rajasthan. One sea water based RO plant with a capacity of 6000 LPH was installed in Narayan Sarovar located in Kutch district of Gujarat. The cost of production was estimated to be 11 paise per liter. A programe was organized in the institute wherein the women folk of Rajasthan were fully trained regarding the operation and maintenance of RO desalination units.

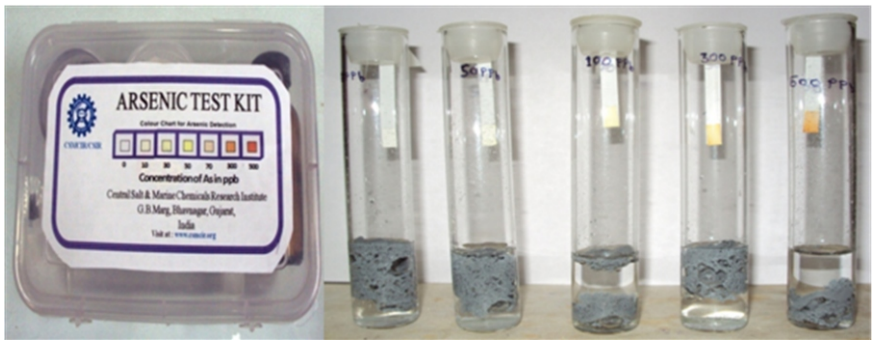
Solar PV powered brackish water RO plant installed in (Left) Bhopa ki Dhani village (2011) and (Right) Solawata village (2012) of Ajmer district in Rajasthan



(Left) 6000 LPH seawater RO plant installed at Narayan Sarovar of Kutch region in Gujarat; (Right) RO plant operation and maintenance training was organized for woman operators from Rajasthan villages

Installation of dearsenification units for safe drinking water

The Institute's activities on arsenic removal were continued during the reporting period. After an exhaustive field survey at various sites, 65 resin-based domestic dearsenification units were fabricated and installed in Maslandapur, Ghoshpur and Merudandi villages of 24 Parganas (N), West Bengal. 5 community scale dearsenificating units with a production capacity of 250 litre per hour were also installed in arsenic affected areas and the units cater the healthy water requirement of 50 families in the region. 250 arsenic test kits to check arsenic in drinking water were also prepared and its shelf life was monitored for a period of 18 months. After ensuring the consistency of performance of the kits they were distributed to those who have installed the domestic and community scale units. The salient features of the kit are (i) affordability and (ii) long shelf life. The people at different sites were trained on the operation of the units, particularly the pre-treatment procedure necessary. Persons were also trained in the use of the test kits supplied to them.



(Left) Arsenic test kit with demonstration of observed color changes;
(Right) Community unit for Arsenic removal from ground water

Educating & training people at Bashirhat, West Bengal

Utilization of waste heat for the recovery of potable water in marginal solar salt works

The fabrication of a device for utilizing the waste heat generated in the diesel engine used for pumping subsoil brine was previously reported. Looking to the effective utilization of this waste

One of the desalination unit installed at LRK

heat, Industries Commissionerate, Govt. of Gujarat desired CSIR–CSMCRI to install such units in the marginal salt works of Little Rann of Kutch. Accordingly, 100 units were installed in different salt farms of LRK region of Surendranagar district and the performance of the units is reported to be satisfactory. A final report was submitted to the IC office, Gandhinagar.

Farming of seaweeds to empower coastal communities

During 2010-12, several training programs of seven days each were conducted in the TN districts of Ramnathapuram (Akkalmadam and Pamban), Pudukkottai (Kottaipattinam) and Tanjavore (Chatram and Palakudi). Over 100 beneficiaries were trained on general aspects of cultivation of *Kappaphycus* and its economic importance, market demand, and value addition through technologies developed by CSIR-CSMCRI. Following the indoor training programs, the trainees were given practical demonstration including preparation of rafts, selection of seed materials, preparation of seeding ropes, tying of seed material and the seeded ropes on the rafts, transplanting of rafts in clusters on the sea, tying of rafts to anchors, management of the farm and harvesting practices. The trainees were also made aware about the matters related to sale of seaweeds.

(Left) Beneficiaries being trained on seeding of rope; (Right) Preparation of raft

Kappaphycus cultivation along the Jafrabad coast (Gujarat)

The potential of *Kappaphycus* farming has been well proven in Tamil Nadu, where several self-help groups have been actively engaged in the cultivation activities for the past ten years. This

Tube net and net bag methods of cultivation

Close up of tube net with enclosed *Kappaphycsu* (45 days)

Fully grown *Kappaphycus* biomass in tube net after 45 days

success story has generated interest in other states like Maharashtra, Odisha, Andhra Pradesh and very recently Gujarat. The Fisheries Department, Government of Gujarat has funded the pre-feasibility study to ascertain the suitability of Jafrabad coast for cultivation of *Kappaphycus alvarezii* in February 2012. The survey revealed two potential locations namely, Sarkeshwar Mahadev (N 200 48.45'; E710 14.15') and Waraswarup (N 200 52.15'; E710 25.26') suitable for undertaking scaled up cultivation to over 1000 rafts. A pre-feasibility study further found the raft cultivation to be successful and the total biomass obtained translated to a high daily growth rate of over 6%. The tube net method also worked well. It is of particular interest in the context of preservation and maintenance of biomass as seed stock during monsoon period when wave action is high.

Survey of Nellore and Prakasam coast (Andhra Pradesh) for identifying the suitable sites for initiating *Kappaphycus* seaweed cultivation

The cultivation group went on expanding the *Kappaphycus* cultivation activity to other maritime states by conducting feasibility studies. As part of this activity, extensive field surveys to identify the localities and assess its potentialities for cultivation of *Kappaphycus* seaweed were undertaken. 33 coastal regions in the districts of Nellore and Prakasam in Andhra Pradesh were surveyed and 19 potential locations were identified.

Wasteland Agriculture

Establishment of Jatropha plantation on wastelands

As reported previously, the institute entered into joint collaboration with General Motors Corporation and US Department of Energy with an aim to demonstrate 50 ha plantation of *Jatropha curcas* on marginal lands using cuttings and micro-propagated elite germplasm identified in the previous years. It was also aimed to improve upon the existing cultivation practices to maximize Jatropha oil productivity. A full life cycle analysis was further proposed. During the reporting period new suitable sites were identified and acquired from the relevant agencies and plantation activities initiated at the following places.

Name of Village	District	GPS	
		N	E
Bhadraval	Bhavnagar	21° 29' 530"	072° 00' 167"
Kanod	Panchmahal	22° 41' 376"	073° 29' 649"
Nesvad	Bhavnagar	21° 30' 494"	072° 02' 185"

The physical and chemical properties of soil including macro-nutrient composition were also completely characterized. Meanwhile, the plantation established previously in the rocky premises of General Motors, Talegaon, Pune using the elite germplasm (IC 565735/CP-9 and IC-565731/PCM) fruited heavily during this period.

(Left) Jatropha plantation at General Motors' premises at Talegaon, Maharshtra;
(Right) Heavy fruiting being witnessed by a GM official

Raising large scale nurseries of Jatropha in Odisha and Gujarat from elite germ-plasm

Large scale nursery with stem cuttings from elite germplasm of Jatropha was raised at Odisha and the rooted plantlets were planted on 50 ha area at Panchmahal and Bhavnagar districts of Gujarat in 2010 and 2011. The newly transplanted Jatropha plants were successfully established in the field. The Working Group of scientists constituted by MNRE identified CP-9 (IC 565735) as one of the best performing germplasm and recommended its proliferation in Rajasthan.

Nursery of elite cuttings at Berhampur, Orissa

Deployment of biodiesel technology in running tourist buses in Gir Lion's sanctuary

In the earlier biennial report, it was reported that the institute had tied up with Forest Department, Govt. of Gujarat to test the utility of B 100 Jatropha biodiesel in the forest vehicles. The test trials were quite successful and since then the institute is continuously supplying neat (B 100) biodiesel to the National Lion Sanctuary at Gir where all the tourist buses are operating with this biodiesel.

Tourist vehicles plying in Gir Lion's sanctuary on neat B 100 biodiesel of CSIR – CSMCRI

Estimation of Salicornia biomass and their salt concentrations at various salt marsh sites

The cultivation of *Salicornia brachiata* halophyte and the extraction of oil and vegetable salt from the biomass have been described in earlier reports. Further to the above work, survey and analysis work was done to estimate the biomass production and salt content of plants growing at five densified sites (Sartanpar, Methla, Nigala, Victor and Diu) without manuring and irrigation. It was found that the plant population varied from 100000 (Victor port) to 3310000 (Sartanpar) per ha with a mean value of 8.35 lakhs per ha, across different sites. The dry biomass varied from site to site and the average yield was 2.15 ton per ha. Among the sites, the least mean dry biomass was obtained at Sartanpar (1.46 ton per ha), while the maximum dry biomass production was observed at Nigala site (3.22 ton per ha). No significant correlation was observed between plant population and dry biomass production per unit area, while there were indications of negative correlation (correlation coefficient=-0.53) between plant population and individual plant dry weight. The percentage of seed obtained out of the total dry biomass was 7.2 with a mean value of 4.7, while the seed oil content ranged from 25.2 to 34.6% with a mean value of 32.5%. The percentage salt (commercialized as vegetable salt named as *Saloni*) obtained from the dry biomass ranged from 9-27% with an average salt content of 16.6%. The Nigala site produced the highest quantity of vegetable salt (829.6 kg per ha).

Multi-institutional project on liquid seaweed plant stimulant

The liquid seaweed sap from Kappaphycus was shown to improve productivity of a number of crops in the previous years based on trials carried out by a number of agencies. Expanding its scope, the sap compositions produced from *Kappaphycus alvarezii* and *Gracilaria edulis* were tested for their efficacy on nine different crops, viz., maize, rice, blackgram, greengram, soybean, sesame, potato, sugarcane and grasses/fodder in a number of locations in various agro-ecological regions and different soil types in the country. CSIR-CSMCRI is coordinating the CSIR-funded project in collaboration with different agricultural universities and ICAR institutes. In all, 41 institutions across 20 states of the country are involved in the trials and the results obtained are encouraging. After optimizing the dosage, trials are being conducted at larger scale in farmers' fields.

Sesame crop treated with seaweed sap (bottom) and water spray (top)

Kufri jyoti grown using seaweed sap at Burdwan, West Bengal

PSB, Viswabharati centre conducted a three acre trial in the farmer's field at Burdwan, with *Kufri jyoti* variety of potato grown with recommended dose of fertilizer and following standard package of practices. It was concluded that in Lateritic region of West Bengal, the said potato crop variety gave good responses to the spray application of seaweed sap. The application of Kappaphycus sap recorded 35.56 t/ha tuber yield which was 26.6% higher than in the control plot. Some unexpected observations were also reported. For example, for the trial on *Boro* rice conducted in the farmer's field at BCKV, Nadia centre, the principal investigator wrote thus: "*It has been found that though the rice crop in the*

fields adjoining to the demonstration field was lodged during heavy storm (Norwester), the rice crop receiving K sap and G sap in the said demonstration field did not lodge at all. The plants stood erect". A trial conducted by a farmer under RAU, Pusa, Bihar observed that dessicated Parwal (*Trichosanthes dioica*) crop could be revived through application of *K sap*.

Please find herewith some photographs of Parwal (Trichosanthes dioica) which was treated with K sap. It so happened that some sap was left after spraying on maize crop at farmers field. The farmer just sprayed that sap on some plant of parwal which according to him was almost dry and desiccated. To his surprise the crop rejuvenated in 3-4 days of spray. He was so happy that he came to the department and asked for some more sap. First i doubted him and asked that i would like to see the crop. The next morning Iwent and saw that the crop was really in good condition. I took some photographs and gave the farmer some more (2.5 L) K sap.

Owing to this finding i feel that some more vegetable crops could be included in our programme.

regards

SANTOSH KUMAR SINGH
JR SCIENTIST CUM ASST. PROF.
RAU, PUSA, SAMASTIPUR, BIHAR-848125
Mob. 09431807104

Assisting the local artisans of Ootakamand (Nilgiri district) engaged in the extraction of essential oils (MSME cluster development program)

At the instance of Ministry of Micro, Small and Medium Enterprises, Govt. of India an essential oil cluster development program was initiated along with HOPE foundation. The scientists from CSIR-CSMCRI along with officials from HOPE visited the site at Nilgiri where the local people are engaged in the farming and extraction of essential oils from rosemary, eucalyptus, medicinal herbs etc. Opportunities were identified to improve the oil extraction process, with an eye on energy efficiency.

(Left) Herbal plantation at Doddabetta; (Right) Community oil extraction unit

Household solar distillation unit for sea water desalination targeted for coastal areas

Solar distillation is a means of desalination which is inexpensive, user-friendly, and ideally suited for individual households. A conventional solar still works on the simple principle of evaporation and condensation and in the process impurities in water get removed. The basic challenge is to enhance the production from a solar still by enhancing the evaporation rate and, at the same time, enhancing the condensation efficiency. It is an especially attractive option for seawater desalination which is difficult to undertake at household scale through techniques such as membrane desalination. It was possible

Household solar distillation unit

to achieve a maximum output of 7.2 litres of water from 1m^2 of irradiance area by incorporating the following innovative features:

- Enhanced water surface area for improved evaporation
- Enhanced solar energy on still through use of North–South reflectors in V-trough
- Improved efficiency of condensation by incorporating condensers and also flowing cool feed water by gravity over the condenser surface
- Making use of night sky radiation and thermal insulation strategy to cool the condenser water at night and keep it cool during the day
- Easy access to still interior for easy maintenance

Contributions of CSIR–CSMCRI towards Kalpasar project

It is reported earlier that the institute has been awarded various project activities by Kalpasar Technical Cell, Govt. of Gujarat for the proper project implementation. The project activities were completed successfully as per KTC norms and the findings were presented before PMG & EAG held in 2012.

Analytical services to academia and other institutions

The institute extended the analytical services to academia, government institutions, medium, large and small scale industrial units with due discounts on the analytical charges as per the laid out norms.

CSIR Program on Youth Leadership in Science (CPYLS)

In the tradition of previous years, two CPYLS programs were organized in the institute during 2011 for the benefit of the toppers in the class X examination of Gujarat Secondary Education Board (GSEB) and Central Board of Secondary Education (CBSE). Distinguished Professor Jahar Saha, former Director, IIM-Ahmedabad was the Chief Guest for the CPYLS Program held during 20 – 21, January 2011. He gave an inspiring talk to the participants tracing his own career path. The second CPYLS program was conducted during 24 – 25, November 2011 wherein CSIR Outstanding Scientist, Professor Amitabha Chattopadhyay of Centre for Cellular & Molecular Biology, Hyderabad was the Chief Guest. The teachers & parents who accompanied the students for the program appreciated the efforts made by CSIR–CSMCRI in conducting such programs which are an eye opener for the youth and guide them in their career choice.

CPYLS programs conducted during the year 2011

Scientific training programs for the students & teaching staff of primary & secondary sections

The institute imparted training to the students & staff of primary, secondary and higher secondary schools of Bhavnagar district to stimulate scientific thinking as a part of societal mission activities. The students and teachers attended these training programs/workshops in large numbers. A workshop on similar lines was organized on 14 October 2011 wherein Mr. Anil Manekar, Director, Nehru Science Centre, Mumbai was the Chief Guest. 72 students and 10 teachers participated in this workshop. A second training program for the primary and secondary teachers was organized during the period under report from 5 to 7 March 2012. Dr B N Das, The Eminent Physicist from Kolkata was the special invitee on this occasion. Altogether 50 teachers from various primary and secondary schools of the district participated in the training program.

Workshops on capacity building in science for students & teachers (2011) and stimulating scientific thinking (2012)

Workshop on writing scientific papers in Hindi language

The Hindi Cell has been active in promoting our national language by encouraging the scientists and administrative staff to communicate in Hindi. As part of this initiative a one day workshop on "Writing Scientific Papers in Hindi Language" was organized. Dr. D.D. Oza, Scientist and Member, Hindi Advisory Committee, Govt. of India was the Chief Guest. 53 scientists and technical staff participated in the workshop.

Workshop on scientific paper writing in Hindi language

ANNEXURE

Research Output and Other Activities

1. Research Papers Published
2. Books / Chapters in Books
3. Patents - Granted / Filed
4. Papers / Lectures Presented in Seminars / Symposia
5. Inter Agency Linkages
6. Human Resources Development
7. Awards and Recognitions
8. Deputation abroad: CSMCRI Scientists & Research Scholars
9. Visitors from abroad to CSMCRI
10. Distinguished Visitors & Lectures
11. Invited Talks / Lectures Delivered By CSMCRI Scientists
12. Knowledge Resource Centre (Library)
13. Dateline CSMCRI
14. Seminars / Workshops / Events / Meetings Organized
15. Appointments
16. Research Council
17. Resources - Staff and Budgetary Details
18. Management Council

1. Research Papers Published

2010-2011

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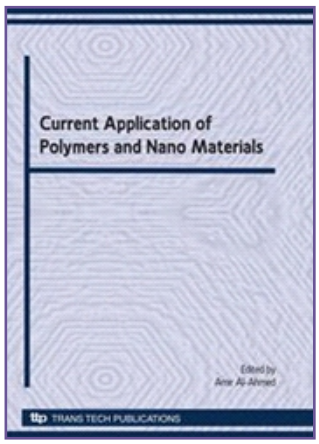

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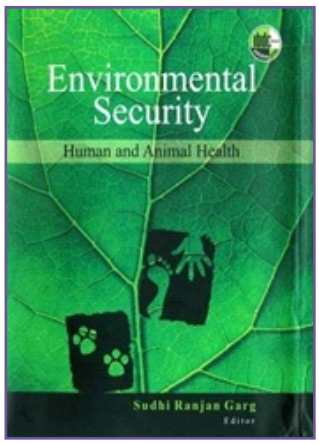
Synthesis and characterization of titanium dioxide nanotubes for photocatalytic degradation of aqueous nitrobenzene in the presence of sunlight
R.J.Tayade and D.L. Key, pp. 62-74



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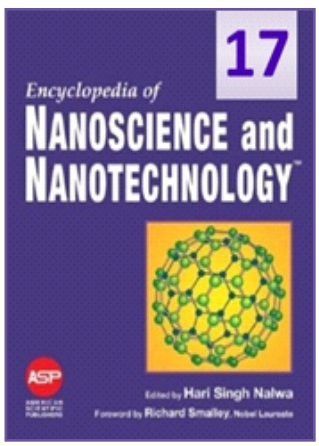
D.Gangadaharan, K.M.Popat and P.S.Anand, pp. 41-55



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Nano-materials as adsorbents and catalysts in chemical process industry
BeenaTyagi, Kalpesh B. Sidhpuria and RakshVir Jasra
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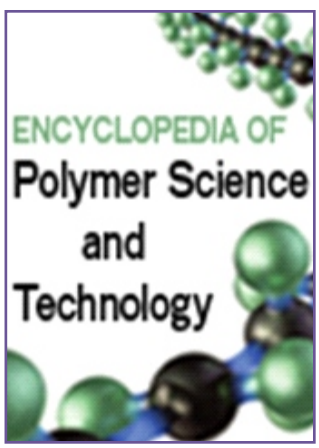

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Polymer cross-linking
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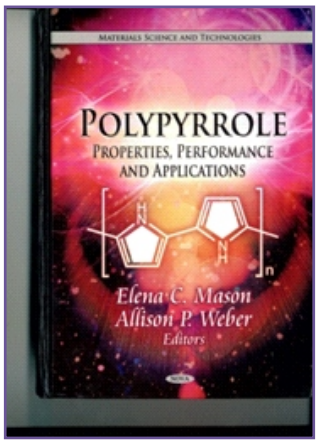

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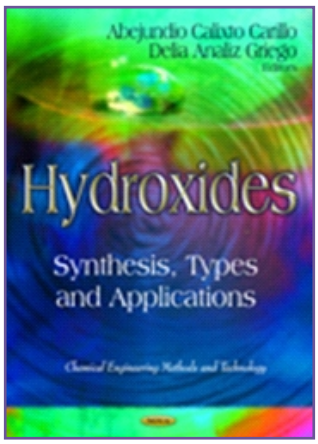
Immobilization of enzymes on polypyrrole and potential applications

Shweta Singhal, D.C. Mukherjee and A. Bhattacharya, pp.177-198



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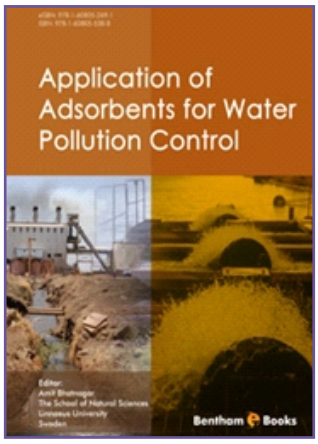
Delamination of layered double hydroxides: Methodologies, characterization and applications

C. A. Antonyraj, P. Koilraj and S. Kannan, pp. 105-139



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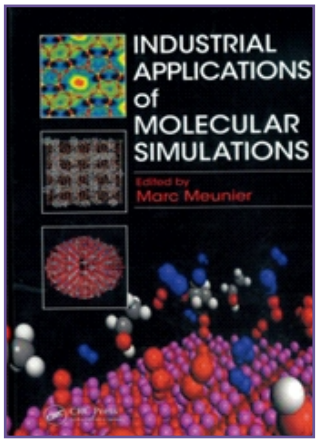
Layered double hydroxides as potential adsorbents for water remediation

P. Koilraj, C. M. Jinesh and S. Kannan, pp. 153-237



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Density functional theory study of urea interaction with potassium chloride surfaces

Ajeet Singh and Bishwajit Ganguly, pp. 109-120

3. Patents – Granted / Filed

2010-2011
Foreign Patent Granted

Sr. No.	Title	Inventors	Patent No
1	Iodizing agent and process for preparation thereof	P.K. Ghosh, S.H. Mehta, J.R. Chunawala, M.V. Sheth and M.R. Gandhi	US 7,695,707
2	Preparation of non-hazardous brominating reagent	G. Ramachandriah, P.K. Ghosh, A.S. Mehta, S. Adimurthy, A.D. Jethva and S.S. Vaghela	JP 44,98,744
3	Improved process for simultaneous recovery of industrial grade potassium chloride and edible salt enriched with KCl (low sodium salt) from bittern	R.N. Vohra, P.K. Ghosh, A.B. Kasundra, H. L. Joshi, R.H. Dave, M.R. Gandhi, K.J. Langalia, K. Halder, S.L. Daga, R.D. Rathod, P.R. Jadav, H.H. Deraiya, V.P. Mohandas and A.U. Hamidani	CA 25,52,206
4	Process for the preparation of a molecular sieve adsorbent for the adsorptive dehydration of alcohols	R.V. Jasra, J. Sebastian and C.D. Chudasama	CN 1929910B
5	Process for the preparation of a molecular sieve adsorbent for the adsorptive dehydration of alcohols	R.V. Jasra, J. Sebastian and C.D. Chudasama	KR 10-1016664
6	Novel integrated process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P.K. Ghosh, K.J. Langalia, M.R. Gandhi, R.H. Dave, H.L. Joshi, R.N. Vohra, V.P. Mohandas, S.L. Daga, K. Halder, H.H. Deraiya, R.D. Rathod and A.U. Hamidani	CN 1962443B
7	Process for the recovery of low sodium salt from bittern	R.N. Vohra, P.K. Ghosh, M.R. Gandhi, H.L. Joshi, H.H. Deraiya, R.H. Dave, K. Halder, K.M. Majeethia, S.L. Daga, V.P. Mohandas and R.J. Sanghavi	JP 45,09,568
8	A novel device for estimation of brine density in solar salt farm from afar	P.K. Ghosh, K.M. Majeethia, M.R. Gandhi, J.N. Parmar, S.A. Chauhan, V.P. Mohandas and A.U. Hamidani	IL 169,252
9	Novel integrated process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P.K. Ghosh, K.J. Langalia, M.R. Gandhi, R.H. Dave, H.L. Joshi, R.N. Vohra, V.P. Mohandas, S.L. Daga, K. Halder, H.H. Deraiya, R.D. Rathod and A.U. Hamidani	JP 45,16,023

Sr. No.	Title	Inventors	Patent No
10	An improved process for the preparation of hydrotalcite	P.M. Oza, S.H. Mehta, M.V. Sheth, P.K. Ghosh, M.R. Gandhi and J.R. Chunawala	CN 1717368B
11	An improved electrochemical method for oxidation of bromide to bromine	G. Ramachandraiah, P.K. Ghosh, V.K.S. Susarla and S.S. Vaghela	CN 1771353B
12	Process of preparation of biodegradable films from semi-refined kappa carrageenan	P.K. Ghosh, A.K. Siddhanta, K. Prasad, R. Meena and A. Bhattacharya	GB 24,35,768
13	A process for recovery of common salt and marine chemicals from brine in integrated manner	R.N. Vohra, P.K. Ghosh, V.P. Mohandas, H.L. Joshi, H.H. Deraiya, R.H. Dave, K. Halder, R.B. Yadav, S.L. Daga, K.M. Majeethia and U.P. Saraiya	JO 2517
14	Iodizing agent and process for preparation thereof	P.K. Ghosh, S.H. Mehta, J.R. Chunawala, M.V. Sheth and M.R. Gandhi	CA 25,75,744
15	Preparation of nutrient rich salt of plant origin	P.K. Ghosh, M.P. Reddy, J.B. Pandya, J.S. Patolia, S.M. Vaghela, M.R. Gandhi, R.J. Sanghvi, V.G. Kumar and M.T. Shah	CA 24,29,700
16	An improved process for the preparation of fatty acid methyl ester (Bio-diesel) from triglycerides oil through trans esterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	AU 2004/ 324,250
17	An improved process for the preparation of fatty acid methyl ester (Bio-diesel) from triglycerides oil through trans esterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	CA 2,626,129
18	Catalytic process for the preparation of isolongifolene	R.V. Jasra, B. Tyagi and M.K. Mishra	EP 16,44,305
19	Preparation of non-hazardous brominating reagent	G. Ramachandriah, P.K. Ghosh, A.S. Mehta, S. Adimurthy, A.D. Jethva and S.S. Vaghela	CA 24,74,338
20	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, P. Agnihotri and S. Patra	EP 19,45,567

Sr. No.	Title	Inventors	Patent No
21	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, P. Agnihotri and S. Patra	ES 19,45,567
22	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, P. Agnihotri and S. Patra	DE 19,45,567
23	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, P. Agnihotri and S. Patra	NL 19,45,567
24	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, P. Agnihotri and S. Patra	IR 19,45,567
25	Improved process for simultaneous recovery of industrial grade potassium chloride and edible salt enriched with KCl (low sodium salt) from bittern	R.N. Vohra, P.K. Ghosh, A.B. Kasundra, H.L. Joshi, R.H. Dave, M.R. Gandhi, K.J. Langalia, K. Halder, S.L. Daga, R.D. Rathod, P.R. Jadav, H.H. Deraiya, V.P. Mohandas and A.U. Hamidani	JP 45,55,227
26	A novel device for estimation of brine density in solar salt works from afar	P.K. Ghosh, K.M. Majeethia, M.R. Gandhi, J.N. Parmar, S.A. Chauhan, V.P. Mohandas, A.M. Bhatt and A.U. Hamidani	DE 1,02,97,838
27	An improved process for preparation of magnesia (MgO) from crude $Mg(OH)_2$ [lime based]	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	US 7,771,682
28	A process for the recovery of palladium from spent silica	A.B. Boricha, H.C. Bajaj, R.V. Jasra, P. Ghosh and P. K. Ghosh	CA 25,08,237
29	An improved process for the preparation of hydrotalcite	P.M. Oza, S.H. Mehta, M.V. Sheth, P.K. Ghosh, M.R. Gandhi and J.R. Chunawala	EP 1,575,874
30	An improved process for preparation of magnesia (MgO) [ammonia based]	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi. R.H. Dave, K.J. Langalia and V.P. Mohandas	US 7,811,535
31	Improved process for simultaneous recovery of industrial grade potassium chloride and edible salt enriched with KCl (low sodium salt) from bittern	R.N. Vohra, P.K. Ghosh, A.B. Kasundra, H.L. Joshi, R.H. Dave, M.R. Gandhi, K.J. Langalia, K. Halder, S.L. Daga, R.D. Rathod, P.R. Jadav, H.H. Deraiya, V.P. Mohandas and A.U. Hamidani	EP 16,99,738

Sr. No.	Title	Inventors	Patent No
32	A novel iodizing agent and preparation of iodised salt there from	P.K. Ghosh, S.H. Mehta, J.R. Chunawala, M.R. Sheth and M.R. Gandhi	CA 26,27,154
33	A process for the preparation of zeolite-A from kimberlite tailings	R.V. Jasra, R.S. Somani, H.M. Mody, H.C. Bajaj, J.R. Chunawala, H. Ranpara, D. Barochiya, D. Ghelani, M.K. Dhar, S. Chndra, K. Rao and K. Kumar	CN 101090864B
34	A process for the preparation of zeolite-A from kimberlite tailings	R.V. Jasra, R.S. Somani, H.M. Mody, H.C. Bajaj, J.R. Chunawala, H. Ranpara, D. Barochiya, D. Ghelani, M.K. Dhar, S. Chndra, K. Rao and K. Kumar.	ZA 2007/05227
35	An improved process for the single pot synthesis of 2,4,4,6-tetrabromo-2,5-cyclohexadienenone	A.V. Bedekar, G. Ramachandraiah and P.K. Ghosh	IL 169,376
36	Process for the preparation of aldol derivatives from alkenes using catalyst	R.V. Jasra, V.K. Srivastava, R.S. Shukla, H.C. Bajaj and S.D. Bhatt	CN 101094826
37	An eco-friendly process for acylation of alkylated benzene derivatives	R.V. Jasra, B. Tyagi and Y.M. Badheka	EP 1,670,738
38	A cost-effective process for preparation of solar salt having high purity and whiteness	I. Mukhopadhyay, P.K. Ghosh, V.P. Mohandas, A.U. Hamidani, R.J. Sanghavi and V.R.K.S. Susarla	EP 1,928,569
39	Low sodium salt of botanic origin	P.K. Ghosh, K.H. Mody, M.P. Reddy, J.S. Patolia, K. Eswaran, R.A. Shah, B.K. Barot, M.R. Gandhi, A.S. Mehta, A.M. Bhatt and A.V.R. Reddy	AU 2004-318169

2010-2011
Indian Patent Granted

Sr. No.	Title	Inventors	Patent No
1	Enhancement of anti-tubercular activity of extracts of *Salicornia brachiata*	M.R. Rathod, B.D. Shethia, J.B. Pandya, P. K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava, V. Chaturvedi and M. Vairamani	IN 241,463
2	A method for the manufacture of alkali iodates from iodides using an ion-exchange membrane flow reactor	P.K. Ghosh, G. Ramachandraiah, V.R.K.S. Susarla, S.S. Vaghela and A.D. Jethva	IN 242,170
3	Process for the preparation of a molecular sieve adsorbent for the adsorptive dehydration of alcohols	R.V. Jasra, J. Sebastian and C.D. Chudasama	IN 243,813
4	Process for preparation of sulphate of zirconia catalyst	R.V. Jasra, B. Tyagi and M.K. Mishra	IN 243,879
5	Polyamide composite membrane for reverse osmosis and method of producing the same	V.J. Shah, P.K. Ghosh, S.V. Joshi, J.J. Trivedi, C.V. Devmurari, P. Rao, P.D. Parmar, N.K. Vaghani, K.S. Balaraman, M.S. Swami and T.B. Gohil	IN 244,150
6	An improved clay based process for the preparation of acylated aromatic ethers	R.V. Jasra, S. Muthusamy and Y.M. Badheka	IN 244,658
7	Low sodium salt of botanic origin	A.M. Bhatt, K. Eswaran, J.S. Patolia, A.V.R. Reddy, R.A. Shah, B.K. Barot, A.S. Mehta, M.R. Gandhi, K.H. Mody, M.P. Reddy and P.K. Ghosh	IN 245,319
8	A process for preparing amorphous silica from kimberlite tailings	R.V. Jasra, H.M. Mody, H.C. Bajaj, R.S. Somani, J.R. Chunawala, H.N. Ranpara, D.J. Barochiya, D.L. Ghelani, S. Chandra, M.K. Dhar, K. Rao and K. Kumar	IN 246,306

2010-2011
Foreign Patents Filed

Sr. No.	Title	Inventors	Patent Application No.
1	100-500 µm size spherical sodium chloride having improved flow and process of preparation from brine thereof	I. Mukhopadhyay, P.K. Ghosh and V.P. Mohandas	IL/ 206876 AU/ 2008346088 EP/ 08789942.3
2	A method for isolation, purification and identification of extreme alkaliphilic bacteria using carrageenan as a gelling agent	G. Gnanasekaran, K.H. Mody, S. Datta and B. Jha	MY/Pl2010003240 PH/12010501544 ID-W0/201002510
3	An improved process of preparation of common salt of high purity from brines in solar salt pans	A. Kumar, P.K. Ghosh, V.P. Mohandas, I. Mukhopadhyay, J.J. Shukla and R.J. Sanghavi	IL/206877 AU/2008346089 EP/08870374.9
4	Improved process for the preparation of iodate-exchanged synthetic hydrotalcite as iodizing agent with zero effluent discharge	P.K. Ghosh, M.R. Gandhi, S.H. Mehta, G. Ramachandraiah, J.R. Chunawala, M.V. Sheth and G.S. Gohil	EP/08871595.8 IL/207213 LK/15916 JP/2010-543628 AU/2008348619 CA/2713315 AP/P/2010/005359 CN/200880127465.6
5	A stable iodine-water concentrate formulation to iodinate drinking water for the effective prevention of iodine deficiency disorders	G. Ramachandraiah, D. Livingston, A. Hussain and D. B. Shukla	ZA 2010/05263
6	A process for integrated production of ethanol and seaweed sap from *Kappaphycus alvarezii*	K.H. Mody, P.K. Ghosh, B. Sana, G. Gnanasekaran, A.D. Shukla, K. Eswaran, H.R. Brahmbhatt, B.G. Shah, S. Thampy and B. Jha	PCT/IN2010/000508
7	Preparation of highly efficient heterogeneous catalyst for asymmetric nitro-aldol reaction	S.H.R. Abdi, R.I. Kureshy, N.H. Khan, H.C. Bajaj, V.J. Mayani and A.K. Shah	PCT/IB2010/002576
8	Preparation of inorganic hydrogels with alkali halides	A. Singh and B. Ganguly	PCT/IB2011/00506

2010-2011
Indian Patent Filed

Sr. No.	Title	Inventors	Patent Application No.
1	A novel process for production of high purity salt, potassium chloride and ammonium sulphate in integrated manner employing ammonia, bittern and CO_2 from flue gas as raw materials	P.K. Ghosh, H.M. Mody, R.S. Somani, P. Maiti, M.R. Gandhi, H.C. Bajaj and J.R. Chunawala	0930/DEL/2010
2	Improved solar dryer and method of operation for enhanced efficiency of drying	P.K. Ghosh, S. Maiti, P. Patel, J.N. Bharadia, S.S. Chauhan and M.L. Sanghani	0931/DEL/2010
3	Production of potable water from highly saline sub-soil brine in salt works using exhaust waste heat form diesel engine employed round the clock during the salt manufacturing season to charge the salt pans with subsoil brine	P.K. Ghosh, G.R. Desale, B.H. Khatri, R.N. Patel, M.R. Gajjar and N.G. Borle	0932/DEL/2010
4	Zn(II) based colorimetric sensors and process for the preparation thereof	P. Mahato, A. Ghosh, S.K. Mishra, A. Shrivastava, S. Mishra and A. Das	1242/DEL/2010
5	Attachment to domestic RO unit for high recovery of pure water from brackish water without compromising on quality	P.K. Ghosh, S. Thampy, B.S. Makwana, G.R. Desale, V.K. Shahi and S.L. Daga	1418/DEL/2010
6	A non-catalytic electrochemical membrane process for the preparation of solid potassium iodate	G. Ramachandraiah, V.R.K.S. Susarla, V.P. Mohandas, B.G. Shah, R.J. Sanghavi and M.N. Parmar.	1688/DEL/2010
7	High flux hollow fiber ultrafiltration membranes	A.V. Reddy, P. Ray, P.S. Singh, P. Kallem, S. Maurya and J.J. Trivedi	2178/DEL/2010
8	Improved process for the preparation of fatty acid methyl esters (biodiesel) from triglyceride oils using eco-friendly solid base catalyst	S. Kannan, S. Sankaranarayanan and C.A. Antonyraj	0371/DEL/2011

2011-2012
Foreign Patent Granted

Sr. No.	Title	Inventors	Patent No.
1	Biodegradable films based on semi refined kappa carrageenan	P.K. Ghosh, A.K. Siddhanta, K. Prasad, R. Meena and A. Bhattacharya	PH 1-2007-501125
2	An improved process for preparation of magnesium oxide	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	CN 101374767
3	An improved catalytic process for the preparation of epoxides from alkenes	N.H. Khan, S.H.R. Abdi, R.I. Kureshy, S. Singh, I. Ahmed, R.V. Jasra and P.K. Ghosh	JP 4,733,109
4	Eco-friendly method of preparation of high purity tetrabromobisphenol-A	G. Ramachandraiah, P.K. Ghosh, A.S. Mehta, R.P. Pandya, A.D. Jethva, S.S. Vaghela and S.N. Misra	JP 4,741,784
5	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, R. Meena, B.D. Shethia, D.R. Parmar, J.B. Pandya, M.R. Rathod, M.G. Patel, P.J. Dodia, R.A. Parmar and S.N. Patel	MG 481
6	A stable iodine-water concentrate formulation to iodinate drinking water for the effective prevention of iodine deficiency disorders	G. Ramachandraiah, D. Livingston, A. Hussain and D.B. Shukla	ZA/2010/05263
7	An eco-friendly process for acylation of alkylated benzene derivatives	R.V. Jasra and B. Tyagi	AU 2003-290424
8	Improved process for simultaneous recovery of industrial grade potassium chloride and edible salt enriched with KCl (low sodium salt) from bittern	R.N. Vohra, P.K. Ghosh, A.B. Kasundra, H.L. Joshi, R.H. Dave, M.R. Gandhi, K.J. Langalia, K. Halder, S.L. Daga, R.D. Rathod, P.R. Jadav, H.H. Deraiya, V.P. Mohandas and A.U. Hamidani	IL 176481
9	Process for the recovery of low sodium salt from bittern	R.N. Vohra, P.K. Ghosh, M.R. Gandhi, S.L. Daga, R.H. Dave, H.H. Deraiya, K. Halder, H.L. Joshi and K.M. Majeethia	BR 0215574B1

Sr. No.	Title	Inventors	Patent No.
10	Method for the preparation of kappa-carrageenase	Y.N. Khambhaty, K.H. Mody and B. Jha	US 7,951,561
11	An improved process for preparation of magnesium oxide	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	MX 2,878,66
12	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, S. Eringathodi, S. Patra and P. Agnihotri	JO 2595
13	A process for the preparation of amorphous silica from kimberlite tailings	R.V. Jasra, H.M. Mody, H.C. Bajaj, R.S. Somani, J.S. Chunawala, H.N. Ranpara, D.J. Barochiya, D.L. Ghelani, S. Chandra, M.K. Dhar and K. Kumar	CN 101094808B
14	An improved process for the preparation of hydrotalcite	P.M. Oza, S.H. Mehta, M.V. Sheth, P.K. Ghosh, M.R. Gandhi and J.R. Chunawala	IL 1,69,375
15	A novel use of herbal extracts of Salicornia species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	KE AP2250
16	A novel use of herbal extracts of Salicornia species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	ZW AP2250
17	A novel use of herbal extracts of Salicornia species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	ZM AP2250
18	A novel use of herbal extracts of Salicornia species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	TZ AP2250
19	A novel use of herbal extracts of Salicornia species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	SD AP2250

Sr. No.	Title	Inventors	Patent No.
20	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation thereof	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	AP 2250
21	Process for production of glycine enriched sodium chloride crystals with improved flow	P. Dastidar, P.K. Ghosh, A. Ballabh, D.R. Trivedi, A. Pramanik and V.N.G. Kumar	CA 2,551,051
22	Anti-tubercular extracts of *Salicornia brachiate*	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava, V. Chaturvedi and M. Vairamani	US 7,989,004
23	An eco-friendly process for acylation of alkylated benzene derivates	R.V. Jasra and B. Tyagi	JP 4,800,765
24	Process for production of glycine micronutrient-enriched NaCl crystals with near spherical shape and improved flow characteristics	P. Dastidar, P. K. Ghosh, A. Ballabh, D.R. Trivedi, A. Pramanik and V. Nai	JP 4,805,677
25	Iodised salt and a process for its preparation	P.K. Ghosh, S.H. Mehta, J.R. Chunawala, M.V. Sheth and M.R. Gandhi	AU 2004-325827
26	Herbal extracts of *Salicornia* species, process of preparation thereof, use thereof against tuberculosis	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodia, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	MX 290,119
27	Process for the preparation of common salt of high purity from brines in solar salt pans	A. Kumar, I. Mukhopadhyay, P.K. Ghosh, V.P. Mohandas, J.J. Shukla and R.J. Sanghavi	US 8,021,442
28	A process for the preparation of sodium silicate from kimberlite tailings	R.V. Jasra, H.C. Bajaj, R.S. Somani, H.M. Mody, J.R. Chunawala, D.L. Ghelani, H.N. Ranpara, D.J. Barochiya, S. Chandra, M.K. Dhar, C.K. Rao and K. Kumar	CN 101,296,865B
29	A novel device for estimation of brine density in solar salt works from afar	P.K. Ghosh, K.M. Majeethia, M.R. Gandhi, J.N. Parmar, A.M. Bhatt, S.A. Chauhan, V.P. Mohandas and A.U. Hamidani	CA 2,511,473

Sr. No.	Title	Inventors	Patent No.
30	Process for the preparation of a molecular sieve absorbent for the size/shape selective separation of air	R.V. Jasra, C.D. Chudasama and J. Sebastian	CN 1533833B
31	Solid nutrient media useful for isolating and identifying alkaliphilic bacteria	G. Gnanasekaran, K.H. Mody, S. Datta and B. Jha	US 8,097,447
32	Biodegradable films based on semi refined kappa carrageenan	P.K. Ghosh, A.K. Siddhanta, K. Prasad, R. Meena and A. Bhattacharya	CN 101316865B
33	An improved process for preparation of magnesium oxide	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	AU 2006-337403
34	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	AP 2230
35	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	KE AP2230
36	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	MZ AP2230
37	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	SD AP2230
38	Improved process for the preparation of fatty acid methyl ester (biodiesel) from triglyceride oil-through transesterification	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Vaghela, M.R. Rathod, B.D. Shethia, J.B. Pandya, R.A. Parmar, P.J. Dodia, M.G. Patel, D.R. Parmar and S.N. Patel	TZ AP2230

Sr. No.	Title	Inventors	Patent No.
39	Biodegradable films based on semi refined kappa carrageenan	P.K. Ghosh, A.K. Siddhanta, K. Prasad, R. Meena and A. Bhattacharya	ID P0029510
40	An improved process for the preparation of nonhazardous brominating reagent	G. Ramachandraiah, P.K. Ghosh, S. Adimurthy, A.V. Bedekar and D.B. Shukla	IL 172,280
41	An improved process for preparation of magnesium oxide	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	MX 294,699
42	A cost-effective process for preparation of solar salt having high purity and whiteness	I. Mukhopadhyay, P.K. Ghosh, V.P. Mohandas, A.U. Hamidani, V.R.K.S. Susarla and R.J. Sanghavi	CN 101272837B
43	A cost-effective process for preparation of solar salt having high purity and whiteness	I. Mukhopadhyay, P.K. Ghosh, V.P. Mohandas, A.U. Hamidani, V.R.K.S. Susarla and R.J. Sanghavi	AU 2006-201116
44	An improved process for preparation of magnesium oxide	P.K. Ghosh, H.L. Joshi, H.H. Deraiya, M.R. Gandhi, R.H. Dave, K.J. Langalia and V.P. Mohandas	AU 2006-337405
45	An improved catalytic process for the preparation of epoxides from alkenes	N.H. Khan, S.H.R. Abdi, R.I. Kureshy, S. Singh, I. Ahmed, R.V. Jasra and P.K. Ghosh	KR 10-1131207
46	Improved process for the preparation of iodate-exchanged synthetic hydrotalcite as iodizing agent with zero effluent discharge	P.K. Ghosh, M.R. Gandhi, S.H. Mehta, G. Ramachandraiah, J.R. Chunawala, M.V. Sheth and G.S. Gohil	EP 2,244,978
47	Improved k-carrageenase production and a method of preparation thereof	Y.N. Khambhaty, K.H. Mody and B. Jha	JP 4,955,753
48	Low sodium salt of botanic origin	P.K. Ghosh, K.H. Mody, M.P. Reddy, J.S. Patolia, K. Eswaran, A.M. Bhatt, A.V.R. Reddy, R.A. Shah, B.K. Barot, A.S. Mehta and M.R. Gandhi	JP 4,955,538

2011-2012
Indian Patent Granted

Sr. No.	Title	Inventors	Patent No.
1	Catalysed acylation of alkylated benzene derivatives	R.V. Jasra, B. Tyagi and Y.M. Badheka	IN 247,645
2	Process for the preparation of a molecular sieve absorbent for the size/shape selective separation of air	R.V. Jasra, C.D. Chudasama and J. Sebastian	IN 250,597
3	Improved process for the recovery of sulphate of potash (SoP) from sulphate rich bittern	P. Paul, P.K. Ghosh, K.J. Langalia, P.S. Subramanian, E. Suresh, S. Patra and P. Agnihotri	IN 251,482

2011-2012
Foreign Patents Filed

Sr. No.	Title	Inventors	Patent Application No.
1	Production of potable water from highly saline sub-soil brine in salt works using exhaust waste heat form diesel engine employed round the clock during the salt manufacturing season to charge the salt pans with subsoil brine	P.K. Ghosh, G.R. Desale, B.H. Khatri, R.N. Patel, S.N. Patel, M.R. Gajjar and N.G. Borle	WO/PCT/IB2011/000851
2	An improved process for the preparation of para-nitrobenzyl bromide	M.K. Agrawal, P.K. Ghosh, M.R. Gandhi, S. C. Upadhyay, S. Adimurthy, G. Ramachandraiah, P.U. Patoliya, G. Joshi, H. Brahmbhatt and R.J. Sanghavi	IL/212684 JP/2011-535172 KR/10-2011-7012748 CN/ 200980153346.2
3	An improved solar dryer with enhanced efficiency of drying	P.K. Ghosh, S. Maiti, P.A. Patel, J.N. Bharadia, S.S. Chauhan, M.L. Sanghani, P.V. Parmar, K. Eswaran and P.V. Agravat	WO/PCT/IB2011/001039
4	An improved process for the eco-friendly preparation of 3,5-dibromo-4-hydroxybenzonitrile (Bromoxynil)	S. Adimurthy, G. Ramachandraiah, G. Joshi, R. Patil, M.R. Gandhi, M. Subbareddy and P. Maiti	IL/214786 AU/2010217236 CA/2753644 BR/020110088673 MX/A/2011/008931 CN/20108009438.6

Sr. No.	Title	Inventors	Patent Application No.
5	High flux hollow fiber ultrafiltration membranes and process for the preparation thereof	A.V.R. Reddy, P. Ray, P.S. Singh, K. Parashuram, S. Maurya and J.J. Trivedi	WO/PCT/IB2011/002124
6	Improved process for the preparation of agarose polymer from seaweed extractive	R. Meena, K. Prasad, A.K. Siddhanta, P.K. Ghosh, G.K. Mehta, B.K. Ramavat, M.S. Ganesan, B. Jha, A. Mishra, M.R. Gandhi, P.K. Agarwal and K. Eswaran	AU/2010-227247 PH/1-2011-501869 ID/W-00201103393 CA/2756520 JP/2012-501402 EP/10715346.2 CN/201080017359.X RU/2011142728
7	A process for the production of oil bearing chlorella sp. Utilizing by-products of Jatropha methyl ester production from whole seeds	P.K. Ghosh, S. Mishra, M.R. Gandhi, S.C. Upadhyay, S.K. Mishra, I. Pancha, A.V. Shrivastav, D. Jain, B.D. Shethia, S. Maiti and K.S. Zala	WO/PCT/IN2010/000655
8	A manually operated continuous flow type drinking water disinfector using concentrated solar radiation	S.T. Rajan, P.K. Ghosh, S.N. Patel and J.N. Bharadia	LK/16446 IL/215390 US/13/260383 AE/949/2011
9	Integrated process of production of potassium sulphate, magnesium hydroxide and ammonium sulfate from kainite mixed salt and ammonia	P.K. Ghosh, H.M. Mody, J.R. Chunawala, M.R. Gandhi, H.C. Bajaj, P. Maiti, H.L. Joshi, H.H. Deraiya and U.P. Saraiya	JP/2012-501508
10	A method of preparation of enantio-selective composite membrane	K. Singh, H.C. Bajaj and P.G. Ingole	DE/112010001374.8 JP/2012-501507 KR/2011-7025333 CN/201080022405.5
11	Plant extract for treating anxiety disorders	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.J. Dodiya, G. Palit, M. Chatterjee, S.S. Gupta, A.K. Agarwal and V.K. Khanna	EP/10716619.1 DE/10716619.1 US/13/260454
12	Improved process for the preparation of fatty acid alkyl esters (Biodiesel) from triglyceride oils using eco-friendly solid base catalysts	S. Kannan, S. Sankaranarayanan and C.A. Antonyraj	WO/PCT/IN2012/000092

Sr. No.	Title	Inventors	Patent Application No.
13	A process for integrated production of ethanol and seaweed sap from *Kappaphycus alvarezii*	K.H. Mody, P.K. Ghosh, B. Sana, G. Gnanasekaran, A.D. Shukla, K. Eswaran, H.R. Brahmbhatt, B.G. Shah, S.K. Thampy and B. Jha	JP/2012-528504 PH/1-2012-500567 EP/10760105.6 US/13/394745 ID/W00201201223
14	Novel process for the preparation of polyhydroxyalkanoate and high density shell briquette integrated with improved process of production of methyl ester from whole seed capsule of *Jatropha curcas*	P.K. Ghosh, S. Mishra, M.R. Gandhi, S.C. Upadhyay, P. Paul, A.P. Singh, K.M. Popat, A.V. Shrivastav, S.K. Mishra, N. Ondhiya, R.D. Maru, G. Dyal, H. Brahmbhatt, V. Borisha, R.C. Doongar, R. Babulal and K.S. Zala	BR/112012005133-4 EP/10719642.0 ZA/2012/01885
15	Preparation of AC@MOF composite with enhanced methane storage capacity	H.C. Bajaj, R.S. Somani, R. Phani, D. Patil, K.P. Prasanth, M.C. Raj, R.S. Thakur, B.L. Newalkar and N.V. Chaudhary	WO/PCT/IB2012/000641
16	Zn(II) based colorimetric sensors and process for the preparation thereof	P. Mahato, A. Ghosh, S.K. Mishra, A. Shrivastava, S. Mishra and A. Das	DE/11730409.7 EP/11730409.3

2011-2012
Indian Patent Filed

Sr. No.	Title	Inventors	Patent Application No.
1	Process for engine worthy fatty acid methyl ester (biodiesel) from naturally occurring and cultured microalgal mat	S. Mishra, P.K. Ghosh, M.R. Gandhi, S. Bhattacharya, S. Maiti, S.C. Upadhyay, S.K. Mishra, A.V. Shrivastav, I. Pancha, C. Paliwal, T. Ghosh, R. Maurya, D. Jain, P. Gupta, S.K. Patidar, A. Shah, A. Sahu, V. Vekariya, K. Dave, H. Bosamiya and K. Zala	1507/DEL/2011
2	Preparation of high purity precipitated calcium carbonate from highly impure calcium hydroxide such as generated during the production of acetylene from calcium carbide	M.R. Gandhi, J.R. Chunawala, H.C. Bajaj, R.S. Somani, M.V. Sheth, H.L. Joshi, H.H. Deraiya, P. Maiti and S.C. Upadhyay	1750/DEL/2011

Sr. No.	Title	Inventors	Patent Application No.
3	Hand pressure driven portable ultrafiltration unit	P.K. Ghosh, A.V.R. Reddy, S.L. Daga, A.A. Patel, P. Ray, P.S. Singh, J.J. Trivedi, P.A. Patel, K. Parashuram, A.P. Rao, C.V. Devmurari, K.H. Mody and R.B. Mandavia	2076/DEL/2011
4	Cost-effective natural salt formulations for seawater substitution, mineral fortification and processes thereof	P.K. Ghosh, S.C. Upadhyay, S.C. Mishra, V.P. Mohandas, D.N. Srivastava, V.K. Shahi, R.J. Sanghavi, S. Thampy, B.S. Makwana, I. Pancha, R. Pal and R. Sen	3422/DEL/2011
5	An improved process for the preparation of 2-phenyl ethanol by catalytic hydrogenation of styrene oxide	H.C. Bajaj, S.H.R. Abdi, R.I. Kureshy, N.H. Khan, A.A. Dabbawala and T. Roy	3656/DEL/2011
6	An improved process for preparation of high purity heavy basic magnesium carbonate from bittern containing magnesium	M.R. Gandhi, J.R. Chunawala and S.H. Mehta	0326/DEL/2012
7	A method for the preparation of L-enantiomers selective membrane for optical resolution of alpha-amino acids	K. Singh, H.C. Bajaj and P.G. Ingole	0327/DEL/2012
8	Process for the purification of saline reject water of desalination plant and its direct use thereafter as salt solution for cooking purpose	P.K. Ghosh, R.J. Sanghavi, A.V.R. Reddy, N. Pathak and V. Solanki	0593/DEL/2012
9	Production of high purity salt with reduced levels of impurities	P.K. Ghosh, S.C. Upadhyay, V.P. Mohandas, R.J. Sanghavi and B. Rebary	0597/DEL/2012
10	Improved household solar still with easy operation and maintenance and enhanced output	S. Maiti, P.A. Patel, C. Bhatt, J.N. Bharadia, M.R. Gajjar, P.S. Bapat and P.K. Ghosh	0599/DEL/2012

Sr. No.	Title	Inventors	Patent Application No.
11	Integrated process of production of potassium sulphate and ammonium sulphate from kainite mixed salt	P.K. Ghosh, P. Maiti and M.R. Gandhi, H.H. Deraiya, H.M. Mody, J.R. Chunawala, H.C. Bajaj, U.P. Saraiya and H.L. Joshi	0600/DEL/2012
12	Process for solar driven solvent extraction of microalgal lipids	P.K. Ghosh, S. Mishra, S. Maiti, C. Paliwal, S. Mishra, T. Ghosh, P. Patel and J.N. Bharadia	0601/DEL/2012
13	A novel process for preparation of synthetic hydrotalcite from industrial waste	M.R. Gandhi, J.R. Chunawala and S.H. Mehta	0603/DEL/2012
14	Process for production of sulphate of potash from bittern through selective extraction of potassium	P. Maiti, P.K. Ghosh, M.R. Gandhi, J. Solanki and H.R. Brahmbhatt	0606/DEL/2012
15	Novel double fortified salt composition containing iron and iodine and process of preparation thereof	J.R. Chunawala, P.K. Ghosh, M.R. Gandhi, S.H. Mehta and M.V. Sheth	0607/DEL/2012

4. Papers / Lectures Presented in Seminars / Symposia

2010 – 2011

Analytical Sciences

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Coupled PET and resonance energy transfer in a pyrene-anthracene based [2] pseudorotaxane	3rd Asia Pacific Symposium on Radiation Chemistry and 10th Biennial Trombay Symposium on Radiation & Photochemistry, **14-17, September, 2010**	Lonavala, Maharashtra	A.K. Mandal, M. Suresh, M. Kumar Kesherwani, B. Ganguly and A. Das
2	Effect of electron donating groups in the interfacial electron transfer dynamics of catecholate bound Ru(II)polypyridyl based sensitizers on TiO_2 nanoparticles: A time resolved ultrafast study	3rd Asia Pacific Symposium on Radiation Chemistry and 10th Biennial Trombay Symposium on Radiation & Photochemistry, **14-17, September, 2010**	Lonavala, Maharashtra	T. Banerjee, S. Rawalekar, S. Verma, A. Das and H.N. Ghosh
3	Synthesis, magnetic properties and structural investigation of L-amino acid based dual-ligand Cu(II)helical coordination polymers with 1-D to 3-D networks: Helical chain, Shubnikov hexagonal plane net and hose type topologies	39th National Seminar on Crystallography (39th NSC-2010), **25-27, October, 2010**	University of Jammu, Jammu-Tawi, J&K	K.K. Bisht and E. Suresh
4	$HBr-H_2O_2$: A facile protocol for regioselective synthesis of bromohydrins and α-bromoketones and oxidation of benzylic/secondary alcohols to carbonyl compounds under mild aqueous conditions	3rd International Symposium on Materials Chemistry(ISMC-2010), **7-11, December, 2010**	Chemistry Division, Bhabha Atomic Research Center, Trombay, Mumbai	G. Joshi, R.D. Patil and S. Adimurthy (*Best Paper Award*)

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
5	$KHSO_4$-A highly efficient and reusable heterogeneous catalyst for hydroarylation of styrene	3rd International Symposium on Materials Chemistry (ISMC-2010), **7-11, December, 2010**	Bhabha Atomic Research Center, Trombay, Mumbai	R.D. Patil, G. Joshi and S. Adimurthy (*Best Paper Award*)
6	Zn(II)-2-2':6,2"-terpyridine based complex as fluorescent chemosensor for PP, AMP and ADP	International Symposium on Facts of Weak Interaction in Chemistry, **13-15, January, 2011**	University of Calcutta, Kolkata	P. Das, A. Ghosh, M.K. Kesherwani, B. Ganguly and A. Das
7	Electrospray ionisation-mass spectrometry : A convenient tool for quantification of plant growth regulators present in *Kappaphycus alvarezii*	National Seminar on Mass Spectrometry, **11-14, January, 2011**	CDRI, Lucknow	A.K. Das and K. Prasad
8	Calixarene based molecular sensors with pyrene as fluoregenic unit: Effect of solvent in ion selectivity and colorimetric detection of fluoride	13th CRSI NSC Symposium, **4-6, February, 2011**	KIIT University, Bhubaneswar	D. Maity, A. Chakroborty, R. Gunupuru and P. Paul
9	Cation-induced fluorescent excimer formation in calyx[4]arene-chemosensors bearing quinoline moiety: Experimental, molecular modelling and crystallographic studies	Conference on Indian Society of Chemists and Biologists (ISCB-2011), **4-7, February, 2011**	Saurashtra University, Rajkot	R. Gunupuru, S. Patra, E. Suresh, R. Lo, B. Ganguly and P. Paul
10	Synthesis of a family of fluorescent molecular sensors and study on their anion recognition property with a large number of anions	Conference on Indian Society of Chemists and Biologists (ISCB-2011), **4-7, February, 2011**	Saurashtra University, Rajkot	A. Chakraborty, R. Gunupuru, D. Maity, S. Patra and P. Paul

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
11	Effect of Fe_3O_4 nano-particle on MRI contrast and self diffusion of water	17th Conference on National Magnetic Resonance Society (NMRS), **1-4, March, 2011**	GNDU, Amritsar	H. Gupta, P. Paul and N. Kumar
12	Mesoporous silica thin films - A reliable sensor for measuring pH of water	International Conference on Recent Trends in Materials Science and Technology, (ICMST-2010), **29-31, October, 2010**	Trivandrum, Kerala	S.S. Chauhan, R.V. Jasra and A.L. Sharma
13	Dye immobilized mesoporous silica thin film as optical pH sensor	Nanotechnology and Advanced Materials (NANOS-2010), **17-19, December, 2010**	Visakhapatnam, Andhra Pradesh	S.S. Chauhan, R.V. Jasra and A.L. Sharma

Salt & Marine Chemicals

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Non-common salts production in LRK: Problems & prospects	RULNR and JANPATH, **4, January, 2011**	MGLI, Ahmedabad	V.P. Mohandas
2	Micelle to vesicle to micelle transitions in mixed ionic liquids-aqueous system	13th CRSI National Symposium-2011, **4-6, February, 2011**	NISER, Bhubaneswar	K. Srinivasa Rao, P. Bharmoria and A. Kumar

Inorganic Materials & Catalysis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	New functional materials from topochemical reactions of layer perovskites	240th American Chemical Society National Meeting &Exposition, ACS Inorganic Nanoscience Award: Symposium in Honor of Frank Osterloh, **24, August, 2010**	Boston, USA	C.N. Henderson, S. Kannan, E.C. Sklute, M. Eguchi, Y. Kobayashi, J. Kwak and T.E. Mallouk

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
2	Synthesis, characterization, and photocatalytic activities of Bi-doped TiO_2 nanotubes in presence of solar light irradiation	International Conference on Recent Trends in Materials Science and Technology (ICMST-2010), **29-31, October, 2010**	Trivandrum, Kerala	N.T. Sivakumar, N. Kalithasan, R.J. Tayade and H.C. Bajaj
3	Solvent free condensation of acetophenone to dypnone over nano-crystalline sulfated zirconia catalyst	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	K. Saravanan, B. Tyagi and H.C. Bajaj
4	Alkylation of benzene with 1-hexene using spent FCC catalyst	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	S.D. Bhatt
5	Selective production of liquid fuels from renewable: One pot sequential multifunctional catalysis in water	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	C.A. Antonyraj and S.Kannan
6	A novel ruthenium hydrotalcite based catalyst in the effective hydrogenation of cinnamaldehyde	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	A.K. Chaturvedi, S.K. Sharma and R.S. Shukla
7	Solvent-free aldol condensation of linear aldehydes using functionalized chitosan as a solid base catalyst	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	T. Jose, N. Sudheesh and R.S. Shukla
8	In-situ encapsulated $RhCl(TPPTS)_3$ into the hexagonal mesoporous silica for hydroformylation of vinyl esters	20th National Symposium on Catalysis for Energy Conversion and Conservation of Environment, **19-22, December, 2010**	IIT, Madras	N. Sudheesh, A.K. Chaturvedi and R.S. Shukla

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
9	सल्फेटिड जिरकोनिया ठोस अम्लीय उत्प्रेरक के द्वारा उत्कृष्ट रसायनो का हरति संश्लेषण	वैज्ञानिक एवं तकनीकी जागरुकताके लिए राष्ट्रीय सम्मेलन, **27-28, जनवरी, 2011**	प्लाज्मा अनुसंधान संस्थान, गांधीनगर	बीना त्यागी एवं एच. सी. बजाज (उत्तम पोस्टर निर्माण द्वितिय पुरस्कार)
10	Nano-crystalline sulfated zirconia for esterification of caprylic acid with short chain alcohols	XXV Gujarat Science Congress 2011, **26-27, February,2011**	Gujarat Science City, Ahmadabad	K. Saravanan, B. Tyagi and H.C. Bajaj
11	Photocatalytic reactor based on UV-LED/TiO_2 coated quartz tube for degradation of malachite green dye	XXV Gujarat Science Congress 2011, **26-27, February, 2011**	Gujarat Science City, Ahmadabad	N. Kalithasan, N.T. Sivakumar, H.C. Bajaj and R.J. Tayade

Reverse Osmosis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Effect of membrane properties on performance of membrane distillation for ammonia removal from industrial wastewaters	International Membrane Science and Technology Conference, **22-26, November, 2010**	Sydney, Australia	Z. Xie, M. Hoang, T. Duong, D. Ng, P.S. Singh, P. Ray, A.V.R. Reddy, K. Parashuram and S. Maurya
2	Structure-performance-fouling studies of polysulfone microfiltration hollow fiber membranes	National Conference on Recent trends in Exotic Materials, **26-28, August, 2010**	Sharda University, Noida, Delhi	K. Parashuram, S. Maurya, P.S. Singh, P. Ray and A.V.R. Reddy
3	Structure-performance relationship of dense polysulfone membranes obtained from high temperature processing	National Conference on Recent trends in Exotic materials, **26-28, August, 2010**	Sharda University, Noida, Delhi	G.L. Jadav and P.S. Singh
4	Influence of film thickness on the structure and properties of silicone rubber based polymeric membrane	International Symposium on Materials Chemistry, **7-11, December, 2010**	BARC, Mumbai	G.L. Jadav, V.K. Aswal and P.S. Singh

Electro Membrane Processes

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Organic-inorganic nano-composite polymer electrolyte membrane	DST-EPSRC Fuel Cells Initiative Scoping Workshop, **15-17, September, 2010**	Centre for Fuel Cell Technology, ARCI, Chennai	V.K. Shahi
2	Radiation cross-linked ion-exchange membranes for electrochemical processes	International Conference-2010 Isotope Technologies and Applications-New Horizons (NIC-2010), **13-15, December, 2010**	National Association for Applications of Radioisotopes & Radiation in Industry (NAARI) and DAE, Mumbai	V.K. Shahi
3	Highly charged membranes and their potential applications for energy devices	International Conference on Renewable Energy, **17-21, January, 2011**	Centre for Non-Conventional Energy Resources, University of Rajasthan, Jaipur	V.K. Shahi
4	Electrochemical membrane reactor for producing HI as a source of hydrogen	International Conference on Renewable Energy, **17-21, January, 2011**	Centre for Non-Conventional Energy Resources, University of Rajasthan, Jaipur	V. Kulshrestha
5	Organic-inorganic nano-composite polymer electrolyte membranes for fuel cell and electrochemical devices	INDO-EUROPE Workshop on Recent Developments in Membrane Technology for Industrial Applications, **10-11, February, 2011**	Department of Chemical Engineering, AC Tech, Anna University, Chennai	V.K. Shahi

Marine Biotechnology & Ecology

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Functional modifications of seaweed polysaccharides	2nd International Conference on Natural Polymers, Biopolymers, Biomaterials, their Composites, Blends, IPNs, Polyelectrolytes and Gels, **24-26, September, 2010**	Centre for Nanoscience& Nanotechnology, Mahatma Gandhi University, Kottayam, Kerala	A.K. Siddhanta
2	Efficient microprojectile bombardment mediated genetic transformation using embryo axes in *Jatropha curcas* L.: An important biofuel plant	National Conference of Plant Physiology on Physiological and Molecular Approaches for Crop Improvement under Changing Environment, **25-27, November, 2010**	BHU, Varanasi	M. Joshi, A. Mishra and B. Jha
3	Isolation and *in-silico* characterization of glutathione-s-transferase gene promoter from an extreme halophyte *Saliornia brachiata*	National Conference of Plant Physiology on Physiological and Molecular Approaches for Crop Improvement under Changing Environment, **25-27, November, 2010**	BHU, Varanasi	V. Tiwari, A. Mishra and B. Jha
4	Natural polymers – chemistry and utilization	Refresher Course for College Teachers, **6, December, 2010**	Chemistry Department, Gujarat University, Ahmedabad	A.K. Siddhanta
5	Isolation, characterization and heterologous expression of a type-2 metallothionein gene SbMT2 from and extreme halophyte *Saliornia brachiata*	4th International Conference on Plants and Environment Pollution, **8-11, December, 2010**	NBRI, Lucknow	A.K. Chaturvedi, A. Mishra and B. Jha
6	Functional new materials prepared from polysaccharides	National Seminar on Recent Advances in Synthesis and Catalysis (RASC-11), **10-12, February, 2011**	Dibrugarh University, Assam	K. Prasad
7	Importance of natural polymers in our daily life	National Level Two-day Workshop on Chemistry: Contributions to Well-being of Mankind, **28 February -1 March, 2011**	Pramukh Swami Science & H.D. Patel Amorts College, Kadi, Mehsana	K. Prasad

SPEU

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Performance evaluation of a community scale solar photovoltaic powered brackish water reverse osmosis desalination unit	International Conference on Renewable Energy, **17-21, January, 2011**	Centre for Non-Conventional Energy Resources, University of Rajasthan, Jaipur	S. Maiti, P.S. Bapat, N. Pathak, S.L. Daga and P. Patel
2	केन्द्रीय नमक एवं समुद्री रसायन अनुसंधान संस्थान द्वारा परावर्तक के साथ प्रकाश विद्युत फलक के बारे में नजदीकी काल में किया गया हुआ संशोधन व विकास कार्य	वैज्ञानिक तकनीकी एवं जागरुकता हेतु हिंदी के उपयोग पर राष्ट्रीय सम्मेलन, **27-28**, OZdar, **2011**	प्लाज्मा अनुसंधान संस्थान, गांधीनगर	प्र. बापट, सु. मैती और पु. घोष
3	सौर उष्मीय ऊर्जा के क्षेत्र में कैन्द्रीय नमक एवं समुद्री रसायन अनुसंधान संस्थान द्वारा किए जा रहे संशोधन	वैज्ञानिक तकनीकी एवं जागरुकता हेतु हिंदी के उपयोग पर राष्ट्रीय सम्मेलन, **27-28**, OZdar, **2011**	प्लाज्मा अनुसंधान संस्थान, गांधीनगर	सु. मैती, प्र. बापट और पु. घोष

2011 – 2012

Analytical Sciences

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Optical functions of nanostructured silica films for pH sensing	3rd International Conference on Frontiers in Nanoscience and Technology (COCHIN NANO-2011), **14-17, August, 2011**	Department of Physics, Cochin University of Science and Technology, Kochi, Kerala	S.S. Chauhan, R.V. Jasra and A.L. Sharma
2	Studies on the [3] pseudorotaxane formation from a bis-azacrown derivatives as a host and imidazolium ion-derivatives as guest	EPS Montreal International Renewable Energy, **15-16, August, 2011**	Montreal, Canada	A.K. Mandal (Guest speaker, Oral Presentation)
3	A sustainable approach for important organic functional group transformations	West India Research Scholars meet, **17, September, 2011**	M.S. University, Vadodara	R.D. Patil, G. Joshi, K.C. Chunavala and S. Adimurthy
4	Receptor design and extraction of inorganic fluoride ion from aqueous medium	3rd Asian conference on Coordination Chemistry (ACCC-3, 2011), **17-20, October, 2011**	India Habitat Centre, New Delhi	P. Das, A.K. Mandal, M.K. Kesharwani, E. Suresh, B. Ganguly and A. Das
5	Ratiometric detection of Cr^{3+} and Hg^{2+} by a naphthalimide -rhodamine based dual fluorescent probe	3rd Asian conference on Coordination Chemistry (ACCC-3, 2011), **17-20, October, 2011**	India Habitat Centre, New Delhi	P. Mahato and A. Das
6	Colorimetric detection of Cu^{2+} and Pb^{2+} with calix[4]arene functionalized gold nanoparticles	3rd Asian conference on Coordination Chemistry (ACCC-3, 2011), **17-20, October, 2011**	India Habitat Centre, New Delhi	R.Gunupuru, D.Maity, A.Chakraborty, D.N. Srivastava and P. Paul
7	Influence of anomeric effect on the lithium ion affinity in 1,3-diaza systems	Theoretical Chemistry Symposium-10, **12, December, 2011**	IIT, Kanpur	M.K. Kesharwani, W. Thiel and B. Ganguly

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
8	Colorimetric detection of cobalt ion with calixarene functionalized gold nanoparticles	Modern Trends in Inorganic Chemistry (MTIC) – XIV, **10-12, December, 2011**	Hyderabad University, Hyderabad	D. Maity, R. Gunupuru, A. Chakraborty, D.N. Srivastava and P. Paul
9	A computational approach to study the dissolution of potassium chloride: Single molecule to microcrystal	Modern Trends in Inorganic Chemistry, (MTIC)- XIV **10-12, December, 2011**	Hyderabad University, Hyderabad	A. Sen and B. Ganguly
10	Interfacial and solvent tuned different aggregation behaviour of photoactive Ru(II)bipyridyl based metallosurfactants	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, January, 2012**	Gujarat University, Ahmedabad	P. Mahato, S. Choudhury and A. Das
11	Restricted conformational flexibility of a triphenylammine derivative on formation of host-guest complexes with various macrocyclic hosts	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, January, 2012**	Gujarat University, Ahmedabad	A.K. Mandal, M. Suresh, P. Das and A. Das
12	Competitive binding of Ba^{2+} and Sr^{2+} to 18-crown-6 in a receptor with 1-methoxyanthraquin-one analogue as the other binding site	Trombay Symposium on Radiation and Photochemistry, **4-7, January, 2012**	Bhabha Atomic Research Centre, Mumbai	T. Banerjee, M. Suresh, H.N. Ghosh and A. Das
13	Recognition of Hg^{2+} and Cr^{3+} by rhodamine based receptor under physiological condition and its applications in cell imaging	Trombay Symposium on Radiation and Photochemistry, **4-7, January, 2012**	Bhabha Atomic Research Centre, Mumbai	S. Saha, P. Mahato, U. Reddy, M. Baidya, S.K. Ghosh and A. Das

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
14	Design, syntheses and single crystal XRD studies of MOFs based on 5-bromoisophthalate and N donor tethers	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, January, 2012**	Gujarat University, Ahmedabad	K.K. Bisht and E. Suresh
15	Template free growth of polyaniline nanostructure across the organic/aqueous interface	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, January, 2012**	Gujarat University, Ahmedabad	R. Gupta and D.N. Srivastava
16	Application of NMR on spherical NaCl agglomerates	Symposium on New Developments in NMR & Conference of National Magnetic Resonance Society, **5-8, February, 2012**	NMR Research Centre, IISc, Bangalore	R.S. Thakur and I. Mukhopadhyay
17	Colorimetric and electrochemical sensing of cobalt ion in aqueous and organic medium using calixarene functionalized gold nanoparticles	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, February, 2012**	Gujarat University, Ahmedabad	D.Maity, R. Gupta, R.Gunupuru, D.N. Srivastava and P. Paul
18	Synthesis, crystal structures and competitive binding property of a family of functionalized calyx[4] arene ionophores	International Conference of Supramolecules and Nanomaterials Research and Application, **6-8, February, 2012**	Gujarat University, Ahmedabad	V. Ramakrishna, S. Patra, E. Suresh, A.K. Bhatt, A. Hussain and P. Paul
19	Study of physical and optical pH sensing characteristics of functionalized nanostructured silica thin films	Applications of Ion Beam in Device Fabrication and Nanotechnology, **5-6, March, 2012**	School of Instrumentation, DAVV, Indore.	S.S. Chauhan, R.V. Jasra and A.L. Sharma

Salt and Marine Chemicals

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Technical and scientific possibilities to augment livelihood of Agariyas in LRK	CESS Workshop arranged by CESS and AHRM, **23, September, 2011**	Ahmedabad Textile Manufacturer`s Association (ATMA), Ahmedabad	V.P. Mohandas
2	Production of high quality salt with enhanced yield in the marginal and small salt works in the country	CSIR–800 Workshop, **28-31, January, 2012**	CMMACS, Bengaluru	S.C. Upadhyay
3	Aqueous-mixed ionic liquid system: Phase transitions and synthesis of gold nanocrystals	Chemical Constellation Cheminar – 2011 (CCC-2011), **20-21, August, 2011**	Dr. B.R.Ambedkar National Institute of Technology, Jalandhar	K. Srinivasa Rao and A. Kumar
4	Very high dissolution of agarose in mixed ionic liquids: Regeneration and strong ion gel formation	Chemical Constellation Cheminar – 2011 (CCC-2011), **20-21, August, 2011**	Dr. B.R.Ambedkar National Institute of Technology, Jalandhar	T.J. Trivedi and A. Kumar

Inorganic Materials and Catalysis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	A facile UV-LED source and TiO_2 nanotube array based reactor for photocatalytic application	3rd International Conference on Frontiers in Nanoscience and Technology (COCHIN NANO-2011), **14-17, August, 2011**	Cochin	N. Thillai Sivakumar, N. Kalithasan, H.C. Bajaj and R.J. Tayade
2	High sorptive removal of borate from aqueous solution using calcined ZnAl layered double hydroxides (LDHs)	Western India Research Scholars Meet, **17, September, 2011**	M.S. University, Vadodara	P. Koilraj and S. Kannan

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
3	Characterization of carbon soot produced from vegetable oil: A large scale catalyst free approach for carbon nanospheres	National Conference on Recent Trends in Material Science (RTMS-2011), **8-10, October, 2011**	Jaypee University of Information Technology, Solan, Himachal Pradesh	S.Y. Sawant, R.S. Somani, S.S. Sharma and H.C. Bajaj
4	Hydrogenation of various alkenes catalyzed by water soluble ruthenium complex in green aqueous biphasic protocol	3rd Asian Conference on Coordination Chemistry, **10-14, October, 2011**	Habitat center, New Delhi	A.A. Dabbawala, H. Bricout, E. Monflier and H.C. Bajaj
5	Evaluation of UV-LED source based photocatalytic reactor performance by degradation of tartrazine dye: An investigation of the effects of operational parameters	International Conference on Vistas in Chemistry (ICVC-2011), **11-13, October, 2011**	Kalpakkam, TamilNadu	N. Thillai Sivakumar, N. Kalithasan, H.C. Bajaj and R.J. Tayade
6	Chiral macrocylic Mn (III)salen complexes for efficient radical scavenging activity and DNA damage protection	National Conference on Chirality, **2-3, December, 2011**	M.S. University, Vadodara	N. Pandya, N.H. Khan, R.I. Kureshy, S.H.R. Abdi, S. Mishra and H.C. Bajaj
7	Enantioselective synthesis of chiral β-amino alcohols via asymmetric ring opening (ARO) of mesoepoxide with aniline catalyzed by novel and recyclable Ti(IV)-binol based salen complexes	National Conference on Chirality, **2-3, December, 2011**	M.S. University, Vadodara	M. Kumar, R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
8	Titanium complexes of chiral amino alcohol derived schiff bases as efficient catalysts in asymmetric oxidation of prochiral sulfides with hydrogen peroxide as an oxidant	National Conference on Chirality, **2-3, December, 2011**	M.S. University, Vadodara	P.K. Bera, S.H.R. Abdi, R.I. Kureshy, N.H. Khan and H.C. Bajaj

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
9	Enantio selective synthesis of β-hydroxynitroalkane via nitro-aldol (Henry) reaction catalyzed by chiral metal complexes	National Conference on Chirality, **2-3, December, 2011**	M.S. University, Vadodara	R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
10	Asymmetric Strecker reaction of aldimines catalyzed by chiral catalysts	National Conference on Chirality, **2-3, December, 2011**	M.S. University, Vadodara	N.H. Khan, R.I. Kureshy, S.H.R. Abdi and H.C. Bajaj
11	Biomass to fuels and chemicals	15th National Workshop on The Role of New Materials in Catalysis, **11-13, December, 2011**	National Centre for Catalysis Research, Indian Institute of Technology, Madras	S. Sivashanmugam, S. Gajula and S. Kannan
12	Green route for biodiesel production from edible, non-edible and used cooking oils using calcined layered double hydroxides as reusable base catalysts	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	S. Sivashanmugam, C.A. Antonyraj and S. Kannan
13	ZnAl Layered double hydroxide (LDH) as potential sorbent for molybdate: Utility of residue for catalytic wet peroxide oxidation	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	P. Koirlaj and S. Kannan
14	Nano-crystalline sulfated zirconia for esterification of myristic acid with short chain alcohols	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	K. Saravanan, B.Tyagi and H.C. Bajaj
15	Heterogeneous hydroformylation of propene over Rh-complex encapsulated hexagonal mesoporous silica	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	N. Sudheesh, J.N. Parmar and R.S. Shukla

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
16	Macrocyclic Mn(III) salencomplex as recyclable catalyst for oxidative kinetic resolution of secondary alcohols	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	P.K. Bera, S.H.R. Abdi, N.H. Khan, R.I. Kureshy and H.C. Bajaj
17	Macrocylicsalen Co(III) complex catalyzed hydrolytic kinetic resolution of racemic epoxide and its application in synthesis of neurogenic drug PFC3-OMe	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	N.Ch. Maity, S.H.R. Abdi, R.I. Kureshy, N.H. Khan and H.C. Bajaj
18	Titanium complexes of chiral amino alcohol derived Schiff bases as efficient catalysts in asymmetric oxidation of prochiral sulfides with hydrogen peroxide as an oxidant	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	D. Ghosh, P.K. Bera, S.H.R. Abdi, R.I. Kureshy, N.H. Khan and H.C. Bajaj
19	Base catalysed Knoevenagel condensation of aromatic aldehydes with malononitrile using amino functionalized silica gel	National Seminar on Catalysis for Sustainable Development, **27-28, January, 2012**	M.S. University, Vadodara	V. Manu, A.S. Bhatt, H.M. Mody and H.C. Bajaj
20	Chiral dinuclear den-drimeric Mn(III)salen complex immobilzed on OMS/dendrimer hybrid-an efficient and recyclable catalyst for asymmetric epoxidation of non-functionalized olefins	18th International Conference (Post ISCBC-2012), **28-30, January, 2012**	Institute of Advanced Study in Science & Technology, Guwahati	T. Roy, R.I. Kureshy, N.H. Khan, S.H.R. Abdi, A. Sadhukhan and H.C. Bajaj
21	Asymmetric cyanation reaction catalyzed by chiral catalysts	18th International Conference (Post ISCBC-2012), **28-30, January, 2012**	Institute of Advanced Study in Science & Technology, Guwahati	N.H. Khan, R.I. Kureshy, S.H.R. Abdi and H.C. Bajaj

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
22	Chiral metal complexes catalyzed various asymmetric organic transformations	18th International Conference (Post ISCBC-2012), **28-30, January, 2012**	Institute of Advanced Study in Science & Technology, Guwahati	R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
23	Cu(II)-macrocylic [H_4] salen catalyzed asymmetric nitroaldol reaction of aldehyde: An approach for the synthesis of valuable drug (R)-isopretrenol (β-receptor agonist)	18th International Conference (Post ISCBC-2012), **28-30, January, 2012**	Institute of Advanced Study in Science & Technology, Guwahati	A. Das, R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
24	Selective adsorption of CO_2 over N_2 by cation exchanged Zeolite L: Experimental and simulation studies	14th CRSI National Symposium in Chemistry, **2-5, February, 2012**	CSIR- National Institute for Interdisciplinary Science and Technology (NIIST), Trivandrum	G.P. Dangi, R.S. Somani and H.C. Bajaj
25	$Fe(OH)_3$: A remarkable hydrogen bonded catalyst for selective epoxide ring opening reaction by amines	National Symposium on Green Chemistry & Technology for Sustainable Development (NSGC-2012), **24-25, February, 2012**	GCET, Vallabh Vidhyanagar	N.H. Khan, R.I. Kureshy, S.H.R. Abdi and H.C. Bajaj
26	Green impact of chiral catalysis on the sustainable development	National Symposium on Green Chemistry & Technology for Sustainable Development (NSGC-2012), **24-25, February, 2012**	GCET, Vallabh Vidhyanagar	S.H.R. Abdi, R.I. Kureshy, N.H. Khan and H.C. Bajaj
27	Ionic liquid as greener reaction medium for chiral Co(III) salen complexes-catalyzed enantioselective aminolytic kinetic resolution (AKR) of aryloxy/terminal epoxides with amine derivatives	National Symposium on Green Chemistry & Technology for Sustainable Development (NSGC-2012), **24-25, February, 2012**	GCET, Vallabh Vidhyanagar	R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj

Reverse Osmosis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	In-situ synthesis of PDMS-nanocomposite membranes and its characterization using small-angle neutron scattering	1st Asia-Oceania Conference on Neutron Scattering, **20-24, November, 2011**	Tsukuba, Japan	G.L. Jadav, V.K. Aswal and P.S. Singh
2	Removal of atrazine from water by low pressure reverse osmosis membranes	International Conference on Advancement in Polymeric Materials (APM-2012), **10-12, February, 2012**	CIPET, Ahmedabad	M. Saxena, A. Devi and A. Bhattacharya
3	Tailoring of surface potential of nanofiltration thin film composite membrane	International Conference on Advancement in Polymeric Materials (APM-2012), **10-12, February, 2012**	CIPET, Ahmedabad	P.S. Singh, S. Maurya and P. Ray
4	Chiral membranes for optical resolution of racemic arginine	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	P.G. Ingole, H.C. Bajaj and K. Singh
5	Preparation of high flux polydimethylsil-oxane polysulfone composite membrane for treatment of VOCs aqueous solution	International Conference on Advancement in Polymeric Materials (APM-2012), **10-12, February, 2012**	CIPET, Ahmedabad	A.M. Kansara, G.L. Jadav, S.G. Chaudhri and P.S. Singh
6	CO_2/N_2 separation through nanocrystalline template containing zeolite TEA-Beta membranes	German Zeolite Conference, **7-9, March, 2012**	Magdeburg, Germany	P.S. Singh, A. Avhale, T. Selvam, A. Inayat, S. Lopez-Orozco, S. Reuß and W. Schwieger

Electro Membrane Processes

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Microscopy technique for materials	DST-INSPIRE Science Camp, **20-24, April, 2011**	Department of Physics, Bhavnagar University	V. Kulshrestha

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
2	Iso-electric separation of amino acids by electro-dialysis	CRSI Zonal Meeting, **13-14, May, 2011**	NCL, Pune	T. Chakrabarty and V.K. Shahi
3	Radiations and its preventions for human life	DST-INSPIRE Science Camp, **20-24, October, 2011**	Department of Physics, Bhavnagar University	V.Kulshrestha
4	Cross-linked zirconium tri-ethylene tetra-amine membrane in aqueous media for selective separation of Cu^{2+}	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	B. Shah, T. Chakrabarty, V.K. Shahi and U. Chudasama
5	Silver nanoparticles trapped in chitosan for selective detection and removal of arsenic from water samples	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	T. Chakrabarty, S. Prakash and V.K. Shahi
6	Effect of metal alkoxides on water splitting across bipolar membrane	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	A.M. Rajesh, A.K. Singh, S. Prakash and V.K. Shahi
7	Recovery of chromic acid by electrochemical membrane reactor	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	A.K. Thakur, T. Chakrabarty and V. K. Shahi
8	Water selective poly-ethyleneimine (PEI) based polyelectrolyte membrane for pervaporation application	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), **27 February – 1 March, 2012**	SVKM's Mithibai College, Vile Parle, Mumbai	A.K. Thakur, A.K. Singh, V. Kulshrestha and V.K. Shahi
9	pH responsive separation of amino acid by electro-phoretic membrane contactor	3rd International Multicomponent Polymer Conference (IMPC-2012), **23-25, March, 2012**	M. G. University, Kottayam, Kerala	T. Chakrabarty and V.K. Shahi

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
10	SPEEK/TiO_2 hybrid nanocomposite membrane for dehydration of ethanol	National Conference on Current Trends in Materials Research, **17-19, March, 2012**	Department of Physics, University of Rajasthan, Jaipur	S. Gahlot, V. Kulshrestha and V.K. Shahi

Wasteland Research

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Assessment of DNA methylation changes induced by salinity stress in *Jatropha curcas* L. seedlings using methylation sensitive amplification polymorphism (MSAP) marker	National Symposium (XXXII PTCA (I) Annual Meet) on Impact of Plant Tissue Culture on Advances in Plant Biology, **19-21, January, 2012**	St. Xavier's College, Ahmedabad	S.G. Mastan, M.S. Rathore, V. Bhatt, P. Yadav and J. Chikara

5. Inter Agency Linkages

2010-2011

(A) GRANT–IN–AID PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Collection, identification and chemical investigation of marine flora	Ministry of Earth Sciences, New Delhi	6.86
2	Genetic improvement of *Jatropha curcas* for adaptability and oil yield	TNBD, New Delhi	NR
3	Development of membrane bio-reactor for the synthesis of structured lipids from groundnut oil and long chain polyunsaturated fatty acid by interesterification using lipase immobilized on membrane	DBT, New Delhi	1.02
4	Synthesis of carbohydrate based natural surfactants and evaluation of their performance	DST, New Delhi	1.50
5	Non-hazardous brominations with bromide/bromate couple obtained as intermediate of recovery plants: exploratory studies on diverse applications	DST, New Delhi	1.01
6	Cloning and characterization of genes encoding Na^+/H^+ antiporter and SOS-1 like protein from *Salicornia brachiata*	DST, New Delhi	3.00
7	Improving the quality and yield of salt produced from sea brines by the marginal agarias of Amreli district through upgradation and improving their income through value addition of bittern under the cluster development program	Industrial Commissionerate, Udyog Bhawan, Gandhinagar	54.00
8	Design, synthesis and characterization of metal organic framework with rectangular topology and their application	DST, New Delhi	1.50
9	Acetylcholinesterase (AChE) inhibitors: The neurotoxic phosphotriesterase substrates and related nerve reagents-conformation, dynamics, hydrolysis and the therapeutic pharmacophores	Department of Atomic Energy, Mumbai	2.59
10	Development of enantioselective polymer membrane for optical resolution of chiral compounds	DST, New Delhi	2.50

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
11	Study of DREB and MYC/MYB transcription factors from *Salicornia brachiata* for abiotic stress tolerance in plants	DST, New Delhi	2.75
12	Disinfection of river/pond/ground waters by novel disinfecting polymers	Ministry of Environment & Forests, New Delhi	NR
13	Two dimensional sheets and interlayers of hydrotalcite-like materials: Potential scope of environmental remediation	Ministry of Environment & Forests, New Delhi	3.87
14	Effective removal of arsenic from ground water covering Maslandpur - Ghoshpur blocks of 24 - Paraganas (N) (II - Phase) by ion-specific adsorbents carrying sorbed ferric hydroxide	Ministry of Environment & Forests, New Delhi	20.00
15	Development of bipolar membrane technology for water purification and salt recovery as their corresponding acid and base from industrial effluent	Ministry of Environment & Forests, New Delhi	NR
16	Studies on the dynamics of the electron/energy transfer in multicomponent Ru(II)-tris-bipyridyl or porphyrin derivatives and interfacial electron transfer	Dept. of Atomic Energy, Mumbai	4.41
17	Development of radiation-induced grafted composite polyelectrolyte membrane for fuel cell and electro-membrane application	Dept. of Atomic Energy, Mumbai	5.23
18	Inhibition of quorum sensing and bacteria communication: Potential for antifouling agents from marine algae	DBT, New Delhi	4.49
19	High performance nanocomposite polyelectrolyte membranes with low electro-osmotic drag for energy and electrochemical devices	DST, New Delhi	NR
20	Synthesis of monodispersed organic-inorganic hybrid nano-structured materials	DST, New Delhi	3.00
21	Sensitized nanoparticles as new hybrid photo-driven devices	DST, New Delhi	4.85

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
22	Development of electrospun nanofibrous membranes for separation and electrochemical processes	DST, New Delhi	4.00
23	Functional modification of agar and *kappa* carrageenan for their wider utility in diverse applications	DST, New Delhi	NR
24	Design and synthesis of organocatalysts and organometallic catalysts for one pot three component enantioselective strecker reaction required for the synthesis of α – aminoacids	DST, New Delhi	7.00
25	Development of transgenic groundnut *(Arachis Hypogaea L.)* of enhanced abiotic stress tolerance	DBT, New Delhi	3.57
26	Evaluation of chemopreventive potential of c-phycocyanin in mouse skin tumorigenesis and its effects on cell cycle regulators and apoptosis	Indian Institute of Toxicology Research, Lucknow	NR
27	Structure property correlation studies of imidazolium based room temperature ionic liquids in ethylene glycol derivatives: Thermodynamic and spectroscopic investigations	DST, New Delhi	NR
28	Remotely monitored and controlled high capacity RO plant for desalination of sea water	DST, New Delhi	NR
29	The WRKY family transcription factors in Jatropha: Genome-wide cloning and functional analysis	DST, New Delhi	6.20
30	Enhancing power output from commercial silicon PV modules by concentration and selective filtration of incoming solar radiation	DST, New Delhi	2.00
31	A two stage indigenous RO process of 6000 LPH capacity for seawater desalination (2 Nos)	DST, New Delhi	NR
32	Sensors for biologically important ions and molecules	DST, New Delhi	NR
33	Pigment biomarkers and spectral fingerprints of mono-specific algae for development of detection algorithms of algal blooms from remote sensing data	Department of Space, Ahmedabad	NR

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
34	Assessment of techno-economic feasibility of large scale seaweed cultivation integrated with biofertilizer and ethanol production	Ministry of Environment & Forests, New Delhi	NR
35	Design and fabrication of UV-LED based photo catalytic reactor for the purification on contaminated water	Ministry of Environment & Forests, New Delhi	2.50
36	Design, synthesis and DNA interaction studies with novel photosensitizer molecules as efficient photodynamic therapeutic reagents	DBT, New Delhi	NR
37	Development of chiral catalysts for asymmetric hydroformylation of olefins for the synthesis of chiral drug intermediates	DST, New Delhi	NR
38	Green and sustainable room temperature ionic liquids from bio renewable feed stocks: Synthesis, physicochemical characterization, self assembly and interaction with biopolymers gelatin and agarose	DST, New Delhi	24.50
39	Studies on the activity of nano-building block based MgO microstructures as heterogeneous base catalyst in industrially important chemical conversions	DST, New Delhi	9.75
40	Colorimetric sensing of ions with calixarene functionalized gold nanoparticles	DST, New Delhi	16.00
41	Development of prototype point of care blood gas and electrolytes analyzer	DST, New Delhi	5.83
42	Test bed for integrated production of 0.75 TPD, FCO grade SOP (Sulphate of Potash), 0.75 TPD of ammonium sulphate and 0.3 TPD of ultra pure magnesia from seawater bittern-based mixed salt through patented process	DST, New Delhi	635.10
43	Synthesis of poly(meth) acrylates and polyesters-based thermoplastic elastomers and their clay nanocomposites for hydrolytically/oxidatively stable coatings	DST, New Delhi	7.00
44	Large scale micropropagating of elite genotypes of *J. curcas*	DST, New Delhi	55.8

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
45	SANS investigation of the silicon rubber membranes	UGC –DAE Consortium Bhabha Atomic Research Center, Trombay, Mumbai	0.35
46	Understanding the reactivation of organophosphate inhibited acetyl cholinesterase (AChE) with nucleophiles and examining competing aging processes	DST, New Delhi	15.60
47	Development of nanofiltration membrane technology for drinking water purification and water reclamation for industrial use	Ministry of Water Resources, New Delhi	6.80

NR – Funds were not received in the financial year

2010-2011

(B) COLLABORATIVE PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Biowaste and algae knowledge for the production of 2nd generation Biofuel Development of protoplast based seeding technique and their cultivation using outdoor tank culture system for select seaweed species	University of Rome, Roma	25.26
2	Research and development of adsorbent materials for adsorption based space cooling system	Thermax Ltd., Pune	17.86
3	Establishment of model salt farm at Ganjam in Orissa	Office of the Superintendent of Salt, Ganjam, Orissa,	NR
4	To prepare bio-diesel from *Jatropha* seeds of different origin and carry out performance evaluation by various users	Officer of the Forest Sasan-Gir; General Motors India Pvt. Ltd., Halol; Mahindra & Mahindra Ltd., Nasik	6.10
5	Development of adsorbents for the recovery of CO_2 from power plant flue gas	NTPC, Noida (UP)	NR

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
6	Study on storage of natural gas using nanomaterials by IISc, CSMCRI & BPCL to undertake experimental studies in order to evaluate the theoretical study carried out in the project	Society for Innovation & Development, Bangalore	NR
7	Developing 2 acre Jatropha plantation at Talegaon, Maharashtra	General Motors India Pvt. Ltd., Halol	4.13
8	Development of adsorbents for the recovery of CO_2 from power plant flue gas	Gujarat Narmada Valley Fertilizers Company Ltd., Bharuch	2.97
9	Determination of the economic viability & technical feasibility of commercial *Jatropha curcas* production for generation of Jatropha oil as bio-fuels feedstock from wastelands	General Motors India Pvt. Ltd., Halol	11.28

NR – Funds were not received in the financial year

2010-2011

(C) SPONSORED PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Feasibility study for suitability of lime stone for making PCC and ACC	M/s. Aarvinder National, Bangalkot, Kartnataka	0.90
2	Feasibility studies for the preparation of detergent grade zeolite-A from bauxite	M/s. Reminco Resource Pvt. Ltd., Ahmedabad	3.41
3	Exploratory work on removal/reduction in fluoride content of soda ash from Trona of Magadi deposits	M/s. Tata Chemicals Ltd., Mithapur	2.66
4	Exploratory work on preparation of SHT using their effluents	M/s. Heubach Colour Pvt. Ltd., Ankleshwar	1.80
5	Exploratory work of separation of sodium hydroxide and phosphorus acid from sodium hypophosphite using bipolar membrane	M/s. Anish Chemicals, Bhavnagar	0.096

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
6	Conducting the feasibility exploratory lab scale ED experiments	Nagarjuna Cerachem Pvt. Ltd., Hyderabad	0.22
7	Electrodialysis test for our seepage water	Thriumalai Chemicals Ltd. Tamil Nadu	0.27
8	Know-how demonstration for various technologies transferred by CSMCRI to entrepreneurs on charge basis	Shriram Vinyl Chemicals Industries, Uniqflux Membranes LLP, Pune	3.05
9	Supply of RO plants of different capacities to various parties	RSMML, CEERI, FORRAD, Neha Global, Social Work & Research Center	41.88
10	Development of nanoclays based on bentonite deposits of Gujarat	GMDC Science & Research Centre, Ahmedabad	4.24
11	To assist GOMBRT in undertaking trial indigenous seaweeds cultivation and training to interested self-help groups in Gulf of Mannar area	Gulf of Mannar Biosphere Reserve Trust, Ramanathapuram	0.45
12	Beneficiation studies of attapulgite for their application in bleaching, oil well drilling & pharmaceutical industries	GMDC Science & Research Centre, Ahmedabad	4.14
13	Developing process for producing activated clay for suitable hydrocarbons purification from Gujarat natural bentonite clays	GMDC Science & Research Centre, Ahmedabad	4.05

2010-2011

(D) CONSULTANCY PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Marine environmental monitoring work	Patel Energy Ltd., Hyderabad	0.25
		Bharuch Eco-Aqua Infrastructure Ltd., Ankleshwar	14.45
		Cargil India Pvt. Ltd., Kutch	NR
		Indian Rayon, Veraval	NR
		Gujarat Construction Ltd., Ahmedabad	NR
		Cambay Chem Ltd., Ahmedabad	NR
2	Appoint of CSMCRI as Advisor/Consultant for setting up a 20 MLD desalination facility at Nagaur	RSMML, Udaipur	8.57
3	Survey of the area in Rann of Kutch on the Indo-Pak border in Barmer dist. of Rajasthan and assessing its suitability for salt manufacture	The Commissioner of Industries, Industries Department, Jaipur	8.55
4	The preliminary survey of the site of solar salt production and assessing techno-economic feasibility of land for manufacture of common salt	Gujarat Alkalies and Chemicals Ltd., Vadodara	NR
5	Study of present status of salt pans and assessment of social, economical and environmental impact (positive and negative) in context to the proposed site of the Kalpasar reservoir	Kalpasar Technical Cell, Gandhinagar	14.75
6	Survey and assessment of mangrove population in Gulf of Khambhat – Kalpasar project	Executive Engineer, Kalpasar Technical Cell, Bhavnagar	8.35

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
7	Survey of potential area of salt production in Orissa	Office of the Director of Handicraft & Cottage Industries, Orissa	10.17
8	Exploring the possibility of valuable chemicals from ZLD projects of tannery sector	Tamil Nadu Pollution Control Board, Chennai	NR
9	Assessment of baseline, environmental quality and social status on coastal, tidal and marine areas of Kalpasar project	Kalpasar Technical Cell, Gandhinagar	28.14
10	Assessment of loss of salt due to heavy rains and flooding situation	M/s. Rakesh Narula & Co., Vadodara	0.11

NR – Funds were not received in the financial year

2011-2012

(A) GRANT–IN–AID PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Installation of 100 units of production of drinking water from sub-soil brine using exhaust gas heat of diesel engine	District Industries Center, Surendranagar, Commissionerate of Industries, Government of Gujarat	8.00
2	Development of ion-exchange membranes and mixed bed resin based electro-deionization process for fluoride removal from ground water	DST, New Delhi	7.95
3	Ion conducting polymer-metal nanoconductive (ICMPN) based electrochemical sensors for biological fluids	DST, New Delhi	8.04
4	Synthesis, characterization and catalytic application of ionic liquid supported on nano-crystalline metal oxides	DST, New Delhi	1.68
5	Organic-inorganic nanocomposite ion-exchange membranes for the removal of toxic metal ions from waste water by electrodialysis	DST, New Delhi	6.10
6	Establishment of model salt farm in Marakanam salt factory, Tamil Nadu	Salt Commissioner, Jaipur, Government of India	10.00
7	Synthesis and characterization of recyclable chiral transition metal complexes for asymmetric nitroaldol or Henry reaction under homogenous and heterogeneous reaction condition	DST, New Delhi	14.00
8	Development of polymer electrolyte membrane for non-conventional electrochemical energy devices	Ministry of New and Renewable Energy, New Delhi	5.00
9	Green and sustainable room temperature ionic liquids from biorenewable feedstocks: Synthesis, physicochemical characterization, self -assembly and interaction with biopolymers gelatin and agarose	DST, New Delhi	NR

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
10	Studies on the activity of nano-building block based MgO microstructures as heterogeneous base catalyst in industrially important chemical conversions	DST, New Delhi	NR
11	Colorimetric sensing of ions with calixarene functionalized gold nanoparticles	DST, New Delhi	8.00
12	Development of prototype point of care blood gas and electrolytes analyzer	DST, New Delhi	NR
13	Test bed for integrated production of 0.75 TPD, FCO grade SOP (Sulphate of Potash), 0.75 TPD of ammonium sulphate and 0.3 TPD of ultra-pure magnesia from seawater bittern-based mixed salt through patented process	DST, New Delhi	NR
14	Synthesis of poly(meth) acrylates and polyesters-based thermoplastic elastomers and their clay nanocomposites for hydrolytically / oxidatively stable coatings	DST, New Delhi	NR
15	Large scale micro propagating of elite genotypes of *J. curcas*	Ministry of New Renewable Energy, New Delhi	NR
16	Improving the quality and yield of salt product from sea brines by the marginal agarias of Amreli district through technology up-gradation and improving their income through value addition of bittern under the cluster development program	Industrial Commissionerate, Gandhinagar	NR
17	SANS investigation of the silicon rubber membranes	UGC –DAE Consortium, Trombay, Mumbai	NR
18	Understanding the reactivation of organophosphate inhibited acetylcholinesterase (AChE) with nucleophiles and examining competing aging processes	DST, New Delhi	NR
19	Development of nanofiltration membrane technology for drinking water purification and water reclamation for industrial use	Ministry of Water Resources, New Delhi	NR
20	Collection, identification and chemical investigation of marine flora	Ministry of Earth Sciences, New Delhi	20.00

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
21	Studies on the dynamics of the electron/energy transfer in multicomponent Ru(II)-trisbipyridyl or porphyrin derivatives and interfacial electron transfer	Dept. of Atomic Energy, Mumbai	2.16
22	Development of radiation-induced grafted composite polyelectrolytie membrane for fuel cell and electro-membrane application	Dept. of Atomic Energy, Mumbai	6.09
23	Inhibition of quorum sensing and bacteria communication: Potential for antifouling agents from marine algae	DBT, New Delhi	3.93
24	Synthesis of monodispersed organic-inorganic hybrid nano-structured materials	DST, New Delhi	5.92
25	Sensitized nanoparticles as new hybrid photo-driven devices	DST, New Delhi	NR
26	Development of electro spun nanofibrous membranes for separation and electrochemical processes	DST, New Delhi	NR
27	Functional modification of agar and *kappa carrageenan* for their wider utility in diverse applications	DST, New Delhi	2.20
28	Design and synthesis of organocatalysts and organometallic catalysts for one pot three component enantioselective Strecker reaction required for the synthesis of α – amino acids	DST, New Delhi	2.00
29	Development of transgenic groundnut (*Arachis hypogaea L.*) of enhanced abiotic stress tolerance	DBT, New Delhi	NR
30	Evaluation of chemo preventive potential of c-Phycocyanin in mouse skin tumorigenesis and its effects on cell cycle regulators and apoptosis	Indian Institute of Toxicology Research, Lucknow	NR
31	Structure-property correlation studies of imidazolium based room temperature ionic liquids in ethylene glycol derivatives: Thermodynamic and spectroscopic investigation	DST, New Delhi	3.45

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
32	Remotely monitored and controlled high capacity RO plant for desalination of sea water	DST, New Delhi	12.00
33	The WRKY family transcription factors in Jatropha: Genome-wide cloning and functional analysis	DST, New Delhi	5.00
34	Enhancing power output from commercial silicon PV modules by concentration and selective filtration of incoming solar radiation	DST, New Delhi	1.00
35	A two stage indigenous RO process of 6000 LPH capacity for seawater desalination (2 Nos)	DST, New Delhi	NR
36	Sensors for biologically important ions and molecules	DST, New Delhi	7.00
37	Pigment biomarkers and spectral fingerprints of mono-specific algae for development of detection algorithms of algal blooms from remote sensing data	Department of Space, Ahmedabad	14.00
38	Assessment of techno-economic feasibility of large scale seaweed cultivation integrated with bio-fertilizer and ethanol production	Ministry of New and Renewable Energy, New Delhi	NR
39	Design and fabrication of UV-LED based photocatalytic reactor for the purification on contaminated water	DST, New Delhi	NR
40	Design, synthesis and DNA interaction studies with novel photosensitizer molecules as efficient photodynamic therapeutic reagents	DBT, New Delhi	NR
41	Development of chiral catalysts for asymmetric hydroformylation of olefins for the synthesis of chiral drug intermediates	DST, New Delhi	5.00
42	Genetic improvement of *Jatropha curcas* for adaptability and oil yield	TNBD, New Delhi	8.58
43	Synthesis of monodispersed organic-inorganic hybrid nano-structured materials	DST, New Delhi	8.88

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
44	Molecular polymorphism among different strains of *Dunaliella* (Chlorophyceae; Chlamydomonadales)	DST, New Delhi	0.21
45	High performance nanocomposite polyelectrolyte membranes with low electro-osmotic drag for energy and electrochemical devices	DST, New Delhi	7.00
46	Effective removal of arsenic from ground water covering Maslandpur - Ghoshpur blocks of 24 - Paraganas (N) (II-Phase) by ion-specific adsorbents carrying sorbed ferric hydroxide	Ministry of Environment & Forests, New Delhi	NR

NR – Funds were not received in the financial year

2011-2012

(B) COLLABORATIVE PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	To prepare bio-diesel from Jatropha seeds of different origin and carry out performance evaluation by various users	Officer of the Forest, Sasan-Gir; General Motors India Pvt. Ltd., Halol; and Mahindra & Mahindra Ltd., Nasik	24.64
2	Study on storage of natural gas using nanomaterial by IISc, CSMCRI & BPCL to undertake experimental study in order to evaluate the theoretical study carried out in the project	Society for Innovation & Development, Bangalore	18.00
3	Developing 2 acre Jatropha plantation at Talegaon, Maharashtra	General Motors India Pvt. Ltd., Halol	1.33
4	Determination of the economic viability & technical feasibility of commercial *Jatropha curcas* production for generation of Jatropha oil as bio-fuels feedstock from wastelands	General Motor Corporation, Warren, USA	120.39
5	Development of adsorbents for the recovery of CO_2 from power plant flue gas	NTPC, Noida (UP)	3.87

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
6	Development of adsorbent for hybrid-sorption enhance steam reforming process for production of hydrogen	Bharat Petroleum Corporation, Greater Noida	6.45
7	Biowaste and algae knowledge for the production of 2nd generation Biofuel Development of protoplast based seeding technique and their cultivation using outdoor tank culture system for select seaweed species	University of Rome, Roma	NR
8	Research and development of adsorbent materials for adsorption based space cooling system	Thermax Ltd., Pune	NR

NR – Funds were not received in the financial year

2011-2012

(C) SPONSORED PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Know-how demonstration for various technologies transferred by CSMCRI to entrepreneurs on charge basis	Amit Hypophosphites, Tata Chemicals Ltd., Marinelixirs, Credo Minerals Industries Ltd., Anish Chemicals	22.36
2	Supply of RO plants of different capacities to various parties	Gov. of Rajasthan, CEERI, FORRAD, CMFRI, RSMML, Social Work & Research Centre, Narwagian Church Aid, Afghanistan	220.14
3	Development of nanoclays based on bentonite deposits of Gujarat	GMDC Science & Research Centre, Ahmedabad	NR
4	Beneficiation studies of attapulgite for their application in bleaching, oil well drilling & pharmaceutical industries	GMDC Science & Research Centre, Ahmedabad	NR

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
5	Developing process for producing activated clay for suitable hydrocarbons purification from Gujarat natural bentonite clays	GMDC Science & Research Centre, Ahmedabad	NR
6	Feasibility studies for the preparation of detergent grade zeolite-A from bauxite	Reminco Resource Pvt. Ltd., Ahmedabad	NR
7	The study on removal of salt from the effluent by electro dialysis method	Jay Chemicals Industries, Ltd., Ahmedabad	0.49
8	Exploratory research for making high strength α– Plaster of Paris from mineral gypsum	FCI Aravali Gypsum and Minerals India Ltd., Jodhpur, Rajasthan	0.60

NR – Funds were not received in the financial year

2011-2012

(D) CONSULTANCY PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Marine environmental monitoring work	J H Kharawala Pvt. Ltd., Ahmedabad	NR
		Bharuch Eco-Aqua Infrastructure Ltd.	NR
		Cargil India Pvt. Ltd., Kutch	NR
		Indian Rayon, Veraval	NR
		Gujarat Construction Ltd., Ahmedabad	NR
		Cambay Chem Ltd., Ahmedabad	NR
2	Collection of physiochemical and marine biological data for regional EIA study for Dholera, SIR	Gujarat Industrial Corridor Corporation Ltd., Gandhinagar	90.53

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
3	The survey of the area in village Tunda, Mundra (Kutch) and assessing the soil characteristics	Adani Mundra Port and Special Economic Zone Limited, Ahmedabad	0.61
4	Study of present status of salt pans and assessment of social, economical and environmental impact (positive and negative) in context to the proposed site of the Kalpasar reservoir	Kalpasar Technical Cell, Gandhinagar	NR
5	Survey and assessment of mangrove population in Gulf of Khambhat – Kalpasar Project	Executive Engineer, Kalpasar Technical Cell, Bhavnagar	NR
6	Survey of potential area of salt production in Orissa	Office of the Director of Handicraft & Cottage Industries, Bhubaneswar	NR
7	Assessment of baseline, environmental quality and social status on coastal, tidal and marine areas of Kalpasar project	Kalpasar Technical Cell, Gandhinagar	NR
8	Exploring the possibility of valuable chemicals from ZLD projects of tannery sector	Tamil Nadu Pollution Control Board, Chennai	NR
9	Appoint of CSMCRI as Advisor/Consultant for setting up a 20 MLD desalination facility at Nagaur	RSMML, Udaipur	4.28
10	The preliminary survey of the site of solar salt production and assessing techno-economic feasibility of land for manufacture of common salt	Gujarat Alkalies and Chemicals Ltd., Vadodara	NR

NR – Funds were not received in the financial year

6. Human Resources Development

A. Training Programme Attended by CSMCRI Staff

2010-2011

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
1	Refresher Training Programme for Section Officer (F&A)	CSIR-HRDC-Ghaziabad, New Delhi	4-9 Jan., 2010	V. Harikrishnan
2	Training Programme on Service Jurisprudence for Personal Management	CSIR-HRDC-Ghaziabad, New Delhi	13-15 Jan., 2010	K. Rajagopalan
3	Workshop on Intellectual Property Protection & Management Issues	CSIR-HRDC-Ghaziabad, New Delhi	22-23 Feb., 2010	David Livingston
4	Work-Life Balance for Women Scientists	CSIR-HRDC-Ghaziabad, New Delhi	3-5 March, 2010	Beena Tyagi
5	Meeting of Chairpersons of Knowledge Resource Centers	CSIR-HRDC-Ghaziabad, New Delhi	15-16 April, 2010	Arvind Sharma
6	Workshop on Effective Implementation of RTI Act	CSIR-HRDC-Ghaziabad, New Delhi	6-7 May, 2010	Rambabu
7	Workshop on Effective Implementation of RTI Act	CSIR-HRDC-Ghaziabad, New Delhi	6-7 May, 2010	Anil Kumar
8	Workshop on Effective Implementation of RTI Act	CSIR-HRDC-Ghaziabad, New Delhi	6-7 May, 2010	D.B. Shukla
9	Refresher Programme for Section Officers	CSIR-HRDC-Ghaziabad, New Delhi	10-14 May, 2010	Kumar Rahul
10	Planning for Life after Retirement	CSIR-HRDC-Ghaziabad, New Delhi	14-16 June, 2010	Kuldeep Kaushik
11	Induction Training Programme for Scientists	CSIR-HRDC-Ghaziabad, New Delhi	4-13 July, 2010	Aneesha Singh

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
12	Induction Training Programme for Scientists	CSIR-HRDC-Ghaziabad, New Delhi	4-13 July, 2010	V. Kulshrestha
13	Induction Training Programme for Scientists	CSIR-HRDC-Ghaziabad, New Delhi	4-13 July, 2010	Hariom Gupta
14	Orientation Training Programme for Assistants Appointed on Compassionate Grounds	CSIR-HRDC-Ghaziabad, New Delhi	14-17 Sept., 2010	Ravi H. Patel
15	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	28 Sept. – 1 Oct., 2010	B.S. Makwana
16	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	28 Sept. – 1 Oct., 2010	H.R. Brahmbhatt
17	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	28 Sept. – 1 Oct., 2010	R.J. Sanghavi
18	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	28 Sept. – 1 Oct., 2010	Jignesh Shukla
19	Self-Effectiveness at Workplace	CSIR-HRDC-Ghaziabad, New Delhi	25-27 Oct., 2010	Rambabu
20	Planning for Life after Retirement	CSIR-HRDC-Ghaziabad, New Delhi	28-30 Oct., 2010	S.D. Bhatt
21	Planning for Life after Retirement	CSIR-HRDC-Ghaziabad, New Delhi	28-30 Oct., 2010	A.M. Shah
22	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	9-12 Nov., 2010	A.B. Boricha
23	Competency Development Programme for Technical Officer	CSIR-HRDC-Ghaziabad, New Delhi	9-12 Nov., 2010	M.T. Shah

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
24	Harnessing Intellectual Property for Strategic Competitive and Collaborative Advantage	CSIR-HRDC-Ghaziabad, New Delhi	08-10 Feb., 2011	S.H. Zaidi
25	Planning for Life after Retirement	CSIR-HRDC-Ghaziabad, New Delhi	28-30 March, 2011	Amjad Hussain

2011-2012

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
1	Induction Training Programme for SO & Executive Asst. Batch 2nd Phase 2nd	CSIR-HRDC-Ghaziabad, New Delhi	9-27 May, 2011	S.D. Chauhan
2	Induction Training Programme for SO & Executive Asst. Batch 2nd Phase 2nd	CSIR-HRDC-Ghaziabad, New Delhi	9-27 May, 2011	N. Chandalia
3	High End Workshop for Transparency Officers/AA and PIOs of CSIR System	CSIR-HRDC-Ghaziabad, New Delhi	10-12 May, 2011	K. Rajagopalan
4	Training Programme on Emotional Intelligence for Managerial Efficiency	CSIR-HRDC-Ghaziabad, New Delhi	18-20 July, 2011	Girija Shankar
5	Training Programme on Emotional Intelligence for Managerial Efficiency	CSIR-HRDC-Ghaziabad, New Delhi	18-20 July, 2011	Kumar Rahul
6	Training Programme on Emotional Intelligence for Managerial Efficiency	CSIR-HRDC-Ghaziabad, New Delhi	18-20 July, 2011	Rambabu
7	Training Programme on Emotional Intelligence for Managerial Efficiency	CSIR-HRDC-Ghaziabad, New Delhi	18-20 July, 2011	J.K. Pothal
8	Training Programme on Crafting Effective S&T Communication	CSIR-HRDC-Ghaziabad, New Delhi	24-26 August, 2011	R.J. Tayade
9	Training Programme on Crafting and Managing R&D Projects	CSIR-HRDC-Ghaziabad, New Delhi	19-23 September, 2011	S. Bhattacharya

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
10	Professional Skills Development Programme For PS / PA / Stenographer	CSIR-HRDC-Ghaziabad, New Delhi	28-30 September, 2011	V.M. Rajan
11	Professional Skills Development Programme For PS / PA / Stenographer	CSIR-HRDC-Ghaziabad, New Delhi	28-30 September, 2011	P.G.M. Pillai
12	Professional Skills Development Programme For PS / PA / Stenographer	CSIR-HRDC-Ghaziabad, New Delhi	28-30 September, 2011	V.J. Gohel
13	Induction Training Programme for Newly Recruited Scientists	CSIR-HRDC-Ghaziabad, New Delhi	10-19 October, 2011	Shibaji Ghosh
14	MDP for Section Officers and Under Secretary Level Officers of Admin, Finance and S&P Streams	CSIR-HRDC-Ghaziabad, New Delhi	14-18 November, 2011	S.S. Choudhary
15	Raj Bhasha Kaushal Vikas Prashikshan Karyakram	CSIR-HRDC-Ghaziabad, New Delhi	01-03 February, 2012	A.C. Gairola
16	Workshop on HR Development in CSIR	CSIR-HRDC-Ghaziabad, New Delhi	22-24 February, 2012	D.B. Shukla
17	Induction Training Programme for Newly Recruited Scientists	CSIR-HRDC-Ghaziabad, New Delhi	18-27 March, 2012	M.S. Rathore

B. M.Sc. / M.Tech. / B.E Dissertation/Thesis Submitted 2010-2011

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
1	Ms. Ankita Sharma	M.Sc.	Epoxidation of ethyl linoleate and vegetable oils using CoCuAl ternary hydrotalcites	Dr. S. Kannan	Devi Ahilya Viswavidyalaya, Indore
2	Ms. Anita Badlani	M.Sc.	Molecular characterization of genetic divergence in *Salicornia brachiata* (Roxb.) using RAPD and ISSR markers	Dr. Ch. Ravi Prakash	Saurashtra University, Rajkot
3	Ms. Ankita Patel	M.Sc.	Molecular markers based assessment of selected genotypes of *Simmondsia Chinensis* (Link.) Schneider	Dr. Ch. Ravi Prakash	Sardar Patel University, VV Nagar
4	Mr. Gandhi Ronak	M.Tech.	In vitro studies in *Simmondsia chinensis* and *Jatropha curcas*	Dr. J. Chikara	Saurashtra University, Rajkot
5	Ms. Hemadri Sharma	M.Sc.	Assessment of methylation pattern by methylation sensitive amplified polymorphism (MSAP) profiling in biodiesel crop (*Jatropha curcas L.*) subjected to salinity stress	Dr. J. Chikara	Mody Institute of Science and Technology, Lakshmangarh, Sikar
6	Ms. Aditi Langalia	M.Sc.	Cloning of a pathogenesis related proteins (PR-10) from *Jatropha curcas L.*	Dr. J. Chikara	Bhavnagar University, Bhavnagar
7	Ms. Khushboo Sadadia	M.Sc.	Identification and isolation of WRKY transcription factor from *Jatropha curcas*	Dr. J. Chikara	Bhavnagar University, Bhavnagar

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
8	Mr. Jaikishan Dhangdhariya	M.Sc.	Metagenomical assessment of initial soil microbial diversity in rocky wasteland	Dr. J. Chikara	Sardar Patel University, Vallabh Vidyanagar
9	Mr. Vipul Bambhaniya	M.Sc.	Molecular cloning of JcPR10 gene, expression and purification of its recombinant protein and development of regeneration protocol in Okra and Tomato	Dr. J. Chikara	Sardar Patel University, Vallabh Vidyanagar
10	Mr. Amit Jadav	M.Sc.	In vitro studies on leaf regeneration of vegetable rennet (*Withania coagulans*), a critically endangered medicinal plant	Dr. J. Chikara	Saurashtra University, Rajkot
11	Ms. Poorvi Sachani	M.Sc.	Molecular cloning of a WRKY transcription factor from *Jatropha curcas L.*	Dr. J. Chikara	Bhavnagar University, Bhavnagar
12	Ms. Ankita Sinha	M.Sc.	Baeyer-Villiger oxidation using molecular oxygen and Claisen-Schmidt condensation reaction over mesoporous zirconium phosphate	Dr. A.B. Panda	Indian School of Mines, Dhanbad
13	Ms.Woormileela Sinha	M.Sc.	Preparation and characterization of magnesium carbonate hydrates and MgO and their catalytic evaluation for some organic transformation	Dr. H.M. Mody	Indian School of Mines, Dhanbad
14	Mr. Bhavesh Patel	M.Tech.	Investigations on flow behavior inside the compartments of electrodialysis (ED) stack	Dr. G.R. Desale	Nirma University, Ahmedabad

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
15	Mr. Darshan Patel	M.Tech.	Analysis of exhaust gases and soot collected from the automobile engine operated with biodiesel and diesel	Dr. G.R. Desale	Nirma University, Ahmedabad
16	Mr. Krunal Shah	M.Tech.	Solar adsorption chiller for public health center	Dr. S. Maiti	Nirma University, Ahmedabad
17	Mr. Navalsingh Parmar	M.Tech.	Ambient air quality monitoring at selected saline areas of Bhaal region, Gujarat – Baseline Data	Dr. S. Goel	GS Institute of Technology & Science, Indore
18	Ms. Shilpa Chauhan	M.Sc.	Isolation and screening of –polyhydroxybutyrate producing bacteria utilizing glycerol – A Jatropha biodiesel byproduct	Dr. S. Mishra	Kadi Sarva Vishwa Vidyalaya, Gandhinagar
19	Ms. Mittal Patel	M.Sc.	Assessment of ground water quality of Bhavnagar with a focus on bacterial contamination	Dr. K.H. Mody	Veer Narmad South Gujarat University, Surat
20	Ms. Rajeshwari Sarvaiya	M.Sc.	Phylogenetic systematic of ulvaceae (Ulvales, Chlorophyta) using DNA molecular markers from Gujarat coast	Dr. C.R.K. Reddy	CG Bhakta, Institute of Biotechnology, Surat
21	Mr. Satyen Mitra Mr. Govind Motwani	M.Tech.	Microalgal biofuel	Dr. S. Mishra	Padmashree Dr D Y Patil University, Navi Mumbai
22	Mr. Vikram Poriya	M.Sc.	Biogas production from residual deoiled biomass of micropore chlorella & Jatropha cake	Mr. S. Bhattacharya	MB Patel Science College, Anand

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
23	Ms. Komal Dimana	M.Sc.	Study on agrobacterium mediated genetic transformation in nicotianatabacum using pCAMBIA 1301 vector	Prof. B. Jha	AN Patel PG Institute, Anand
24	Ms. Jigna Patel	B.E.	Internet with computer management system	Mr. P. Kumar	SS Eng. College, Bhavnagar
25	Mr. Janki Makwana	B.E.	Internet with computer management system	Mr. P. Kumar	VVP Eng. College, Rajkot
26	Mr. Aakanksha Gohil	M.Sc.	Effect of nutritional and physical factors on production of organic solvent tolerant protease from bacillus cerus strain AK 1871	Dr. K.H. Mody	Kadi Sarva Vishwavidyalay, Gandhinagar
27	Prof. Ketan Desai (IASC-INSA-NASI Summer Research Fellow – 2010)	Ph.d	Mechanistic study of rearrangement process in styrene-based system via deiodination pathway: A computational study	Dr. B. Ganguly	Sir. P T. Sarvajanik College of Science, Surat
28	Mr. Shishir Chourey (IASC-INSA-NASI Summer Research Fellow – 2010)	M.Sc.	Understanding recognition phenomenon at molecular level using fluorescence markers	Dr. A. Das	IISER, Pune
29	Mr. S. Palaniappan (IASC-INSA-NASI Summer Research Fellow – 2010)	M.Tech.	Kinetic studies for transesterification reaction of sunflower oil with methanol using CaAl-LDH as catalyst	Dr. S. Kannan	Sastra University, Thanjavur

2011-2012

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
1	Ms. Nimisha Singh	M.Sc.	Characterization and transesterification of *Jatropha curcas oil*	Dr. B. Tyagi	SVNIT, Surat
2	Ms. Surinder Kaur Ms. Ruchi Arora Ms. Priyanka Verma	M.Sc.	Effect of ethylene glycol monomethyl ether on micellization of TX – 1W in aqueous medium	Dr. Arvind Kumar	NIT, Jalandhar
3	Ms. Pooja Bachani	B.Tech.	Introduction to plant tissue culture techniques, RAPD polymorphism and histological preparations	Dr. J. Chikara	Jayoti Vidyapith Women's University, Jaipur
4	Mr. Mithesh Kumarchhatrala	M.Sc.	Synthesis and characterization of calixarene based sensors for ion-recognition study	Dr. P. Paul	Navyug Science College, Surat
5	Ms. Ira Joshi	M.Sc.	Studies on fungal diversity in the soil cultivated with Jatropha	Dr. J. Chikara	Bhagwan Mahavir College of Biotechnology, Surat
6	Ms. Gargi Sengupta	M.Sc.	Synthesis and characterization of chiral aminoalcohol based ligands and its Ti (IV) complexes for asymmetric Strecker reaction	Dr. N.H. Khan	Tezpur University, Tezpur
7	Ms. Shilpa Bothra	M.Sc.	Transesterification and esterification reactions using solid acid catalyst	Dr. B. Tyagi	SVNIT, Surat
8	Mr. Prateek Jain	B.Tech.	Studies on removal of olefin as different molecular weight from aromatic hydrocarbon by acid activated clay	Dr. H.M. Modi Dr. H.C. Bajaj	Rajiv Gandhi Institute of Petroleum Technology, Rae Bareli

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
9	Ms. Khushali Patel	M.Sc.	Meta genomic analysis of microbial communities in wasteland soils	Dr. J. Chikara	ARIBAS, Vallabh Vidyanagar
10	Mr. Keval Mistry	M.Sc.	RAPD analysis for identification of hybrids and anatomical observation of in vitro organs of *Jatropha curcas*	Dr. J. Chikara	ARIBAS, Vallabh Vidyanagar
11	Mr. Mayank Saxena	M.Tech.	Remediation of atrazine from water by low pressure thin film composite membrane	Dr. A. Bhattacharya	CIPET, Lucknow
12	Ms. Sadhana Devi	M.Tech.	A study of antifouling behavior of amphiphilic copolymer micelles deposited ultrafiltration membranes	Dr. S. Jewrajka	CIPET, Lucknow
13	Ms. Shalini Chauhan	M.Tech.	Protein fouling in e-poly L-lysine concentration using thin film composite polyamide nanofiltration membrane with modified composition	Dr. N.K. Saha	CIPET, Lucknow
14	Ms. Nikita Jain	MMS Program	Seawater sampling and mangrove survey at the sea coast	Dr. K.H. Modi	BK School of Management, Ahmedabad
15	Mr. Nirav Parmar	M.Sc.	Isolation and screening of lipid bearing microalgae from the Gulf of Kutch	Dr. S. Mishra	CG Bhakta Institute of Biotechnology, Surat
16	Mr. Gadhiya Rahul	M.Sc.	Utilization of agrowaste for bio-surfactant production	Dr. K.H. Modi	CG Bhakta Institute of Biotechnology, Surat

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
17	Ms. Barkha Purohit	M.Sc.	Isolation and screening of polyhydroxyalkanoates (PHA'S) producing marine halotolerant bacteria utilizing glycerol from Gujarat coast (India)	Dr. S. Mishra	Madurai Kamaraj University, Madurai
18	Mr. Jasminkumar Kheni	M.Sc.	Molecular assessment of genetic purity of leaf regenerated cultures and histological observations in biodiesel crop *(Jatropha curcas)*	Dr. J. Chikara	AN Patel PG Institute, Anand
19	Ms. Hetal Trivedi	M.Tech.	Performance evaluation of stepped solar still unit for seawater desalination	Dr. S. Maiti	SVNIT, Surat
20	Ms. Dodiya Komalba	MCA	Web application in library books & reprographic inventory	Mr. A. Kumar	Bhavnagar University, Bhavnagar
21	Ms. Honey Parekh	M.Sc.	Fermentative production of ε-polylysine through soil bacteria	Dr. S. Bhattacharya	BM College of Biotechnology, Surat
22	Ms. Vaishali Saliya	M.Sc.	Molecular phylogeny of the genus Ulva (*Ulvophycea, Chlorophyta*) occurring along Gujarat coast	Dr. C.R.K. Reddy	Veer Narmad South Gujarat University, Surat
23	Mr. Sameerkumar Dohare	M.Tech.	Mesoporous beta zeolite synthesis & isomerization of higher alkane	Dr. H.C. Bajaj	SVNIT, Surat
24	Ms. Nazneen Mansuri	M.Sc.	Removal of ammonical nitrogen using low cost adsorbents	Dr. K.H. Mody	The Maharaja Sayajirao University of Baroda, Vadodara

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
25	Mr. Rounak Vanzara	BE	Document management system	Mr. P. Kumar	Dharmsinh Desai University, Nadiad
26	Ms. Krupali Mehta	MCA	Content management system	Mr. Arvind Sharma	Bhavnagar University, Bhavnagar
27	Mr. Dipak Makwana	MCA	Content management system	Mr. P. Kumar	Bhavnagar University, Bhavnagar
28	Mr. Dhanani Harikrishna	M.Sc.	Isolation of nuclear ribosomal DNA internal transcribed spacer (ITS) sequence from *Jatropha curcas*	Dr. J. Chikara	CG Bhakta Institute of Biotechnology, Surat
29	Ms. Monika Tabadiya	M.Sc.	Nutrient and fatty acid profiling of dominated microalgal strain from freshwater environment	Dr. S. Mishra	CG Bhakta Institute of Biotechnology, Surat
30	Ms. Leena Patel	M.Sc.	Lipid profiling of microalgal strain isolated from contaminated effluent and its environmental assessment	Dr. S. Mishra	CG Bhakta Institute of Biotechnology, Surat
31	Mr. Manish Patel	M.Sc.	Isolation of biopigments and its profiling from microalgae	Dr. S. Mishra	CG Bhakta Institute of Biotechnology, Surat
32	Ms. Hiral Lakhani	M.Sc.	Molecular characterization of gamma –irradiated *Jatropha curcas* using PCR based markers	Dr. J. Chikara Dr. Mangal Singh	Veer Narmad SGU, Surat
33	Mr. P.V. Surya Lakshmi (IASC-INSA-NASI – Summer Research Fellow-2011)	M. Pharm	Controlled release of colon targeted 5 – aminosalicyclic acid from hydrotalcite and their bio-polymer hybrids	Dr. S. Kannan	Gitam University, Visakhapatnam

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
34	Mr. P. S. Ramesh (IASC-INSA-NASI – Summer Research Fellow-2011)	B.Sc.	Preparation and characterization of charge transfer complexes of TCNQ with various metal ions	Dr. D.N. Srivastava	University of Madras, Chennai
35	Mr. Paresh Salodiya (IASC-INSA-NASI –Summer Research Fellow-2011)	M.Sc.	Antibacterial activity of seaweed collected from Indian coastal region and isolation of bioactive compound	Prof. B. Jha	Charotar University of Science and Technology, Anand
36	Mr. Kritika Khulbe (IASC-INSA-NASI –Summer Research Fellow-2011)	B.Sc.	Synthesis of N-bromosuccinimide and 2,4,4,6-tetrabromocyclohexa-2,4-dienone using bromide/bromate couple as a green brominating reagent and their synthetic applications	Dr. S. Adimurthy	St. Stephen's College, New Delhi
37	Mr. S. Vijayanarayana (IASC-INSA-NASI –Summer Research Fellow-2011)	B.Tech.	One-pot synthesis of 5-hydroxymethyl furfural from biomass derived glucose using combined solid acid and base catalysts	Dr. S. Kannan	National Institute of Technology, Suratkal
38	Mr. C. Manikkaraja (IASC-INSA-NASI –Summer Research Fellow-2011)	M.Sc.	Plastic degradation by marine bacteria	Prof. B. Jha	Alagappa University, Karaikudi
39	Mr. Suhas Acharya (IASC-INSA-NASI –Summer Research Fellow-2011)	M.Sc.	Synthesis and characterisation of photoactive crown ether: An approach to develop molecular plug/socket system	Dr. A. Das	National Institute of Technology, Suratkal

C. Ph. D. Thesis Submitted

2010-2011

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
1	Mr. Munir Khokhar	Novel catalysts for selective conversion of methane and carbon monoxide to commercially useful chemicals	Dr. R.S. Shukla Dr. R.V. Jasra	Bhavnagar University
2	Mr. Prasenjit Kar	Synthesis, characterization, physicochemical studies of some new photoactive molecules and studies on interfacial electron transfer dynamics to semiconductor nanoparticles	Dr. Amitava Das	Bhavnagar University
3	Mr. P. Mosae Selvakumar	Studies on supramolecular helical compounds: Synthesis, structural investigation and functional application	Dr. P. S. Subramanian	Bhavnagar University
4	Mr. Kripal Singh	Preparation and characterization of enantioselective polymer membranes for separation of enantiomers	Dr. H.C. Bajaj	Bhavnagar University
5	Ms. Anubha Sharma	Cloning and characterization of glutathione – s – transferase (GST) gene from *Salicornia brachiata*	Prof. B. Jha	Bhavnagar University
6	Mr. Praveen Kumar Surolia	Development of novel photocatalytic materials and surfaces for environmental cleanup	Dr. R.V. Jasra	Bhavnagar University
7	Mr. S. Ranjith	Molecular modeling and experiment studies on adsorption of gases in zeolite molecular sieves	Dr. R.V. Jasra	Bhavnagar University
8	Ms. Amruta Ghosh	Design and syntheses of photoactive molecules and studies on their interaction with DNA molecules, material and sensing properties	Dr. Amitava Das	Bhavnagar University

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
9	Ms. Meenakshi	Salinity induced molecular change in *Jatropha curcas*	Dr. M.P. Reddy	Bhavnagar University
10	Mr. Boricha Vinodkumar Punjabhai	Studies on molecular sensors for the detection of alkali, alkaline earth and toxic heavy metal ions	Dr. Parimal Paul	Bhavnagar University
11	Mr. Subrata Patra	Fluorescent molecular sensors: Design, synthesis and ion recognition study	Dr. Parimal Paul	Bhavnagar University
12	Ms. Madhu Pareek	Molecular and biochemical characterization of Indian species of Gracilaria *(GracilarialesRhodophyta)*	Prof. B. Jha	Bhavnagar University
13	Mr. K.P. Prashant	Synthesis and characterization of complex hydrides, metal hydrides and zeolite based inorganic materials for hydrogen storage	Dr. R.V. Jasra	Bhavnagar University
14	Mr. Bijoy Prakash Tripathi	Organic – inorganic nanocomposite polymer electrolyte membranes for electrochemical processes	Dr. V.K. Shahi	Bhavnagar University

2011-2012

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
1	Mr. Jinka Krishna Mohan	Development of green technologies for organic chemicals	Dr. R.V. Jasra	Bhavnagar University
2	Mr. Tejwant Singh	Studies on room temperature ionic liquids and their application to gelling biopolymer agar/agarose	Dr. Arvind Kumar	Bhavnagar University
3	Mr. Govind Sethia	Synthesis characterization and adsorption properties of microporous solids for gas separation	Dr. R.V. Jasra Dr. R.S. Somani	Bhavnagar University

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
4	Mr. Mahendra Kumar	Highly charged membranes for ion substitution and electro-membrane separations	Dr. V.K. Shahi	Bhavnagar University
5	Mr. Yogesh	Studies on the role of photo-irradiation in membrane performances	Dr. Amit Bhattacharya	Bhavnagar University
6	Ms. Shweta Gupta	Studies on immobilization of lipase on microporous polymer membranes and their hydrolytic activities for model compounds	Dr. Sandhya Mishra Dr. Amit Bhattacharya	Bhavnagar University
7	Mr. Suresh	Chemo sensor for ion recognition: Syntheses, characterization and computational studies	Dr. Amitava Das	Bhavnagar University
8	Mr. Churchil Angel Antonyraj	Layered double hydroxides: Variations of synthesis methodologies and their influence on catalytic behaviour – A structure-property relationship study	Dr. S. Kannan	Bhavnagar University
9	Mr. Mahesh Chhatbar	Chemical studies on the polysaccharides of some phaeophyceae seaweed species of Indian coast with special reference to alginate	Dr. A.K. Siddhanta	Bhavnagar University
10	Ms. Anupama Jha	Cloning and characterization of Na^+/H^+ antiporter (NHX-1) gene from *Salicornia brachiate*	Dr. C.R.K. Reddy	Bhavnagar University
11	Mr. Sanjay Mishra	Studies on phycoerythrin from marine algae from south west coast of India	Dr. Sandhya Mishra	Bhavnagar University
12	Mr. D. Gangadharan	Synthesis of biocidal polymers for disinfecting drinking water	Dr. P.S. Anand	Bhavnagar University

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
13	Mr. Kunal Shah	Isolation and characterization of bacteria tolerant to organic solvent for their exploitation in bioremediation	Dr. Kalpana Mody	Bhavnagar University
14	Mr. Girdhar Joshi	A green protocol for the synthesis of industrially important compounds through oxidative bromination reactions	Dr. S. Adimurthy	Bhavnagar University
15	Mr. K. Jaya Pratap	Synthesis and characterization of chiral inorganic metal complexes as active catalysts for enantioselective synthesis of chiral β-amino alcohols via epoxide-ring opening reaction	Dr. R.I. Kureshy	Bhavnagar University

7. Awards and Recognitions

2010-2011

Sr. No	Awards and Recognition	Awardee(s)
1	ICC Lifetime Achievement Award (Education & Research)	Dr. P.K. Ghosh
2	Fellow of National Academy of Agricultural Sciences	Dr. B. Jha
3	Fellow of Society for Applied Biotechnology	Dr. Sandhya Mishra
4	CRSI Bronze Medal - 2011	Dr. B. Ganguly
5	Distinguished Women Scientist Award by India Society of Chemists & Biologists	Dr. R.I. Kureshy
6	CSIR Young Scientist Award for the year 2010 for Chemical Sciences	Dr. Kamlesh Prasad
7	Young Scientist Award in Chemical Science for the year 2010-11 by Indian Science Congress Association	Mr. Moorthy Suresh (CSIR, SRF)
8	Secretary, Catalysis Society of India - 2010-12	Dr. S. Kannan
9	Raman Research Fellowship - 2010-11	Dr. Vaibhav Mantri
10	Member, Editorial Board, Journal of Applied Phycology	Dr. C.R.K. Reddy
11	Member, Editorial Board, Blue Biotechnology Journal	Dr. Sandhya Mishra

2011-2012

Sr. No	Awards and Recognition	Awardee(s)
1	Second National Award for Technology Innovation in Petrochemicals & Downstream Plastics Processing Industry by Ministry of Chemicals & Fertilizers, for the work on *"Microbial Synthesis of Green Plastic- Polyhydroxyalkanoates (PHA) using Jatropha Biodiesel Waste Residues"*	Dr. Sandhya Mishra & the team
2	Young Scientist Award for the year 2011 by Council of Science & Technology, Government of Uttar Pradesh	Dr. Avinash Mishra
3	Raman Research Fellowship - 2011-12	Dr. Arvind Kumar
4	International Desalination Association Fellowship for exposure visit to US in the area of water desalination & reuse	Mr. Hiren Raval
5	JSPS Post-doctoral Fellowship	Mr. Tejwant Singh (CSIR-SRF)
6	Alexander von Humboldt Research Fellowship	Mr. B.P. Tripathi and Mr. M. Kumar (both CSIR-SRF)
7	Co-Chair, Indo-EU New Indigo NPP2 (Water)	Dr. P.K. Ghosh
8	Member, Planning Commission working group on S&T for vulnerable section of society	Dr. P.K. Ghosh
9	Chairman, BIS, Inorganic Chemicals Sectional Committee	Mr. M.R. Gandhi
10	Member, Editorial Board, Indian Journal of Natural Product & Resources	Dr. A.K. Siddhanta

Membership of Scientific Societies and Committees

S No	Name of the scientist	Name of the committee
1	Dr. P.K. Ghosh	• Chairman, SERC Programme Advisory Committee (Inorganic Chemistry), Department of Science & Technology, Government of India, New Delhi • Chairman, SERC Programme Advisory Committee (Water Technology Initiative), Department of Science & Technology, Government of India, New Delhi • Chairman, Chemical Division Council, Bureau of Indian Standards, New Delhi • Chairman, Water Technologies, TIFAC Technology Vision 2035 • Co-Chair, EU-INDIA New Indigo Programme on Water Challenges • Member, Board of Governors, Indian Institute of Management, Ahmedabad • Member, SERC Green Chemistry Task Force, Department of Science & Technology, Government of India, New Delhi • Member, Advisory Committee, Center for Advanced Studies in Chemical Engineering, Institute of Chemical Technology, Mumbai • Member, Barefoot College, Tilonia, Rajasthan

Membership of Scientific Societies and Committees

S No	Name of the scientist	Name of the committee
2	Dr. R.I. Kureshy	• Life member, Catalysis Society of India • Life member, Chemical Research Society of India • Life member, Indian Society of Chemists & Biologists
3	Dr. H.C. Bajaj	Life member, Catalysis Society of India
4	Dr. C.R.K. Reddy	Member, DBT Project Monitoring Committee for Algal Biofuels
5	Dr. N.H. Khan	• Life member, Catalysis Society of India • Life member, Indian Society of Chemists & Biologists
6	Dr. S.H.R. Abdi	• Life member, Catalysis Society of India • Life member, Indian Society of Chemists & Biologists
7	Dr. S. Kannan	• Executive Committee Member, Catalysis Society of India • Member, National Organizing Committee, 15th National Workshop on 'The Role of New Materials in Catalysis", NCCR, IIT, Madras, December 11-13, 2011
8	Dr. R.S. Somani	• Life member, The Clay & Clay Minerals Society of India • Life member, The Catalysis Society of India • Member, National Advisory Committee, National Symposium on 'Advances in Separation and Purification Science & Technology (NSST 2011)', G H Patel College of Engineering & Technology (GCET), Vallabh Vidyanagar, Gujarat, February 4-5, 2011
9	Dr. Beena Tyagi	Life Member, The Catalysis Society of India

8. Deputation abroad: CSMCRI Scientists & Research Scholars

2010-11

Sr. No	Name	Purpose of Visit	Duration
1	Dr. P.K. Ghosh	For possible partnership in setting up of a 6000 LPH solar powered seawater RO unit and also to inspect different sites and other requirements for setting up of the RO unit, Oman	25/04/2010 to 28/04/2010
2	Dr. P.K. Ghosh	To participate in the workshop on "Scientific issues on bio-fuels", Brazil	22/05/2010 to 25/05/2010
3	Dr. S. Mishra	For participation and presenting poster presentation entitled 'Marine cyanobacterial phycobiliprotenins: CSMCRI achievements', Gordon Research Conference, USA	06/06/2010 to 11/06/2010
4	Dr. Ramavatar Meena	To avail the BOYSCAST fellowship, Germany	28/06/2010 to 27/06/2011
5	Dr. Vaibhav A Mantri	"Raman Research Fellowship" research work entitled "Endosymbiotic bacteria in coenocytic green algae exploration of a partnership", Belgium	01/09/2010 to 31/12/2010
6	Dr. P.S. Subramanaian	Under the CSIR-DAAD exchange of scientists research work on "Synthesis of triple stranded lanthanide helicates: Water soluble fluorescent sensor for anions", Germany	01/10/2010 to 29/11/2010
7	Mr. Moorthy Suresh	Under DST-UKIERI collaborative project "Sensitized nanoparticles as new hybrid photo-driven devices", UK	10/10/2010 to 10/12/2010
8	Mr. Prasenjit Mahato	Under DST-UKIERI collaborative project "Sensitized nanoparticles as new hybrid photo-driven devices", UK	10/10/2010 to 10/12/2010
9	Ms. Kumari Kavita	Under Indo-German collaboration in biotechnology, Germany	07/11/2010 to 07/01/2011
10	Prof. B. Jha	Under Indo-German collaboration in biotechnology, Germany	07/11/2010 to 07/01/2011

Sr. No	Name	Purpose of Visit	Duration
11	Dr. P.K. Ghosh	To deliver a plenary talk at the "Unilever Chemistry Symposium" hosted by Unilever R&D, China	21/02/2011 to 24/02/2011
12	Dr. Amitava Das	Under DST-UKIERI collaborative project "Sensitized nanoparticles as new hybrid photo-driven devices", UK	27/03/2011 to 10/04/2011
13	Mr. Prasenjit Mahato	Under DST-UKIERI collaborative project "Sensitized nanoparticles as new hybrid photo-driven devices", UK	27/03/2011 to 06/05/2011
14	Mr. Amal Kumar Mandal	Under DST-UKIERI collaborative project "Sensitized nanoparticles as new hybrid photo-driven devices", UK	27/03/2011 to 06/05/2011

2011-2012

Sr. No	Name	Purpose of Visit	Duration
1	Dr. R.S. Shukla	Visit to South Korea under the grant of sabbatical leave as a Brain Pool Scientist –Under Brain Pool Programme at Inha University, South Korea	02/04/2011 to 01/04/2012
2	Dr. V.K. Shahi	To deliver a lecture and discussion on possible collaboration between CSMCRI and University of Science and Technology of China, China	13/04/2011 to 19/04/2011
3	Dr. A.V.R. Reddy	As a part of Indian delegation to the Indo-Dutch Expert Meeting on Water Technology, held at University of Utrecht, The Netherlands	18/04/2011 to 20/04/2011
4	Dr. S.H.R. Abdi	As a member of the Indian delegation visiting Germany to participate in the Indo-German Conference on Catalysis at Rostock, Germany	19/06/2011 to 24/06/2011
5	Dr. J. Chikara	Visit to China on an invitation from Centre for Management Technology (CMT), Singapore to participate as a guest speaker at the Jatropha World Asia 2011 Summit/Conference, held at Haikou, Hainan Island, China	27/06/2011 to 28/06/2011
6	Mr. Hiren Raval	Visit to USA under to avail the award of IDA fellowship –from International Desalination Association, USA	15/07/2011 to 26/08/2011

Sr. No	Name	Purpose of Visit	Duration
7	Dr. Arvind Kumar	Visit to USA under the award of Raman Research Fellowship for the year 2011-2012	22/08/2011 to 21/01/2012
8	Dr. Amitava Das	To pursue the collaborative research work under the joint collaborative project at the University of Sheffield, UK	22/08/2011 to 05/09/2011
9	Dr. P.K. Ghosh	Participation in the seventh meeting of the India-Brazil Science Council and discussions with the Brazilian scientists for planning of future collaborative activities and further strengthen bilateral scientific cooperation between two countries, Brazil	25/08/2011 to 27/08/2011
10	Dr. E. Suresh	Visit to Germany under the CSIR-DAAD exchange of scientists programme for the year 2011, Germany	01/09/2011 to 30/10/2011
11	Prof. B. Jha	To carry out research work on on-going project entitled "Inhibition of quorum sensing and bacterial communication: Potential for antifouling agents from marine algae between CSMCRI and Helmholtz Zentrum Munich under DBT-BMBF Programme", Germany	01/10/2011 to 15/10/2011
12	Dr. Beena Tyagi	Visit under Indo-Portugal joint research project-for discussion and progress review, Portugal	11/10/2011 to 17/10/2011
13	Dr. C.R.K. Reddy	To participate in the Governing Board and Technical Committee meeting of the on-going EU sponsored project on "Bio-waste and algae knowledge for the production of 2nd generation biofuels" and also to present the progress of work within the project at the European Commission project financing under EU collaborative project on Bio Walk 4 Biofuels, Italy	18/10/2011 to 19/10/2011
14	Dr. P.S. Subramanian	To carry out research work on the joint project, "Novel polymeric materials incorporating helicate motifs as selective alkali metal binders" under the CSIR-IB-BMBF Cooperative Science Programme, Germany	07/11/2011 to 17/11/2011
15	Dr. P.K. Ghosh	To co-chair the meeting of the scientific council for the EU-India joint call for proposals in the field of water related issues, The Netherlands	10/11/2011

9. Visitors from abroad to CSMCRI

2010-2011

Sr. No	Name / Organization	Purpose of Visit	Duration
1	Dr. David James Tulauskas, GM International Operations, GM, China Dr. Candace Sue Wheeler, General Motors,USA	Discussion on Jatropha biodiesel project	12/04/2010 to 13/04/2010
2	Ms. Yolanda Porcel Tejido, Barcelona, Spain	Discussion on biofuels	19/04/2010 to 21/04/2010
3	Ms. Robles Mary Elizabeth, Innovation at Colgate Palmolive, USA Dr. Ravi Subramanyam, Advanced Technology Oral Care Research and Development, Colgate-Palmolive Company, USA	To have discussion on kappa-carrageenan and polyhydroxyalkanoates, and bio-degradable films	29/04/2010
4	Mr. Mccallum Mark Willims, Edinburgh Instruments Ltd, UK	For installation of spectrofluorimeter	26/07/2010 to 30/07/2010
5	Dr. (Mrs) Onawumi, Department Of Pure And Applied Chemistry, Ogbomoso, Oyo State, Nigeria	Under the award of CSIR-TWAS post-doctoral fellowship program	27/07/2010 to 25/01/2011
6	Mr. Wu Qianghua, GM Asia Pacific Regional Innovation Manager, Shanghai, China	For discussion on biodiesel project	13/09/2010
7	Mr. Zalmai Hameedi, Mr. Mirwais, Mr. Mohammad Nabi, Norwegian Church Aid, Kabul, Afghanistan	Signing an agreement for installation of five RO plants	04/10/2010 to 05/10/2010
8	Dr. Anne –Gaëlle Jacquin, The Algonauts, French Research Institute, Kerheruneau, France	The algonauts road in India	12/10/2010 to 13/10/2010
9	• Dr.Budhendra L Bhaduri, Oak Ridge National Laboratory, Oak Ridge, USA • Ms. Candace Sue Wheeler, General Motors Company, Warren, USA	Discuss progress and direction on joint collaborative project on Jatropha development	25/10/2010 to 26/10/2010

Sr. No	Name / Organization	Purpose of Visit	Duration
	• Mr. Glenn Edward Sonntag, U.S. Department of Energy, Washington DC,USA • Ms. Kathleen Nawas, National Renewable Energy Laboratory, Washington DC, USA • Ms. Jennifer Baka, Yale University Environmental Economics, USA • Ms. MadhaviZope Martin, Oak Ridge National Laboratory, Tennessee, USA • Ms.Ramanujam Raj Sekar, Argonne National Laboratory, Argonne, USA		
10	Mr. Ehsanullah, Mr. Abdul Wasi, Norwegian Church Aid, Kabul, Afghanistan	For inspection of RO plants prior to dispatch to Afghanistan under an agreement for supply of 5 new desalination plants to Norwegian Church Aid	06/01/2011 to 09/01/2011
11	Mr. Michael Walker, Mr. Ashley Wragg, The University of Sheffield, Sheffield, UK	To carry out project research work under DST-UKIERI collaborative project	15/02/2011 to 06/03/2011
12	Dr. Jim A Thomas, The University of Sheffield, Sheffield, UK	To review the progress of collaborative project	19/02/2011 to 25/02/2011
13	Prof. Kozlowski Marisa Carina, Department of Chemistry, University of Pennsylvania, Philadelphia, USA	For delivering a lecture on 'New catalysts: From design to application' and discussions	06/03/2011 to 07/03/2011
14	Ms. Rie Yasuda, Osaka Prefecture University, Osaka, Japan	Short visit to CSMCRI for discussions	09/03/2011
15	Prof. K. Kalyansundaram, Laboratory of Photonics and Interfaces of Federal Institute of Technology, Switzerland	For delivering a lecture on design of dyes for dye sensitized solar cells and discussions	24/03/2011 to 25/03/2011

2011-2012

Sr. No	Name / Organization	Purpose of Visit	Duration
1	Prof. Dr. Anton Hartmann, Abteilungsleiter Abtilung Mikroben-Pflanzen Interaktionen (AMP), Munich, Germany	For carrying out research work under the collaborative project entitled 'Inhibition of quorum sensing and bacterial communication: Potential for antifouling agents from marine algae'	19/04/2011 to 23/04/2011
2	Mr. Abdul Handi Marufi, Mr. Mohammad Inam, Norwegian Church Aid, Kabul, Afghanistan	To sign the contract agreement for installation of 5 desalination plants at Afghanistan	18/05/2011
3	• Dr. Luís Augusto Barbosa Cortez, State University of Campinas - UNICAMP, Brazil • Ms.Telma Teixeira Franco, State University of Campinas - UNICAMP,Brazil • Dr. Marcelo Menossi Teixeira, Instituto de Biologia Universidade Estdual de Campinas-SP, Brazil • Mr. Marcelo Ramalho Moreira, Negotiations-ICONE, Brazil • Mr. Paulo Seleghim Junior, University of Sáo Paulo, Sáo Carlos-SP, Brazil • Mr. Manoel Regis Lima, Bioethanol Science and Technology Laboratory, Campinas/SP, Brazil	Participation at a India-Brazil Workshop on bioenergy and also to discuss collaboration in research in the area of bioenergy	31/07/2011 to 03/08/2011
4	Dr. Yasuhisa Sumitomo Electric Industries Ltd., Konohana-Ku,Osaka, Japan	For having discussion on algae as well as on Jatropha and other bio fuels	05/08/2011
5	Dr. Hendrik Stoffel Buijtenhek, Dr. Albert EdwardJansen, Netherlands Organization for Applied Scientific Research, The Netherlands	To setup strategic partnership for the EU –India	18/08/2011
6	Mr. Abdul Hadi Marufi, Norwegina Church Aid Norwegian Church Aid, Kabul, Afghanistan	For inspection of 5 RO plants prior to dispatch to Afghanistan	03/10/2011 to 04/10/2011

Sr. No	Name / Organization	Purpose of Visit	Duration
7	Dr. Ahmed Al-Busaidi, Sultan Qaboos University, Muscat, Oman	To hold discussions for exploring possibilities of collaboration between India and Oman in the area of Jatropha cultivation and other related aspects	02/11/2011 to 04/11/2011
8	Dr. Samir Gupta, Monash University, Australia	For discussion on the innovation process with reference to specific case studies from our institute	07/11/2011
9	Dr. Pabitra Baran Chatterjee, Colorado State University, Colorado, USA	For exploring scientific association with CSMCRI	15/11/2011 to 16/11/2011
10	Prof. Junichi Kadokawa, Kagoshima University, Kagoshima, Japan	To discuss technology of bacteriological grade agar & agarose	16/11/2011 to 17/11/2011
11	Professor Markus Albrecht, University of Aachen, Germany	Visit under CSIR-BMBF collaborative project	27/02/2012 to 01/03/2012
12	Dr. Robin D. Rogers, The University of Alabama, Tuscaloosa, USA	Visited on an invitation for discussions and delivering a talk	14/03/2012 to 15/03/2012

10. Distinguished Visitors & Lectures

2010-2011

Date	Speaker	Title of the lecture
20-04-2010	Dr. S.K. Narang, Applied Chemistry & Corrosion, NML (CSIR) Jamshedpur	Sanksharanjagrukataevam sanksharankamahatava, karan, tathanivaran
14-05-2010	Prof. B.N. Thorat, Institute of Chemical Technology (Formerly UDCT), Mumbai	Recent advances in solids handling with reference to crystallization, filtration and drying (CFD)
29-07-2010	Prof. Dr. Ajit Varma, Amity Institute of Microbial Technology, Amity Science, Technology & Innovation Foundation, Amity University, Noida, Uttar Pradesh	New symbiotic fungus -*Piriformosporaindica:* Structure, molecular taxonomy and eco-functions
06-09-2010	Dr. Raghu Chitta, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota, USA	Tetrapyrrole and metal-polypyridine based light harvesting systems for dye sensitized solar cell applications
21-10-2010	Prof. S.R. Dave, Microbiology and Biotechnology Dept., Gujarat University, Ahmedabad	Acid mine drainage and its remediation
28-10-2010	Dr. Abha Kumari, Dept. of Biotechnology, Delhi College of Engineering, Delhi	Oxygen evolution anodes for hydrogen production in seawater electrolysis - for prevention of global warming & supply of renewable energy
07-01-2011	Prof. Tharmalingam Punniyamurthy, Department of Chemistry, IIT, Guwahati	Newer methods for carbon-heteroatom cross-coupling reactions and macromolecular catalysis for organic synthesis
25-01-2011	Dr. Subhash Chandra Shit, Central Institute of Plastics Engineering and Technology (CIPET), Ahmedabad, Gujarat	Trends in polymer technology research
27-01-2011	Dr. M.H. Mehta, Chairman-GLS-Biotech, Vadodara, Gujarat	Eco-agriculture for a sustainable world

Date	Speaker	Title of the lecture
07-02-2011	Dr. Ajayan Vinu, International Centre for Materials Nanoarchitectronics,World Premier International Research Centre, NIMS, Tsukuba, Japan	Fabrication and applications of hierarchically ordered macro/mesoporous films and powders
17-02-2011	Dr. Purusharth Rajyaguru, Dept. of Molecular and Cellular Biology, University of Arizona	mRNP transitions
04-03-2011	Dr. Arvinder Singh, (BD Biosciences – India/Sri Lanka / Nepal/Bhutan & Bangladesh)	Flow cytometry and its applications in marine biology and research
07-03-2011	Prof. Marisa Kozlowski, Department of Chemistry, University of Pennsylvania, USA	New catalysts: From design to application
18-03-2011	Dr. S. Arulananda Babu, Indian Institute of Science Education and Research, Mohali	Stereo-selective C-C bond formations
25-03-2011	Prof. Kuppuswamy Kalyanasundaram, Laboratory of Photonics and Interfaces of Federal Institute of Technology, Switzerland	Design of dyes for dye sensitized solar cells

2011-2012

Date	Speaker	Title of the lecture
13-04-2011	Dr. Pawan Kapur, Central Scientific Instrument Organisation (CSIR), Chandigarh	Instrumentation
20-04-2011	Dr. Anton Hartmann, Abteilung Mikroben-Pflanzen Interaktionen (AMP), Munich, Germany	Cross-kingdom signaling of bacteria with relevance for environment and human health
21-04-2011	Dr. B.J. Agarwal, Department of Textile Chemistry, The Maharaja Sayaji Rao University of Baroda, Vadodara	Biotechnology – An emerging eco-friendly technology for sustainability of textile industry
20-07-2011	Dr. Anindya Dutta, Department of Chemistry, Indian Institute of Technology, Mumbai	A fluorescence spectroscopist's perspective of nanovolumes and nanomaterials

Date	Speaker	Title of the lecture
29-08-2011	Prof. Ramkrishna Sen, Department of Biotechnology, IIT, Kharagpur, West Bengal	Microbial surfactants and microalgal lipids of marine origin: Case studies on progress and prospects in R&D
21-10-2011	Dr. Ajay Venugopal, Institute for Inorganic Chemistry, RWTH-Aachen, Germany	Recent developments in organolanthanide chemistry
03-11-2011	Prof. Vijaykumar Mahajani, Department of Chemical Engineering, University of Mumbai, Mumbai	Recovery of CO_2 from flue gas - Process engineering issues
04-11-2011	Prof. Vijaykumar Mahajani, Department of Chemical Engineering University of Mumbai, Mumbai	Project Economist - A close friend of R&D scientists
16-11-2011	Prof. Jun-Ichi Kadokawa, Kagoshima University, Japan	Fabrication of regularly ordered nanoparticles by controlled self-assembly of amphiphilic molecules under aqueous conditions
16-11-2011	Dr. Pabitra B. Chatterjee Colorado State University, Fort Collins, CO 80523, USA	Bio-active molecules in nano-confinement: An efficient model for bioinorganic chemistry
21-11-2011	Dr. Pushpendra K. Gupta Meerut University, Meerut	Integrated breeding for crop improvement using molecular approaches
15-12-2011	Dr. Suhrit Ghosh, Indian Association for the Cultivation of Science, Kolkata, India	H-bonding mediated supramolecular -assembly of donor and acceptor chromophores: Self-sorting vs. mixing
19-12-2011	Dr. J.S. Yadav, CSIR-IICT, Hyderabad	Towards drug discovery from natural products with special reference to marine resource
29-12-2011	Prof. Bharat B. Chattoo, CSMCRI - Institutional Biosafety Committee, Director, Genome Research Center, Department of Microbiology and Biotechnology Center, M.S. University of Baroda, Vadodara	Current excitement in genome research
13-02-2012	Dr. A.V.S. Sainath, CSIR-IICT, Hyderabad	Di-block copolymers- preparation, characterization and their microphase -separated nanostructures: Highly ordered nanocylinders in thin films and applications

Date	Speaker	Title of the lecture
13-02-2012	Dr. S. Veera, Chemistry and Biology & Integrative Regenerative Medicine, Linköping University, Sweden	Carbon-based nanostructured materials for photo cells to living cells
29-02-2012	Professor Markus Albrecht, Institute of Organic Chemistry, University of Aachen, Aachen, Germany	Cation recognition with supramolecular systems
01-03-2012	Professor Markus Albrecht, Institute of Organic Chemistry, University of Aachen, Aachen, Germany	Novel receptors for anion recognition: Concepts and examples
15-03-2012	Prof. Robin D. Rogers, Centre for Green Manufacturing and Department of Chemistry, The University of Alabama, Tuscaloosa, USA	Ionic liquid solvents for the grand challenge inherent in a bio-refinery: Extraction and separation of lignin, cellulose, and hemicellulose
27-03-2012	Prof. Dr. V.V.N. Kishore, Department of Energy and Environment, TERI University, Delhi	Experiments in sustainable technologies
27-03-2012	Dr. J.J. Isaac, Propulsion & Wind Energy, CSIR-NAL, Bangalore	Power generation from solar energy-the Pondicherry solar pond power plant
27-03-2012	Dr. T.V. Chavda, Sardar Patel Renewable Energy Research Institute, Vallabhvidya Nagar	Solar energy and its application
27-03-2012	Dr. Subroto Mukherjee, FCIPT Division, Institute for Plasma Research, Gandhinagar	Plasma surface engineering-possible applications in harnessing solar energy
27-03-2012	Shri. D.P. Joshi Gujarat Energy Development Agency, Gandhinagar	GEDA experience in solar energy
27-03-2012	Dr. A.S. Mehta, OM Engineering College, Junagadh	CSMCRI experience on solar thermal gadgets on a large scale
27-03-2012	Dr. S.T. Rajan, Dr. P. Subhash Chavda Ahir Kelvani Mandal's Group of Institutions, Junagadh	An alternate strategy and an R & D challenge for leveraging micro solar devices for mega scale solar energy harvest

11. Invited Talks / Lectures Delivered By CSMCRI Scientists

2010-2011

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
1	Frontiers of inorganic chemistry	Mini Conference, April 2, 2010	Indian Institute of Technology, Kanpur	Dr. P.K. Ghosh
2	Recent advances & innovations in renewable energy & energy efficiency	National Festival, April 24, 2010	Indus Institute of Technology, Ahmedabad	Dr. P.K. Ghosh
3	CSMCRI's research on alternative energy for a sustainable future	During the visit at Oman as per the invitation of Oman Government, April 28, 2010	Sultan Qaboos University, Muscat	Dr. P.K. Ghosh
4	Nanotechnology in water treatment: An emerging trend	Global R & D Conclave-2010, May 11-12, 2010	New Delhi	Dr. H.D. Raval
5	Sustainability of biofuels and scope of carbon sequestration: Case studies of Jatorpha and Kappaphycus seaweed	Workshop of Scientific Issues on Biofuels, May 25, 2010	Sao Paulo, Brazil	Dr. P.K. Ghosh
6	Case studies of recent innovations in the area of salt and marine chemicals	Midyear Meeting of Indian Academy of Science, July 2-3, 2010	Indian Institute of Science, Bangalore	Dr. P.K. Ghosh
7	Computational explorations in organic systems, solid surfaces and bio-molecules	Theoretical Conference, September 13, 2010	Indian Institute of Technology, Indore	Dr. B. Ganguly
8	Organic-inorganic nano-composite polymer electrolyte membrane	DST-EPSRC Fuel Cell Initiative Scoping Workshop, September 15-17, 2010	Center for Fuel Cell Technology, ARCI, Chennai	Dr. V.K. Shahi
9	Supramolecular interactions and superior helical materials	October 22, 2010	Institute of Organic Chemistry, RWTH Aachen University, Germany	Dr. P.S. Subramanian

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
10	Surfactant enhanced filtration performances of thin film composite membrane for removal of pesticides	International Conference on "Recent Trends in Material Science and Technology", October 29-31, 2010	IIST, Thiruvananthapuram	Dr. A. Bhattacharya
11	In silico studies on the detoxification of organophosphorus compounds, reactivation and aging processes of inhibited ache	Theoretical Conference, November 20, 2010	Indian Institute of Technology, Kharagpur.	Dr. B. Ganguly
12	Goal driven research in chemical sciences	National Conference on Frontiers in Chemical Sciences, December 3-4, 2010	IIT, Guwhati	Dr. P.K. Ghosh
13	Calixarenes: Versatile molecule as chemical sensor	National Conference on Frontiers in Chemical Sciences, December 3-4, 2010	IIT, Guwhati	Dr. P. Paul
14	Radiation cross-linked ion-exchange membranes for electrochemical processes	NAARRI International Conference-2010 (NIC-2010) organized by NARRI & DAE, December 13-15, 2010	Hotel Renaissance, Mumbai	Dr. V.K. Shahi
15	Computational explorations from surfaces to biomolecules	*Keynote Address:* National Symposium on Cheminformatics, January 7, 2011	Christ Church College, Rajkot	Dr. B. Ganguly
16	Recognition phenomena utilizing non-bonded interactions and designer molecular receptors	International Symposium on Facets of Weak Interactions in Chemistry, January 13-15, 2011	University of Calcutta, Kolkata	Dr. Amitava Das
17	Highly charged membranes and their potential applications for energy devices	International Conference on Renewable Energy, Centre for Non-Conventional Energy Resources, January 17-21, 2011	University of Rajasthan, Jaipur	Dr. V.K. Shahi

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
18	New materials for gas separation	National Symposium on Advances in Separation and Purification Science & Technology, February 4-5, 2011	GCET, V.V. Nagar	Dr. R.S. Somani
19	Organic-inorganic nano-composite polymer electrolyte membranes for fuel cell and electrochemical devices	Indo-Europe Workshop on Recent Developments in Membrane Technology for Industrial Applications, February 10-11, 2011	Dept. of Chemical Engineering, AC Tech, Anna University, Chennai	Dr. V.K. Shahi
20	Current and future landscape of Indian chemical research	Unilever Chemistry Symposium, February 22-23, 2011	Shanghai, China	Dr. P.K. Ghosh
21	Research for societal impact can be full of exciting scientific challenges	*Keynote Address :* Gujarat Science Congress-2011, February 26, 2011	Gujarat Science City, Ahmedabad	Dr. P.K. Ghosh
22	Contributions of MM. Marie curie and other women to chemistry	Workshop for IYC 2011 and National Science Day, February 28, 2011	P S Science & H. D. Patel Arts College, Kadi, Ahmedabad	Dr. B. Tyagi
23	The role of computational chemistry in chemical science research	*Plenary Lecture:* International Year of Chemistry Symposium, February 28, 2011	P S Science & H. D. Patel Arts College, Kadi, Ahmedabad	Dr. B. Ganguly
24	Tagore's vision on natural resources and its societal relevance	National Seminar on Science and Nature, March 12-13, 2011	VishwaBharati University, Shantiniketan	Dr. P.K. Ghosh
25	Calixarene as molecular receptor: Design, synthesis and ion-recognition study	Recent Advances in Some Selected Topics of Chemistry – II, March 24-25, 2011	Bengal Engineering and Science University, Howrah	Dr. P. Paul

2011-2012

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
1	Ion-exchange membranes for water and energy	April 15, 2011	University of Science Technology of China, Hefei, P.R. China	Dr. V.K. Shahi
2	Novel catalysis in the reactions of the C_1 chemicals	April 16, 2011	Department of Chemistry, Inha University of Incheon, Korea	Dr. R.S. Shukla
3	Electro-membrane for separation and isolation of molecules	April 18, 2011	Hefei University of Technology, Hefei, P.R. China	Dr. V.K. Shahi
4	Water purification & associated issues	Indo-Dutch Expert Meeting on Water Technology, April, 18- 20, 2011	University of Utrecht, Netherlands	Dr. A.V.R. Reddy
5	Membrane technology for providing safe drinking water	Science Inspire Programme, April 21-25, 2011	Bhavnagar University, Bhavnagar	Dr. V.K. Shahi
6	Designer molecules, supra molecular chemistry and molecular recognition	Recent Advances in Analytical Chemistry, May 12, 2011	SVNIT, Surat	Dr. Amitava Das
7	Organic-inorganic nano-composite charged membranes for energy and electro-separation devices	CRSI Zonal Meeting, May 13-14, 2011	NCL, Pune	Dr. V.K. Shahi
8	Designer molecule for molecular recognition and photo induced energy/ electron transfer processes	22nd Mid-Year Meeting of the Indian Academy of Sciences, July 8-9, 2011	IISc, Bangalore	Dr. Amitava Das
9	Recognition of ions having biological significance	National Seminar on Inorganic Chemistry – 2011 and celebration of 150th Birth Anniversary of Acharya P. C. Ray, July 8-9, 2011	Jadavpur University, Kolkata	Dr. Amitava Das

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
10	Designer molecule for molecular recognition and photo-induced energy/ electron transfer processes	July 11, 2011	Kalyani University, Kolkata	Dr. Amitava Das
11	Spectroscopy for structural elucidation and ion recognition study in solution	Seminar on Inorganic Chemistry- Celebration of 150th Birth Anniversary of Acharya P. C. Ray, August 15, 2011	M. S. University, Vadodara	Dr. P. Paul
12	Membrane desalination and water purification: Opportunities & associated challenges	Indo-UK Workshop on Current Development of Wastewater Treatment- Advanced Separation Processes, August 29-31, 2011	National Institute of Technology, Tiruchirappalli	Dr. A.V.R. Reddy
13	Solar research at CSMCRI in the past and recent initiatives with concentrated relation	National Symposium on Solar Energy Application, September 1, 2011	National Physical Laboratory, New Delhi	Dr. P.K. Ghosh
14	Fascinating journey of peeling layered materials	*Keynote Lectue*: Western India Research Scholars' Meet, 17th September, 2011	M. S. University, Vadodara	Dr. S. Kannan
15	Calixarene based molecular sensors: Design, synthesis and ion-recognition study	3rd Asian Conference on Coordination Chemistry (ACCC-3,2011), October 17-20, 2011	India Habitat Center, New Delhi	Dr. P. Paul
16	Excitement in science yet simple – Graphene	Inspire Science Camp, October 20-24, 2011	Bhavnagar University, Bhavnagar	Dr. S. Kannan
17	Supramolecular interactions on detection of small molecular ions	November 11, 2011	Institute of Organic Chemistry, RWTH Aachen University, Germany	Dr. P.S. Subramanian
18	Nanocatalysis	November 14, 2011	Department of Chemistry, Inha University, Incheon, Korea	Dr. R.S. Shukla

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
19	Salinity removal technologies and pros and cons of RO systems	National Workshop cum Exhibition on Drinking Water Quality, New Delhi, November 15-16, 2011	India Habitat Centre, New Delhi	Dr. A.V.R. Reddy
20	Designer molecule for recognition of ions having biological significance	Celebration of Chemistry @ IIT Kanpur, December 3-5, 2011	IIT, Kanpur	Dr. Amitava Das
21	First principle study towards the dissolution of potassium chloride and the influence of solvent on the morphology of salt crystals and conformation of organic molecules	48th Annual Convention of Chemists, December 6, 2011	University of Allahabad, Allahabad	Dr. B. Ganguly
22	Design and synthesis of fluorescent molecular receptors for ion recognition study	Modern Trend in Inorganic Chemistry, (MTIC)-XIV, December 10-12, 2011	Hyderabad University, Hyderabad	Dr. P. Paul
23	Seaweed polysaccharides and gelatin based composite material : Physicochemical and rheological studies	3rd International Conference on Heterocyclic Chemistry, December 10-13, 2011	Rajasthan University, Jaipur	Dr. Ramavatar Meena
24	Biomass to fuels and chemicals	15th National Workshop on 'The Role of New Materials in Catalysis', December 11-13, 2011	NCCR, IIT, Madras	Dr. S. Kannan
25	First principle study towards the dissolution of potassium chloride and the influence of solvent on the morphology of salt crystals and conformation of organic molecules	4th International Congress of Environmental Research, December 16-19, 2011	SVNIT, Surat	Dr. B. Ganguly
26	Designer molecule and recognition of biologically significant analyses	4th International Congress of Environmental Research, December 16-19, 2011	SVNIT, Surat	Dr. Amitava Das

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
27	Design and synthesis of fluorescent molecular sensors for toxic metal ions	4th International Congress of Environmental Research, December 16-19, 2011	SVNIT, Surat	Dr. P. Paul
28	Green technology and new trends in waste management	Technical Seminar on Green Technology, December 21, 2011	National Environmental Engineering Research Institute, Nagpur	Dr. P.K. Ghosh
29	Designing of sensitizer dye molecule and its implication on interfacial electron transfer	Symposium on Prospects of Modern Chemistry, Organized as part of International Conference CONIAPS-XIV, December 22-26, 2011	SVNIT, Surat	Dr. Amitava Das
30	Fluorescence response as the probe for studying host-guest adduct formation between crown ether or macrocyclic host molecules and imidazolium or ammonium ion as guest components	International Conference of Supramolecules and Nanomaterials Research and Application, January 6-8, 2012	Gujarat University, Ahmedabad	Dr. Amitava Das
31	Design and synthesis of molecular sensors for ion recognition study	International Conference of Supramolecules and Nanomaterials Research and Application, January 6-8, 2012	Gujarat University, Ahmedabad	Dr. P. Paul
32	Molecular receptors: Design, synthesis and ion recognition study	National Workshop on Frontiers in Chemical Sciences, February 2-4, 2012	Sardar Patel University, V.V. Nagar	Dr. P. Paul
33	Illustrations of supramolecular assemblies in action in emerging technologies under development at CSIR-CSMCRI	International Conference on Chemistry, February 6, 2012	School of Science, Gujarat University, Ahmedabad	Dr. P.K. Ghosh

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
34	Sophisticated analytical techniques for material characterization	Basic Sciences for Advanced Science & Technologies, February 22, 2012	Sir PP Institute of Science, Bhavnagar	Dr. P. Paul
35	Chemistry - Our life, our future	Basic Sciences for Advanced Science & Technologies, February 22, 2012	Sir PP Institute of Science, Bhavnagar	Dr. B. Ganguly
36	Membranes: The energy efficient tool for green industrial process separations	Symposium on Emerging Trends in Separation Science and Technology (SESTEC-2012), February 27– March 1, 2012	SVKM's Mithibai College, Mumbai	Dr. A.V.R. Reddy
37	Recognition of ionic analytes of biological and environmental relevance in aqueous medium	National Symposium on Foundations and Frontiers in Supramolecular Chemistry, March 1-2, 2012	Jawaharlal Nehru University, New Delhi	Dr. Amitava Das
38	Design, syntheses and single crystal XRD studies of MOFs based on multidentate dicarboxylate / amino acids and donor tethers	3rd National Symposium on Condensed Matter and Materials Physics CMMP-2012, March 3-5, 2012	Sardar Patel University, V.V. Nagar	Dr. E. Suresh
39	Hybrid ion-exchange membranes for energy and electro-separation devices	Third International Multicomponent Polymer Conference (IMPC-2012), March 23-26, 2012	Mahatma Gandhi University, Kottayam, Kerala	Dr. V.K. Shahi
40	Seaweed polysaccharides based new hydrogel materials: Preparation and characterization	Third International Multicomponent Polymer Conference (IMPC-2012), March 23-26, 2012	Mahatma Gandhi University, Kottayam, Kerala	Dr. Ramavatar Meena
41	Polysaccharide based ionic materials	Third International Multicomponent Polymer Conference (IMPC-2012), March 23-26, 2012	Mahatma Gandhi University, Kottayam, Kerala	Dr. Kamalesh Prasad

12. Knowledge Resource Centre (Library)

The CSMCRI Library is considered to be premier one in this region having rich collections of books, periodicals, reference materials etc in the areas of R & D being carried out in the institute. Besides catering to the information needs of R&D staff of the institute, the library also extends facilities to the visiting research scholars, university staff, R& D staff of the industries, government officials and others. A brief account of library collection, facilities, services are as under:

COLLECTION OF KRC

Sr. No.	Particulars	Available as on 31-3-2010	Addition during 2010-11	Addition during 2011-12	Collection as on 31-03-2012
1	Books	11975	53	68	12096
2	Back Vols.	27347	99	-	27446
3	Translation	427	-	-	427
4	Photocopy	2149	-	-	2149
5	Patents	340	-	-	340
6	Standards	761	-	-	761
7	Micro-cards	67	-	-	67
8	Microfilms	1326	-	-	1326
9	Maps/Charts	265	-	-	265
10	Reprints	2698	-	-	2698
	Total	**47355**	**152**	**68**	**47575**

JOURNALS/DATABASES/E-JOURNALS SUBSCRIPTION

International Journals	70
National Journals	74
Bibliographic Databases	05 (Sci-Finer, ASTM DL, Thomson Innovation)

Apart from the above library has received the access of online journals through CSIR-NKRC from the Elsevier, Springer, ACS, RSC, Wiley Blackwell, Oxford University Press publishers. The library is having specialized collection of International Abstracting and Indexing Services viz. Chemical Abstracts, Biological Abstracts, Current Contents/FTP/2005, Back Volumes of Journals in Chemistry, Chemical Technology, Biological Sciences and General Sciences.

INFORMATION SERVICES

For easy and quick access to current and latest information by the R & D staff, library renders various information services to its users. Through these services, scientific and technical staff is kept well informed about the current trends in the field of their interest. The services rendered are as follows:

1. Inter-Library Loan Services
2. Reader's Queries
3. Document Delivery Service
4. Bibliographic Search through databases
5. Reference Service
6. Literature Search Facility to outsider

The external members from corporate sectors, universities are also granted permission to consult the documents in the library. This fulfills the aim of maximum utilization of library documents.

WORKSHOP/TRAININGS

The library has organized one day training on various e-resources subscribed by the library. About 125 users participated in the programme and benefited by the training for the use of electronic resources effectively.

INSTITUIONAL REPOSITORY

Library has set up an institutional repository ir@csmcri having research articles, thesis and dissertations submitted by the scientists and students of the institute. As on Mar 2012, it has 1200+ records in the collection and tt was also linked to the CSIR harvester.

13. Dateline CSMCRI

2010-11

Date	Salient Details
10 April 2010	CSMCRI Foundation Day Function. Dr. Anil Kane, Chairman, World Wind Energy Association and Chairman, Indian Wind Energy Association was the Chief Guest. He delivered a lecture on Wind Energy to the Rescue of Mankind from the Menace of Fossil Fuel
13 April 2010	Visit of officials from General Motors 1. Mr. David J. Tulauskas, Director of Publicity Policy 2. Mr. P. Balendran, Vice President Corporate Affairs, GM India 3. Dr. Candace Wheeler, GM Technical Fellow For interaction on Jatropha cultivation
31 May 2010	Demonstration of TFC RO knowhow to Uniqflux Membranes LLP - Mr. Rahul Pathak
3 June 2010	One day workshop on Salt & Marine Chemicals in Hindi. Dr. D.D. Oza, Rajasthan gave a presentation in Hindi
18 June 2010	27th Management Council Meeting
20 June 2010	CSIR-UGC NET Examination
30-31 July 2010	60th Research Council meeting
20 August 2010	Bureau of Indian Standards (BIS) Meeting
14 September 2010	Hindi day celebrations: Online quiz competition & Open Hindi quiz, Hindi Unicode typing, Hindi dictation, noting and drafting in Hindi, Kavyapathan, Tasvir kya bolti hai, Shabdavali (from Rajbhasha Sahayika), Samachar pathan, Yadgar prasang kathan, scientific presentation in Hindi were arranged
26 September 2010	CSIR Foundation Day Function. Dr. E. R. R. Iyengar, Former Scientist, CSMCRI, Bhavnagar and former Professor Emeritus (CSIR) University of Agriculture Science, Bangalore was the Chief Guest. He delivered a lecture on "Salinity and Plant Growth- Old Problem and No Solution Yet"
4 October 2010	Signed purchase agreement for five RO plants. Norwegian Church Aid, Afghanistan

Date	Salient Details
25 October 2010	Visit of Dr. Glenn Sonntag lead US-India Biofuels team to discuss progress and direction on joint collaborative project on Jatropha development
26 October 2010	Vigilance Awareness Week 25 Oct to Nov 1, 2010; Events namely essay competition, drawing competition on "Prevention of Corruption", slogan & cartoon competition were conducted for CSMCRI staff including temporary staff
16 December 2010	61st Research Council Meeting
24 December 2010	Discussions with M/s Reminco Resources P. Ltd., Ahmedabad for draft agreement on technology transfer
20-21 January 2011	CSIR Programme for Youth on Leadership in Science. Prof Jahar Saha, Former Director, IIM-A was the Chief Guest. 67 Students attended the programme
4-7 February 2011	CSIR-CSMCRI participated in the exhibition arranged on the occasion of 15th Indian Society of Chemistry & Biology. International Conference organized by Dept. of Chemistry, Rajkot
25 February 2011	Organized a Half -day Workshop on Reverse Osmosis in Hindi जलशुध्धिकरण प्रोद्योगिकियों में विकास – एक दष्टिपात डॉ. अमिता गिल and डॉ. डी डी ओझा made presentations
28 February 2011	National Science Day Celebrations. A science teacher's motivation programme was organized and roughly 60 teachers participated
4 March 2011	National Safety Day Celebrations. Safety pledge was taken by all the staff. Mr. Prakesh Nagesh, Business Development Manager and Mr. Digamber Mistry, Business Development Executive, Sai Marketing, Vapi gave a Presentation on "Various Respiratory Masks" and demonstration on "Breathing Apparatus". The Safety Division demonstrated the operation of fire extinguishers and other methods to extinguish the fire to all staff members. Prizes were given to staff for different competitions conducted in Hindi, English and Gujarati
7-11 March 2011	Exposure training program to the salt manufacturers of Orissa & the State Dept. officials, Govt. of Orissa

2011-12

Date	Salient Details
10 April 2011	CSMCRI Foundation Day Function. Dr Saroj Ghose, former DG, National Council of Science Museums and Museum Adviser, Parliament Museum, Gujarat Science City was the Chief Guest. He delivered a lecture on "Science for the People"
11 May 2011	Technology Day Celebrations: Lecture by Dr P K Ghosh, Director on 'Case study of indigenous potash knowhow'
20 May 2011	Visit by Ms. Rita Teaotia, Commissioner & Principal Secretary, Rural Ministry, Government of Gujarat to discuss on on-going projects
15 June 2011	28th Management Council Meeting
12 July 2011	Tavera runs on Biofuel: News coverage by Times of India on 12 July, 2011
1-2 August 2011	Indo-Brazil Workshop on Bio-energy. A delegation of six scientists from Brazil have particpated
9 August 2011	Inauguration of AcSIR at CSIR-CSMCRI. Inaugural lecture by Dr P.K. Ghosh on "Ethics & Safety" to AcSIR students
26 August 2011	Laying of Foundation Stone for model salt farm at Marakanam Salt Factory Smt C T Manimekalai, District Collector, Villupuram ; Mr S Sundaresan , Salt Commissioner, Govt. of India were present. Dr.V.P. Mohandas briefed the project appraisal
5-6 September 2011	62nd Research Council Meeting
14 September 2011	Hindi day celebrations. Online quiz competition & Open Hindi quiz, Scientific poster competition in Hindi, Debate competition, Tasvir kya bolti hai, Précis writing (for administration and workshop staff), noting and letter competition, children Hindi film show, Hindi Unicode typing
26 September 2011	CSIR Foundation Day Function. Prof Asis Datta, Padma Shri and Padma Bhushan, Professor of Eminence, National Institute of Plant Genome Research, New Delhi was the Chief Guest. He delivered a lecture on "Dreams to Bring Science to Society"
13 December 2011	63rd Research Council Meeting
20-21 January 2012	MoES Drugs Project's Steering Committee Meeting under the Chairmanship of Prof. Goverdhan Mehta

Date	Salient Details
20 January 2012	Felicitation to Prof. Dr. Sukh Dev by Prof. Goverdhan Mehta
20-25 February 2012	Training program on Marine Bacterial Diversity
5-7 March 2012	Organized teachers training programme for primary & secondary science teachers. More than 35 teachers participated
9 March 2012	National Safety Day Celebrations: Safety pledge was taken by all the staff. Mr. Rishikesh Chormare, Safety Officer, CSIR-CSMCRI gave a presentation on "Hazmat Awareness". The Safety Division demonstrated the operation of fire extinguishers and other methods to extinguish the fire to all taff members. Prizes were given to staff for different competitions conducted in Hindi, English and Gujarati
27 March 2012	Seminar on "Solar Energy Utilization: Learning from the Past". Former senior scientists were invited to share their experience and talks were given.

14.Seminars / Workshop / Events / Meetings Organized

Dr. Anil Kane, President, World Wind Energy Association and Chairman, Indian Wind Energy Association delivered the CSMCRI Foundation Day Address on "Wind Energy to the Rescue of Mankind from the Menace of Fossil Fuel" on 10th April 2010.

Dr. E.R.R. Iyengar , Former Senior Scientist, CSMCRI & Professor of Emeritus, University of Agriculture, Bangalore gave the CSIR Foundation Day Address on "Salinity and Plant Growth - Old Problems and No Solution Yet" on 26th September 2010.

Distinguished Professor Jahar Saha, Former Director, IIM-Ahmedabad was the Chief Guest for the CSIR Programme for Youth on Leadership in Science (CPYLS) Programme held during 20-21 January 2011.

Padma Shri and Padma Bhushan Dr. Saroj Ghose, was the Chief Guest and delivered the CSMCRI Foundation Address on "Science for the People" on 10th April 2011.

One day workshop on "Scientific writing in Hindi" was organized on 7th July 2011 for the scientific and technical staff of the Institute. Dr. D D Oza, Scientist and Member, Hindi Advisory committee was the Chief Guest. In this Hindi workshop, 53 scientists and technical staff participated.

Indo-Brazil Workshop on Bio-energy was organized at the behest of Indian Academy of Sciences and The Brazilian Academy on 1-2 August 2011. A delegation of six scientists from Brazil attended the workshop.

Padma Shri and Padma Bhushan Professor Asis Datta, Professor of Eminence, National Institute of Plant Genome, New Delhi was the Chief Guest and delivered the CSIR Foundation day on "Dreams to Bring Science to Society" on 26th September 2011.

Padma Shri and Padma Bhushan Professor Asis Datta, Professor of Eminence, National Institute of Plant Genome Research, New Delhi Inaugurated Molecular Biology Facility at CSIR-CSMCRI on 26 September 2011. This facility has state-of-art infrastructure for carrying out research and development on stress genomics and proteomics, transgenics, molecular microbiology and metagenomics.

A workshop was organized on 14 October 2011 for students and teachers of primary & secondary schools to enhance/develop the scientific thinking - the need of the hour. Mr. Anil Manekar, Director, Nehru Science Centre, Mumbai was the Chief Guest of the function. In this workshop 72 students and 10 teachers participated.

Distinguished Professor Amitabha Chattopadhyay, Scientist-H, Centre for Cellular & Molecular Biology, Hyderabad was the Chief Guest for the CSIR Programme for Youth on Leadership in Science (CPYLS) Programme held during 24-25 November 2011.

Function was arranged at CSIR-CSMCRI to felicitate Padma Bhushan Prof. Sukh Dev on 20 January 2012. Felicitation was done through the hands of Prof. Goverdhan Mehta.

The Institute organized training programme for primary and secondary science teachers during 5-7 March 2012. Dr. B.N. Das Physicist, Kolkata was the special invitee on this occasion. In this programme more than 50 teachers from primary and secondary schools participated.

One day seminar on 'Solar Energy Utilization-Learning from the Past' was organized in the Institute on the 27th March 2012. The eminent speakers from TERI, Engineering Colleges, Professors from universities, R&D laboratories, GEDA gave informative lectures. Later, the participants visited the laboratory of solar applications.

15. Appointments

Name and date of joining	Area and Qualifications
 Mr. J. K. Pothal (23.07.2010)	**Mechanical Engineer** • B.E Mechanical Engineering, BPUT, Odisha • M.Tech, NIT, Rourkela • Area of work: Workshop Engineer
 Mr. G. R. Bhadu (27.10.2010)	**Technical Support** • M.Sc. Organic Chemistry, University of Rajasthan, Jaipur • M. Tech Polymer Science & Technology, IIT, Delhi • Area of work: Analytical Sciences
 Mr. V. K. Jaiswal (22.11.2010)	**Section Officer** • B.Sc. Mathematics • M.B.A.(HR) 3rd Semester (Running), Sikkim Manipal University • Certificate in E Governance from UN, USA • Certificate Course in Disaster Management, National Institute of Disaster Management, Ministry of Home Affairs, Government of India • Area of work: Finance & Accounts
 Mr. S. D. Chauhan (10.01.2011)	**Support Services** • B. E. Textile Engineering (M. S. University, Baroda 2003) Visiting Faculty Member of M. S. University, Baroda on Indian Quality System • Area of work: Administration Section
 Mr. S. D. Chauhan (17.01.2011)	**Support Services** • M. Sc. Mathematics • NET (CSIR June 2006) • Area of work: Purchase section

Name and date of joining	Area and Qualifications
 Dr. S. B. Kamble (11.05.2011)	**Chemical Engineer** • M. Tech. Chem. Engg. UDCT, Mumbai • Ph. D. (Chem.Engg.) UDCT, Mumbai • Area of work: Sulphate of Potash (SOP)
 Dr. N. K. Saha (12.05.2011)	**Chemical Scientist** • Ph. D. TERI Univ. New Delhi • Area of work: Reverse Osmosis
 Dr. S. K. Jewrajka (12.05.2011)	**Chemical Scientist** • Ph. D. Chem. IACS Jadavpur University • Post Doc Univ. Bordea, France • Post Doc Univ. Akron, USA • Scientist Fellow 18 months in RO Discipline • Area of work: Reverse Osmosis
 Dr. Soumya Haldar (13.05.2011)	**Environmental Science** • M. Sc. Marine Biology & Oceanography • Ph. D. Chennai & Osaka (Japan) • Area of work: Marine Biotechnology &Ecology
Dr. (Mrs.) S. P. Mukherjee (26.08.2011)	**Chemical Scientist** • M. Sc. Burdwan University • Ph. D. Central University, Hyderabad • Area of work: Inorganic Materials & Catalysis
 Mr. Shibaji Ghosh (01.09.2011)	**IPR Scientist** • M. Sc. Chem. Burdwan University • PGDIPL IIT, Kharagpur • Area of work: IPR

Name and date of joining	Area and Qualifications
 Mr. G. Shukla (28.09.2011)	**Office Assistant** • M. Sc. Com. Sc. Indore • Area of work: Administration Section
 Dr. R. S. Thakur (30.09.2011)	**Chemical Scientist** • M. Sc. Chem., Ph. D. Solid State NMR – TIFR, Mumbai • Area of work: Analytical Science
 Dr. M. S. Rathore (30.09.2011)	**Biological Science** • M. Sc. Botany; Ph. D. • Area of work: Wasteland Research
 Mr. S. K.Vania (17.11.2011)	**Computer Science & Engineering** • M. E. Comp. Engg. (SP Univ., V.V. Nagar - Anand) • Area of work: Information Technology
 Dr. (Ms.) Sushma Ijardar (01.12.2011)	**Chemical Scientist** • Ph. D. VN. South Gujarat University, Surat • Area of work: Salt & Marine Chemicals
 Dr. (Mrs.) Uma Chatterjee (06.02.2012)	**Chemical Scientist** • Ph. D. Chem IACS, Jadavpur University • Post Doc Univ. Akron, USA • Scientist DRDO 3 years • Area of work: Electro Membrane Processes

Dr. A. R. Paital
(24.02.2012)

Chemical Scientist

- M. Sc. Ravenshaw Univ., Odisha
- Ph. D. IIT, Kharagpur
- Post Doc. University of Michigan, USA/ University of Missouri, Columbia, USA
- Area of work: Salt & Marine Chemicals

Mr. S. R. Prajapati
(05.03.2012)

Chemical Scientist

- Dip. in Chemical Engg., Surat
- B. E. Chemical Engg., Valsad
- Garden Silk, Process Engg.
- Aditya Birla, Veraval, Shift Supttd. (3 yrs industrial experience)
- Area of work: Scaleup & Process Engineering Unit

Dr. Soumydeb Ghosh
(12.03.2012)

Scientist

- M. Sc. & M.E. University of Delhi
- Ph. D. IISc, Bangalore
- Area of work: Electro Membrane Processes

Retirement / Voluntary / Transfer / Termination / Resignation

Sr. No.	Name	Designation	Date	Remarks
1	Mr. M.G. Makwana	Asst. (G) Gr. I	30.04.2010	Retired
2	Dr. P.V. Subba Rao	Scientist Gr. IV (5)	30.04.2010	Retired
3	Mr. S. Earnestine	Head, Armed Guard	31.05.2010	Retired
4	Dr. C.V. Devmurari	Scientist Gr. IV (2)	31.05.2010	Retired
5	Dr. Satybrata Das	Scientist Gr. IV (3)	14.06.2010	Terminated
6	Mr. Chander Prakash	Asst.	08.04.2011	Terminated
7	Dr. Atindra Shukla	Scientist Gr. IV (2)	11.05.2011	Resigned
8	Mr. Anil Kumar	C O A	24.05.2011	Transferred
9	Dr. G. Ramachandraiah	Scientist Gr. IV (5)	30.06.2010	Retired
10	Dr. (Ms.) Nivedita Sahu	Scientist Gr. IV (1)	23.07.2010	Temporary transfer for two years
11	Dr. A. Prakash Rao	Scientist Gr. IV (3)	31.07.2010	Resigned
12	Mr. S.N. Patel	Gr. III (3)	31.07.2010	Retired
13	Mrs. R.U. Beg	Tech. Gr. I (4)	31.08.2010	Retired
14	Mr. K.C. Das	Asst. (G) Gr. II	15.09.2010	Transferred
15	Mr. Shrikant Sharma	Asst. (G) Gr. I	15.09.2010	Transferred
16	Mr. L.J. Karmatiya	Asst. (G) Gr. I	30.09.2010	Retired
17	Mr. S.N.Vaja	Jr. Security Guard	31.10.2010	Retired
18	Mr. J. David Livingston	Sr. Tech. (1)	01.11.2010	Transferred
19	Mr. H.L. Joshi	Scientist Gr. IV (5)	30.11.2010	Retired
20	Mr. Harshad Kumar Vania	Section Officer	17.01.2011	Resigned
21	Mr. R.G. Khetsi	Tech. Gr. I(4)	31.01.2011	Retired
22	Mr. S. Shyam Sundar	Scientist Gr. IV (3)	10.02.2011	Resigned
23	Dr. Indrajit Mukhopadhyay	Scientist Gr. IV (3)	16.02.2011	Resigned
24	Mr. C.M. Sugandh	Jr. Security Guard	28.02.2011	Retired
25	Mr. Baljeet Singh	FAO	18.04.2011	Temporary transfer from CSIR, New Delhi up to 15.07.2011
26	Mr. D.P. Maret	FAO	25.04.2011	Transfer to CECRI
27	Dr. S.D. Bhatt	Scientist Gr. IV (4)	30.04.2011	Retired
28	Ms.Afsanabanu Makwa	Technician	25.05.2011	Resigned
29	Shri R.P. Pillai	Sr. Technician (1)	31.05.2011	Retired
30	Smt. A. Lucial	Lab. Assistant	31.05.2011	Retired
31	Dr. Amjad Hussain	Scientist Gr. IV (4)	30.06.2011	Retired
32	Shri S.N. Rao	Scientist Gr. IV (4)	30.06.2011	Retired
33	Dr. G R. Desale	Scientist Gr. IV (3)	08.07.2011	Transfer to NCL
34	Mr. Joy M. Kottaram	SO (S&P)	04.08.2011	Transfer to URDIP
35	Mr. B. Rajender Kumar	SO (S&P)	05.08.2011	Transfer on promotion from IICT
36	Mr. S.S. Chuadhary	SPO	18.08.2011	Transferred from NBRI
37	Mr. Kuldeep Kaushik	SPO	29.08.2011	Transfer to NPL
38	Shri A.M. Shah	Sr. Principal Scientist	31.08.2011	Retired
39	Shri J.T. Visani	Lab. Assistant	31.08.2011	Retired
40	Shri S.H. Kalsaria	Sr. Technician (2)	31.10.2011	Retired
41	Dr. R.H. Trivedi	Sr. Technical Officer (3)	31.10.2011	Retired
42	Shri G.M. Thakkar	Lab. Attendant (2)	31.10.2011	Retired
43	Mr. C.K. Chandrakanth	Sr. Scientist	11.11.2011	Transfer to NIIST
44	Dr. B.D. Shethia	Principal Technical Officer	30.11.2011	Retired
45	Shri U.P. Saraiya	Sr. Technical Officer (3)	31.12.2011	Retired
46	Shri Dilawar H. Khokhar	Sr. Technician (2)	29.02.2012	Retired
47	Shri B.M. Shah	Sr. Principal Scientist	31.03.2012	Retired

16. Research Council

Prof. V. Krishnan Hindustan Lever Research Professor & Head, Chemical Biology Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur Campus PO, Bangalore 560 064	**Chairman**
Prof. Kasturi Datta Adjunct Professor, School of Environment Sciences, Special Centre for Molecular Medicine, Jawaharlal Nehru University, New Delhi 110 067	**Member**
Prof. S.S. Bhojwani Emeritus Professor of Botany, 3/43, Prem Nagar, Deyalbagh, Agra 282 005	**Member**
Prof. G.D. Yadav Director (Vice Chancellor) & R T Mody Distinguished Professor, J C Bose National Fellow, Institute of Chemical Technology, Nathalal Parekh Marg, Matunga, Mumbai 400 019	**Member**
Prof. V. Chandrasekhar Department of Chemistry, Indian Institute of Technology, Kanpur 208 016	**Member**
Shri C.G. Sethuram Executive Director – Emerging Business, Archean Group of Companies, TVH Phase II, 5th Floor, Block No. 94, Beliciaa Towers, MRC Nagar, Chennai 600 028	**Member**
Dr. B. Bhargava Director (SPV), Ministry of New and Renewable Energy, Block 14, CGO Complex, Lodi Road, New Delhi 110 003	**Member**
Dr. P.K. Biswas Former Adviser (S&T), Planning Commission, GOI MS-11/905, KendriyaVihar, Sector-56, Gurgaon, Haryana 122 003	**Member**
Dr. G. Ramesh Scientist G and Dy. Head (MAV), Experimental Aerodynamics Division, National Aerospace Laboratories, Post Bag No. 1779, Bangalore 560 017	**Member**
Dr. M.O. Garg Director, Indian Institute of Petroleum, PO IIP, Mohkampur, Dehradun 248 005	**Member** **Cluster Director**
Dr. Pushpito K. Ghosh Director, Central Salt & Marine Chemicals Research Institute, Bhavnagar 364 002	**Member**
Head or his Nominee, PPD, CSIR, New Delhi 110 001	**Permanent Invitee**
Dr. D.B. Shukla, Secretary Chief Scientist, Central Salt & Marine Chemicals Research Institute, Bhavnagar 364 002	**Member**

17. Management Council

01 April 2010 to 31 March 2012)

• **Dr Pushpito K Ghosh, Director**	**Chairman**
• Dr. B. Jha, Chief Scientist	Member
• Dr. G.R. Desale, Senior Scientist	Member
• Dr. (Mrs.) Subarna Maiti, Scientist	Member
• Shri R.J. Sanghavi, Sr. Technical Officer (1)	Member
• Dr. S. Sivaram, Director, NCL, Pune	Member
• Dr. D.B. Shukla, Chief Scientist	Member
• CoFA/F&AO	Member
• Sr. COA/COA/AO	Member- Secretary

18. Resources – Staff and Budgetary Details

Staff Details

Category	Particulars	Persons on Roll 31.3.2011	Persons on Roll 31.3.2012
Scientific	Group IV	**88**	**95**
Technical	Group III	37	35
	Group II	66	59
	Group I	18	15
	Total (Technical)	**121**	**109**
Non – Technical	Group A	6	6
	Group B	28	26
	Group C	21	20
	Group D	0	0
	Total (Non-Technical)	**55**	**52**
	Total 'A'	**264**	**256**
	Ad-hoc Scientist	NIL	NIL
	Scientist Fellow (QHS)	5	0
	EMR and Project related temporary personnel	NIL	NIL
	Research Associate (RA/Sr. RA)	1	0
	Senior Research Fellow (SRF)	47	44
	Junior Research Fellow (JRF)	39	41
	Project Assistants	118	75
	Others (Project Related)	12	5
	Apprentice	29	27
	Total 'B'	**251**	**192**
	Total A + B	**515**	**448**

CSIR Allocation

Financial Year	2010-2011 Rs. in Lakhs	2011-2012 Rs. in Lakhs
A. Revenue (National Labs.)		
Total Salaries	1428.504	1544.725
Budget (Including P04/P05/P06/P70-Staff Qtr.)	185.400	249.580
P07 Chemical/Consumables& Other Res.	337.507	683.766
Total Revenue	**1951.411**	**2478.071**
B. Capital (National Labs.)		
Budget (Including W & S/ Staff Qtrs. Capital)	75.190	100.000
P-50 Land Cost	0.000	5.069
P-50 (App. & Equipment / Computer Equipment / Off. Equipment)	345.000	676.050
P-50 (Furniture & Fittings/Workshop Machinery)	2.000	4.000
P-50 (Library Books/Lib. Journals)	95.000	120.000
P-50 Vehicles	0.000	20.500
P-26 (ICT) (Infrastructure/Facilities)	50.000	20.000
Total Capital	**567.190**	**945.619**
Total Revenue + Capital (A+B)	**2518.601**	**3423.690**
C. Total Network & RSP Projects	598.210	410.420
Total National Lab. (A+B+C)	**3116.811**	**3834.110**
P-61 NMITLI	313.379	145.672

Revenue other than CSIR Allocation

Financial Year	2010-2011 Rs. in Lakhs	2011-2012 Rs. in Lakhs
Sponsored R&D	64.044	221.778
Collaborative/Cooperative R&D	64.814	163.893
Grant-in-Aid R&D	978.610	167.668
R&D Consultancy	72.356	84.917
SMM	0.000	0.000
SUB TOTAL (ECF)	**1179.823**	**638.256**
Analytical/Tech. Services	12.495	17.134
Knowhow transfer/Royalty	47.096	71.799
Sale of Lab Products	1.504	2.912
Conference/Seminar/Workshop	0.000	0.000
SUB TOTAL (credited to CSIR/Lab Reserve)	**61.095**	**91.845**
Amount collected as service tax (Repaid to government)	23.566	49.967
GRAND TOTAL	**1264.484**	**780.068**

Laboratory Reserve

Financial Year	2010-2011 Rs. in Lakhs	2011-2012 Rs. in Lakhs
Opening cash balance	93.568	92.087
Receipt during the year	239.036	378.246
Investment encashment on maturity	700.000	900.000
Total receipt (A)	**1032.604**	**1370.333**
Expenditure during the year	27.197	115.145
Reinvestment	913.320	1190.000
Total expenditure (B)	**940.517**	**1305.145**
Closing cash balance (A-B)	**92.087**	**65.188**