वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्

Council of Scientific and Industrial Research

द्विवार्षिक प्रतिवेदन
BIENNIAL REPORT
2008-2010

Indian Patent, 224938
US Patent, 6893479

केन्द्रीय नमक व समुद्री रसायन अनुसंधान संस्थान
CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE


EXIT

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BIENNIAL REPORT
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केन्द्रीय नमक व समुद्री रसायन अनुसंधान संस्थान

गिजुभाई बधेका मार्ग, भावनगर – 364 021

CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE

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महात्मा गांधी, जिन्हॉने ब्रिटिश साम्राज्य की जड़ों 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 की इन प्रयोगशालाओं में कोई भी कार्यकर्ता सिर्फ अपनी आजिवीका 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

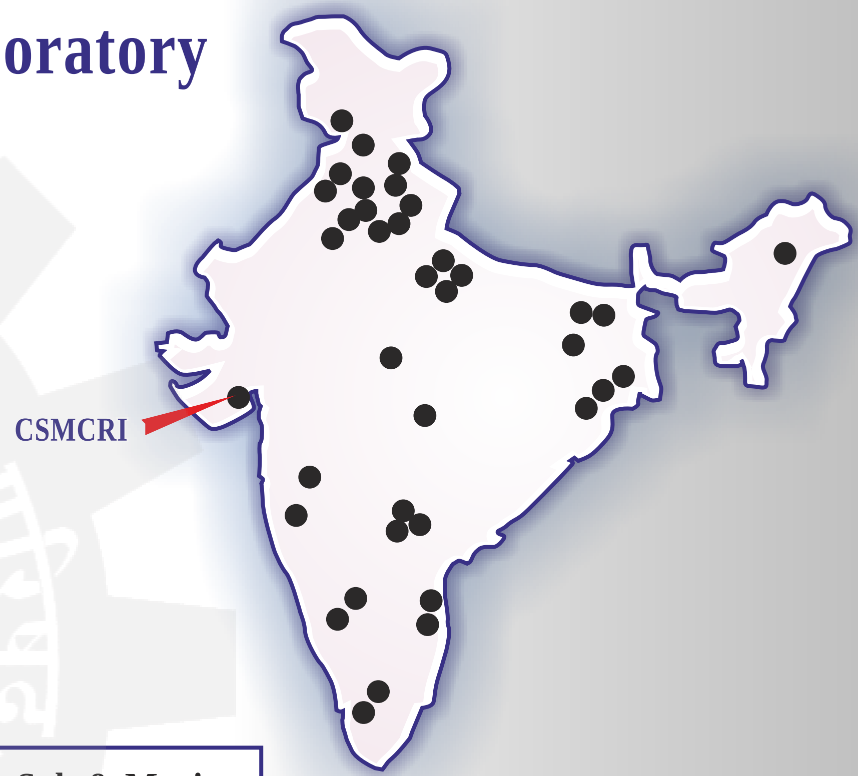
10 अप्रैल 1954 को दिये गये उदघाटन भाषण से उद्धृत

"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"

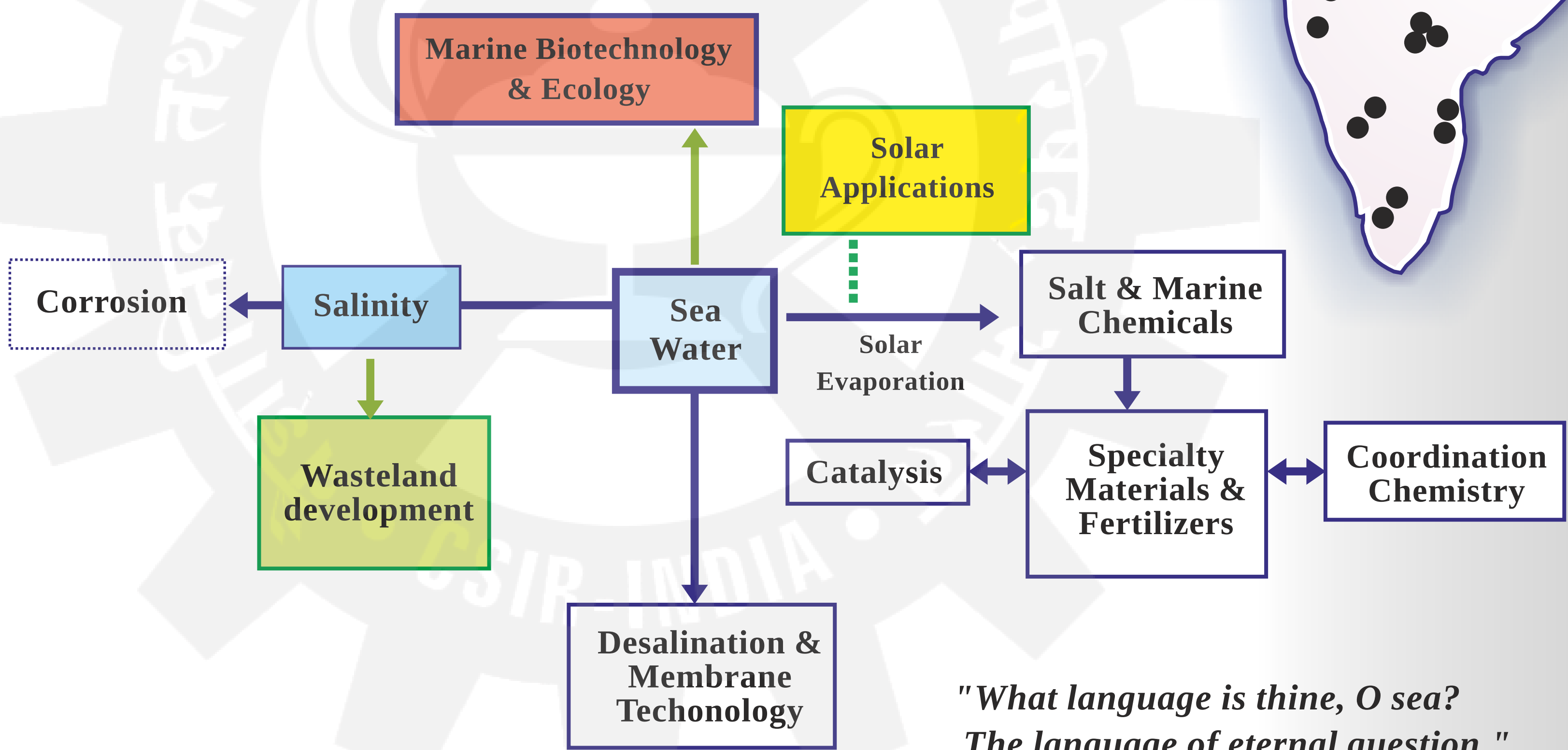
Pandit Jawaharlal Nehru

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)

Contents

Foreword

I have great pleasure in presenting the report for the period 2008-10. Details of the grant received from CSIR, earnings from other sources, manpower details, papers, patents, technology transfer, etc. pertain to the financial years 2008-09 and 2009-10, respectively. The “balanced” scorecards for these periods are provided immediately following this foreword. As compared to 2007-08, the grant from CSIR was almost 60% higher in 2008-09 ({32.90 crore vs. {20.50 crore), mainly due to the pay increase/payment of arrears arising from implementation of the Sixth Pay Commission recommendations and the generous funding under Network Projects. In the same period the external cash flow (ECF) declined to {4.5 crore (from {6.57 crore in 2007-08) in line with the greater focus on implementation of CSIR-funded projects. There was a reversal of trend the following year: the grant from CSIR declined by ca. 8% and, due to our proactive measures, the ECF touched the {10 crore mark (25% of total allocation) for the first time in the institute's history. We hope to better the record in the coming years.

At the research end, the institute was able to sustain the high standards it set for itself over the last decade. In recognition of some of the outstanding research being undertaken here, two of our research scholars got the opportunity to interact with Nobel Laureates in Germany in 2009 under invitation from the *Lindau Foundation*. There were 114 papers with average impact factor of 2.23 in 2008-09 and the number climbed to 142 in 2009-10. The average impact factor also rose to 2.695. This was possible because of the greater rigour with which scientific problems were addressed and the outstanding analytical facilities which enhanced the quality of publications. (The value of our analytical services was computed at {6.36 crore and {5.80 crore during 2008-09 and 2009-10, respectively based on the CSIR-approved charges as applicable to industries; actual earnings were, however, minimal as there was no direct charging for institutional and grant-in-aid projects while analyses for academic institutions and SSIs received 75% and 40% discounts, respectively.) Another reason was the improvement in quality of publications in biological sciences boosted by the network projects in this area and international collaborations. For example, the finding of a plant-associated natural habitat for Cronobacter spp. published in *Research in Microbiology* is being featured in the cover page of all the 12 issues of the journal in 2010. A recent article (Raghuraman et al. *Current Science* (2010), *99*, pp. 577-587) has placed CSMCRI at #16 in “*P*” index among autonomous R&D sector institutions in India (Chemical Sciences) (Table 3). It will remain our goal to constantly sharpen the focus of the basic research so that it is seen as a seamless part of our overall thrust on innovation. At the same time, the number of foreign patents granted could be sustained at a high level

(35 and 26 in the two years, respectively). The US patent on our *Jatropha* biodiesel process was granted during this period. It is also to the institute's credit that filing of new patent applications continued unabated – a sign of sustained innovative thinking. The institute also successfully licensed a few of its technologies and demonstrated these to the satisfaction of the clients. One such technology, which has now been commercialized, is the co-production of κ-carrageenan and seaweed sap (by M/s Aquagri Pvt. Ltd.), the latter having found great utility as a foliar spray to boost agricultural productivity. Keeping an eye on the health of students and teachers, the institute also perfected the knowhow of producing dust free chalk which too has been commercialized.

CSMCRI has all along believed that its innovations must reach the people. It is in that spirit that the biennial reports since 2006 contain a separate section entitled "CSMCRI and Society". It was indeed our privilege that we could serve the people in North 24 Parganas, West Bengal in the aftermath of cyclone Aila. Nearly 20,000 people got a taste of desalinated drinking water produced through our indigenous RO membrane technology (the water bodies turned saline after the cyclone). It has also given us great joy that the Forest Department, Government of Gujarat chose to run its tourist vehicles in Sasan Gir lion sanctuary with our eco-friendly B100 *Jatropha* biodiesel having high flash point and low emissions. CSMCRI also received wide coverage from the media, both national and international. The German state TV channel, ZDF, filmed our biodiesel activities and broadcasted a documentary largely based on our work. We are told there was a viewership of nearly 2 million. The baseline data we are generating on the Kalpasar project is yet another illustration of work of societal and environmental relevance.

Our endeavour in the coming years will be to work on large mission projects as well as those especially relevant to CSIR800 programmes catering to the masses. These will happen on the back of excitement generated among stakeholders in our work as was the case in 2010 when the National Manufacturing Competitiveness Council (NMCC), New Delhi took keen interest in our home grown technologies, particularly potash and indigenous TFC RO membrane.

People are at the heart of any organization. The institute has benefited from the knowledge and enthusiasm exhibited by the staff and they, in turn, have flourished as the institute has grown. I offer my congratulations to all those who have won awards and recognition for their achievements and hope they will sustain their creativity and intensify the research efforts. I also convey my thanks to all the support staff members who have played a vital role in the functioning of the institute. Even support functions such as the Workshop now play a pivotal role in research. Finally, the Institute would not have been able to grow but for the support it received from all stakeholders and well-wishers. We express our sincere thanks to all of them.

Pushpito K. Ghosh

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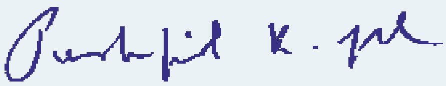

Pushpito K. Ghosh

BALANCED SCORECARD (2008-2009)

Allocation from CSIR (2008-2009 financial year) - {32.90 crore
External Cash Flow (2008-2009 financial year) - {4.53 crore

Manpower Resources (March 31, 2009) : 275 permanent staff and 259 temporary staff comprising scientist fellows/research associates/research fellows/project assistants/apprentices

HRD – 9 research scholars were awarded Ph. D; 32 persons were provided training (2008-09)

Papers : 114 papers in SCI journals with average impact factor of 2.232 (April 2008 – March 2009)

Patents – (April 2008 – March 2009) :
Filed: Indian – 16, Foreign – 17; Granted: Indian –20, Foreign –35 (including 5 US patents)

Technology transfer – 8

(1) Integrated RO system for desalination of brackish water containing fluoride followed by the treatment of RO reject (Tata Project Ltd., Secunderabad)

(2) Production of very high purity solar salt from sea water (DCW Ltd., Tuticorin)

(3) Production of very high purity industrial grade salt suitable for chlor-alkali manufacture (Grasim Industries Ltd., Nagda)

(4) Production of dustless chalk using calcium carbonate (Arasan Phosphates Pvt. Ltd., Tuticorin)

(5) Production of high strength Plaster of Paris (Arasan Phosphates Pvt. Ltd., Tuticorin)

(6) Multi-purpose solar oven (Mrs S Jayashree Rajan, Bhavnagar)

(7) *Kappaphycus* knowhow (Tripartite agreement with M/s Pepsico Holdings, Gurgaon and M/s Aquagri Ltd., Bangalore)

(8) *Kappaphycus* knowhow for cultivation outside Tamil Nadu (M/s Aquagri Ltd., Bangalore)

Societal Initiatives

(1) Setting up of additional RO plants in Afghanistan in partnership with Norwegian Church Aid

(2) Setting up of 2000 LPH 2-stage seawater desalination plant in Kenya

(3) Commissioning of 1 TPD zero effluent Jatropha biodiesel plant at DRDO Military Farm, Secunderabad

Important media coverage

A number of articles appeared in the print media (Economic Times, Business Standard, etc.) covering developments around superior quality writing chalk, double fortified salt, Humma (Orissa) model salt farm and commercialisation of biodiesel engine by Rajkot firm following testing on CSMCRI biodiesel

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BALANCED SCORECARD (2009-2010)

Allocation from CSIR (2009-2010 financial year) - {30.22 crore
External Cash Flow (2009-2010 financial year) - {9.95 crore

Manpower Resources (March 31, 2010) : 274 permanent staff and 251 temporary staff comprising ad hoc scientists/scientist fellows/research associates/research fellows/project assistants/apprentices

HRD – 11 research scholars were awarded Ph. D; 41 persons were provided training (2009-10); 1 Young Scientist Award to research scholar (Indian Science Congress 2010)

Papers – 142 papers in SCI journals with average impact factor of 2.695 (April 2009-March 2010)

Patents – (April 2009 – March 2010):
Filed: Indian – 09, Foreign – 15; Granted: Indian – 07, Foreign – 26 (including 3 US patents)

Technology transfer – 3

(1) 18E6 Omega ultra pure water system (Infusil India Pvt. Ltd., Bangalore)
(2) Know how to cultivate *Kappaphycus Alvarezii* in the sea (inter tidal water) (M/s Indian Seaweed Co. Ltd., Vijaywada, AP)
(3) Preparation of styrene oxide from styrene by H_2O_2 and hydrogenation of styrene oxide to phenyl ethyl alcohol (M/s Aquila Organics P. Ltd., Mumbai)

Major new initiatives

(1) Project on *Bioethanol from indigenous seaweeds with scaled up off-shore cultivation* has been sanctioned by MNRE
(2) CSIR-MoES inter-laboratory NMITLI project on *Microalagal Biofuels* has commenced with CSMCRI as nodal laboratory
(3) Collaborative project with Agaria Hith Rakshak Manch on new salt cluster development (funded by Gujarat Industries Commissionerate) has commenced
(4) Project with General Motors/US Department of Energy on technical feasibility & economic viability of commercial *Jatropha curcas* production together with life cycle analysis
(5) Discussions initiated with NMCC on promotion of home grown CSMCRI sulphate of potash knowhow

Most significant societal initiative :

Providing desalinated drinking water to 20,000 people on daily basis for 2 weeks in Hingalganj, N. 24 Parganas, West Bengal in the aftermath of cyclone Aila

Important media coverage

(1) Article entitled "Worth the Salt" in Business India, Sep 6, 2009, pp.106-108
(2) Coverage by Nature correspondent, Katharine Sanderson, in *nature.com* (Climate Feedback blog) (17 Sep, 2009) stating that: "*The CSMCRI (Jatropha) project has benefited from a realistic approach from the start*". The *Jatropha* plantation in Orissa was also featured
(3) Documentary film on *Jatropha* biodiesel shown on German State TV Channel, ZDF, with extensive coverage of CSMCRI activities (2 million viewers)
(4) PTI news on PHA bioplastic from *Jatropha* biodiesel waste stream

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Biennial Report 2008-2010

CHAPTER 1
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INORGANIC CHEMICALS
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Salt & Marine Chemicals
Analytical Science
Inorganic Materials & Catalysis

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SALT & MARINE CHEMICALS

Production of superior quality industrial grade salt from sea/subsoil brines

In the Biennial report 2006 - 08 we have reported the development of an improved process for the recovery of high purity solar salt with highly reduced levels of Ca, Mg and SO_4 impurities and proper Ca/Mg ratio suitable for chlor-alkali manufacture. The process developed on a mini field scale was implemented on a large scale at our Experimental Salt Farm during 2008 - 09. The salt produced through the improved methodology is found to be of high purity with respect to NaCl and other major impurities like Ca, Mg and SO_4. However, the salt was found to be contaminated with traces of Br and other trace element impurities beyond the prescribed limits for its specialty applications. These impurities could not be removed by simple heap washing. Looking to the fluorchem industrial demand, an innovative route was developed for the production of high purity solar salt with all the impurities including Br and other trace elements well within the prescribed limits.

Production of high purity solar salt in progress through upgraded process

Specifications of salt produced through upgraded technology

Constituents	Before Upgradation (% w/w)	After Upgradation (% w/w) (unwashed)
Ca^{2+}	0.09	0.03
Mg^{2+}	0.05	0.02
SO_4^{2-}	0.28	0.07
Br^-	60 ppm	< 10 ppm
NaCl (on dry basis)	99.4	> 99.7

Trace metal analysis of upgraded salt

Constituents	Upgraded Salt (unwashed), in ppm
Al	< 0.0280
Cd	< 0.0130
Co	< 0.0070
Cr	< 0.0071
Fe	< 0.1520
Pb	< 0.0420
Ni	< 0.0150
Zn	< 0.0059

Semi mechanization of solar salt works

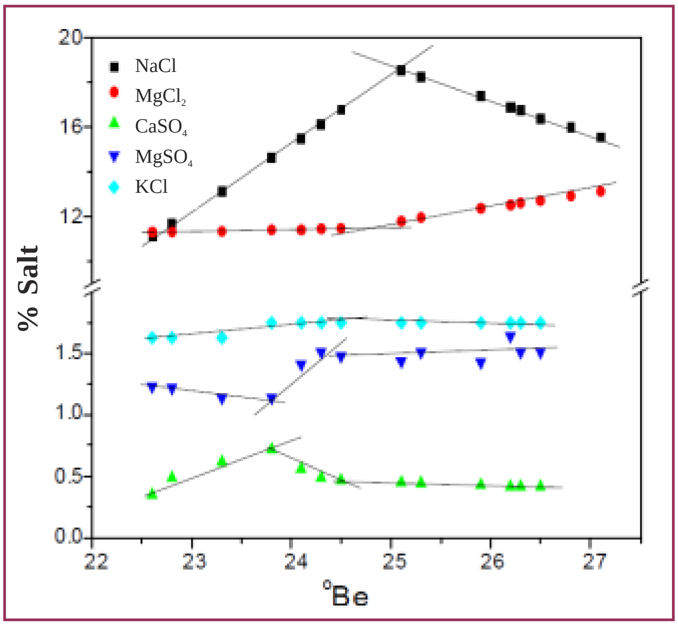
In India more than 30% of the total salt produced in the country comes from marginal and unorganized sector. The modernization and mechanization being introduced in the country should be amendable to marginal sector also. Innovations are in progress to design and develop mechanization implements adaptable to smaller units where one can work with light machinery. These changes are very important in making small salt units competitive and reduce the drudgery of salt workers as majority of the younger generation are shifting away from salt production activities. It is equally important to design and develop the equipments at an affordable price to the marginal agarias. Several equipments are available for mechanical harvesting of salt. However, most of the machines are less appropriate for small salt works. The institute had developed a mechanical device in 2000 to form salt ridges in the crystallizers reducing the drudgery of labourers. During 2009, the device was further modified suiting to the size of the crystallizers and mechanical salt harvesting process was undertaken without affecting the purity of the product. The system of harvesting and loading of salt was also introduced as a part of semi- mechanization process.

Various stages of salt harvesting introducing semi mechanization

Basic studies on brine systems

Effect of bittern mixing on solubility path of dissolved salts in the brine system and consequent effect on solar salt quality

It has been observed that in solar salt works the bittern left after the recovery of salt is recycled in the process brine. This exercise is practiced to promote NaCl crystallization with reduced evaporation demand and also to recover salt lost in the bittern. Studies were undertaken to see the change in solubility of the inherent salts in brine and its subsequent effect on quality of salt produced. Bittern of 27 to 28 ^{0}Be' was added to subsoil brine of 16.5 ^{0}Be' in different proportions. The mixed system was allowed to concentrate through solar evaporation and the figure shows the changes in the probable composition. The studies are continuing.

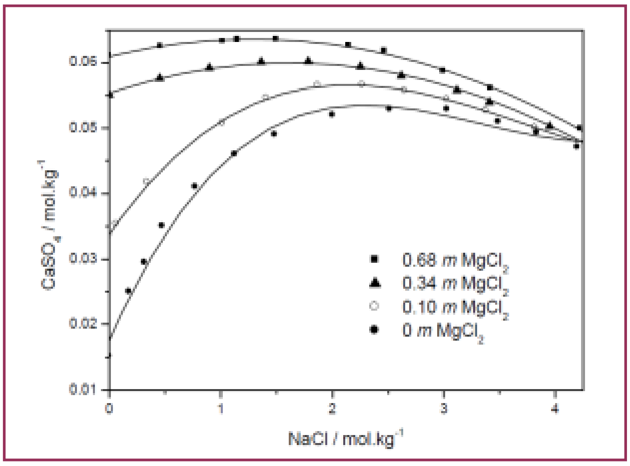


Solubility path of probable salts in mixed brine/bittern (16.5 +28 ^{0}Be) system

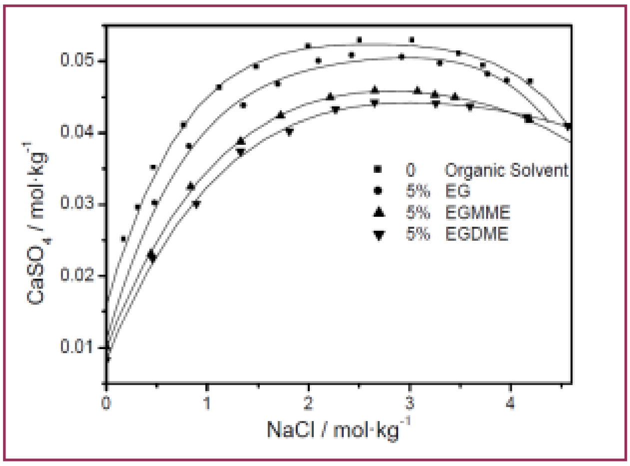
Effect of addition of $MgCl_2$ or organic additives on solubility of $CaSO_4{\cdot}2H_2O$ in aqueous NaCl solutions up to high salinities

The solubility studies of $CaSO_4{\cdot}2H_2O$ in aqueous NaCl solutions up to very high salinities were carried out in presence of $MgCl_2$ and organic additives (ethylene glycol and its derivatives) at ambient temperatures with a view to improving our understanding of gypsum solubility in presence of electrolytes other than NaCl, particularly those that are present in brine. The studies revealed that the addition of $MgCl_2$ in the brine system, in general, enhanced the solubility of $CaSO_4.2H_2O$. The solubility of $CaSO_4{\cdot}2H_2O$ increases markedly at lower salinities, and this increase is significant up to approximately 3.0 *m* NaCl concentration in the solution. At still higher concentrations of NaCl, the effect of Mg^{2+} ions was less pronounced. Further, the addition of $MgCl_2$ shifts the solubility maximum of $CaSO_4{\cdot}2H_2O$ slightly towards lower NaCl concentrations. Addition of $MgCl_2$ decreases the solution compressibility quite significantly which is mainly due to the weakening of hydrogen bonding of bulk water, thereby making the solutions more rigid. The total hydration number of the ionic species at lower salt concentrations in brines enhances significantly with the addition of $CaSO_4{\cdot}2H_2O$ or $MgCl_2$ but at higher molalities of NaCl ($\approx$ 2.5 *m*) the effect of added electrolytes on the ionic hydration is much less pronounced (*J. Chem. Eng. Data*, *55 (2010) 1623*).

Addition of ethylene glycol (EG), ethylene glycol monomethyl ether (EGMME), and ethylene glycol dimethyl ether (EGDME) showed an antisolvent effect wherein the solubility of $CaSO_4{\cdot}2H_2O$ decreased with the increase in concentration of organic component in all the systems. Replacement of hydroxyl group of EG by the methoxy group decreased the solubility of $CaSO_4{\cdot}2H_2O$ in the order: EGDME > EGMME > EG. A comparatively stronger hydrogen bonding between EGDME and water molecules is responsible for lower solubility of $CaSO_4{\cdot}2H_2O$ in the NaCl + H_2O + EGDME system. However, there is less of a decrease in the NaCl + H_2O + EG system due to the comparatively weaker hydrogen bonding interactions between EG and water molecules owing to self association of EG. The addition of organic solvent did not shift the solubility maximum of $CaSO_4{\cdot}2H_2O$ (*J. Chem. Eng. Data*, *55 (2010) 4704*).



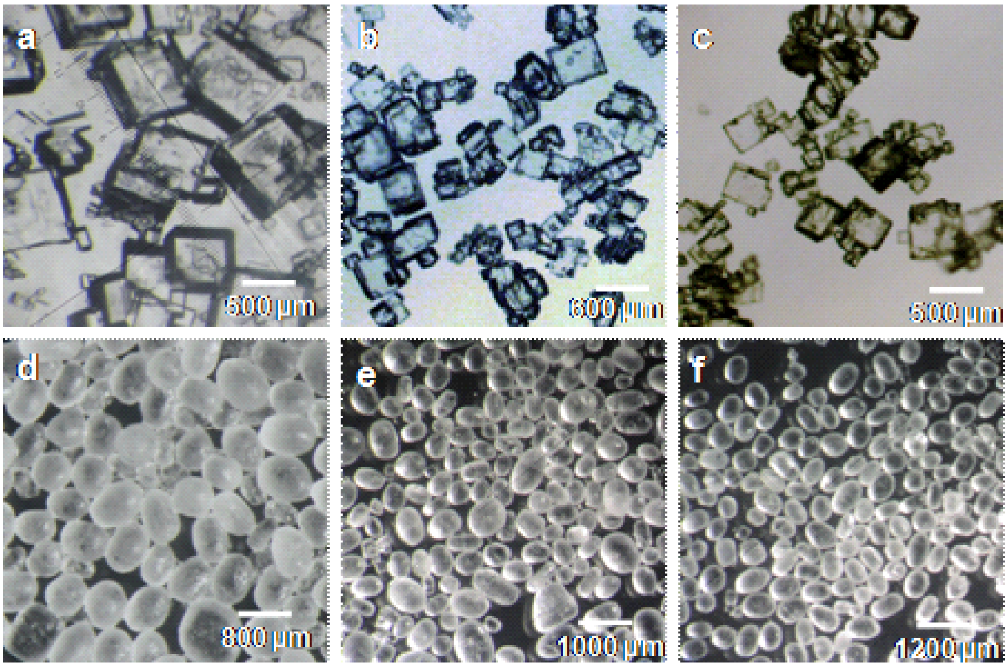
$CaSO_4 \cdot 2H_2O$ solubility at constant $MgCl_2$ concentrations but varying NaCl concentration at 35 °C



Comparison of solubility of $CaSO_4 \cdot 2H_2O$ in aqueous NaCl solutions at 35 °C having similar concentration of EG / EG derivatives. Lines are polynomial and fit to the experimental data

Preparation of spherical crystals of NaCl and KCl by simple mechanical means without using habit modifier

In the biennial report 2006 - 08 we have reported an innovative route for the production of common salt with nearly spherical morphology through simple mechanical means. This followed the highly publicized innovation on preparation of rhombic dodecahedral solar evaporated salt from natural brines through use of glycine as habit modifier. A sample of the mechanically engineered spherical salt was sent to an American company for testing in bio-medical applications. The sample yielded encouraging results in their applications. Arising out of the request for larger amounts of the salt, the laboratory process was successfully scaled up to 10 kilogram level and the salt was once again confirmed by the company to be well suited to their applications. Morphology control was equally effective with synthetic and natural brines. In further studies undertaken here, the sieved spherical salt of 350-500 µm size treated with potassium ferrocyanide anti-caking additive was shown to exhibit superior free flow (ca. 20% greater mass flow rate through funnel; angle of repose ~ 16°) compared to commercial vacuum evaporated free flow cubic salt of comparable dimension. The superior flow characteristic was retained even after 3 months of storage. Scanning electron microscopic studies revealed that the round polycrystalline particles were derived from the stacking of minute NaCl cubes and the average size of the spheres was amenable to reduction through use of ethanol as anti solvent. The spherical salt crystals could also be successfully iodised *(Ind. Eng. Chem. Res., 49 (2010) 12197).*

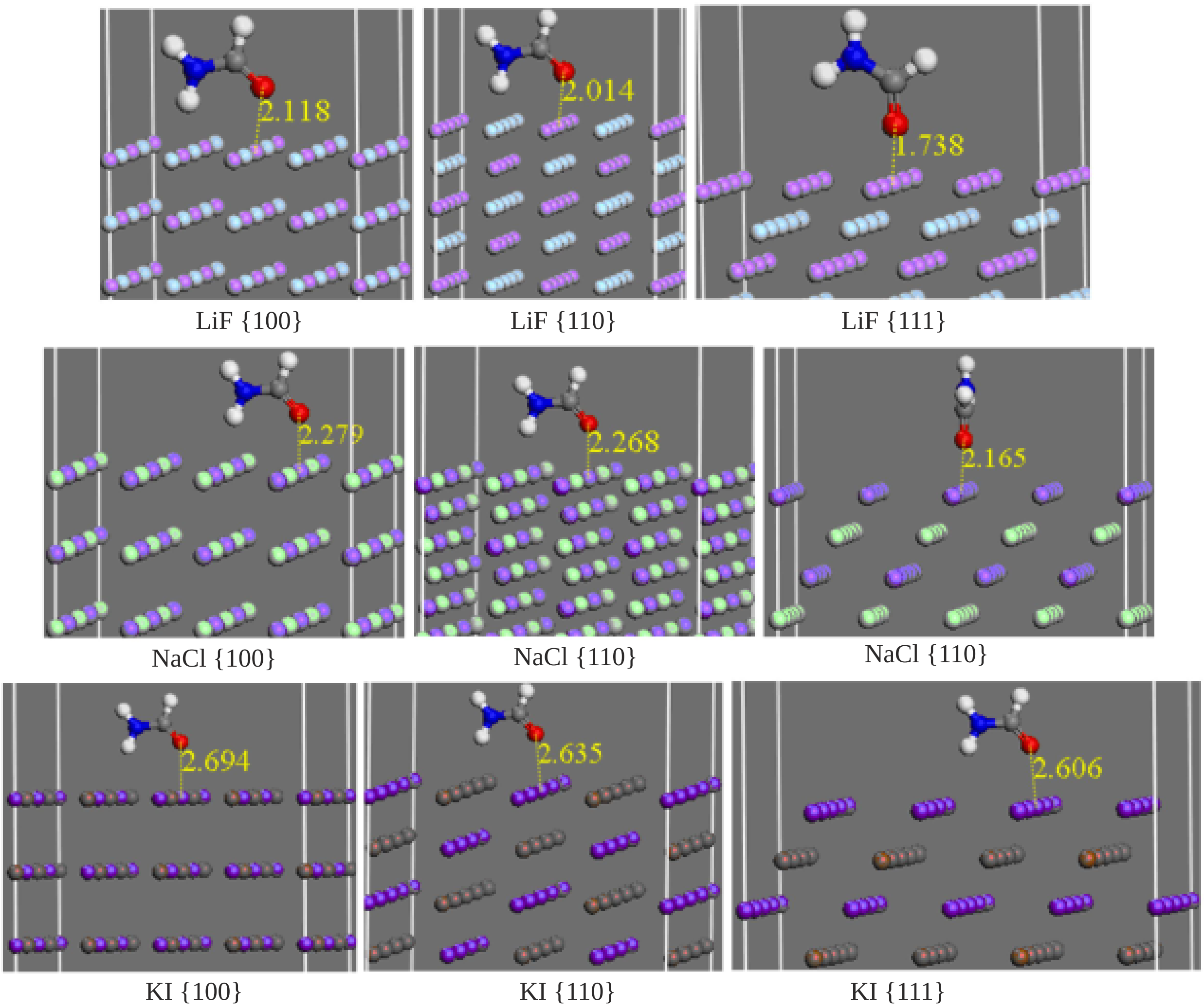


Optical microscopic images of cubic salt crystals obtained through crystallization of (a) synthetic-, (b) sea- and (c) sub-soil brines in an open beaker under gently magnetic stirring at 55 °C. When the experiments were repeated using a special impeller operating at 250 rpm while maintaining all other conditions identical spherical salt particles shown in (d), (e) and (f), respectively, were obtained

We are in the process of up-scaling the process to 1 TPD scale with the assistance of a globally recognized expert in computational fluid dynamics. Studies on similar lines are being undertaken for the preparation of low sodium spherical salt.

Influence of formamide on the crystal habit of LiF, NaCl, and KI: A DFT and aqueous solvent model study

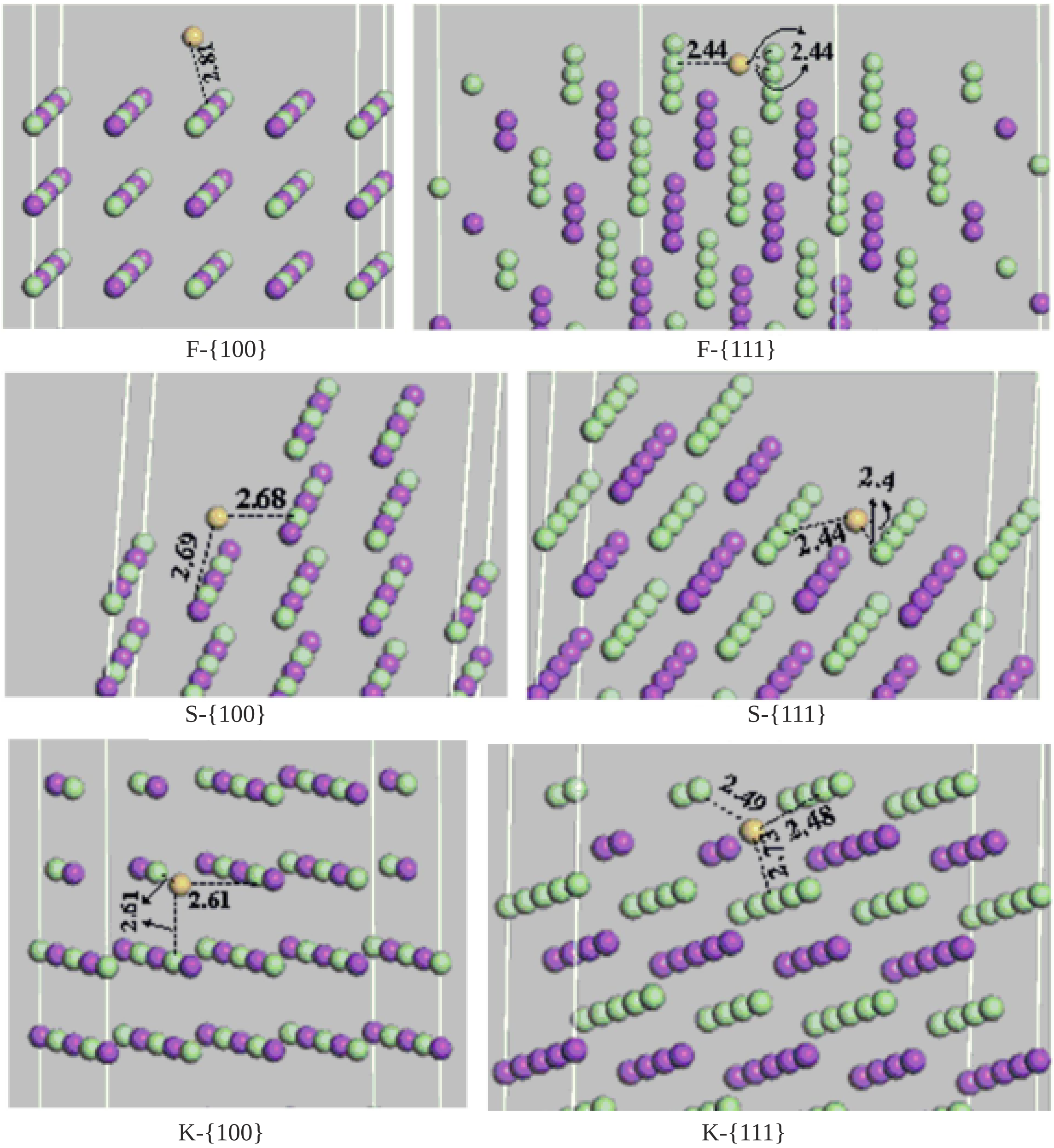
We have performed a density functional study to examine the effect of formamide on the morphology of different alkali halide (namely LiF, NaCl, and KI) crystals. The calculations were performed both in the gas phase and aqueous phase using a continuum model (COSMO/COSMO-RS). Solvation is observed to have a major effect on the interaction energies whereas the matching of the size of the additive with the neighboring ion spacing on the lattice planes of the different alkali halides is seen to be less important. The calculated results employing the slab models show that, in the aqueous phase, formamide interacts preferentially with the {111} surface of sodium chloride (ΔE) -23.8 kcal/mol for {111}vs -0.4 and -4.3 kcal/mol for {100} and {110}, respectively). This would favor the formation of octahedral-shaped crystals as reported experimentally (Surf. Sci. 2003, 523, 307-315). On the other hand, interaction of formamide with all the surfaces of LiF are found to be repulsive in the aqueous phase while, in the case of KI, the interactions are weak (-2 to -5 kcal/mol) on all surfaces, i.e., no pronounced effect of formamide on morphology *(Can. J. Chem., 87 (2009) 514).*



LDA/PWC/DND-calculated geometries of formamide with {100}, {110}, and {111} surfaces of NaCl, LiF, and KI in the slab model (purple: sodium, lithium, and potassium; green: chlorine and fluorine; brown: iodine; red: oxygen; blue: nitrogen; white: hydrogen)

First principle study towards the influence of Cd^{2+} on the morphology of sodium chloride

The interaction of Cd^{2+} with various surface sites of sodium chloride such as, flat face, steps and kinks was examined theoretically by DFT methods. The stabilization of the {111}NaCl surface by a 1:3 (molar ratio) combination of Cd^{2+} ions and water molecules was the highest, in agreement with the SXRD results (Surf. Sci., 599 (2005)196) reported by others .



Interaction of Cd^{2+} ion with flat, step and kink sites of {100}and {111}NaCl planes at LDA/PWC/DND level of theory. The distances are in angstroms (purple: sodium, green: chlorine and yellow: Cd^{2+})

Recovery of important minerals from marine sources

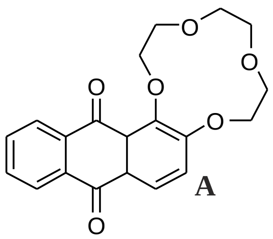
Apart from the well known marine chemicals such as NaCl, gypsum, potash, magnesium chloride and bromine, sea water also contains important elements such as lithium (0.2 ppm), strontium (8 ppm), boron (4.8 ppm) and uranium (3 ppb), albeit in trace amounts. However, their concentration can increase with concentration of brine as occurs during the recovery of marine chemicals. A base data of the concentration of lithium and strontium at various stages of solar evaporation of brine of different sources from different locations was generated using ICP-OES.

Lithium and strontium concentration of various brine systems

Sr. No.	Sample Type	Density °B'e	Lithium content in mg/L	Strontium content in mg/L	Location Details
1	Sea Brine	14.0	0.42	30.96	ESF sea brine collected in Jan-2010
2	Subsoil Bittern	30.0	3.55	13.67	ESF subsoil bittern from year 2009 crop, collected in Jan-2010
3	Sea + Subsoil Bittern	27.7	3.3	32.2	Navlakhi (Vinod Salt), collected in Dec-2009
4	Subsoil Bittern	29.74	0.183	3.86	Sambar Lake Nava, Rajasthan, collected in Jan-2010
5	Sea Brine	7.56	0.243	11.98	Navlakhi (Vinod Salt), Collected in Feb-2010
6	Sea Brine	27.4	2.01	42.17	Navalakhi (Vinod Salt) from pre crystallizer, collected in Feb-2010
7	Sea Bittern	29.4	3.04	28.58	Navalakhi (Vinod Salt), collected in Feb-2010
8	Subsoil Bittern	27.31	2.238	5.693	GRK, collected in 2002
9	Sea Brine	3.67	0.142	6.384	Alang coast, collected in March-2010
10	Sea Bittern	27.01	1.955	24.13	Modern Salt, Bhavnagar collected in Jan-2010
11	Sea Brine	3.81	0.132	22.486	Khambhat, collected in Feb-2010
12	Subsoil Bittern	29.31	2.183	15.78	Khambhat, collected in Feb-2010
13	Subsoil Brine	16.56	0.726	39.073	Chandasani, Rajasthan (part of GRK nr. Indo-Pak Border in Badmer district) collected in March-2010
14	Carnalite Bittern	35.3	6.315	121.85	Carnalite End bittern, after removal of Carnalite ($KMgCl_3.6H_2O$) at ESF
15	Kainite Bittern	38.0	9.81	0.523	Kainite End bittern, after removal of Kainite ($MgSO_4.KCl.3H_2O$) at ESF
16	Mg-free concentrated Bittern	32.0	10.5	1.125	The bittern at #2 was concentrated to 30°Be' and then Mg was removed with NaOH. The solution was further concentrated to 32.0°Be'
17	Enriched Bittern	40.0	23.1	19.0	The solution at #16 was further evaporated to 40°Be'
18	Enriched Bittern	29.0	4.75	--	The bittern at #2 was concentrated to 29°Be' and then Mg was removed with soda ash
19	Sea Bittern	27.74	1.95	39.63	Rajula, Collected in June-2010

ESF = CSMCRI Experimental Salt Farm

It is of interest to note that a ca. 100-folds enhancement in the lithium concentration to a value of 23.1 ppm was observed in going from normal seawater to concentrated bittern from which the magnesium ion was precipitated out with caustic soda (entry 17 in accompanying table). Exploratory studies were also carried out towards selective extraction of lithium from the mother liquor of entry 17, after diluting to 7.5 ppm Li concentration. Two 12-crown-4 ether



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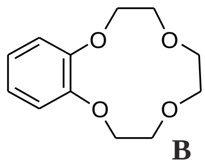

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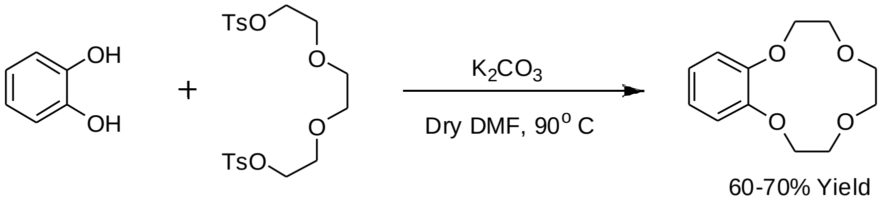


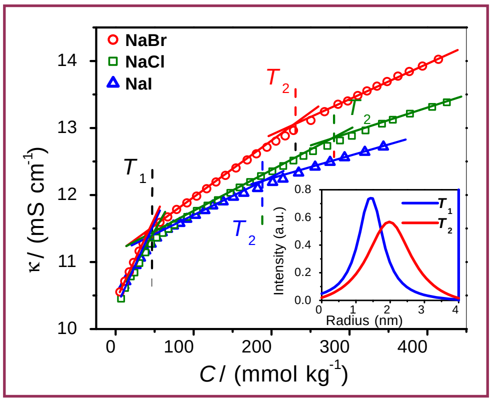
derivatives were synthesized and evaluated. 11.7% uptake of Li by the ligand was observed. Studies will continue to maximize the concentration of Li in brine and its selective uptake.

Room temperature ionic liquids

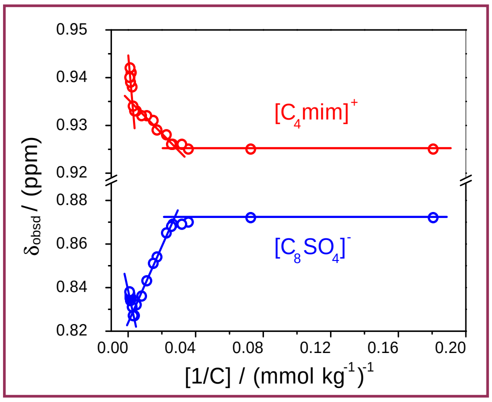
Room temperature ionic liquids (ILs), due to their unique physicochemical properties are rapidly gaining interest as greener replacements for traditional volatile organic solvents used in chemical processes. We have initiated the work on ILs during 2006 – 08 and included our exploratory results in the earlier biennial report. In continuation to our earlier studies we have physico-chemically characterized various room temperature ionic liquids in neat, aqueous as well as non aqueous medium and have explored their potential applications for dissolution, regeneration and ion gel formation of agarose and other biopolymers.

Micellar transitions in the aqueous solution of a surfactant like ionic liquid: 1-butyl-3-methylimidazolium octyl sulfate

While investigating the surfactant like behavior of 1-butyl-3-methylimidazolium octylsulfate $[C_4mim][C_8SO_4]$ in aqueous media, an ionic liquid (IL), we noticed dual transition in its various physical properties. Interestingly, in the conductivity measurements it was found that the second transition which was comparatively weaker in pure water can be enhanced through addition of a suitable electrolyte. Using an array of techniques such as conductivity, ultrasonics, TEM, cryo-TEM, DLS, ^{1}H NMR and 2D ^{1}H-^{1}H NOESY, it has been established that the first transition corresponds to the anionic aggregation with imidazolium cations adsorbed as counter ions, and the second transition corresponds to the restructuring of initially formed aggregates in a way that the alkyl chain of imidazolium cation is incorporated towards the micellar core leading to a unique mixed micelle type structure in a single IL system *(Phys. Chem. Chem. Phys., 12 (2010) 11728).*



Transitions in conductivity



Transitions in chemical shift

Physicochemical characterization of imidazolium-based room temperature ionic liquids

Physical properties such as density, speed of sound and refractive index for the ILs: $[C_8mim][Cl]$, $[C_4mim][C_1OSO_3]$, and $[C_4mim][C_8OSO_3]$ were measured as a function of temperature at normal atmospheric pressure. From measured properties internal pressure and molar refraction were computed. Internal pressure decreases with increase in temperature for all the ILs except $[C_4mim][C_1OSO_3]$, which may be attributed to the more self-associated nature of IL due to high polarity of $[C_1OSO_3]$ anion. Internal pressure of the investigated ILs was found higher than those of water and molecular organic liquids but less than that of classical molten salts. Also, the derived parameters from experimental quantities as a function of temperature were found to vary with the nature of cation and anion of various ILs. Results have been compared to the ILs investigated in previous biennial report and found to be in agreement *(J. Soln. Chem., 38 (2009) 1043).*

Technology transfer

Transfer of technology for the production of high purity solar salt on a commercial scale to M/s. Grasim Ltd., Nagda

In the biennial report 2006–08 we have reported the transfer of technology for the production of high purity solar salt to M/s. Grasim Ltd., Nagda as per our patented process. The technology was initially demonstrated on 200 ton scale at Vinod Salt Works, Navalakhi (Gujarat). Seeing the results of demonstration the party desired CSMCRI to demonstrate the process on a commercial scale producing about 10000 ton of high purity salt. All the facilities for commercial solar salt production were provided by Grasim and Vinod Salt Works. About 10000 ton of high purity salt having the specifications Ca = 0.06 – 0.08%, Mg = 0.03 – 0.04%, SO_4= 0.20 – 0.22% and NaCl > 99.3% with < 100 ppb iodine was produced during the process demonstration and the certificate of satisfactory demonstration was signed between Grasim & CSMCRI.

High purity solar salt technology demonstration on a commercial scale at Vinod Salt Works, Navlakhi

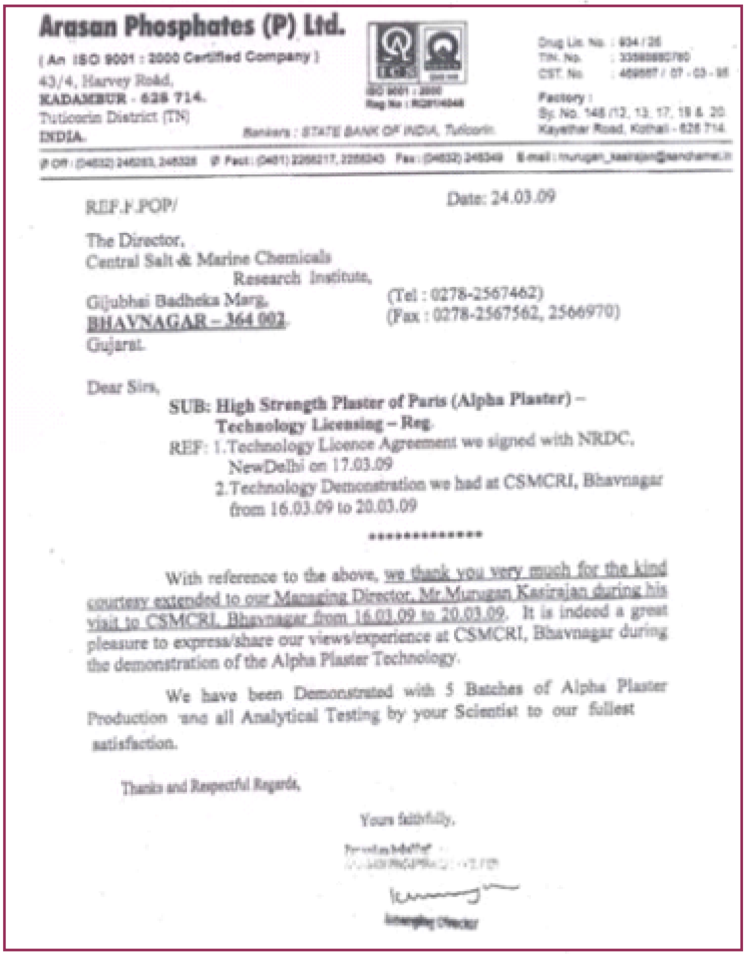
Sr. General Manager P & QC, Grasim Chemical (Left) & Scientist & Head, SMC, CSMCRI (Right) signing the technology transfer certificate for production of high purity solar salt in field

Transfer of technology for the production of high purity solar salt from subsoil brines of Rajasthan to M/s. DCM Consolidated, Kota

The innovative process for the production of high purity solar salt from subsoil brines of Rajasthan was demonstrated to M/s. DCM Consolidated, Kota. The process was demonstrated in one part of the model salt farm established by CSMCRI at Nawa. As the party wanted the demonstration in the last salt season itself, the activities were carried out under not too conducive conditions with the limited facilities available. High purity solar salt with > 99% NaCl and low sulphate was produced during the demonstration. The iodide content in salt was also reduced from 4 – 5 ppm to < 1 ppm, i.e. the iodide content was reduced by more than 80%.

Demonstration of high purity solar salt technology to M/s. DCM Shriram Consolidated, Kota at HSL site, Nawa

Transfer of α-plaster knowhow



Arasan Phosphates (P) Ltd.

(An ISO 9001 : 2000 Certified Company)
43/4, Harvey Road,
KADAMBUR - 628 714.
Tuticorin District (TN)
INDIA.

Bankers : STATE BANK OF INDIA, Tuticorin

Factory :
Kayathar Road, Kothai - 628 714

REF.F.POP/ Date: 24.03.09

The Director,
Central Salt & Marine Chemicals Research Institute,
Gijubhai Badheka Marg,
BHAVNAGAR – 364 002.
Gujarat.

(Tel : 0278-2567462)
(Fax : 0278-2567562, 2566970)

Dear Sirs,

SUB: High Strength Plaster of Paris (Alpha Plaster) – Technology Licensing – Reg.

REF: 1. Technology Licence Agreement we signed with NRDC, NewDelhi on 17.03.09
2. Technology Demonstration we had at CSMCRI, Bhavnagar from 16.03.09 to 20.03.09

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With reference to the above, we thank you very much for the kind courtesy extended to our Managing Director, Mr Murugan Kasirajan during his visit to CSMCRI, Bhavnagar from 16.03.09 to 20.03.09. It is indeed a great pleasure to express/share our views/experience at CSMCRI, Bhavnagar during the demonstration of the Alpha Plaster Technology.

We have been Demonstrated with 5 Batches of Alpha Plaster Production and all Analytical Testing by your Scientist to our fullest satisfaction.

Thanks and Respectful Regards,

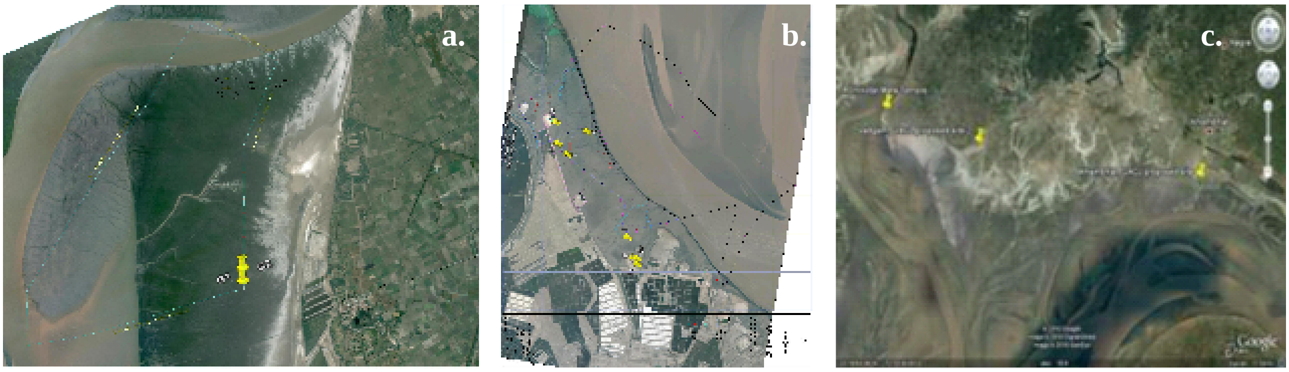
Yours faithfully,

Managing Director

The institute had developed the technology for the production of high strength α-plaster from marine gypsum in the early 90s and transferred the process to various industrial units. Interest in the know how was revived recently and there have been inquiries from cottage industries for technology transfer. During 2009, we transferred the technology to M/s. Arasan Phosphate Pvt. Ltd. and the technology was demonstrated at bench scale to the full satisfaction of the party.

Pre-feasibility study of the site selected for manufacture of salt by M/s. GACL, Vadodara

M/s. Gujarat Alkalies and Chemical Ltd., Vadodara has two manufacturing units in Vadodara and Dahej for the production of caustic soda. The company produces about 1200 – 1250 MT of caustic soda per day and they are in the process of expanding their units to double the capacity. The company consumes 1900 – 2000 MT of industrial salt per day for caustic soda manufacture. As a part of backward integration, they intend to manufacture their own salt. The company approached the institute for conducting prefeasibility studies of potential sites to assess their suitability for solar salt production. Preliminary surveys were conducted at Paniyadra & Katpar in Bharuch district and Khambhat & Vadgamin Anand district where the company is acquiring land for salt production. All the essential parameters like physical and chemical characteristics of soil, initial density of brine available at the locations and its continuous and copious supply, climatic parameters of the region, GPS of the location, infrastructural facilities available for the transport of salt, etc., were studied in detail and a comprehensive report submitted to the party.

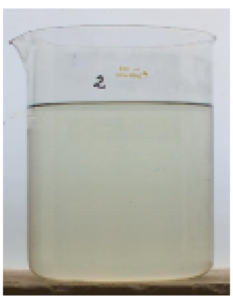


Sites surveyed: a. Katpar, b. Paniyadra, c. Khambhat & Vadgam

Exploratory studies on recovery of chemicals from tannery waste liquor

It is reported that large amounts of tannery waste liquor are being generated by the leather industries. The liquor is first subjected to RO desalination and the reject water is evaporated upto dryness stage using forced evaporation for its safe disposal. The solid residue generated during the process is found to be a mixture of sodium chloride, sodium sulphate and calcium sulphate as major constituents with minor quantities of magnesium chloride as well as other insoluble/soluble impurities. Various alternatives for the effective utilization of the effluent including the recovery of chemicals in their pure form were discussed during the meeting held at Tamil Nadu Pollution Control Board (TNPCB), Chennai. Encouraged by the laboratory results a project on exploratory studies on the recovery of valuable chemicals from the tannery waste liquor was awarded to CSMCRI by TNPCB. Both laboratory and bench scale studies were conducted and we could recover gypsum and NaCl in 97.8% and 99.3% purity from the waste liquor. A detailed report of exploratory studies was submitted to M/s. TNPCB within the stipulated timeframe.

Original liquor



Decolourized liquor

Clarified liquor

Decolorization and clarification of tannery waste liquor

Studies on the environmental impact assessment of the saline land of M/s. Hindustan Salts Limited, Jaipur in Little Rann of Kutch, Gujarat

M/s. Hindustan Salts Limited, Jaipur has allotted 3100 acres of their saline land out of the total 22700 acres in Little Rann of Kutch to one of the leading salt producers of Tamil Nadu. M/s. HSL desired to have some environmental parameters to be studied by an expert institution so that construction of large solar salt works may not create any environmental problems in future. The party approached CSMCRI, Bhavnagar, for conducting the above studies. After visiting the site the scientists agreed to take up the job jointly by Salt & Marine Chemicals and Marine Environment Disciplines. The project work will be initiated after signing an agreement between CSMCRI and M/s. HSL, Jaipur which is in progress.

Low sodium salt from bittern

In the biennial report 2006 – 08 we have reported the initiation of demonstration of low sodium salt technology to M/s. Hindustan Lever Ltd., Mumbai at the site of M/s. Sahaymatha Salt Refinery Ltd., Tuticorin, Tamil Nadu where the party is operating their salt refinery. The low sodium salt produced during the demonstration had the specifications: NaCl = 55 – 58%, KCl = 42 – 45% and other trace elements within the permissible limits for edible salt. Based on the success of the demonstration, M/s. HUL has decided to utilize the low sodium salt in all their food products which will be marketed globally with the technology brand name of CSIR / CSMCRI. M/s. HUL also expressed their desire to produce low sodium salt at our Experimental Salt Farm on a commercial basis. Accordingly, carnallite preparation is in progress at our ESF.

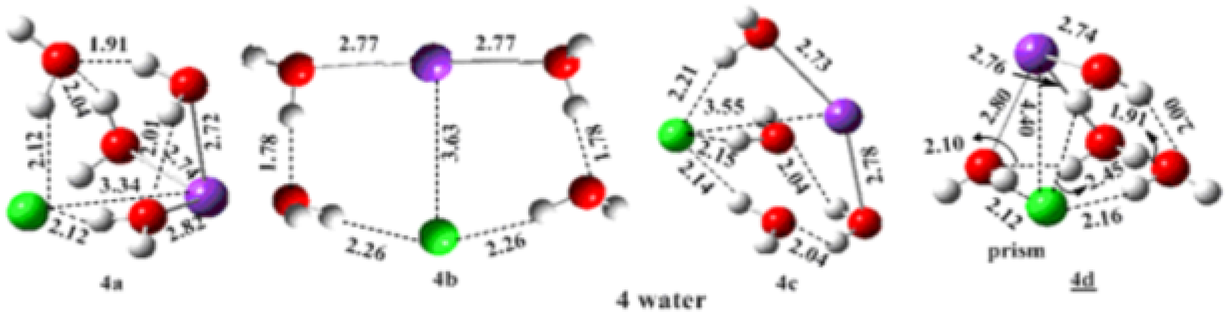
Carnallite production in progress at ESF

Ambient temperature potash recovery from CDP

As part of the ongoing R&D activities, efforts are being made to develop ambient temperature process for separation of potassium chloride from NaCl/KCl mixture (carnallite decomposed product), obtained after decomposition of carnallite type mixed salt. Conventional hot leaching process for effecting this separation is highly energy intensive & also requires substantial capital expenditure. To address these issues, presently four different ambient temperature NaCl/KCl separation methods, harnessing difference in their physico-chemical properties, are being explored. Preliminary findings are encouraging & scaled up experiments are in progress.

Study of the minimum requirement of water molecules for dissolution of a KCl molecule

Quantum chemical calculations were carried out with Møller-Plesset second-order perturbation method (MP2) and further employing the coupled cluster theory (CCSD(T)). The calculated results show that 4 water molecules stabilize a solvent separated K^+/Cl^- ion-pair in prismatic structure, and with 6 water molecules, further dissociation is observed. Previous work by others on attenuated total reflection (ATR) infrared spectroscopy of dissolution of KCl in water had established that clusters are made of closely bound ions with a mean of five solvated water molecules per ion pair $K^+(H_2O)_5Cl^-$(Applied Spectroscopy 53 (1999) 1601; J. Chem. Phys.115(2001) 2664), in good agreement with the present findings *(J. Comput. Chem., 31 (2010) 2948).*



MP2/6-31+$_{Cl}$G* optimized geometries for various conformers of $KCl(H_2O)_{n=4}$
[potassium : purple; chlorine : green; oxygen : red; hydrogen : white]

Preparation of triple fortified salt (TFS)

Salt is an excellent and cheap carrier of micro nutrients essential for human body. This will help to augment the nutrient deficiency among the common masses by providing essential nutrients through intake of common salt. We have developed an innovative route for fortification of salt with essential micro nutrients like iodine, iron and zinc. The TFS has been tested for its stability under varying climatic conditions and the nutrients are found to be quite stable even under extreme atmospheric conditions. Patent application on the development is being prepared. Meanwhile, feedback was obtained from the Salt Department regarding the stability of the Fe+I double fortified salt developed by the institute.

Value addition of gypsum produced in the integrated CSMCRI SOP process and the improved Solvay process with utilization of distiller waste for high purity salt production

During preparation of sulphate of potash, kainite is decomposed with water/sea water to generate solid schoenite and mother liquor which is de-sulfated by calcium chloride. During this process gypsum is generated. We have undertaken the optimization studies for the preparation of ammonium sulphate and calcium carbonate by reacting gypsum with ammonia and carbon dioxide (Merseberg process). In a laboratory scale (3 kg batch) reaction 93% of gypsum got converted to calcium carbonate along with ammonium sulphate. The calcium carbonate thus obtained was used to prepare lime by calcination and the lime was used to prepare lime slurry in decarbonated water. This lime slurry was reacted with de-sulfated schoenite end liquor to obtain high purity $Mg(OH)_2$ and $CaCl_2$. *(CSIR IPMD NF Number: 0233NF2008 and PCT Ref. No: PCT/IN2010/000194).*

In a parallel development, an improved process – coined as the Solvay-Merseberg-CSMCRI process – has been developed to co-produce ammonium sulphate along with soda ash while reducing the need for quarrying of limestone. Another important aspect of this invention is the part utilization of flue gas as feedstock (CO_2) for the Merseberg process.

Ultrapure magnesia from bittern

The institute had earlier reported the preparation of ultra-pure magnesia (purity > 99%). The Refractories Division, Central Glass and Ceramic Research Institute, Kolkata prepared magnesite refractory from this magnesia and have stated that *"the 99% MgO grade gave excellent results (RUL>1680C)"*. Simultaneously, the ultra-pure magnesia was also evaluated by the Metal Extraction and Forming Division, National Metallurgical Laboratories (NML), Jamshedpur to assess its suitability for magnesium metal production. The laboratory has written saying that they have *"analysed the MgO sample (>99% pure) of CSMCRI and found it suitable for Mg production."*

Progress update on sulphate of potash (SOP) knowhow

In the biennial report 2006 – 08 we have reported the development of an integrated technology for the production of sulphate of potash fertilizer from bittern. The technology was transferred to M/s. Archean Chemical Industries, Chennai and the party is in the process of establishing a 100,000 TPA plant at GRK which will be subsequently up-scaled to 300,000 TPA. In view of the increasing export prices and growing demand for potassic fertilizers in the country, the dire need for the indigenous production of potash is gaining momentum. CSMCRI's internationally patented SOP process was discussed in detail during various meetings at national level. Following the initiatives of National Manufacturing Competitiveness Council, Government of India, a 0.75 TPD Sulphate of Potash test bed is proposed to be set up at our Experimental Salt Farm with the financial support from Department of Science & Technology, Government of India. This test bed will also produce 0.75 TPD ammonium sulphate (FCO grade) & 0.3 TPD ultra-pure MgO. This will serve as a scaled-up demonstration facility and will help to instill confidence about robustness & scalability of the technology among the entrepreneurs & financial institutions alike. In parallel, discussions are underway with M/s Tata Chemicals on licensing of the SOP knowhow.

Studies to accelerate solar evaporation rate for enhanced efficiency of potash recovery

As reported in our earlier Biennial Reports, a novel scheme has been devised to produce sulphate of potash (SOP) using bittern and lime as the sole raw material inputs. In this approach, schoenite and muriate of potash (MOP) are reacted together to obtain SOP and the MOP is generated from the side stream (SEL) of schoenite production from kainite mixed salt. The scheme as devised forms a closed loop in as much as the side stream is continuously recycled. In view of the closed loop it was felt appropriate to explore the accelerated evaporation of the SEL through use of dyes. 10 to 15% increase in the rate of evaporation was recorded with a green dye (Devaracid Green VA) and with only marginal loss of dye over the entire cycle. Efforts are underway to minimize the losses and maximize the acceleration of evaporation through better selection of dyes, especially those having high absorptivity and broad absorption.

BR-S, green bromine reagent, without NaCl contamination

The institute has previously patented the production of 2:1 sodium bromide: sodium bromate from the intermediate stream of liquid bromine manufacture via the cold process, wherein bromine vapors released from bitterns is trapped in alkali. The intermediate having 4:1-5:1 bromide:bromate ratio was thereafter oxidized further with Cl_2/alkali or hypochlorite to the 2:1 composition and the reagent was coined as "green bromine" as it eliminates the use of liquid bromine and carries out bromo substitution reactions with high bromine atom efficiency. This approach, however, introduces NaCl as by-product which, although, innocuous, may not be desired by all. Accordingly, an electrochemical process of oxidation of 5:1 bromide:bromate to 2:1 bromide:bromate in a membrane cell was developed which avoided NaCl contamination.

$$NaBr + 6\,OH^- \rightarrow NaBrO_3 + 3H_2O + 6\,e^- \quad (1)$$

$$6\,H_2O + 6\,e^- \rightarrow 3\,H_2 + 6\,OH^- \quad (2)$$

$$5\,NaBr + NaBrO_3 \rightarrow 4\,NaBr + NaBrO_3 = 2{:}1\ NaBr{:}NaBrO_3 \quad (3)$$

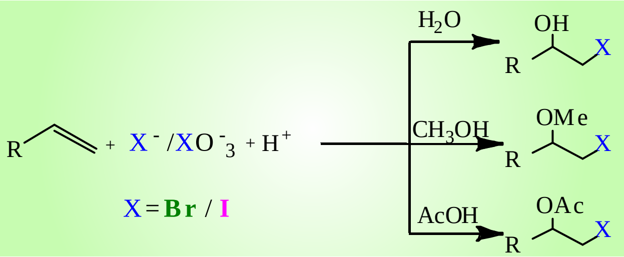
Paranitrobenzyl bromide

The process for production of pure *p*-nitrobenzyl bromide (PNBBr) from *p*-nitrotoluene (PNT) employing green bromine (2:1 NaBr-$NaBrO_3$ generated from bromine intermediate) was further improved. Carbon tetrachloride was identified as an ideal solvent in as much as it promoted the reaction efficiently and also facilitated cold crystallization of the product. 250-300 g of 98% pure PNBBr was obtained per batch and the mother liquor containing excess PNT, residual product and impurities was recycled directly in the subsequent batch thereby greatly simplifying the operations. At the end of the 8^{th} cycle, solvent was stripped off from the mother liquor and the residue was subjected to vacuum distillation to recover PNT. The residue remaining after distillation of PNT contained over-brominated impurity(NO_2-Ar-$CHBr_2$) along with PNT and PNBBr. The impurity could be converted back into a PNT or PNBBr and the product as obtained was recyclable. The overall yield and bromine atom efficiency were 96% and 90%, respectively, arising out of the improvements.

Comparative study of the vicinal functionalization of olefins with 2:1 bromide-bromate and iodide-iodate reagents

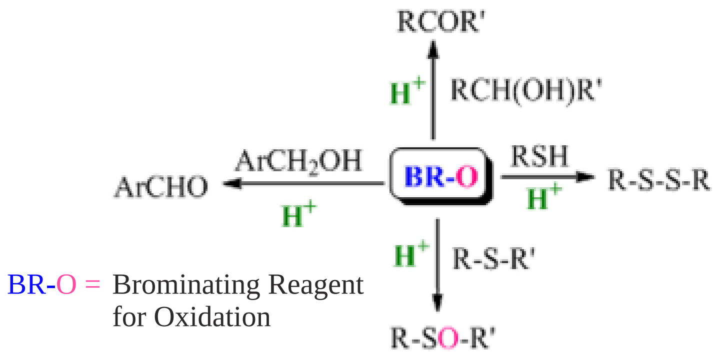
A comparative evaluation was made of the syntheses of vicinal halohydrins, halo methyl ethers and halo acetates from olefins using 2:1 Br^-/BrO_3^- and I^-/IO_3^- reagents. In many cases both reagents afforded products selectively in high yields. The highest halogen atom efficiencies attained were 97% and 93% for Br^-/BrO_3^- and I/IO_3^-, respectively. Of the two reagents, I^-/IO_3^- was established to be the preferred reagent for vicinal functionalization of linear alkenes and also for halo acetate preparation. However, only Br^-/BrO_3^- was effective for vicinal functionalization of *trans*-stilbene and chalcones.

An efficient one-pot process was devised for synthesis of rose oxide from citronellol in 82% yield via the iodomethyl ether obtained using 2:1 I^-/IO_3^- (*Tetrahedron, 65 (2009) 2791).*



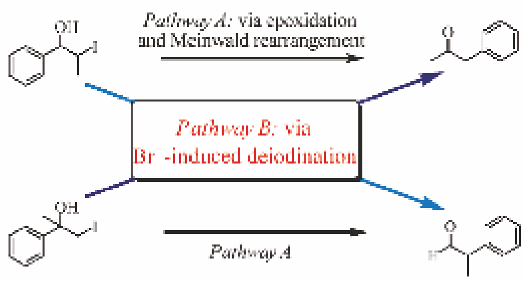
BR-O – A new oxidizing agent derived from "green bromine"

Green bromine having 2:1 molar ratio of Br^-/BrO_3^- was converted into two oxidizing reagents, one having $Br^-:BrO_3^-$ = 1:3.5 and the other 1:8. The former was used for thiol oxidation and the latter for sulfide and alcohol oxidation. The oxidation of thiols to disulfides was achieved in high yields with 6:1 mole ratio of thiol to BrO_3^- while the oxidation of sulfides and benzylic/secondary alcohols to the corresponding sulfoxides and aldehydes/ketones was successfully undertaken with 3:1 mole ratio of substrate to BrO_3^-.



These ratios correspond to the minimum theoretical requirement of BrO_3^-. The reactions were conducted at 0-30 ^oC, depending upon substrate, and were initiated with catalytic amounts of H^+ and Br^-, the latter being already present in the reagents. Regeneration and reuse of the spent reagents was also demonstrated (*Ind. Eng. Chem. Res., 49 (2010) 1236)*.

In a related study, acid activation of BR-O at 0-10 ^oC was found to trigger the deiodination of styrene-based vicinal iodohydrins. Violet coloration of the organic layer was ascribed to formation of IBr. Deiodination was followed by phenyl migration and deprotonation leading to formation of phenyl acetone and 2-phenylpropanal in good yields from 1-iodo-2-phenylpropan-2-ol and 2-iodo-1-phenylpropan-1-ol, respectively. Phenyl acetaldehyde- which was obtained in 92% GC yield from styrene iodohydrin - was also presumably formed in analogous manner. NBS and HOCl too were effective for transformation of styrene iodohydrin into phenyl acetaldehyde *(J. Org. Chem., 74 (2009) 7947)*.



Technical assistance rendered to industrial units / state agencies

Preliminary survey of the site of M/s. Sanghi Industries Ltd., Sanghipuram, Kutch

Sanghi Industries Ltd., Sanghipuram is the world's largest manufacturer of cement, producing about 8000 ton per day. The party has put up an MED unit (Multiple Effect Distillation plant) to produce drinking water and process water. During the operation of this plant about 300 M^3 per hour of saline water having a TDS of 50000 – 55000 ppm is produced. The cement plant and MED unit are located near the Kharo creek where there is a continuous in flow of tide water. The party has been allotted 1104 acres of government waste land for the manufacture of salt near Kharo creek at village Akri, Dist. Kutch, and approached CSMCRI for technical assistance. CSMCRI scientists made a preliminary survey of the area to assess its suitability for solar salt production and a detailed project proposal was submitted to the party.

Technical services for the utilization of RO reject for solar salt production to M/s. Patel Energy Ltd., Mumbai

M/s. Patel Energy Ltd., Mumbai is going to set up 2 coal fired power plants near village Lunsapur in Jafrabad Taluka of Amreli district in Gujarat, each with a capacity of 660 MW/h. The party is also planning to set up RO plants for desalination of sea water. It is expected that during the process of desalination, about 750 M^3/ h of brine concentrate having a density of 5.5 – 6 ^{0}Be' will be obtained. The party desired to explore the possibilities of utilizing this RO reject water for the production of solar salt. Two of our scientists visited the proposed site along with the company officials and a consultancy proposal was submitted to the party.

Analysis of soil samples collected by M/s. HSL, Jaipur from the reservoir area admeasuring 45 acre near Sambhar Lake

It is reported that M/s. Sambhar Salts Ltd., a subsidiary of HSL, Jaipur is planning to construct a reservoir area for storage of brine. They have identified a 45 acre land near Sambhar lake area for this purpose. The company desired to test the soil to assess the percolation rate of brine. It is observed from the soil analysis of 15 samples that the soil falls under the clayey soil category where minimum percolation rates are recorded. Hence the area selected appears suitable for construction of reservoirs.

Reduction of fluoride in soda ash

A breakthrough was achieved in reduction of fluoride content in mined trona in collaboration with Magadi Salt Works, Kenya. Several processes were developed based on phase chemistry and it was possible to remove more than 90% fluoride in finished product (soda-ash).

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 and also outside users on payment basis. It 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 31 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 and modification of existing methods for better results.

The list of instruments under centralized facility available during the period, and the number of samples analyzed per year, 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.

As mentioned above, in addition to routine analytical services, we were also involved in analytical method development and modification of existing methods for better results. Highlights 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 and 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
11	Single Crystal XRD	Bruker Smart Apex CCD
12	Powder XRD	Philips X'pert MPD System
13	Thermal Analysers (TGA, DSC, DMA)	Mettler Toledo
14	Surface Analyser	Micromeritics, ASAP 2010
15	Particle Size Analyser	Malvern Mastersizer 2000
16	Mercury Porosimeter	PASCAL 140
17	Gravimetric Sorption Analyser	MB-300 GHP
18	Scanning Electron Microscope (SEM)	LEO 1430 VP
19	Transmission Electron Microscope (TEM, 200 KV)	JEOL, JEM 2100
20	Tensiometer	Data Physics
21	Rheometer	Anton Paar, Haake,
22	Spectrofluorimeter	Perkin-Elmer, LS-50B
23	Spectrofluorimeter (with life-time attachment)	Horiba Jobin, Fluorolog
24	Spectrophotometers (UV-VIS-NIR)	Varian cary 500, Shimadzu,
25	Circular Dichroism (CD) Polarimeter	Jasco, J-815
26	HPLC (three)	Waters (Allience) and Shimadzu
27	GC	Thermo, Trace-GC Ultra
28	GC-MS (with head space analyzer)	Shimadzu, QP-2010
29	Total Organic Carbon Analyzer (TOC)	Elementar, Liqui TOC
30	Biodiesel Rancimat	Metrohm 873
31	Atomic Force Microscope	NT-MDT, Model Ntegra Aura

Sample analyzed during April, 2008 – March, 2009

Name of the instrument	Total samples analyzed
FT-NMR [500 MHz]	H =3208, C=1001, P=46, Solid:H=3, C=12, Si=4, Al=3, P=16, B=11
FT-IR	2295
FT-Raman	14
CHNS/O Analyser	874
Inductively Coupled Plasma Spectrometer (ICP)	322 (elements 2170)
X-ray Fluorescence Spectrometer (XRF)	65
Atomic Absorption Spectrometer(AAS)	847
Ion Chromatograph (IC)	665
LC-MS	1651
Powder XRD	1675
Single Crystal XRD	159 (154 solved)
Thermal Analyses (TGA, DSC, DMA)	1068
Surface Area Analyser (BET)	673
Particle size Analyser	150
Scanning Electron Microscope (SEM)	1435
Transmission Electron Microscope (TEM)	210
Tensiometer (Goniometer)	51
Luminescence (Perkin Elmer)	206
Spectrofluoremeter (with lifetime measurement)	4967
Spectrophotometers (Varian and Shimadzu)	16,189
CD Polarimeter	598
HPLC (Shimadzu)	975
GC	822
GC-MS	2316
TOC	560

The total value of services on nil subsidy basis is Rs.636 lakhs

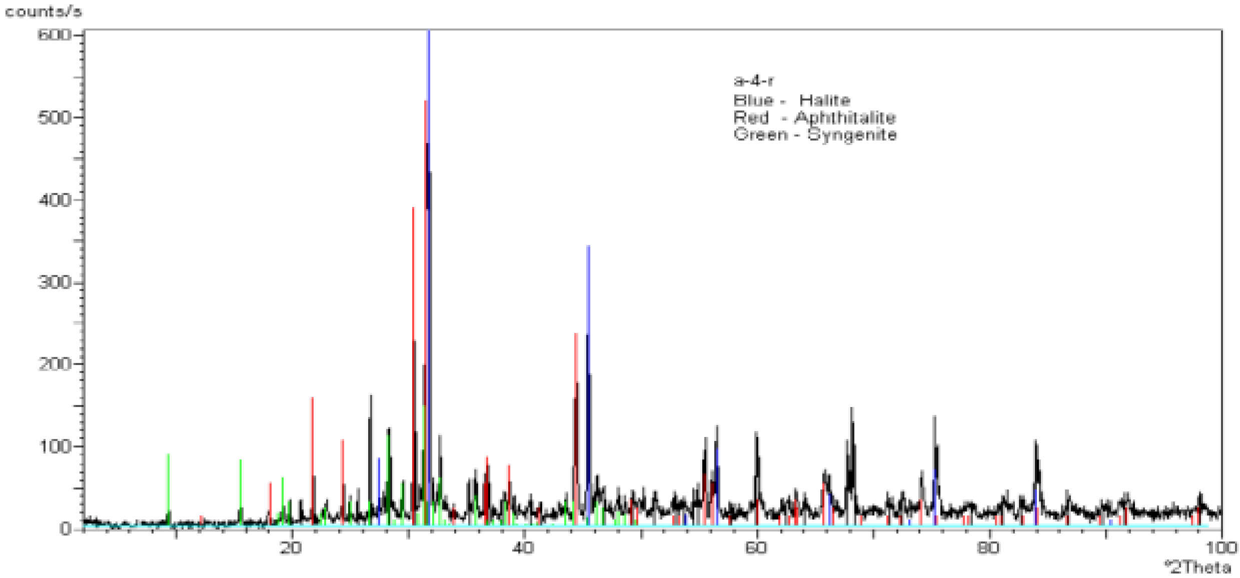
Sample analyzed during April, 2009 – March, 2010

Name of the instrument	Total samples analyzed
FT-NMR [500 MHz]	H =1397, C=508, P=23, B=4; Solid:H=4, C=59, Si=45, B=8
FT-NMR [200 MHz]	H =984, C=521, P=12
FT-IR	2546
FT-Raman	26
CHNS/O Analyser	684
Inductively Coupled Plasma Spectrometer (ICP)	903 (elements 5582)
X-ray Fluorescence Spectrometer (XRF)	262
Atomic Absorption Spectrometer(AAS)	650
Ion Chromatograph (IC)	297
LC-MS	1464
Powder XRD	850
Single Crystal XRD	108(104 solved)
Thermal Analyses (TGA, DSC, DMA)	1039
Surface Area Analyser (BET)	414
Particle size Analyser	195
Scanning Electron Microscope (SEM)	1623
Transmission Electron Microscope (TEM)	404
Tensiometer (Goniometer)	171
Rheometer	19
Spectrofluoremeter (Perkin and Horiba)	1982
Spectrophotometers (Varian and Shimadzu)	5787
CD Polarimeter	296
HPLC (Shimadzu)	1645
GC	363
GC-MS	2612
TOC	413

The total value of services on nil subsidy basis is Rs.580 lakhs

Phase identification of seaweed constituents using powder-XRD

Process research is underway in the institute to extract energy from dry seaweed granules and to explore the possible utility of the ash as manure. It is therefore necessary to understand in depth the composition of the ash. A method was developed for phase identification of the constituents using powder-XRD measurements followed by search match analysis. Approximate ranking of the concentration of constituent phases of each sample was done based on the relative intensity of the major peak of each phase. Intensity of the peak depends on concentration, structure factor and molecular absorption coefficient of the constituent phase. Approximate ranking of the structure factor and molecular absorption coefficient was done based on the values given in literature. Intensity ranking is known experimentally and based on all of the data concentration ranking could be carried out. Experimental data are summarized below.



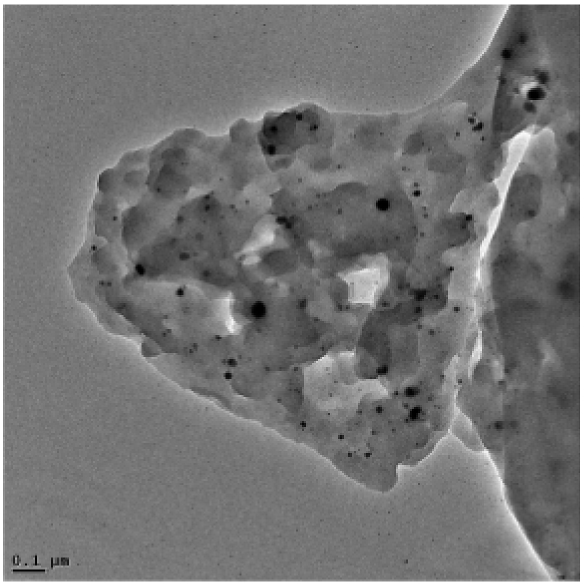
Powder X-ray diffractogram of seaweed ash showing different constituents in different colour code

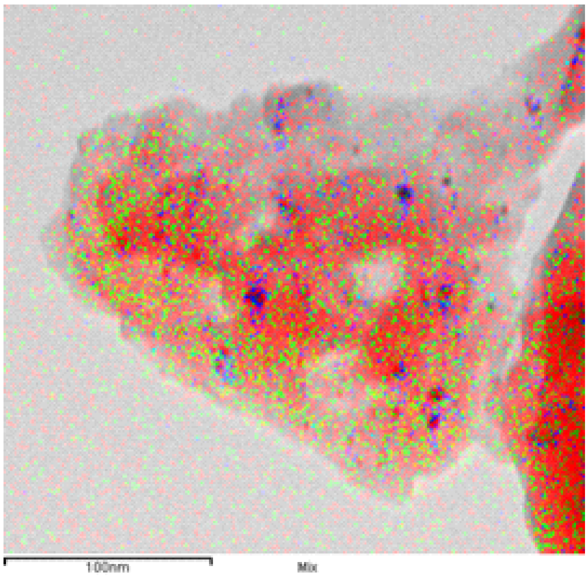
Sample code	Phase -ID	Chemical formula	JC-PDF number	Approximate ranking of phase concentration
A-1	1. Aphthitalite 2. Arcanite syn	$K_3Na(SO_4)_2$ K_2SO_4	20-0928 44-1414	Aphthitalite > Arcanite
A-2	1. Aphthitalite 2. Syngenite 3. Quartz	$K_3Na(SO_4)_2$ $K_2Ca(SO_4)_2H_2O$ SiO_2	20-0928 11-0117 33-1161	Aphthitalite > Quartz > Syngenite
A-3 (KP-A3)	1. KCl 2. Aphthitalite 3. Quartz 4. Syngenite	KCl $K_3Na(SO_4)_2$ SiO_2 $K_2Ca(SO_4)_2H_2O$	04-0587 20-0928 33-1161 11-0117	KCl > Aphthitalite > Quartz > Syngenite
A-4 (A-4-R)	1. Halite 2. Aphthitalite 3. Syngenite syn	NaCl $K_3Na(SO_4)_2$ $K_2Ca(SO_4)_2H_2O$	05-0628 20-0928 11-0117	Halite > Aphthitalite > Syngenite

Transmission electron microscopy (TEM) for material characterization

Silver-impregnated resins

Silver impregnation is gaining importance in view of the bactericidal effect imparted by silver. A sample of poly (vinyl-alcohol) impregnated with nanoparticulate Ag was given for analysis. The black spots seen in TEM and STEM images were suspected to be silver, which was further confirmed using in-situ STEM-EDS mapping.

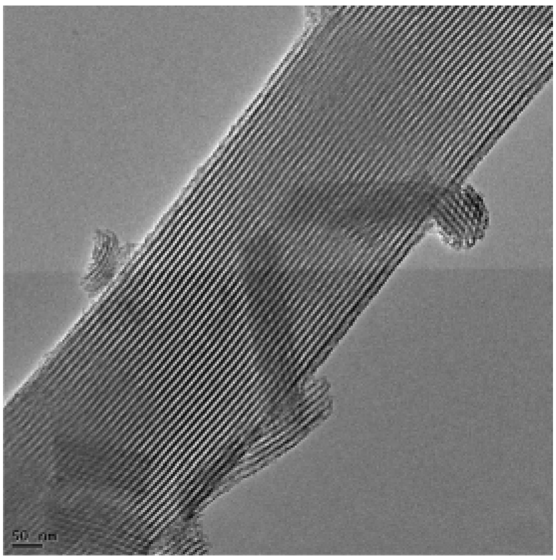




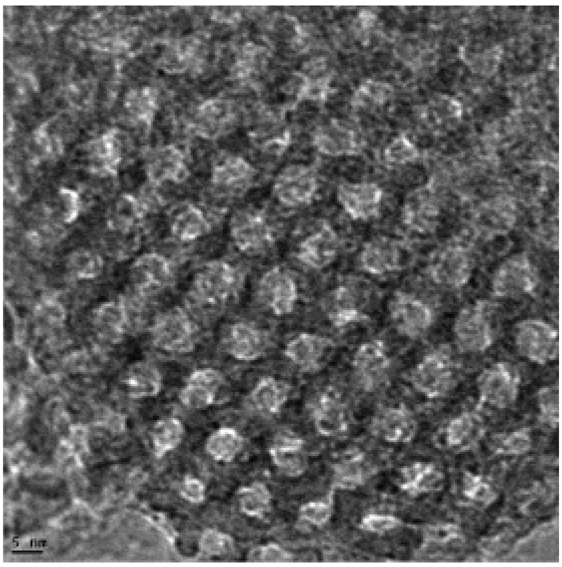
(Left) Normal bright field TEM image and (right) STEM image with elemental mapping (Legend - Red: Carbon, Green: Oxygen, Blue: Silver)

Investigation of mesoporous materials

SBA-15 type mesoporous silica was synthesized from sodium silicate in presence of PEG-20,000 (surfactant).The images below provide glimpses of the channel like structure (left) and of the pore openings (right).

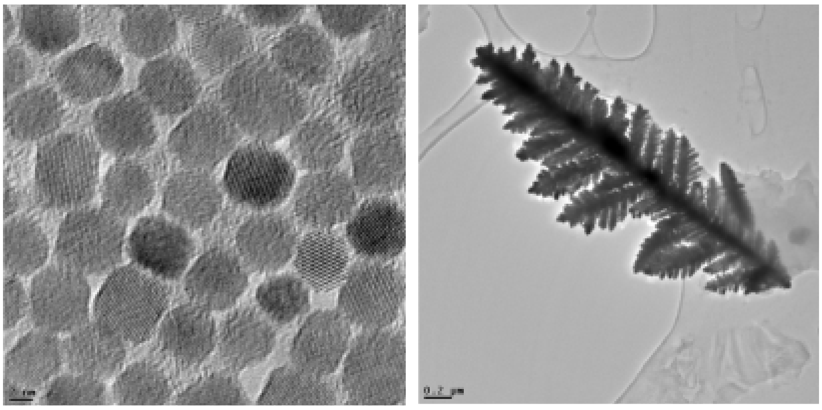


Pore channels



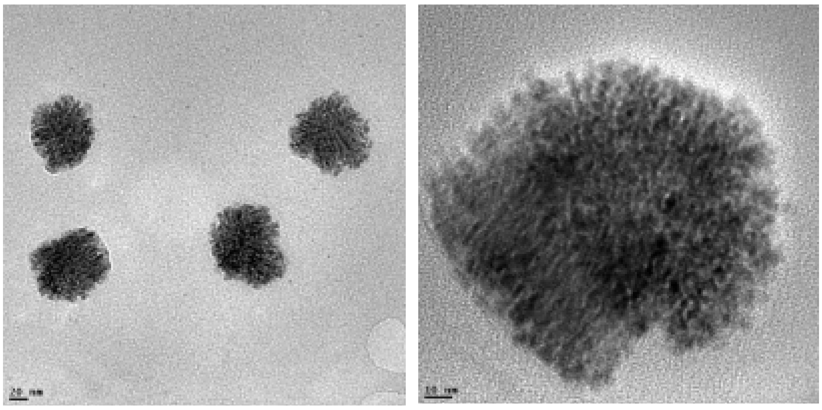
Hexagonal pore opening

Investigation of nano materials



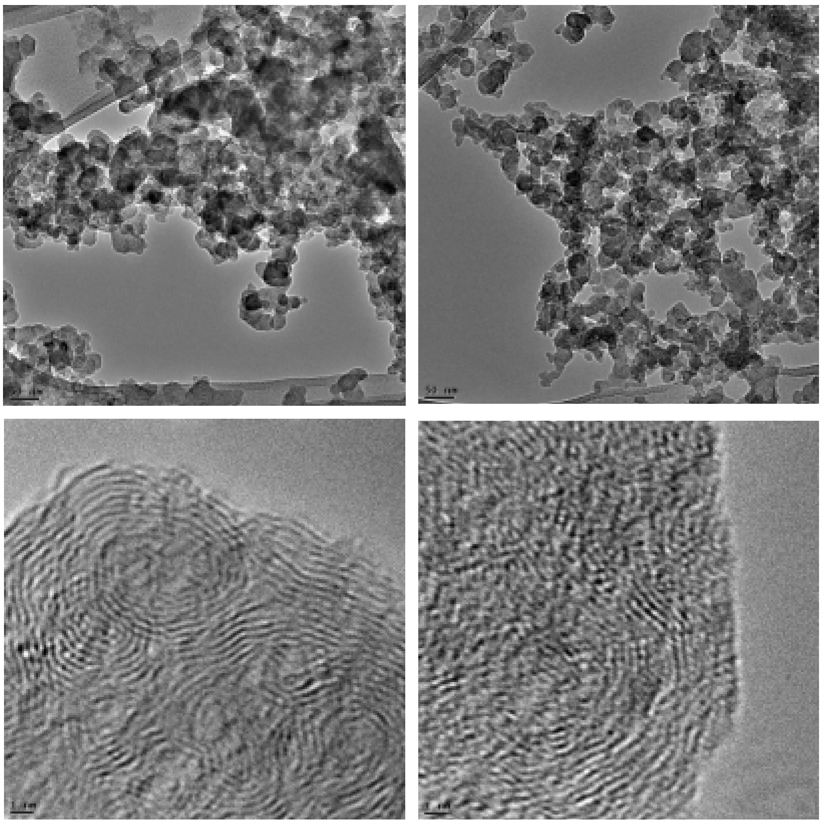
Nanomaterials were also investigated by TEM. The image on the left is of CeO_2 nano cubes synthesized under hydrothermal condition at 180 °C while the image at right is of an Au-Pd core-shell nanoparticle with leaf like morphology

Investigation of vesicles



The images shown are of vesicles formed from a mixture of surfactants (ionic liquids) in aqueous solution. The images were recorded after overnight drying of the sample placed over the TEM grid. The image on the right provides a blown up view.

Comparison of the soot from bio-diesel and fossil-diesel

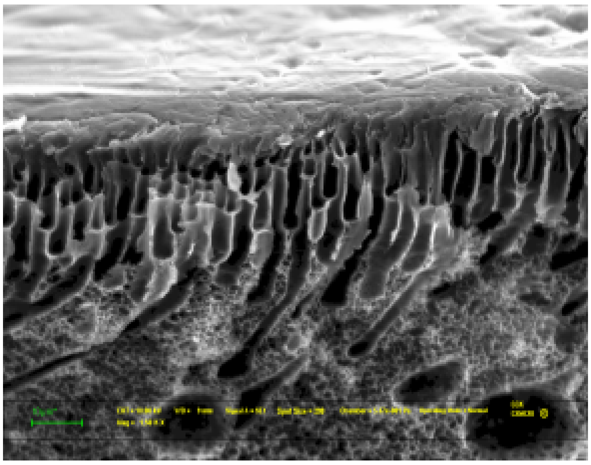


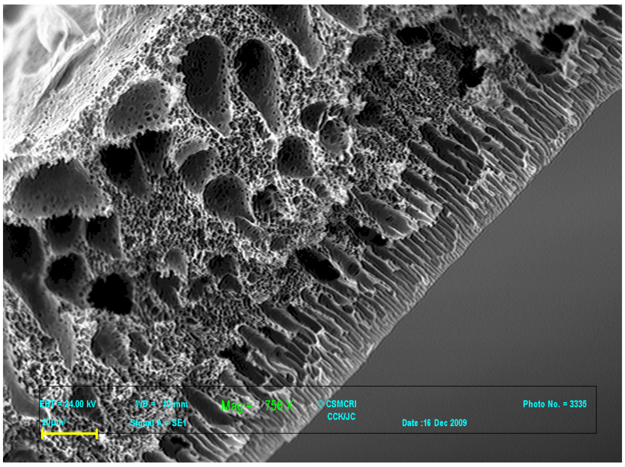
The TEM pictures shown are those of soot particles collected using an accessory fitted to the tail pipe of regular vehicles running on (left) CSMCRI's B100 Jatropha biodiesel and (right) fossil diesel. At low magnification (25 K; top) the particles were seen to form open ring like structures while at high magnification (1 MK; bottom) the particles were seen to possess onion like microstructure with interlayer spacing similar to that found in graphene.

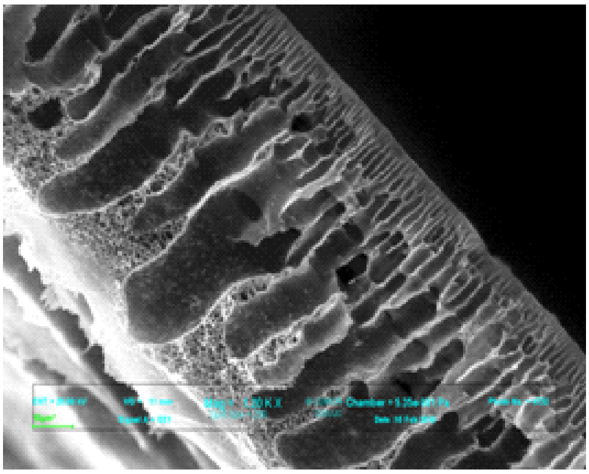
Scanning electron microscopy (SEM) for material characterization

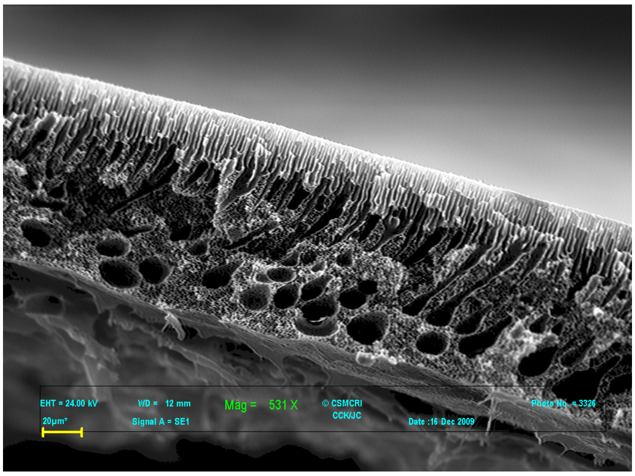
Cross-sectional investigation of polysulfone membrane

CSMCRI has developed and scaled up both flat sheet and hollow fibre membranes for specialty applications such as water disinfection. The knowhow was licensed in 2010. It is necessary to understand the pore structure and pore dimensions arising from subtle modifications in the membrane preparation method. Such understanding was provided through SEM studies of the membranes. Sectioning was done using a sharp knife. A vertical groove was made over the aluminium stub to hold the sample vertically. The samples were coated with gold using sputter coater and imaged. Selected images are given below

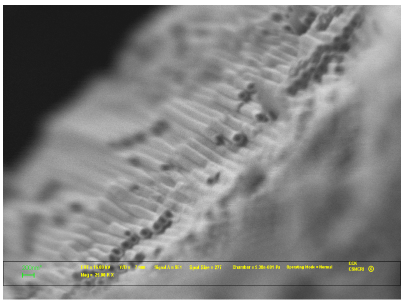


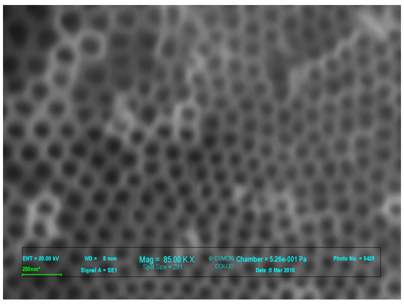






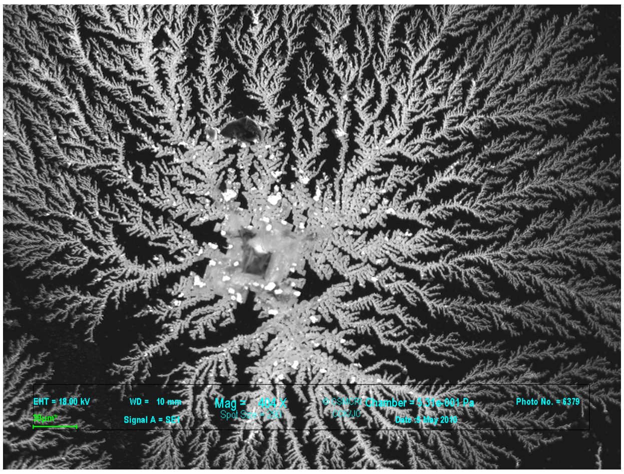
Investigation of titanium dioxide nanotube





A titanium dioxide nanotube structure was developed over titanium metal using an electrochemical method. The lateral view (left) shows the tube like structures while the top view (right) shows the opening of the tubes.

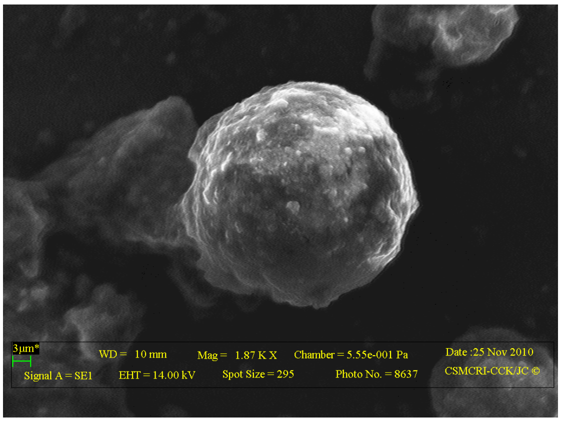
Electrodeposited polyaniline



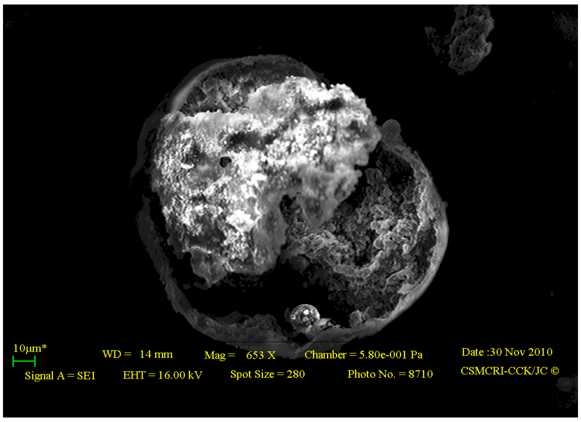
Polyaniline has been widely studied in view of its conducting properties and ease of electrochemical preparation. The fractal like structure obtained over graphite surface by electrochemical synthesis is readily discernible from the accompanying image.

Imaging of polymer film without conductive coating under cryo condition

Two images are shown below taken in conventional and cryo condition (-10 ^{o}C). The internal structures are better revealed in the micrograph of cryo-fractured sample imaged under cryo conditions.



Normal imaging

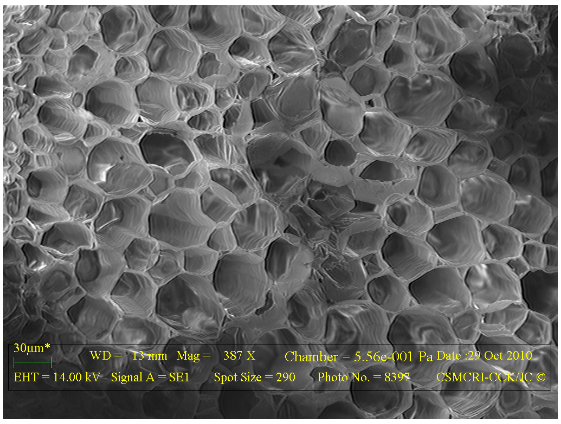


Imaging under cryo condition

Investigation of groundnut plant and seeds (external samples)

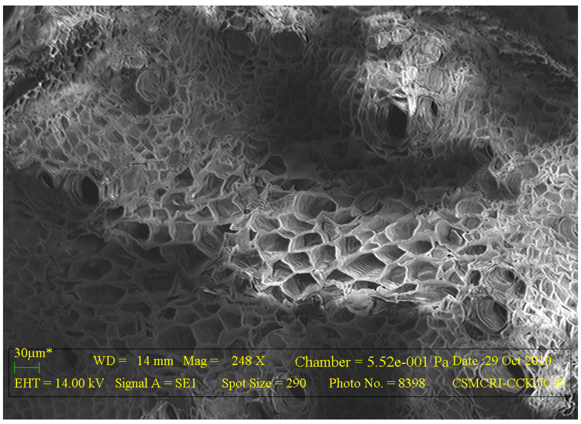
SEM images of the groundnut plants of normal and infected samples were investigated and a few images are shown below. The infected plant parts exhibited clear differences.

CS-19 Infected



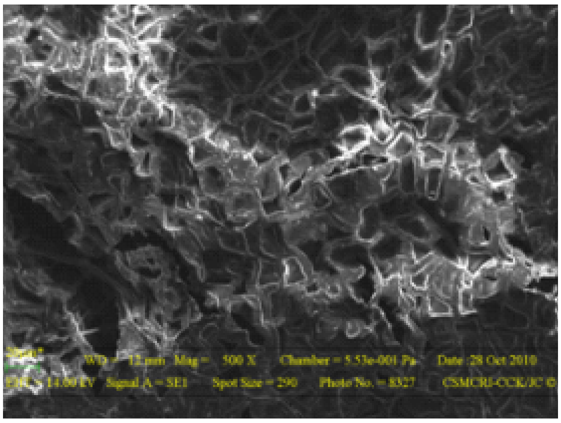
Root surface

GG-20 Infected



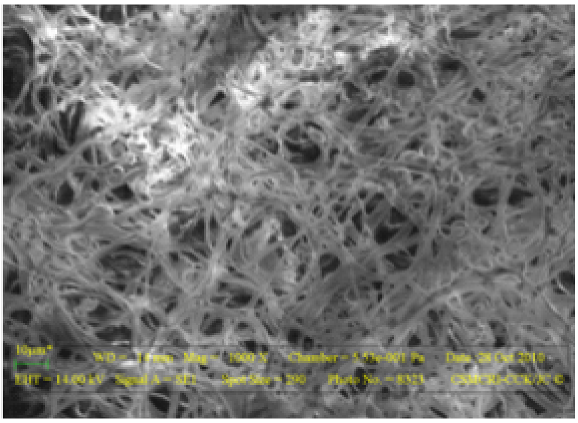
Root surface

GG-20 Control

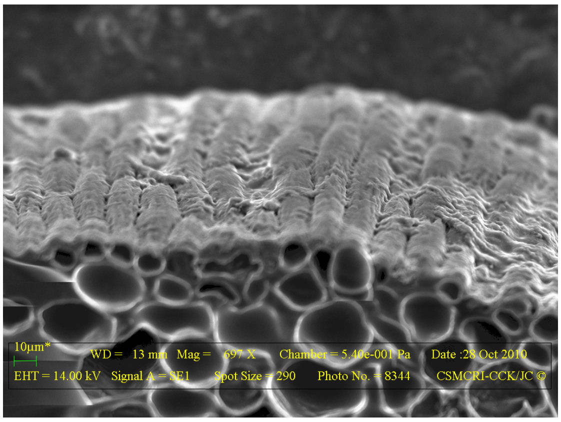


Seed

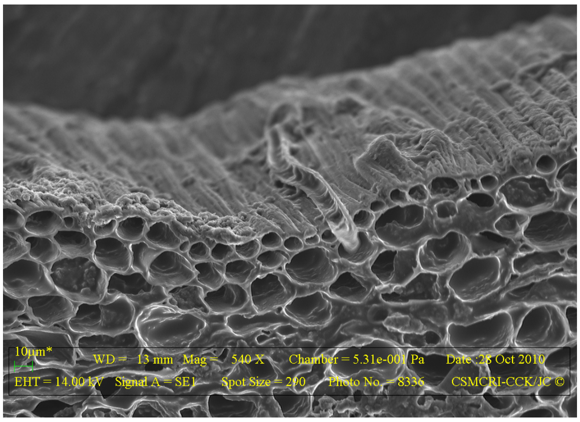
GG-20 Infected



Seed

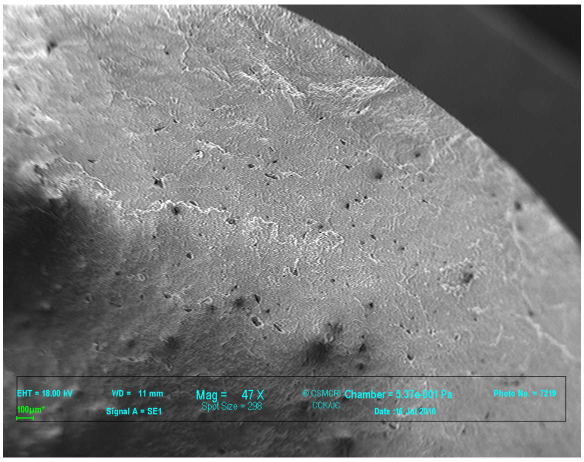


Stem surface



Stem surface

Investigation of fractures in clean-write chalk: Analytical investigation using electron beams



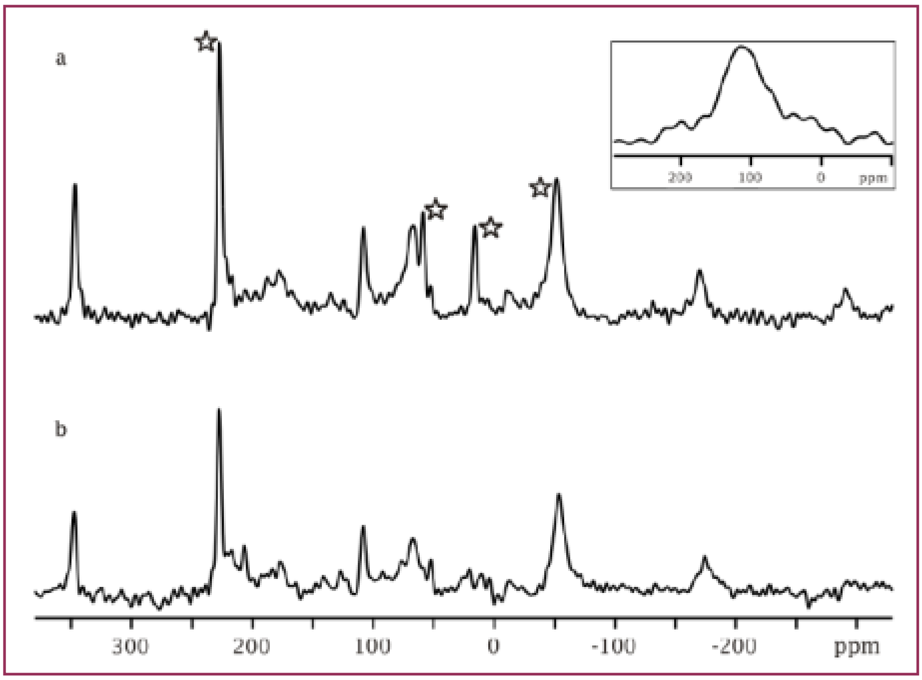
Clean Write chalk developed by the institute was examined through scanning electron microscope to understand the distribution of fractures. Length of a fracture in a brittle material is known to reduce the safe range of stress. Higher density of fractures was observed closer to the centre than nearer the periphery, suggesting formation of fractures during the process of drying. Comparison of elemental composition (by EDAX) of few randomly selected fractures and of the plane surfaces indicated similar compositions. Hence compositional variations are not the likely cause of the fractures.

Atomic force microscope (AFM) for surface characterization

AFM is very useful to understand the surface texture of films and coatings at high resolution. Studies were carried out on the textures of the polysulphone support layer and the polyamide salt rejecting layer in RO membranes produced at the institute. These studies are helpful in identifying future directions of research to improve upon the surface texture.

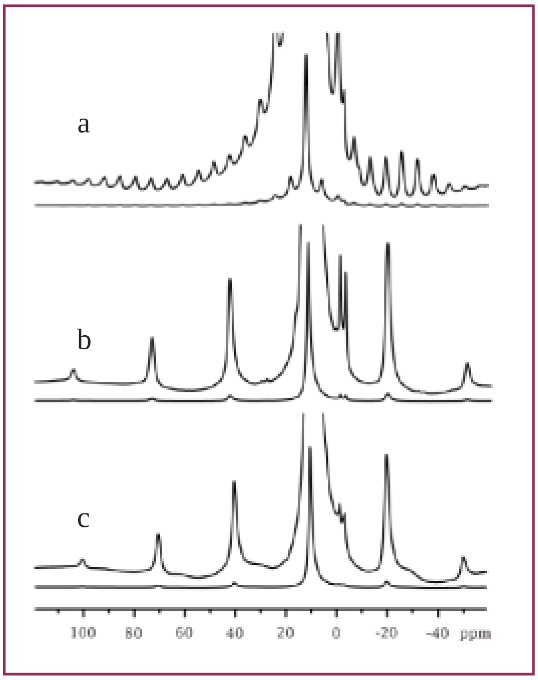
Investigating gas-storage material with solid-state NMR

Gas storage capacity of a metal-organic framework (Cu-BTc) is significantly enhanced upon incorporation of activated carbon during the synthesis. Solid-state NMR investigation was undertaken to understand the state of activated carbon. The porous nature of the material and the presence of paramagnetic Cu^{2+} necessitated modification of the spectrum acquisition protocol. High resolution ^{13}C spectra were obtained by applying an echo and accumulating large number of scans with a short relaxation delay. ^{13}C NMR spectra (shown below), show that two resonances (out of four in Cu-BTc) are broadened in carbon-incorporated Cu-BTc, suggesting interaction with constituents of carbon.



^{13}C solid-state NMR spectra of the (a) Cu-BTc and (b) carbon incorporated Cu-BTc. Inset shows the spectrum of activated carbon

Solid-state ^{1}H NMR spectrum (peaks marked with star are isotropic and others are spinning side bands) of bare Cu-BTc suggests fractional incorporation of water molecules in the cavity as well as attachment to Cu cation. The intensities of both resonances were reduced significantly upon incorporation of carbon suggesting that some of the water molecules were displaced. This was confirmed through TGA measurements. High resolution at MAS frequency of 3kHz suggests that the distance between ^{1}H nuclei are large in the system as a consequence of porous nature of the preparation. solid-state ^{1}H NMR is thus shown to be a useful tool for the characterization of porous materials.



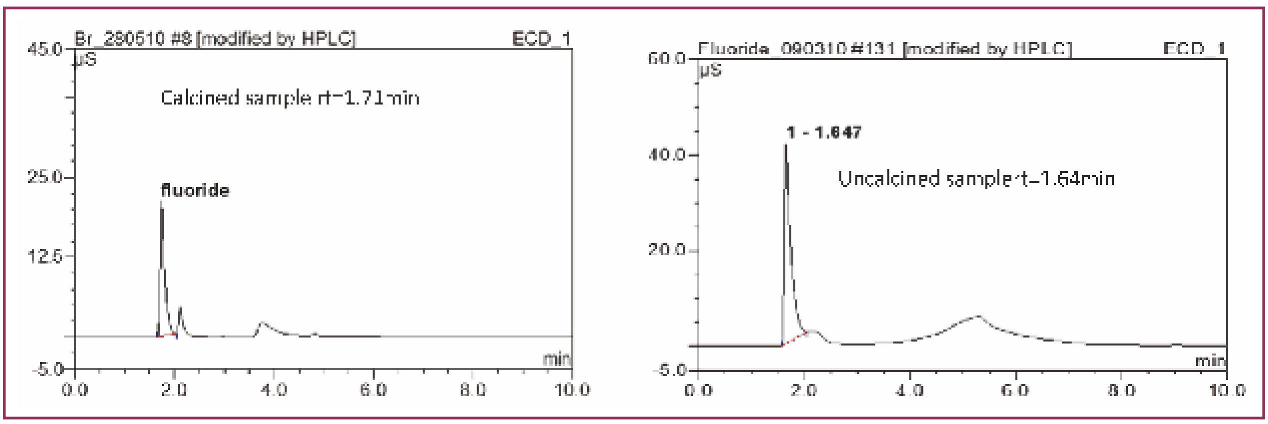
Solid-state [1]H NMR spectra of Cu-BTC at
(a) 3 kHz MAS
(b) 15 kHz MAS
(c) carbon incorporated Cu-BTC at 15 kHz MAS

The diffusion study of ED membrane by MRI

The diffusion of ions through charged electrodialysis (ED) membranes is expected to depend on the membrane ion exchange capacity A study has been initiated to understand the diffusion of protons and other cations across the cationic Nafion membrane. Once the method is validated, the studies will be extended to CSMCRI's anionic and cationic inter-polymer membranes.

Determination of fluoride in industrial product (fluoride removal process) by ion chromatography

Method has been developed for quantitative estimation of fluoride in solid waste generated in the course of fluoride removal from high fluoride-containing RO reject water, the knowhow for which was licensed to Tata Projects. There was a problem in getting a well defined retention time of of fluoride in the sample. We prepared standard of fluoride with different possible matrix constituents (sodium carbonate, sodium bicarbonate and sodium chloride) and the chromatogram showed no interference from these entities. We then calcined the sample for one day at 500 °C and found the expected retention time for fluoride (1.71 min) and analyzed the samples. Chromatograms of calcined (left) and uncalcined (right) samples are shown below.



Elemental analysis by X-ray fluorescence (XRF) spectrometer

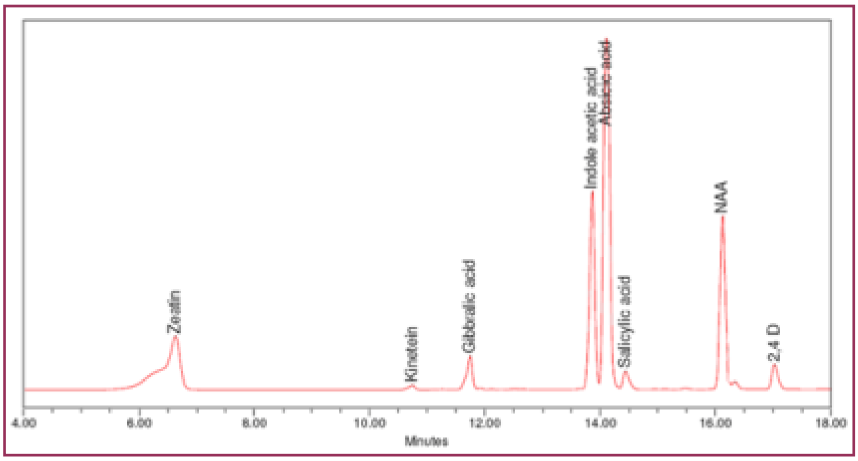
For the elemental analysis of samples in solid form, XRF is an appropriate and versatile analytical technique, yielding both qualitative and quantitative data with high precision and accuracy. Various types of samples were analyzed such as bauxite, sediments, clays, seaweeds, and soil taken from different locations. Reproducible & reliable results from percentage to ppm level were obtained. Toxic heavy metals at trace level in soil could also be determined successfully. Recently, elemental analysis (Na, Al, Ca, F etc.) of fluoride removal resin at various stages of preparation and use have been analyzed for better understanding.

Inductively coupled plasma (ICP) spectrophotometer for elemental analysis

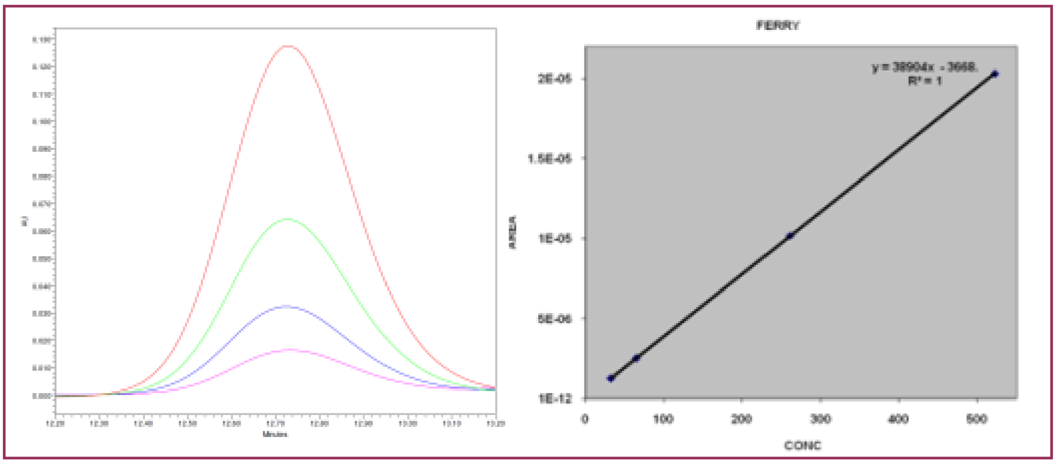
Inductively coupled plasma (ICP) spectrophotometry is a technique for quantitative determination of metal ions as well as sulphur, phosphorus, silicon, arsenic present in solution in trace amounts (ppm, ppb). This instrument has been extensively used for the elemental analysis of a wide variety of samples obtained from different sources, particularly from the Environmental Group. It has been used for (i) monitoring of heavy/toxic metal ions in effluent, (ii) determination of metal ions/leaching of metal ion during reaction, (iii) determination of exchange of metal ions in zeolites, (iv) metallic impurities in certain samples e.g. pharmaceuticals, (v) to study the effect of metal ions on biological functions, (vi) soil analysis after extraction, (vii) presence/absence of micronutrients in biological samples and (viii) to monitor quality of water. For analysis of all these samples, various techniques for sample preparation have been applied and in many cases new methodologies had to be devised.

Method for separation of plant growth regulator using RP-HPLC

A method was developed for different plant growth regulators (PGR) using RP-HPLC system. Luna C18 column having 150 mm length, 4.6 mm diameter and 5 µM particle size was used as a stationary phase. Acetonitrile-water was used as a mobile phase. Spectra were monitored at 265 nm wavelengths for all components (except gibberillic acid which was monitored at 208 nm).

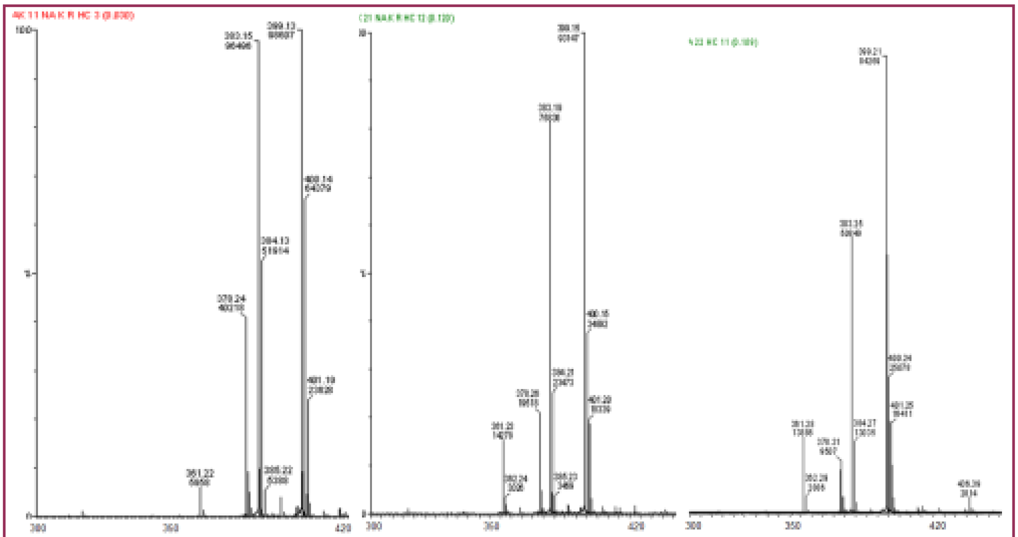


Method was developed for the estimation of Feraccylum in gel formation for a private company. Feraccylum is a polymer based on polyacrylic acid, which contain Fe^{3+}. Feraccylum has antibacterial property with gelling nature. Feraccylum (in gel formulation) was estimated using HPLC-GPC system.



Measurement of stability constant using electrospray ionization-mass spectrometry (ESI-MS)

Determination of stability constant of a macrocyclic ionophore with K^+ and Na^+ was done using ESI-MS. In this work, measurement of complexation efficiency and concentration ratio of the two metal complexes was obtained by generating ESI-MS spectra with the help of internal standards. The data was used for calculation of stability constant using the equation reported in literature. The same method was extended for determination of stability constant for other macrocyclic ionophore with K^+. The figure below shows the mass spectra of the metal complex with different metal concentration ratio.



Mass spectra comparison at metal ion concentrations of various molar ratios

Moisture analysis of different products

Moisture analyses for different types of samples such as hydrotalcite, biodiesel, ionic liquids etc. were carried out using Karl-Fischer titration. For some of these analyses, modifications of the existing methods were necessary.

Analysis of nitrate-nitrite and phosphate in aqueous media

Nitrate-nitrite and phosphate analyses were carried out with the help of a flow injection analyser (FIA, Model 5000, Foss Tecator). It was possible to obtain both total NO_2^- - NO_3^- and NO_2^- analysis alone in sea water keeping the calibration conditions equivalent to salinity of sea water. Analysis of total phosphorus and ortho-phosphate in aqueous media was also carried out using the same instrument, albeit with the modification of the existing method. Large number of samples have been analysed using this modified method.

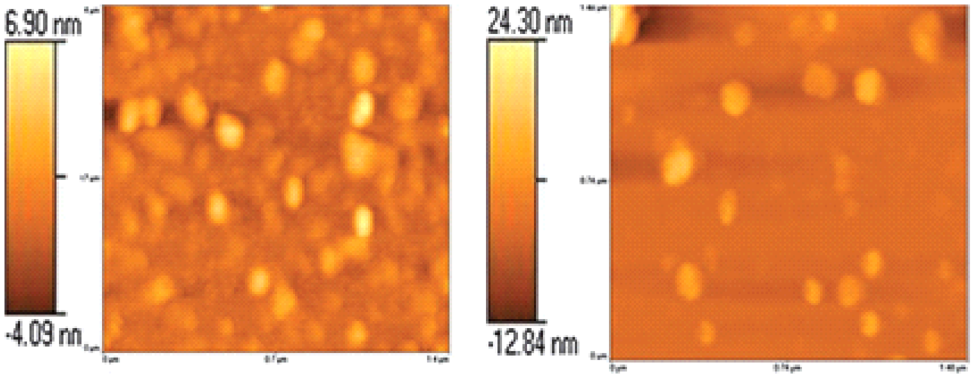
INORGANIC MATERIALS AND CATALYSIS

Catalysis and adsorption are hand-in-hand central themes of a chemical industry. CSMCRI has been pursuing research in these areas for more than a decade. We have made exciting contributions in improving our fundamental understanding of these processes and made inroads in collaborating with industry in developing materials/processes with focus on specific objectives. The discipline has strength in the understanding of materials like clays, zeolites, layered materials, mesoporous materials, metal complexes, metal oxides, metal nano particles and carbons and explored them for diverse catalytic (homogeneous, heterogeneous, heterogeneously modified homogeneous, photo and supported) and adsorption applications. In catalysis, hydroformylation, asymmetric transformations, selective oxidation, isomerisation, condensation and degradation reactions were carried out in view of their potential application in pharmaceutical, fine chemical, agrochemical and perfumery industries. In the area of adsorption, oxygen-nitrogen separation, CO enrichment of a tail gas, CO_2 recovery from flue gas, hydrogen storage, selective recovery of methane are some of our on-going research ventures. Further, material synthesis capability of this institute dovetails with the contributions made in these important areas. Needless to say, such exciting contributions were covered extensively in international journals of high impact and protected through IP rights. With this brief background, we are excited in presenting here work that we carried out during 2008-10.

MATERIALS

Synthesis of delaminated LDH: A facile two step approach

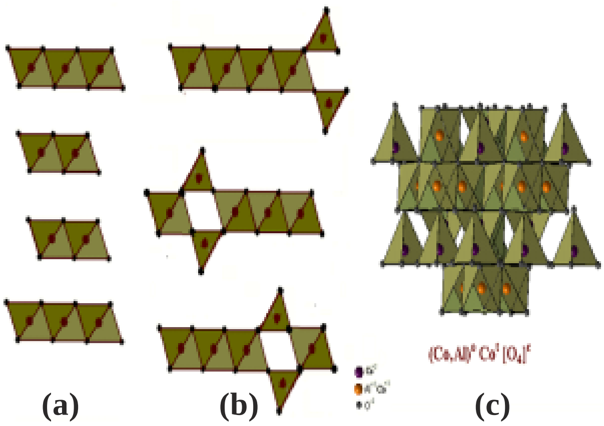
Layered double hydroxides (LDHs) are ionic lamellar compounds that consist of positively charged hydroxide sheets and interlayers filled with anions. They are expressed by the general formula $[M^{2+}_{(1-x)}M^{3+}_{x}(OH)_2]A^{n-}_{x/n}.mH_2O$, wherein M^{2+} and M^{3+} are any divalent and trivalent metal ions capable of occupying the octahedral vacancies of brucite-like sheets and A^{n-} is any hydrated anion. Recent applications in functional nanocomposites or nanostructures demand delamination of LDHs into nano sheets of thickness around 1–5 nm as they possess novel physical and chemical properties. In comparison with other inorganic anions, nitrate-containing LDHs have a greater degree of exfoliation; however, the one-step synthesis of such nitrates in interlayer always leads to carbonate impurities. We have recently synthesized nitrate-containing NiAl or CoAl-LDHs without any carbonate impurity in a novel one step scalable method using a well-known hexamethylenetetramine (HMT) hydrolysis wherein the temperature of hydrolysis is critical. These LDHs were delaminated successfully in water under optimized conditions and they showed total delamination in formamide. AFM results show a similar extent of exfoliation with similar particle shape/dimension irrespective of the medium; on the contrary, restacking behaviour showed a strong dependence on the medium. Phosphate uptake studies showed that these materials have higher ion exchange capacity than reported for uncalcined LDHs. *(Chem. Commun., 46 (2010) 1902).*



AFM images of CoAl–NO_3 LDH
delaminated in (a) formamide and (b) water

Thermal decomposition of CoAl–LDH: Identification of precursor to oxide with spinel structure

Understanding of thermal decomposition pathway of $3R_1$ polytype of Co-Al-CO_3^{2-} LDH was unraveled using combined physicochemical techniques comprising of variable temperature X-ray diffraction, UV-vis and SEM along with theoretical DIFFaX simulations. The LDH phase decomposes to yield spinel structure below 250 °C. The decomposition reaction is preceded by the formation of an intermediate hydroxide in which the metal hydroxide layers are regularly stacked about the *c*-crystallographic axis, but the layers themselves are aperiodic. Aperiodicity is modeled by locating randomly chosen Co^{2+} ions in tetrahedral sites in the interlayer region. The nucleation of aperiodicity in the layer is facilitated by the small difference between the octahedral and tetrahedral ligand field stabilization energies of Co^{2+} ions, leading to Co^{2+} migration without significant loss of energy. This phase is characterized by a single

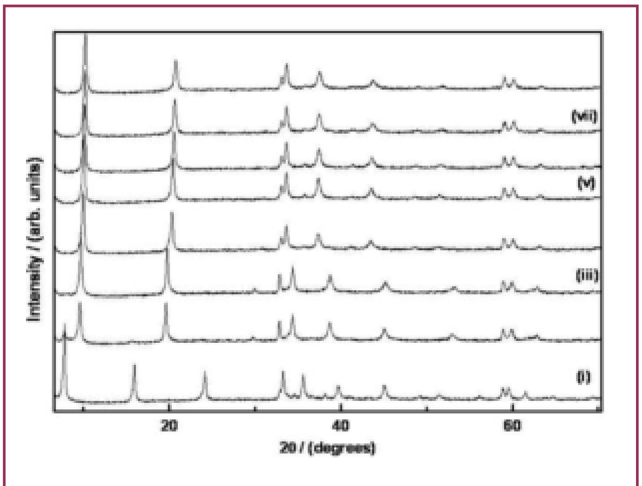


Schematic representation of the structural transformation taking place during the calcination of the Co-Al-CO_3^{2-} LDH, (a) $3R_1$ polytype, (b) 'inverse house of cards' hydroxide phase and (c) spinel (Interlayer atoms in (a) and (b) are removed for the purpose of clarity)

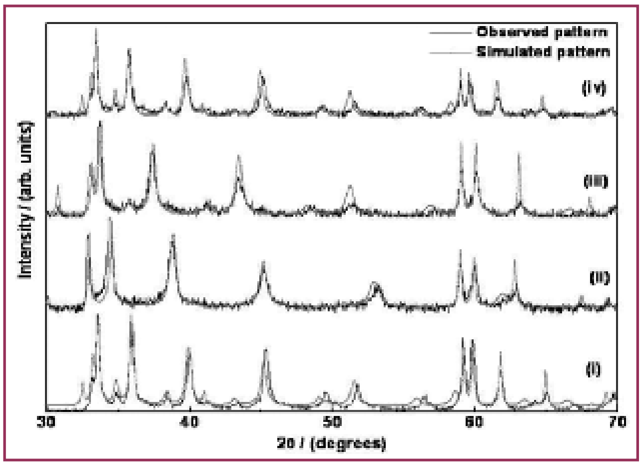
strong basal reflection in its powder diffraction pattern. All other reflections are extinguished on account of (1) turbostratic disorder which destroys all *hkl* reflections and (2) layer aperiodicity, which destroys all two dimensional *hk* reflections. We refer to the structure of this intermediate phase as the 'inverse house of cards' structure. Given its topochemical relationship with the spinel structure, such an intermediate is a necessary precursor to spinel formation *(Bull. Mater. Sci., 33 (2010) 319).*

Metal hydroxide layer as 'structural synthon' in LDH

Among the LDHs, the stacking pattern of the metal hydroxide layers is mediated by the anions. In the case of the sulfate ion, it intercalates with one of its C_3 axes (also the S–O bond) aligned parallel to the crystallographic c axis of the LDH. The sulfate ions form strong hydrogen bonds with water molecules and depending on the temperature and pH of solids) and the interconversion of polytypes of rhombohedral and hexagonal symmetries takes place by rigid translations of successive layers by (± 1/3, ± 2/3) relative to one another in the *ab* plane. These translations are selected among the many possible, as they preserve the coincidence of the symmetry elements of the individual layers and thereby conserve the



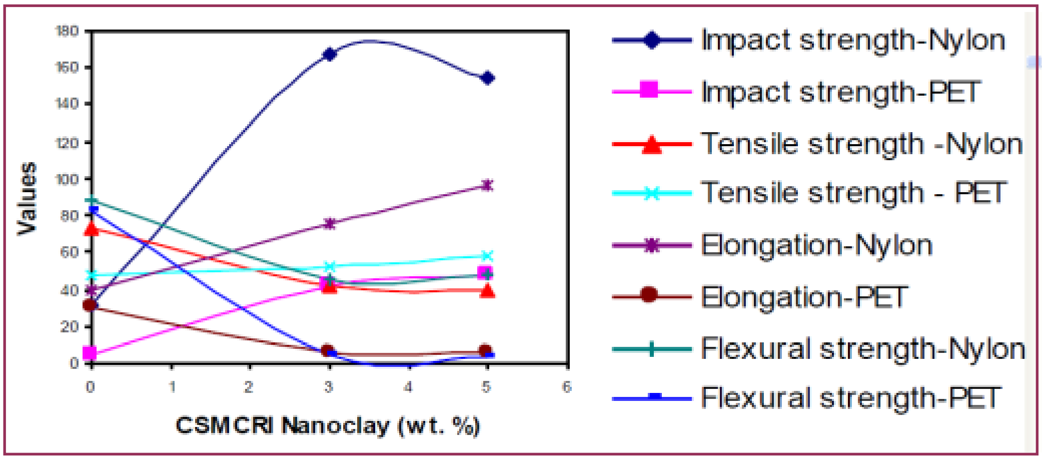
Variable temperature PXRD data of [Zn–Cr–SO_4] LDH at different temperatures (°C): (i) 30, (ii) 40, (iii) 50, (iv) 60, (v) 70, (vi) 80, (vii) 90 and (viii) 100



Variable temperature PXRD patterns of [Zn–Cr–SO_4] LDH at different temperatures (°C) overlaid with their DIFFaX simulations: (i) 30 (3R1), (ii) 40 (1H), (iii) 60 (3R1) and (iv) similar data for the sample heated to 100 °C, cooled and rehydrated for 10 h under wet N_2 gas. Basal reflections are removed for clarity

precipitation grow their hydration sphere to different extents. Several phenomena can occur during the dehydration of the interlayer region resulting in polytype transformation. Such transformation is monitored through variable temperature powder X-ray diffraction and complemented with DIFFaX simulation studies. The metal hydroxide layer behaves as a “structural synthon” (a certain packing motif of atoms that occurs repeatedly in diverse families threefold symmetry of the crystal across the interpolytype conversions. These translations are facilitated at near ambient temperatures (30–60 °C) by the reversible dehydration of the LDH, which involves the deinsertion/insertion of water molecules within the restricted space of the interlayer region. The structural synthon approach adopted here can be used widely to predict the crystal symmetries of a wide range of solids *(Z. Anorg. Allg. Chem., 636 (2010) 2658).*

Nanoclays for polymer composites

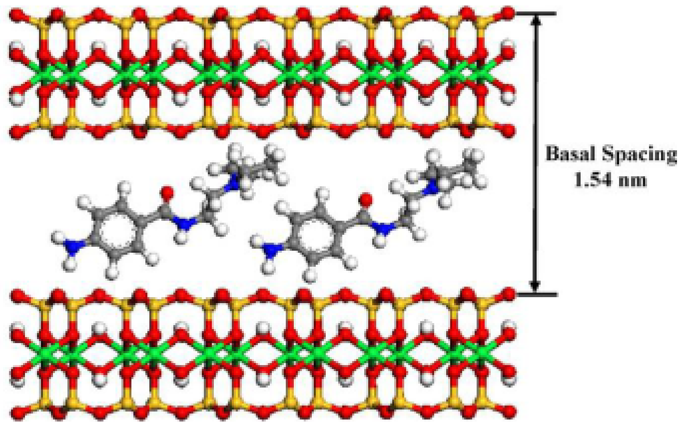


Properties of polymer composite as a function of CSMCRI nanoclay content

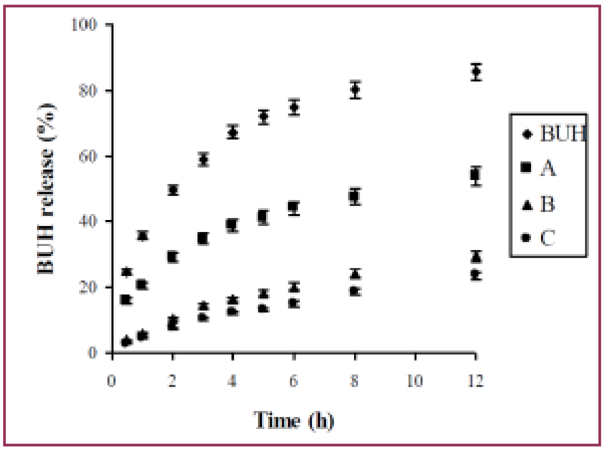
To build data and knowledge base on polymer -clay nanocomposites using bentonite clay of Indian origin, a study was conducted to evaluate nanoclays developed at CSMCRI. In this study, nylon, polycarbonate (PC) and PET , were compounded with 3 and 5 wt. % of three different nanoclays , with and without compatibilizers. It is observed that all compounded samples are opaque, and having yellowish color with Nylon, brownish with PC and pinkish with PET. CSMCRI nanoclay is suitable for use with Nylon and the percent elongation increased significantly upon addition of suitable compatibilizers. It has also indicated that higher nanoclay content required for obtaining higher percentage of elongation. Our nanoclay is also suitable for PET and good impact strength was imparted at 3% level of the filler. However, the CSMCRI nanoclay was not suitable for PC *(Ind. Eng. Chem. Res., 49 (2010) 1677).*

Montmorillonite as drug delivery carrier

Controlled drug delivery technology is one of the most rapidly advancing areas of biomedical materials science, in which chemists and chemical engineers are contributing equally to human health care. By designing controlled delivery systems, the desired concentration of drug can be maintained without reaching a higher toxic level or dropping below the minimum

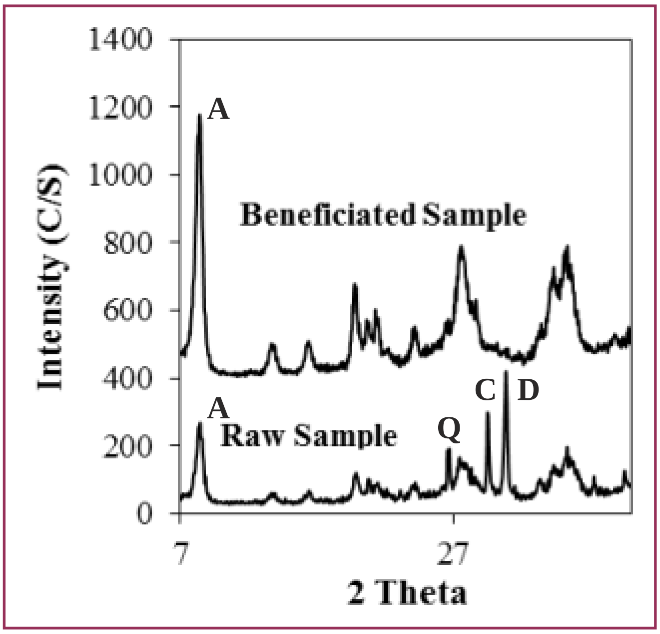


Possible structural arrangement of PA into interlayer gallery of MMT

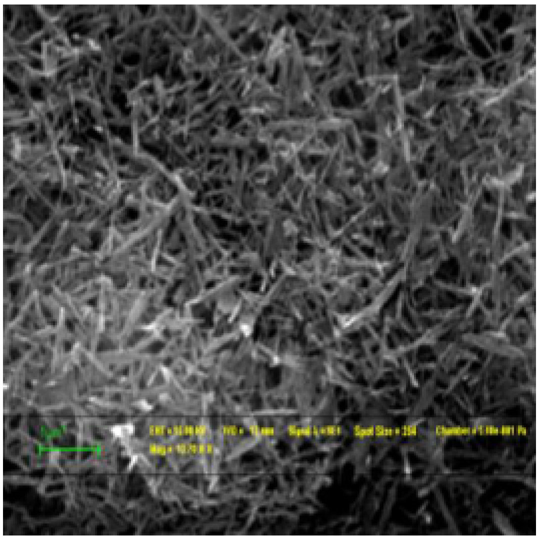


Release profiles of BUH from pure BUH, (A) MMT–BUH composite, (B) MMT–BUH/Eudragit® L 100 55 (1:0.5), and (C) MMT–BUH/Eudragit® L 100 55 (1:1) in buffer pH 6.8 at 37 ± 0.5 °C effective level. Purified bentonite clay, containing mainly montmorillonite (MMT), was exploited as drug delivery carrier. In particular, the intercalation of several cationic drug molecules, e.g., timolol maleate (TM, a β–adrenergic blocking agent), ranitidine hydrochloride (RT, antacid), buspirone hydrochloride (BUH, antianxiety agent), and procainamide hydrochloride (PA, an antiarrythmia drug), were studied systematically. Further, the intercalated drugs were incorporated in synthetic or natural biodegradable polymers (Eudragit® E 100 (cationic); Eudragit® L 100 55 (anionic); alginate (anionic)). *In vitro* drug release behaviours were performed using buffer solutions of pH 1.2, 6.8, and 7.4 at 37 ± 0.5 °C. It was found that, depending on the requirements, one can tailor the MMT–drug/biopolymer composites. One limitation, however, is that MMT does not release all of the intercalated drug *(Appl. Clay Sci., 45 (2009) 248; Int. J. Pharm., 374 (2009) 53; J. Biomaterials Applications, 25 (2010) 161).*

Beneficiation of attapulgite clay of Bhavnagar district



Powder XRD Patterns of raw and beneficiated attapulgite samples A= Attapulgite; C = Calcite; D = Dolomite; Q = Quartz



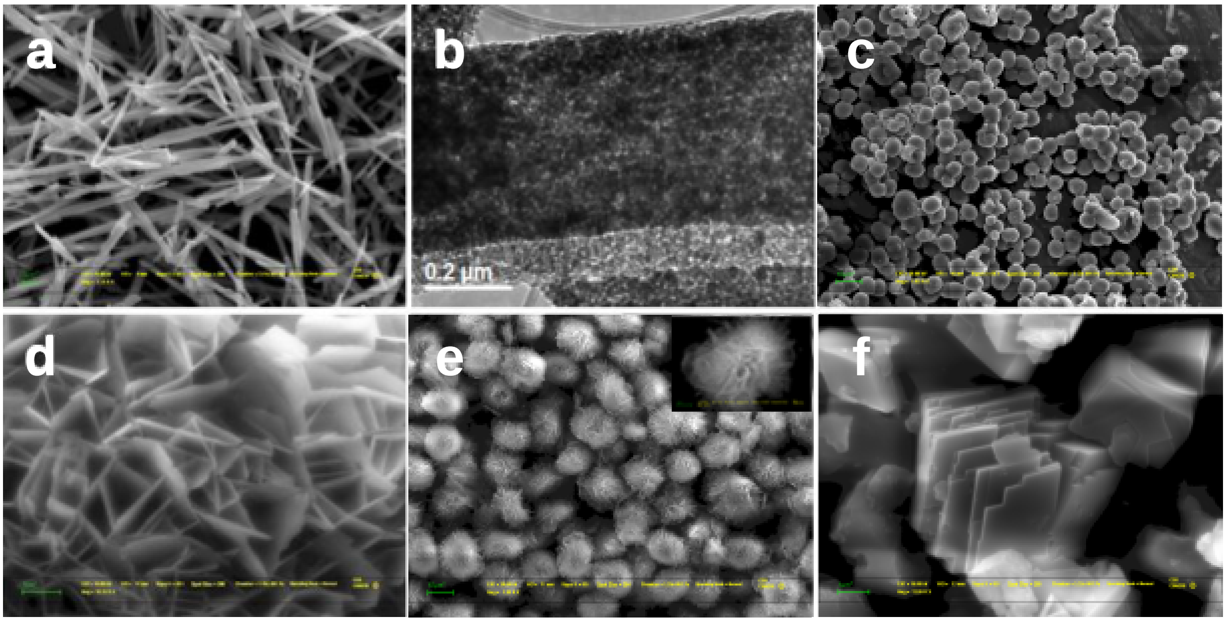
Scanning electron micrograph of beneficiated sample

Attapulgite (also known as Palygorskite) has a fibrous morphology, with cation exchange capacity (cec) of 10-40 meq/100 g. These minerals possess (3.7 x 6.4 Å) channels running parallel to 'x' direction. The mineral offers excellent adsorptive properties and high viscosity under saline conditions and finds application in drilling mud for off-shore oil well drilling. Further, it is useful in anti-diarrheal formulation. The protocol for the beneficiation of this mineral was optimized at 1 kg batch scale, keeping in mind the anti-diarrheal (specifications were in conformity with USP-29 and BP-2004) and oil well drilling mud (viscosity data comparable with that found with DC150 from BASF) applications.

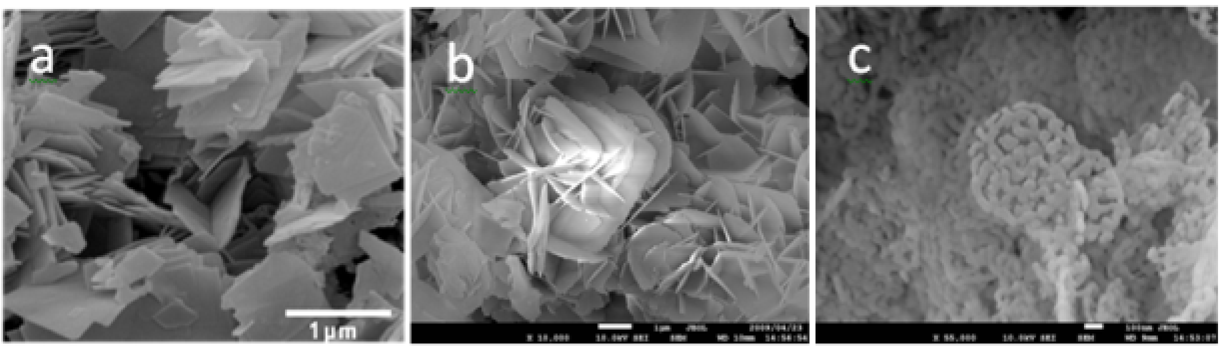
Synthesis and applications of MgO nanostructures

MgO is an important metal oxide with diverse applications. Recently self-assembly of nano-building blocks to one-, two- and three-dimensional ordered hierarchical structures of MgO have attracted much attention. A simple precipitation method was developed for the preparation of Nesquehonite (NSQ) [$Mg(HCO_3)OH.2H_2O$] micro-rods exhibiting excellent catalytic activity in base catalyzed reactions. For example, it was highly effective in the solvent-free Claisen-Schmidt condensation of benzaldehyde with acetophenone, giving >99 % conversion in 2 h. The method of preparation of different hydromagnesite [$4MgCO_3.Mg(OH)_2.4H_2O$] microstructures through hydrothermal treatment of Nesquehonite rods was also developed. On calcination, these Nesquehonite and hydromagnesite microstructures yielded porous MgO made up of self-assembled MgO nano-crystallites.

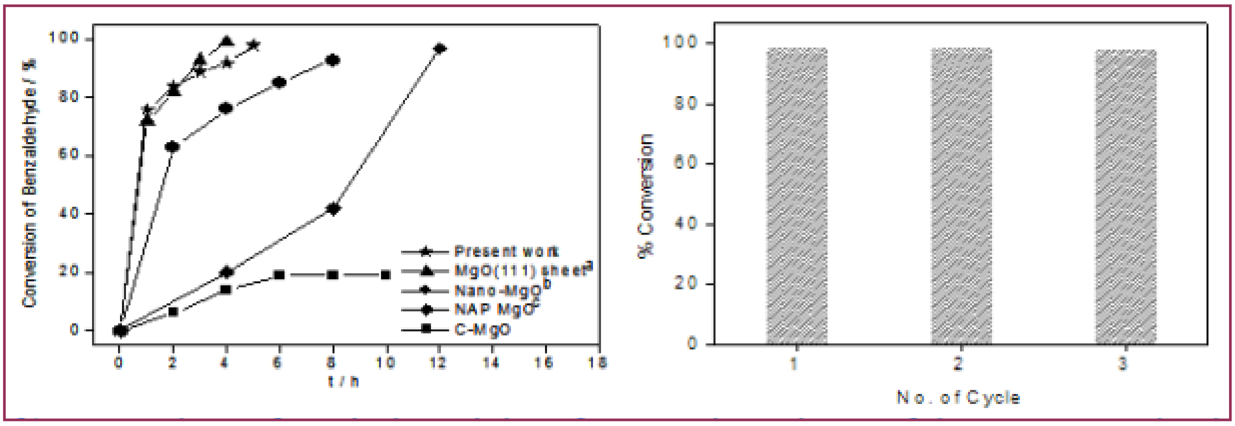
In continuation of our earlier studies on the preparation and characterization of MgO micro sheets, the process was further modified to eliminate difficulties encountered in the earlier process. The shape of the MgO-precursors could be varied by controlling the kinetics and thermodynamics of the reaction process. Calcination of the MgO precursors at 450–500 ^{0}C under various environmental conditions gave MgO with enhanced surface chemical activity. Their utility as solid base catalysts in chalcone synthesis from the reaction of acetophenone derivatives with benzaldehyde was studied *(Catal. Commun., 11 (2010) 537).*



SEM image of (a) nesquehonite rod; (c), (d), (e), (f) hydromagnesite ball, house of card, flower, assembled cube structures and TEM image of (b) rod, (e inset) flower structures



SEM images of (a) MgO sheet and (b) MgO flower and (c) commercial MgO porous petals



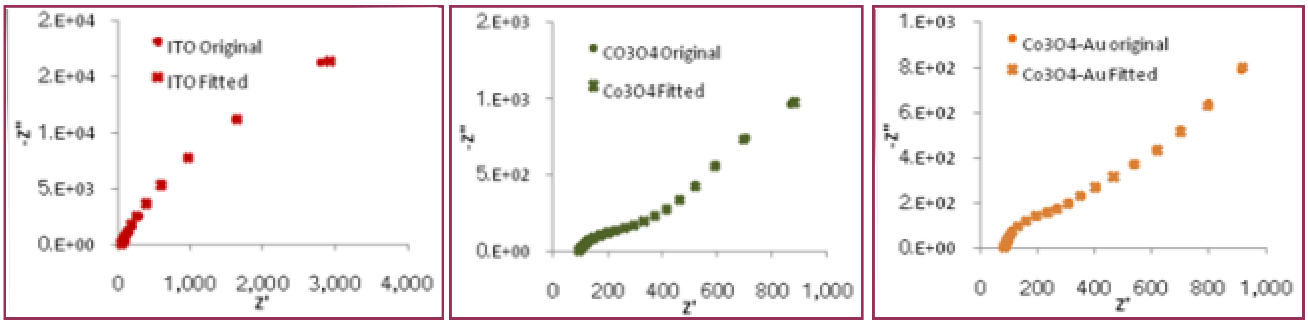
(Left) Comparison of catalytic activity of MgO micro-sheets of the present work with the best performing MgO nano-structures and (right) the results of cycle performance of the MgO-catalyst

Synthesis of monodispersed nanostructure materials

Development of new synthetic procedures for the synthesis of monodispersed inorganic nanostructured materials with uniform shape and size is gaining importance. Most of the existing procedures are not easily scalable and some involve use of noxious and expensive chemicals. We have developed a rapid and generalized approach for the synthesis of a variety of nearly monodispersed inorganic nanostructured materials using sub- or super-critical ethanol (SCE) as eco-friendly solvent. The strategy is based on the rapid homogeneous nucleation and growth in the presence of organic ligand by SCE. The ligands and precursors are soluble in ethanol at room temperature yielding a homogeneous solution. Also, ethanol generates a reducing environment which facilitates the formation of metal particles. This method not only makes it possible to synthesize nearly monodispersed nanostructured materials, it also allows control of the particle size and shape by simply varying the reaction parameters.

Electrochemical impedance spectroscopy of Co_3O_4 and Au-Co_3O_4 nanowire deposited on ITO electrodes

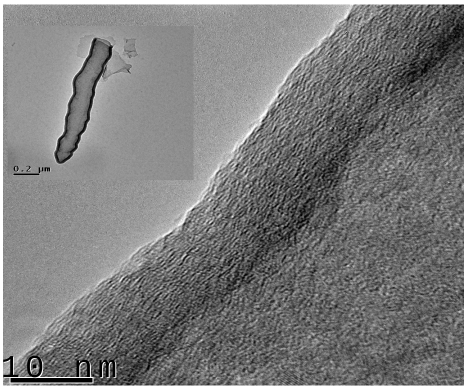
The Co_3O_4 and Au-Co_3O_4 nanowires deposited on ITO electrodes were studied by electrochemical impedance spectroscopy (EIS) in 0.1 M NaOH. The impedance spectra were recorded in a frequency range (1 Hz to 0.1MHz) and the data were fitted to an equivalent electrical circuit by NLS fit method using software provided by EG & G. This study was carried out in collaboration with Prof. Jeffrey Pyun at Department of Chemistry, University of Arizona, USA (*J. Am. Chem. Soc., 132 (2010) 3234*).



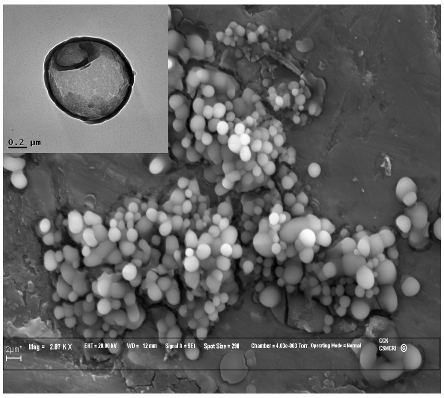
Nyquist plots for experimental and fitted data for [I] ITO substrates [II] calcined Co_3O_4 nanowires on ITO [III] calcined Au-Co_3O_4 nanowires on ITO

Carbon based materials

A simple, rapid and energy efficient approach based on copper mediated chemical reduction – solvothermal method was employed to prepare submicron size hollow carbon spheres using carbon tetrachloride as carbon source. The synthesized samples displayed macroporous nature of carbon with carbon and chloride contents of about 72% and 12% on atomic basis, respectively. Horn shaped multi-walled carbon nanotubes with uniform diameter of ~100 nm, an average wall thickness of 10 nm and length of about 1 µm could be prepared *(Mater. Lett., 63 (2009) 2339; Carbon, 48 (2010) 668).*



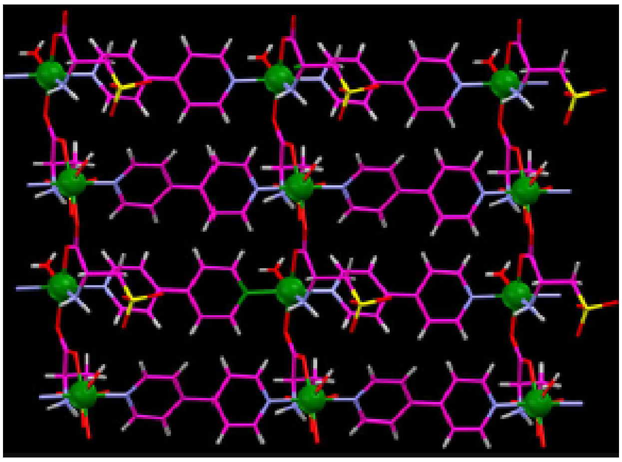
Horn shaped multi-wall carbon nano tubes



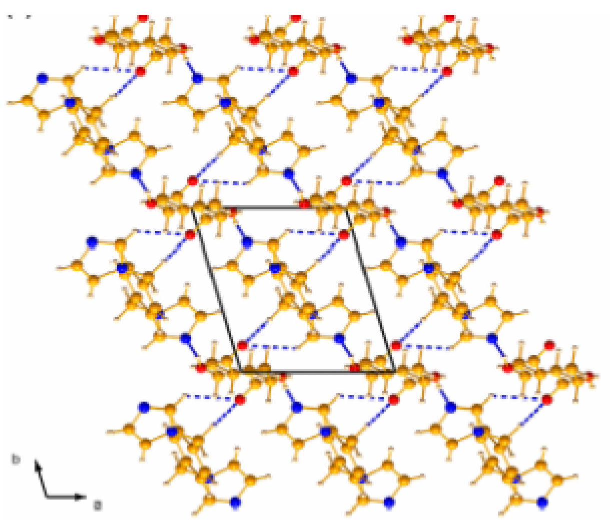
Hollow carbon spheres

Metal-organic framework

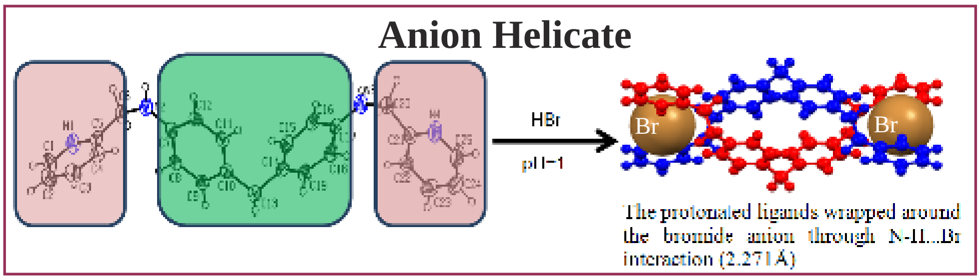
Metal-organic framework (MOF) with suitable cavity size is receiving growing interest because of its application as storage material for gases and other small molecules. CSMCRI has made significant contribution in this area and during the reporting period, series of MOFs of transition metal ions were synthesized using amino acids and bipyridine as ligands. The network structures were formed via coordinate covalent bonds (involving metal ions) and weak interactions, such as hydrogen bonding and stacking. Analysis of packing diagram revealed interesting structural features such as 2-D network topology (as shown in the accompanying figure) and formation of helical bilayers via O–H....O and N–H.....O interactions *(Polyhedron, 29 (2010) 1801).*



In the area of MOF, another series of new binary compounds using exobidentate N-heterocycle and a series of dicarboxylic acid ligands have been synthesized. X-ray crystallographic investigation of the molecular adducts revealed the primary intermolecular interactions between carboxylic acid and amine (via O–H....N) as well as carboxylate and protonated amine (via N–H$^+$....O$^-$) within the binary compounds. These, in turn, generated layered and two dimensional sheet type H-bonded networks (as shown in the accompanying figure). Thus, such interactions provide suf?cient driving force for the directed assembly of binary molecular complexes *(J. Mol. Struct., Communicated).*



Coordination helicates and their application in catalysis



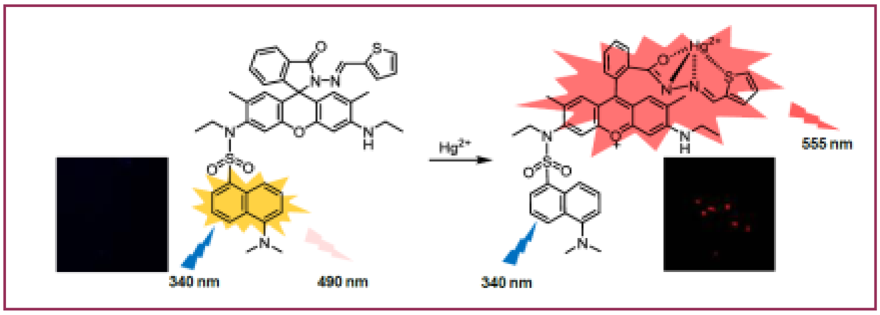
The simple ligand, bis-pyridinediamino-xylene,was treated with HBr under acidic pH and double stranded helicates were isolated and characterized. ^{1}H NMR studies revealed the interaction of the pyridyl moiety with Br^- to form the helices. Similarly, a series of double stranded Cu(II) mesocates comprising simple *m*-xylenediamine spacer helicands were synthesised and characterized. These novel materials were prepared by first preparing Schiff bases of *m*-xylenediamine with salicaldehyde and chloro-salicaldehye and thereafter complexing with $Cu(II)(OAc)_2$. The two classes of helicates were studied for their catalytic activity towards the Mannich and Nitroaldol reactions, respectively (*Inorg. Chem. Acta., in press).*

Molecular sensors for biologically and industrially important ions and molecules

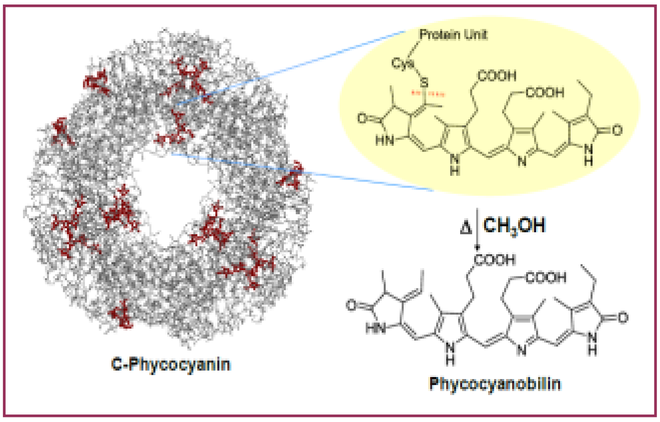
Development of molecular sensors is an important area of current research interest. Detection by fluorescent technique has been widely used because of some distinct advantages in terms of sensitivity, selectivity, response time and in-situ monitoring. The institute has contributed significantly in this area, and some of the work is briefly described below.

Molecular sensors for metal ions

A sensitive and selective rhodamine-based chemosensor for detection of Hg^{2+} in aqueous acetonitrile mediumwas synthesized. Resonance energy transfer from dansyl unit to the rhodamine moiety was utilized successfully for detection of Hg^{2+} in aqueous solution and *Pseudomonas putida (Org. Lett., 11 (2009) 2740).*



Schematic representation of one FRET based fluorescence response

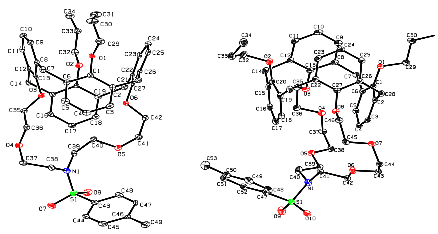


A tetrapyrrole-based chromophore was obtained through methanolysis of *C-Phycocyanin*, extracted from *Spirulina platensis*, and was found to act as a selective receptor for Hg^{2+} in physiological pH condition. This has relevance to the long standing question about the site for binding of Hg^{2+}in *Spirulina platensis*. *(Chem. Commun., (2009) 1496).*

A number of molecular receptors containing ruthenium(II)/rhenium(I) bipyridine moiety as fluorophore and crown ether as ionophore, have been synthesized and their cation binding property was investigated with a large number of cations. Three compounds exhibited preferential binding towards Pb^{2+}, Cu^{2+}, Hg^{2+} and Na^{+} while one compound exhibited towards Cd^{2+} and Hg^{2+}. From emission titration data, binding constants (K_s) and stoichiometry were computed while ^{1}H NMR study helped to establish the binding site of the metal ion in the ionophore moiety *(Eur. J. Inorg. Chem., (2009) 1256)*. A number of calix[4]arene-azacrown derivatives also functioned as selective receptors towards Hg^{2+}, Pb^{2+} and Cd^{2+} *(Dalton Trans., (2009) 8683)*.

A family of calix[4]arene-azacrown derivatives with variation in ring size and substituents at the upper and lower rims was synthesized and their molecular structures established by single crystal X-ray study. For studies conducted with alkali and alkaline earth metal ions, the ionophores bearing *tert*-butyl at upper rim exhibited selectivity towards Na^{+} only whereas ionophores of similar size but without this group were found to bind Na^{+} and K^{+} whereas ionophores bearing three tosyl substituents at the lower rim did not complex to any of the cations *(New J. Chem., 34 (2010) 2796)*.

A series of fluoroionophores have been synthesized incorporating Ru(II)-bipyridine moiety as fluorogenic unit and amino/benzenesulphonamido functionalized 1,10-phenanthroline moiety, attached to Ru(II), as binding sites. Some of these compound/complexes have been characterized crystallographically. Anion recognition property, studied by luminescence, UV-vis and ^{1}H NMR spectroscopy, with a large number of anions exhibit strong complexation with F^{-}, $H_2PO_4^{-}$ and AcO^{-}. Binding constants determined from luminescence titration and ^{1}H NMR study gave insight about binding site of anions. Bidentate chelating nature of the $H_2PO_4^{-}$ and AcO^{-} anions and steric crowding created by benzenesulphonamide moiety has significantly influenced binding constants and selectivity *(Inorg. Chem. Commun., 13 (2010) 1522)*.

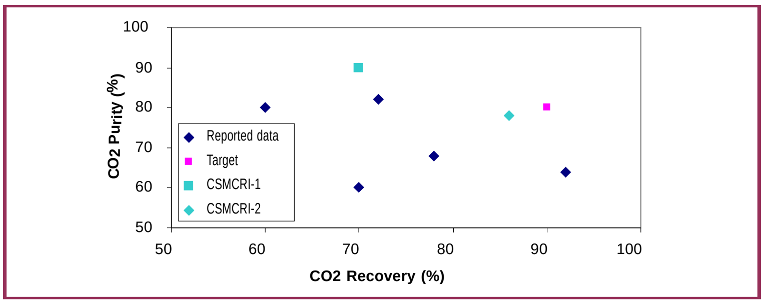


The structure at left binds to both Na^{+} and K^{+} whereas the one at right binds to Na^{+} only

Adsorption

Recovery of carbon dioxide from flue gas

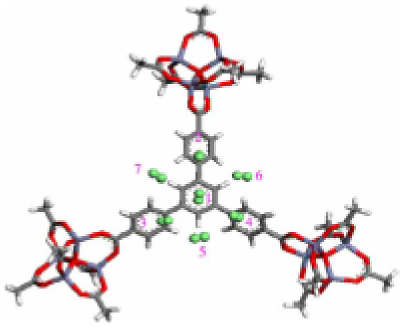
For selective capture of CO_2, pore-engineered zeolite-based adsorbents were prepared by controlled cation exchange of zeolite 13X as part of a multi-institutional project sponsored by NTPC. Best results were obtained with K_nNa_mX (CSMCRI-1) and $K_pNa_qBa_rX$ (CSMCRI-2) at 55 °C and 1 atm, the subscripts corresponding to the optimum stoichiometries. The above adsorbents were prepared on kilogram scale and tested for two and three column pressure/vacuum swing adsorption. CSMCRI-1 gave 70% recovery with 90% CO_2 purity whereas CSMCRI-2 gave 86% recovery with 78% purity. A comparison of results with reported data on zeolite 13X indicates superior performance as validated also through studies at IIP, Dehradun (*PCT/IN2010/000187 and PCT/IN2010/000027*).



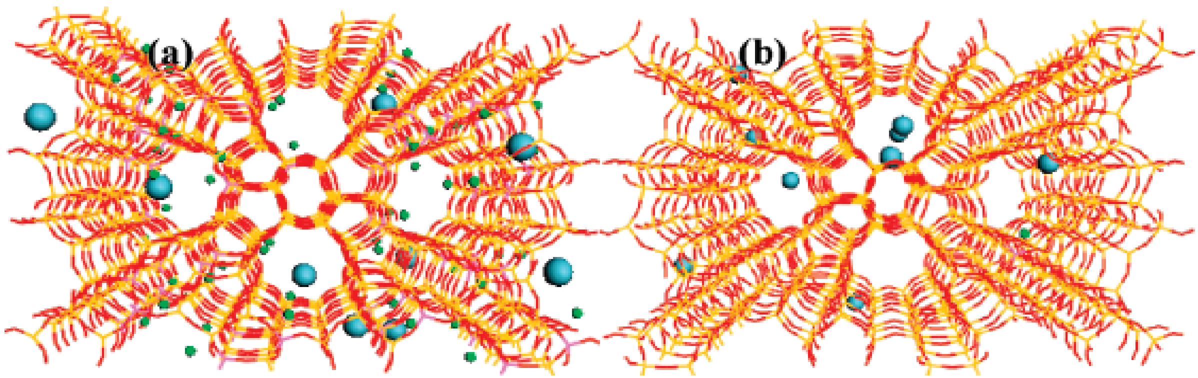
Comparison of PSA results with reported data for zeolite 13X

Molecular modeling for adsorption of gases in zeolites

The binding energies of H_2 molecule with MOF-177 clusters at various possible interaction sites have been calculated using density functional theory. The results showed that both the inorganic connector and the organic linker play an important role, the computed binding energies being 3–4.5 kJ/mol and 2.6–3.8 kJ/mol, respectively. DFT-optimized structure of seven H_2 molecules adsorbed on the organic linker is shown in the figure *(Molecular Simulation, 36 (2010) 373)*.



Sorption of CH_4, N_2, O_2, and Ar on ZSM-5 having different SiO_2/Al_2O_3 ratios was studied by volumetric measurements and grand canonical Monte Carlo simulation. The high methane and nitrogen adsorption capacities could be rationalized as a function of SiO_2/Al_2O_3 ratio in ZSM-5 *(Ind. Eng. Chem. Res., 49 (2010) 2353)*.



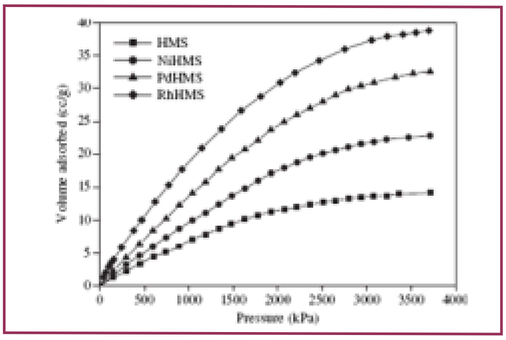
Molecular graphics snapshots of Ar adsorption at 101.3 kPa and 288.15 K in (a) ZSM-5(25) and (b) ZSM-5(900) (yellow for silicon, pink for aluminum, red for oxygen, green for sodium ions, and cyan for argon molecules)

CO enrichment from ammonia tail gas comprising CO, CH_4 and N_2

A zeolite-A based CO selective adsorbent and a process for CO enrichment from tail gas of ammonia plant was developed and the target of >90% recovery of CO with >95% purity set by the client (GNFC) was achieved. This work has much significance as the enriched CO can be used as feedstock. Pilot plant studies are in progress at GNFC *(Sep. Sci. Technol., 45 (2010) 413)*.

Hydrogen storage

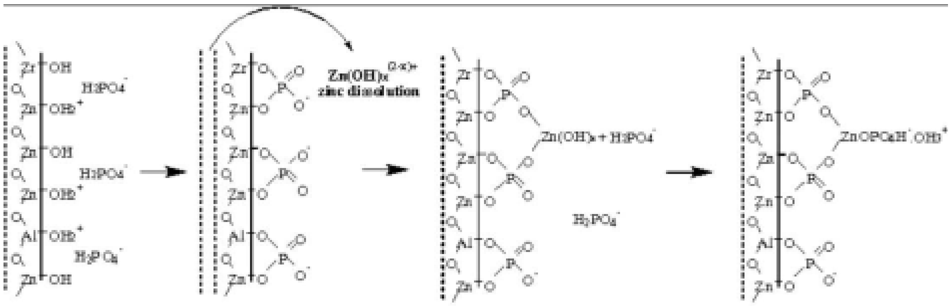
Adsorption of hydrogen in suitably modified titanosilicates , MCM-41, MCM-48, HMS and SBA-15 was tested. The modification involved incorporation of certain transition metal ions. Adsorption capacity ranged from 66-82 cc H_2/g at 77.4 K and 30-35 cc H_2/g at 303 K. The isotherms were completely reversible at 77.4 K but not at room temperature *(Int. J. Hydrogen Energy, 34 (2009) 888; 35 (2010) 2351).*



Hydrogen adsorption isotherms at 303 K up to 4000 kPa in pure and 5 wt% Ni, Rh and Pd incorporated in hexagonal mesoporous silica (HMS)

Phosphate uptake over ZnAlZr ternary hydrotalcites

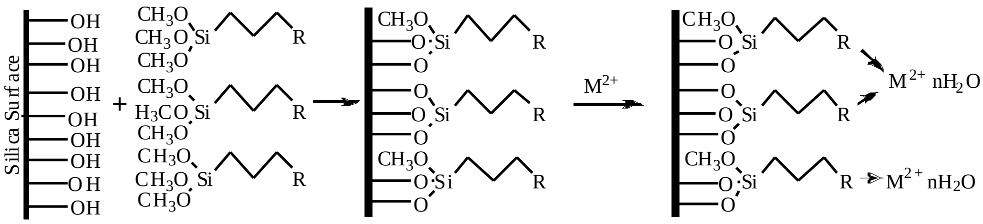
Hydrotalcites are being explored as adsorbents for environmental remediation of problematic anions in aqueous streams, e.g., phosphates and nitrates, which can cause eutrophication. ZnAlZr hydrotalcites synthesized here have shown good uptake capacity for phosphate, with a maximum uptake of 91 mgP/g. Layered hopeite mineral ($Zn_3(PO_4)_3.4H_2O$) was formed through surface precipitation of dissolved zinc ion in course of phosphate uptake. Interestingly, co-presence of nitrate anion enhanced the uptake of phosphate to 148 mgP/g. Recycle studies of the material showed a decrease in the uptake of phosphate with the number of cycles *(J. Coll. Interfac. Sci., 342 (2010) 289).*



Mechanism of phosphate uptake over ZnAlZr LDH

Metal ion adsorption on surface functionalized mesoporous silica gel

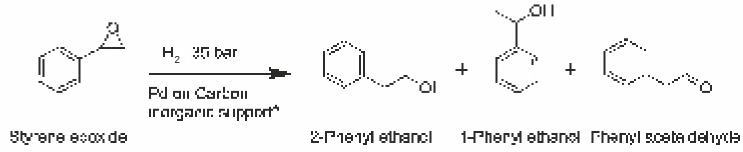
Condition for the synthesis of mesoporous silica gel having high surface area (550 m^2/g) and narrow pore size distribution (BJH pore size of 5 nm) was optimized on 300 g scale. Surface of these materials was functionalized with amino and mercapto groups. Adsorption capacities ca. 95 mg/g and 245 mg/g were estimated for Cu^{2+} and Hg^{2+}, respectively *(Ind. Eng. Chem. Res., 48 (2009) 8954; ibid 49 (2010) 8184).*



$R = -NH_2; -SH ; M^{2+} = Cu^{2+}; Hg^{2+}$

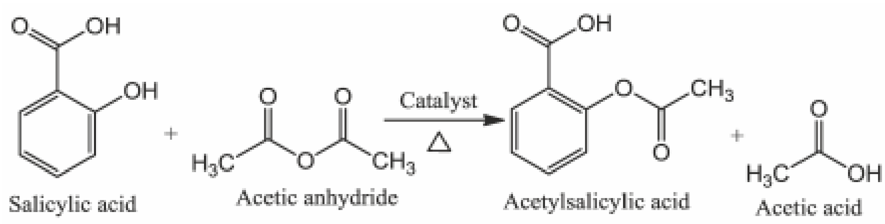
Heterogeneous Catalysis

Synthesis of 2-phenylethyl alcohol by catalytic hydrogenation of styrene oxide at 100 g scale



2-Phenylethyl alcohol (commonly known as phenyl ethyl alcohol) is the main component of rose oils and most widely used in the synthesis of range of perfumery chemicals. The styrene oxide obtained by successful demonstration of environmentally friendly process for the epoxidation of styrene at 1 Kg level was hydrogenated in presence of monometallic and bimetallic catalyst supported on basic inorganic solid supports giving 98% yield of phenyl ethyl alcohol with 98% selectivity at 100 g level which was successfully demonstrated to Aquila Organics, Mumbai.

Solvent free synthesis of acetyl salicylic acid over nano-crystalline sulfated zirconia



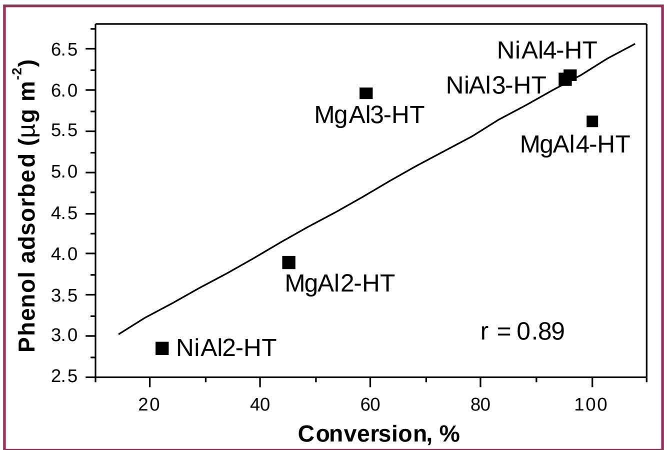
Aspirin could be synthesized in 95% yield by an eco-friendly route of *O*-acetylation of salicylic acid with acetic anhydride using nano-crystalline sulfated zirconia as solid acid catalyst. Thermally regenerated catalyst showed similar yield as obtained with the fresh catalyst *(US Patent, 7544831 B2, Aug, 2009; J. Mol. Catal. A:Chem., 317 (2010) 41).*

Nopol synthesis via Prins condensation of β-pinene and paraformaldehyde

Different sulfated zirconia (SZ) compositions with variable sulfur loading were synthesized through conventional methods. The FT-IR analysis of the catalyst gave the mode of the sulfate binding and the DRIFT-IR analysis confirmed distribution of Lewis/Brönsted acid sites via pyridine sorption, as further supported by NH_3–TPD analysis. Calcined SZ-2N showed high catalytic activity in the Prins condensation reaction of β-pinene with paraformaldehyde (99 % conversion), yielding nopol with 99% selectivity under controlled conditions *(Appl. Catal. A: Gen., 390 (2010) 158).*

Isomerization of allylbenzene

Isomerization of allylbenzene to β-methyl styrene (*cis*+*trans*) is a simple double bond migration reaction wherein the product finds application as an intermediate for psychostimulant drugs. Traditionally, the reaction was done using alkali bases or transition metal complexes. We have successfully carried out this reaction over Mg and Ni-containing hydrotalcites as solid base catalysts. Among the materials screened MgAl4–HT (Mg/Al atomic ratio is 4.0) gave nearly quantitative conversion at 160 °C in 6 h, using DMF as solvent. Those solvents which facilitate swelling of the hydrotalcite favored the reaction. Reaonsable correlation existed between the activity with the amount of phenol adsorbed (see figure) *(Appl. Clay Sci., 48 (2010) 243).*



Correlation between phenol adsorption and isomerisation activity

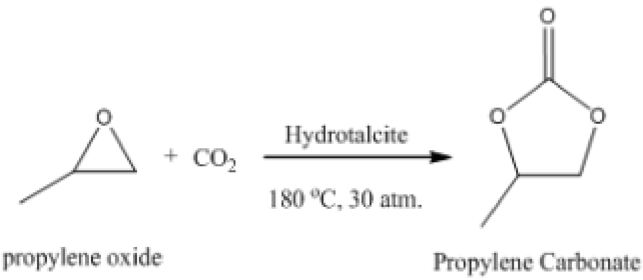
Hydroxylation of phenol over Cu-containing layered double hydroxides (LDHs)

Hydroxylation of phenol to catechol (CAT) and hydroquinone (HQ) is an industrially important reaction which is being pursued here for several years. In continuation of our earlier studies, we have attempted to assess the effect of copper ions at very low content (< 1 atom %) incorporated in LDHs on the oxidation of phenol using H_2O_2 as oxidant and H_2O as solvent. A conversion of 26.2% at 2:1 phenol:H_2O_2 ratio was noted for CuZnAl-5-CLDH-450. STEM measurements indicated a homogeneous distribution of Cu^{2+} up to the Cu atom % of 0.038. Highly dispersed isolated Cu^{2+} species with strong interaction with ZnO, as illustrated from TPR measurements, are the active centers responsible for the observed high activity *(Ind. Eng. Chem. Res., 49 (2010) 6020).*

Cu mapping in CuZnAl-CLDH-450
(inset STEM image)

Hydrotalcite catalyzed cycloaddition of carbon dioxide to propylene oxide

The catalytic activity of hydrotalcite (as-synthesized and calcined) of varying Mg/Al molar ratio (1.5-5) was studied for the addition reaction of carbon dioxide to propylene oxide in presence of DMF. The calcined hydrotalcite was found to lower (by 10 kJ/mol) the activation energy of cycloaddition in the presence of DMF. Higher TON (307 mmol/g of catalyst) was obtained at higher ratio of propylene oxide : catalyst. *(Ind. J. Chem. A, 49 (2010) 288).*

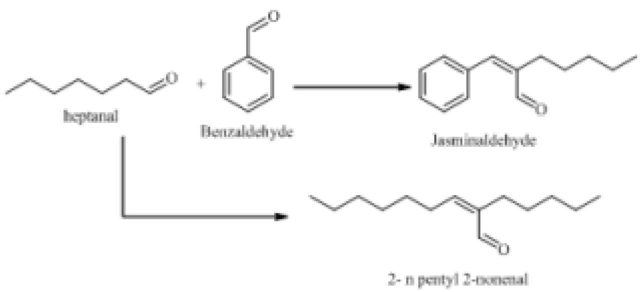


Synthesis of mesoporous zirconium phosphate: An efficient solid acid catalyst

Layered zirconium phosphate (ZrP) is an important solid acid catalyst with the properties of high thermal stability, water tolerance and easy sedimentation. However, its low surface area and small interlayer spacing limit its application considerably. Mesoporous ZrP with excellent acidic nature, high surface area (532 m^2g^{-1}) and narrow pore size distribution (~2.9 nm) was synthesized employing *in-situ* generated zirconium carbonate as precursor. High catalytic activity was observed towards Friedel-Craft benzylation of benzene *(Appl. Catal. A: Gen., 385 (2010) 22).*

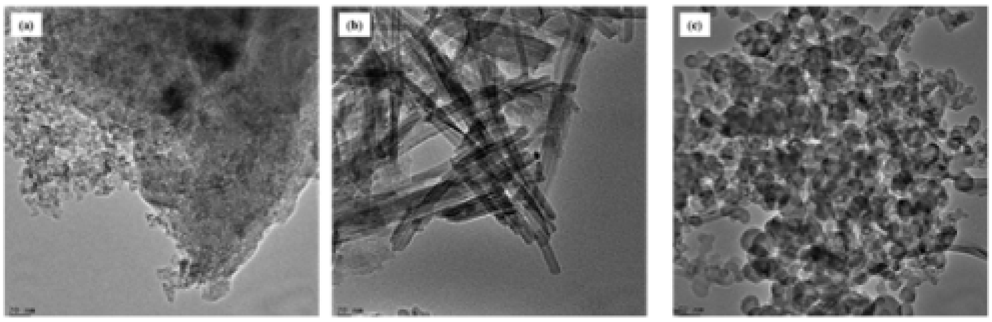
Chitosan as a solid base catalyst for aldol condensation reactions

Chitosan was modified through the hydrogel synthesis route and its catalytic activity was evaluated for the synthesis of jasminaldehyde by the condensation of 1-heptanal with benzaldehyde under solvent-free conditions. Near-quantitative conversion with 88% selectivity was obtained at 160 °C under



optimized conditions. The catalyst was recycled six times without significant loss in its activity and selectivity. In a related development, an aminopropyltrimethoxysilane functionalized chitosan was found to function as solid base catalyst for the self aldol condensation of linear aldehydes under solvent-free conditions *(J. Mol. Catal. A: Chem., 321 (2010) 77; 333 (2010) 158).*

Recovery and reuse of spent catalyst



TEM images of FCC (a) fresh, (b) spent and (c) H_3PO_4 acid treated catalysts

Recovery of metal from spent metal catalysts is an important objective both from the viewpoint of waste management and economics. A process was developed for the recovery of Ni from spent Raney Ni catalyst in two steps: i) extracting the metals from spent catalyst using a suitable acid and ii) selective precipitation of Ni in the form of $Ni(OH)_2$ at optimum pH. Ni recovery was nearly 100%.

In continuation to the previous studies on reuse of spent FCC (fluid catalytic cracking) catalyst, FT-IR investigation of physisorbed pyridine indicated low intensities of the major bands in case of spent catalyst. However, these increased upon calcination of the catalyst and increased further upon phosphoric acid treatment (Lewis acid-bound pyridine : ~ 1490, 1595 and 1625 cm^{-1}; Brönsted acid-bound pyridinium cation: ~1540 cm^{-1}). The acid treated spent catalyst regained the free particle nature of the fresh catalyst but the particle size was larger. A comparative study of liquid phase alkylation of benzene with 1-hexene was carried out and the calcined, phosphoric acid treated spent catalyst revealed some extent of regeneration of the catalyst.

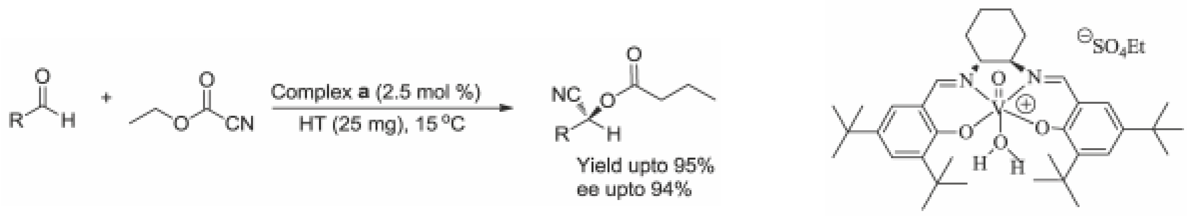
Homogeneous Catalysis

Asymmetric Synthesis

During the period under review, studies were undertaken on asymmetric C-C bond formation, chiral epoxidation of non-functionalized olefins and ring opening of racemic/*meso* epoxides. Various chiral catalysts were designed, synthesized and evaluated for their efficacy in the above stated reactions. Due to the high cost of chirally pure catalytic materials, catalysts were designed in such a way that they are reasonably stable, recyclable and are able to impart high enantio-induction in the target molecules. Wherever possible a solvent free protocol and/or environmentally benign reaction media (e.g., ionic liquids) was applied.

Chirally pure cyanohydrins via asymmetric cyanation of aldehydes

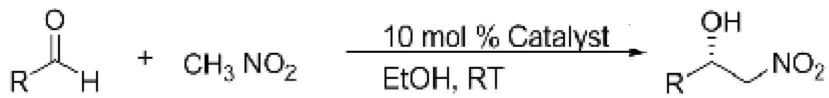
Chiral cyanohydrins are important building blocks in fine chemical synthesis. Monomeric, dimeric and polymeric salen complexes were synthesized and screened for catalytic activity. Ethylcyanoformate and trimethylsilyl cyanide were employed under mild reaction conditions to get the targeted functionalized cyanohydrins in high yields (92-99%) and excellent enantioselectivity (ee, 94-99%) in the best cases *(Eur. J. Org. Chem., (2008) 4511).*



a

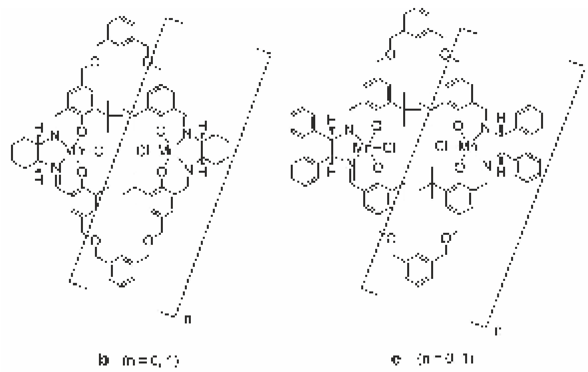
Asymmetric nitro-aldol reaction

Asymmetric nitro-aldol is another very important C-C bond formation reaction to produce multipurpose β-nitro alcohols. Earlier we have reported truly heterogeneous chiral catalyst which gave-nitro alcohols in high yields and ee in the presence of chiral imine as additives. To further simplify the catalytic protocol several metal complexes were synthesized which gave promising catalytic activity. This work is in progress *(J. Org. Chem., 75 (2010) 6191).*



Asymmetric epoxidation of non-functionalised alkenes

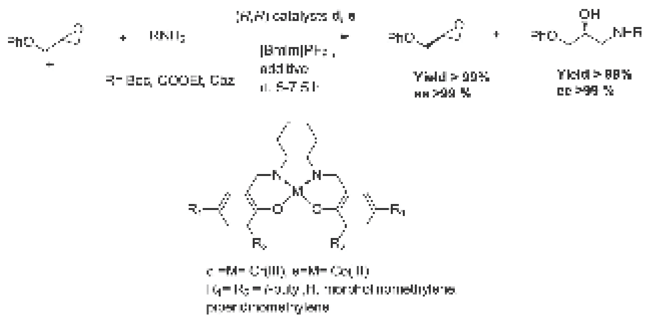
Chiral epoxides are feed-stocks for pharmaceuticals and fine chemicals. In continuation of our interest in designing efficient recyclable catalysts for the production of enantiomerically pure epoxides, new chiral macrocyclic Mn(III) salen complexes (**b, c**) were synthesized and characterized. These catalysts (5 mol%) were used for enantioselective epoxidation of non functional olefins viz. styrene, indene and chromenes using PyNO, 4-PPyNO, PPPyNO as proximal ligands with NaOCl as an oxidant at 0 °C. Excellent conversion (>99%) to epoxide with high chiral induction (97%) was obtained in the case of 6-cyanochromene oxide. The catalysts worked well for several cycles without loss in their performance. Further, the substrate chromenes are not commercially available *(Catal. Commun., 10 (2009) 572).*



Enantioselective ring opening reactions on racemic/*meso*-epoxides

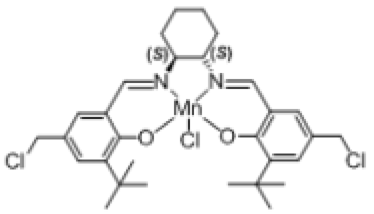
Hydrolytic kinetic resolution (HKR) and aminolytic kinetic resolution (AKR) of racemic epoxides was carried through ring opening with H_2O and amine as nucleophiles, using in-house synthesized chiral catalysts. Commercially important terminal and aryloxy epoxides (epichlorohydrin, styrene oxide, 1,2-epoxy propane, etc.) were used for HKR using water as resolving agent. Excellent conversion and selectivity was achieved in each case and the catalyst could be reused several times.

Similarly, AKR of *trans*-epoxides with chiral Co(III) and Cr(III) salen complexes in ionic liquid as greener reaction media was carried out using several amines and amine derivatives as nucleophile to get *syn*/*trans* 1,2-aminoalcohols with high chiral induction *(Eur. J. Org. Chem., (2009) 2863; SYNFACT, 9 (2009) 991).*

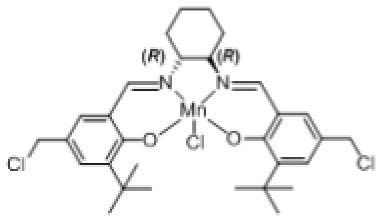


Study of the interaction of chiral Schiff base complexes with DNA

The binding ability of chiral vanadium (V) Schiff base complexes to calf thymus (CT) DNA and bovine serum albumin (BSA) protein was studied. (***R***) enantiomer of the complex showed higher binding constant (0.5 x 10^6 ± 0.01 M^{-1}) as compared to (***S)*** enantiomer (0.8 x 10^5± 0.01M^{-1}) *(J. Organomet. Chem., 695 (2010) 1133).* Similarly, among various chiral Mn(III) salen complexes studied, the best results in term of binding constant (intercalative) (130.4 x 10^4) was achieved with the complex ***S*-1** below *(Spectrochim. Acta Part A: 74 (2009) 113).*



S-1

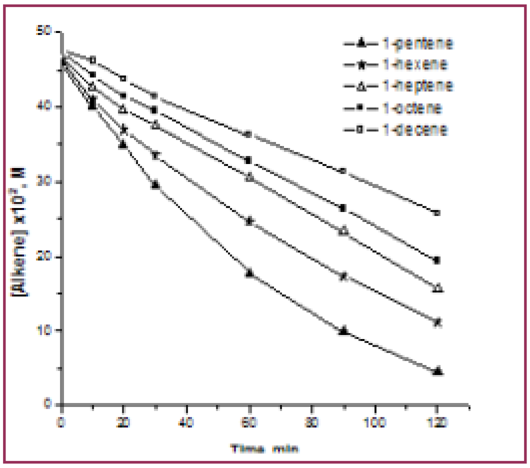


R-1

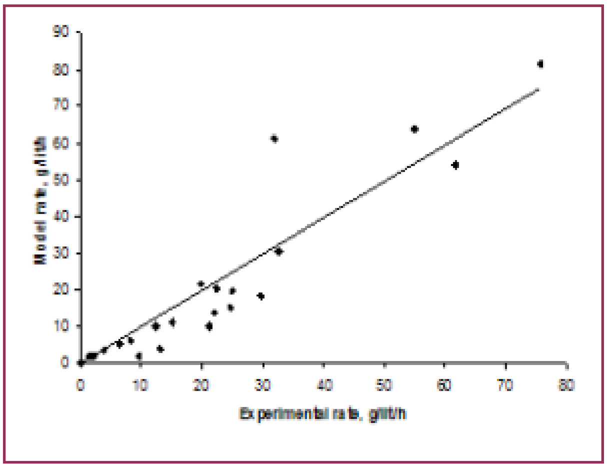
Hydroformylation

The rates of hydroformylation of C_5-C_{12} alkenes, determined under identical conditions, indicated a decreasing trend with the chain length of the alkenes. The rate was first order with respect to p_{H_2}. The rate was increased with the catalyst amount and approached saturation.

The cobalt catalyzed hydroformylation of higher olefins (1-octene, 1-nonene, 1-decene and 1-dodecene) was investigated in a biphasic system in the presence of chemically modified cyclodextrins. Partially methylated β-cyclodextrin gave good conversion (>92%) and selectivity (>92%) for the hydroformylation of higher olefins without impeding the recovery of the catalytic system *(Catal. Commun., 10 (2009) 1808).*



Alkene consumption profile:
Alkene = 47.6 x 10^{-2} M,
catalyst = 100 mg, CO+H_2 (1:1)
= 40 bar, temp. = 80 ºC,
toluene = 50mL



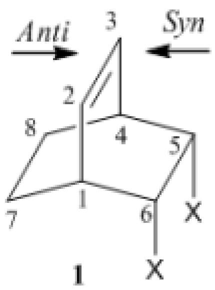
Kinetic modelling for
1-hexene hydroformylation

Rates increased on increasing the p_{CO} and 1-hexene concentration up to certain values beyond which there was inhibition. A kinetic rate model derived based on the mechanism of hydroformylation of 1-hexene fitted well with the experimental rate within 15% deviation *(J. Mol. Catal. A: Chem., 316 (2010) 23).*

The regioselective hydroformylation of vinyl acetate catalyzed by rhodium complex of tri-1-naphthylphosphite [P(ONp)$_3$] was investigated. This ligand had pronounced effect on the rate and selectivity, notably high turnover frequency (up to 11,520 h^{-1}), high selectivity to aldehyde (93%), and excellent regioselectivity (99%) to branched aldehyde *(Catal. Commun., 11 (2010) 616)*.

Theoretical understanding of π-facial selectivity

The origin of π-facial diastereo selection has been the subject of intense debate. Density functional and *ab initio* calculations revealed that π-facial selectivity can be controlled by the atom centres of an electrophile, even though it may not be directly involved in the bond formation while interacting with substrates. This was tested in the reactions of 5, 6-disubstituted bicyclic[2.2.2]oct-2-enes with *m*-chloroperbenzoic acid and diazomethane *(Tet. Lett., 51 (2010) 143)*.



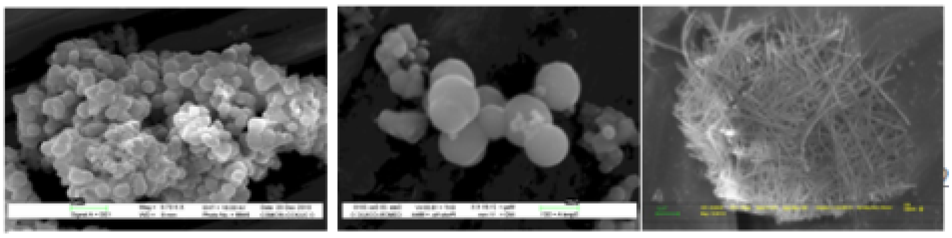
1

X=CN, OH, Oac, OSO_2Me
X-X=$OCMe_2O$, OCOO

Photocatalysis

Synthesis of metal ion impregnated nanocrystalline TiO_2 photocatalysts

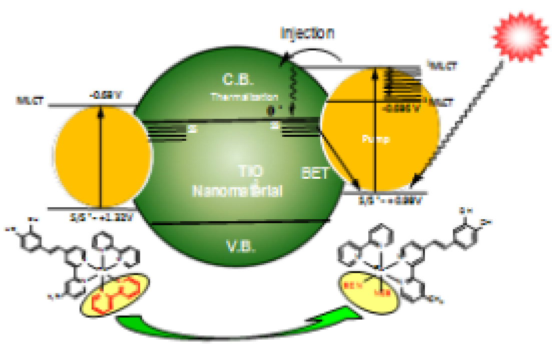
Influence of metal ion doping on photocatalytic activity of nanocrystalline TiO_2 was studied. Metal ions such as strontium, magnesium, palladium, lithium, and bismuth were impregnated over nanocrystalline TiO_2 by wet impregnation method. Significant change in the morphology was seen depending on the nature of the metal ion. Blue shift of 21 nm and 9 nm was observed for Pd and Li ions, respectively. In case of titanium nanotube, the photocatalytic activity was in the order: nanocrystalline TiO_2 < TiO_2 nanotube < bismuth doped TiO_2 nanotube.



SEM images of Mg (left) Li doped nanocrystalline TiO_2 (middle) and bismuth doped titanium (right) nanotubes

Dye sensitized photo induced electron transfer process at TiO_2 interface

Ruthenium (II)-polypyridyl bis-thiocyanate complex with pendant catecholate functionality was synthesized. This molecule interacted strongly with TiO_2 nanoparticles. Interfacial electron transfer study confirmed electron injection to the conduction band in 100 fs timescale via the excited state. The back electron transfer dynamics was also determined *(J. Phys. Chem. C, 113 (2009) 7970)*.

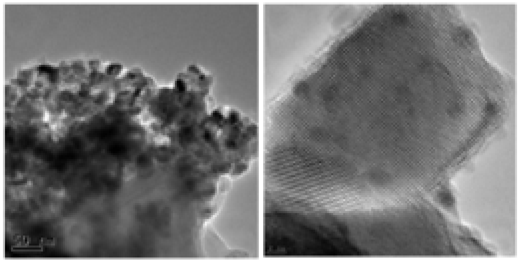


Schematic representation of photo induced processes and relative potential of the ground and excited states

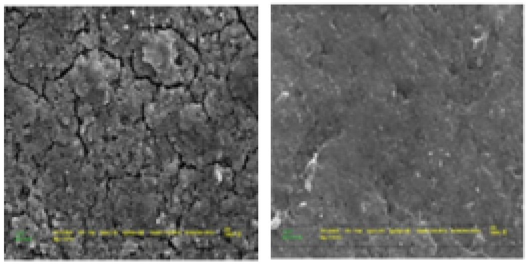
Development of photocatalytic reactors

Photocatalytic surfaces were developed for designing of photocatalytic reactor based on optical fiber and solar light. For coating of photocatalyst on substrates such as optical fiber, quartz tube, and glass plate, nanocrystalline TiO_2 sol was prepared by modified sol-gel method.

The electron microscopic images of parallel synthesised nano-crystalline TiO_2 and coated surface at different magnification on glass plate are shown in the accompanying figures.

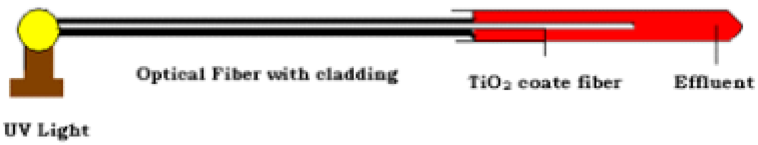


TEM images of parallel synthesised nanocrystalline TiO_2



SEM of TiO_2 coated glass plate (left) and TiO_2 coated optical fibre (right)

Optical fiber reactor

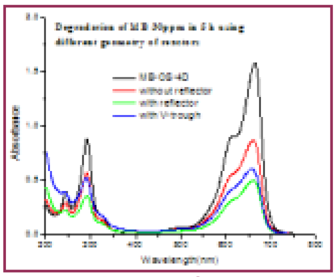


TiO_2 coated optical fiber based photocatalytic reactor has been designed for the degradation of leather industry effluent and dyes present in wastewater. The optical fiber based photocatalytic reactor has been successfully applied for the photocatalytic degradation of methylene blue dye and leather industry effluent. Figure given shows single optical fiber based photocatalytic reactor for degradation leather industry effluent.

Solar light based photocatalytic reactor

Photocatalytic Reactor

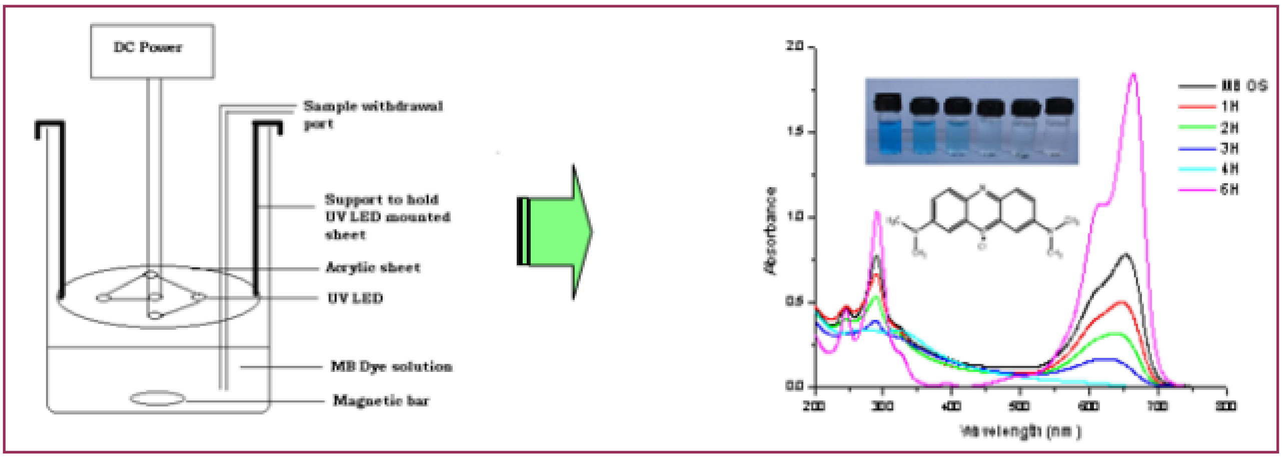
To develop solar light based photocatalytic reactor quartz tube was coated with TiO_2 photocatalyst at optimum conditions and used. Two types of reactor were used for this study such as with and without reflector, V-trough type reactor. Further work on the development of solar light concentrated photocatalytic reactor and optimization of various parameters is under progress. Figure given shows the schematic representation and experimental setup with and without reflector used for this work. The results demonstrated that the percentage degradation of methylene blue dye was increased in case of reactor with reflector.



Degradation of MB dye in presence of solar light using different geometry

UV-LED source based photocatalytic reactor

To avoid the use of traditional UV sources and solar light irradiated photocatalytic reactor, a UV-LED based photocatalytic reactor setup was developed. A simple reactor arrangement was made to carry out the photocatalytic degradation of methylene blue dye. The photocatalytic activity of P-25 Degussa TiO_2 was evaluated using 5 numbers of UV-LED reactor. The effects of various parameters such as catalyst loading, initial dye concentration, pH and addition of H_2O_2 on decolourisation and degradation have been investigated to find out optimum conditions. The complete mineralization of MB dye (3.12×10^{-5} M) was confirmed by COD analysis. Results demonstrated that the UV-LED/TiO_2 process can effectively degrade methylene blue dye with optimized conditions and technically feasible. The UV-LED source based photocatalytic reactor schematic diagram and methylene blue degradation profile are shown above *(Ind. Eng. Chem. Res., 48 (2009) 10262).*



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$NaCl$ d vykok] fo'kÔdj ckbu e fLFkr vU; byDVkykbVl dh mifLFkfr e ftIle dh ckbu e foy;rk dk $MgCl_2$,o dkcfud foyk;dk ¼bFkkbyhu Xykbdku ,o bld 0;RiUu½ dh mifLFkfr e ifjo'kh rkieku ij ekik x;k gA v/;;u l irk pyk g fd $MgCl_2$ dh mifLFkfr e ckbu e ftIle dh foy;rk dkQh c< tkrh gA ued dh de lknrk e ;g T;knk c<rh g ,o 3.0 m lknrk rd fujrj c<rh jgrh gA blI vf/kd lknrk ij Mg^{2+} vk;u dk çHkko de gkrk gA $MgCl_2$ ikuh d gkbMkstu vkc/k dk detkj djrk g

ft l dh otg l ?kky dh l ihM;rk de gkrh g ,o ?kky T;knk dBkj gkrk gA ftlls vFkok $MgCl_2$ d feyku ij vk;uk dk gkbM'ku vd de lknrk ij c<rk g] tcfd vf/kd lknrk NaCl (≈ 2.5 m) ij vk;uk d gkbM'ku xkyd d ijLij feyu d dkj.k vfrfjDr byDVkykbVl d dkj.k Hkh vk;ul d gkbM'ku ij çHkko ugh iMrk gA bFkkbyhu Xykbdky (EG)] bFkkbyhu Xykbdky ekukfeFkkby bFkj (EGMME) rFkk bFkkbyhu Xykbdky MkbfeFkkby bFkj (EGDME) ,Vh lkYoUV çHkko n'kkr g, ftlls dh ckbu e foy;rk dk de djr gA bFkkbyhu Xykbdky d gkbMkfDlly dk ;fn feFkkDlh leg l ifjofrr djr g rk ftlls dh foy;rk foyk;d bl Øe e de djr g ¼ EGDME > EGMME > EG A NaCl + H_2O + EGDME bl ç.kkyh e EGDME rFkk ikuh d v.kvk d chp vi{kkdr T;knk etcr gkbMkstu vkc/k cuu d dkj.k ftlls dh foy;rk e T;knk deh vkrh gA EG dh Lo;a tMh ljpuk d dkj.k EG rFkk H_2O e vi{kkdr detkj gkbMkstu vkc/k curk g ftld dkj.k l ftlls dh foy;rk ij T;knk çHkko ugh iMrk gA blds vfrfjDr ftlls dh egÙke foy;rk ij dkcfud foyk;dk dk T;knk çHkko ugh n[kk x;k gA

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oÔ 2006 – 08 dh f}okf"kd çfronu e ued dk yxHkx xkykdkj vkdfr e <kyu dh lJy ;kf=d çfØ;k dk uohu rjhdk crk;k x;k gA Xyk;lhu dk vknr ifjord d #i e mi;kx djd dnjrh ckbu e l xkykdkj v"VQydh; lkj ck"iu ued cuku d vUoÔ.k dk 0;kid #i e çlkj gvk gA bl ued dh ekx c<u ij çfØ;k dk 10 Kg d Lrj rd lQyrkiod c<k;k x;k vkj mDr diuh u viu mi;kx d fy, bl loFkk mfpr crk;kA vefjdu diuh dk bl ued dk ueuk viuh tkp fpfdRlk ijh{k.kk d fy, Hkst x;k] ftlu bu mi;kxk d fy, mRlkgo/kd ijh.kke n'kk;A bl çfØ;k e nkuk df=e rFkk çkdfrd ckbu l çkIr ued d fØLVy vkdkj dk fu;f=r fd;k tk ldrk gA ikVf'k;e Qjkl kbukbM l fØ;k d ckn 300-500 μm eki d xky ued dh eDr çokg fo'kÔrk lk/kkj.k ?ku vkdkj d ued l J"B ikb xb g ¼fjikl dk dk.k ~16°½A cgrj çokg fo'kÔrk HkMkj.k d 3 eghu ckn rd cjdjkj ikb xb gA Ldfux byDVkuh l{e v/;;u l Kkr gvk g fd xky ikyhfØLVykbu d.k NkV&NkV NaCl ?kuk d <j l cu g, g rFkk budk vklr eki bFkuky dk çfr foyk;d d #i e mi;kx }kjk de fd;k tk ldrk gA eDr çokgoky xkykdkj ued dk lQyrkiod vk;kMhdr fd;k tk ldkA

foÜo d çfr"Br btkhfu;fjx lykgdkjk dh enn l çfØ;k dk 1 TPD Lrj ij fodflr fd;k tk jgk gA blh rtt ij de NaCl oky xkykdkj ued cuku d fy, ç;kl fd, tk jg gA

LiF, NaCl vkj KI d fØLVy #ix.kk ij QkekekbM dk çHkko ¼Mh- ,Q- Vh- ,o tyh; foyk;d ekMy v/;;u

{kkj gykbMk ¼tl LiF, NaCl vkj KI½ d fØLVy dh ljpuk ij QkekekbM d çHkko dh tkp d fy, ?kuRo QD'kuy dk v/;;u fd;k x;k gA xl vkj tyh; nkuk ek/;e e dfUVuve ekMy (COSMO/COSMO-RS) dk mi;kx djd x.kuk dh xbA lkekU;r% foy;rk dk] c/ku Åtk ij ,d cMk çHkko ekuk tkrk g] tcfd {kkj gykbMk d tkyd lrg ij mifLFkr vk;uk d e/; LFkku dk vkdkj vkj l;kth v.k d vkdkj d feyku dk de egRoi.k le>k tkrk gA Lyc ekMy dk ydj fd; x, x.kuk d ifj.kke l ;g fofnr gkrk g fd tyh; ek/;e e QkekekbM e[;r%] lkfM;e DykjkbM d {111} lrg dk çHkkfor djrk g ¼Øe'k% c/ku Åtk ΔE= -23.8, -0.4 ,o -4.3 fdyk dyksjh çfr eky Øe'k½A ;g voLFkk v"VQydh; ljpuk d fØLVy d cuu dk çkRlkfgr djrk g] tlk igy ç;kxk }kjk crk;k tk pdk gA (lQ- lk;Ul- 2003, 523, 307-315) tcfd tyh; ek/;e e QkekekbM dk çHkko LiF d lHkh lrgk ij çfrdÔ.k LoHkko dk rFkk KI d lrgk ij cgr detkj gkrk g] tk ljpuk e ifjoru d fy, i;kIr ugh gkrk gA ¼de- t- dfe- 87 (2009) 514½

lkfM;e DyksjkbM dh vkdkfjdh ij Cd^{2+} dk çHkko dk l)kfUrd v/;;u

geu DFT i)fr }kjk l)kfUrd #i l Cd^{2+} d çHkko dh NaCl d fofHkUu lrgh LFkkuk] tl ¶yV Ql] fdd vkj LVIl ij tkp dh gA Cd^{2+} vk;uk rFkk ty v.kvk d 1:3 v.k vuikr d feJ.k }kjk lkfM;e DyksjkbM d lrg {111} dk LFkk;h gkuk] io çdkf'kr SXRD ifj.kke l mPprj gA (lQ- lk;Ul, 599, 2005, 196)

lenh lkrk l egRoi.k [kfutk dh çkfIr

NaCl d vfrfjDr lenh ikuh e cgr l lkekfjd egRo d jlk;u tl& yhfFk;e (0.2 ppm)] LVkf';e (8 ppm)] ckjku (4.8 ppm) rFkk ;jfu;e (3ppm) bR;kfn çkIr fd, tk ldr gA gkykfd bu rRok dh ek=k len d ikuh e cgr de gA gkykfd lenh jlk;uk dh çkfIr d nkjku ckbu dh lknrk d lkFk bu jlk;uk dh lknrk c<kb tk ldrh gA fofHkUu LFkkuk l rFkk fofHkUu lkrk l çkIr ckbu d fofHkUu pj.kk e lkj ok"ihdj.k d vuलkj yhfFk;e rFkk LVkf'k;e dh ek=k d vk/kkjHkr vkdM ICP-OES d mi;kx }kjk ,df=r fd, x, gA pfunk yhxMl dh enn l yhfFk;e dk çkIr dju d fy, xgu v/;;u fd;k x;k gA ;g jlçn g fd tc lkfnr fcVu e l dkLVhd lkMk mi;kx }kjk eXuf';e dk vo{kfir dju ij lkekU; lenhty d cny yhFkh;e dh lknrk e 100 xuk vnkftr of) ikb xb tk 23.1 ppm ftruk gA ekrno e l yhFkh;e d p;fur fu"dÔ.k d fy, çk;kfxd v/;;u fd;k x;kA 12 Økmu bFkj 4 0;RiUuk dk lÜyfÔr djd eY;kdu fd;k x;kA yhxM }kjk 11.7% yhFkh;e çkIr fd;k x;kA ckbu e yhFkh;e dh ek=k rFkk mldk p;fur mnxg.k c<ku d fy, v/;;u tkjh gA

dej d rkieku ij vk;fud no

vk;fud no viu vf}rh; HkkSfrd&jklk;fud x.kk d dkj.k fofHkUu m|kxk e ç;kx gkuoky lk/kkj.k dkcfud nok d LFkku ij ,d gfjr çfrLFkkiu dh rjg ç;kx e vk jg gA lLFkku u Hkh bu nok ij v/;;u 'k# fd;k g rFkk [kkt i.k ifj.kke 2006-08 dh f}okfÔd çfronu e 'kkfey fd, gA bl v/;;u dk vkx c<kr g, geu vk;fud nok dh LoPN] tyh; rFkk xj tyh; ek/;e e HkkSfrd&jklk;fud fo'kÔrk, Kkr dh g rFkk budk ,xkt ,o vU; to ikyhej dk ?kkyu] iu% mRFkku vkj vk;utyucku d fy, lHkkfor vuç;kx fd, gA

ljQdVUV tl vk;fud no ¼1&C;Vkby&3&feFkkby bfeMktkfy;e vkDVkby lYQV [C_4mim][C_8SO_4] dk ikuh d ?kky e felyh cnyko

vUoÔ.k d nkjku] vk;fud no e IL 1 C;Vkby&3 feFkkby behMktkfy;e vkDVkby lYQV dh ikuh d ?kky e fØ;k dju ij bud HkkSfrd&jklk;fud x.kk e nk çdkj dk ifjoru n[kk x;kA fnypLi ckr ;g ikb xb fd pkydrk ekiu d x.kk e ik, x, nlj cnyko tk igy cnyko dh ryuk e de Fkk mle mi;Dr byDVkykbV feyku ij of) ikb xbA cgr lh rduhdk] tl fd dUMDVhfoVh] vYVk lkfuDl] TEM] Øk;k& TEM] Mh ,y ,l] ^1H NMR rFkk 2D ^1H-^1H NOESY d }kjk ;g LFkkfir fd;k x;kfd igyk cnyko _.kk;u ,xhx'ku d dkj.k g rFkk nljk cnyko ,xhx'ku d iu% fuek.k ftle fd _.kk;u d lkFk& lkFk /kuk;u dh ,ykdby pu Hkh lfEefyr g] d dkj.k gvk gA bl rjg ,d vf}rh; felyh dk fuek.k gvk g tk ,d vk;fud no l çkIr fefJr felyh tlh gA

bfeMk t kfy ;e vk;fud no dh rkieku d lkFk Hkkfrd&jklk;fud fo'kÔrk,

lk/kkj.k ncko ,o fofHkUu rkieku ij [C$_8$mim][Cl], [C$_4$mim][C$_1$OSO$_3$] rFkk [C$_4$mim][C$_8$OSO$_3$] vk;fud no d Hkkfrd x.kk tl ?kuRo] /ofu dh xfr ,o viord lpdkd dk ekik x;k gA eki x, Hkkfrd x.kk l vkrfjd ncko vkj ekyj vioru Kkr fd;k x;k gA [C$_4$mim][C$_1$OSO$_3$] d vykok lHkh vk;fud no dk vkrfjd ncko rkieku c<ku l de gvk gA vk;fud no dk vkrfjd ncko ikuh ,o dkcfud nok l vf/kd rFkk fi?ky g, yo.kk l de ik;k x;k gA bld vfrfjDr vkrfjd ncko /kuk;u ,o _.kk;u dh çdfr ij fuHkj ik;k x;k gA bu ifj.kkek dk fiNy f}okfÔd çfronu e fn, x, ifj.kkek l ryuk dh xbl g x;k g rFkk budh leifl"V dh xbl gA

çk|kfxdh gLrkrj.k

mPp 'k) rkoky lkj ued dk 0;kolkf;d ieku ij cuku dh çk|kfxdh dk el l xkfle fyfeVM] ukxnk dk gLrkrj.k

oÔ 2006-08 dh f}okfÔd çfronu e geu gekjh iVUVhdr çfØ;k vulkj mPp 'k) rkoky lkj ued cuku dh çk|kfxdh] xkfle fyfeVM uked diuh dk gLrkrj.k dju dk mYy[k fd;k gA igy] ;g rduhd 200 Vu d ieku ij foukn lkYV oDl] uo[kyh] xtjkr e çnf'kr dh xbl FkhA vPN ifj.kkek dk n[kr g, ikVh u bl rduhd dk 0;kolkf;d rjhd l 10000 Vu ued cuku d fy, çnf'kr dju dh bPNk 0;Dr dh FkhA 0;kolkf;d Lrj ij ued cuku d fy, foukn lkYV oDl e xkfle bUMLVh t u lHkh lfo/kk, tVkb FkhA çfØ;k fun'ku d nkjku Ca = 0.06 – 0.08%, Mg = 0.03 – 0.04%, SO$_4$= 0.20 – 0.22% rFkk NaCl >99.3% ft le < 100 ppb ek=koky vk;kMhu dh fo'kÔrkokyk 10000 Vu l T;knk lkj ued cuk;k x;kA xkfle bUMLVh t rFkk lh,l,e lhvkjvkb d chp e çk|kfxdh gLrkrj.k çek.ki= ij gLrk{kj Hkh fd, x, gA

jktLFkku d voenk ckbu l mPp 'k) rkoky lkj ued dh çk|kfxdh dk el l Mhlh,e dkulkyhMfVM] dkVk dk gLrkrj.k

jktLFkku d voenk ckbu l mPp 'k) rkoky lkj ued dh çkflr dh vfHkuo çfØ;k el l Mhlh,e dkulkyhMfVM] dkVk dk n'kkb xbA vfHkuo çfØ;k dk ukok e lh,l,e lhvkjvkb }kjk cuk, x, ekMy lkYV Qke d ,d fgLl e çnf'kr fd;k x;kA ikVh dh ekx ij fiNy ued çkflr d ekle e pje fLFkfr;k e miyC/k e;kfnr lfo/kkvk dk ç;kx djd çk|kfxdh dk çnf'kr fd;k x;kA bl çn'ku d nkjku > 99.4% NaCl okyk mPp 'k) rkokyk ued rFkk fuEu lYQV cuk;k x;k gA ued e vk;kMhu dh ek=k dk 4 – 5 ppm l ?kVkdj < 1 ppm dj fn;k x;kA bl rjg ued e vk;kMhu dh ek=k yxHkx 80% de dj nh xbA

α&iykLVj cuku dh tkudkjh dk gLrkrj.k

lLFkku e 1990 d 'k#vkrh nkj e α&iykLVj cuku dh rduhd dk fodkl fd;k x;k rFkk bl rduhd dk cgr lh vk|kfxd bdkb;k dk gLrkrfjr fd;k x;kA gky gh e dVhj m|kxk d }kjk bl rduhd dk tkuu dh bPNk 0;Dr dh xbl gA 2009 e el l vkjlu QkLQV fyfeVM dk ;g rduhd LFkkukrfjr dh xb rFkk ikVh dk cp ieku ij çfØ;k dk lQyrkiod n'kk;k x;kA

oMknjk fLFkr GACL }kjk pu x; {k=k e ued mRiknu dh lHkkoukvk dk ryLi'kh vH;kl

oMknjk fLFkr el l xtjkr ,Ydyh ,UM dfedYl fyfeVM diuh d dkfLVd lkMk cuku d nk ;fuV oMknjk ,o ngt e gA diuh nfud 1200 l 1250 efVd Vu dkfLVd lkMk dk mRiknu djrh g vkj vkxkeh Hkfo"; e ; {kerk nxuh dju tk jgh gA lkekU;r% dkfLVd lkMk cuku d fy, çfrfnu 1900-

2000 efVd Vu vk|kfxd ued dk mi;kx fd;k tkrk gA xtjkr d dN pu x, {k=k e vk|kfxd ued d mRiknu d fy, vu#i ued {k=k dk fuek.k dju dk diuh u r; fd;k gA lkj Åtk l çkIr ued mRiknu d l;kX; LFkku dh i lnxh dk lHkfor ryLi'kh vH;kl dju d fy, diuh u lUVy lkYV fjlp lLFkk l lid fd;kA diuh u tgk ij tehu gLrxr dh g , l Hk#p fty d ifu;knk ,o drij rFkk vk.kn fty d [kHkkr vkj oMxke e lLFkku d oKkfudk u çkFkfed lo{k.k (survey) dk dk; i.k fd;k gA bu {k=k d lyXu lHkh vko';d çkpyk (parameters) tl fd feVh d Hkkfrd ,o jklk;fud x.k/ke] ckbu dk 'k# dk ?kuRo ,o mudh çpj ek=k e vfojr çkfIr] tyok;oh; ;kuh dh okrkoj.kh; çkpy] {k= d GPS, ued ;krk;kr d i;kIr lk/kuk dh 0;oLFkk vkfn dk ryLi'kh vH;kl fd;k x;k vkj foLrr fjikV diuh dk Hkth x;h gA

pe'kk/ku d mfPN"V çokgh e l jlk;uk dh çkfIr ij vUoÔ.kkRed v/;;u

;g fjikV fd;k x;k g fd pe m|kxk }kjk cMh ek=k e mfPN"V çokgh mRiUu gkrk gA bl çokgh dk igy vkj vk rduhd }kjk foyo.khdj.k d ckn cp g, vLohdk; ty d lQy fuiVku gr mPp nkc ok"iu d mi;kx }kjk l[kk;k tkrk gA bl rjg l Bkl cu] cp g, inkFk e lkfM;e DykjkbM] lkfM;e lYQV rFkk dfYl;e lYQV fo'kÔ ek=k e rFkk de ek=k e eXuhf'k;e DykjkbM vU; vfoy; rFkk foy; v'kf);k gkrh gA rfeyukM i;koj.k fu;=.k ckM] pUub e liUu cBd e mDr cfgL=ko d çHkkoh mi;kx rFkk mll 'k) jlk;uk dh çkfIr d fy, fofHkUu fodYik d ckj e fopkjfoe'k fd;k x;kA gekj lLFkku d dk;l l çkRlkfgr gkdj TNPCB }kjk lh,l,elhvkjvkb dk pe'kk/ku d mfPN"V çokgh e l eY;oku jlk;uk dh çkfIr ij vUoÔ.kkRed v/;;u d fy, ,d ifj;kstuk nh xbA mfPN"V çokgh e l jlk;uk dh çkfIr dh lHkkO;rk d v/;;u gr ç;kx'kkyk rFkk cp Ldy] nkuk ij vUoÔ.kkRed dk; fd;k x;kA ge bl çokgh e l ftlle rFkk lkfM;e DykjkbM Øe'k% 97.8% rFkk 99.3% 'k) #i e çkIr dj ldA bl vUoÔ.kkRed v/;;u dh foLrr fjikV djkj d fu/kkfjr le; e ell TNPCB dk çLrr dh xbA

ell fgUnLrku lkYV fyfeVM] t;ij dh xtjkr] dPN d NkV j.k dh yo.kh; Hkfe dk i;koj.kh; çHkko d eY;kdu ij v/;;u

ell fgUnLrku lkYV fyfeVM] t;ij u dPN d NkV j.k e viuh 227000 ,dM tehu e l 3100 ,dM tehu rfeyukM d ,d vx.kh ued fuekrk dk nh gA ell ,pl h,y u bl tehu d i;koj.kh; çkpyk dk v/;;u ,d fo'kÔK lLFkku }kjk djoku dh bPNk dh ftlll Hkfo"; e cM lkj lkYV oDl dh fuek.k dju e fd lh çdkj dh i;koj.kh; leL;k mRiUu u gkA mDr ikVh u mijkDr v/;;u d fy, lh,l,elhvkjvkb] Hkkouxj l lid fd;kA dfFkr LFky d voykdu d ckn oKkfud] lLFkku d ued o lenh jlk;u foHkkx rFkk lenh toçk|kfxdh rFkk ikfjfLFkfrdh foHkkx }kjk l;Dr #i l dk; dju e lger g,A lh,l,elhvkjvkb rFkk ell fgUnLrku lkYV fyfeVM] t;ij }kjk djkj gku ij ifj;kstuk dk; çkjHk fd;k tk,xkA

fcVu l fuEu lkfM;e lkYV

2006-08 d f}okfÔd çfronu e mYy[k fd;k x;k Fkk fd e l l lgk;ekrk lkYV fjQkbujh fyfeVM] rrhdkjhu tgk l e l l fgUnLrku fyoj fyfeVM viuh lkYV fjQkbujh ifjpkfyr djrk g] mudk fuEu lkfM;e lkYV çk|kfxdh dk dk;Z fun'ku nuk çkjHk fd;k x;k gA dk;Z fun'ku d nkjku mRikfnr fuEu lkfM;e lkYV dk fof'k"V fooj.k bl çdkj jgk& lkfM;e DykjkbM = 55-58%, ikVk'k = 42-45% rFkk vU; fojy rRo [kk| ued d fy, vue; ek=k e FkA

dk;Z fun'ku dh lQyrk d vk/kkj ij e l l HUL u viu lHkh [kk| mRiknuk e fuEu lkfM;e lkYV dk gh mi;kx dju dk fu.k; fy;k g ftldh foÜo e lh,lvkbvkj@lh,l,e lhvkjvkb çk|kfxdh ckUM uke d lkFk fcØh gkxhA

e l l HUL u gekj çk;kfxd lkYV Qke e Hkh 0;kikfjd Lrj ij fuEu lkfM;e lkYV dk mRiknu dju dh bPNk 0;Dr dh gA rnu lkj lLFkku d çk;kfxd lkYV Qke e dkjuykbV cuku dh çfØ;k py jgh gA

dkjuykbV MhdEikslM çkMDV (CDP) e l lkekU; rkieku ij ikVk'k dh çkfIr

lLFkku e dk;jr vkj ,UM Mh (R & D) dk;{k= d QyLo#i] NaCl/KCl feJ {kkj e l lkekU; rkieku ij ikVf'k;e DykjkbM çkIr dju fd çfØ;k dk vkfo"dkj dju dk l?ku ç;kl fd;k x;k gA ;g feJ {kkj] (CDP) dkjuykbV {kkj dk ikuh d lkFk fo?kVu dju l çkIr gkrk gA lkekU; r% bl feJ {kkj dk iFkDdj.k xje yhfpx (hot leaching) çfØ;k l fd;k tkrk g] tk vf/kd ek=k e Åtk [kp djrh g vkj cgr T;knk (capital expenditure) /ku [kp djrh gA bu nkuk dfe;k dk /;ku e j[kr g,] pkj çdkj dh iFkDdj.k çfØ;k fodflr fd xb g ftl e NaCl vkj KCl {kkj d Hkkfrd vkj jklk;fud x.k/ke e ik; tkuoky vrj dk mi;kx fd;k x;k gA çkjfHkd #i l fd; x, vH;kl mRlkgçjd g vkj cgr ieku ij dk;Z tkjh gA

ikVf'k;e dk ty e ?kyku d fy, ty dh U;ure vko';drk ij v/;;u

bl v/;;u d fy, dokUVe jklk;f.kd x.kuk d lkFk MP2 ,o CCSD(T) fof/k;k dk mi;kx fd;k x;kA x.kukRed ifj.kke ;g çnf'kr djrk g fd pkj tyk.k K^+/Cl^- d foyk;d iFkDdr vk;u dk lk{kf=d (prismatic) lajpuk e LFkk;h j[kr gA N% tyk.k d lkFk Hkh KCl dk iFkDdj.k fn[kk;h iMrk gA KCl d tyh; foy;u dk ru dy ijkorh vojDr LiDVkLdkih (ATRIS) v/;;u }kjk ;g crk;k x;k g fd LFkk;h leg e çR;d vk;u tkMh ikp ty v.kvk l f?kj gkr gA $K^+(H_2O)_5Cl^-$ (,lykbM LiDVkLdkih 1999, 53, 1601; t- dfe- fQ th- 2001, 115, 2664)

rhu ikÔd rRok l le) ued cukuk ¼Vh,Q,l½

ekuo 'kjhj d fy, ued] mRd"V ,oe lLrk l{e ikÔd okgd d #i e egRoi.k gA tu lk/kkj.k e ikÔd rRok d vHkko dk lk/kkj.k ued }kjk de fd;k tk ldrk gA geu vk;kMhu] vk;ju rFkk ftd tl vko';d l{e ikÔd rRok l ued dk le) cuku d fy, ,d uohure ç.kkyh fodflr dh gA mDr Vh,Q,l ued d ikÔd rRok dh fLFkjrk dk ijh{k.k fofHkUu okrkoj.k ,oe ifjfLFkfr;k e fd;k x;k gA ; ikÔd rRo fofHkUu okrkoj.k dh pje lhek e Hkh ued e fLFkr ik; x;A bl uohure ç.kkyh ij iVUV r;kj fd;k tk jgk gA blh nkjku ued foHkkx l lLFkku }kjk cuk; x; Fe^{+}1 ikÔd rRok l le) ued dh fLFkjrk d ckj e çfrif"V çkIr dh xbA

lh,l,elhvkjvkb dh lekdfyr SOP çfØ;k e mRiUu ftIle dh eY; of) rFkk vfr'k) ued mRiknu d fy, vklouh mfPN"V ¼fMLVhyj oLV½ dh mi;kfxrk d lkFk mUur foyk;d çfØ;k

lYQV vkQ iksVk'k cukr le;] ikuh@lenh ty d lkFk dkbukbV dk fo?kVu gkrk g vkj Bkl 'kk;kukbV vkj ekrno mRiUu gkrk g tk dfYl;e Dykjkbm }kjk lYQVfoghu fd;k tkrk gA bl çfØ;k d nkjku ftIle mRiUu gkrk gA geu ftIle dh ,ekfu;k rFkk dkcu MkbvkDlkbM ¼elcx çfØ;k½ çfrfØ;k djd ,ekfu;e lYQV rFkk dfY'k;e dkckuV cuku dh lHkkforrk dk v/;;u fd;kA ç;kx'kkyk d Lrj ij ¼3 fdxk cp½ çfrfØ;k dju ij 93% ftIle ,ekfu;e lYQV d lkFk d dkckuV e ifjofrr gvkA bl rjg l çklr dfY';e dkckuV dk mi;kx djd fuLrkiu }kjk puk cuk;k x;k vkj bl pu dk mi;kx dkckuV foghu ikuh e ykbeLyjh cuku e fd;k x;kA vfr'k) $Mg(OH)_2$ rFkk $CaCl_2$ çklr dju d fy, bl ykbeLyjh dh lYQVfoghu 'kk;kukbV vR; çokgh ¼,UMyhdj½ d lkFk mipfjr fd;k x;kA (lh,lvkbvkj vkbih,eMh ,u,Q ucj 0233 NF 2008 ih lh Vh lnHk ucj PCT/IN2010/000194) lekrj fodkl e ykbeLVku dh vko';drk de djr le; lkMk ,'k d lkFk ,ekfu;e lYQV d lg&mRiknu d fy, ,d mUur elcx&lh,l,elhvkjvkb çfØ;k fodflr dh xb gA

fcVu l vfr'k) eXuhf'k;k

lLFkku u igy fjiksV fd;k g fd lLFkku e vfr'k) eXuhf'k;k ¼'k)rk > 99%½ cuk;k x;kA jhÝDVjh fMoh tu] lhthlhvkjvkb] dydrk u bl eXuhf'k;k l eXu lkbV jhÝDVjh cuk;k vkj crk;k fd 99% MgO xM u mRd"V ifj.kke fn;A (RUL > 1680°C) bld lkFk gh vfr'k) eXuhf'k;k e l eXuf';e /kkr mRiknu dh lHkkouk dk ijh{k.k dju d fy, eVy ,DlVDlu ,UM Qkjehx fMoh tu NML, te'knij e Hkh bldk eY;kdu fd;k x;kA ,u,e,y u crk;k fd] geu lh,l,elhvkjvkb d MgO lEiy (> 99%) dk fo'yÔ.k fd;k vkj ml eXuhf'k;k /kkr mRiknu d fy, ;kX; ik;kA

lekdfyr çk|kfxdh }kjk lYQV vkQ iksVk'k

foxr 2006-08 dh fjiksV e] fcVu e l lekdfyr çk|kfxdh }kjk lYQV vkQ iksVk'k mojd d mRiknu d ckj e mYy[k fd;k x;k gA ;g çk|kfxdh ellj vkph;u dfedy bUMLVht] pUub dk gLrkrfjr dh xb gA ;g ikVh dPN d cM j.k e 1,00,000 Vhih, {kerkokyk lykUV LFkkfir dju tk jgh g tk ckn e 3,00,000 Vhih, Ldy ij LFkkfir fd;k tk,xkA n'k e iksVkf'kd mojdk dh c<rh gbZ ekx rFkk fu;kr dher dk utj e j[kr g, Lon'kh iksVk'k mRiUu dh rho vko';drk eglll dh xbZ gA lLFkku d }kjk fodflr] vrjjk"Vh; iVUVhdr SOP çfØ;k d ckj e fofHkUu jk"Vh; Lrj ij foLrr ppk dh xbZ gA NMCC, Hkkjr ljdkj d ç;kl l lLFkku d ç;kfxd lkYV Qke e] 0.75 VhihMh lYQV vkQ iksVk'k dh ijh{k.k D;kjh dk lykUV LFkkfir dju d fy, DST }kjk foÙkh; lg;kx çklr gvk gA ;g lykUV 0.75 VhihMh ,ekfu;e lYQV ¼FCO xM½ rFkk 0.03 vfr'k) eXuhf'k;k dk Hkh mRiknu djxkA ;g lykUV cM iekus ij fun'ku dju d #i e Hkh lfo/kk çnku djxk rFkk m|kxdfe;k rFkk foÙkh; lLFkkuk e çk|kfxdh foLrrhdj.k d ckj e n< foÜokl fnyk;xkA

Lon'kh iksVk'k çk|kfxdh dk çkRlkfgr dju d fy, gekjh rduhd ij vk/kkfjr NMCC d rRok/kku e gekjh ,d 3 VhihMh {kerkokyk SOP lykUV ell VkVk dehdYl fyfeVM] ehBkiqj e DST] Hkkjr ljdkj dh vkf'kd foÙkh; lgk;; l PPP ¼Public, Private, Partnership & tuleg] fu th] lgHkkfxrk½ vk/kkj LFkkfir fd;k tk jgk gA VhlhLy d vf/kdkfj;k dk gekj lkYV Qke e bl çk|kfxdh dk dk; fun'ku lQyrkiod fn;k x;kA gky e bl çk|kfxdh dk gLrkrj.k ,oe yk;lUl djkj fd;k x;k gA

ikVk'k çkfIr e of) d fy, Ikj ck"iu nj c<kuu ij v/;;u

gekj io fj ikV e mYy[k fd; vu Ikj] ykbe vkj pu dk dPph Ikexh d #i e mi;kx djd IYQV vkQ ikVk'k (SOP) mRiknu dju dh uohu çfØ;k fodfIr dh xb gA bI vfHkxe e dkbukbV fefJr ued e I mRikfnr 'kk;kukbV d vfreno e I SOP ,o MOP çkIr dju d fy, 'kk;kukbV rFkk E;jV vkQ ikVk'k (MOP) dk mipfjr fd;k tkrk gA ;g çfØ;k bI [kch I fodfIr dh xb g ftIIs IgmRikfnr no dk Irr IIxrrk I iu% pfØr fd;k tk Idrk gA bI h nkjku SEL d ck"iu dh xfr c<ku d fy, jtd dk mi;kx djuk mfpr Ie>k x;kA gfjr jtd ¼nokj, IhM xhu oh,½ dk mi;kx dju ij ok"iu nj e 10-15% of) ikb xb vkj i.k fØ;k e jtd dh deh cgr de ek=k e ikb xbA jtd dh deh nj dju e rFkk vf/k'kkÔ.k {kerk T;knk gk o I jtd d ckj e ç;kxkRed I'kk/ku dk; tkjh gA

BR-S gfjr ckehu vfHkded dk IkfM;e DykjkbM jfgr InÔ.k I fuek.k

bI ILFkku u igy gh 2:1 IkfM;e ckekbM % IkfM;e ckeV tk nfor ckehu g] mI cuku dh 'khr çfØ;k dk ,dkf/kdkj çkIr fd;k gA bI fof/k e rh{.k ckehu dh dkfLVd IkMk d IkFk vfHkfØ;k djk nr g rri'pkr 4:1-5:1 ckekbM % ckeV vuikr dk iu% Dykjhu vkj dkfLVd IkMk I vkDIhdr djr g ftII 2:1 vuikr dk gfjr ckehu çkIr gkrk gA bI çfØ;k }kjk ckehu dh vfHkdkjd {kerk de gk tkrh gA bI çde e mi&mRikn ued gA rnu Ikj eEcu d{k e vkDIhdj.k dh fo|r jkIk;fud çfØ;k dh xb ftII NaCl dh v'kf) nj dh xbA

ijkbVkcU tkby ckekbM

ijk&ukbVkVkY;u ¼ih,uVh½ e I gfjr ckehu ¼ckehu e I rjr mRikfnr 2:1 NaBr-NaBrO$_3$½ dk mi;kx djd 'k) ih&ukbVkcU tkby ckekbM mRikfnr dju dh fof/k dk mUur fd;k x;kA dkcu VVkDykjkbM ,d vkn'k foyk;d d #i e igpkuk x;k D;fd bI I çfrfØ;k dk LQfVdhdj.k Hkh fd;k tk IdkA bI fof/k }kjk çfr cp e 250-300 xk 98% 'k) PNBBr rFkk PNT I Ief) ekrno Hkh feykA vo'kÔ mRikn rFkk v'kf);k dk vxyh cp e Ijy ifjpkyu e iu%pfØr fd;k x;kA vkBoh ckj iu%pØ.k d vr e foyk;d dk ekrno I vyx fd;k x;k vkj PNT çkIr dju d fy, vo'kÔ dk fuokr fuL;nu fd;k x;kA PNT d fuL;nu d ckn cp vo'kÔ e PNT rFkk PNBBr d IkFk ckehuVM v'kf);k (NO$_2$-Ar-CHBr$_2$) ikb xbA bu v'kf);k dk iu% PNT rFkk PNBBr e ifjofrr fd;k x;k vkj iu% mi;kx dju ;kX; mRikn çkIr fd;k x;kA I/kkj d mRiUu fof/k }kjk dy mit rFkk ckehu ijek.k n{krk Øe'k% 96% rFkk 90% ikb xbA

2:1 ckekbM&ckeV rFkk vk;kMkbM&vk;kMV vfHkdedk d IkFk vkfyQhu dh folhyhu fØ;kRedrk dk ryukRed v/;;u

ryukRed eY;kdu d fy, vkfyQhu I β&gykfeFkkby bFkj vkj β'&gyk ,IhVV çdkj d gykgkbfMuk dk 2:1 vEy o X$^-$/XO$_3^-$;Xe }kjk I'yÔ.k fd;k x;kA çk;kfxd #i I mPpre gyktu ijek.k çHkkfodrk mi;Dr dk; d fy, 97% Br$^-$/BrO$_3^-$ rFkk 93% I$^-$/IO$_3^-$ d fy, ikb xbA mDr vfHkded jkt vkDIkbM d I'yÔ.k gr Hkh IokÙke ik;k x;kA I$^-$/IO$^-$ vfHkded] vkYdhu rFkk gyk ,IhVV IÜyÔ.k dh folhyhu fØ;kRedrk d fy, mi;Dr jh,tUV ik;k x;kA ;|fi pkydkU I rFkk VkU I LVhychu dh folhyhu fØ;kRedrk d fy, Br$^-$/Bro$_3^-$ çHkkoh ik;k x;kA 2:1 I$^-$/IO$_3^-$ dk mi;kx djd vk;kMkfeFkkby }kjk] fIVkuyky e I ,d gh çfØ;k fodfIr dh xb vkj 82% mit çkIr dh xbA (fIUFk- dE;- 2010, 40, 3233)

BR Ө- gfjr ckehu e lU0;RiUu ,d uohu vkDlhMkbuhx ,tUV

Br⁻/BrO$_3^-$ d 2:1 v.k vuikroky gfjr ckehu dk nk vkDlhMkbthx ,tUV e ifjoru fd;k x;kA ,d] Br⁻/BrO$_3^-$ = 1:3.5 rFkk nlj e 1:8 vuikr FkkA igy ,tUV dk mi;kx Fkhvky vkDlhM'ku d fy, rFkk nlj dk lYQkbM rFkk vkYdkgky vkDlhM'ku d fy, mi;kx fd;k x;kA Fkhvky dk lYQkbMfofgu vkDlhM'ku e Fkhvky rFkk BrO$_3^-$ dh 6:1 v.k vuikr d lkFk mPp mit feyhA tcfd lYQkbM rFkk ctkbd f}rh; vkYdkgky d vu#ih lYQkDlkbM rFkk ,YMgkbMl @ dhVkul dk BrO$_3^-$ d 3:1 v.k vuikr d lkFk lQyrkiod fy;k x;kA

; vuikr BrO$_3^-$ dh l)kfUrd U;ure vko';drk d vu#i gA 0.30°C ij inkFkk d vk/kkj ij H$^+$ rFkk Br⁻ d mRçj.k ek=k d lkFk çfrfØ;k çkjHk dh xbA nljk jh,tUV e igy l gh lekfo"V FkkA mi;kx e fy, x, jh,tUV dk iu% mRiknu ,o iu% mi;kx dk Hkh fun'ku fd;k x;kA ¼bUM- bth- de- fjl- 2010, 49, 1236;1241½

vk|kfxd ;fuVk@jkT; ,tfUl;k dk çnku dh xb rduhdh lok,

ell lk/kh bUMLVhtfyfeVM] lk/khije] dPN d fy, LFky p;u lc/kh çkFkfed lo{k.k

lk/kh bUMLVht foÜo dk lcl cMk lheV fofuekrk g tk çfrfnu yxHkx 8000 Vu lheV dk mRiknu djrk gA bl ikVh u i;ty rFkk çfØ;k ty mRiknu d fy, ,d cgfo/k çHkkoh fuL;nu lykUV (MED) LFkkfir fd;k gA bl lykUV d 300 eh³ çfr ?k.Vk ifjpkyu d nkjku 50000-55000 ihih,e VhMh,l okyk uedhu ty mRikfnr gkrk gA mDr lheV lykUV rFkk MED ;fuV [kkjk Øhd d ikl fLFkr g tgk fujrj Tokj ty dk çokg jgrk gA ljdkj u bl ikVh dk [kkjk Øhd d ikl dPN fty d vdjh xko dh 1104 ,dj ctj tehu mRiknu d fy, nh g vkj mUgku ljdkj }kjk forfjr tehu dh ued mRiknu d fy, ;kX;rk eY;kdu dju gr rduhdh lgk;rk çkIr dju d fy, lh,l,elhvkjvkb l lid fd;kA lh,l,elhvkjvkb d oKkfudk u lkj ued mRiknu d fy, LFky dh ;kX;rk dk eY;kdu dju d fy, LFky dk çkFkfed lo{k.k fd;k rFkk foLrr fjikV ,oe çLrko ikVh dk Hkt x,A

ell iVy ,uth fyfeVM] ecb dk lkj ued mRiknu d fy, vkj vk vLohdk; ty d mi;kx d fy, rduhdh lok,

ell iVy ,uth fyfeVM] ecb] xtjkr d vejyh fty d tkQjkckn rglhy d y'kkij xko d ikl 660 mw/?kVk dh {kerkoky nk dky Qk;jM ikoj lykUV LFkkfir dju tk jgk gA ;g ikVh lenhty d foyo.khdj.k d fy, vkj vk lykUV Hkh LFkkfir dju dk vk;ktu dj jgh gA vi{kk dh tkrh g fd foyo.khdj.k çfØ;k d nkjku yxHkx 5.5-6° Be ?kuRookyk ckbu vLohdr 750 eh³@?kVk gkxkA ikVh bl vkj vk vLohdk; ty dk lkj ued mRiknu e dju dh lHkkoukvk dk mi;kx djuk pkgrh gA bl vLohdk; ty d mi;kx }kjk ued mRiknu dk 0;olk; djuoky m|edrk <<u e ikVh dh fo'kÔ bPNk gA ikVh }kjk vujk/k dju ij gekj nk oKkfudk u vf/kdkfj;k d lkFk Rofjr fopkj gr çLrkfor LFky ij eykdkr dh vkj foLrr ijke'k çLrko ikVh dk Hkt x;kA

e l l HSL, t ; ij }kjk lkHkj ljkoj l utnhd 45 ,dM foHkkftr djuoky dM e l ,df=r feVh d ueuk dk fo'yÔ.k

;g fjikV fd;k x;k g fd e l l lkHkj lkYV fyfeVM] tk HSL dk vunku vkfJr g og] ckbu d lxg d fy, dM cuku dk vk;ktu dj jgk gA bl gr d fy, mUgku lkHkj ljkoj d fudV 45 ,dj tehu dk p;u fd;k gA ckbu d vr%L=o.k nj tkpu d fy, d iuh feVh dk ijh{k.k djuk pkgrh gA feVh d 15 ueuk d fo'yÔ.k l Kkr gvk fd ;g feVh e.e; çdkj dh g ftle U;ure fjlu nj ik;k x;k gA vr% dM fuek.k d fy, p;fur {k= vPNk gA

lkMk ,'k e ¶ykjkbM dk de gkuk

dU;k dh ekxMh lkYV oDI d lg;kx l ¶ykjkbM dh ek=k dk U;ure djd rduhd fodflr dh gA Qt deLVh d vk/kkj ij dN çfØ;k, fodflr dh xb vkj lkMk ,'k mRikn e 90% l T;knk ¶ykjkbM vyx djuk lHko gvkA

fo'yÔ.k lok, vkj fof/k fodkl

oÔ 2002 e fo'yfÔd foKku foHkkx d vrxr dUnhdr midj.k lfo/kk dk ltu gvk ftle lHkh e[; midj.kk dk ,d gh txg ij j[kk x;k ftlls lHkh mi;kxdrvk dk leku volj feyA bld xBu d i'pkr lLFkku dh vkUrfjd ifj;ktukvk ,o Hkxrku d vk/kkj ij ckgjh mi;kxdrvk d ueu fo'yÔ.k gr fo'yfÔd vkj ckf)d v'knku çnku djrk gA bldh 'k#vkr dN midj.kk l gb Fkh] ifj.kkeLo#i oreku e 31 e[; midj.k lLFkku e ekStn gA lefir oKkfud rFkk rduhdh fo'kÔKk dk ,d ny bu midj.kk dh n[kHkky vkj mi;kx d fy, dk;Z dj cgrj fo'yfÔd fof/k;k dk fodkl dju d lkFk lkFk oreku e ekStn fof/k;k dk cgrj cuku e yxk gvk gA

lenh 'koky d ?kVdk dh çoLFkk igpku d fy, ikoMj XRD dk mi;kx

l[k 'koky d d.kk l Åtk çkfIr rFkk [kkn d #i e bldh jk[k dh mi;kfxrk irk yxku d fy, lLFkku e çfØ;k vuql/kku py jgk gA bld ?kVdk dh çoLFkk igpku d fy, ikoMj XRD fof/k cukb xbA ?kVdk dh çoLFkk pkVh dh rhork] lkUnrk] lajpuk vkj vkf.od vo'kkÔ.k x.kkd dh jfdx] lkfgR; e fn, x, ekuk d vk/kkj ij fd;k x;k FkkA rhork jfdx ç;kxkRed #i l dh tkrh g vkj lEi.k lkUnrk ij jfdx vk/kkfjr gA

inkFk x.k fp=.k gr VkfLe'ku byDVªku ekbØkLdkih ¼Vhb,e½

jtr lIpu jthu

jtr lIpu thok.kuk'kd gku d dkj.k egRo çkIr dj jgk gA jtr&dkVM ikyh foukby ,Ydkgky d ueu dk fo'yÔ.k fd;k x;kA TEM vkj STEM çfrcUc e dky /kCc dk ik;k tkuk jtr dh vkj lUng djokrk g ftudh if"V STEM-EDS ekufp=.k l gbZ gA

ehlkl j/kh ikjl inkFk dh tkp

PEG-20,000 ¼ljQDVUV½ dh mifLFkfr e lkfM;e flyhdV l SBA-15 rjg dh fetkikjl flfydk l'yfÔr dh xbA

uukinkFk dh tkp

Vhb,e dh lgk;rk l uuk inkFkk dh tkp dh xbA mnkgj.k CeO2 uuk D;c vkj Au-Pd uuk&ikVhdyA

olkbdYl dh tkp

tyh; ek/;e e ljQDVUV d feJ.k l fufer olkbdYl dk TEM }kjk ijh{k.k dj çfrfcc fy, x,A TEM fxM d Åij ueu dk j[kdj jkrHkj l[ku ij çfrfcc fy;k x;kA

to Mht y vkj thok'e Mht y d dkfy[k dh ryuk

to Mh t y (B100) vkj thok'e Mh t y pfyr okgu d ikbi l ,d lgk;d ;U= dh enn l dkfy[k dk bDVBk dj TEM rLohj yh xbA de exuhfQd'ku ij d.k xkykdkj fn[kkb fn, tcfd mPp exuhfQd'ku l l;kt d tlh l{e ljpuk fn[kh ftlе vUrjijr xkfQu d leku gA

byDVku ekbØkLdki }kjk inkFkk dk x.k fp=.k

ikyhlYQku f>Yyh d Økl vuHkkxh; tkp

ty dhVk.k'kk/ku d fy, lh,l,elhvkjvkb u piVh pknj leku vkj [kk[kyh Qkbcj leku f>Yyh fodflr dj ml cM ieku ij cuku ij dk; fd;kA rduhdh tkudkjh dk lu 2010 e ykblUl fn;k x;kA f>Yyh fuek.k çfØ;k e l{e ifjoru dj fNn ljpuk vkj fNn vkdkj e ifjoru dk n[kuk t#jh gA f>Yyh dk bl rjg dk v/;;u TEM }kjk fd;kA rt pkd l vuHkkx dkVk x;kA ,yfeuh;e LVc ij ueu dk [kMk j[kdj [kMh ukyh cukb xbA lku l yfir ueu dh Nfc yh xbA

VkbVfu;e MkbvkDlkbM uukV;c dh tkp

fo|rjlk;u fof/k }kjk VkbVfu;e d Åij VkbVfu;e MkbvkDlkbM uuk V;c fodflr dj ml dk çfrfcc fy;k x;kA

byDVkfMikft VM ikyh,uhyhu

fo|r jklk;fud fuek.k e vklkuh vkj pkyd gku dh otg l ikyh,uhyhu dk 0;kid v/;;u fd;k x;k gA xQkbV lrg ij fo|r jklk;fud l'yfÔr dj Nfc yh xb ftlе Hkx ljpuk ikb xbA

Øk;k ifjfLFkfr e vpy ikyhej fQYe dh Nfc

vkrfjd ljpuk e Øk;k&ÝDpj dk fn[kku e Øk;kfQD'k'ku lgk;d gA

exQyh d ik/k vkj cht dk ijh{k.k

lekU; vkj lØfer exQyh ik/k d ueu dh SEM Nfc }kjk tkp dh xbA

LoPN fy[kkboky pkd e ÝDpj dh tkp % byDVku fdj.kk l fo'yÔ.k

lLFkku }kjk fodflr LoPN fy[kkboky pkd dk Ldfux byDVku ekbØkLdki }kjk ÝDpj d forj.k dk ijh{k.k fd;k x;kA ,d Hkxj inkFk e ÝDpj dh yEckb ruko dh ljf{kr lhek dk de djrh gA dUn d lehi ÝDpj dk ?kuRo ifjf/k dh ryuk e T;knk g tk ;g n'kkrk g fd l[ku dh çfØ;k d nkjku ÝDpj fodflr gvkA vfu;fer <x l pu x, ÝDpj vkj lrg dk EDAX fo'yÔ.k leku rRo dh jpuk fn[kkrk gA blfy, jpuk fofo/krkvk dk ÝDpj e dkb lEHkkfor dkj.k ugh gA

,Vkfed Qkl ekbØkLdki }kjk lrg dk x.k fp=.k

fQYe dh lrg dh cukoV rFkk mPp foHknu ij vkoj.k tkuu d fy, AFM vR;r mi;kxh gA lLFkku e cukb xb vkj vk eEcu d ikyhlYQku vkoj.k rFkk ikyh,ekbM {kkj vLohdfr vkoj.k dh cukoV ij v/;;u fd;k x;kA ;g v/;;u] lrg cukoV e l/kkj dju d fy, Hkfo"; d l'kk/ku dh fn'kk fu/kkfjr dju e mi;kxh gA

Bk l voLFkk NMR }kjk x l Hk.Mkj.k inkFk dh tkp

l 'yÔ.k d nkjku lfØ; dkcu fefJr dju l /kkr&dkcfud <kp (Cu-BTC) dh x l Hk.Mkj.k {kerk c<rh gA lfØ; dkcu dh voLFkk dk le>u d fy, Bk l&voLFkk NMR v/;;u fd;k x;kA inkFk e ijkexufVd (Cu^{+}) LiDVe vf/kxg.k çkVkdky dk ifjofrr djrk g vkj çfr/ofu ç;Dr dj ^{13}C LiDVk çkIr fd, vkj vYidky e db foJke&foyEc Ldu fd, x,A dkcu fefJr Cu-BTC e d pkj e l nk vuuknk dk pkMkb gkuk ^{13}C NMR n'kkrk g] ft l l dkcu ?kVd dh ijLij fØ;k dk ck/k gkrk gA doy Cu-BTC dk Bk l&voLFkk NMR ;g n'kkrk g fd ty d dN v.k xgk d lkFk lkFk Cu d lkFk Hkh fylr gA nkuk vuuknk dh rhork e deh gkuk ;g l dr nrk g fd dkcu feJ.k dju ij dN ikuh d v.k foLFkkfir gk tkr g] ft l dh if"V rkieku fo'yÔ.k l Hkh gb gA 3KHZ MAS vkofr }kjk irk pyk fd ^{1}H d chp njh T;knk g tk inkFk d >j>jiu dk ifj.kke gA ^{1}H Bk l voLFkk NMR dk mi;kx >j>jk inkFkk dk vkdyu dju e mi;kxh gA

ED f>Yyh e MRI }kjk çlkj v/;;u

vk;u vknku&çnku vk;uk d çlkj eY; ij fuHkj djrk gA /kuk;u ukQhvku eEcu ij çkVku rFkk vU; /kuk;uk dk vknkuçnku n[ku d fy, v/;;u 'k# fd;k x;kA i)fr ekU; gku ij lh,l,e lhvkjvkb dh /kuk;u rFkk _.kk;u bUVjikyhej eEcu ij v/;;u foLrr fd;k tk,xkA

vk|kfxd mRikn ¼¶ykjkbM fu"dklu çfØ;k½ e ¶ykjkbM dk vk;u ØkeVkxkQh }kjk fu/kkj.k

vfr ¶ykjkbM ;Dr ty vkj vk rduhd l mipfjr djr le; mRiUu vkj vk rduhd ty e ¶ykjkbM dh ek=k dk vkdyu dju d fy, ,d fof/k fodfl r dh xbA efVDl vfLFkj gku d dkj.k bl e vo/kkj.k le; dk ydj dN leL;k FkhA geu fofHkUu efVDl ¼lkfM;e dkckuV] lkfM;e ck;dkckuV vkj lkfM;e DykjkbM½ e ¶ykjkbM Kkr dju dh ekud fof/k fodfl r dh vkj ØkeVkxke dk pykdj ;g ik;k fd fHkUu eVhDl dk dkb gLr{ki ugh gA 500°C ij ueu dk ,d fnu d fy, xje dju ij ogh vo/kkj.k le; ¼1.71 feuV½ ik;k vkj ueuk dk fo'yÔ.k fd;kA

,D l&j ¶ykjkslUl LiDVkehVj }kjk rRok dk ijh{k.k

Bk l inkFkk e rRok d ijh{k.k d fy, XRF ,d mfpr ,o cge[kh rduhd gA XRF ç.kkyh }kjk rRok dk x.kkRed ,o ek=kRed fo'yÔ.k lVhd #i l gkrk gA fofHkUu çdkj d ueu t l ckDlkbV] lMheUV] Dy] lenh 'koky] feVVh vkfn dk fo'yÔ.k fd;k x;kA PPM Lrj l ydj çfr'kr rd ;kX; vkj fo'oluh; ifj.kke çkIr fd, x,A feVVh e foÔkDr Hkkjh /kkrvk dk vkdyu fd;k x;kA gky gh e ¶ykjkbM fu"dklu jthu dk blds fofHkUu pj.kk e Na, Al, Ca, F vkfn dk ijh{k.k fd;k x;k ftl l blds çfØ;k dk cgrj le>k tk ldA

rRo fo'yÔ.k d fy, ;fXer lykTek LiDVkQkVkehVj

foy;u e /kkr ek=k fu/kkj.k d lkFk&lkFk lYQj] QkLQkjl] flfydku] vklfud d (ppm/ppb) ek=kRed fo'yÔ.k d fy, ;fXer lykTek LiDVkfefr ,d lxe rduhd gA fofHkUu lkrk l çkIr ueu [kklrkj ij i;koj.k leg d ueu d fo'yÔ.k e bldk 0;kid mi;kx gvk gA Hkkjh foÔkDr /kkr d vk;uk dh fuxjkuh] vfHkfØ;kvk e vk;uk dh yhfpx] ft;kykbV e vk;uk d vknku&çnku] Qkek e /kkr v'kf) o tfod r= e /kkr d çHkko feêh rRo fo'yÔ.k] tfod inkFkk e ikÔd rRo dh mifLFkfr@vuifLFkfr vkj ikuh dh x.koÙkk dk ijh{k.k fd;k x;kA bl çdkj d fo'yÔ.k e ueu cuku d fHkUu rjhdk dk vuç;kx fd;k x;kA

ik/k d fodkl fu;U=d d iFkDdj.k d fy, fof/k

RP-HPLC ;U= dk mi;kx dj fofHkUu ik/k d fodkl fu;U=d d fy, fof/k fodflr dh xbA 150 fefe yEckb] 4.6 fefe O;kl vkj 5uM d.k vkdkjoky Luna C18 LrEHk dk fLFkj pj.k d #i e bLreky fd;k x;kA ,lhVkukbVkby ty dk pfyr d #i e bLreky fd;k x;kA lHkh ?kVdk ¼fxCcjfyd ,flM dk NkMdj½ dk 256 nm dh rjx ij LiDVk fy;k x;kA Qjklhye ty xBu d vkdyu d fy, fof/k fodflr dh xbA Qjklhye ,d ikyh ,djyhd vEy vk/kkfjr ikyhej g ftle Fe^{3+} gkrk gA ty fuek.k d lkFk bldh thok.kjk/kh x.k g] ftl dk vkdyu HPLC-GPC ç.kkyh l fd;k x;kA

ESI-MS d mi;kx l fLFkjrk fLFkjkd eki

K^{+} vkj Na^{+} d lkFk eØklkbdyhd vk;ukQkj d fLFkjkd ekiu d fy, ESI-MS fof/k dk mi;kx fd;k x;kA vkrfjd ekudk dk mi;kx dj] bl dk;i e /kuk;uhdj.k {kerk vkj vk;ukQkj d /kkr ldyu dk ESI-MS LiDVk l fLFkjkd ik;kA lkfgR; e fn, x, lehdj.k d fglkc l mijkDr MkVk dk mi;kx dj fLFkjkd dh x.kuk dh xbA K^{+} d lkFk vU; pØh; vk;ukQkj dh Hkh blh rjg fLFkjkd Kkr dh xbA

fofHkUu mRiknk e ueh fo'yÔ.k

dky&fQ'kj dh lgk;rk lgkbMkVy lkbV] to Mh ty] vk;fud no vkfn e ueh ijh{k.k fd, x,A bu fo'yÔ.kk e ldN d fy, ektnk rjhdk e l'kk/ku vko';d FkkA

tyh; ek/;e e ukbVV&ukbVkbM vkj QkLQV dk fo'yÔ.k

¶ykbU tD'ku fo'yÔd (FIA, 5000, Qk l Tecator) ;U= dh enn l ukbVV&ukbVkbM vkj QkLQV fo'yÔ.k fd;k x;kA li.k NO$_2^-$- NO$_3^-$ Kkr dju d fy, fof/k e l'kk/ku fd;k x;k vkj lenh ty e doy NO$_2^-$ dk Kkr dju d fy, okLrfod yo.krk ydj dyhc'ku fd;k x;kA ektnk fof/k e l'kk/ku dj li.k QkLQV vkj vkFkk&QkLQV dk Hkh bl ;= l Kkr fd;k x;kA bl l'kkf/kr fof/k l ueuk dh cMh l[;k fo'yfÔr dh xbA

vdkcfud inkFk ,oe mRçj.k

mRçj.k vkj vf/k'kkÔ.k jklk;fud m|kxk d çe[k foÔ; gA lh,l,eluhvkjvkb bl {k= e n'kkCnh l vf/kd le; l 'kk/k dj jgh gA bu çfof/k;k d ey Kku dh of) rFkk m|kxk l lg;kxu e] mí';k dh çkflr gr inkFk@çfof/k d fodkl e geu jkekpd ;kxnku fd;k gA fofHkUu çdkj d inkFk tl fd] enk] ft;kykbV] lrgh inkFk] ehlkfNnh] /kkr ldy rFkk vkDlkbM] /kkr uuk d.k rFkk dkcu cuku rFkk mud mRçj.k ¼lekx] foÔekx] l'kkf/kr foÔekxh lekx] QkVk rFkk voycå vkj vf/k'kkÔ.k d mi;kx e gA vkÔf/k] l{e jlk;u] dfÔ jlk;u rFkk lx/k m|kxk e fo'kÔ mi;kx dh íf"V l] mRçj.k e] gkbMkQkjeyhdj.k] vlefer ifjoru] p;fur vkDlhdj.k] leko;ou] l?kuu rFkk vidÔ.k vfHkfØ;k;] dh xbA vf/k'kkÔ.k e] vkDlhtu ukbVktu foyxu] Vyxl e CO dh of)] ¶yx l l CO_2 dh çkflr] gkbMktu HkMkj.k rFkk ehFku dh p;fur iukçkflr ij 'kk/k dk; gk jgk gA bu inkFk l'yÔ.k dh vnHkr {kerk bu egRoi.k {k=k d ;kxnku l ey [kkrh g tk mPp biDVoky vrjjk"Vh; tuyk rFkk iVVk l ljf{kr fd; x;A bl lf{kIr Hkfedk d lkFk 2008-10 dk 'kk/kdk; çLrr gA

inkFk

vlrgh LDH dk l'yÔ.k ¼ ,d ljy f}inh vfHkxe

LDH vk;fud lrgh ;kfxd gkr g ftue /kukof'kr gkbMkDlkbM ijr vkj vkrfjd lrg _.kk;uk l Hkjh gkrh gA bUg lkekU; l= $[M^{2+}_{(1-x)} M^{3+}_{x}(OH)_2]A^{n-}_{x/n}.mH_2O$, l 0;Dr fd;k tkrk g] tgk M^{2+} vkj M^{3+} f} rFkk f=&l;kth /kkr vk;u g vkj cLkbV tl ijrk e vkDVkgMy fLFkfr e gkr g vkj A^{n-} tyh; _.kk;u gA gky d mi;kxk e çdk;d uuk l?kVdk rFkk ljpukvk d fy, vlrgh LDH dh ekx g ftle uuk ijrk dh ekVkbl yxHkx 1 l 5 uuk ehVj gk D;kfd mue uohu Hkkfrd rFkk jklk;fud x.k gkr gA vU; vdkcfud _.kk;uk dh ryuk e ukbVV ;Dr LDH e vi'kYdu T;knk gkrk g] gkykfd bld ,d in l'yÔ.k e vrj lrgk e dkckuV dh v'kf) jgrh gA geu vHkh ukbVV ;Dr NiAl/CoAl LDH fcuk dkckuV v'kf) d ,d in e cuk;k g ftle Kkr fof/k l gDlkehFkhfyu VVkehu dk ty fo?kVu fd;k x;k tgk rki Økfrd FkkA bu LDH dk lQyrkiod ty e mPp n'kkvk e vlrgh fd;k x;k ftle QkjekekbM e i.k vlrgu ik;k x;kA AFM u mlh rjg d d.k vkdkj@ifjeki d lkFk mruk gh vi'kYdu fcuk ek/;e d çHkko d fn[kk;k tcfd bld fo#) iuLVd u ek/;e ij dkQh fuHkjrk crk;hA QkLQV xg.k v/;;u u fn[kk;k fd Kkr vlrfir LDH dh ryuk e bu inkFkk e mPp vk;u mÙke {kerk gA mDr fof/k l ukbVV cuku dh fof/k dk ;g çFke çfronu gA tyh; ,o dkcfud ek/;e e lQy LDH dk vlrgu] lonh fQYek] l?kVd idftx vkj de ek=k e p;fur gkfudj _.kk;uk dk de lknrk l vyx dju d fy, mi;kxh fodYi gA

Co-Al-LDH dk rkih; vi?kVu ¼ jh<h ljpukoky ioorh vkDlkbM dh igpku

Co-Al-CO_3^{2-} LDH d 3R_1 ikyhVkbi d m"eh; vi?kVu iFkk dk] Hkkfrd jlk;u rduhdk] fofHkUu rki XRD, UV-vis SEM rFkk l)kfUrd DIFFaX vudj.k }kjk le>k x;kA LDH 250° l- d uhp vi?kfVr gkdj jh<h ljpuk nrk gA vi?kVu l igy ,d ek/;fed ljpuk curh g] ftle /kkr gkbMkDlkbM C&v{k l fu;fer LVd gkrk g fdr lrg vukorh gkrh gA ;g ljpuk bUol gkÅl vkQ dkMl tlh gA Vkikjklk;fud lc/k d dkj.k ;g jh<h ljpuk jh< cuku d fy; t#jh ek/;fed gA ¼cy- eVfj- lk- 33 (2010) 319½

LDH e ljpukRed fLFkku d #i e /kkr vkDlkbM ijr

LDH e /kkr gkbMkDlkbM ijrk dk ;g iVu _.kk;uk d ek/;e l gkrk gA lYQV vk;u d ekey e C_3 v{kk ¼S-O c/k l Hkh½ l vUrfo"V gkrk g tk C&v{k d lekUrj gkrk gA lYQV vk;u d ekey e ikuh d lkFk etcr gkbMkstu c/k cukrk g vkj rki rFkk vo{ki.k pH d vk/kkj ij t;ktu xky dk fofHkUu ifj.kke e c<krk gA futyu d nkjku vUrijr {k= e ikyhVkbi cuu d fy; db rF; gk ldr gA bUg fofHkUu rki XRD rFkk DIFFax vudj.k l tkpk x;kA /kkr gkbMkDlkbM dh ijr "ljpukRed fLFkku" tlk 0;ogkj djrh g] vkj ikyhVkbi d jkgekgMy rFkk ÔVdk.kh; lefefr;k e vUrifjoru] Øfed ijrk

(± 1/3, ± 2/3) d l[r LFkkukUrj.k l] ab lyu d ,d nlj dh ryuk e] gkrk gA db lHkkoukvk e l bu LFkkukUrj.kk dk puk x;k] D;kfd ;g çR;d ijr d lefer rRok d l;kx dk cuk; j[krk g vkj mll fØLVy dh QkYM lefer vUrlrg ifjoru e ljf{kr jgrh gA LDH d mRØe.kh; futyu l lekU; rki d ikl ¼30-60° l½ ; ifjoru ljy gk tkr g] ftlle vUrijr {k= d fufÔ) LFkku l ikuh fudyrk@?kLrk gA bl ljpukRed fLFkku vfHkxe dk vud BklkS dh fØLVy lefer dh Hkfo";ok.kh d fy; mi;kx fd;k tk ldrk gA ¼t- ,ukx- vkYx- dfe- 636 (2010) 2658½

cgyd l?kVdk d fy; uuk enk

Hkkjrh; ey dh cVkukbV enk l] cgyd enk uuk l?kVdk d vkdM ,oe tkudkjh gr] lh,l,elhvkjvkb e fodflr uuk enk d ;kxu ,oe tkp gr ,d v/;;u fd;k x;kA bl v/;;u e llxrd d fcuk rFkk lkFk e ukbyu] PC rFkk PET] rhu vyx&vyx uuk enkvk d lkFk 3 rFkk 5% Hkkj d vuikr e feyk; x;A ; ueu vikjn'kh ik; x; ftue ukbyku d lkFk ihykiu] PC d lkFk Hkjkiu rFkk PET

d lkFk xykch jx jgkA bue lh,l,elhvkjvkb uuk enk dk ç;kx ukbyku d lkFk mi;Dr g ftlle çfr'kr c<kb egRo i.k <x l c<hA blls ;g Hkh irk pyk fd nh?kdj.k d çfr'kr c<ku d fy; uuk enk dh mPprj ek=k dh t#jr gA vPN çHkko 'kfDr d fy;] gekjh uuk enk] 3% ijd ek=k d lkFk PET d fy; Hkh mi;Dr g] ijUr PC d fy; Bhd ugh gA ¼bUM- bth- dfe- fjl- 2010, 49, 1677½

ekVekfy;kukbV vkÔf/k fMyhojh lokgd d #i e

fu;f=r vkÔf/k fMyhojh çk|kfxdh to vkÔf/k /kkr foKku dk rth l c<rk gvk {k= g ftle jlk;uK rFkk blds btfu;j ekuo LokLF; d ykHk d fy; fujrj ;kxnku dj jg gA fu;f=r fMyhojh i)fr dk fMtkbu djd] mPp foÔkDr Lrj rd igp fcuk ;k fuEure çHkkoh Lrj l de ij gh] vkÔf/k dh okfNr ek=k cuh j[kh tk ldrh gA e[;r% MMT ;Dr 'k) cVkukbV vkÔf/k fMyhojh d fy; dke e ykb xbA MMT d lkFk] /kuk;u vkÔf/k v.kvk Vkbekykly efy,V] çfrvEy RT, BUH, PA rFkk LC d vUro'ku ij 0;ofLFkr v/;;u gvkA df=e ,o çkdfrd to{kj.k cgydk ;MkfxV ® E100 ¼/kuk;fud½ vkj ® L100 55 ¼_.kk;fud½ d lkFk fuxfer fd;k x;kA MMT-PA rFkk MMTLC dk

çkdfrd tocgyd vkfYtuV l yi fd;k x;kA ik= vkÔf/k fjyht 0;ogkj ij] 1.2, 6.8 rFkk 7.4 pH d cQj d lkFk 37 ± 0.5 ° l ij dk;Z fd;k x;k ftlls ;g irk pyk fd vko';drk d vuLkj MMT-vkÔf/k@tocgyd uuk l?kVdk dk vkÔf/k fMyhojh lokgd d vudy fd;k tk ldrk gA ijr blds ,d e;knk g fd MMT vUrof'kr vkÔf/k dk i.k #i l eDr ugh dj ldrk gA ¼dkyk;M ikyhej lk- 287(2009)1071; vlykbM Dy lk- 45 (2009) 248; bUM- t- Qke- 374 (2009) 53; 388 (2010) 280; t- ck;kefVj;y ,lyhd'ku 25 (2010) 161; ekbØk- eh lk- efVfj;y 132 (2010) 526; MxMoy ieV bM- Qkelh 36 (2010) 1046)

Hkkouxj ftys d vVVkiYxkbV enk dk leifj"dj.k

vVVkiYxkbV] ftls iyhxkLdkbV Hkh dgrs g] bldh j'knkj vkdkfjdh gkrh g vkj /kuk;u fofue; {kerk 10-40 meq/100 xk gkrh gA bu [kfutk e X&fn'kk d lekrj puy (3.7 x 6.4 Å) gkrs gA mPp lrg{k= rFkk yk{kf.kd vkdkfjdh d dkj.k ;s [kfut [kkjh n'kk e vf/k'kkÔ.k x.kk ls ;Dr gkrs g rFkk budk mi;kx lenxkeh ry dvk d [knkb e gkrk gA budk mi;kx nLr fojk/kh nokvk e gkrk gA blds ifj"djd fy;s blds çkVkdky dk 1 fØxk cp d Lrj ij ç;kx fd;k x;kA budh nLr fojk/kh fo'kÔrk ftldh if"V USP-29 rFkk chih 2004 e dh xbA bls /;ku e j[krs g,] ry dvk dh [knkb] '; kurk dk fooj.k DC/50 BASF d mi;kxk d lerY; ik;k x;kA

MgO uuk lajpukvk dk l'yÔ.k

eXuf'k;e vkDlkbM (MgO) bld cgfo/k mi;kx d dkj.k ,d egRoi.k /kkr vkDlkbM gA gky d oÔk e u; HkkfrdË ,o Hkkfrd&jklk;fud x.kk ls liUu] 0;ofLFkr ,o iofu/kkfjr ,d] f} ,o f=foHkh; lajpukvk dk uuk vkdfr MgO }kjk fuek.k] 'kk/k dk e[; vkdÔ.k jgk gA Mg(HCO$_3$)OH.2H$_2$O ¼uLD;ukbV½ dh cgrjhu mRçjd {kerkoky l{e nMk d fuek.k d fy, ljy vo{ki.k fof/k fodflr dh xb gA fofHkUu ifjfLFkfr;k e uLD;ukbV nMk d gkbMkfFkey mipkj }kjk fofHkUu gkbMkeXulkbV [4MgCO$_3$.Mg(OH)$_2$.4H$_2$O] dh l{e lajpukvk dk cuku dh i)fr fodflr dh xb gA bu uLD;ukbV nMk rFkk gkbMkeXulkbV l{e lajpukvk dk fuLrkiu ¼dYlhu'ku½ dju ij leku vkdkjoky Lo;a lfEefyr MgO uuk LQfVdk ;Dr lj?k l{e lajpuk cuhA MgO l{e'khVl dk lÜyÔ.k rFkk pfj=.k ij gekjs io v/;;uk dh fujrjrk e] igy vkb dfBukb;k dk nj dju d fy; çfØ;k e ifjoru fd, x,A MgO d vkdkj e çfrfØ;k çfØ;k d FkekMkbuehDl rFkk dkbuVh l fu;=.k }kjk fofHkUu rkiekuk ij ioj.kh; ifjfLFkfr;k e 400-500°C ij iooh MgO dk ngu dju ij of/kr lrgh jklk;f.kd lfØ;rkokyk MgO feykA ,lhVkfQuku 0;RiUuk d lkFk cUtkYMgkbM dh çfrfØ;k e l lÜyfÔr pkydu e Bkl cl mRçjd d #i e bldh mi;kfxrk lc/kh v/;;u fd;k x;kA ¼dVk-] dkE;- 11 (2010) 537½

,d fo{kih; uukfoHkh; inkFk dk l'yÔ.k

,dy fo{kihj vdkcfud uuk foHkh; inkFkk d l'yÔ.k d fy, ub df=e çfØ;kvk dk fodkl mud leku vkdkj] dn d fy, egRoi.k gA T;knkrj ektn çfØ;k, ieku vuUlkj cnyrh ugh vkj dN çfØ;kvk e gkfudkjd vkj egx jlk;uk dk mi;kx gkrk gA ;gk geu lc ;k lij fØVhdy bFkuky dk (SCE) dk i;koj.k vudyfoyk;d d #i e mi;kx djd ,dy fo{kih vdkcfud uuk foHkh; inkFk dk l'yÔ.k dju dh rt vkj lkekU;hdr çfØ;k fodflr dh gA ;g çfØ;k dkcfud fytM SCF dh mifLFkfr e rst ltkrh; ukfHkdhdj.k rFkk fodkl ij vk/kkfjr gA fytM rFkk ijkorh d{k d rkieku ij bFkuky e ?kyu'khy g rFkk ltkrh; okrkoj.k cukrk gA bl fof/k }kjk vfr 0;ofLFkr ,o ,dy #i ls çlkfjr uuk foHkh; inkFk dk fuek.k lHko gk ldk gA bld lkFk&lkFk bl fof/k }kjk çfrfØ;k çkpkyk e ifjoru }kjk mRikfnr inkFk d.kk d vkeki ¼lkbt½ ,o vkdfr dk fu;f=r fd;k tk ldrk gA

vkbVh vkXykl ij te dkckYV vkDlkbM uukd.kk d fy; fo|rjklk;fud çfrck/kk fo'yÔ.k byDVk dfedYl bEiMUl LiDVkLdkih }kjk lokÙke led{k ifjiFk d vudkj ,o fu/kkj.k

vkbVh vkXykl ij Co$_3$O$_4$ vkj Au-Co$_3$O$_4$ uukok;j dh iryh fQYek dk 0.1 M NaOH e fo|rjklk;fud çfrck/kk LiDVkLdkih (EIS) }kjk v/;;u fd;k x;kA çfrck/kk LiDVk vkofr jt 1 gVt 0.1 ekgVt rd d fy, nt fd, x, vkj MVk ,u,y,l fQV fof/k }kjk bth ,M thd }kjk çnku fd;s x;s lk¶Vo;j dk mi;kx djr g,] lokÙke led{k ifjiFk d fy, fQV fd;s x;sA

dkcu vk/kkfjr inkFk

dkij l] jklk;fud vip;u&lkYokFkey fof/k l] dkcuVVkDykjkbM dk dkcu lkr d #i e ç;kx djd] ,d ljy] rt rFkk Åtkn{k vfHkxe l lcekbØku eki d [kk[ky dkcu xky cuk; x;A l'yfÔr ueuk u dkcu dh eØkfNnh çofr fn[kkb] ftle ijek.kfod vk/kkj ij dkcu rFkk DykjkbM dh ek=k Øe'k% 72% rFkk 12% jghA mDr fof/k l lhx d vkdkj dh db nhokykokyh] leku 0;kl ~100 nm] yckb 1μm rFkk vklr nhoky dh ekVkb 10 nm okyh dkcu dh uuk uyh cukb tk ldhA ¼eVfy- yV- 63 (2009) 2339; dkcu 48 (2010) 668½

/kkr&dkcfud Ýeod

xl o vU; NkV v.kvk d HkMkj.k lkexh d #i e mi;Dr xgk vkdkj d /kkr&dkcfud Ýeod e #>ku c<rk tk jgk gA ,ehuk vEy vkj ckbifjMhu dk yhxM d #i e mi;kx dj lØe.k /kkr vk;uk dh MOF J[kyk l'yfÔr djus e lh,l,e lhvkjvkb u egRoi.k ;kxnku fn;k gA lgl;ktd ¼/kkr vk;uk lfgr½ o gkbMkstu c/k vkj LVfdx }kjk uVod ljpukvk dk xBu fd;k x;kA ifdx vkj[k dk fo'yÔ.k 2-D uVod Vkikykth tl fnypLi <kpkxr fo'kÔrk vkj O–H..O vkj N–H...O rjg dh ipnkj f}ijrh; xBu fn[kkrk gA MOF d {k= e] ,Dlkf}nrh; N &foÔepØh; vkj MkbdkckvkDlfyd vEyk d mi;kx l u, f}vk/kkjh ;kfxdk dk l'yÔ.k fd;k x;kA f}vk/kkjh ;kfxdk dk ,Dl&j vkf.od fo'yÔ.k ;g n'kkrk g fd dkckvkDlfyd vEy vkj ,ehu (O–H...N) dk çkFkfed c/k g ftldh f}vk;keh pknj e H&c/k uVod vkj C–H...O d ek/;fed detkj uVod gA bl rjg ,l vknkuçnku] f}vk/kkjh vkf.od ;kfxdk d leg d fn'kk fun'ku d fy, i;klr gA

leUo; gyhdVl vkj mRçj.k e mudh mi;kfxrk

chl&ihjhMhuMkbvehuk tl lk/kkj.k yhxM dk HBr d lkFk vEyh; voLFkk e fØ;k djokdj lcf/kr ckekbM f}LVUM dk iFkd dj fn;k vkj flxy fØLVy ,Djs l ljpuk Kkr dh xbA mldk ¹H NMR v/;;u ;g fn[kkrk g fd fijhMhu Hkkx e ldyu cuu ij ifjoru gkrk gA ckekbM vk/kkfjr f}LVUM ;g igyh ljpuk g ftl l rhu ?kVdh; euhp vfHkfØ;k dk mRçfjr fd;k tk ldrk gA Cu(II) f}LVUM eh lkdV ftle tkbyhuMkbvekbM Li lj gyhdV g dk l'yÔ.k fd;k vkj lcf/kr Cu(II) ldyu l'yfÔr dj mudk fofHkUu fo'yÔ.kk l x.k/ke ik, x,A bl uohure inkFk dk lÜyÔ.k ,e& tkbyhuMkb,ekbM dk lyhdyvkYMhgkbM d f'kQ ct cukdj Cu(II) (OAC) d lkFk l;kftr djd fd;k x;kA gyhdVl d nk oxk dk mudh euhp rFkk ukbVk,YMky çfrfØ;kvk d çfr mRçj.k lfØ;rk ij[ku d fy, v/;;u fd;k x;kA

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

vkf.od lUlljk dk fodkl oreku vuql/kku dk jlçn foÔ; gA çfrnhflr rduhd viuh lonu'khyrk] p;ukRedrk vkj ljyrk dh otg l vf/kdre mi;kx e yh tkrh gA lLFkku u bl {k= e egRoi.k dne mBk; g] vkj mDr {k= e mRd"V çdk'kuk dk ;kxnku fn;k gA

/kkr vk;uk d fy, vkf.od lalj

tyh; ,lhVksukbVkby ek/;e esa ikjs dh igpku gsrq ,d jkMksehu vk/kkfjr lonu'khy vkj p;fur jklk;fud laslj dk la'yÔ.k fd;k x;kA MfUly ls jkMksehu ij vuuksn Åtkz gLrkarj.k }kjk tyh; ,o lMksekuksa ls;fVMk esa ikjs dh igpku dh xbA ¼vkx- yVj- 2009, 11, 2740½ Lisb#fyuks lykVkfUl ls fu"dfÔr C&Qksbdkslkbfuu feFkkbyhdj.k }kjk VVkikbjksy vk/kkfjr ØkekQksj cukrk gS tks dkf;Z dh pH ijkl ij ikjs d fy, p;ukRedxzgh dh Hkfedk fuHkkrh gA blds lc/k] cgqr lss;ksa ls ikjs dk Lisb#fyuks lykVkfUl ls c/ku dh leL;k ls gA

#Fkhfu;e(II) vkSj jhfu;e(I) ckbfijhMhu vk/kkfjr ¶ykjksQksy ,o Øksmu bFkj tSls vk;ukQksj feydj /kuk;uksa dks igpkuu gsrq vkf.od xkgh cukrs gA rhu ;kfxdksa u Pb²⁺, Cu²⁺, Hg²⁺ vkSj Na⁺ gsrq çkFkfedrk n'kkbA tcfd ,d ;kfxd u Cd²⁺ rFkk Hg²⁺ d çfr çkFkfedrk n'kkbA cU/k lkeF;Z vkSj LVksfd;kferh] mRlTtu vuekiu }kjk xf.kr fd;s x;A vk;ukQksj esa /kkrq vk;u dh c/k fLFkfr LFkkfir djus gsrq çksVku NMR v/;;uu lgk;rk dhA ¼;jks- tuy buvkx- dfe- 2009, 1256½

dfyDl[4] ,fju&,tks Øksmu 0;RiUuks Hkh xkgh Hg²⁺ Pb²⁺vkSj Cd²⁺ d çfr p;ukRedrk fn[kkrs gA ¼MkyVu VkUl 2009, 8683½

dfyDl[4] ,fju&,tks Øksmu dh oy;kdkj ,o çfrLFkkfi;k dh fHkUurk d vk/kkj ij ,d J[kyk cukbZ xbZ rFkk budh vkf.od lajpuk SXRD }kjk cukbZ xbA vkYdyh rFkk vkYdkbu vFk eVy vk;uksa d lkFk fd, x, v/;;uksa d fy, rrh; C;fVyoky vk;ukQksj Na⁺ rFkk K⁺ çfr p;ukRedrk n'kkrs g tcfd rhu VkslkbYy çfrLFkkfi;kokyk vk;ukQksj fdlh /kuk;u d çfr p;ukRedrk ugh n'kkrkA

Ru-II ck;fijhfMu #fFkfu;e ckb fijhMhu ,o ,feuk@cUtu lYQk,ehMk] 10 fQuUFkksyhu&¶ykjks vk;ukQksj J[kyk cukbZ xbA bues ls dN fØLVykxkQh }kjk rFkk _.kk;u igpku v/;;u Y;feusUl] UV-vis vkSj çksVku NMR }kjk v/;;u fd;k x;kA dN _.kk;u F⁻, $H_2PO_4^-$ vkSj AcO⁻ vf/kdre p;ukRedrk n'kkrs gA _.kk;uksa dh c/k lkeF;Z rk çksVku NMR vkSj Y;feusUl vuekiu }kjk Kkr dh xbA $H_2PO_4^-$ vkSj AcO⁻ dh f}nUrh fdyVhx çofr c/k lkeF;Z o p;ukRedrk dk çHkkfor djrh gA ¼buvkx- de- dkE;- 2010, 13, 1522½

vf/k'kkÔ.k

¶yw xSl ls dkcuMkbvkDlkbM dh çkfIr

NTPC }kjk çk;kftr cgqLFkkuh; ;kstuk d Hkkx#i ft;ksykbV 13X d fu;f=r /kuk;u fofue; }kjk n{k CO_2 p;fur vf/k'kkÔd d fodkl gsrq] fNn bthfu;jh ft;ksykbV vk/kkfjr vf/k'kkÔd ¼PE-T10, PE-K20 rFkk PE-K30½ cuk; x;A Ka, NamX rFkk KbNagBar d lkFk 55° lS rFkk 1 atm ok;nkc ij vf/k'kkÔ.k fd;k x;k ft lesa KX esa vf/k'kkÔ.k {kerk lhlh@xk esa] CO_2, N_2 vkSj O_2 d fy; Øe'k% 72 , 3 rFkk 1.8 FkhA ,dy dkye PSA lsa irk pyk fd lh,l,elhvkjvkb d vf/k'kkÔd dk dk;Z 0;kolkf;d ft;ksykbV 13X ls dN n'kkvks esa

J"B gA blh vk/kkj ij nks vf/k'kkÔd 1.5 fdxk@cp ij cuk; x; vkSj nks rFkk rhu dkye d fy; ij[kk x;A vf/k'kkÔd lh,l,elhvkjvkb&1 ls 90 % 'k) CO_2 d lkFk 70 % iu%çkfIr rFkk lh,l,elhvkjvkb&2 ls 78% 'k) CO_2 ls 86 % iu%çkfIr gbA 13X ft;ksykbV d fjikV fd, x, fooj.k d lkFk bu ifj.kkek dh ryuk u vkbvkbih] ngjknu d v/;;u esa Hkh cgrjhu dk;çn'ku n'kk;k gA ¼iVV PCT/IN2010/000187 rFkk PCT/IN2010/000027½

ft;kykbV e xl k d vf/k'kkÔ.k d fy; vk.kfod ekMfyx

?kuRo dk;kRed fl)kr l H_2 v.k dh] MOF-177 xPN d lkFk fofHkUu lHko vUrfØ;u lkbVk ij] c/ku Åtk dh x.kuk dh xbA ifj.kke l irk pyk fd vdkcfud lc/kd rFkk dkcfud l;ktd dh vge Hkfedk gA vdkcfud lc/kd rFkk dkcfud l;ktd d fy; x.kuk dh xb] Åtk Øe'k% 3–4.5 kJ/eky rFkk 2.6–3.8 kJ/eky gA ¼ekfyDyj fley'ku 36 (2010) 373½

fofHkUu SiO_2/Al_2O_3 vuikrh ZSM-5 ij CH_4, N_2, O_2, vkj Ar d 'kkÔ.k dk v/;;u] vk;ruekih rFkk xkM dukfudy ekVdkyk vudj.k }kjk fd;k x;kA vkj mPp feFku rFkk ukbVkstu vf/k'kkÔ.k {kerk ZEM-5 e SiO_2/Al_2O_3 vuikr d lkFk rdlxr ikb xbA CH_4 vkj N_2 dh vf/k'kkÔ.k {kerk] p;urk rFkk vf/k'kkÔ.k m"ek mPp ikb xbA bldk dkj.k ukbVkstu v.kvk dk Na^+ d lkFk etcr fLFkj fo|r vUrfØ;k rFkk CH_4 dk ft;kykbV l lkFk mPp SiO_2/Al_2O_3 d lkik{k /kork gA ¼bM- bt- de- fjl- 2010, 49, 2353½

CH_4 vkj N_2 xl feJ.k l CO dh lef)

ft;kykbV vk/kkfjr CO p;fur vf/k'kkÔd rFkk vekfu;k lykV d Vyxl feJ.k] CH_4 rFkk N_2] l xl d lef) d fy; PVSA fof/k fodflr dh xbA xkgd (GNFC) }kjk fu/kkfjr CO dh >90 % çkflr >95 % 'kf) dk y{; çkIr fd;k x;kA le) CO l dherh jlk;u cukus dk egRo gA GNFC d ikbyV lykV ij v/;;u tkjh gA ¼l i- lk- Vduk- 45 (2010) 413½

gkbMkstu HkMkj.k

mfpr #i l ifjofrr VkbVukflfydV MCM-41, MCM-48, HMS rFkk SBA -15 ij gkbMkstu vf/k'kkÔ.k dk ijh{k.k fd;k x;kA mDr ifjoru fuf'pr lØfer /kkrq vk;ul lfEefyr gA vf/k'kkÔ.k {kerk dh jt 77.4 K ij 66-82 CC H_2Lg rFkk 303 K ij 30-35 cc H_2Lg FkhA vkblkFke 77.9 K ij i.kr;k çfrorh g, tk d{k d rkieku ij ugh FkA ¼bUM- t- gkbMkstu ,uth 34 (2009) 888, 35 (2010) 2351½

ZnAlZr f=&gkbMkVy lkbV ij QkLQV mnxg.k

gkbMkVy lkbV l tyh; ek/;e e LDH dk i;koj.k e leL;kçn _.kk;uk d vf/k'kkÔ.k d fy, ç;Dr fd;k x;kA mnk- QkLQV l rFkk ukbVkbV l tk lkiÔ.k d dkj.k cu ldr gA ;gk lÜyfôr f=&ZnAlZr gkbMkVy lkbV u QkLQV d fy; 91 fexk P@xk d lkFk mPp mnxg.k {kerk fn[kkbA ;g ik;k x;k fd QkLQV mnxg.k e ?kyu'khy ftd vk;u d lrg vo{ki.k }kjk gkfiV [kfut ($Zn_3(PO_4)_3.4H_2O$) vkoj.k curk gA çfr;kxh _.kk;u ukbVV dh lg&mifLFkfr e QkLQV dk mnxg.k 148 fexk P@xk rd c<+ tkrk gA inkFk d iu%pØ.k v/;;u l Kkr gvk fd l[;k c<u ij QkLQV mnxg.k] fØLVyrk c<u d dkj.k] de gkrk gA ¼t- dky- bUVjQl- lkbl 342 (2010) 289½

lrg dk;kRed ehlkfNnh flfydk ty ij /kkrq vk;u vf/k'kkÔ.k

mPp lrg {k= ¼550 eh²@xk½ rFkk lfØ; fNn eki forj.k ¼BJH fNn eki 5 nm½ oky ehlkfNnh flfydk ty cukus d fy, 300 g cp Lrj ij n'kkvk dk v/;;u fd;k x;kA ty lkrk e l çnfÔr /kuk;uk dk ,ehuk rFkk ejdiVk leg d lkFk dk;kfUor fd;k x;kA vf/k'kkÔ.k {kerk 95 fexk@xk vkj 245 fexk@xk d fy, jghA ¼bUM- bUth- de- fjl- 48 (2009) 8954; bUM- bUth- de- fjl- 49 (2010) 8184½

foÔekx mRçj.k

LVk;jhu vkDlkbM d mRçj.kh; gkbMkstuhdj.k }kjk 2-fQukby bFkkby ,Ydkgy dk 100 xke Lrj ij l'yÔ.k

2-fQukby bFkkby ,Ydkgy xykc d Qy d ry dk ,d e[; Hkkx gA bldk ç;kx e[;r% b= m|kx e gkrk gA i;koj.k lxr fof/k l lQyrkiod çnf'kr bikDlhdj.k l çkIr 1 fdxk LVkbjhu vkDlkbM dk gkbMkstuhdj.k] ,dy rFkk f}/kkr] vdkcfud Bkl ij vk/kkfjr mRçjdk }kjk fd;k x;kA 100 xke d Lrj ij bl fof/k l 98% 2-fQukby bFkkby ,Ydkgy dh çkfIr gkrh g] rFkk lkFk gh bldh 98% p;urk gA bl fof/k dk lQy çn'ku vfdyk vkxfuDl] ecb dk fn[kk;kA

uuk LQfVd lYQfVd ftjdkfu;k Bkl vEyh; mRçjd }kjk ,lhVkby lfyfIfyd vEy dk foyk;d eDr l'yÔ.k

uuk LQfVd lYQfVr ftjdkfu;k dk mi;kx djd] i;koj.k vudy fof/k }kjk] lfyfIfyd vEy dk ,lhfVd ,ugkbMkbM d lkFk ,lhfVyhdj.k djd ,fLçu dk lÜyÔ.k 95% mit d lkFk fd;k x;kA

chVk ikbuhu vkj ijkQkjeyMhgkbM d fçl l?kuu }kjk ukiky dk l'yÔ.k

fofHkUu SZ mRçjd cnyr g, lYQj Hkkj] d lkFk ijijkxr fof/k l cuk; x;A FT-IR u mRçjd d lYQV c/ku d çdkj dk crk;k rFkk DRIFT-IR l ybl@czkUlVM vEy lkbV dh if"V ihjhfMu 'kkÔ.k fof/k l dh x;h tk iu% NH$_3$–TPD fo'yÔ.k l lefFkr gvkA SZ-2N lrkfir mRçjd u chVk&ikbuhu dk ifjoru 99 % rFkk p;urk 99 % ukiky d fy, mPp mRçj.k {kerk fu;fU=r vfHkfØ;kvk fn'kkvk e fn[kk;hA ¼,lykbM dVfyfll ,½ tujy 390 (2010) 158½

vfYdu cthu dk leko;ou

vfYdu cthu d leko;ou l β&efFky LVkbjhu ¼fIl$VkUl½ cukuk ,d ljy f}c/k ifjoru vfHkfØ;k gA ftle mRikn dk ç;kx eumÙktd vkÔf/k;k d ek/;fedk dk cukuk e gkrk gA ikjifjd <x l bl vfHkfØ;k e {kkj rFkk lØe.k /kkrq ldy ç;kx gkr gA geu Mg rFkk Ni ;Dr gkbMkVy lkbV tl Bkl {kkj mRçjd l ;g vfHkfØ;k dh gA tkp x, mRçjdk e l MgAl$_4$–HT ¼Mg/Al ijek.kfod vuikr 4.0½ u ifjek.kRed ifjoru 160° l ij DMF foyk;d e fn[kk;kA foyk;dk d cnyu l irk pyk fd lttu c<kuoky foyk;dk u lfØ;rk c<kbA ¼,lykbM Dy lk- 48 (2010) 243½

Cu ;Dr LDH ij fQuky dk gkbMkDlyhdj.k

fQuky d gkbMkDlyhdj.k l dVdky (CAT) rFkk gkbMkfDouku (HQ) cukuk ,d vk|kfxd egRo dh vfHkfØ;k g] ftl ij ;gk dN lkyk l dke gk jgk gA igy d dk; d Øe e geu dkij vk;ul ;Dr LDH dk] fQuky dk ikuh e H$_2$O$_2$ vkDlhdkjd rFkk H$_2$O foyk;d d #i e mi;kx djd vkDlhdj.k dk eY;kdu dju dk ç;kl fd;kA LDH dk fQuky dk ikuh e H$_2$O$_2$ vkDlhdkjd l p;fur vkDlhdj.k fd;k x;k ftle fQuky dk i.k vkDlhdj.k lgf}l;kxh vk;uk d çdfr l gvkA 26.2% ifjoru] 2:1 fQuky H$_2$O$_2$ vuikr ij CuZnAl-5-CLDH-450 d lkFk feykA STEM l irk pyk fd 0.038 v.k % Cu rd] Cu^{2+} dk lekx forj.k gkrk g TPR l irk pyk fd dkQh fNrjk gvk vyx Cu^{2+} ZnO d lkFk etcr vrjfØ;k djrk g vkj lfØ; dn lfØ;rk dk c<krk gA ¼bM- bf t- dfe- fj l- 49 (2010) 6020½

gkbMªksVYdkbV mRçsjd dkcuZMkbvkWDlkbM dk çksihyhu vkWDlkbM esa ;ksftr Mkyk

fofHkUu Mg/Al v.kq vuqikrh (1.5-5.0) gkbMªksVYdkbV ¼esy rFkk lrkfir½ dh mRçsjdh lfØ;rk dk v/;;u DMF foyk;d esa CO_2 dh tMu vfHkfØ;k ls çksihyhu vkWDlkbM cuus esa fd;k x;kA lrkfir uewus us esy ls vf/kd lfØ;rk fn[kkbA vfHkfØ;k rki dk v/;;u fd;k x;k rFkk lrkfir gkbMªksVYdkbV dh mifLFkfr rFkk vuqifLFkfr esa DMF esa vkgfu;l lyksV ls lfØ;.k Åtk fudkyh x;hA lrkfir ueus us pØh; tMu dh lfØ;.k Åtk 10 kJ@eksy] de fd;kA çksihyhu vkWDlkbM ¼mRçsjd dk mPp vuqikr ij] mPprj TON ¼307 feyheksy@xzk ¼mRçsjd½½ feykA lHkkfor vfHkfØ;k fof/k çLrkfor dh xbA ¼bM- t- dfe-A ,, 49 (2010) 288½

ehlksiksj?kh ftdksfu;e QkLQsV ¼ ,d n{k Bksl vEy mRçsjd

ijrh ftdksfu;e QkLQsV (ZrP) mPp m"eh; fLFkjrk] tSy lárk rFkk vklkuh vo/kkjuk okyk ,d egRoi.kZ Bksl vEy mRçsjd gSA ijr blds fuEu lrg {k= vkj vUrijr dh de txg] blds ç;ksx dks NksVk v.kqvksa rd gh lhfer j[krh gS vkSj ifjoru dksQh de jgrk gSA blds fy; mPp lrg{k= (532 eh^{2}xzk^{-1}) rFkk ldjh fNnz eki forj.k (~2.9 nm) okys m"eh; fLFkj ehlks fNnzh mRd"V vEy çdfr ds ZrP] LoLFkkus cus ftjdksfu;e dkcksuV dk iooZrh tSlk ç;ksx djds] cuk;s x;sA iooZrh dsfoy;u esa QkLQsV dh lkUnzrk rFkk lrkiu rki nkuksa us l'yfÔr ZrP dh lajpuk rFkk vEyrk ij çHkko MkykA foyk;d eDr voLFkk esa fÝMsy ØkÝV] cSathu rFkk vU; foLFkkfir cUthu dk] cfTtyhdj.k blls mRçsjd ls mPp lfØ; ik;k x;kA ¼,lykbM dVy , ½ tjuy 385 (2010) 22; ,lykbM dVy , ¼çsl esa½½

vYMksy laxuu vfHkfØ;kvksa esa Bksl {kkj mRçsjd ds #i esa fpVkslu

fpVkslu dk gkbMªkstsy fof/k ls l'kksf/kr djds blds lfØ;rk dk eY;kdu foyk;d jfgr voLFkk esa 1&gsIVuy rFkk cstfYMgkbM ds laxuu ls tSLkfeukfYMgkbM cuus esa fd;k x;kA vudqy ifjfLFkfr esa 160° ls ij mPpre ifjoru >99 % rFkk 88 % p;urk feyhA lfØ;rk rFkk p;urk esa fcuk fo'kÔ gkfu ds mRçsjd dk N% ckj iu%pfØr fd;k x;kA rr lc/kh l'kk/ku fodkl vrxr ,feukçksikbyVkb feFkkvkWDlhyu dk;kUor fpVkslu us foyk;d jfgr voLFkk esa fyuj vkYMhgkbMls ds vkYMksy laxuu esa Bksl {kkj mRçsjd ds #i esa dk;Z fd;kA ¼t- eksy- dVy , ½ de 321 (2010) 77½

LiV mRçsjd dh iu%çkfIr ,oe iu%mi;ksx

LiV eVy mRçsjdks ls eVy mRçsjdks dh iu%çkfIr vkfFkd ,oe mfPN"V çc/ku nkuks íf"V ls egRoi.kZ gSA LiV eVy esa ls N1 mRçsjd dh çkfIr gr çfØ;k fodflr dh xbZ gSA blfof/k esa nks ing (1) mfpr ,lhM d mi;ksx }kjk LiV mRçj.k esa ls /kkrvksa dk fu"dÔ.k (2) N1 (OH)$_2$ esa ls vudy pH ij N1 dk p;fur vo{ki.k N1 dh iuçkfIr yxHkx 100% gbA

io v/;;u dh fujrjrk esa LiV FCC ds iu%mi;ksx gr] LiV rFkk vEy mipfjr FCC dk] FT-IR rFkk TEM lrg{k= eki ls] 'kks/k fd;k x;kA Y;l rFkk ckUlVM vEy lkbVks ds x.kk dh le> ds fy; Hkkfrd'kkfÔr fijhMhu FT-IR ls irk pyk fd LiV FCC mRçsjd dh rhoork esa e[; c/kd yxHkx ux.; Fk] fdUrq mRçsjd dk lrkfir dju ij cM dh rhork c<+ xbZ rFkk QkLQkfVd vEy ls mipfjr dju e] rhork esa vkj vf/kd of) gkx;hA ¼Y;l vEy ckf/kr fijhMhu ½ ~ 1490, 1595 rFkk 1625 leh^{-1} ckUlVM vEy ckf/kr fijhMhu /kuk;u ~1540 leh^{-1}½A vEy mipfjr LiV mRçsjd u rktk mRçsjd dk eDr d.k çofr iu% ik fy;k] ijr d.k eki cM+ FkA no voLFkk] cSthu d 1&gDthu ds lkFk vkfYdhdj.k ij H_2SO_4, H_3PO_4, HCl mipfjr LiV mRçsjd rFkk rktk mRçsjd ds lkFk ryukRed v/;;u fd;k x;k ftlesa vU; dh ryuk esa H_3PO_4 mipfjr mRçsjd us lcls vPNk ifj.kke fn;kA

lekx mRçj.k

vlefer lÜyÔ.k

fjikV dh vof/k d nkjku C-C c/k fuek.k] vçdkf;r vkYdhu dk dkbjy bikDlhdj.k vkj jlfed@elk bikDlkbM oy; dk [kkyuk] ij v/;;u fd;k x;kA db rjg d dkbjy mRçjdk dh #ij[kk rFkk mudk mi;kx mi;Dr vfHkfØ;kvk e fd;k x;kA dkbjy inkFk dkQh egx gku l budh bl rjg l #ij[kk r;kj dh tkrh g fd ; fLFkj] iu%mi;kxh rFkk yf{kr inkFk e mPp çdk'kdh; miyC/krk nA tgk Hkh foyk;d eDr vfHkfØ;k dh lHkkouk g] ogk vk;fud no dk mi;kx fd;k x;kA

mRçfjr fofHkUu lkrk d lkFk ,fYMgkbM dh vfHkfØ;k l dkbjyh 'k) lk;ukgkbfMu dk vlefer l'yÔ.k

dkbjy lk;ukgkbfMUl Qkbu dfedYl d egRoi.k ?kVd gA dkbjy ,dydh@f}ydh rFkk cgydh lyu ldy fofHkUu /kkr vk;uk d lkFk cuk; x, vkj n{k mRçjd d #i e] mudh {kerk dh tkp dh xbA lhykby lk;ukbM] bFkkby lk;ukQkjeV en çfrfØ;k ;Dr ifjfLFkfr e ç;Dr fd; x; ftle mRikn lk;ukgkbfMu mPp (ee, 94-99%) rFkk çkfIr (92-99%) d lkFk feykA ¼;jk- t- vkx- de- (2008) 4511; t- vkxukeVyhd de- 695 (2010) 1133; dk;jyhVh] 22 (2010) 153; dVy- dE;- 11 (2010) 907; VVkgMu , lheVh 21 (2010) 2076½

vlefer ukbVk&,YMky vfHkfØ;k

vlefer ukbVk&,YMky ,d cgr gh mi;kxh C-C c/k fuek.k dh vfHkfØ;k g] ;g vfHkfØ;k cgmí'kh; β ukbVk&,Ydkgy cukrh gA igy ;g lfpr fd;k x;k fd foÔekx dk;jy mRçjd l;kxh dk;jy ,feu dh mifLFkfr e β ukbVk&,Ydkgy dk mPp mRiknu rFkk çdk'kdh; miyC/krk(ee) nrk gA bl fØ;k&fof/k dk vkj ljy cuku gr ge ykxk u /kkr ldy dk l'yÔ.k fd;k] tk fui.k mRçj.k fØ;k'khyrk çnf'kr djrk gA ;g çfØ;k vHkh fodkl dh vkj gA ¼t- vkx- de- 75 (2010) 6191½

vçdkf;r ,fYduk dk vlefer bikDlhdj.k

dk;jy bikDlkbM] vkÔf/k;k rFkk jlk;uk d fuek.k d fy, cgr gh egRoi.k v.k gA gekjk /;; fujUrj u, dk;jy /kkr ldy d fuek.k ij g] tk fo'k) bikDlkbM cuk,] blh Øe e geu Mn(III) lyu eØkpØh; /kkr ldy dk l'yÔ.k fd;k gA bu mRçjdk ¼5 eky %½ dk mi;kx] fofHkUu çdkj d vçdkf;r ,fYduk tl fd LVk;jhu] bMhu vkj ØkfeUl dk lkfM;eDykjkbM ¼,d vkDlhdkjd½ d lkFk 0° rki ij] ,ufUl;k p;fur bikDlhdj.k e fd;k x;kA 6&lk;uk Økfeu vkDlkbM d lkFk vf/kdre ifjoru 99% rFkk 97% dk;jy bMD'ku çkIr gvkA ;g mRçjd iu%pØh; g] vkj bldk mi;kx db pØ rd dk; l iknu e fcuk fdlh gkfu d fd;k x;kA ØkfeUl dh 0;kikfjd miyC/krk ugh gkrh gA

jlfed@eh tk bikDlkbM dk ,ufUl;k p;fur vlefer oy;k dk [kyuk

lLFkku esa l'yfÔr dk;y mRçsjd }kjk bikDlkbMksa dk gkbMªksfyfVd dkbufVd fjT;ksy;w'ku (HKR) rFkk ,ehuksfyfVd dkbufVd fjT;ksy;w'ku (AKR) tSls rFkk ,feu dk U;wDyhvksfQyhd ds #i esa lLFkku }kjk lÜyfÔr dkbjy mRçsjdksa }kjk fd;k x;kA 0;olkf;d #i ls eY;oku Vjfeuy rFkk ,jhykDlh bikDlkbMksa tSls bfiDyksjksgkbfMu] LVk;jhu vkDlkbM] 1,2-bikDlh çksiu] bu lc dk ç;ksx HKR vfHkfØ;k esa tSly dk ç;ksx djds fd;k x;kA lHkh çfØ;kvksa esa mRçsjd ds iqu% mi;ksx djus ds ckotwn Hkh vnHkqr #ikarj.k rFkk p;ukRedrk çkIr gqbZA

bl çdkj Vkl bikDlkbMksa dk AKR dk;Z Co(III) rFkk Cr(III) lyu ldyksa dks mi;ksx] vk;fud no tSls gfjr çfØ;k ek/;e esa ,ehuksa rFkk mudk 0;riUu ds lkFk djus ij] pkj ?kaVs esa vR;f/kd dk;Z bMDlu (ee, >99%) dks çnf'kZr djrk gS, egRoiw.kZ flu rFkk Vkl 1,2-,ehukvYdksgy ds lkFk 'kq) dk;Z bikDlkbM çnku djrk gSA ¼fluQsV 9 (2009) 991; VVªkgsMªu ,flkefV 21 (2010) 45; ;w- tsa vkx- dse- (2009) 2863; dk;jfyfV (2010) çsl esa½

dk;jy f'kQ {kkj ldy dh ijLij fØ;k ij v/;;u

u;s dkbjy V(V) f'k¶Q {kkj ldy dk fuekZ.k fd;k x;k gSA bu ldyksa dk tSMko dkQ Fkk;esl ¼lhVh½ Mh,u, vkj xksatrh; lhje vYcehu ¼fc,l,½ çksVhu ds lkFk dk v/;;u fd;k x;kA ldy ds vkj(*R*) ,ufUl;ksej us mPpre c/ku fLFkjkad (0.5 x 10⁶ ± 0.01 M⁻¹) ,l(*S*) ,ufUl;ksej dh rqyuk esa (0.8 x 10⁵± 0.01M⁻¹) çnf'kZr fd;s gSA ¼t- vkxZuksesV- dse- 695 (2010) 1133½

dk;jy Mn(III) lyu ldy dk v/;;u fd;k x;kA lHkh ldyksa ds chp c/ku fLFkjkad ds (130.4 x 10⁴) 'kr ij ldy ,l&1 dk lcls vPNk ik;k x;kA ¼LiDVªksfde- ,DVk- Hkkx 74 (2009) 113½

C_1 mRçj.k

leku n'kkvksa esa ekih xbZ C_5-C_{12} vkYdhuksa ds gkbMªksQkeyhdj.k dh xfr lafofnr gvk fd J[kyk dh yEckbZ c<us ls vfHkfØ;k dh xfr de gks xbZA H_2 ds vkf'kd nkc ds lkFk xfr çFke dksfV dh FkhA mRçsjd dh lkanzrk ds lkFk xfr c<h vkSj T;knk lkanzrk ij lrr gksus yxhA 1&gDlhu ds gkbMªksQkeyhdj.k ds fy;s dk;Z fof/k ds vk/kkj ij] ,d xfrdh ekMy fd;k x;k] ftlesa çk;ksfxd rFkk ekMy xfr] 15% fopyu esa ikbZ xbZA ¼t- eky- dSV- ,- dse 316 (2010) 23½

dkckZyV mRçsfjr mPp vkYdhuksa ¼1&vkDVhu] 1&ukuhu] 1&Mhdhu rFkk 1&MksMhdhu dk gkbMªksQkjeyhdj.k jlk;u l'kkf/kr lkbDyksMfDlfVu ds lkFk tyh; f}voLFkk esa fd;k x;kA ifj.kkeksa ls irk pyk fd vkf'kd #i.k efFkyhdr &lk;Dyks MfDlfVu ls mRçsjd dh iqu%çkfIr esa jkd ds fcuk] mPp vkYdhuksa ds gkbMªksQkeyhdj.k esa vPNk ifjoru (>92%) rFkk p;urk (>92%) feyh ¼dVy- dkE;qu-10 (2009) 1808½A

,dnrh; QkLQkbV fyxsM] f=&1&ufIFkyQkLQkbV P(ONp)$_3$ ds Rh ldy ls mRçsfjr foukby ,flVsV ds gkbMªksQkeyhdj.k ij 'kks/k fd;k x;kA fyxsM us vfHkfØ;k xfr rFkk p;urk ij fo'kkô çHkko Mkyk ftlesa mPp Vuvkoj vkofr ¼11,520 çfr ?kaVk rd½ rFkk ,fYMgkbM p;urk (93%) mRd"V {k= p;urk (99%) 'kk[kk ,fYMgkbM ds fy;s jghA ¼dVy- dkE;qu- 11 (2010) 616½

fo lhuy vk;kMkgkbfMu dk fovk;kMhuhdj.k fQukby ekbxlu }kjk ;FkkfLFkfr ifjoru

Lvkbfju vk/kkfjr fo lhuy vk;kMkgkbfMu dk fovk;kMhuhdj.k 0-10°C ij BrO_3^-/Br^- d vEyh; lfØ;dj.k }kjk fd;k x;kA mRikn e cxuh jx dh dkcfud lrg IBr d fuek.k dh if"V djrh gA 1 vk;kMk&2-fQukby çkiu-2-vky rFkk 2-vk;kMk 1-fQukbyçkiu 1-vky d fovk;uhdj.k rFkk fQukby ekbxlu }kjk fQukby ,lhVku rFkk 2-fQukby çkiuky vPNh yfC/k e cuk;k x;kA 92% yfC/k okyk fQukbu ,flV&,fYMgkbM Hkh LVkbjhu vk;kMh gkbfMu l cuk;k x;kA NBS rFkk HOCl Hkh LVkbjhu vk;kMkgkbfMu }kjk fQukby ,flVfYMgkbM d fuek.k e mi;kxh gA (t- vkx- de- 74 (2009) 7947–7950; VVkgMu 65 (2009) 2791)

dEl;V'kuy v/;;u

5, 6&f}LFkkfir f}pØh; [2.2.2] vkDV 2&bu dh m&Dykjkijcu thu vkj Mkb,tkehFku d lkFk π&Qf'k;y dh foijhr p;ukRedrk dk byDVkLVVhd mnxe

π&Qf'k;y MkbLVhfj;kflyD'ku dk mnxe vk/kh 'krkCnh l cgl dk foô; g vkj ble lfØ; vul/kku dk; gk jgk gA byDVkfud {kC/krk l Vkbxkuy dkcu d vykok π&Qf'k;y p;ukRedrk dk çfjr dju dh lHkkouk u dkQh #fp idM yh gA db lClVV] ftle LVhfjd çHkko dk vUn[kk fd;k x;k g] fM tkbu fd, x, g ft ll njLFk foLFkkfirk dh çkFkfedrk dk ij[kk x;k gA gky d dN oÔk e çklr ç;kxkRed vkdMk d db x.kkRed ekMy dk ijh{k.k gvk o Ng v/kek=kRed ekMy vkj ek=kRed v/;;u dk mi;kx dj π&Qf'k;y p;ukRedrk dk ioKkr dj rdlxr fd;kA d{kh; fo#i.k çHkko] byDVkLVfVd çHkko vkj fofHkUu fof'k"V d{kh; i{kk dk ydj x.kkRed ekMy dk mi;kx dj p;ukRedrk vkj T;kfefr dk n[kk x;kA ,d dUQje'kuyh LoPNki.k lClVV e mijkDr rF;k dk vkijfVo ik;kA ;|fi ,d fu"i{k lClVV e] T;kfefr cgr egRoi.k ugh gA fliyd ekMy ¼σ-σ* gkbijdUtx'ku ifjdYiuk½ dk ç;kxkRed rkj ij ;fDr lxr Bgjk;k fdUr detkj c/k d cuu l ;g tYn gh fooknkLin gbA vkn'k voLFkk e foijhr ijhlyuV σ c/k l σ* c/k d nku d egRo ij fliyd ekMy u çdk'k MkykA gkbijdUtx'ku ijLij lc/kk dh p;ukRedrk e Hkfedk dk n[ku d fy, njLFk foLFkkfirk dk u, <kpkxr ijh{k.k d lkFk mi;kx fd;k x;kA byDVkQkbYl d lkFk Vkj'kuyh o LVjhdyh fu"i{k 5,6-cis, exo-disubstituted f}pØh; [2.2.2]-vkDV-2-bu dk mi;kx dj xUMkydh o vU; u njLFk foLFkkfirk l MkbLVhfj;k p;ukRedrk dk irk yxk;k vkj viuh ldYiuk dk fliyd ekMy d i{k e n[kk yfdu foijhr 0;frdj.k dh çHkRork dk fliyd ekMy d foijhr ik;k x;kA Mkb,tkefFku d lkFk π&Qf'k;y p;ukRedrk dk dkrgytud #i l foijhr gkuk σ-σ* rjg d gkbijdUtx'ku ij ç'u yxkrk g vkj vHkh Hkh ;g ,d igyh gA ?kuRo dk;kRed o ab initio x.kuk ;g n'kkrh g fd byDVkQkby dk og v.k tk lClVV d lkFk çR;{k #i l c/k ugh cukrk g og π&Qf'k;y p;ukRedrk dk fu;f=r dj ldrk gA

çdk'k mRçj.k

/kkr vk;u vUrHkfjr uukfØLVyh TiO_2 çdk'k mRçj.k dk l'yô.k

/kkr vk;u vifeJ.k d çHkko dk v/;;u uukfØLVyh TiO_2 d çdk'kmRçj.k lfØ;rk ij fd;k x;kA ue vUrHkj.k fof/k l uukfØLVyh TiO_2 e /kkr vk;uk] LVkf'k;e] eXuhf'k;e] iyfM;e] yhfFk;e rFkk fcLeFk dk vUrHkfjr fd;k x;kA /kkr vk;u dh çdfr d vk/kkj ij vkdkfjdh e egRoi.k ifjoru gvkA uhyh f'k¶V 21 nm ij rFkk 9 nm ij Øe'k% Pd rFkk Li vUrHkfjrk d lkFk ikb xbA VkbVfu;e uukuyh d fy; çdk'kmRçjd lfØ;rk dk Øe% uukfØLVyh TiO_2 < VkbVfu;e uukdyh < fcLeFk vifeJr uukuyh] jgkA

jtd lonh çdk'k çfjr TiO_2 e byDVªku LFkkukrj.k çfØ;k

iUMUV dVpkyV fØ;kRedrk d lkFk #Fkfu;e (II) ikyhf;VhMkby fcl&Fkkbvkl;uV l;ktu dk lÜyÔ.k fd;k x;kA ;g v.k TiO_2 uukd.kk d lkFk í<rk l ijLij fØ;k djrk gA bUVjQlh;y byDVªku LFkkukrj.k v/;;u l] mRlkfgr voLFkk e 100fs d le;eku e byDVªku cM dh if"V gbA okil byDVªku LFkkukrj.k xfr'khyrk Hkh fu/kkfjr dh xbA ¼t- pe- lh- 2009, 113½

çdk'k mRçjd fj,DVjk dk fodkl

iUMUV dVpkyV fØ;kRedrk d lkFk #Fkfu;e (II) ikyhf;VhMkby fcl&Fkkbvkl;uV l;ktu dk lÜyÔ.k fd;k x;kA ;g v.k TiO_2 uukd.kk d lkFk í<rk l ijLij fØ;k djrk gA bUVjQlh;y byDVªku l;çdk'k rFkk çdk'kh j'kk ij vk/kkfjr çdk'k mRçjd fj,DVj] fMtkbu dju d fy; çdk'k mRçjd lrg fodflr dh xbA çdk'khj'kk] DokVt uyh rFkk Xykl lyV ij çdk'k mRçjd dk yiu d fy; l'kkf/kr ly&ty fof/k l uukfØLVyh TiO_2 lky cuk;k x;kA bldk pfj=.k TEM vkj SEM l fd;k x;kA

çdk'kh j'kk fj,DVj

pe m|kxk d mfPN"Vk rFkk ty cfgL=kok d jxk d vidÔ.k d fy; TiO_2 yfir çdk'kh j'kk vk/kkfjr çdk'k mRçfjr fj,DVj fMtkbu fd; x;A çdk'kh j'kk vk/kkfjr fj,DVj dk lQy ç;kx efFkfyu CY; Mkb rFkk pe m|kx d mfPN"Vk d vidÔ.k d fy; fd;k x;kA

l;çdk'k vk/kkfjr çdk'k mRçfjr fj,DVj

l;çdk'k vk/kkfjr çdk'k mRçfjr fj,DVj d fodkl gr] mPp n'kkvk e TiO_2 l DokVt uyh yfir djd ç;kx e ykb xbA nk rjg d fj,DVj] tl fd ijkord d lkFk rFkk fcuk rFkk V&VQ vkdkj d] ç;kx e yk; x;A vkx dk dk;] lkfnr l; çdk'k d fj,DVj d fy; rFkk çkpyk dh mPprk d fy; çxfr ij gA ifj.kkek u fn[kk;k fd efFkyhu CY; Mkb dk çfr'kr vidÔ.k ijkord d lkFk c<+ x;kA

UV-LED lkr vk/kkfjr çdk'k mRçfjr fj,DVj

ijijkxr UV lkr rFkk l;çdk'k fdj.kh çdk'k mRçjd fj,DVj d ç;kx l nj jgu d fy;] UV-LED vk/kkfjr fj,DVj lV fodflr fd;k x;kA ,d ljy fj,DVj dk çc/ku efFkyhu CY; Mkb d çdk'k mRçfjr vidÔ.k gr fd;k x;kA P-25 MxLlk TiO_2 d çdk'k mRçjd lfØ;rk dk eY;kdu 5 ucj UV-LED fj,DVj l fd;k x;kA mPp n'kkvk dk çkIr dju d fy;] mRçj.k Hkkj] çkjfHkd Mkb lknrk] pH rFkk H_2O_2 tl çkpyk dk v/;;u fojxu rFkk vidÔ.k ij fd;k x;kA MB Mkb dk i.k feuujyhdj.k (3.12×10^{-5} M) COD fo'yÔ.k }kjk i"V fd;k x;kA ifj.kkek l irk pyk fd UV-LED/TiO_2 fof/k l efFkyhu CY; Mkb dk çHkkoh vidÔ.k mPp n'kkvk e gkrk g rFkk ;g rduhdh #i l lHkk0; gA ¼bM- bt- dfe- fjl- (2009), 48, 10262½

CHAPTER
çdjÆ 2

POLYMER & MEMBRANE SCIENCE
cgyd ,o eEcu foKku

Reverse Osmosis & Related Polymeric Membranes
Electro Membrane Processes

çfrorh jlkdÔ.k rFkk blls lcf/kr cgydh eEcu
fo|r f>Yyh çfØ;k,

REVERSE OSMOSIS AND RELATED POLYMERIC MEMBRANES

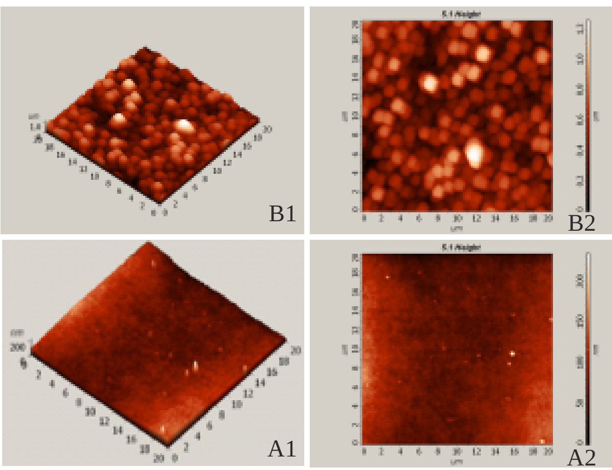
I. TFC RO Membrane

Spiral module rolling facility

Our efforts continued to develop an indigenous module rolling facility. We have nearly completed the process, with procurement of most of the balance equipment, and can presently fabricate the 4040 modules with much higher success rate than initially. This has happened because of (a) improvement in membrane consistency, (b) overcoming of problem of membrane deterioration during the intervening period between membrane preparation and module fabrication, (c) overcoming difficulties encountered with adhesion and (d) eliminating leaks.

Important spiral module rolling machinery

Study of the surface roughness of TFC RO membrane



A1 and A2 are 3D and 2D AFM surface images of polysulfone support (height scale in nm), respectively; B1 and B2 are 3D and 2D surface images of RO TFC membrane (height scale in micron), respectively

In order to increase the flux of TFC RO membrane, it is necessary to make the polyamide composite layer as thin as possible. However, this has to be done while simultaneously avoiding the formation of pinholes which would adversely affect the rejection efficiency. A study was therefore undertaken to ascertain the roughness of the polyamide layer under actual production condition of the RO membrane. It was found by atomic force microscopy (AFM) that whereas the polysulphone support layer is quite smooth, the roughness of the polyamide layer is as much as 120 nm. Future studies will seek to reduce the roughness so that the thickness of the film can be reduced.

Development of TFC RO membranes using indigenous non-woven fabric

In the manufacturing of TFC RO membrane in a two step process, non-woven fabric is the most important raw material which is used in the first step for making the reinforced porous polysulfone support according to phase inversion process. In order to indigenize the materials and also to reduce the manufacturing cost of TFC membrane, the non-woven fabric available in the country was evaluated for making such membranes. The imported and indigenous non-woven fabrics exhibited significant differences in the thickness (Imp: 100-110 microns; Ind: 110-140 microns) and air permeability (Imp: 5-6CFM/m^2; Ind: 20-25CFM/m^2). It was observed that polysulfone solution percolates to the opposite side of the indigenous fabric when the membrane was cast at the same rate optimized for PS membrane cast on the imported fabric. In order to overcome this problem, PS supports on indigenous fabric were cast at a higher rate and on which polyamide skin layer was formed according to the usual interfacial polymerization. The RO test kit data for brackish water and sea water desalination for the TFC membrane made under the separately optimized conditions for indigenous and imported are given in Tables below.

Performance of TFC membranes made using different samples of indigenous non-woven fabric

TFC No	Brackish water; (2000 to 2500 ppm TDS) 250 psi		Sea water; 600 psi	
	%SR	Flux, LMH	%SR	Flux, LMH
IndPS1PA1	90	29	95	43
IndPS3PA2	84	48	90	52
IndPS4PA3	85	43	92	48
IndPS5PA4	88	49	79	26
IndPS6PA5	83	39	84	33

Performance of TFC membranes made on imported fabric; Feed: NaCl solution

Pressure (psi)	Feed, ppm	Product, ppm	Flux, LMH	%SR
250	2302	87	69.7	96.22
600	34493	1917	47.6	94.44
900	32798	1464	90.1	95.54

The data in the above tables indicate that there is scope to utilize indigenous fabric but further improvements in fabric quality and casting/coating process are necessary.

Effect of DMF concentration in gelation bath on TFC membrane performance

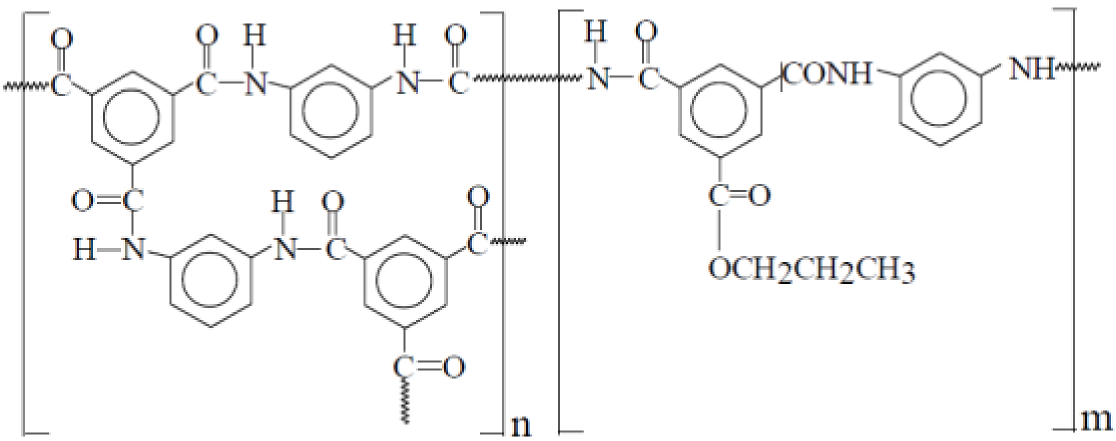
In the manufacture of TFC membrane, the first step is the preparation of porous polysulfone support according to phase inversion process using casting dope of the polymer in dimethylformamide. In the present facility, about 800 liters of gelation bath containing water, DMF & SLS is used while making porous polysulfone support. DMF concentration in the gelation bath is increased by about 1.5% per 100 m PS membrane. To evaluate the effect of this concentration increase on membrane performance, TFC membranes were made on polysulfone support membranes prepared using gelation bath containing 2%, 6% or 10% DMF along with 0.1% SLS. Since changes in the DMF concentration in the gelation bath affects the PS support morphology (pore size and distribution during the phase inversion process), which in turn would have an effect on the morphology of polyamide skin layer and eventually on the performance of the TFC membrane, a study of this aspect was deemed necessary. It was observed (Table below) that the the salt rejection increased significantly in going from 2% to 3% initial DMF but thereafter decreased slightly with further increase in DMF concentration. However, the significant increase in water flux at the higher concentrations of DMF may justify its use at the higher levels provided the long term performance remains stable.

Effect of DMF concentration in gelation bath on TFC membrane performance

TFC Membrane No	% DMF in gelation bath	80 psi		250 psi		900 psi	
		Flux, LMH	%SR	Flux, LMH	%SR	Flux, LMH	%SR
128	2	34	80.01	74	92.06	61	90.05
129	3	34	90.86	74	96.26	65	93.55
130	4	33	89.94	77	94.78	71	92.36
131	6.5	34	85.48	92	93.97	67	91.82

Novel polyamide TFC RO membranes containing propyl ester pendant group

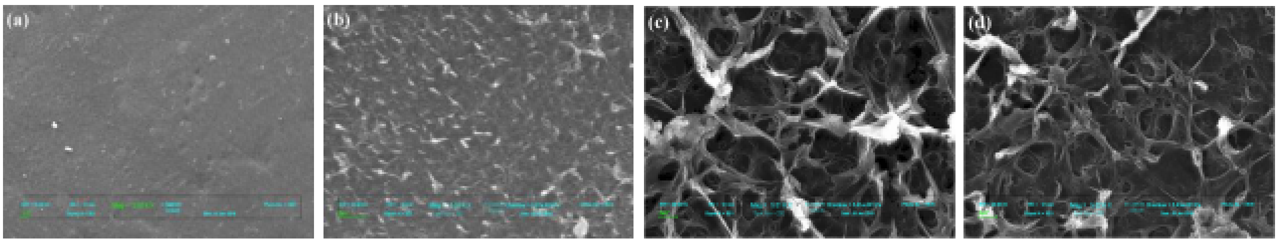
TFC membranes with polyamide skin layer having propyl ester pendant group were prepared according to the interfacial polymerization technique involving *m*-phenylenediamine in water and a mixture of trimesoyl chloride + 3-propyloxycarbonyl isophthaloyl chloride in hexane under different conditions. The chemical structure of the polyamide layer is shown below.



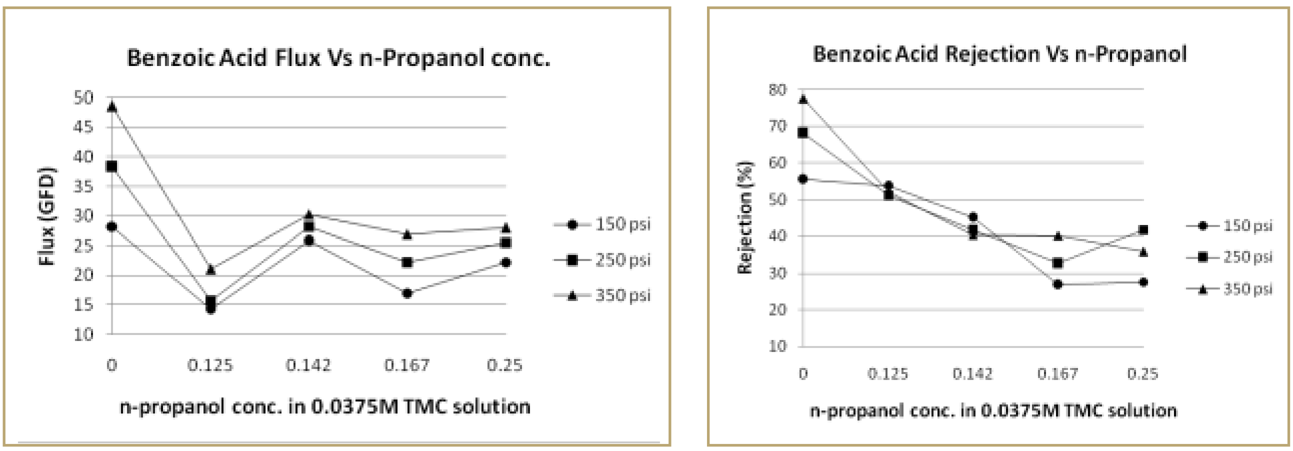
Chemical structure of the polyamide skin layer with propyl ester pendant group

The TFC membranes were characterized by IR, SEM and contact angles measurements.The IR spectra of the TFC membranes showed the characteristic bands at 1649 cm^{-1} due to amide-I C=O stretch, at 1543 cm^{-1} due to amide-II C-N stretch and at 1737 cm^{-1} due to ester carbonyl group. The contact angles of the TFC membranes was increased (from about 45° to 61°) when propyl ester was increased (from 0 to 0.025%) in TMC solution thus indicating the higher hydrophobic nature of the polyamide skin layer. The surface SEM photographs showed that the polyamide skin layer formed with MPD and TMC consists of ridge (white) and valley (black) structure with uniform distribution throughout the surface (Figure below).The presence of 3-propyloxycarbonyl isophthaloyl chloride along with TMC in hexane appeared to have a pronounced effect on the surface morphology of the resulting polyamide skin layer. The top surface of these TFC membranes contained highly rough structure with large size peaks and valleys throughout the surface. The surface roughness of the polyamide skin layer differs with the composition of acid chloride solution.

It was observed that both water flux and solute rejection of the TFC membranes for the separation of organic solutes (benzoic acid, p-chlorophenol) and inorganic solutes (NaCl, Na_2SO_4, $MgSO_4$) were decreased with the increase of propyl ester content in the polyamide skin layer. This may be attributed to the formation of bulky ridge structure which may offer greater resistance to water permeation.



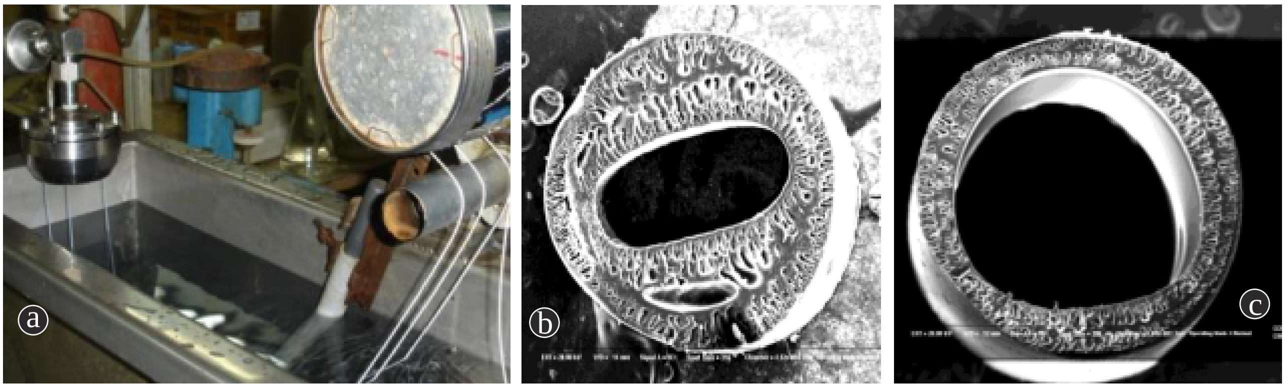
SEM photographs of the membranes: (a) PS membrane, (b) MPD-TMC
(c) MPD-TMC- PA (0.0125) and (d) MPD-TMC-PA (0.0142) TFC membranes



Separation of benzoic acid by TFC membrane: Effect of propyl ester group

II. Perfection of hollow fiber membranes

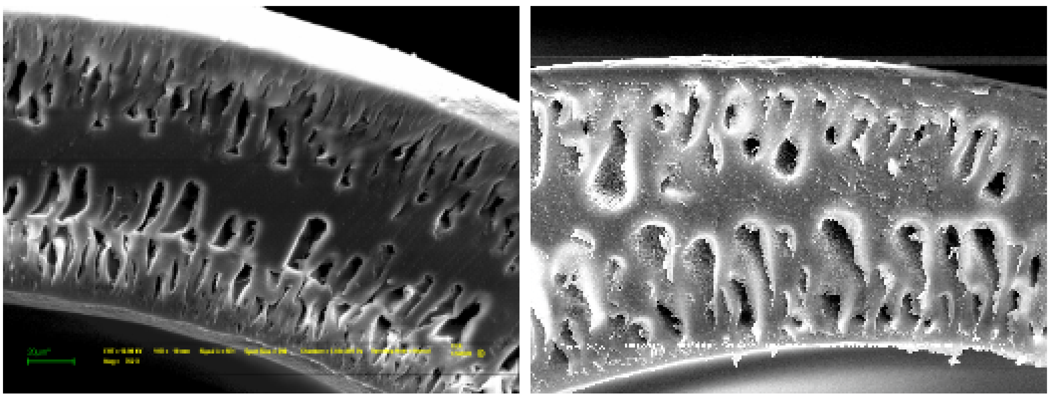
The major advantage of HF membranes lies in the fact that they can be configured to pass feed solution on the outer-side of the fiber to obtain permeate from the inner side of the hollow fiber (outside-in) or from in-side the fiber to obtain permeate on the outer side of the hollow fiber (inside-out), making cleaning of the fiber easier. In continuation of the work reported in 2006-2008 biennial report, we optimized the conditions (polymer dope composition, volumetric flow rate of bore forming liquid, fiber drawing rate and post-treatment of fibers) for spinning hollow fibers (1.0-1.4 mm OD and 0.5-0.8 mm ID) of 5000-10,000 m length continuously from polysulfone (PS), poly(acrylonitrile-co-methacrylic acid) (PANMA), polyvinyldenefluoride (PVDF) and blends of PS & PANMA .The stability and performance of the hollow fiber membranes depended mainly on the morphology of the skin layer and supporting structure.



(a) Hollow fiber spinning; SEM micrograph of the hollow fibers from volumetric flow rate (ml/min) of bore forming liquid: (b)10 and (c) 25 ml/min

The HF membranes were characterized by scanning electron microscopy (SEM) for morphology, contact angle measurements for surface hydrophilicity, pure water permeation rates and molecular weight cut off (MWCO) values. SEM photographs of the fibers showed asymmetric structure with a dense skin layer on both the inner as well as on the outer surface with finger-like channels originating from the skin layer. In the case of PANMA hollow fibers, the finger-like channels from the outer and inner surfaces were almost interconnected together. However, these finger-like channels from inner & outer layers were separated by a sponge like intermediate structure in the case of PS hollow fibers (*Int. J. Nuclear Desalination, 4 (2010) 149).*

Hollow fiber modules of different sizes (1-4” dia x 12-60” length) and point of use units were made by potting the fibers appropriately for practical applications. The hollow fiber modules



Cross-sectional SEM morphology of PANMA (left) & PSF (right) hollow fibers exhibited the MWCO values in the range 10-100 kDa with water fluxes of 50-140 LMH, depending on the spinning conditions. The pore size of the hollow fiber membranes were calculated based on the empirical equations relating to MWCO and pore radius and were found to be in the range of 5-14 nm, depending on membrane MWCO value. It was found that HF modules are suitable for disinfection of drinking water as they exhibit 4-6 log reduction for bacteria like cocci, e-coli & bacillus and viruses.

Performance of hollow fibre membranes

Hollow fiber type	Water flux of hollow fibers, LMH	MWCO of hollow fibers, kDa
PANMA18	212	90
PS-PANMA	117	95
PS2020	132	69
PS2220	71	37
PS2480	140	28
PS2420	24	9

HF membrane manufacturing technology transfer

Following perfection of the hollow fibre membrane process, the technology for its manufacture with different molecular weight cut off (MWCO) values was licensed to M/s Uniqflux Membranes LLP, Pune. HF module preparation was also demonstrated as part of the knowhow. The hollow fibers produced during the demonstration were confirmed to exhibit 4 log reduction of MS2 virus (i.e., reduction from 1 lakh virus counts to ≤ 1) making the indigenous product of global standard.

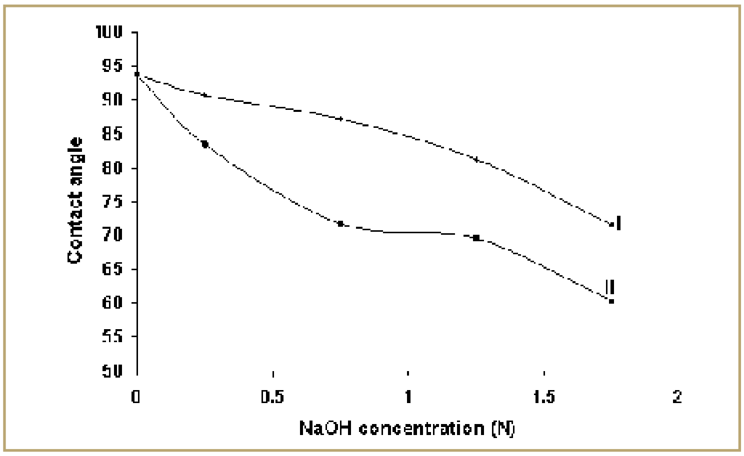

India CURRENTS news

Uniqflux to launch Ultrafiltration Membrane Modules in India

Uniqflux Membranes LLP is setting up hollow fiber spinning plant under license of CSMCRI in Pune, India. The plant is capable of spinning Polysulphone and PAN Polymer with MWCO ranging from 10-100 kd with State-of-the-art Wet Spinning Phase Inversion technology. The company will launch ultrafiltration membrane modules for the domestic as well as industrial sector with flows ranging from 40 LPH to 4500 LPH/ module. The membranes are capable of rejecting Log 4 virus.

Efforts to further improve HF properties through surface modification

Chemical modification of PANMA hollow fiber membranes was carried out by treating them with alkali followed by acid to impart antifouling properties to the fibers and also to diversify the spectrum of applications. The contact angle of the treated fibers was decreased with the increase of sodium hydroxide concentration and acid treatment.



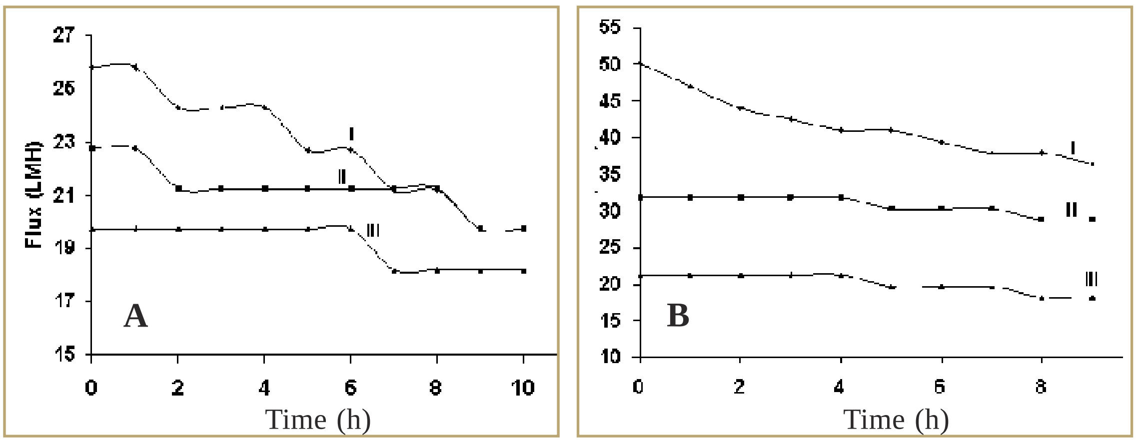
Variation of contact angle of the modified PANMA hollow fibers Treatment with NaOH (I), and NaOH followed by 0.1N HCl (II)

The flux was decreased and the rejection was increased with the increase in the alkali concentration. Maximum reduction in MWCO values by about 10 times was observed for the fibers treated for an appropriate time with an appropriate concentration of NaOH. Further increase in the concentration of NaOH or the time of hydrolysis for more than 10 h decreased the stability of the hollow fibers.

Characteristics of the surface modified PANMA HF membranes

Modification	PWP (LMH)	MWCO values, kDa	Pore radius, nm (from MWCO data)
virgin	212	95	7.85
1	166	92	7.50
2	74	71	6.40
3	26	10	2.70

Antifouling characteristics of the virgin and modified HF membranes were measured by ultrafiltration of aqueous solutions of PEO-100 kDa (500 ppm) and bovine serum albumin (BSA, 100 ppm) for several hours (Figure below) and by measuring their flux recovery ratio (FRR) values, which are assumed to be the measure for fouling resistance nature of the membrane.The larger is the FRR value the higher is the antifouling nature of the membrane (Table shown on next page).



Variation of membrane flux with time: A: PEO and B: BSA solutions. I- virgin membrane, II- membrane treated with NaOH (1.25N, 6 h) followed by HCl (0.1N, 2 h) solutions, and III- membrane treated with NaOH (1.75 N, 9 h) solution

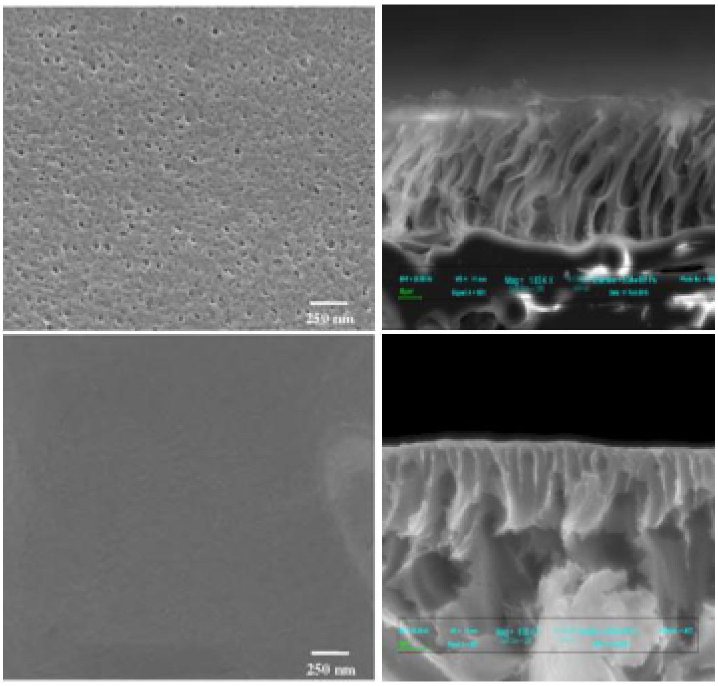
Flux recovery ratio (FRR) values for virgin & modified HF membranes

Membrane Type	% Flux Recovery Ratio (FRR)	
	PEO solution	BSA solution
PANMA virgin	58	85
PANMA- 1.75M NaOH for 6 hours	100	100
PANMA- 1.25M NaOH for 6 hours/HCl	95	95

Development of flat sheet ultrafiltration membrane-based submersible cartridges for water reclamation

Submersible water purification membrane cassettes were prepared from flat sheet PANMA (polyacrylonitrile-methacrylic acid) UF membranes. The membranes had a molecular weight cut off value of about 90 kDa and the surface was modified to impart hydrophilic character. A prototype unit comprising 10 membrane cartridges (0.3 m x 0.3 m), with provision of continuous permeate withdrawal and aeration was fabricated. The key advantage of such units is the easy washability of fouled membranes. The unit has shown water fluxes of about 25-120 LMH with <1 NTU of permeate from initial feed water having maximum turbidity of 200 NTU. Efforts will be made to commercialise the indigenous submersible membrane.

Fouling is a major problem associated with membrane bioreactor (MBR) systems, particularly since these are occasionally used to treat highly contaminated water/effluents. The top (left) and cross-sectional (right) SEM photographs of virgin (top) and fouled (bottom) PS membranes are shown. As can be seen, fouling caused complete blocking of the membrane pores both on the top surface, as well as inside the pore channel, with concomitant drop in flux. It was found that the problem can be mitigated through a combination of techniques such as surface modification, air bubbling, incorporating suitable surfactants in the feed and intermittent backwashing.

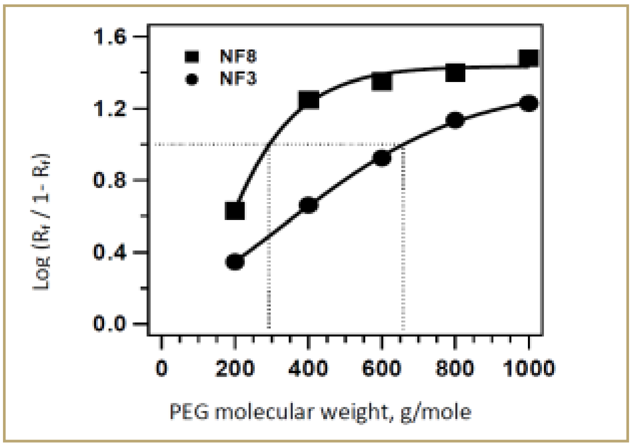


Top: Flat sheet membrane based submersible cartridges
Left: SEM micrographs of virgin and fouled membranes

III) Other research and development activities

Loose composite membranes

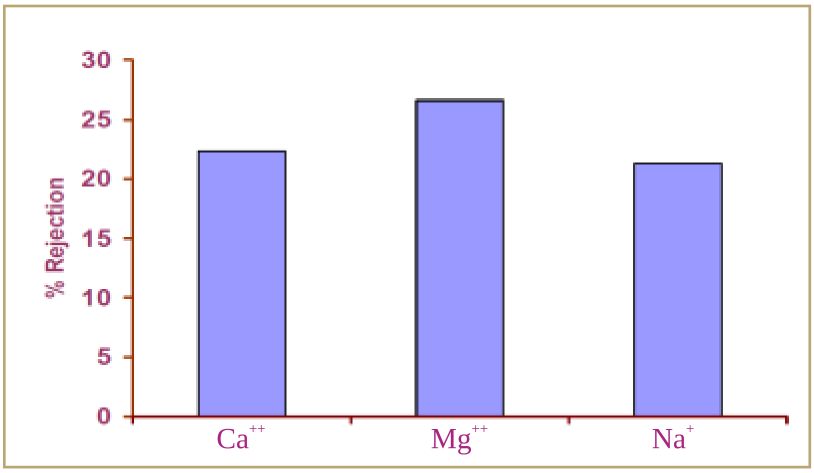
In continuation of the work described in the previous biennial report, the loose type TFC membranes were studied to ascertain their molecular weight cut off (MWCO) for organic solutes. The contact angles and zeta potentials were also measured. The MWCO values of the membranes were determined by passing aqueous solutions of polyethyleneglycols (PEG) of different molecular weight (200-1000 Da) at 125 psi. The value of molecular weight at log $[R_f / (1–R_f)]$ (R_f = rejection factor) value of 1 can be taken as MWCO of membrane assuming that there is a linear correlation between the rejection factor and molecular weight of solute. The MWCO values for NF3 and NF8 were found to be 650 and 300 Da, respectively.



Plot of log(R_f/1-R_f) vs. molecular weight of PEG for NF membranes

The membrane surface charge was estimated by measuring the streaming and zeta potentials with Zeta CAD zeta potential analyzer using 1 mM solution of KCl at different pH values. The membranes became increasingly more negative in charge as the pH increased and, not surprisingly, separation of magnesium sulphate from sodium chloride was higher under these conditions. The contact angle values of all the composite membranes were similar (ca. 39°) as compared to ca. 84° for polysulphone support membrane, indicating greater hydrophilic nature of the composite membrane surface. Membrane modules of 2” diameter x10” length were made. The membranes were tested (at 150 psi) for rejection of ampicillin (500 ppm aqueous solution). Concentration of antibiotic in feed and permeate was analyzed by HPLC technique and it was found that 96% reduction in the concentration of ampicillin was observed in the permeate water. These membranes were also studied for separation of different chloride salts. It can be seen that solutions containing NaCl, $MgCl_2$ and $CaCl_2$ (300 ppm) behaved rather similarly, i.e., there was hardly any selectivity among the cations.

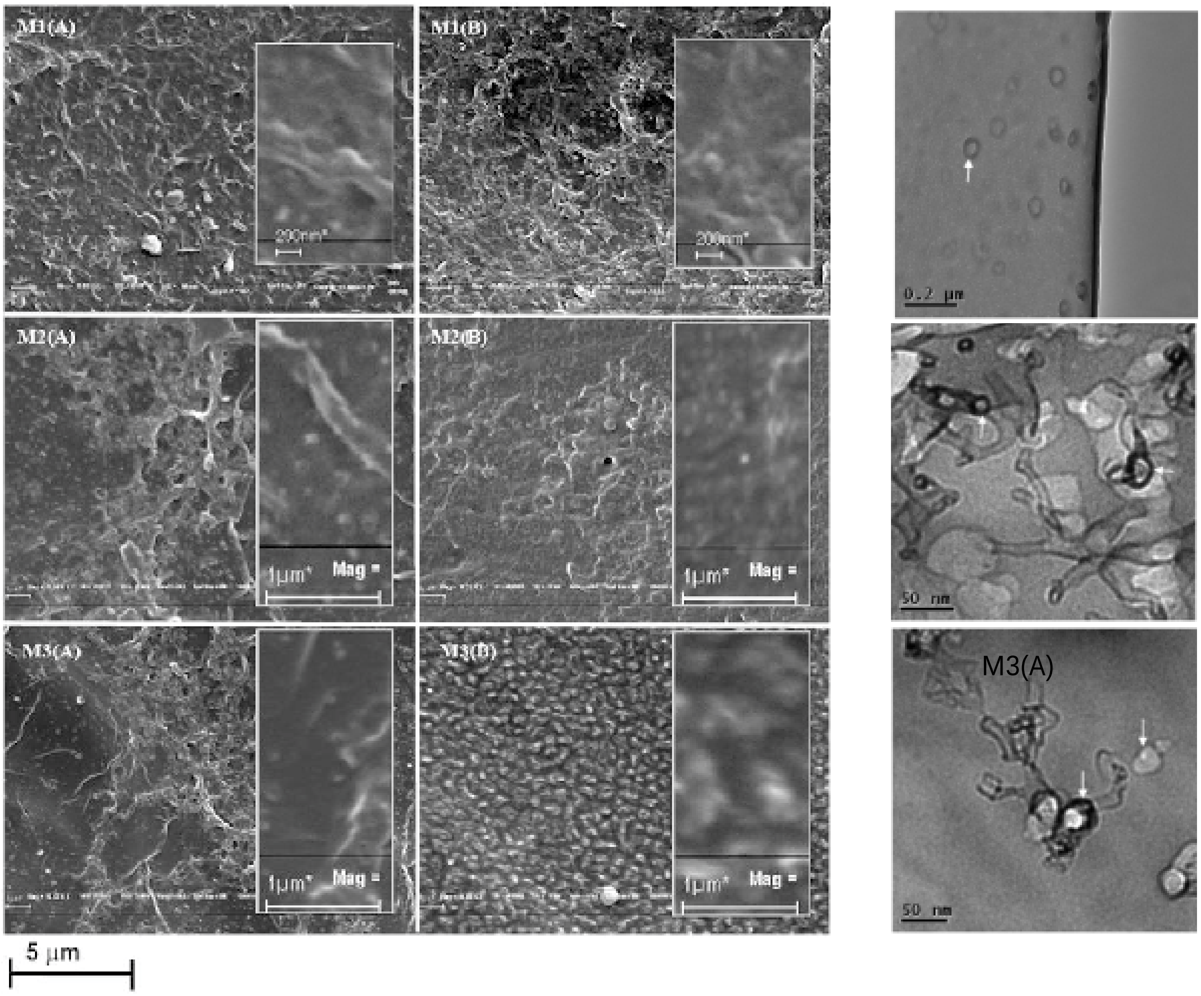
A new type of composite membrane containing a maleic acid (MA)-cross-linked PVA barrier layer over PS membrane was also prepared. For the membrane prepared using 1% PVA + 0.2% (w/w) MA solution, and cured at 125 ± 2 °C for 30 minutes, the average molecular weight cut off of neutral organic solutes was in the range of 250-350 Da. When inorganic salts were studied, the observed rejection showed the following trend: $R_{Na_2SO_4} > R_{MgSO_4} > R_{NaCl} > R_{CaCl_2} \cong R_{MgCl_2}$. It can be seen that high rejections were observed only when sulphate was present as anion regardless of the nature of the cation.



Rejection of Ca^{++}, Mg^{++} and Na^{+}

Silica-polyamide nanocomposite membranes

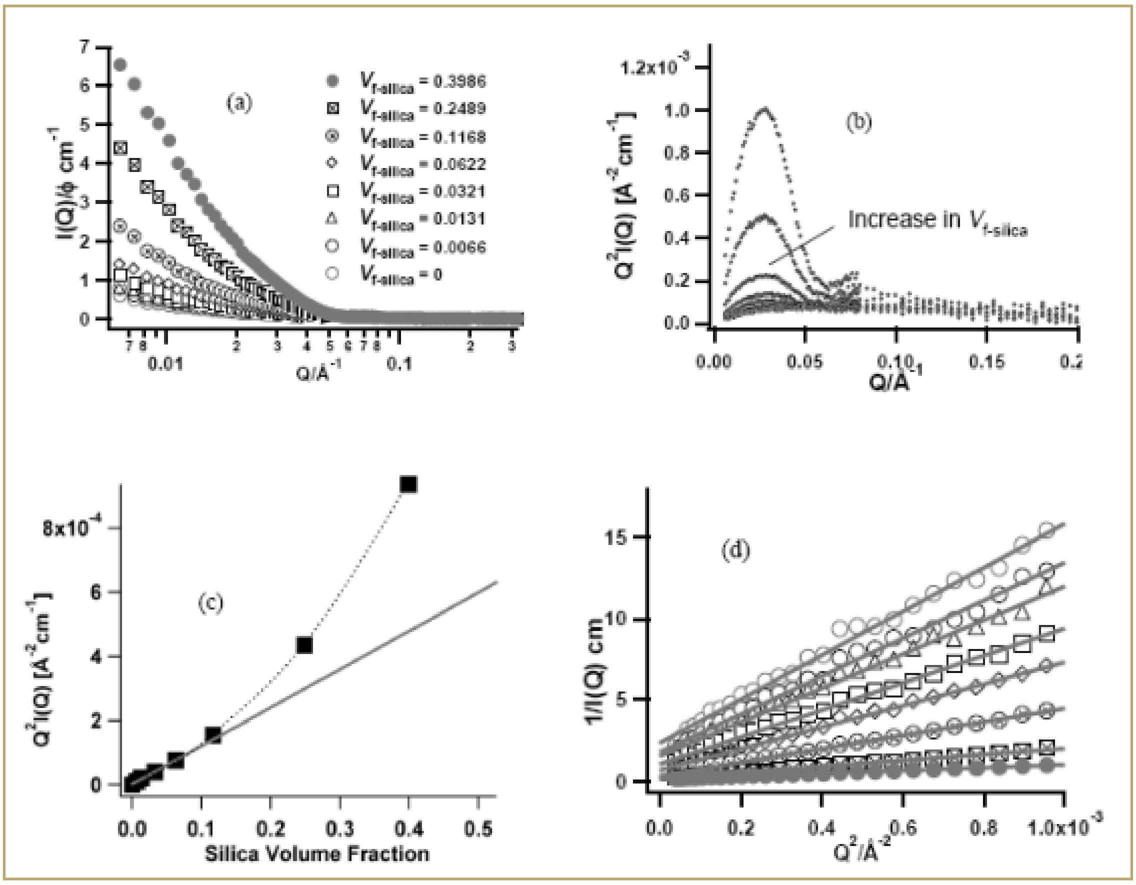
Silica-polyamide nanocomposite membranes containing monodisperse spherical particles of 10– 18 Å R_g (gyroscopic radius) were prepared and their structures characterized by SANS, TEM and SEM. The SEM images of the membrane samples show two-phase (particle-polymer) microstructure and the particle-polymer distribution depended on the type and amount of silica. The TEM images showed predominantly ring-like particle nanostructures [M1(A)] of the membrane produced using TEOS as silica precursor. Membranes [M2(A)] made using a mixture of TEOS and MPTMS as mercaptopropyl-silica precursor showed elongated ring or chain structures, and the M3(A) membrane with highest mercaptopropyl-silica content exhibited predominantly chain-like particle nanostructures *(J. Colloid. Interface Sci., 351 (2010) 304).*



SEM (left) and TEM (right) micrographs of the membranes. (A) and (B) are with the low and high silica loading respectively. Insert: magnified SEM images. Arrows indicate silica

Influence of hydrophilic silica particles to polymer chain conformation

Interactions between polymer chain and silica nanoparticles was studied in a dilute aqueous system using an idealized model system comprised of a well characterized polyvinyl alcohol of 100 Å R_g and hard spherical silica of 80 Å radius. The scattering intensity increased dramatically with increasing silica fraction implying that a new extended structure was formed by *interchain* polymer interactions as revealed by a small angle peak at ~ $Q = 0.03$ Å^{-1} in the Kratky plots [$I(Q)Q^2$ *vs.* Q] below. At higher silica content, the peak intensity varied exponentially with the silica volume fraction. Under these conditions, the polymer chain apparently was attracted to the silica and got adsorbed on the silica hard surface. The scattering data fit nicely with a model form factor comprising of one unit forming the core of the spherical silica particles and the interacting polymer as the corona.

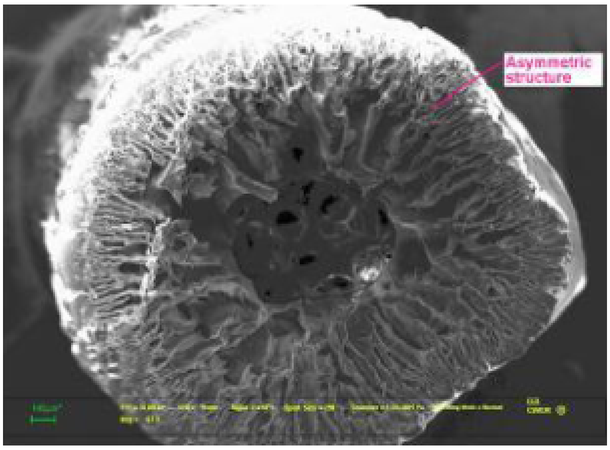


SANS profiles for 1 wt.% PVA aqueous solution with LUDOX®-HS40 silica particles. (a) *I(Q)/ vs.* ln*Q* profile as the function of silica volume fraction. (b) Kratky plot, $Q^2/I(Q)$ vs. Q, of the absolute intensities scattered by the mixed solutions. (c) Plots of peak intensity from Kratky plots as a function of silica volume fraction. (d) Zimm plot, 1/$I(Q)$ vs. Q^2

Enantioselective membranes

BSA immobilized and BSA semi IPN polysulfone and composite membrane containing chiral selective group were prepared and characterized by SEM and ATR-FTIR techniques. Enantiomeric separation of tryptophan and d-enantiomers of α-amino acids (arginine, alanine) was performed under different conditions. The composite membranes exhibited higher enantioselectivity (54%) for d-arginine compared to d-alanine (21%). BSA immobilized membrane exhibited higher enantiomeric excess (30.8%) compared to BSA semi-IPN membrane (23.8%) after 8 h *(Sep. Sci. Tech., 45 (2010) 346; ibid 1374).*

Immobilization of lipases on polymer matrices and their hydrolytic performances



SEM of lipase-immobilized PS globule

The hydrolytic performance of lipase immobilized on PS, PVA-modified PS membrane and PS globule for olive oil was studied. The hydrolysis of different oils was studied and the extent of hydrolysis followed the order: olive oil > palm oil > castor oil. The presence of ricinoleic acid in its main composition in castor oil lowers the hydrolysis rate. The hydrolytic reaction parameters could be fit to the Lineweaver–Burk plot *(Polym. Bull., 64 (2010) 141)*.

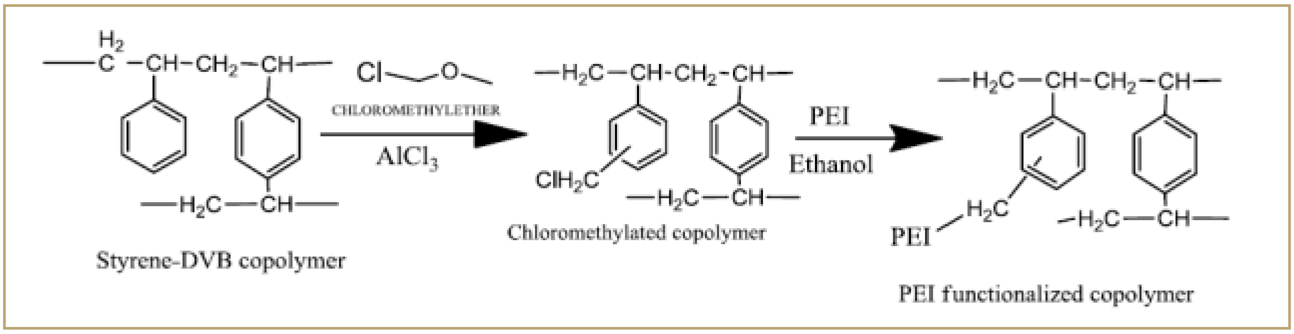
Pervaporation membranes for the separation of aqueous-organic liquid mixtures

Polysulfone, polydimethylsiloxane, and polyamide TFC membranes were prepared by solution casting, dip coating and interfacial polymerization techniques, respectively. The membranes were evaluated for the separation of aqueous-oragnic liquid mixtures like water-methanol, water-dichloromethanol/benzene using the pervaporation test kit. Maximum separation factors of about 8 for water-methanol and about 120 for water-dichloromethanol/ benzene mixture were achieved.

Development of polymeric microspheres containing silver nanoparticles for water disinfection

A facile methodology was developed for disinfection of water. It involved the anchoring of silver nanoparticles on to macroporous-methacrylic acid copolymer beads. Silver nanoparticles formed on these copolymer beads by chemical reduction method were stable. The beads were tested for their antibacterial activity and were found to be highly effective against both gram positive and gram negative bacteria. The bacterial count went down to undetectable limit for all the strains tested except spore forming *Bacillus subtilis* which showed 99.9% reduction *(Water Research, 48 (2010) 5481)*.

Different types of porous polymers based on the copolymerization of: (i) styrene-divinyl benzene, (ii) methacrylic acid- divinyl benzene, and (iii) acrylonitrile-divinyl benzene were prepared in the presence of porosogenic agents to obtain macroporous resins. These were functionalized with 5,5-dimethyl hydantoin, polyethyleneimine or triethylenetetramine.



Scheme: Synthesis of biocidal polymer functionalized with PEI

The polymers were characterized by CHN analysis, FTIR, UV visible spectroscopy, DRS, SEM, EDX, TEM and optical microscopy to confirm the introduction of functional group. The antibacterial activities of the polymers were evaluated by plate (Figure on left) and test tube methods for four different types of bacteria namely *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa and Escherichia coli*. The antibacterial activity of the PEI based polymers was found to increase with increasing molecular weight of the PEI as evident from the increasing inhibitory zone. The antibacterial activity of the polymers may be compared with the effect of bleaching powder, albeit with the advantage of dispensing with residual chlorine in water.

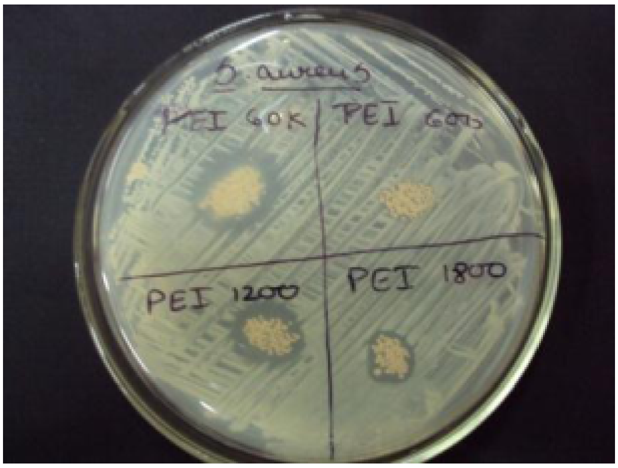


Plate testing PEI functionalized polymers for biocidal activity against *B.subtilis*

ELECTRO MEMBRANE PROCESSES

Continuing efforts towards development of heterogeneous ion exchange membranes

Although the interpolymer ion-exchange membranes perfected by the institute in the eighties have many merits, there is a need for a "greener" technology of production of ion exchange membranes. Accordingly, efforts have been continuing for over a decade to develop membranes matching the performance of the interpolymer membranes. In this approach, PVC powder and powdered ion exchange resin are suspended in a suitable solvent and the membrane was cast on fabric. Systematic studies were conducted with different formulations, concentration variations, size distribution of polymer particles, casting speed, solvent composition, film thickness and temperature of drying. Although the property of the membrane was found to be satisfactory for optimized compositions, there was nevertheless substantial rejection of membrane on account of defects such as pinholes. Efforts are continuing to understand the cause(s) of pinhole formation and the means to circumvent them.

Desalting of seaweed hydrolysate by ED to improve fermentation efficiency

The institute has envisioned the production of ethanol from seaweed. It is specifically envisaged to cultivate seaweeds offshore for this purpose and to utilize the seaweed for production of biofertilizer (from the sap) and ethanol (from the residual polysaccharide-rich biomass). Although the efficiency of breakdown of the polysaccharide into sugars was facile, the fermentation was sluggish due to high salt concentration. The institute's ED technology to separate salt from organic biomass was exploited to raise the efficiency of fermentation. About 80-90% of inorganic salts could be separated out (initial salt concentration ca. 5-7% w/v) with minimum loss of sugar in a 70 cell pair (60 cm x 30 cm membrane area) ED stack capable of processing 500 liters hydrolysate over 8 h. As reported elsewhere, the ethanol obtained was refined and used as 10% gasohol to run an ambassador car.

Regeneration of fouled ion exchange membranes employed in chlor-alkali industry

Membrane
before treatment

Membrane
after treatment

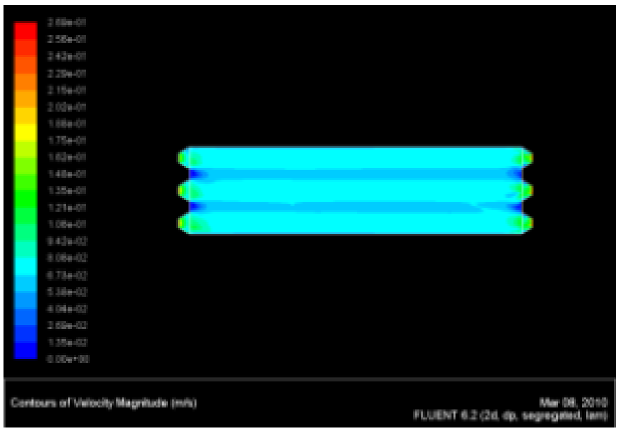
The Institute was approached by M/s. Shriram Chemicals & Fertilizers, Kota, Rajastan to study the feasibility of regenerating fouled membranes employed in their chlor-alkali factory. The work is of great significance as the membranes are costly. Cleaning was found to be feasible even for large size membranes – i.e., those actually used in the plant – and the report was submitted to the party.

Licensing of knowhow for 18E6Ω ultra pure water system

As mentioned in the previous report, a continuous electro-deionization (CEDI) unit was successfully developed which is a critical component in ultrapure water units. The unit helps to reduce salts from a level of ca. 30 ppm (output of RO) to >12MΩ.cm resistivity and thereby greatly reduces the subsequent load on the resin polishing unit employed to further raise the resistivity to $\geq$ 18MΩ.cm. Design improvements were carried out to increase the capacity of the system and to maintain its efficacy 24x7. This was achieved through several modifications, including the study of CEDI unit by CFD simulations. Finally, the unit was fully automated and the knowhow was licensed to M/s Infusil India Ltd., Bangalore.

Analysis of water flow inside the compartment of CEDI unit using computational fluid dynamics

Since the flow within the CEDI unit cannot be visually observed, CFD simulations were resorted in order to understand such flow behaviour. The commercially available 2D Navier-Stokes code (FLUENT) with laminar model was used for this purpose. Necessary boundary conditions were identified and employed in the simulation. The active and dead zones (least velocity) were identified and suitable modifications were incorporated to minimize the latter since these are ineffective for ion transport. This was the basis of improving the performance efficiency of the CEDI unit.

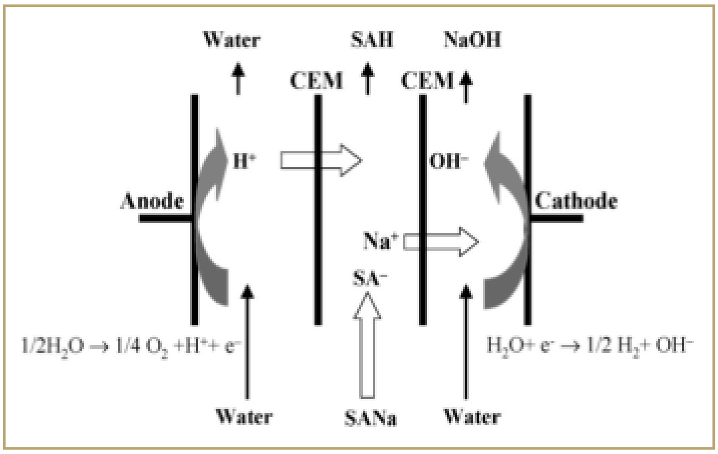


Development of hybrid membrane domestic desalination technology (ED-RO) for the high recovery of water

Although RO water purification units have become increasingly popular in the last 5 years, an important drawback is the low recovery of water and the difficulties encountered in their functioning when the salinity of the water increases beyond 2000 ppm. To mitigate the above problems, the concept of ED-RO hybrid water purification was conceived and a patent application filed. Whereas ED has the advantage of high recovery and ability to deal with high salinity, it suffers from the disadvantage of reduced current efficiency at comparatively low TDS which makes it difficult to reduce the TDS beyond 600-700 ppm whereas people today have got used to water of very low TDS as obtained from RO. The developed unit takes advantage of the respective merits of the individual technologies to provide water having <200 ppm TDS from feed water of 3000 ppm, and with overall 65% recovery – something hitherto unheard of in standalone domestic RO units. An affordable unit of appropriate capacity suitable for households is being fabricated. Separately, an attachment is being devised for existing RO units.

Ionic transport phenomenon across cation selective membranes

Permselective membranes are required for certain specific applications and such separations are important from both academic and application viewpoints. A monovalent cation selective special nanocomposite membrane (MCSM) was designed and a study was undertaken to measure the concentration polarization of monovalent (Na^+) and divalent (Ca^{2+}, Mg^{2+}) cations. Electro-transport efficiency (η) for the three cations across the membrane was derived from the change of their concentration with the passage of a fixed number of coulombs. The electro-transport efficiency of Na^+ was significantly higher than that of the divalent ions. The study gains significance in light of the need to provide drinking water with not only low TDS but having the desired nutrient composition such as higher levels of Ca^{2+} and Mg^{2+} over Na^+ *(J. Membr. Sci., 340 (2009) 52).*



Electro membrane process for *in situ* ion substitution and separation of salicylic acid from its sodium salt

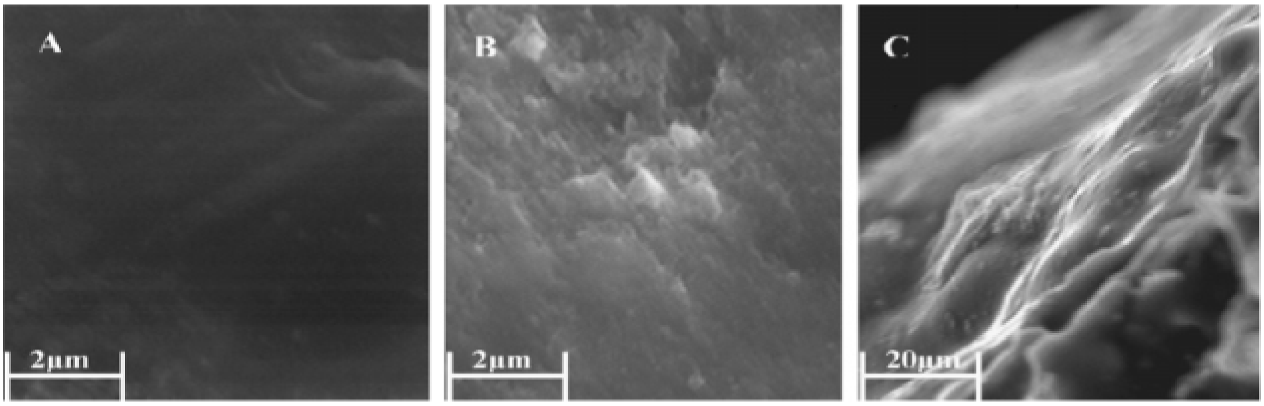
Salicylic acid is conventionally prepared by carboxylating sodium phenolate with CO_2 under high pressure and temperature, followed by acidification and separation of sodium sulphate. An electrochemical membrane process (EMP) with three compartments (anolyte, catholyte, and central compartment) was developed to achieve in situ ion substitution and recovery of salicylic acid (SAH) from its sodium salt thereby dispensing with the acidification and separation steps. The cation-exchange membrane (CEM) used was prepared in-house. The power requirement was found to be 10 kWh/kg of the product. Formation of caustic soda in the cathode stream was a spin off *(Ind. Eng. Chem. Res., 48 (2009) 923).*

Cross-linked PVA-PAN-*co*-2-DMAEMA-based anion-exchange membranes prepared under aqueous condition

As already mentioned above, conventional interpolymer membranes have excellent characteristics but their preparation needs to be made greener, especially of the anion exchange membrane for which chloromethyl ether is presently required. A novel anion exchange membrane based on polyvinyl alcohol (PVA) and the copolymer of polyacrylonitrile (PAN)-dimethylaminoethylmethacrylate (DMAEMA) was prepared in aqueous medium. The synthesized membrane was characterized through physicochemical and electrochemical techniques. The membrane exhibited good ion-exchange capacity (1.18 meq/g) and conductivity (3.45 mS cm^{-1}). The electrodialytic performance revealed its suitability for water desalination *(J. Phys. Chem. B, 114 (2010) 198).*

Heterogeneous–homogeneous composite bipolar membrane

A heterogeneous–homogeneous composite bipolar membrane (BPM) was prepared by casting. In this process, heterogeneous anionic layer (AL) of desired thickness was cast onto a clean glass plate followed by an interfacial layer comprising sulphonated PEEK (with 80% degree of sulphonation) and poly(4-vinyl pyridine). This was then followed by deposition of the cationic layer (CL) which was basically sulphonated PEEK. The SEM images of AL and CL confirmed absence of cracks, holes and phase separation. In cross-section image, two separate layers with strong interfacial adhesion were clearly visible. The contact region, also referred to as interfacial layer, is where water dissociation occurs and the structure of this region is of critical importance. A study was undertaken with 0.5 M NaCl solution and formation of equimolar amounts of NaOH and HCl were confirmed. After passage of 7.68×10^{3} C of electricity, 67.6% current efficiency corresponding to 3.1 $kWhkg^{-1}$ energy consumption was observed *(J. Membr. Sci., 349 (2010) 130).*



SEM images of: (A) CL; (B) AL and (C) cross-section of composite bipolar membrane (BPM)

Glucoside bioconjugates

Assistance was rendered to a party towards a project funded by DSIR on synthesis and purification of glucoside bioconjugates. Whereas the desired vitamins and carbohydrates (dissolved in buffered solutions) could be conjugated by immobilized microbial strains to form glucoside bioconjugates within 6 hours, almost all downstream processing approaches that were previously envisaged were cost-ineffective, time consuming, resource-demanding and did not scale-up. A combination ED-RO purification-cum-enrichment technique worked nicely and a 1.5 L raw stock could be processed to get 80% enriched product. Subsequent scale up to 6 liters per day scale on a larger unit gave similar results, the effective enrichment of the target bioconjugates being approximately 70-75%. Importantly, loss of the bioconjugates into the waste stream was minimum. ED-RO processing flow-designs capable of handling up to 100 liters per day are being worked out. An MoU has been signed between the party and CSMCRI for sharing of benefits.

Feasibility studies on water recovery coupled with concentration of useful chemicals from aqueous effluent streams

Studies were undertaken for two large companies on processing of aqueous effluents. In the first case, the goal was to recover acetic acid from an effluent stream with simultaneous reuse of water. Under optimized conditions, it was possible to recover ca. 75% of water with laboratory and pilot scale trials conducted using both ED and RO technologies separately and combination. RO-ED: The treatment of Dr M waste water gave 0.06 g/L acetic acid starting from an initial concentration of 1.93 g/L acetic acid. The economics was, however, not worked out. With regards to enrichment of acetic acid, this objective was found to be technically unattractive.

In the second study, the idea was to process a dilute sodium hydroxide waste stream to recover water, on the one hand, and the alkali, on the other hand, in relatively more concentrated form. It was possible to generate reusable water with TDS< 500 ppm from feed of 15,000 ppm by recirculation mode. The concentration of alkali was simultaneously raised from 5.5g/L to 13g/L.

çfrorh j lkdÔ.k ¼vkj vk½ rFkk bl l lcf/kr cgydh eEcu

iryh l?kfVr ¼Vh,Q lh½ vkj vk eEcu

lfiy vkdkj d ekM;y cuku dh lfo/kk

Lon'kh ekM;y cuku dh lfo/kk fodflr dju e gekjk ç;Ru tkjh gA bl lfo/kk d fy, lc t#jh lkexh çkIr djd 4040 lkbt d lfiy vkdkj d ekM;y cuk, x, tk igy cuk, x, ekM;y dh ryuk e lQy g vkj mldh lQyrk dk dkj.k g& ¼v½ iryh l?kfVr ¼Vh,Q lh½ vkj vk eEcu e l/kkj ¼c½ eEcu cuku rFkk ekM;y cuku dh fof/k e eEcu d fcxMu dh leL;k dk lek/kku ¼d½ eEcu dk fpidku dh leL;k dk lek/kku vkj ¼M½ fydt dh leL;k dk lek/kkuA

Vh,Q lh vkj vk eEcu dh #[kh (rough) lrg dk v/;;u

Vh,Q lh vkj vk eEcu dk çokg c<ku d fy, ikyh,ekbM dkEikftV eEcu dh lrg dk vf/kd l vf/kd iryk gkuk vfuok;l gA bld lkFk gh ikyh,ekbM dkEikftV eEcu dh lrg ij fiu gky ¼fNn½ u cu] bldk /;ku j[kuk Hkh vko';d g ftld dkj.k vi{kkj vLohdfr çHkkfor gkrh gA bl çdkj Vh,Q lh eEcu fuek.k d le; ikyh,ekbM lrg d [kjnjkiu (roughness) dk v/;;u AFM l fd;kA AFM v/;;u l ;g Kkr gvk fd Vh,Q lh vkj vk eEcu e ikyhlYQku dh lrg lery rFkk ikyh,ekbM dh lrg 120 nm [kjnjh ik;h xbA bldk [kjnjkiu de dju d fy, v/;;u tkjh g ftl l fQYe dh ekVkbZ de dh tk ldA

Lon'kh fcuk cu g, diM ij Vh,Q lh vkj vk eEcu dk fodkl

Vh,Q lh vkj vk eEcu dk fuek.k nk pj.kk e ijk gkrk g] ftle fcuk cuk gvk diMk] ,d dPp eky d #i e egRoi.k g] ftl ij çcfylr lj?k ikjl ikyhlYQku dh lrg çFke pj.k e Qt bUo'ku çfØ;k }kjk cukbZ tkrh gA Lon'kh rFkk de ykxr e Vh,Q lh vkj vk eEcu cuku gr gekj n'k e miyC/k fcuk cu g, diM dk v/;;u fd;k x;kA fon'kh rFkk Lon'kh (Ind) fcuk cu g, diM dh ekVkbZ (Imp: 100-110 microns; Ind: 110-140 microns) rFkk ok;q ikjxE;rk (Imp: 5-6CFM/m²; Ind: 20-25CFM/m²) e lkFkd vUrj gA 4-6 ehVj@feuV dh xfr l ikyhlYQku vk/kkj cuku d fy, geu fofHkUu ifjfLFk;k dk v/;;u fd;kA Kkr gvk fd Lon'kh fcuk cu g, diM ij ikyhlYQku ihN dh rjQ Nu tkrk g] tcfd blh ifjfLFkfr e fon'kh diM ij ikyhlYQku dh lrg dk cuuk vudy ik;k x;kA bl leL;k dk de dju d fy, Lon'kh diM ij ikyhlYQku vk/kkj mPp nj ij cuk;k x;k ftl ij ikyh,ekbM dh iryh lrg bVjQf'k;y ikyhejkbt'ku d }kjk cukbZ x;hA bl çdkj Lon'kh rFkk fon'kh (Nordlys TS 100) diM ij cukbZ xbZ fofHkUu Vh,Q lh vkj vk eEcu 4-5 ehVj@feuV dk uedhu rFkk lenh ty dk vkj vk fdV l Øe'k% 250 ih,lvkbZ nkc rFkk 600 ih,lvkbZ nkc ij v/;;u fd;k x;kA fofHkUu çdkj dh Lon'kh Vh,Q lh vkj vk eEcu u uedhu ty ¼250 ih,lvkbZ½ d fy, yxHkx 86% {kkj vLohdfr d lkFk 45% (LMH) çokg dh miyC/krk n'kk;hA blh çdkj fon'kh diM (Nordlys TS 100) ij cukbZ xbZ Vh,Q lh vkj vk eEcu u Øe'k% 250, 600, 900 ih,lvkbZ nkc ij 96.22%, 94.4 %, 95.54%, dh {kkj vLohdfr d lkFk Øe'k% 70, 47.6, 90.1%, çokg dh miyC/krk n'kk;hA

ftyu'ku ckFk e DMF lknrk dk Vh,Q lh vkj vk eEcu dh çfrfØ;k ¼dk;ç.kkyh½ ij çHkko

Vh,Q lh vkj vk eEcu cuku dh çfØ;k e] DMF e ikyhlYQku d foy;u dk] Qt bUojtu dh çfØ;k }kjk ikjl ikyhlYQku vk/kkj dk cuuk çFke pj.k e vkrk gA oreku lfo/kk e] 800 yhVj d ftyu'ku ckFk e ikuh] SLS rFkk DMF dh ikjl ikyhlYQku eEcu fuek.k e vko';drk gkrh gA 100 ehVj dh ikyhlYQku eEcu d fy,] 1.5% DMF lknrk dh of) gkrh gA DMF lknrk d çHkko v/;;u dju d fy, ftyu'ku ckFk e 2%, 6% rFkk 10% DMF lknrk e ¼0.1% SLS d lkFk½ fofHkUu çdkj dh ikyhlYQku eEcu cukb xbA ;g ik;k x;k fd DMF lknrk c<u d lkFk ty çokg c<rk g tcfd {kkj vLohdfr çfr'krrk

igy c<rh g rFkk ckn e ?kV tkrh gA ;|fi DMF dh mPp lknrk ij ikuh d çokg e mYy[kuh; of) l bld mPp Lrjh; nh?kdkyhd mi;kx vkfpR; i.k jgxkA

çkikby ,LVj ;Dr uohu Vh,Q lh vkj vk eEcu

çkikby ,LVj ;Dr uohu Vh,Q lh vkj vk eEcu bUVjQf'k;y ikyhejkbt'ku }kjk cukb xb ftle MPD dk tyh; foy;u rFkk TMC ,o 3&çkikby dkckukby vkblkFkykby DykjkbM dk gDlu e foy;u d lkFk fofHkUu ifjfLFkfr;k e ç;kx gvkA bl eEcu dk IR, SEM rFkk lid dk.k }kjk v/;;u fd;k x;kA IR LiDVk e bl eEcu dk 1649cm^{-1} ij ,ekbM&I, 1541cm^{-1} ij ,ekbM&II rFkk 1737 cm^{-1} ij dkckukby xi dk c.M ik;k x;kA lid dk.k d v/;;u ij ik;k x;kfd çkikby ,LVj dh ek=k 0 l 0.025% l c<ku ij lid dk.k 45° l 61° rd c< tkrk g tk eEcu dh ty fojk/kh çdfr dk n'kkrk gA bl eEcu dk lrg v/;;u SEM }kjk dju ij MPD rFkk TMC d lQn rFkk dkyk ljpuk e ridge ,o valley leku #i l forfjr ik;k x;A 3&çkikbykDlh dkckukby vkblkFkykby DykjkbM dk TMC d lkFk ç;kx dju ij ikyh,ekbM lrg ij egRoi.k vlj gvkA fofHkUu dkcfud foy; rFkk vdkcfud foy; d iFkDdj.k v/;;u] bl eEcu }kjk dju ij ;g Kkr gvk fd çkikby ,LVj dh ek=k c<u ij ty çokg rFkk foy; vLohdfr nkuk ?kVrh gA bldk e[; dkj.k LFky flyoV ;Dr (bulky ridge) ljpuk dk cuuk ik;k x;k tk tyçfrjk/kh x.k n'kkrk gA

nkÔjfgr gkykQkbcj eEcu

gkykQkbcj dh ljpuk dk e[; ykHk ;g g fd gkykQkbcj dh vrg% lrg dk cká çokg ;k cká lrg l vUrg lrg dh rjQ çokg ik;k tk ldrk gA bl rjg fdlh Hkh çdkj d fNn vojk/k dk nj dju rFkk Qkbcj dh ljy lQkb d fy, gkykQkbcj mi;kxh gA oÔ 2006-08 dh f}okfÔd çfronu e vudy ifjfLFkfr;k ¼ikyhej Mki vuikr] fNn cuku oky rjy dk çokg] Qkbcj cuku dh xfr] i'pkr çfØ;k½ d voykdu d vk/kkj ij 5000-10,000 ehVj yEch ikyhlYQku (PS), ikyh,ØkbykukbVkby dk eFk,Økbfyd ,flM (PANMA), ikyhfofufyMhu ¶ykjkbM (PVDF) rFkk PS-PANMA d lkFk fefJr] ,d gh cp e gkykQkbcj (1.0-1.4 mm OD, 0.5-0.8 mm ID) eEcu cukb xbA gkykQkbcj dh LFkkf;Ro {kerk rFkk dk;ç.kkyh bl dh Ropk ljpuk rFkk vk/kkj ljpuk ij vk/kkfjr gkrh gA gkykQkbcj eEcu dh lrg dk v/;;u SEM l] tyLugh lrg (Hydrophilic surface) dk lid dk.k l] rFkk 'k) ty çokg nj] v.kHkkj dV vkQ (MWCO) l fd;k x;kA SEM QkVkxkQ e gkykQkbcj dh ljpuk n[ku ij l?ku Ropk d lkFk vUrg ,o cká nkuk rjQ dh mxyhuek ljpuk curh fn[kkb nhA PANMA gkykQkbcj e cká rFkk vUrg ,oe cká lrg dh rjQ curh gb mxyhuek ljpukvk d chp Lit d dkj.k ,dnlj l vyx fn[kkb fn;A fofHkUu dn d gkykQkbcj ekM;y (1-4" dia x 12"-60" length) fofHkUu mi;kx d fy; cuk; x;A fofHkUu Lihfux jV d vk/kkj ij cuk; x; gkykQkbcj ekM;y d MWC 0 10-100 kDa rFkk çokg 50-140 LMH rd ik;k x;kA MWCO rFkk fNn f=T;k d lehdj.k d vk/kkj ij gkykQkbcj eEcu d fNn vkdkj dk ukik x;k ,o fNn dk vkdkj 5-14nm ik;k x;kA ;g Hkh ik;k x;kfd ; gkykQkbcj eEcu ihu d ikuh e jkxk.kuk'kd dk Hkh dk; djr g buls Cocci, E-Coil b-coil rFkk Bacillius vkj foÔk.k 99.99% rd nj gkr gA (bUVj- t- U;fDy;j fMlyhu'ku, 4,149-161,2010)

gkykQkbcj eEcu cuku dh çk|kfxdh dk gLrkUrj.k

fofHkUu MWCO dh gkykQkbcj eEcu cuku dh n{krk gkfly dju d i'pkr bl çk|kfxdh dk i.k fLFkr M/S. Uniqflux Membrane LLP dk gLrkrfjr dh xbA gkykQkbcj eEcu cuku dk çn'ku Hkh fd;k x;k] ftle cukb xb eEcu u jkxk.kuk'kd çdfr n'kk;h tk fo'o ekin.M d cjkcj gA

lrg ifjoru }kjk gkykQkbcj dk x.k/ke dk mRd"V cuku dk ç;kl

gkykQkbcj eEcu dh ,VhQkmfyx çdfr rFkk blds mi;kx dk foLrkj dju d fy, PANMA gkykQkbcj eEcu dk jklk;fud ifjoru Øe'k% {kkj rFkk vEy l fd;k x;kA ifjofrr eEcu dk lEid dk.k {kkj rFkk vEy lkUnrk c<ku d lkFk ?kVrk gA {kkj lkUnrk c<ku l ty çokg ?kVrk g rFkk {kkj vLohdfr c<rh gA bl eEcu dk mfpr le; rFkk lknrk ij j[ku l MWCO vf/kdre 10 xuk rd ?kV tkrk gA blds i'pkr vf/kd lkUn NaOH ;k le; lhek 10 ?k.V l vf/kd dju ij gkykQkbcj eEcu dh fLFkjrk ?kVrh gA ey rFkk ifjofrr gkykQkbcj eEcu e ,VhQkmfyx çdfr dk v/;;u dju d fy, PEO-100 kDa (500 ppm) rFkk ckohu flje vkYcehu (BSA) (100 ppm) d foy;u dk db ?k.V rd çokfgr fd;k x;k rFkk çlr çokg vuikr (FRR) d vk/kkj ij eEcu d [kjkc gku dh {kerk dk v/;;u fd;k x;kA v/;;u l Kkr gvk fd FRR eku c<u l eEcu d [kjkc gku dh çdfr c<rh gA

ty iu% çkflr d fy, ¶yV'khV vYVkfQYV'ku eEcu vk/kkfjr lceflcy dkfV t dk fodkl

ikyh,Økbykukbvkby eFkk,Økbyhd ,flM (PAAMA) vk/kkfjr ;,Q eEcu dh ¶yV'khV }kjk lceflcy dkfV t ;fuV cukb xbA eEcu e tyLugh x.k/ke rFkk 90kDa MWCO çklr dju d fy, eEcu dk lrg ifjoru fd;k x;kA yxkrkj ty çkflr rFkk ok;; lpkj.k dju fy,] 10 eEcu dkfV t (0.3 m x 0.3 m) ;Dr ,d çkFkfed ;fuV dk fuek.k fd;k x;kA bl ;fuV dk e[; ykHk bl dh ljy lQkb gA bl bdkb ¼;fuV½ l 200 NTU vfoyrk oky (turbidiry) lifjr ty l 25-120 yhVj çfr ox ehVj çfr ?kVk vkj <1NTU okyk mipfjr ty çklr gvkA Lon'kh eEcu d 0;olkf;dj.k dju d fy, dkf'k'k dh tk,xhA eEcu ck;kfj;DVj (MBR) ç.kkyh e Qkmfyx ,d tfVy leL;k g fo'kÔr% tc blds }kjk vR;Ur nfÔr ikuh dk 'k) fd;k tkrk gA SEM QkVkxkQ l Kkr gkrk g fd [kjkc eEcu d fNn nkuk lrg dh rjQ l cUn gk tkr g] ftl l ckâ çokg e deh vkrh gA bl leL;k dk fujkdj.k lrg ifjoru] ok; çokg rFkk mi;Dr lQDVUV d ç;kx }kjk fd;k tk ldrk gA

vU; vulu/kku ,o fodkl xfrfof/k;k

yt dkEikftV eEcu

fiNy f}okf"kd çfronu d dk; dk vkx c<kr g, <hyh¼y t½ Vh,Q lh eEcu cuku dk v/;;u] dkcfud foy; d MWCO iku d fy, fd;k x;kA lEid dk.k (CA) rFkk ftVk ikVf'k;y (Zeta Potential) Hkh eki x;kA fofHkUu v.kHkkj d MW(200-1000 Da) d fofHkUu PEG foy;u dk 125 ih,lvkb nkc ij çokfgr dj bldk MWCO Kkr fd;k x;kA nk eEcu NF3 ,o MF8 d MWCO Øe'k% 650 rFkk 300 Da ik; x;A fofHkUu pH eki d 1 mM KCl foy;u dk ç;kx djd Zeta CAD Zeta potential analyzer }kjk eEcu d lrg pkt Kkr fd;k x;kA pH c<u d lkFk eEcu e –ve pkt c<rk g rFkk bUgh ifjfLFkfr;k e $MgSO_4$ dk iFkDdj.k NaCl l vf/kd gkrk gA bl eEcu d lEid dk.k d v/;;u l Kkr gkrk g fd bldk lEid dk.k 39°] ikyhlYQku (PS) d lEid dk.k 84° l de g tkbl d tyLugh x.k/ke dk n'kkrk gA bl eEcu d 2" dia x 10 length e ekM;y cuk; x;A 500 ppm ,Eihflyu d foy;u dk çokg 250 ih,lvkb nkc ij djd bldh vLohdfr çfrØ;k dh tkp dh x;hA bl ,UVhck;kfVd foy;u dh lkUnrk lifjr rFkk mipfjr ty e HPLC }kjk Kkr dh xb rFkk ;g ik;k x;k fd ,Eihflyu dh vLohdfr {kerk 96% gA bl eEcu }kjk fofHkUu yo.k foy;u (NaCl, $MgCl_2$, $CaCl_2$) dh vLohdfr {kerk dk v/;;u fd;k x;kA

PS vk/kkj ij MA-PVA ;Dr uohu dkEikftV eEcu Hkh cukb xbA bl eEcu dk fuek.k 1% PVA + 0.2% (w/w)MA l 125° l ij 30 feuV rd xe djd cukb xb rFkk mnklhu dkcfud foy;u dk MWCO 250-350 Da rd ik;k x;kA vdkcfud foy;u dk v/;;u djd vLohdfr {kerk $RNa_2SO_4 > RMgSO_4 > RNaCl > CaCl_2$ $R \cong R\ MgCl_2$ d vulkj ik;h x;hA ;g Hkh n[kk x;k fd lYQV dh mifLFkfr ¼_.kk;u ;k /kuk;u½ gku ij vLohdfr vf/kd ik;h x;hA f}l;ktd dh vLohdfr {kerk ,dy l;ktd l de ik;h x;hA

flfydk ikyh,ekbM uuksdEikfttV eEcu

10– 18 Å f=T;k okys flfydk d.k dk ç;ksx djds flfydk ikyh,ekbM eEcu cuk;h x;h rFkk blds lajpuk] x.k/kek dk v/;;u SANS, TEM rFkk SEM ds }kjk fd;k x;kA SEM QksVksxkQ esa nks fofHkUu Lrj fn[kk;h fn; ftlesa flfydk d.kksa dk forj.k çdkj rFkk ekiu ij fuHkZj djrk gSA TEM QksVksxkQ esa TEOS flfydk ç;ksx ls vxBh ds vkdkj dh l{e lajpuk [M1(A)] fn[kkbZ nhA TEOS rFkk MPTMS feJ.k ds }kjk cukbZ x;h eEcu [M2(A)] esa yEch vxBh ;k pu lajpuk fn[kk;h nhA rhljs çdkj dh eEcu [M3(A)] ftlesa ejdIVks çkikby&flfydk dh vf/kdrs ek=k gksu ij vf/kd pu lajpuk fn[kkbZ nhA

ikyhesj J[kyk dh if"V esa tyjkxh flfydk v.k dk çHkko

100 Å Rg ds ikyhfoukby ,Ydkgy rFkk 80 Å f=T;koky flfydk ds ru tyh; foy;u ds }kjk ikyhesj dMh rFkk flfydk ikVhdy ds chp vfHkfØ;k dk v/;;u fd;k x;kA flfydk dh ek=k c<u ls forj.k {kerk c<rh gS vkj bUgh ifjfLFkfr;k esa ikyhesj flfydk dh lrg ij vkdfÔr gksu ds lkFk vo'kkfÔr gks tkrk g] ftlls flfydk ds pkjks rjQ ikyhesj dMh cu tkrh gSA

bufVl ;kej p;fur eEcu

dkbjy p;fur xi ;Dr BSA xfrghu rFkk BSA ;Dr leh bUVj iuhVVhx ikyhesj uVod ikyhlYQku dEikftV eEcu cukbZ xbZ rFkk blds x.k/keZ fu/kkj.k SEM rFkk ATR-FTIR rduhdh }kjk fd;k x;kA fVIVkQku ,o α -,ehuks ,flM dk iFkDdj.k fofHkUu ifjfLFkfr;k esa fd;k x;kA bl dEikftV eEcu us d-arginine ds fy, 54% p;fur rFkk d-alanine ds fy, 21% dh p;furk n'kk;hA BSA ;Dr eEcu u lcls vf/kd {kerk 30.8% BSA semi-IPN eEcu (23.8%) dh ryuk es 8 ?k.Vs esa n'kk;hA (lsi- lk;Ul- Vd-, 45, 346-354, 2010, 45; 1374-1384, 2010)

ykbi t dk ikyhesj efVDl ij vpj ¼bekcykbt½ gksu rFkk blds gkbMkfyfVd xfrfof/k;k

ikyhlYQku (PS) ikyhfoukby ,Ydkgy (PVA) ifjofrr PS eEcu rFkk PS XykbC;y ds }kjk vkfyo vkby ds fy, ykbit ds gkbMkfyfVd xfrfof/k dk v/;;u fd;k x;kA fofHkUu çdkj ds ry ds gkbMkfyfll dk v/;;u fd;k x;k rFkk gkbMkfyfll oil > Palm > oil ds Øe esa ik;k x;kA Castor oil esa ricinoleic ,flM dh mifLFkfr ds dkj.k blds gkbMkfyfll nj de dh tk ldrh gSA (ikyh- cy-, 64, 141-158, 2010)

tyh; dkcfud rjy feJ.k dk ijoijkbt'ku eEcu }kjk iFkDdj.k

PS, PDMS rFkk PA TFC eEcu Øe'k% dkfLVx] dkfVx ,o bUVjQf'k;y ikyhejkbt'ku }kjk cukbZ xbA bu eEcu dk tyh; dkcfud feJ.k] ty&feFkuky] ty&DCM/Benzene dk ijoijkbtu VLV fdV }kjk iFkDdj.k {kerk dk voykdu fd;k x;kA vf/kdre iFkDdj.k QDVj 8, H_2O—CH_3OH ds fy, rFkk 120 ty&DCM/Benzene feJ.k ds fy, ik;k x;kA

ty dk jksxk.kqeDr djus ds fy, uohure cgyd dk fodkl

tyh; jksxk.kquk'kd uohu ikyhesj dk fodkl

ikuh esa ekStn thok.kvksa ds fouk'k ds fy, ,d mi;Dr fof/k fodflr dh xbA bl fof/k esa eFk,Økbfyd ,flM dk ikyhesj chM ds Åij flYoj ds uukd.k dk yxk;k x;kA flYoj uukd.k ;Dr ikyhesj chMl dh thok.kuk'kd fØ;k fof/k ds fy, tkp dh xb rFkk ;g ik;k x;k fd ; ikyhesj chMl ikyhesj J[kyk dh if"V esa tyjkxh flfydk v.k dk çHkko gram +ve rFkk gram –ve nkuks çdkj ds thok.kvksa ds fy, mi;Dr gSA (okVj fjlp, 48, 5481-5487, 2010)

fofHkUu çdkj ds lj?k ¼ikjl½ ikyhesj dk fuek.k (i) styrene-DVB, (ii) MAA-DVB (iii) AN-DVB dk fuek.k ikjklktfud ,UtV dh mifLFkfr e fd;k x;kA bu ikjl ikyhel dh fofHkUu] 5,5 MkbfeFkkby gkbMUVkbu ikyhbfFkyhubekbu ;k VkbbFkkbfyu,ekbu d }kjk jklk;fud fØ;k dh xbA lHkh ikyhel d x.k/ke fu/kkj.k CHN, FT-R, UV LiDVk] SEM, EDX rduhdh }kjk fd;k x;kA TEM rFkk vklVhdy ekbØkLdkih }kjk bld QD'kuy xi gku dk irk pyrk gA lyV rFkk VLVV;c fof/k }kjk ikyhel e jkxk.kuk'kd çfrfØ;k dk irk yxk;k x;kA jkxk.kuk'kd çfrfØ;k dh tkp PEI ;Dr ikyhej l dju ij irk pyrk g fd v.kHkkj c<u l bufgfcVjh tku e of) gkrh gA fofHkUu QD'kuy ikyhel dh jkxk.kuk'kd {kerk dh ryuk Cyhfpx ikoMj l Hkh dh xb ftlle ;g ik;k x;k fd Cyhfpx ikoMj dh ryuk e ikyhej d mi;kx l ikuh e cph g;h Dykjhu dh ek=k ugh gkrh gA

fo|r f>Yyh çfØ;k,

çk|kfxdh dUn.k

foÔekxh vk;u fofue; djuokyh f>fYy;k d fodkl dh vkj c<r dne

1980 d n'kd e lLFkku }kjk fodflr vr%cgydh vk;u fofue; djuokyh f>fYy;k dk x.k vPNk gkrk g ijr vkt Hkh vk;u fofue; djuokyh f>fYY;k d fy, i;koj.k Lugh rduhd d fodkl dh t#jr gA fiNy ,d n'kd l foÔekxh vk;u fofue; djuokyh f>fYy;k d lerY; x.kokyh f>Yyh d fodkl dh vkj ç;Ru tkjh gA bu ç;Ruk e PVC ,o vk;u fofue; djuokyh jftu dk ,d fof'k"V foyk;d e ?kkyk tkrk g] vkj rRi'pkr ml ?kky dk iryh tkyh ij Qyk;k tkrk gA fofHkUu l=hdj.kk] lkn.k foHkn] cgyd d.kk d vkdkj o forj.k] Qyko dh xfr] foyk;d dh ek=k] f>Yyh dh ekVkb ,o l[kku d rkieku dk ydj fu;eu v/;;u fd;k tk jgk gA gkykfd f>Yyh dh fo'kÔrk, lrkÔtud g] ijr bue l{efNnk }kjk f>Yyh dk vLohdk;dj.k vHkh Hkh ,d e[; nkÔ gA bu fNnk d fuokj.k d fy, ç;kl tkjh gA

ED }kjk lenh [kjirokj gkbMkykblV d foyo.khdj.k l fd.ou {kerk e l/kkj

bFkuky dk len l mRiknu dju dh lLFkku u dYiuk dh gA bld fy, lenh fdukjk ij 'koky mxkb tkrh g] ,o bul to [kkn mRiUu fd;k tkrk gA ikyh lDjkbM dk 'kdjk e cnyu dh {kerk rk vPNh g ijr yo.k ;Dr ty gku d dkj.k fd.ou cgr vPNk ugh gA ED rduhd d }kjk to [kkn l 80-90% yo.k dk vyx dj fy;k tkrk g] ftlls mldh fd.ou {kerk c< tkrh gA 70 dk"B ;Xe d ED }kjk 500 yhVj gkbMkykblV dk foyxhdj.k 8 ?k.V e lHko gA bl bFkuky dk lkQ djd xkMh d b/ku d #i e Hkh ç;kx fd;k x;k gA

Dykj ,Ydyh çØe e ç;kx fd;k x, vk;u fofue; djuokyh foyxu f>fYy;k dk iu%lLdj.k

Dykj ,Ydyh çØe e mi;Dr dh tkuokyh vk;u fofue; djuokyh f>Yyh tk fodr gk tkrh g] mudh lQkb dh lHkkouk d v/;;u gr] Jhjke jklk;fud ,o [kkn] dkVk] jktLFkku u lLFkku dk mixeu fd;kA ;g dk; dkQh egRoi.k Fkk] D;kfd f>fYy;k dk eY; T;knk FkkA budh lQkb lHkfor ikb xb vkj ;g urhtk ikVh dk Hkh Hkkt fn;k x;kA

18E6Ω vfr'k) ty dfy, vuKflr

tlk igy fjiksV ecrk;k x;k gfd lLFkku }kjk fufer fo|r fMvk;kukbt'ku bdkb l vfr'k) ty çkIr fd;k tkrk gA ;g bdkb ikuh e l ued dh ek=k dk de djrh g vkj mlk >12MΩ.cm d çfrjk/k {kerk rd igpkrh gA blls rjg og jflu ikfy'k bdkb dk Hkkj de djrh gA bl bdkb dh {kerk c<ku dfy, i)fr e l/kkj djuk rFkk dk;{kerk 24 x 7 cuk; j[ku dfy, fMtkbu e l/kkj fd;k x;kA bldfy, CEDI bdkb e CFD }kjk v/;;u djd dN ifjoru fd, x, vkj vr e ;g bdkb ijh rjg Lopkfyr dh xb vkj buQflyk bfM;k fy-] cxykj dk vuKflr djnh xbA

(CFD) vfHkdyukRed rjy xfrfoKku }kjk CEDI d{k e ikuh d cgko dh tkp

CEDI d{k d vnj ikuh dk cgko n[kk ugh tk ldrk g] vr% CFD }kjk ikuh d cgko dh tkp dh x;hA ckt kj e feyuokyh 2d tfo;j LVkDl dkM (FLUENT) dk bldfy, ç;kx fd;k x;kA bl vudj.k dfy, t#jh lhek ifjfLFkfr;k dk igpkuk x;k vkj ç;kx fd;k x;kA lfØ; ,o vlfØ; {k=k dk Hkh igpkuk x;kA vlfØ; {k=k e t#jh cnyko fd; x; ftlls o vk;u d fofue; dfy, mi;kx e yk; tk ldA blls rjg CEDI bdkb dh {kerk dk c<k;k x;kA

ty dh iu% çkfIr dfy, mi;Dr ?kjy foyo.khdj.k rduhd (ED-RO) dfy, ldj f>Yyh dk fodkl

fiNy 5 o"kk e ol rk RO ikuh 'kf)dj.k bdkb dk çpyu c<k g ijr mue dN fo'kÔ nkÔ Hkh ik; x; g& tl ty dh de iu%çkfIr ,o 2000 ppm l vf/kd yo.krkoky ty e mldh {kerk e fxjkoV vkukA bu nkÔk dk nj djuk dfy, ED-RO ldj ty 'kf)dj.k bdkb dk fuek.k fd;k x;k ,o bl ij iVUV Hkh çkIr fd;k x;kA tgk ED e vPNh iu%çkfIr gk ldrh g vkj Hkkjh yo.krkoky ty dk Hkh 'k) fd;k tk ldrk g] ogh mlls de yo.krkoky ty d 'kf)dj.k e dfBukb vkrh g tk RO l lHko gA blls rjg nkuk bdkb;k d x.kk dk ge lekxe djd <200 ppm dh yo.krkoky ty l 3000 ppm rd d ty dk 'k) dj ldr gA tgk bldh {kerk yxHkx 65% g] ;g ?kjy Lrj ij ç;Dr gA

/kuk;u p;ukRed f>Yyh }kjk vk;u dk fofue;

foyo.khdj.k çfØ;kvk e p;ukRed f>Yyh dk ç;kx t#jh gA ;g ,d l;kth ,of}l;kth /kuk;u dk lkn.k /ko.k ekiu dfy, ,dl;kth /kuk;u p;ukRed f>Yyh dk ç;kx fd;k x;kA fuf'pr fo|r d cgko ij lkn.k e vrj dk rhu vyx&vyx /kuk;u dfy, ekik x;k ftlls mudh fo|r fofue; {kerk dk Kkr fd;k x;kA ;g ik;k x;k fd Na^{+} dh fo|r fofue; {kerk f}l;kth /kuk;u l dkQh T;knk gA blls v/;;u l ikuh dh 'kf)dj.k rduhdk dk l/kkj k x;k g vkj i;ty e fdl rjg Ca^{2+} ,o Mg^{2+} dh Na^{+} tl ikÔd l;ktuk dh ek=k c<k;h tk;] bl ij fopkj fd;k x;k gA ¼tuy vkQ eEcu lk;Ul 2009, 340, 52–61½

fo|r f>Yyh çØe }kjk lfyflfyd vEy dk lkfM;e yo.k l foHkktu

lfyflfyd vEy dk cuku dh ijijkxr çFkk ftle lkfM;e fQukyV d lkFk dkcu MkbvkDlkbM dk vf/kd nkc vkj rki ij vfHkfØ;k djkr gA rRi'pkr vEyhdj.k djd lkfM;e lYQV vkj lfyflfyd vEy çkIr dj yr gA fo|r f>Yyh çde }kjk bl tfVy çfØ;k dk vklku cuk fn;k x;k gA ble f>Yyh dh lgk;rk l rhu d{k] dFkkM] ,ukM vkj e/; d{k cuk; tkr gA lkfM;e lfyflyV dk e/; d{k e j[kr g vkj dFkkM ,ukM d{k e ikuh Hkj nr gA byDVkMk dh lgk;rk l nkuk d{kk e foHkokUrj mRiUu fd;k tkrk gA fo|r vi?kVu dh çfØ;k }kjk lkfM;e vk;u ikuh dh rjQ tkrk g vkj gkbMkstu vk;u e/; d{k dh rjQ tkrk g vkj lfyflyV vk;u d lkFk vfHkfØ;k djd lfyflfyd vEy çkIr gkrk gA bl çde e ç;Dr /kukRed fofue; f>Yyh dk ç;kx'kkyk e cuk;k x;k gA fo|r Åtk dh [kir 10 kWh/kg ikb xb gA ble mimRikn dkfLVd lkMk çkIr gkrk gA

PVA-PAN-*co*-2-DMAEMA-vk/kkfjr _.kk;u fofue; f>Yyh dk ikuh dh mifLFkfr e fuek.k

mijkDr çde e ç;Dr f>Yyh dk ikuh dh lgk;rk l cuk;k x;k g tk fd ijh rjg fcugkfudkjd gA lkekU; r;k bl çdkj dh f>Yyh dk cuku e Dykjk efFky bFkj ç;Dr fd;k tkrk g tk gkfudkjd gA loçFke ikyh foukby ,Ydkgy dk ikuh e ?kky nr gA rRi'pkr ikyh,Økbykukbfvy Vkb efFky vehuk bfFky eFkk,ØkbyV dk foy;u e Mky nr gA bl foy;u dk 'kh'k dh lyV ij Qykdj l[kk yr gA ftl l f>Yyh çkIr gk tkrh gA bl f>Yyh dk Hkkfrd&jklk;fud x.k fofHkUu çde }kjk Kkr dj yr gA bl f>Yyh dh vk;u&fofue; {kerk (1.18 meq/g) vkj pkydrk (3.45 mS cm^{-1}) ikb xb gA fo|r vikgu çfØ;k }kjk ty fuL;nu e bl f>Yyh dk dk;çn'ku mfpr ik;k x;kA

foÔekxh& lekxh fefJr f}/koh f>Yyh dk fuek.k

foÔekxh& lekxh fefJr f}/koh f>Yyh dk cuk;k x;k gA loçFke _.kk;fud ijr dk 'kh'k dh lyV ij Qykk nr gA rRi'pkr lYQfjdr ikyh bFkj bFkj dhVku ¼80% lYQfjdr½ vkj ikyh foukby fijhMhu dk Mky nr gA ;g /kuk;fud ijr gkrk gA SEM çfrfcEc }kjk irk pyrk g fd f>Yyh e njkj] fNn vkj voLFkk foHkDrhdj.k ugh gA f>Yyh dh vuçLFk dkV e nkuk ijr Li"V fn[kkb nrh gA bl çfrfcEc e nkuk ijrk d tMko dk vUrjki"Bh; ijr gA ;g ijr ikuh d foHkDrhdj.k e e[; Hkfedk fuHkkrk gA bl f>Yyh l leku ek=k e NaOH vkj HCl çkIr gkr gA bl e 7.68×10^{3} dyc fo|r /kkjk çokfgr dju d ckn 67.6% /kkjk dh vf/kdrk vkj 3.1 $kWhkg^{-1}$ Åtk dh [kir gkrh gA

Xydk lkbM tol;Xeh

DSIR u XykbdklkbM ck;kdkU txV dk cuku vkj 'kf) dj.k d fy, ifj;kstuk fuf/k vkj lgk;d fu;Dr fd;k gA dkckgkbMV vkj foVkfeu] thok.k dh mifLFkfr e XykbdklkbM ck;kdkU txV cukr gA bl çde e N% ?k.V dk le; yxrk gA bl çde e le; vkj /ku vf/kd yxrk gA bl deh dk nj dju d fy, fo|r vikgu vkj vkj vk ç.kkyh dk vkil e feykdj dk; djr gA bl ç.kkyh l 1.5 L dPp eky l 80% rd XykbdklkbM ck;kdkU txV cukr gA bldh mRiknu {kerk 6 yhVj çfrfnu gA bldk cM iSeku ij 100 yhVj çfrfnu cuku d fy, dk; py jgk gA bl çde e mRikn dh {kfr cgr de gkrh gA ikVh vkj lh,l,elhvkjvkb u bl ifj;kstuk ij MoU le>krk fd;k gA

çnfÔr ikuh l mi;Dr jlk;u dh iu% çkfIr d fy, v/;;u

dpj l mi;Dr jlk;u dk vyx dju d fy, nk difu;k l lk>k djd dk; py jgk gA bl vul/kku e loçFke ,flfVd vEy dh iu%çkfIr vkj ikuh dk ihu ;kX; cukuk 'kkfey gA bl dk; e 70% ikuh dh iu% vkj 1.93 g/L ,flfVd vEy dh txg 0.06 g/L vEy dk feyu d dkj.k ;g dk; 0;kikfjd ugh gk ldkA nckjk v/;;u e dkfLVd lkMk dk ukyh d ikuh l vyx djuk gA bl fof/k e TDS 15,000 ppm d ikuh d 500 ppm e cny nr g vkj çkIr dpj l 5.5g/L dh txg 13g/L dkfLVd lkMk dh iu% çkfIr gkrh gA

CHAPTER 3

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MARINE & WASTELAND DEVELOPMENT RESEARCH

lenh ,o ctjHkfe fodkl vul/kku

Salt Tolerance & Wasteland Research

Phycological Research

Marine Microbiology

ued lárk ,o ctjHkfe vul/kku

lenh 'koky vul/kku

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SALT TOLERANCE AND WASTELAND RESEARCH

The earlier activities in this area centered mainly around cultivation of crop plants on sand, and degraded saline lands along the coastal regions, using seawater. 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 source of biodiesel. Another dimension of the research in recent years has been on molecular biology. The specific focus has been on isolation and characterisation of genes from halophytic plants followed by their transfer to commercial crops to sustain agricultural productivity in the wake of gradual deteriorations that are manifest in soil and water quality.

Agriculture in saline lands

Continuing studies on densification of *Salicornia brachiata* in the natural habitat

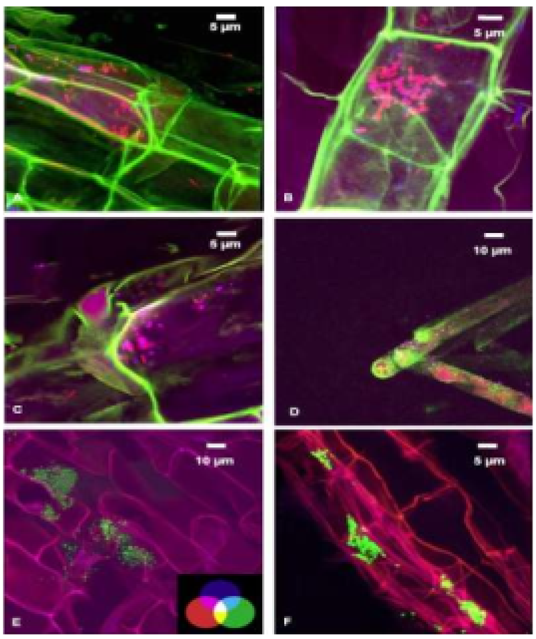
For densification of *Salicornia* vegetation at natural sites of Gujarat, seed/spike material of *Salicornia* was sprayed and approximately 100 ha area was covered at different sites like Ghogha, Avania, Methla, Victor and Diu. Cultivation is being undertaken without any intervention and with direct seawater irrigation. Information regarding biomass productivity, salt content, seed yield/oil content will be provided in the next report. In a related study, 19 ton dry biomass of *Salicornia* was collected from natural resources for preparation of vegetable salt (Saloni, Saloni K). 1000 kg of vegetable salt was prepared in pilot plant from a portion of the dry biomass and supplied to our licensee against payment.

Salicornia densification at Victor port

Dealing with problems of growing brackishness of irrigation water

Halotolerant PGPR and its biotechnological applications

We have previously reported the isolation of a halotolerant rhizobacteria from the root of a halophyte. We have demonstrated that inoculation of PGPR increased significantly the growth and grain yield of Indian rice *(Eur. J. Soil Biol., 45 (2009) 62; Res. Microbiol., 160 (2009) 608).*

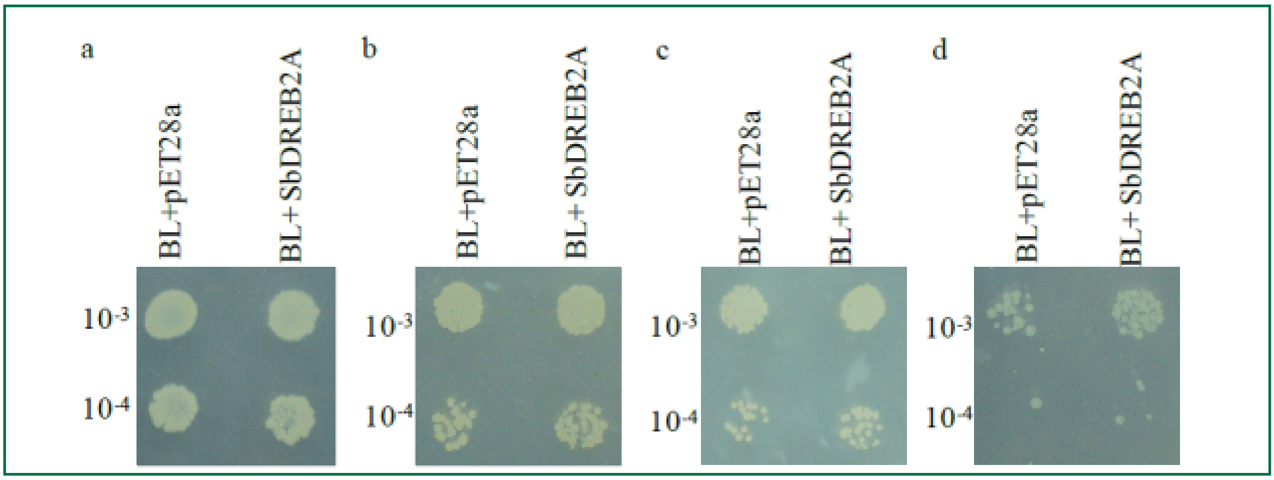


Confocal laser scanning microimages of *Cronobacter sakazakii* Iti 7 strains colonizing roots of tomato and maize plants. Images were taken after fluorescence *in situ* hybridization

Stress genomics for salt tolerance

Isolation and characterization of DREB2A transcription factor from *Salicornia brachiata*

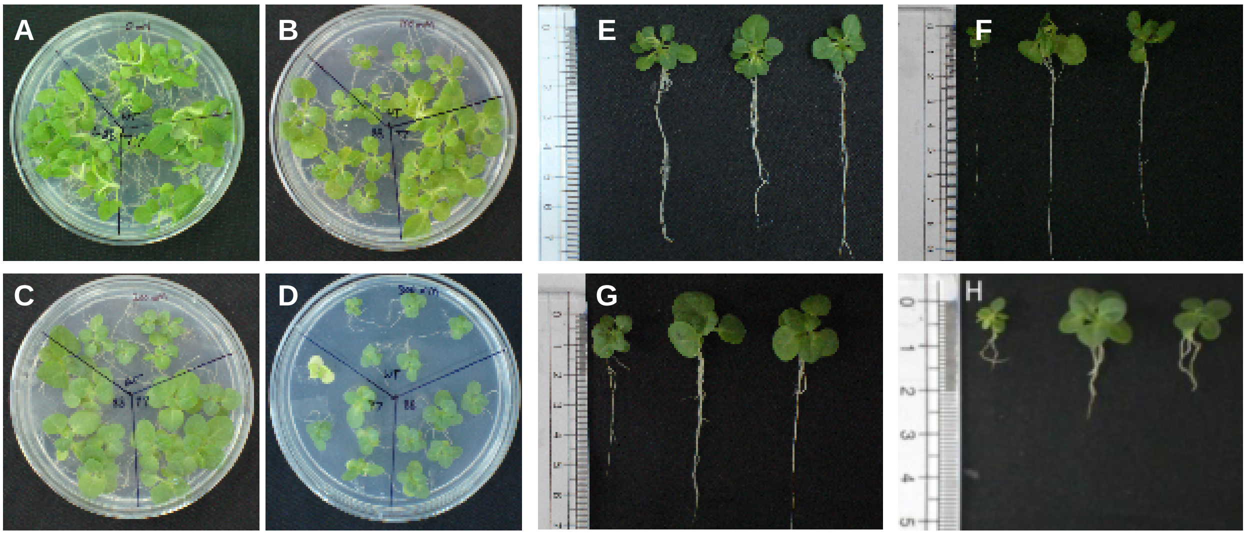
Dehydration-responsive element binding (DREB) transcription factor plays a key role in plant stress signal transduction pathway. SbDREB2A has been isolated from the halophyte *Salicornia brachiata*. SbDREB2A cDNA is 1,062 bp long, encoding protein of 353 amino acids with an estimated molecular mass of 39.37 kDa and a pI of 4.98. The genomic organization confirms that SbDREB2A is an intronless gene. The purified recombinant SbDREB2A protein showed similar binding to the DREs (dehydration-responsive element), ACCGAC and GCCGAC of stress inducible promoter. SbDREB2A showed higher transcript expression by NaCl, drought and heat stress. The role of SbDREB2A in abiotic stress was studied in *E. coli* BL21 (DE3). The recombinant *E. coli* cells exhibited better growth in basal LB medium as well as in medium supplemented with NaCl, PEG and mannitol. The enhanced growth in recombinant *E. coli* could be due to the regulation of stress regulated functional genes by this transcription factor. This system can be applied in biotechnological applications, where growth of *E. coli* can be enhanced under salt stress for efficient recombinant protein production in a short span of time *(Plant Cell Rep., 29 (2010) 1131)*.



Spot assay of BL/pET28a and BL/SbDREB2A-pET28a on the LB plates and LB plates with high salt, KCl and sorbitol. IPTG was added to the cultures of BL/pET28 and BL/ SbDREB2A to induce the expression of recombinant protein. The cultures were adjusted to O.D. 600 = 0.6. Ten microliters from 10^{-3} and 10^{-4} dilutions were spotted onto LB basal (a) plates or with 500 mM NaCl (b), 500 mM KCl (c), and 1100 mM sorbitol (d).

Development of salt tolerance in transgenic tobacco by engineering *Salicornia brachiata* Na^+/H^+ antiporter gene *SbNHX1*

A Na^+/H^+ antiporter *SbNHX1* gene has been isolated from *Salicornia*. The *SbNHX1* cDNA has an open reading frame of 1683 bp, encoding a polypeptide of 560 amino acid residues with an estimated molecular mass 62.44 kDa. Real time PCR analysis revealed that *SbNHX1* transcript expressed maximum at 0.5 M NaCl and maximum expression was observed at 48 h. The transformation of *SbNHX1* gene in tobacco plant showed NaCl tolerance *(Mol Biol Rep., (2010) doi: 10.1007/s11033-010-0318-5)*.



Analysis of *SbNHX1* transgenics (T1). Growth comparison of Wt, L77 and L88 transgenic lines on A. 0 mM, B. 100 mM, C. 200 mM and D. 300 mM NaCl. E-H. Comparison of shoot and root length of Wt, L77 and L88 transgenic lines on 0, 100, 200 and 300 mM NaCl

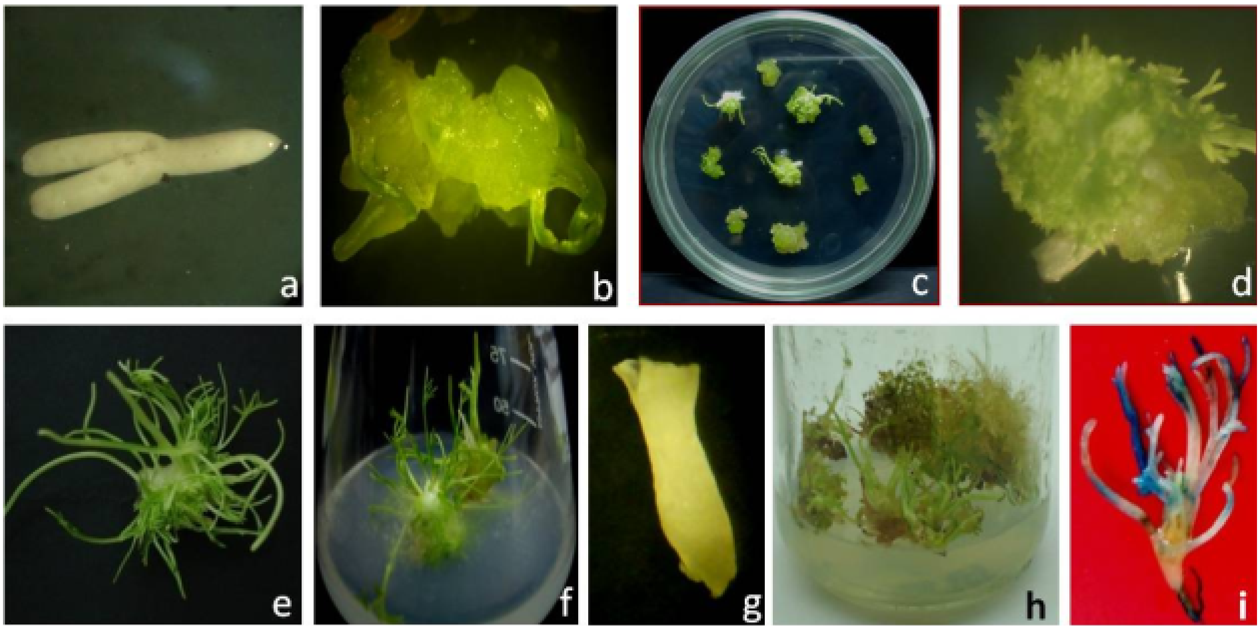
Development of salt tolerant transgenic groundnut

SbpAPX gene was transformed using *Agrobacterium tumefaciens* in the local variety of ground nut GG20 under the control of constitutive promoter (35S CaMV). The transgenic plants are confirmed by the PCR and GUS assay. The transgenic plants showed tolerance to 150 mM NaCl. Seeds of T_1 generation were collected and enzyme analysis is in progress.

Regeneration and transformation of groundnut plant. Functional analysis of transgenic (T_0) line and wild type plant after 14 days of salt stress (150 mM NaCl)

Genetic transformation in Cumin

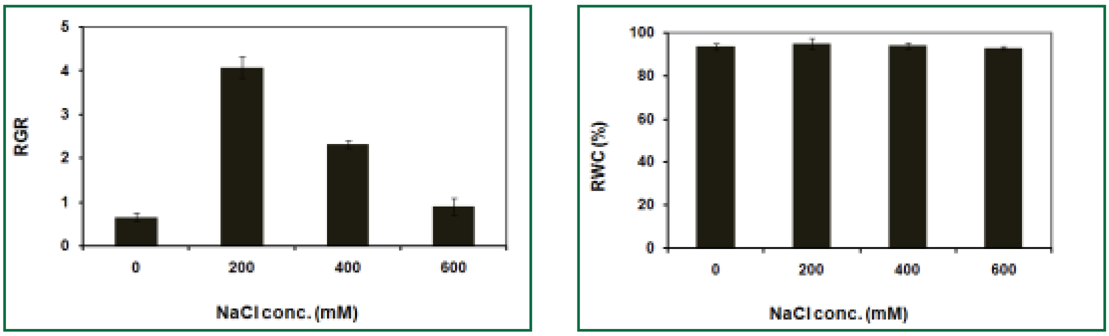
A convenient method for genetic transformation of cumin is established for the first time using biolistic gene gun method and adequately exhibiting the possibility of stable genetic transformation in cumin. Pre-cultured cumin embryos were bombarded under 27 inches Hg vacuum, 25 mm distance from rupture disc to macro-carrier, 10 mm macro-carrier flight distance using 1100 psi rupture disc and 9 cm micro-projectile travel distance. An average of 110 embryos were used per shot and 91% embryos showed transient GUS expression after 24 h. Shoot tips and roots of T_0 plantlets exhibited GUS expression done after 3 months of bombardment. Transformation was confirmed with PCR amplification of 0.96 and 1.3 kb band of *hptII* and *gus* gene respectively from T_0 transgenics and southern blot analysis using PCR amplified DIG labeled *hptII* gene as probe *(Plant Cell Tiss Org., 103 (2010) 1).*



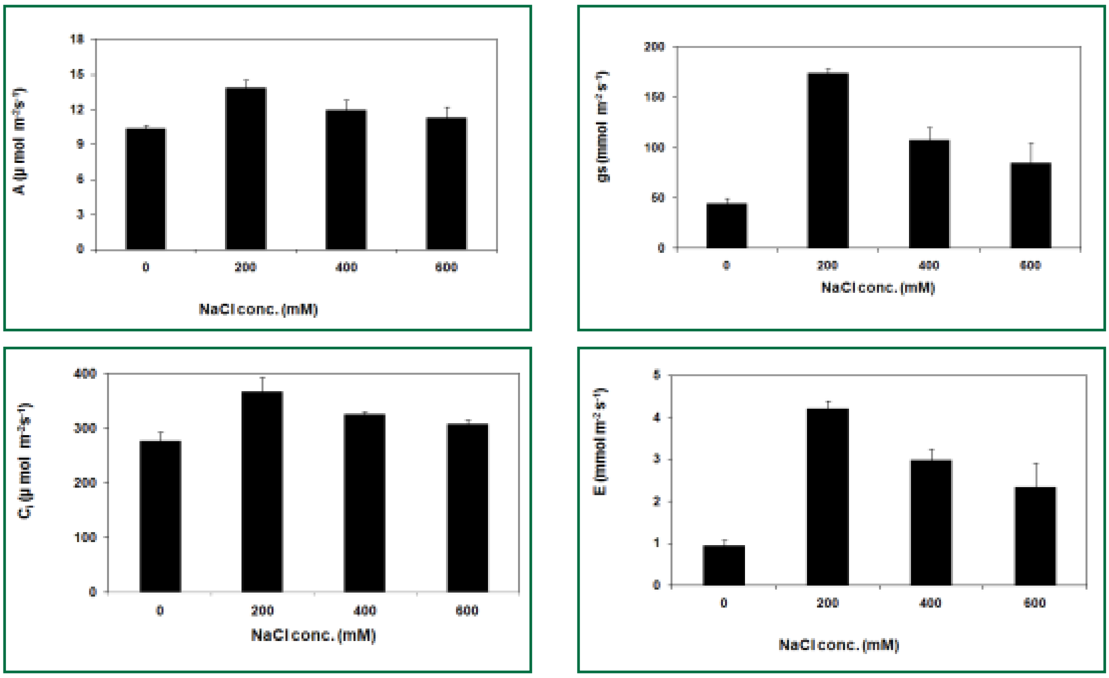
Tissue culture, microprojectile bombardment-mediated transformation, selection and GUS expression of cumin (a) embryo of cumin; (b) callus formation; (c) simultaneous callus formation and multiple shoot regeneration (after 30 days); (d) simultaneous callus formation and multiple shoot regeneration (microscopic view); (e) shoot elongation; (f) sub culturing; (g) preparation of explant (to be transformed) with shoot meristem (part of cotyledons from the top of embryo and a small part of radicle from the bottom are cut) (h) selection of transformants on hygromycin and (i) transgenic cumin plant (T_0) showing GUS expression.

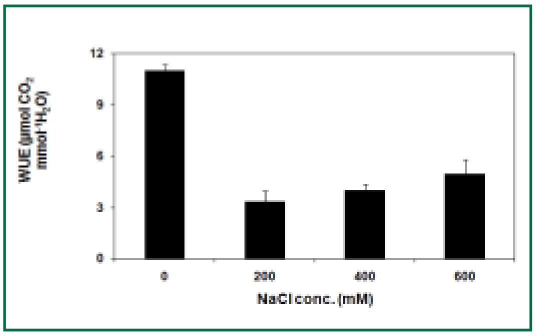
Growth, photosynthesis and photosystem II efficiency of *Salicornia brachiata* under increasing salinity

The effects of salinity (0–600 mM NaCl) on growth, photosynthesis, photosystem II (PSII) efficiency, ion relations and photosynthetic pigment content in *Salicornia brachiata* was examined. Relative growth rate (RGR) was optimum at 200 mM NaCl and was inhibited at higher salt concentrations; however, relative water content (RWC) of shoots remained unaffected by salinity. Accumulation of Na^+ increased with the increase in salinity of shoots, with a concomitant decrease of K^+ and Ca^{2+}. In spite of the large amount of Na^+ accumulated in shoots of salt-treated plants, neither leaf dehydration nor symptoms of severe shoot injury were noticed, indicating no osmotic or toxic effects of salt because of effective compartmentation of salt in vacuoles. Chlorophyll and carotenoid concentrations increased at optimal salinity and decreased at extreme salinities. Net photosynthesis (A), stomatal conductance (g_s), intercellular CO_2 concentration (C_i), maximum quantum efficiency of PSII (F_v / F_m) and quantum yield (ΦPSII) were stimulated at low salinity (200 mm NaCl). Higher salinity adversely affected gas exchange and PSII functional characteristics. This was associated with increased non-photochemical quenching (NPQ). Higher salt levels impaired photosynthetic capacity of *S. brachiata* mainly via stomatal limitation, as g_s was severely reduced. The absence of pigment degradation, reduction of water loss and concomitant PSII protection from photodamage through thermal dissipation of excess excitation energy significantly increased the survival capacity of *S. brachiata* grown at high salinity.



Effects of NaCl on relative growth rate and relative water content in shoots of *S. brachiata*

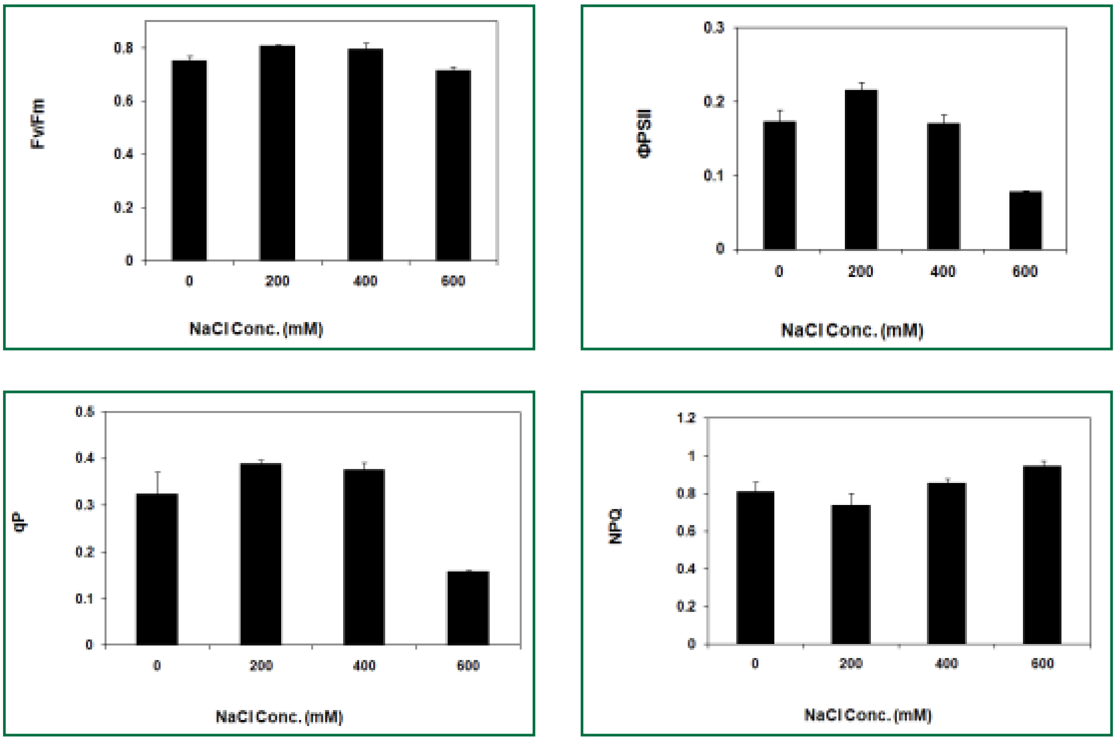




Effects of NaCl on net photosynthetic rate (A), stomatal conductance (g_s), intercellular CO_2 concentration (C_i), transpiration rate (E) and water use efficiency (WUE) in shoots of *S. brachiata*

Effects of NaCl on photosynthetic pigments of *S. brachiata* measured after 21 d of treatment

NaCl (mM)	Total Chl (µg g^{-1} FW)	Chla/b	Carotenoids (µg g^{-1} FW)
0	160.74± 3.93	3.38	45.12±3.93
200	330.59± 13.5	2.56	95.46±4.53
400	256.22± 18.9	2.58	74.94±5.96
600	211.58± 25.5	2.84	60.74±9.40



Effects of increasing NaCl on maximum quantum efficiency of PSII (F_v/F_m), quantum yield of PSII (Φ_{PSII}), photochemical quenching (qP) and non-photochemical quenching (NPQ) in shoots of *S. brachiate*

Use of non-saline degraded soils

The institute's work was again mentioned in the *Nature* magazine (*Wonder weed plans fail to flourish*, Katharine Sanderson, ***Nature*** *461(2009) 328*). Appreciating the methodological approach

nature.com

Climate Feedback

the climate change blog

CURRENT CONTENT

Wonder weed plans fail to flourish

This week in Nature you can read the first (subscription) of four articles unpicking the business of biofuels. First up is jatropha - the shrub that promised to give drought-ridden countries boundless oil supplies. The reality has turned out to be somewhat different. After a period of hype and over enthusiasm, investments have dried up, somewhat like the promise of oil from arid land.

Jatropha definitely still has a future, but the plant genetics really need to be better developed and a number of companies are now doing this, including London-based D1oils - a company which hit trouble earlier this year when a deal with oil giant BP fell through.

We also catch up with Pushpito Ghosh, director of India's Central Salt and Marine Chemicals Research Institute. Nature first encountered Ghosh in 2007 when jatropha was still promising the Earth. His project seems to have benefited from a realistic approach from the start. Here we see a photo taken just last week at a CSMCRI plantation in Mahuda, Orissa. Each plant in this kind of harvest gives 1.75-2.25 kg of seeds, which have the oil extracted and the waste turned into briquettes.

The series continues next week with a look at bioalgae as a potential fuel source. After that comes cellulosic bioethanol, followed by the potential for a 'green gasoline' to be used as a simple drop-in-fuel replacement.

Katharine Sanderson

Image: CSMCRI

Posted by Anna Barnett on September 17, 2009

CSMCRI took on Jatropha with an eye on the long term, the Correspondent further stated in the Climate Feedback blog, nature.com, that: "*The CSMCRI project has benefited from a realistic approach from the start.*" A photograph of seed harvest from the CSMCRI plantation in Humma, Orissa was also featured.

Establishment of experimental Jatropha plantation on a rocky site in the premises of General Motors India at Talegaon

As a part of initial phase of collaboration with General Motors, CSMCRI established 2 acres of Jatropha plantation at the premises of GM India's Talegaon automobile plant in 2008. After studying the topography of land, soil profile, and initial physico-chemical properties of soil, it was depth of 75 cm by breaking the soft rocks with appropriate machinery and putting a layer of 50 cm soil brought from outside in 1 acre area. Accordingly, the plantation was done under both the models and many plants have started bearing fruits.

Characteristics of soil samples collected from Talegoan, Pune (GMI)

Soil depth (cm)	Stone/ pebbles (%)	pH (1:2.5)	EC (1:2.5)	O. C. (%)	Available nutrient (kg/ha)		
					N	P	K
0-10 cm	10	8.1	0.05	0.49L	95.08L	8.10M	171.36M
10-20 cm	29	8.1	0.1	0.17L	65.68L	9.31M	135.18M
0-30 cm	72	8.7	0.06	0.06L	26.78L	3.67L	59.58L
30+ cm	100	-	-	-	-	-	-

NB: L- Low; M-Medium status in soil

initially concluded that *Jatropha curcas* cannot be cultivated owing to poor soil fertility and shallow soil depth (10-20 cm).

However, two models were proposed wherein, Jatropha could be cultivated after suitable land and soil amendment. Model 1 comprised digging pits of size 1m x 1m x 1m with the help of appropriate machinery in 1 acre and filling the pits with soil brought from outside or scraped from vicinity. Model 2 envisaged loosening of the strata to a

Transformation of rocky terrain into green *Jatropha* plantation

Initiation of collaborative project on Jatropha productivity and life cycle analysis with General Motors, USA and US Department of Energy

In the second phase of Jatropha research, CSMCRI entered into a joint collaborative project for five years (starting Jan, 2010) with General Motors Corporation, Detroit, USA and US Department of Energy. The project aims to demonstrate over 50 ha area that *Jatropha curcas* can be raised on non-arable marginal lands with cuttings and micro-propagated elite germplasm and to minimise the carbon footprint by making use of the Jatropha biodiesel itself as fuel for use in the project. A full life cycle analysis will be conducted. Land was acquired at Neswad, Bhadraval (in Bhavnagar district) and Kanod (in Panchmahal district). The sites typically had sparse vegetation and the different species of plants found were identified and enumerated and removed. The above ground and below ground biomass was determined so that primary data is generated for the crade-to-grave life cycle assessment. After clearing the existing sparse vegetation, undulations in the land were removed by ploughing and leveling and plantations were thereafter established.

Press conference of General Motors, US Department of Energy and CSMCRI held in Ahmedabad, on April 12, 2010 announcing the collaborative project with CSMCRI

Selection of elite germplasm of Jatropha and plant improvement

The Working Group of Scientists constituted by the Ministry of New & Renewable Energy identified CP-9 (IC 565735) as one of the best performing germplasm and recommended its proliferation in Rajasthan (vide communication to CSIR dated 5th March, 2010). Meanwhile, the provenance trial with 23 genotypes, initiated during August 2004 at village Chorvadla, Gujarat to select the best genotypes, was also continued. Further, the cuttings of the shortlisted higher yielding germplasm for Gujarat were planted at a separate location at Neswad in 2007, whose performance was also tracked during 2008-10.

Long term performance tracking of plants raised from cuttings of CP-9 (IC 565735) at Mohuda, Orissa

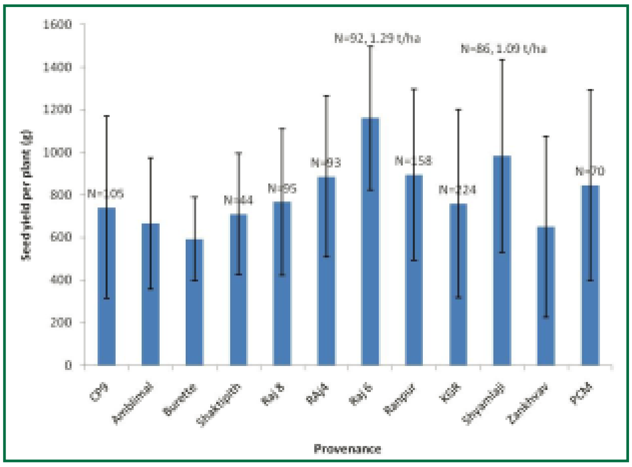
As mentioned above, CSMCRI's CP-9 is one of the *Jatropha curcas* germplasm identified by MNRE for large scale propagation, particularly in Rajasthan. Indeed, the plant has fared well across all locations in the country. In cultivable wasteland under sub-humid conditions of Orissa, we have obtained a seed yield of 2.00 kg per plant (average of 10 plants) in 5.5 years with appropriate agronomy inputs. Further, the yield was sustained the following year. The observed yield is in line with the target we had set for ourselves in 2003 when the plantation came up (see for example, *Hindu*, online edition, Aug 4, 2003: *"Two tonnes of 'Jatropha' seeds per hectare would be cultivated with 25-30 per cent yield which roughly translated into 500-750 kg of bio-diesel per hectare, Central Salt and Marine Chemicals Research Institute Director Pushpito Ghosh, said";PTI report).*

	Mean seed yield in kg/plant (N=10) raised from cuttings of CP-9 at Orissa			
Year	2006-07	2007-08	2008-09	2009-10
Seed yield	0.70±0.2	1.40±0.8	2.00±0.8	2.04±0.6

Plantation raised from cuttings of CP-9 at Mahuda, Orissa **Date of planting**- Jan 2003; **Planting material**- cuttings of IC-565735; **Spacing**- 4X3m (833 plants/ha); Irrigation- once a month with 30 L/plant during non-rainy months; **Fertilizer dose**- During 2005 and 2006- N- 45 kg/ha (by urea); P_2O_5- 30 kg/ha (by Single Super Phosphate); K_2O- 20 kg/ha (by MOP) ; FYM- 2.7 kg/plant; Jatropha cake- 1.2 kg/plant. During 2007 -DAP @ 200g/plant and oil cake 1kg/plant; During 2008 and 2009– 40g/plant of NPK fertilizer of grade 46:48:24, DAP@ 100g/plant and oil cake 1 kg/plant; **Time of fertilizer application**- ½ N and full P and K at just before onset of monsoon and ½ N just before flower iniitiation

Performance trial at Nesvad, Gujarat employing cuttings of selected plants with desirable traits

As reported previously, a provenance trial raised through cuttings of selected germplasm was initiated in Nesvad, Gujarat in 2007-08. The spacing was 3m x 3m and best agro-technological practices as identified by us were implemented. In the third year of this plantation (2009-10), the highest mean seed yield recorded was 1161 g/plant (N=92) for the Raj 6 accession, the seed oil content being 31%. On the other hand, Shyamlaji had a somewhat lower yield of 983 g/plant but the seed oil content was higher at 36%. The seed oil content varied from 29-36% across all the accessions in this trial.



Performance of cuttings of selected plants of desirable characteristics (2009-10).
Per hectare yield assumes 1111 plants per hectare

Unusually high yield of IC 565739 Jatropha accession raised on sand dune in Zanjmer, Gujarat

The two plants of IC 565739 (planted in 1999), which proved high yielding under sand dunes of Gujarat and gave 4.14 kg of seeds in 2007-2008, sustained the high level of productivity and yielded 5.2 kg/plant in 2008-09, while in 2009-10, the yield further increased to 5.55 kg/plant. The oil yield was 26% in October, 2009 (peak collection period) and 31% in March, 2010. It remains to be understood whether this unusually high yield is on account of intrinsically positive traits or whether it is partly on account of lack of competition from other plants in the vicinity. What is clear though is that Jatropha cake applied since 2007 has had a profound effect on the yield.

High yielding plant at Zanjmer sand dune

Performance of an elite plant (IC-565739) on sand dunes of Zanjmer, Gujarat

Year	2006-07	2007-08	2008-09	2009-10
Seed yield (kg/plant; average of two plants)	1.49	4.14	5.20	5.55

An analogous situation was earlier reported for VP-2 grown on sand dune in Orissa. This was a sole plant which gave excellent seed yield for several years but, unfortunately, the plant was infected by fungal disease and the yield drastically went down in the subsequent years.

Multi-location trial under NMITLI project entitled "Genetic improvement of *Jatropha curcas* for adaptability and oil yield"

The multi-institutional NMITLI project commissioned by CSIR was continued and growth data collected from different participating institutions were statistically analyzed both for 17 elite and 161 native accessions. There was wide variation found between each character's mean among all locations for elite accessions. The results obtained showed that CSMCRI's elite accession CSMCRI-GUJ-Banas-1205-C-2 (IC-559364) has performed well at several locations. DRDO has recently evinced interest in this accession.

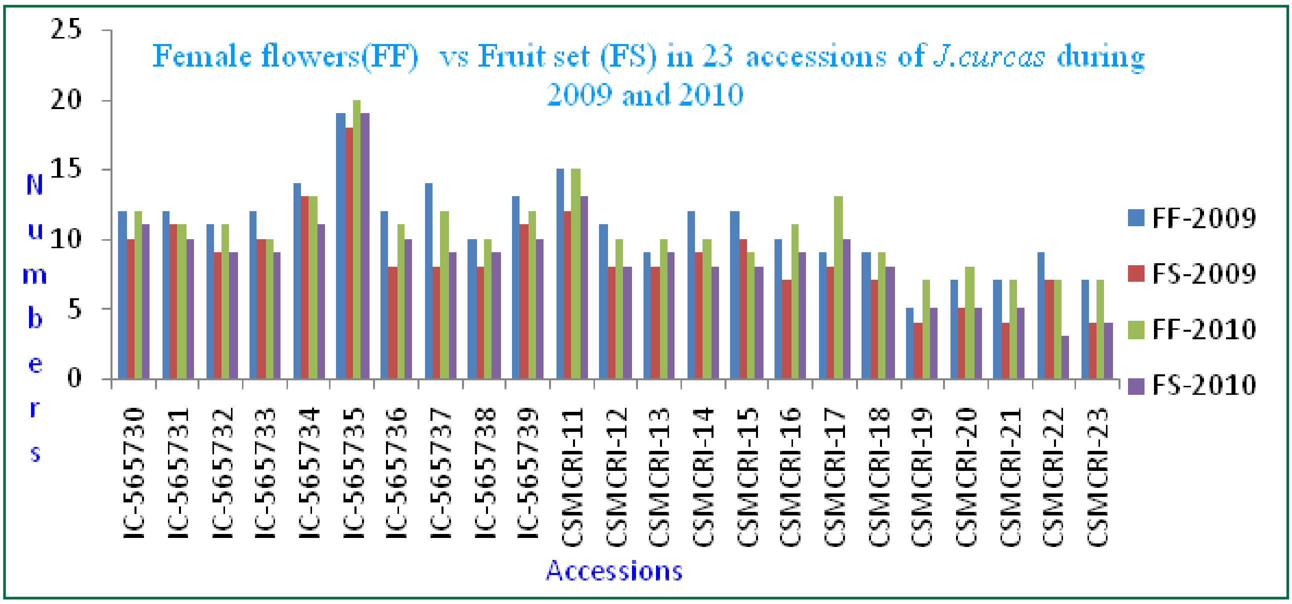
Selected superior accessions over locations (pooled) from elite germplasm

Location	Elite accessions
1. **CRIDA,** Hyderabad	• NBPGR-GUJ-SKN-0605-Urlikanchan • FRI-UA-Teh-1005-DD-EL-1 • CSMCRI-GUJ-Banas-1205-C-2
2. **AFRI,** Jodhpur	• CRIDA-MP-Jhabua-02-03-LJ-05 FRI-UA-The-1005-DD-EL-1 • NBRI-UP-Luck-0401-J-05 NBRI-UP-Luck-1004-J-18
3. **CSMCRI**, Bhavnagar	• NBPGR-GUJ-SKN-0605-Chhatrapati CRIDA-MP-Jhabua-02-03-JJ-05 • NBRI-UP-Luck-0401-J-05
4. **NBRI,** Lucknow	• NBPGR-GUJ-SKN-0605-Chhatrapati CRIDA-MP-Jhabua-02-03-JJ-05 • NBRI-UP-Luck-0401-J-05
5. **NBPGR**, New Delhi	• NBPGR-GUJ-SKN-0605-Urlikanchan FRI-UA-Teh-1005-DD-EL-1 • CSMCRI-GUJ-Banas-1205-C-2
6. **NEIST**, RRL Jorhat	• NBPGR-GUJ-SKN-0605-Chhatrapati CRIDA-MP-Jhabua-02-03-JJ-05 • NBRI-UP-Luck-0401-J-05
7. **NEIST,** Arunachal Pradesh	• NBPGR-GUJ-SKN-0605-Chhatrapati CRIDA-MP-Jhabua-02-03-JJ-05 • NBRI-UP-Luck-0401-J-05
8. **NEIST,** Manipur	• NBPGR-GUJ-SKN-0605-Chhatrapati CRIDA-MP-Jhabua-02-03-JJ-05 • NBRI-UP-Luck-0401-J-05

Out of 17 elite accessions, genotypes viz., NBPGR-GUJ-SKN-0605-Urlikanchan, FRI-UA-Teh-1005-DD-EL-1 and CSMCRI-GUJ-Banas-1205-C-2 have been found superior on seed yield basis at Bhavnagar location. On the other hand, accession CRIDA-AP-Ranga-0106-C-11 was found to be the best performer at Bhavnagar location on the basis of morphological parameters.

Floral Biology

Fluctuation in male to female ratio during different years in various genotypes was estimated and it was observed that difference in the overall ratio for these years was narrow i.e., 24.7:1 and 22.4:1 in 2008-09 and 2009-10, respectively. The maximum number of female flowers was observed in IC-565735 (CP-9) followed by CSMCRI-11 and IC-565734. The relationship between number of female flowers and the fruit set percentage was also studied and the correlation was high with the absolute number of female flowers.



Advancement in *Jatropha* agronomic trials and utilization of *Jatropha* cake as manure

Fertilizer Trial

The first experiment on fertilizer trial in Chorvadla, Gujarat was started in Aug, 2004 which has been continuing. During 2008-2009 and 2009-2010, the following fertilizer combinations were experiment with: N (4 levels, 0, 1, 2 and 3 signifying 0, 40, 80, 120 kg/ha); P_2O_5 (4 levels 0,1,2,3,4 signifying 0, 15, 30, 45 kg/ha) and blanket application of K_2O at 20 kg/ha]. Where no cake was applied during 2005-2008, it was resorted to in 2008-2010. In 2008-09, the combination of 40 kg N and 15 kg P in conjunction with 1 kg of Jatropha cake per plant was the optimum dose that gave significantly higher yield of ca. 1.6 t ha^{-1}, while the combination of 40 kg N and 0 kg P in conjugation with 1 kg of *Jatropha* cake per plant was the optimum dose that gave ca. 1.7 t ha^{-1} in 2009-10. It appears that the soil has got saturated in phosphorous.

The effect of *Jatropha* cake on *Jatropha* yield and soil biochemical properties was studied in Nesvad, Gujarat by application of different nutrient management treatments [100% N dose (140 kg/ha) through Inorganic fertilizer; 50% N through inorganic fertilizer; 100% N through *Jatropha* cake; and 100% N through Farm Yard Manure/FYM]. The seed yield was comparable in all three cases with 140 kg/ha N input, the value for cake treatment working out to 1287 kg/ha in the third year of the plantation.

Increased soil enzymatic activity was observed in all the treatments with respect to control soil (barren soil devoid of Jatropha). Acid and alkaline phosphatase activities were the highest in FYM application 93 and 137 µg p-nitro phenol-released g^{-1} soil h^{-1} respectively, as compared to all other treatments. The urease enzyme activity in soil was found to be significantly influenced by the different nutrient management systems. The amount of urea (microgram per gram of soil) hydrolysed per 5 hours was highest (1976.4) in treatment receiving 100% N through inorganic fertilizer, which was however found statistically at par with the treatments receiving nutrient either through *Jatropha* cake (1969.2) or FYM (1970.8). It remains to be seen what additional benefits accrue over the long term with cake application, besides being a source of nitrogen.

Spacing and pollarding trial of Jatropha

Under NMITLI project, cuttings of high yielding germplasm at different spacing were planted in Nesvad during 2007 and it was found that the seed yield per plant obtained from 4m x 4m spacing was significantly higher (459.9g) than that obtained (350.5g) under the closest spacing of 2m x 2m; however, the seed yield per hectare increased significantly as the spacing was reduced with highest seed yield of 876.2 kg/ha obtained under 2m x 2m spacing. The seed yield will have to be monitored over longer periods, since competition for nutrients and water will increase as the plants grow bigger and mature.

An experiment on pollarding was also initiated during 2009 with four treatments viz. T0= No Pruning; T1= Pruning height 30 cm; T2= Pruning height 45 cm; T3= Pruning height 60 cm at six centers. It was observed that due to pollarding the seed yield dropped considerably in the season following the pruning. The experiment is being continued to assess the long term effect of pruning and, specifically, to understand the best way of pruning if such pruning were deemed necessary, e.g., for the purpose of raising cuttings.

Creating new recombination by breeding in Jatropha

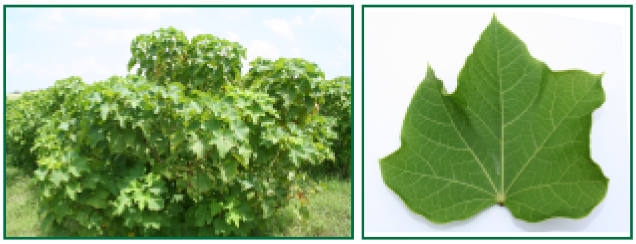
In continuation of the studies on breeding, the cross–compatibility between elite and wild accessions of *J. curcas* was assessed and crosses were made in two different sets of combinations: (I) Single crosses (1X5) using one elite (CP-9) as female parent and five wild genotypes viz. Raj, Amlimal, Shaktipith, Uni, Zankhan as male parents individually; (II) All possible combinations (5x5) using these five wild genotypes. Results of the studies will appear in future reports.

Performance of cuttings derived from F1 Hybrid lines

In continuation of our studies on hybrids experimented with earlier, ca.1500 stem cuttings were raised from various promising hybrid lines in nursery. Out of eight cross combinations, cuttings raised from IC565733×IC565734 and IC565735× IC565739 showed better growth and more branches as compared to the other six combinations. Maximum height and canopy was observed in IC565735 (CP-9 accession) × IC565739 (Zanjmer accession) (140cm and 230cm) with 4.1cm stem girth and 6 number of branches after three months of planting. How this will translate into raising of productivity is yet to be assessed.

Variations in leaf and floral structures in diploid and triploid plants of *Jatropha curcas*

A non-functional hermaphrodite was identified in the germplasm which proved to be triploid (3n) in nature. Variations in the different morphological characters were compared with 2n (diploid) plants.



A normal diploid plant with penta-lobed leaves

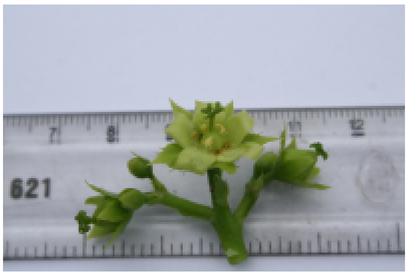
A triploid plant with tri-lobed leaves

SEM micrographs showed that the frequency of stomata was more in diploid as compared to triploid. Sepals and petals were large and

Female flower from 2n plant

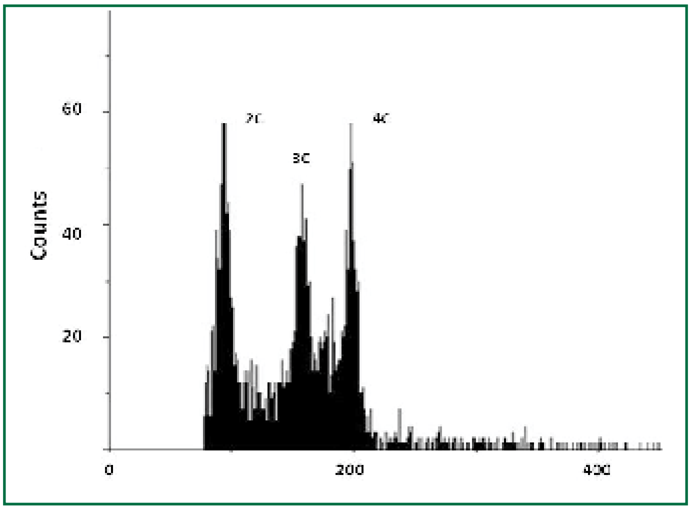
covered the pistil and stamen from all the sides in triploid plants as compared to the diploid plants. Flowers were hermaphroditic with sterile and underdeveloped anthers. The size of the fully expanded flower was larger (ca.2.5 cm) than the normal female flower (ca. 2.0 cm) while the size of fruit was smaller (2.0 cm against 2.5 cm of normal diploid).

The ploidy status of most of the germplasm showed diploidy i.e. 2C with an absolute genome size ranging between 0.83-0.90 pg/cell



Hermaphrodite flower from 3n plant

in ca 184 accessions. The above FRI Dehradun accession (FRI-UA-Deh-0705-DD-EL-C3) showed triploidy, i.e., 3C with an absolute genome size ranging between 1.05-1.13 pg/cell.

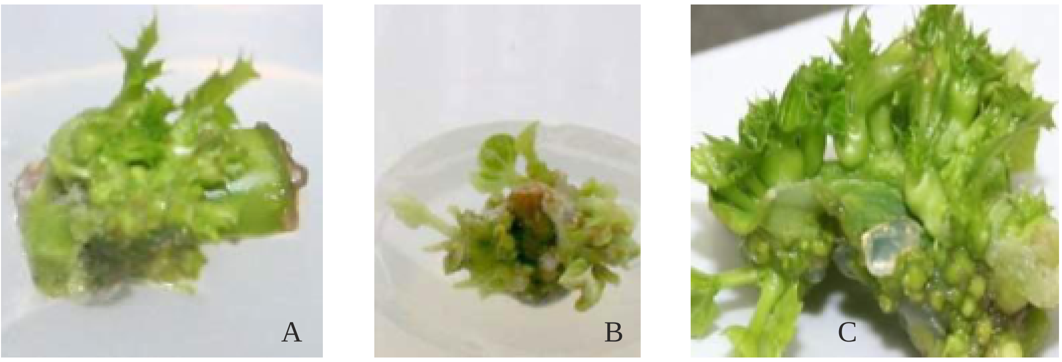


Guassian peaks at
(i) *J. curcas* – 2C (channel 50),
(ii) *Jatropha* pc plant -3C (channel 65) and
(iii) *Simmondsia chinensis* – 4C (channel 105)

Micropropagation of *Jatropha curcas*

In continuation of our earlier studies leading up to successful development of micropropagation protocol of *J. curcas* from nodal and shoot tip explants, wherein 6-12 shoots per culture were typically obtained, the proliferation intensity showed no decline even after repeated sub cultures. Further, work was continued on *ex vitro* rooting, which helps bypass the phase of *in vitro* rooting, thereby shortening the micropropagation cycle by 2–3 weeks and reducing the cost. Elongated shoots were harvested and placed in sterile sand for *ex vitro* rooting and 40% success was achieved. Work is in the progress to improve the technique further.

Attempts were also continued to get regeneration from other plant parts like stem, cotyledonary leaf, petiole of toxic and non toxic plants, callus of leaf and petiole. The percentage of rooting varied in the elongated shoots originated from different plant parts, the highest success being obtained with petiole. No morphological abnormalities were observed in regenerated plants.



Plant regeneration from (A) petiole (B) stem (C) cotyledonary leaf

Effect of heavy metals in leaf regeneration and molecular analysis in *J. curcas*

The effect of various heavy metals on growth and antioxidant enzyme response was evaluated at cellular level to assess whether *J. curcas* can survive under metal stress conditions. Cd, Cu, Al, Cr and Ni were the specific metals employed in the study. Among the metals tested at 30 ppm, Cd was the least toxic whereas Ni was more toxic to the plant at cellular level. Molecular analysis was carried out in samples treated with nickel. Studies showed that the percent regeneration increased at lower concentration (0.01 mM nickel) as compared to control. Concentrations more than 0.01 mM decreased regeneration and complete arrest of regeneration was observed at 1 mM Ni. It was also shown that nickel toxicity might be either partly or completely due to mutagenesis of DNA *(Biometals, 23 (2010) 1149)*. How mature plants will behave remains to be seen.

Soil microbial community structure under cultivation with *Jatropha curcas* and switchgrass

Studies were carried out on microbial communities associated with rhizosphere and bulk soils in the vicinity of *Jatropha curcas* and *Panicum virgatum* (switchgrass). This was done by phospholipid fatty acid analysis and by assessment of natural length heterogeneity in eubacteria sequence amplified from the 5' domain of the 16S rRNA gene. In general, switchgrass soils contained higher abundance of gram positive and monounsaturated PLFA and low abundance of fungal PLFAs compared to jatropha. Both methods successfully differentiated the microbial community of rhizosphere and bulk soils of both crops.

FAME profiling of microbial community structure during *Jatropha curcas* L. residue decomposition

Microbial communities in soils amended with Jatropha residues (leaves, cake, fruit shell) were profiled by fatty acid methyl ester (FAME) analysis and analysed for the activity of enzymes (β glucosidase, cellulase and urease). The microbial biomass was significantly higher in cake amended soil compared to other treatments with concomitant decrease in the stress indicator (saturated to monounsaturated ratio).

Molecular studies on Jatropha curcas

Molecular characterization of CSMCRI accessions of *Jatropha curcas* through RAPD and SSR markers

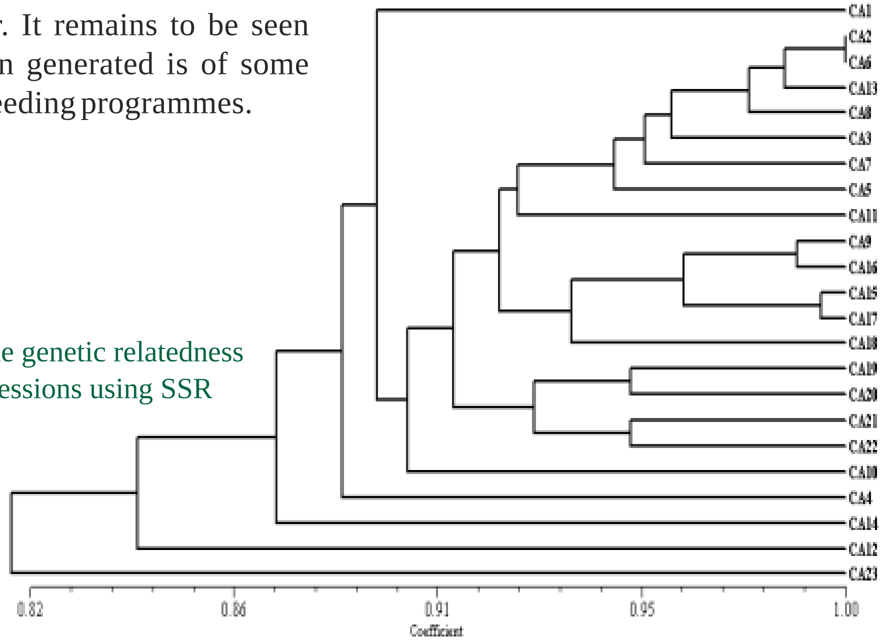
The PCR based DNA fingerprinting i.e., Random Amplified Polymorphic DNA (RAPD) and Simple Sequence Repeats (SSR) analysis was carried to analyze the molecular relatedness among 23 provenances (shown in the table below) of provenance trial whose performance is being evaluated in the field. In present study overall PP (percentage polymorphism) was found to be 54.11% through RAPD analysis; whereas, mean PP given by primers studied was observed to be 52.55%. The mean GS (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). CA15 has shown maximum similarity to other cultivars both through RAPD and SSR analysis.

Both RAPD and SSR dendrograms generated using UPGMA for 23 cultivars/accessions have shown good correlation to each other. CA23 got separated from other cultivars in the cluster analysis showing its distinctness with other cultivars through RAPD analysis. Similar result was obtained through cluster analysis of the data generated by SSRs. Both in RAPD and SSR dendrograms cultivars CA6, CA7, CA8, CA11 and CA13 got clustered together in major cluster showing close relationship with each other, whereas CA5 got separated from the cluster showing its distinctness from rest of the 5 cultivars. In minor clusters CA15, CA16, CA17 got grouped together in one cluster. CA19 and CA20 got grouped in another minor cluster both in RAPD and SSR dendrograms showing

Accession numbers of *J. curcas* germplasm studied for molecular characterization

S.No	Accession name / number	Abbreviations used	S.No	Accession name / number	Abbreviations used
1	IC565730	Ca1	13	SKNJ-7	Ca13
2	IC565731	CA2	14	SKNJ-8	CA14
3	IC565732	CA3	15	SKNJ-9	CA15
4	IC565733	CA4	16	SKNJ-10	CA16
5	IC565734	CA5	17	SKNJ-11	CA17
6	IC565735	CA6	18	SKNJ-12	CA18
7	IC565736	CA7	19	Koteshwar	CA19
8	IC565737	CA8	20	Ambaji	CA20
9	IC565738	CA9	21	Panchmahal	CA21
10	IC565739	CA10	22	Ranpur-f	CA22
11	SKNJ-1	CA11	23	Kumbharia	CA23
12	SKNJ-2	CA12			

closeness to each other. It remains to be seen whether the information generated is of some value while planning breeding programmes.



Dendrogram showing the genetic relatedness among the *J. curcas* accessions using SSR

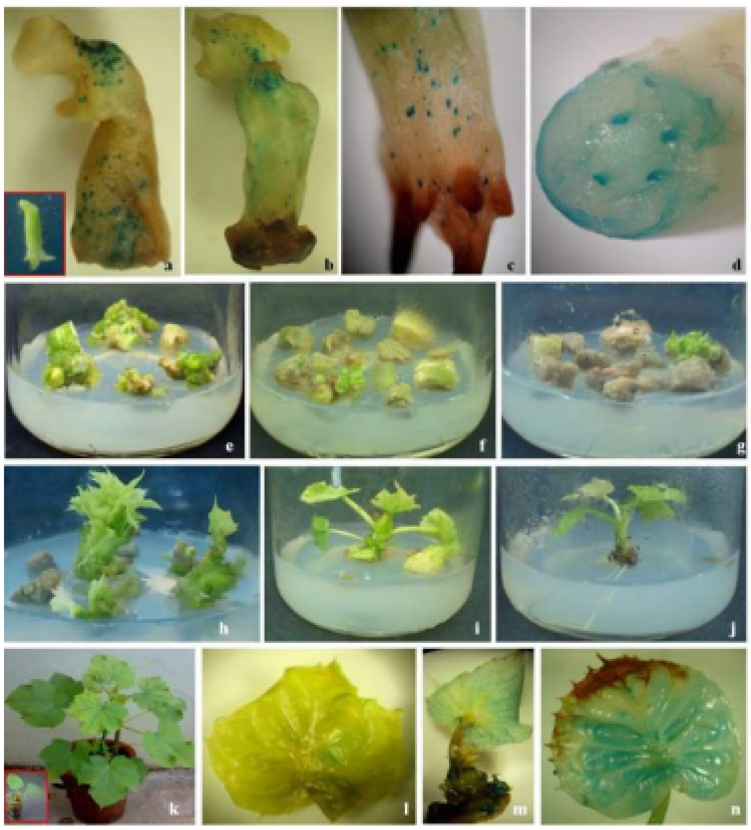
Enhancement of stress tolerance in Jatropha

Collar Rot caused by Macrophomina, a soil borne ascomycete fungi, can lead to heavy loss of plants. Microsclerotia, the fruiting body of Macrophomina, when present in soil, seed or host tissue serves as inoculum and plants die/ decay due to production of fungal toxin (phaseolinone) and fungal tissue that plug the host xylem vessels.

With an aim to enhance abiotic and biotic stress tolerance in Jatropha, a method for isolation of good quality RNA from the leaves has been developed and full length PR genes and WRKY TFs are being isolated for subsequent genetic transformation studies.

Genetic transformation in Jatropha

In view of the keen interest to make the Jatropha plant more stress tolerant, a programme was has been initiated on genetic transformation. Decotyledonated embryos from mature seeds were pre-cultured for 5 days and



Microprojectile bombardment-mediated transformation, selection, regeneration and GUS assay. Transient *gus* expression on (a) embryo axis, (b) whole embryo, (c) radicle part of embryo and (d) inner side (transverse section) of embryo axis after 24 h of bombardment. Five days elongated embryo ready to transform was shown as insight (a). Selection of transformants (e) 1st round, (f) 2nd round and (g) 3rd round on hygromycin. Regeneration of transformants; (h) shoot regeneration, (i) shoot elongation, (j) rooting and (k) hardening of transgenic plant. GUS assay of (l) non transformed leaf, (m) whole plantlet and (n) leaf of transgenic plant elongated embryonic axis was subjected to bombardment for the optimization of physical parameters. The frequency of transient *gus* expression and survival of putative transformants were taken into consideration for the assessment of physical parameters. Statistical analysis revealed that micro-carrier size, helium pressure and target distance had significant influence on transformation efficiency. Selection of putative transformants was done with increasing concentration (5-7 mgL^{-1}) of hygromycin. The integration of desired gene into *Jatropha* genome was confirmed with PCR amplification of 0.96 and 1.28 kb band of *hptII* and *gus* gene, respectively, from the T_0 transgenics and southern blot analysis using PCR amplified DIG labeled *hptII* gene as probe *(submitted for publication).*

In a related study, attempts were made to standardize the transformation protocol for *Jatropha curcas*. A range of parameters like length of the pre-culture period, bacterial growth phase, bacterial cell density, method of wounding of leaf explant, infection time, length of co-cultivation period, pH of the co-cultivation medium and acetosyringone concentration were evaluated. The highest transformation efficiency was scored in intact leaf explant as compared to injured leaf explant. The maximum transformation efficiency was achieved after 4 days of co-cultivation. Gene integration was confirmed by PCR, Dot Blot and Southern hybridization while the expression of gene was confirmed by GUS assay. After transformation, regenerated putative transformed buds could be proliferated and upon transfer to elongation medium, desired shoot was obtained. About 40% rooting was achieved and after 6-8 weeks, ca. 50-60% of plants survived (*Ind. Crop Prod., (2010), doi:10.1016/j.indcrop.2010.09.002).*

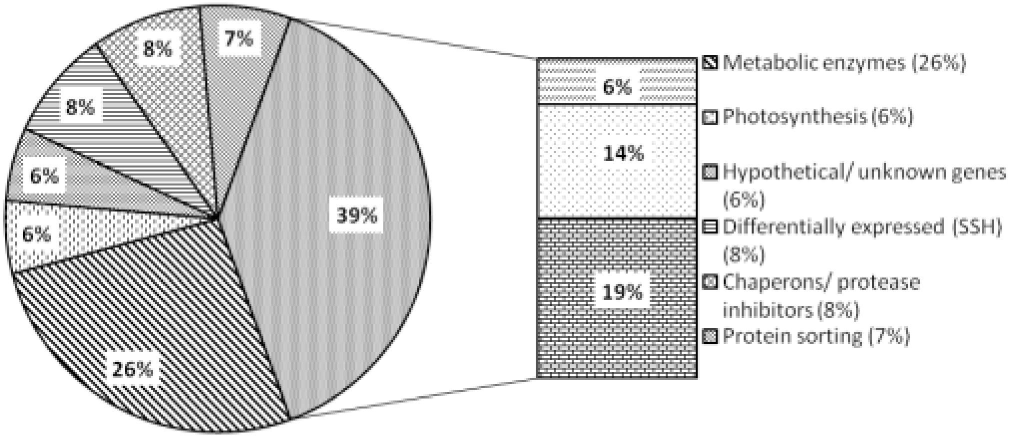
Phycological Research

Algal research comprising seaweeds and microalgae have been a focus area of the institute for many years. The work has embraced biodiversity studies, taxonomy, culture and cultivation, and value addition. Subsequently, the area of marine environment also gained in importance given the interplay between anthropological activities and its consequences to life in the sea. Still more recently, modern molecular biology tools and techniques were introduced and have led to a surge of activity in this area. The Discipline has kept an eye on both basic and applied research along with transfer of technologies to clients. The highlights of progress during 2008-2010 are covered in the following section.

Molecular Biology and Physiology

Cloning of differentially expressed salt induced cDNAs from *Dunaliella salina*

Dunaliella salina isolated from salt crystals serve as an ideal model for the study of hyper salt responsive gene(s), and our findings on the biosynthesis of proline and glycine betaine in micro-algae as osmoprotectants have been reported *(J. Ind. Microbiol. Biotechnol., 35 (2008) 1091).* Differentially expressed genes of *Dunaliella salina* grown under super saturated salt stress (5.5M) were isolated by subtractive hybridization, cloned and classified for further biotechnological and industrial exploration. Sequence homology analysis showed that 26% of the library represents salt responsive genes of metabolic enzymes viz. fructose-1,6-diphosphate aldolase (*AldP*), glucose-6-phosphate dehydrogenase, carbonic anhydrase, phosphoglycerate kinase etc. while 6% clones of the library contain hypothetical/ unknown genes. Six clones (8% of the library) contain genes reported as differentially expressed under salt stress; 6- 8% of the library represent genes, over expressed under salt stress and involved in photosynthesis, defense, cell rescue (chaperon/ protease inhibitor) and protein sorting. About 39% were other genes of which 6% and 14% are transcription factors and house-keeping genes



Functional classification of differentially expressed cDNAs of *D. salina* under salt stress

(putative enzymes/ signaling) respectively, while the remaining 19% of genes have miscellaneous function *(Bot. Mar., 2010, doi:* 10.1515/BOT.2011.011*).*

Isolation and characterization of extracellular polymeric substances from micro-algae *D. salina*

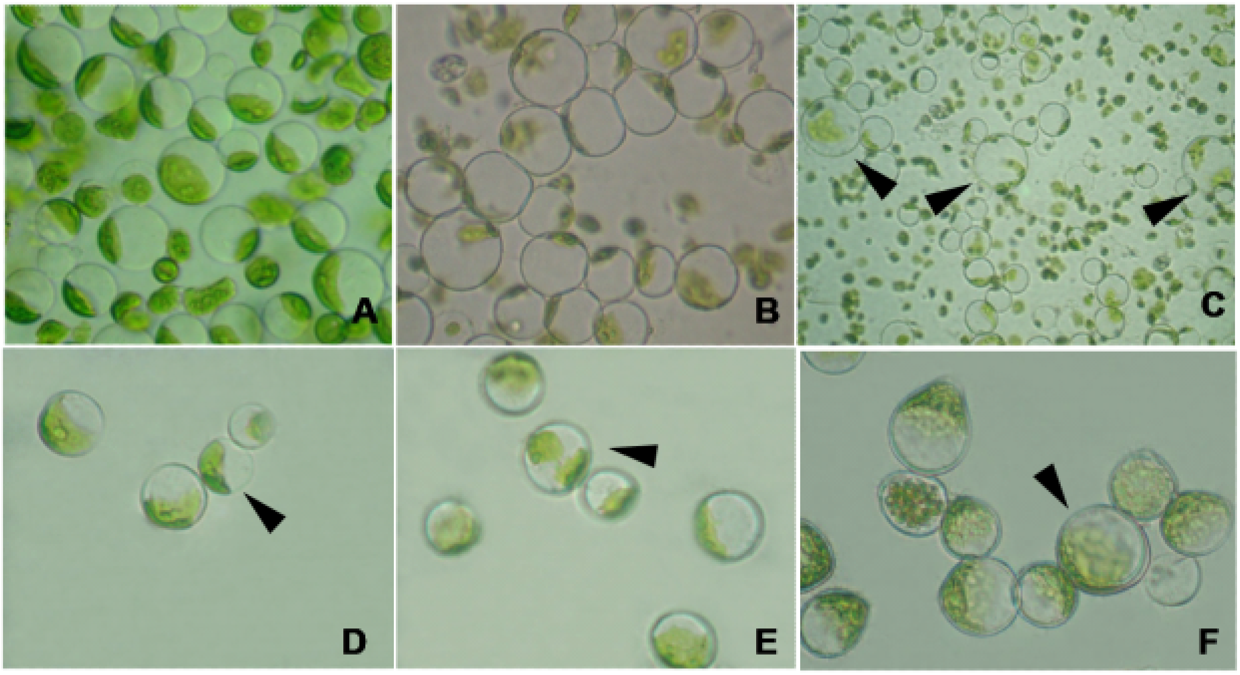
Isolation and characterization of extracellular polymeric substances (EPSs) from *D. salina* was undertaken. The EPSs increased concomitantly with salt concentration and the highest yield (944mg/l) was obtained at 5M NaCl. Emulsifying activity was measured and 86% retention was observed at 0.5M salinity. The FTIR-spectra indicated the presence of carbohydrates. The FTIR-spectra also substantiated the presence of primary amine-group, aromatic-compound and halide-group. Four monosaccharides (glucose, galactose, fructose and xylose) were detected *by HPLC analysis. The p*roduction of EPSs makes *D. salina* a promising candidate for biotechnological and industrial exploitation *(Bioresour. Technol., 100 (2009) 3382).*

Inter-specific protoplast fusion and regeneration of somatic hybrids

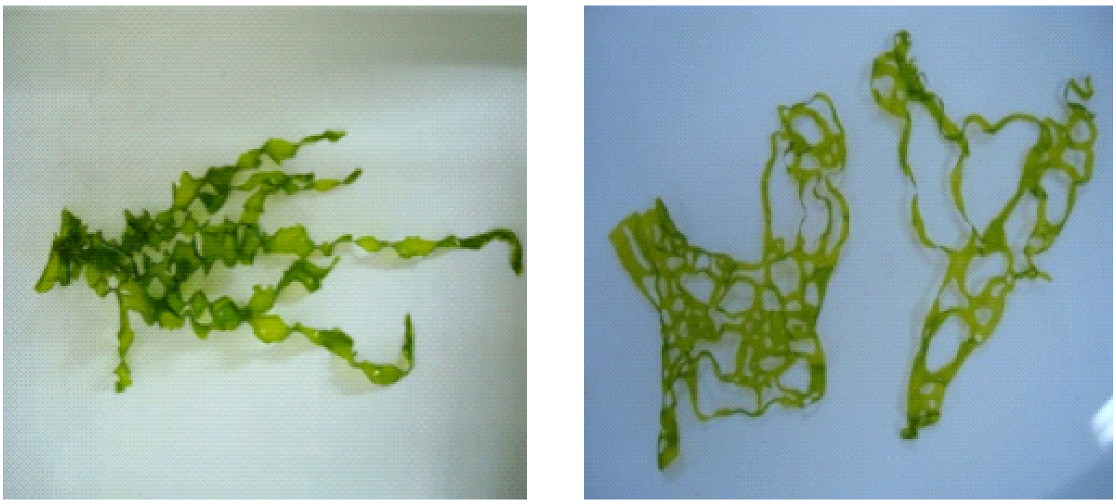
Protoplast fusion studies for development of algal hybrids with useful traits were initiated as early as 1985 but remained inconclusive. In the present study an effort was made to revisit the work. *Ulva reticulata* and *U. taeniata* were selected based on their amenability for protoplast preparation and their fusion. Inter-specific somatic hybrids were produced through electrofusion as reported earlier. The regenerates were confirmed to be hybrids although these showed larger morphological variations than the parent. Inter simple sequence repeat (ISSR) markers revealed introgression of subgenomic components of nuclear genome.

The DNA sequencing of *rbc*L gene from plastome, and of ITS region of nuclear genome, together with the isomorphic expression of LOX enzyme, indicated genomic combinations in hybid plants consisting of different portions of nuclear genome from the fusion partners. Further studies were carried out to ascertain additional evidences of inter-specific heterosis in Ulvales. For example, the C, H, N data and total protein content were average of the parents. The growth rate of hybrids also corresponded to the average growth rate of parents.

The study successfully demonstrated the feasibility of the protoplast fusion technique in seaweeds with concomitant improvement of agronomically important traits such as growth, tolerance and fatty acid composition.



Stages of protoplast fusion A. Protoplasts mix, B. Pearl-chain formation after applying AC current, C. Fused protoplasts, D, E and F. Fused protoplast after 24 h in culture



U. taeniata *U. reticulata*

Hybrid 1 Hybrid 2 Hybrid 3

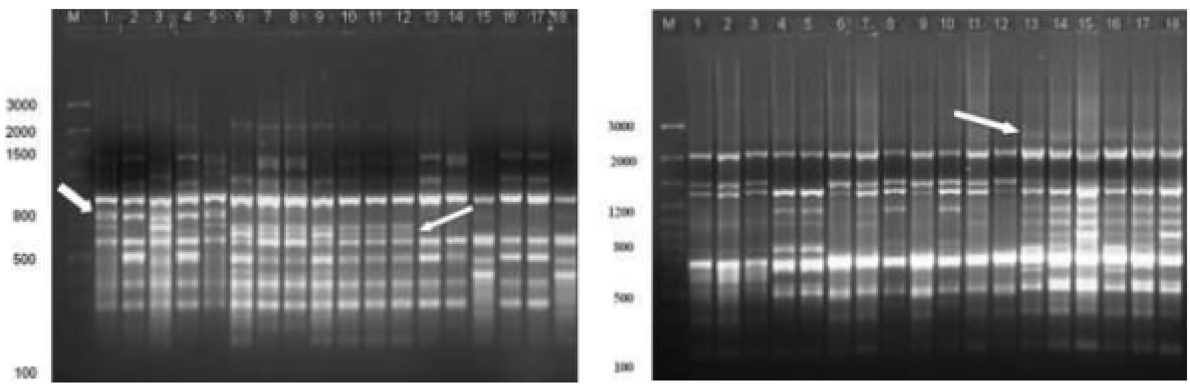
Morphological characterization of hybrids with their parents

Molecular phylogeny of *Gracilaria* spp. from Indian waters

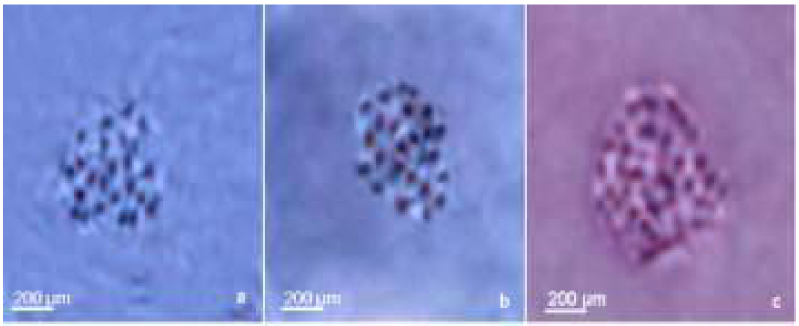
Molecular phylogeny of *Gracilaria* species inferred from molecular markers belonging to three different genomes illustrates the phylogenetic relationship of different *Gracilaria* species based on nucleotide sequences of nuclear (18S rRNA), mitochondrial (cox2-3 spacer) and chloroplast encoded (RuBisCo spacer) genes individually and collectively. It also demonstrates that the phylogeny inferred through combined data set from above gene sequences had showed better resolution supporting the clade with higher consistency index, retention index and bootstrap values. This study, which was reported in the previous biennial report, is now published *(J Phycol., 46 (2010) 1322)* and, according to one of the reviewers, it is the *"first of its kind from Indian subcontinent region and provides new tools for identifying the algal species having greater morphological plasticity while permitting to establish their phylogenetic lineages"*. The results are of interest in assessing molecular taxonomy and phylogeny of marine algae, and fills significant gaps in our understanding of molecular taxonomy of Indian seaweeds).

Genetic analysis and marker assisted identification of life phases of red alga *Gracilaria corticata* (J. Agardh) J. Agardh

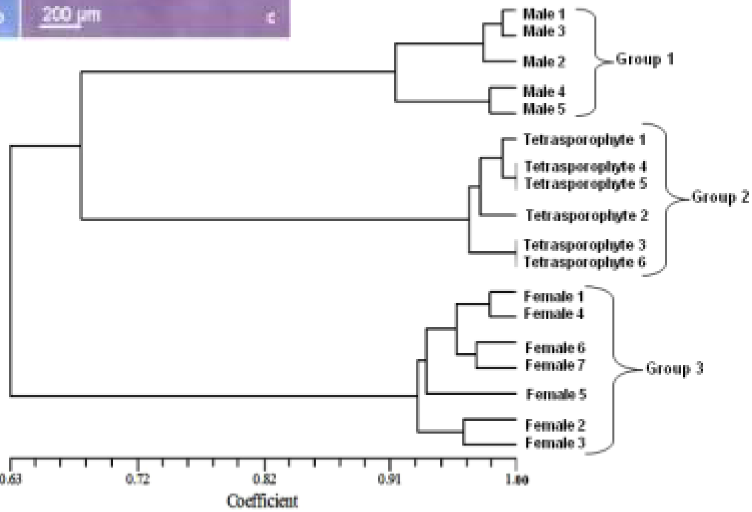
A study was undertaken of the cytological and molecular marker assisted differentiation of isomorphic population of *Gracilaria corticata* (J. Agardh) J. Agardh with inter and intra-phasic genetic diversity analysis using ISSR markers. The genetic diversity of inbreeding population of *G. corticata* as determined in terms of percentage of polymorphic loci (PPL), average heterozygosity (He) and Shannon's Weaver index (I) were 59.80, 0.59 and 1.21 respectively. The inter-phasic pair-wise average polymorphism were found to be 31.6% between male and female, 24.0% in male and tetrasporophyte and 25.3% in female and tetrasporophyte. The intra-phasic average polymorphisms were calculated as a maximum of 5.5% between females, 4.2% between males and the lowest 2.4% between tetrasporophytes. The primer 10 generated a marker of 800 bp specific to male and 650 bp to female gametophyte, while the primer 17 generated a marker of 2,500 bp specific to tetrasporophyte. Both the UPGMA based dendrogram and PCA analysis clustered all the three life phases differentially as distinct identities. Cytological analysis by chromosome count revealed 24 chromosomes in both haploid male and female gametophytes (N) and 48 for diploid (2 N) tetrasporophyte further confirming their genetic distinctness. The life phase specific markers reported in this study could be of help in breeding programmes where differentiation of life phases at the early developmental stages is crucial (*Mol. Biol. Rep., 2010, doi: 10.1007/s11033-010-0543-y*).



ISSR profiles for different DNA samples isolated from *G. corticata* with primer 10 (left) 17 (right)

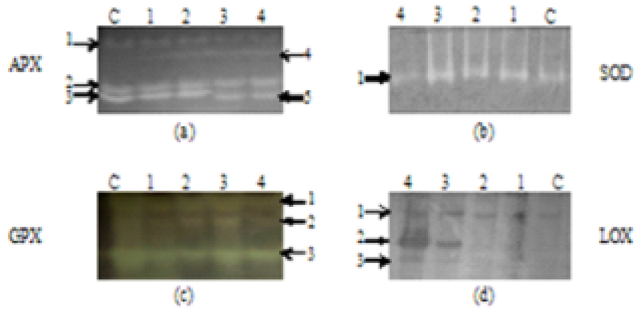


Chromosome number of haploid and diploid thalli of *G.corticata*. a, male (N = 24); b, female (N = 24) and c, diploid (2N = 48)



Dendrogram obtained by UPGMA cluster based on data from ISSR analysis of 18 triphasic populations of *G. corticata*. The scale shown at the bottom is the measure of genetic similarity Dice's coefficients as calculated according to Nei and Li (1979)

Desiccation induced oxidative stress and its biochemical responses in *Gracilaria corticata*

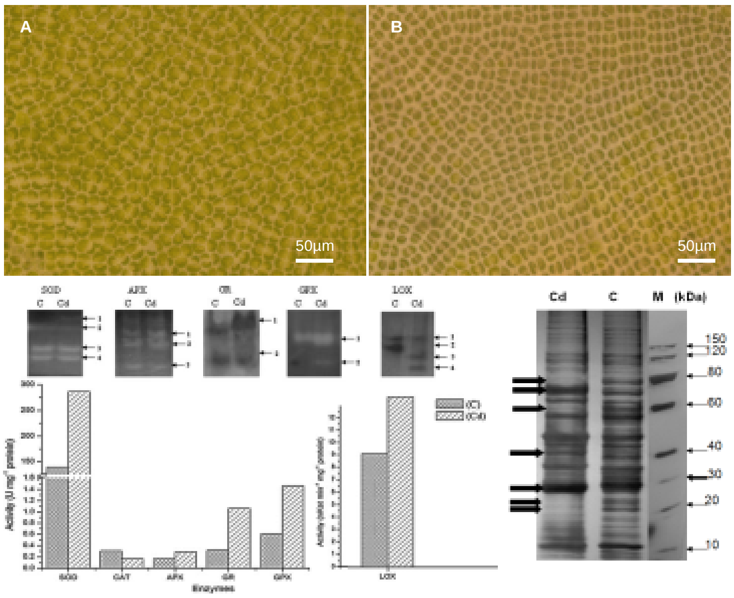


Effect of desiccation exposure on the isoforms of antioxidative enzymes (a) ascorbate peroxidase (APX), (b) superoxide dismutase (SOD), (c) glutathione peroxidase (GPX) and (d) lipoxygenase (LOX) in *G. corticata* following the desiccation exposure for duration 0 (control), 1, 2, 3 and 4 h

The intertidal algae routinely get subjected to desiccation and rehydration in a cyclic manner during low and high tides and have innate physiological ability to deal with cellular damages arising from such environmental stresses. This study gives an account of various biochemical changes in *G. corticata* following the exposure to desiccation for a period of 0 (control), 1, 2, 3 and 4 h under controlled conditions (65% humidity at 28°C). During desiccation, the thalli showed 47% loss of water when desiccated for 4 h. The chlorophyll, carotenoids and phycobiliproteins (phycoerythrin and phycocyanin)were increased during initial 2 h exposure compared to control and thereafter declined in the succeeding exposures (see Table below). The antioxidative enzymes such as superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR), glutathione peroxidise (GPX) and the regeneration rate of reduced ascorbate (AsA) and glutathione (GSH) increased during desiccation up to 2-3 h. Further, the isoforms of antioxidant enzymes Mn-SOD (~150 kDa), APX-4 (~110 kDa) APX-5 (~45 kDa), GPX-1 (~80 kDa) and GPX-2 (~65 kDa) responded specifically to the desiccation exposure (see Figure). The enhanced production of reactive oxygen species (ROS) and increased lipid peroxidation observed during the exposure of 3-4 h chiefly contributed to higher lipoxygenase (LOX) activity with the induction of two new LOX isoforms (LOX-2, ~85 kDa; LOX-3, ~65 kDa). Compared to control, a relatively higher content of both free and bound insoluble putrescine and spermine together with enhanced n-6 PUFAs found during 2 h exposure reveals their involvement in defense reactions against the desiccation induced oxidative stress.

Differential responses to cadmium induced oxidative stress in *Ulva lactuca*

Cadmium (Cd^{2+}) with no reported biological function except as a cofactor for carbonic anhydrase in marine diatom has been classified as a group (I) carcinogen in humans by the International Agency for Research on Cancer. Cd^{2+} being an oxophilic and sulfophilic element forms complexes with various organic particles and thereby triggers a wide range of reactions that collectively puts the aquatic ecosystem at risk. The Cd^{2+} even at trace concentration disturbs the cellular metabolic process by producing excessive reactive oxygen species (ROS) leading to oxidative stress. When exposed to 0.4 mM $CdCl_2$ for 4 days, *Ulva lactuca* showed twofold increase in lipoperoxides and H_2O_2 content that collectively decreased the growth and photosynthetic pigments by almost 30% over the control. The activities of antioxidant enzymes such as superoxide dismutase (SOD), ascorbate peroxidase (APX), glutathione reductase (GR) and glutathione peroxidise (GPX) enhanced by twofold to threefold and that of catalase (CAT) diminished. Further, the isoforms of these enzymes, namely, Mn-SOD (~85 kDa), GR (~180 kDa) and GPX (~50 kDa) responded specifically to Cd^{2+} exposure (see Figure below). Moreover, the contents of reduced glutathione (3.01 fold) and ascorbate (1.85 fold) also increased substantially. SDS-PAGE protein profile revealed high intensity of proteins of 28, 47 and 90 kDa whereas 80, 60, 25 and 20 kDa proteins showed decreased intensity consequent to exposure to Cd. Both endogenous free and bound soluble putrescine increased noticeably without any change in spermidine. In contrast, spermine content reduced to half over control. Among the macronutrients analysed in exposed thalli, the decreased K content was accompanied by higher Na and Mn with no appreciable change in Ca, Mg, Fe and Zn (see Table below). Induction of antioxidant enzymes and LOX isoforms together with storage of putrescine and n - 6 PUFAs in cadmium exposed thallus in the present study reveal their potential role in combating the Cd^{2+} induced oxidative stress in *U. lactuca* *(Biometal, 23 (2010) 315).*

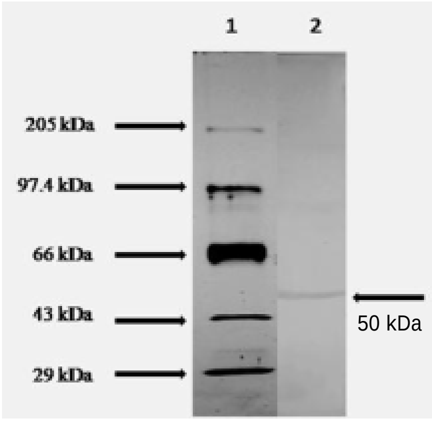


(2) (3)

Morphological changes in the cells of *U. lactuca* thalli with and without Cd exposure (1), changes in the antioxidant enzymes activity and their isoforms (2) and variation in the protein profiles on SDS-PAGE (3) [(C) denotes control and (Cd) represents cadmium exposure]

Sulfohydrolase: a potential candidate enzyme for the improvement of agar quality

The sulphate content in the agar is detrimental to its quality. *Gracilaria dura*, which yields agarose type of phycocolloid with high gel strength and low sulphate content, was identified as a potentially attractive source of sulfohydrolase. Indeed, purified sulfohydrolase obtained from *G. dura* could improve the quality of a commercial agar in terms of gel strength, gelling and melting temperature, and viscosity (*Carbohyd. Polym., 2010, doi: 10.1016/j.carbpol.2011.02.009*).



SDS-poly acrylamide gel electrophoresis (SDS PAGE) of purified sulfohyrolase. Lanes: 1 Marker protein, 2. Purified sulfohydrolase

Comparison of native and enzyme treated agar

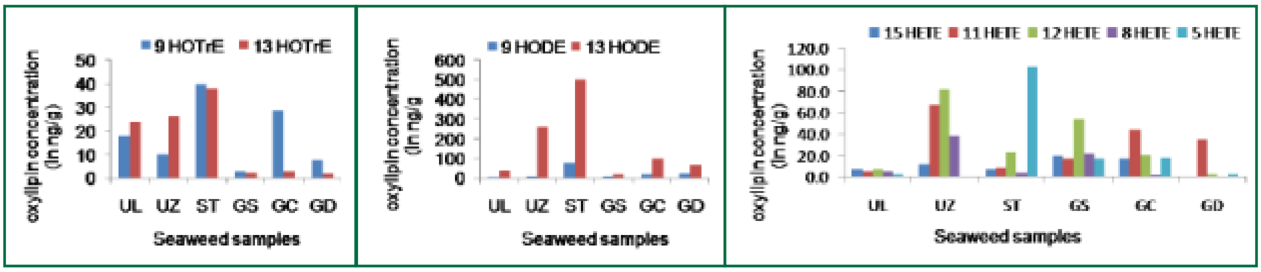
Agar type	Gel strength (g cm^{-2})	Gelling temperature (°C)	Melting temperature (°C)	Sulfate (%)	Viscosity (cp)	Δ Sulfate [a] (%)	3,6-AG content(%)
Commercial agar	190.0 ± 20.0	39 ± 1.5	90.67 ± 3.1	2.8 ± 0.2	9.7 ± 1.5		18 ± 0.9
Enzyme treated agar	486.7 ± 15.3	31 ± 1.0	82.67 ± 2.5	1.1 ± 0.1	18.0 ± 2.0	60.59	30 ± 0.98

[a] Δ sulfate (%): decrease in sulfate content.

Lipids, Fatty acid and Oxylipin in seaweeds

Seaweeds are rich source of biologically active natural products and nutritionally important polyunsaturated fatty acids (PUFAs), carbohydrates, vitamins, minerals and dietary fibres. The earlier study on PUFAs of different seaweed species belonging to Chlorophyta, Rhodophyta and Phaeophyta demonstrated the predominance of C18 PUFAs in Chlorophyta members (*Ulva*, *Caulerpa*, *Codium*, *Chamaedoris*, *Monostroma*spp.) and C20 PUFAs in Rhodophyta (*Gracilaria*, *Hypnea*, *Kappaphycus*, *Porphyra*, *Sarconema*, *Ahnfeltia*, *Soleria*, *Amphiroa*, *Grateloupia*, *Laurencia*, *Coelanthrum* spp.) while both C18 and C20 PUFAs prevailed in Phaeophyta members (*Padina*, *Spatoglossum*, *Stoechospermum*, *Cystosiera*, *Sargassum* and *Dictyota* spp.). Further, a comparative evaluation of different lipid and fatty acid (FA) extraction methods was undertaken to identify the most appropriate method for seaweed. It was found that direct transesterification (DT) gave 1.5 - 2 times higher yields of fatty acids compared with the best conventional method *(submitted for publication)*.

An attempt was also made to determine the basal levels of FA hydroperoxides in healthy seaweeds by FOX assay. The level varied from 0.01% to 0.03% of total FAs in all the three classes of seaweeds. Further, quantitative determination of some targeted oxylipins was carried out with RP – HPLC (see Figure below). These oxylipins derived from oxidation of PUFAs are signalling compounds regulating multitude of physiological responses, ranging from stress responses to development.



Oxylipins concentration (in ng/g f.w.) in seaweeds; UL- *Ulva lactuca*, UZ- *U. linza*, ST- *Sargassum tenerrimum*, GS- *Gracilaria salicornia*, GC- *G. corticata*, GD- *G. dura*

Effect of sulfate ions on agarose gelation: A detailed physicochemical study

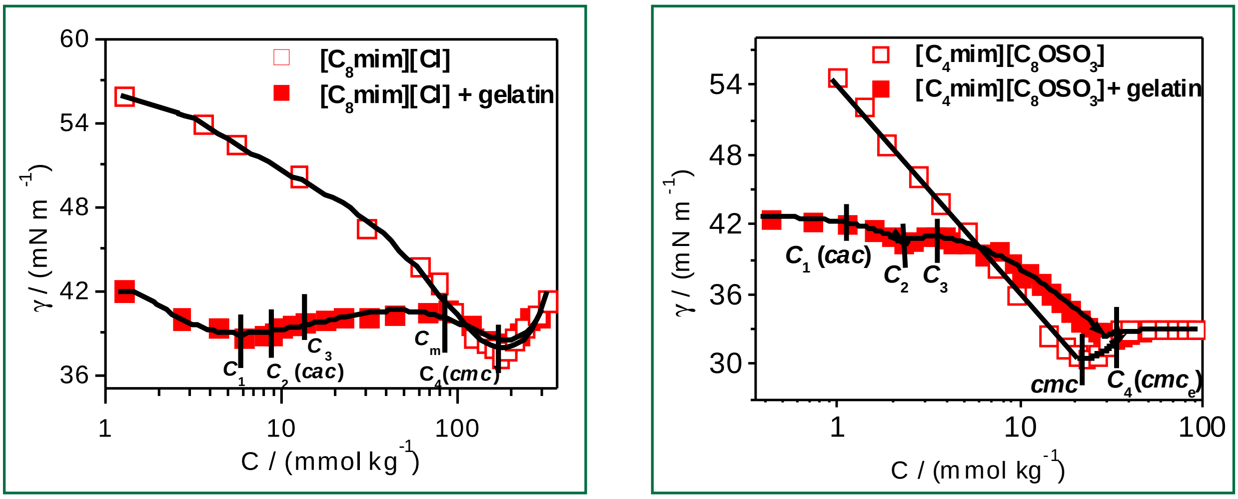
Agarose hydrogels which constitute a special class of soft matter are undoubtedly one of the most studied biopolymer gels. However, certain issues such as why the sulfate salts and sulfate content in the agarose molecules reduce the gel strength are still not well understood. A physicochemical study of aqueous agarose solutions/gels in presence of sulfate ions was carried out. The findings suggest that the sulfate ions in solution not only disfavor the coil–helix transition, but also reduce the helix–helix interactions. IR intensity ratios show the strengthening of tetrahedrally coordinated water structures within the gel network which, however, tend to weaken with the addition of sulfate salt *(J. Phys. Chem. B, 113 (2009) 2519).*

Study of the interaction of agarose with room temperature ionic liquids

Whereas agarose is normally used in aqueous medium, a study was undertaken of its solubility in room temperature ionic liquids containing different cationic (imidazolium or pyridinium with different alkyl chains) and anionic compositions. Except with pyridinium cation, gel formation was observed in all the other cases. The solubility depended on the nature of the anion and amphiphilicity of cation, the maximum RT solubility (16% w/v) being observed in 3-methyl-imidazolium butyl chloride. Dissolved agarose was regenerated through methanol precipitation and was found to maintain the features of native agarose in terms of molecular weight, polydispersity, thermal stability and crystallinity but slight variations were observed in the CD (circular dichroism) pattern *(Green Chemistry, 12 (2010) 1029).*

Interaction of gelatin with room temperature ionic liquids

Since the seaweed polysaccharides are being studied as possible substitutes for animal gelatin (G), we felt it is of interest to also understand the interaction of the latter with ionic liquids. The interaction *of* gelatin *with* 3-methyl-1-octylimidazolium chloride, [C_8mim][Cl],and 1-butyl-3-methylimidazolium octylsulfate, [C_4mim][C_8OSO_3], was *studied.* It was observed that the IL monomers interact with gelatin at interface to form G-IL (monomer) complex initially, and thereafter a less interfacially active complex comprising G-IL (aggregates) was formed at around the critical aggregation concentration (*cac*) *(J. Phys. Chem. B, 114 (2010) 8441).*



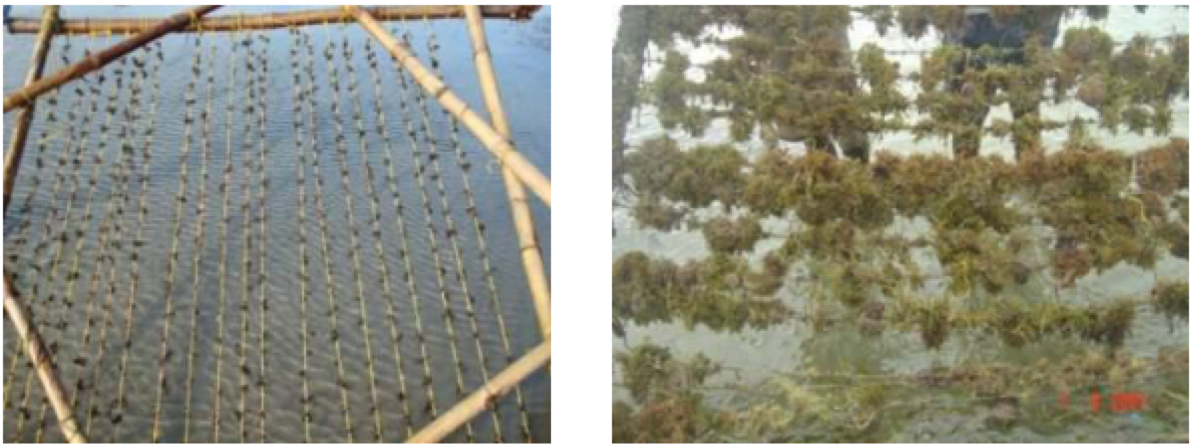
Various stages of interaction of gelatin with room temperature ionic liquids

Seaweed Biology and Cultivation

Gelidiella acerosa cultivation

The raft method which was successfully employed for commercial cultivation of *Kappaphycus alvarezii* seaweed in India was extended for cultivation of *Gelidiella acerosa*.

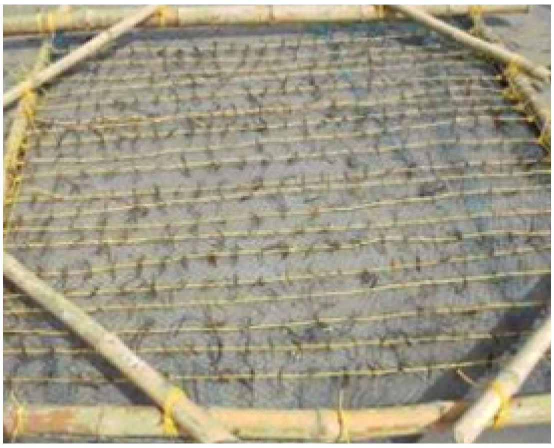
50 numbers of 1.5 m × 1.5m size rafts (2.25 sq. m. total area) were taken for the study. Each raft contained twenty parallel and equidistant lines of 3 mm polypropylene rope (Garware Wall Ropes Ltd, Pune, India). Seedlings of about 1.0 g fresh wt were tied to the nylon thread and then the seeded thread was inserted between the braids of the polypropylene rope. Each rope had a total of 25 seedlings at about 5 cm intervals (approx. 25 g fresh wt). A raft with 20 such ropes has a seed density of 222 g fresh wt. m^{-2}. Seeding was done during April to June 09. All 50 rafts were harvested after 180 days and the biomass harvested varied from 2.0 -11.7 kg fresh wt/ raft, with average weigt of 5.250 ± 1.832 kg. The computed Daily Growth Rate (DGR) was in the range 1.0-2.5%. The minimum and maximum biomass values of a single harvested plant were 33 and 66 g fresh wt, respectively. The above data establishes that raft method of *G. acerosa* cultivation is superior to all the other methods investigated and reported previously.



Bamboo raft just after seeding (left) and before harvest of *G. acerosa* (right)

Gracilaria edulis cultivation

We have reported in the previous biennial report that *G. edulis* can be cultivated on raft off-shore. Studies were conducted thereafter near shore at Thonithurai on 30 rafts (1.5m× 1.5m size), during June-September, 2008. Harvest was made at 60 days interval after planting. First harvest was done during August - December 2008 and 428 kg fresh wt with and average yield of 14.3 ± 3.4 kg. fresh wt/raft was obtained. The corresponding values for second harvest were 586.2 kg and 12.9 ± 3.3 kg, respectively. The same experiments carried out in the subsequent year gave similar results.



Raft just after seeding (left) and before harvest of *G. edulis* after 60 days growth (right)

Off-shore cultivation of seaweed in Mandapam

In continuation of the studies on offshore cultivation of *Kappahycus* seaweed carried reported previously, the work received a boost with the sanction of a project from MNRE on seaweed cultivation for ethanol. Three locations in the Palk Bay side were selected for the further study. The first location was 1.2 km away from the shore with 3 m depth (highest high tide) while the second was 2.5 km away with 8.5 m depth. Parallel experiments in nearshore waters (0.4 m depth and 0.075 km away from the shore) were also carried out to compare biomass yields. 60 rafts (2 m × 2 m) of *Kappaphycus* in the 1st site and 78 rafts in the 2nd site were monitored for growth. Similarly 10 rafts of *Kappaphycus* were placed in nearshore waters at the same time. The findings of these studies reveal that seaweeds grown in offshore waters give higher yields than those grown in near shore waters. Further, larger area of cultivation is feasible offshore. On the other hand, there are major technical challenges to carry out such cultivation offshore besides associated risks.

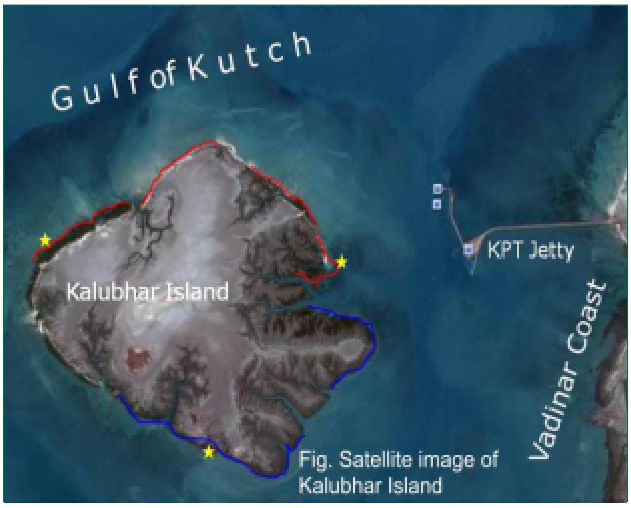
Raft with fully grown *K. alvarezii* in off-shore waters

Biomass yield data of *K. alvarezii* harvested after 45 days (2010)

Location	No.of rafts planted	No.of rafts harvested	Initial wt. kg/raft	Final wt.kg/raft	DGR%
On-shore (150 meter from shore and 1.0 m depth)	10	2	22.5	187.5	4.71
Off-shore –I (1.2 km from shore and 3 m depth)	60	27	22.5	246.5	5.32
Off-shore –II (2.5 km from shore and 8.5m depth)	78	08	22.5	223.5	5.10

Seaweed biodiversity along the Gujarat and Tamilnadu coasts

At present, the seaweed biodiversity study of islands in the Gulf of Kutch is under progress. The southern part of the Gulf of Kutch occurring along the Jamnagar coast has a varied coastal environment with 42 islands having diverse habitats and unique biota. Many of these islands remain submerged during high tide and get exposed for a few hours (3-4 h) during low tide periods. The exposed intertidal area and shallow submerged areas harbour luxuriant growth of a variety of seaweeds from October – May. The growth of seaweeds in terms of diversity and distribution in islands is much superior to mainland coast. In order to protect the biodiversity, these islands were notified as the first Marine National Park of the country in 1982. The marine national park is protected under the Wild Life Protection Act 1972 to preserve the natural ecosystem. Among the 42 islands,



Satellite image of Kalubhar Island

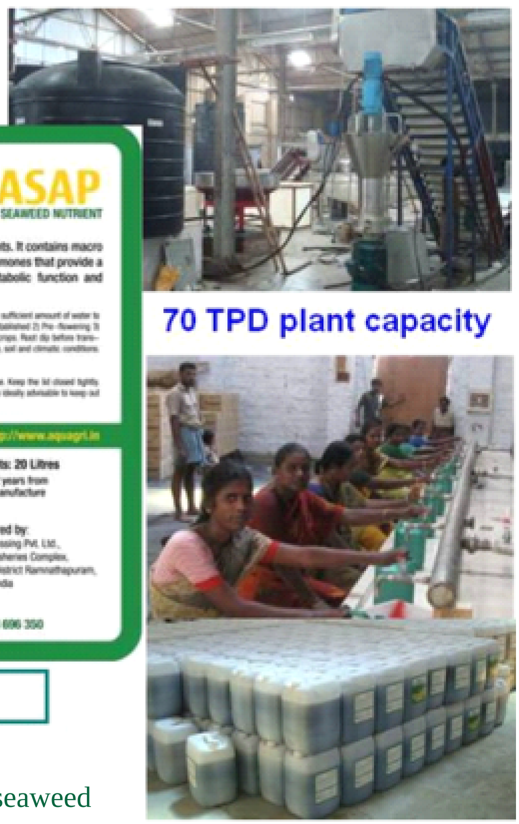
Kalubhar Island, off-Vadinar coast, having 5900 hectare area, was surveyed for the last two years and as many as 93 different species of seaweed were collected. 14 were new to Gujarat coast and 11 to Indian coast and one species is new to the

New seaweeds reported from Kalubhar islands: a: Sargassum aquifolium (Turner) C. Agardh, b: *Codium sursum* Kraft *et* Miller, c: *Ulva pertusa* Kjellman, d: *Rosenvingia nhatrangensis* Dawson, e: *Hydroclathrus stephanosorus* Kraft, f: *Chlorodesmis fastigiata* (C. Agardh) Ducker, g: *Ulva erecta* (Lyngbay) Fries, h: *Asteronema breviarticulatum* (J. Agardh) Ouriques *et* Bouzon world, which we have named as *Codium spiralis* due to the spiral nature of its fronds. This new discovery is important given that *Codium* produces secondary metabolites having blood anticoagulant property. The study is being extended to several other islands (Azad, Bhaidar, Dhani, Dideka, Khara Chusna, Pirotan).

The seaweed biodiversity of mainland coast of the Gulf of Mannar, Tamil Nadu has also been continued in this reporting period. The coast between Rameswaram and Vallinokkam was categorized as zone-1 (comprising 16 stations), Vallinokkam and Kanyakumari as zone-2 (comprising 12 stations) and Mankadu and Chennai as zone-3. The former two zones were extensively surveyed and 116 seaweed species were collected from April 2008-March 2009 and additional 34 species from April 2009-March 2010. All these species are being investigated for taxonomic identification, including molecular taxonomy to resolve ambiguities arising from morphological plasticity of the species and to derive phylogenetic information of the taxa.

Seaweed sap extraction plant at Mandapam

M/s. Aquagri Processing Pvt Ltd has set up a 70 TPD sap extraction plant at Mandapam, Tamil Nadu based on the internationally patented knowhow for simultaneous production of sap rich in plant nutrients and granules rich in kappa-carrageenan from fresh seaweed. The product is being marketed under the Aquasap and "Paras" brand names. Export of the produce has also begun. The possible application of seaweed sap and granules in veterinary applications is also being explored by our licensee and their partners. Meanwhile, the comprehensive work on characterization and quantification of plant growth regulators in the sap was published (*J. Agric. Food Chem., 58 (2010) 4594*).



Integrated method for recovery of phycocolloid and sap from seaweed

Preparation of Agarose from *Gracilaria dura*

In the previous biennial report (2006-2008) it was reported that a new process for preparation of agarose was developed which dispensed with the conventional energy intensive freeze-thaw process of purification. Patent applications have been filed on the new process *[Indian Patent Application No. 0567/DEL/2009 dated 24/03/2009]*. Agarose was prepared in 1 kg to 5 kg scale in the pilot plant employing the newly developed process. Both wild and cultivated *Gracilaria dura* were used. The performance of the product was evaluated by several laboratories including ICGEB, New Delhi and CCMB, Hyderabad. The latter study involved DNA from the human genome. Whereas the gel electrophoresis studies revealed performance at par with commercial product, some improvements were suggested to improve product perception still further.

In a related study, agarose was extracted from naturally occurring male, female and tetrasporophyte plants of *Gracilaria dura*. It was observed that the yield and gel strength followed the trend: tetrasporophyte>female>male. Future optimisation will consider not only product attributes but also growth rate and robustness.

Bioprospecting of seaweeds

In continuation of the studies reported in the previous biennial report (2006-2008), a comparative assessment was made of agars extracted from *G. debilis*, *G. edulis*, *G. crassa*, *G. foliifera*, and *G. corticata*, employing the improved extraction protocol. Further, it was shown that *G. salicornia* is a source of mannogalactan *(J. Appl. Phycol., 20 (2008) 397; J. Appl. Phycol., 22 (2010) 623)*. Cellulose contents were also estimated in twelve seaweed samples, which includes information on α and cellulose *(Bioresour. Technol., 100 (2009) 6669)*.

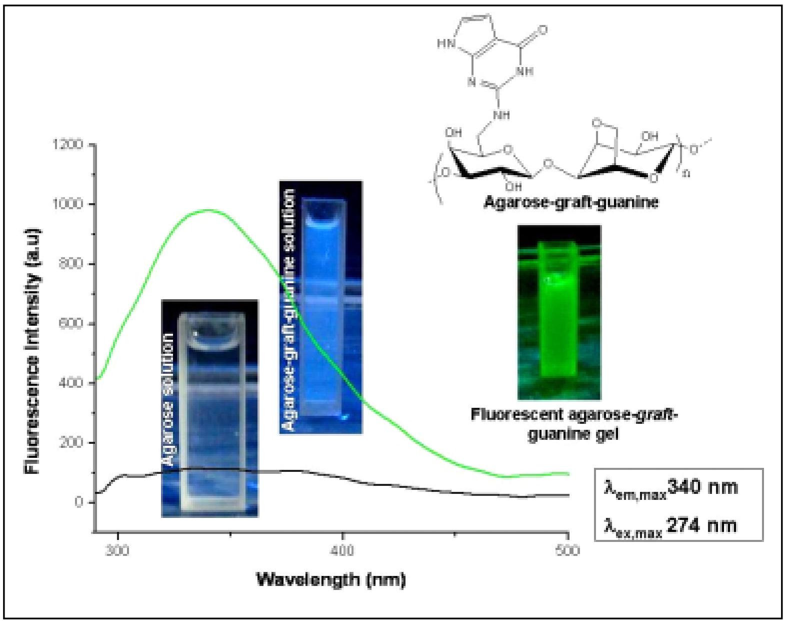
Improved method of determining M/G ratio in sodium alginate

A rapid one-pot method for hydrolysis of sodium alginate for determining M/G ratio was developed using microwave irradiation. Poly-mannuronic acid (PMA) and poly-guluronic acid (PGA) ratio was determined (M/G 0.38), which was similar to that (M/G 0.39) obtained by the conventional method (*Carbohyd. Polym.,76 (2009) 650).*

Modification of seaweed polysaccharides to obtain new materials

(a) A new fluorescent polymeric material was synthesized by grafting the nucleobase guanine on to the backbone of agarose. The emission intensity was enhanced by ca. 85% compared to that of pure guanine solution of the same concentration (*Carbohyd. Polym., 81 (2010) 878*).

(b) A facile method for synthesizing swellable, pH-responsive and water insoluble adducts of acid-soluble chitosan with alkali-soluble poly-



Fluorescent agarose-*graft*-guanine

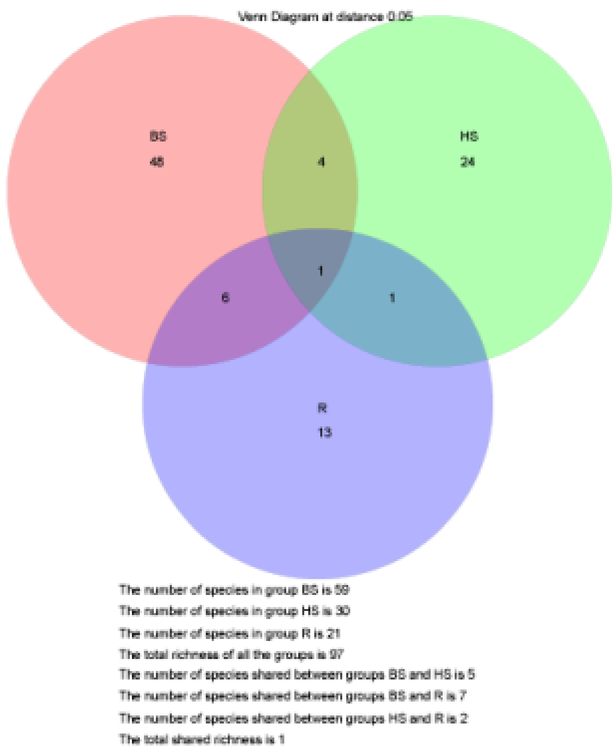
mannuronic and poly-guluronic acids was developed based on microwave heating (*Carbohyd. Polym., (2010) doi:10.1016/j.carbpol.2010.10.023)*. New type of ionic liquids were synthesized in order to solubilize polysaccharides such as chitin, chitosan, guargum, kappa , lambda and iota carrageenan, cellulose and starch (*Macromol. Biosci.*, *9 (2009) 376; J. Mat. Chem., 19 (2009) 4088; Int. J. Biol. Macromol., 45 (2009) 221*).

Marine Microbiology

As part of the ongoing CSIR network project on marine biodiversity a total of 1300 marine bacteria, 110 alkaliphilic and 31 organic solvent tolerant bacteria were isolated from different locations along the Gujarat coast. These isolates are being maintained in recently established bacterial culture collection center at CSMCRI. In addition to routine biochemical and microbiological tests, fatty acid methylester (FAME) analysis followed by 16S rRNA sequencing is also being undertaken for the purpose of identification.

Molecular analysis of chemolithoautotrophic bacterial diversity and community structure from agroecosystem and coastal saline soils

Soils harbour high diversity of bacteria that contribute significantly to CO_2 dynamics in soils. The comparative community structure and diversity of chemolithoautotrophs between agricultural and coastal barren saline soils (low and high salinity) were analyzed using the functional marker gene *cbbL* encoding large subunit of ribulose-1,5-bisphosphate carboxylase/oxygenase while the total microbial community was studied using 16S rRNA gene. The *cbbL* form IC gene was found in all three soil types, whereas form IA was retrieved only from high saline soil. The form IC *cbbL* was also amplified from bacterial isolates obtained from all soil types. Numerous novel monophyletic lineages affiliated with form IC phylogenetic trees were facultative lithotrophs distantly related to already known *cbbL* sequences from agroecosystem, volcanic ashes and marine environments. The agricultural soil was dominated by chemolithotrophs whereas photoautotrophic *Chloroflexi* and sulphide oxidizers dominated saline ecosystems which may provide fundamentally new insights into the role of chemolithoautotrophic and photoautotrophic bacterial diversity in biogeochemical cycling in barren saline soils. This is the first comparative investigation of the community structure and diversity of chemolithoautotrophic bacteria between coastal agricultural and saline barren soils using functional and phylogenetic marker genes.



Venn diagrams representing the observed overlap of OTUs at 0.05 similarity cut-offs for *cbbL* gene libraries. Venn diagrams show overall overlap of representative genera between soils. The values in the diagram represent the number of genera that were taxonomically classified

Bioremediation of a chlor-alkali industrial effluent:

Biological neutralization of a chlor-alkali industrial wastewater was achieved by an alkaliphilic bacterium, *Enterococcus faecium* R5. This isolate was capable of neutralizing the alkali effluents from pH12.0 to 7.0 in three hours in the presence of *Madhuca indica* flowers or sugar cane bagasse as source of carbon.

Studies on organic solvent tolerant bacteria

Total 36 organic solvent tolerant bacteria (OSTB) have been isolated from crude oil contaminated soil samples by culturing them in broth enriched with toluene, benzene and hexane. These isolates exhibited solvent tolerance at 10% solvent concentration (V/V) up to seven days, with log P_{ow} value ranging from 0.24 to 8.8. The *Bacillus cereus* AK1871 isolate produced a serine alkaline protease which showed tolerance to solvent, detergent and oxidizing agents. A 59-fold purification was achieved by a three step purification procedure. This protease is active over a broad range of pH (6.0-9.0) and temperature (40-70ºC), the optimum values being 8.0 and 60°C, respectively.

Biofuel from marine microalgae

The NMITLI project on marine microalgal biofuel was initiated by CSIR and MoES, with CSMCRI as nodal laboratory and 9 partnering institutes in all. Although, there are many claims about the potential of microalgal biodiesel, the project will seek to ascertain ground realities through generation of primary data at sufficient scale and in realistic manner. Meanwhile, a few promising strains were selected based on their lipid productivity and ease of culture. The challenges being faced while scaling up the mass culture are: low growth rate, airborne contaminants and radiation damage. Further, harvesting the biomass (dewatering) and downstream processing for lipid are also major challenges. Although the focus of the NMITLI project is production of lipid production from autotrophic algae, a study was conducted on comparative evaluation of autotrophic and mixotrophic growth. An improvement in the lipid content from 14.5% to 19% CDW was observed in going from autotrophic to mixotrophic conditions, apart from enhancement of cell biomass by ca. 29%, for culturing under static condition *(0684/DEL/2010 dated 22 March 2010)*. Studies were also initiated to search for locations where lipid-bearing microalgae grow copiously in nature so that one may learn from nature.

Chlorella culture in jars (left) and thickened biomass (right)

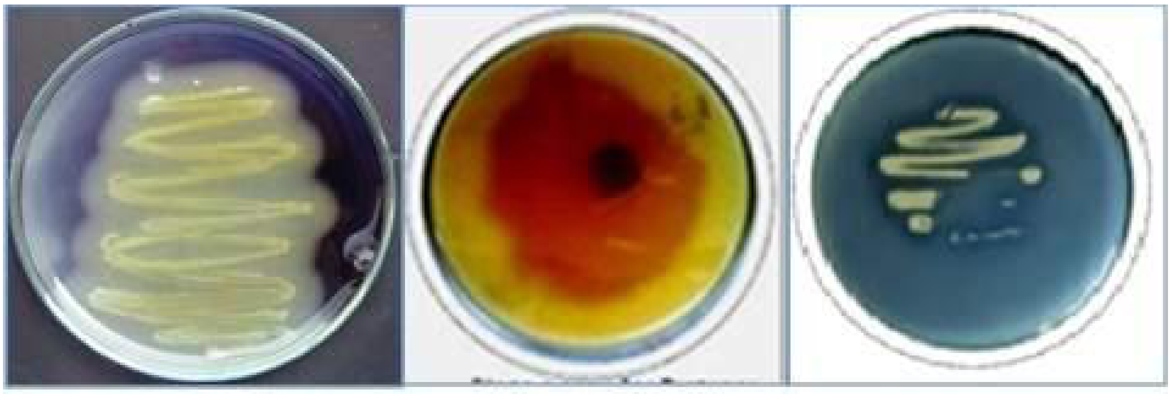
C-Phycoerythrin production from marine cyanobacteria

We have previously reported the culturing of *Spirulina platensis* for high quality C-Phycocyanin, a blue color chromo-protein. In continuation of our studies on cyanobacteria, we isolated from Gujarat coast a cyanobacterium useful for Phycoerythrin (PE) production. It was cultured under different conditions of illumination intensity and spectral wavelength to understand their effect on biomass and pigment production. Genomic DNA from the cyanobacterial sample was isolated for PCR amplification and further sequenced. On the basis of 16S rRNA gene sequence, the isolate was identified as *Pseudanabaena* sp. The chromatic adaptation studies were also completed for maximum PE production. Purified PE showed absorption maxima at 568 and 541 nm, and fluorescence maximum at 578 nm. The absorbance ratio A568/A280 (an indicator of purity) achieved was 6.86. The yield of purified C-Phycoerythrin obtained was 13.6 mg g^{-1} of the cell dry weight with 46.8 % of recovery. The stability of Phycoerythrin was also studied with edible preservative in aqueous solution at 0±5°C and 35±5°C. Citric acid (4 mg/ml) was observed to be the best for storage at 35 ±5°C in aqueous solution for 45 days *(Int. J. Biol. Macromol., 47 (2010) 597).*

Effect of edible preservatives on C-phycoerythrin color after 45 days at 35±5°C (left to right control, citric acid, sucrose, sodium chloride and calcium chloride)

Enzymatic potential of extremotolerant bacteria

Bacteria isolated from the extreme environments were explored for industrially important enzymes such as amylase, lipase and protease .The growth of bacterial strain SM2014 at pH 9-10 and at 60°C revealed its extremophilic nature. As an adaptive mechanism, the ratio of saturated to unsaturated fatty acids changed with growth conditions. Under extreme condition long chain saturated fatty acid (C18:0, C16:0, C14:0, C12:0) predominated at the expense of unsaturated fatty acids. The nucleotide BLAST of 16S rRNA gene sequence showed its resemblance to *Bacillus licheniformis* with 94 % sequence similarity . *(Folia Microbiol., 55 (2010) 614).*

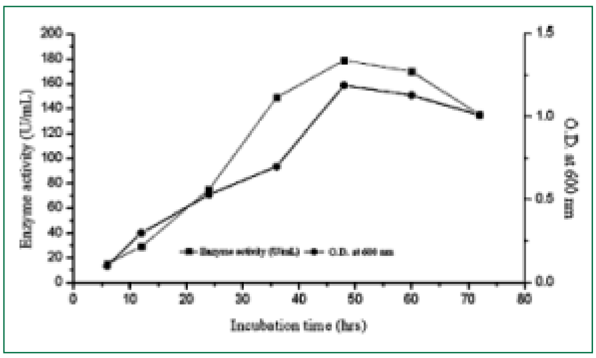


Amylase detection on starch-agar plate — Protease detection on milk-agar plate — Lipase detection on tributyrin-agar plate

Enzymatic potential of extremotolerant bacteria

Production and characterization of a thermoactive α Amylase

Amylases are the most important hydrolytic enzymes for starch-based industries. It is desirable that α-amylases should be active at high temperature of gelatinization (100–110°C) and liquefaction (80–90°C) to economize processes. A highly

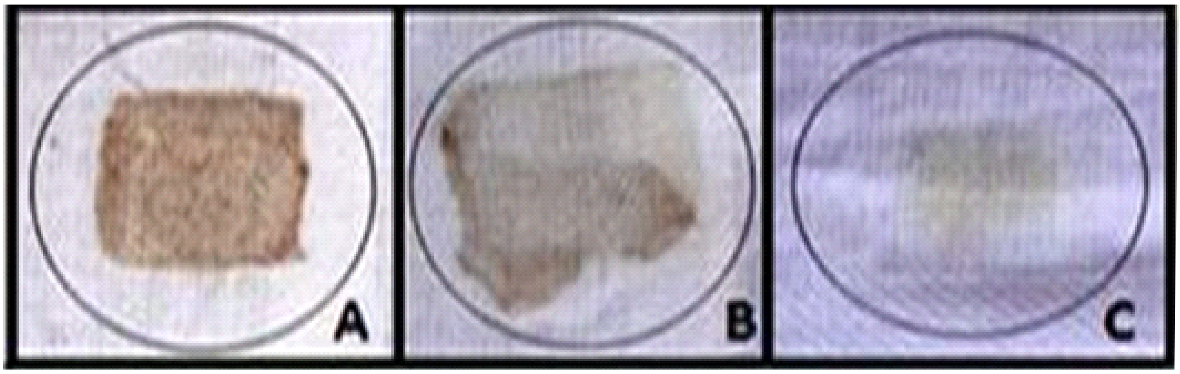


Time-course studies on growth and alphaamylase production by *Bacillus* sp.

thermoactive and thermostable amylase producing *Bacillus* sp. was isolated from the institute's experimental salt farm, yielding 452Uml^{-1} amylase in an optimized medium. Maximum activity of amylase was observed at pH 8.0 and 110°C temperature. The crude enzyme was highly active between pH 6.0 and 11.0 and observed to be active and thermostable after 30 min of incubation at 60°C. These properties indicated that the isolated α-amylase enzyme is suitable for starch liquefaction and other food processing *(Int. J. Biol. Macromol., 47 (2010) 288).*

Purification, characterization and application of solvent tolerant halothermoactive alkaline protease

The *Bacillus sp*. was studied for the production of an extracellular protease with catalytic activity and stability over broad range of pH (8-12), temperature (20-80°C) and salinity (upto 20%). by casein zymography and revealed it as a monomeric protein of molecular weight of about 71 kDa. The values of K_m and V_{max} obtained for the protease were 0.57 mg/ml and 445.23 U/ml. Moreover, the crude enzyme showed an



Wash performance analysis of *Bacillus* sp.SM2014 protease in the presence of the commercial detergent Ariel. Cloth stained with blood. (A) stained cloth washed with tap water only (B) stained cloth washed with detergent only (C) stained cloth washed with Ariel supplemented with the crude enzyme of *Bacillus* sp.SM2014

The enzyme also showed extreme stability towards nonionic (Tween 80 and Triton-X) and anionic (sodium dodecyl sulphate) surfactants and also to commercial bleach (sodium hypochlorite) when pre-incubated for 1 hr at 50°C. Proteolytic activity of this enzyme was further confirmed with *in-vitro* activity staining excellent compatibility with commercial solid detergents like Ariel and Surf Excel. Wash performance of the enzyme carried out on clothes stained with blood, turmeric, chocolate and tomato sauce clearly indicates its possible application in detergent industries.

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thjk e vuokf'kd ifjoru dk lfo/kktud rjhdk igyh ckj Biolistic gene gun d ek/;e l LFkkfir fd;k x;k g] tk LFkkb vuokf'kd ifjoru dh lHkkouk dk n'kkrk gA io&lof/kr thjk d Hk.k dk fuEu ifjfLFkfr;k e Biolostic gene gun l ifjofrr fd;k x;k (27 inches Hg vacuum, 25 mm distance from rupture disc to macro-carrier, 10 mm macrocarrier flight, 1100 psi nkc] 9 cm micro-projectile ;k=k njh)A vkl ru 110 Hk.k dk mi;kx fd;k x;k] ftle 91% Hk.k e 24 ?kV d ckn GUS dh vfHkO;fDr n[kh xbA T_0 dh tMk rFkk ruk e GUS dh vfHkO;fDr 3 efgu d ckn n[kh xbA ifjoru dh leh{kk 0.96 kb hptII rFkk 1.3 kb gus gene d ço/ku }kjk dh xbA T_0 ih<h d ifjofrr ik/kk dk hptII thu d probe }kjk Southern blot l ij[kk x;kA ;g çFke lQy ç;kl g ftle thu dk LFkkukrj.k thu xu d ek/;e l fd;k x;k gA (lykUV ly- fV';w vkx- dYpj- (2010) 103:1-6)

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lyhdkfu;k e yo.krk d çHkko dk of)] çdk'k lÜyô.k] çdk'k r= II (PSII), vk;u lc/kk vkj çdk'k l'yfÔr jtd ij v/;;u fd;k x;kA lcf/kr of) nj (RGR) 200 mm d NaCl ij b"Vre ik;k x;k] vkj ued dh mPp lknrk e of) fuf"Ø; ikb xbA yo.krk e of) d lkFk ruk e Na^+ d lp; e of) rFkk K^+ vkj Ca^{2+} d lp; e âkl ik;k x;kA ruk e Na^+ dh vR;f/kd of) d ckotn u iÙkh dk futyhdj.k gvk vkj u gh xHkhj pkV dk dkb y{k.k ik;k x;kA gfjrd.k (Chlorophyll) rFkk djkfVukbVk dh ek=k e of) b"Vre yo.krk e ikb xb rFkk vf/kd yo.krk e bldh deh ikb xb gA çdk'k l'yô.k (A), stomatal conductance (g_s), vrj dkf'kdh; CO_2(C_i), lkUnrk] PSII (F_v/F_m) vkj DokVe mitt (ΦPSII) dh vf/kdre ek=k 200 mm NaCl e mÙkftr ik;h x;hA mPp yo.krk u çfrdy xl enk vkj PSII dk;kRed fo'kÔrkvk dk çHkkfor fd;k gA bldk lc/k NPQ dh vf/kdrk l ik;k x;kA mPp ued d Lrj u LVkeVy lhek d ek/;e l e[; #i l l'yôd {kerk dk õkl fd;k vkj g_s dk xHkhj #i l de fd;kA vfrfjDr mÙkstuk] Åtk d vi0;; d ek/;e l ikuh dh deh vkj çdk'k{kfr l lgorh PSII lj{kk dh deh d vHkko e lyhdkfu;k cdh;Vk d vfLrRo {kerk dh mPp yo.krk }kjk of) gb gA

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tVkQk vul/kku d nlj pj.k e lh,l,elhvkjvkbZ u ikp lky d fy; ,d l;Dr lg;kxkRed ifj;ktuk ¼tuojh] 2010½ e tujy ekVlZ dkikj'ku] vejhdk ,o vejhdk Åtk foHkkx d lkFk dne j[kk ftldk mí'; tVkQk dh drjuk ,o l{e ço/ku l lhekr cTjHkfe e o{kkjki.k djuk vkj tVkQk ck;kMht y d mi;kx }kjk dkcu QVfçUV de dju dk FkkA blds fy, tVkQk d l i.k thoupØ dk fo'yÔ.k Hkh fd;k tk,xkA

mijkDr mí';k d fy;] Hkkouxj ftyk e ulokM] Hknkoy rFkk ipegy ftyk d dukM xko e tehu çkIr dh xbA lHkh txg ij fc[kjh gbZ ouLifr FkhA bu fofHkUu çtkfr;k dh igpku rFkk fxurh dh xbZ vkj ckn e gVk fn;k x;kA Åijh o tehu d uhp d ikni Hkkxk dk Hkkj rFkk dkcu tkpk x;k ftldk thoupØ fo'yÔ.k e mi;kx fd;k tk;xkA Hkfe dk lery djd tVkQk o{kkjki.k fd;k x;kA

tVkQk d vfHktkr tuun0; rFkk l/kkj dk p;u

tuojh 2003 e lclk vPNk çn'ku djuoky CP-9/IC 565735 dh mi t tkuu d fy, mMhlk e yxk;k x;kA lclk vPNk tuun0; çkIr dju d fy, 23 thukVkbi

xko pkjoMyk ¼xtjkr½ e yxk; x;A vf/kd mitokyh puh xbZ thukVkbi dk 2007 e ulokM xko e yxk;k x;k rFkk 2008-10 e mudh mi t tkph xbA

yc le; ij CP-9 dh dfVx l yxk; ik/kk d çn'ku ij utj j[ku dk egMk ¼mMhlk½ e ç;kx

igy nh xbZ tkudkjh vulkj CSMCRI CP-9, cM ieku ij ço/ku gr tVkQk ddl dk ,d ithdr tuun0; g ftlu n'k d lHkh LFkkuk e l fo'kÔdj jktLFkku e vPNh mi t n'kk;hA mMhlk d le&vkn tyok; e CP-9 d o'kt l vklru 2 fdxk@ik/k nk lkyk l fujrj çkIr dh tcfd ey ik/k ¼5.5 oÔ ijkuk½ dh vklru mit 2.04 fdxk gA rnijkr ;g mit

vxy oÔ Hkh cuh jghA ;g mit oÔ 2003 e fu/kkfjr gekj y{; d vu#i ikbZ xbA ¼mnkg d fy, ?k fgUn dk 2003 dk vxLr 4 dk vd nf[k,A ftle fy[kk x;k g fd lLFkku d fun'kd Mk ih d ?kkÔ u PTI fjikV e crk;k g fd çfr gDVj 25-30% mit d lkFk 2 Vu tVkQk cht çkIr fd;k tk,xk ftldk çfrgDVj 500-750 fdxk ck;kMht y e ifjofrr fd;k tk,xkA½

ulokM ¼xtjkr½ e okNuh; x.kkokyh dfVx dju dk çn'ku ijh{k.k

fofHkUu çk;kfxd ifj.kkek l çkIr gb] mÙke lL; rduhdh dk mi;kx djd oÔ 2007-08 e p;fur thukVkbi dfVx l o{kkjki.k fd;k x;kA rhlj lky e (2009-10) e 3 eh x 3 eh foU;kl l mPpre vklru mit 1161xk@ik/kk (N=92) jkt&6 thukVkbi l çkIr

gbA cht e ry dh ek=k 31% ik;h xbA 'kkeyk th e de mit 983 xk@ik/kk çkIr gb yfdu cht e ry ek=k mPprj 36% ikbZ x;hA blls ijh{k.k e lHkh ik/kk e ry dh ek=k 29 l 36% rd ik;h xbA

f}okf"kd ifronu 2008-2010

xtjkr d tktej e rVh; jrhy Vhy ij mxk; x; tVkQk d ithdr ik/k IC 565739 l vlkekU; mPp mit

,d thukVkbi (IC-565739) ftl xtjkr d rVh; jrhy Vhy ij oÔ 1999 e yxkb x;k mll 2008-09 e 5.2 fdxk@ik/kk o 2009-10 e 5.55 fdxk@ik/kk mit çkIr gbA 2009 e ry dh mit 26% jgh tcfd ekp 2010 e 31% jghA ;g le>uk g fd D;k ;g mit vkrfjd ldkjkRed y{k.k d dkj.k g ;k vklikl d {k= e vU; ik/kk l çfrLi/kk d dkj.k gA bll ;g Li"V g fd 2007 l tVkQk dd d mi;kx l mit e vlj gvk gA

tVkQk ddl e lry mit d fy, vkuof'kd l/kkj ij NMITLI ifj;ktuk d vrxr cgLFkyh; ijh{k.k

NMITLI ifj;ktuk d vUrxr cgLFkyh; ijh{k.k dk tkjh j[kk x;k rFkk fofHkUu çfrHkkxh lLFkkvk d 17 mRd"V rFkk 161 ey mnHkooky ik/k legk dh of) vkdMk dk lk[;dh; fo'yÔ.k fd;k x;kA lHkh mRd"V ik/k legk e] mud lHkh x.k/kek e] lHkh çk;kfxd LFkyk ij vR;f/kd fofHkUurk ikb xbA çkIr ifj.kkek d vk/kkj ij ik;k x;k fd lh,l,elhvkjvkb dh ,d mRd"V fdLe CSMCRI-GUJ-Banas-1205-C-2 (IC-559364) u cgr l LFkyk ij vPNk çn'ku fd;kA DRDO u gky gh e bl ik/k leg e #fp fn[kkb gA ik/kk d 17 mRd"V legk e l cht mit d vk/kkj ij NBPGR-GUJ-SKN-0605-Urikanchan, FRTUA-Tch-1005-DD-EL-1 rFkk CSMCRI-GUJ-Banas-1205-C-2 Hkkouxj çk;kfxd LFky ij lokÙke ik; x; rFkkfi #i rFkk ljpuk d ekinMk d vk/kkj ij CRIDA-AP-Ranga-0106-C011 u mRd"V çn'ku fd;kA

i"i tfodh

fofHkUu thon0;k e vyx&vyx oÔk d nkjku uj ,o eknk i"ik d vuikr e mrkj&p<ko dk vkdyu fd;k x;kA çLrr v/;;u e ;g ik;k x;k fd fiNy nk oÔk e vklr vuikr e vUrj de FkkA oÔ 2008-09 e ;g 24:7:1 ,o 2009-10 e 22:4:1 vfdr fd;k x;kA vf/kdre eknk i"ik dh l[;k IC-565735 e rFkk mll de CSMCRI-11 rFkk IC 56734 e ikb xbA bl ç;kx e eknk i"ik dh l[;k rFkk mue çfr"Br Qyk dh l[;k d chp lc/k dk Hkh v/;;u fd;k x;k tk dkQh mYy[kuh; FkkA

tVkQk dh lL; rduhdh o dd ¼[kyh½ dk [kkn d #i e mi;kx e çxfr mojd ijh{k.k

tk 2004 l tkjh Fkk ftl e ukbVkstu : 0, 40, 80 o 120 fdxk çfr g-] g rFkk QkLQV P_2O_5 : 0, 15, 30 o 45 fdxk@g- rFkk nkuk mojdk dk l;ktu rFkk K_2O 20 fdxk@g- o dd dk leku #i l Hkfe mipkj fd;k x;kA oÔ 2008-09 e] 40 fdxk N o 15 fdxk P_2O_5 d l;ktu l mPpre mit 1.6 Vu@g- çkIr gb] tcfd oÔ 2009-10 e N 40 fdxk o 0 fdxk P_2O_5@g- oky l;ktu e mPpre mit 1.7 Vu@g- çkIr gbA bll ;g Li"V gkrk g fd yxkrkj P_2O_5 d mi;kx l bldk feVh e lp;u gvk g lkFk gh mit ij Hkh bldh çfrØ;k de gb gA
fofHkUu ikÔd rRo çc/ku ç.kkyh e tVkQk dd dk] tVkQk dh mit o feVh dh to jklk;fud fØ;kvk ij çHkko dk v/;;u fd;k x;k ftl e 100% N vdkcfud mojd l] 50% N vdkcfud mojd] 100% N tVkQk dd] 100% N FYM l feVh dk mipkfjr fd;k x;kA rhlj oÔ e 100% N tVkQk dd vkj 100% N vdkcfud mojd l leku mit çkIr gbA 50% N vdkcfud mojd d vykok nlj lHkh mipkjk e 18-46% mit T;knk feyhA fu;f=r mipkj ¼tVkQk jfgr½ l nlj mipkjk e feVh e ,Utkbe xfrfof/k T;knk ikb xbA vEyh; o {kkjh; QkLQVt xfrfof/k lcl T;knk FYM l mipkfjr rFkk ;jh;t xfrfof/k 100% N vdkcfud mojd e ik;h xbA

tVkQk dk vrj.k ¼ikni ?kuRo½ ijh{k.k

NMITLI ifj;kstuk ds rgr] vf/kd mRiknu nuokys thukVkbi dh dfVx dk 2007 esa ulZjh esa yxk;k x;k rFkk ;g ik;k x;k fd 4 eh x 4 eh vUrj ls çkIr çfr iM+ mit ¼459.9 xk½ çkIr gbZ tks 2 eh x 2 eh vUrj ¼350.5 xk½ dh mit ls T;knk FkhA yfdu çfr gDVj mit 0;kid vrj esa de FkhA tSls tSls iM+ds chp dk vUrj de fd;k x;k oSls gh mit esa of) gbZ tks 876.2 fdxk@g- 2 eh x 2 eh esa çkIr gbA chtksa mit dk yclsa le; rd fu;=.k djuk gkxk D;fd tSls tSls ik/ks cM+s gksrs tk,xs mudh ikuh o mojd dh ek=k c<xhA

oÔ 2009 esa NVs g, Ns% txg ij pkj çdkj ds ç;kx fd, x,] T0 = dVkbZ ugh] T1 = 30 cm rd dVkbZ] T2 = 45 cm rd dVkbZ] T3 = 60 cm rd dVkbZA ;g n[kk x;k fd ru dh NVkbZ lsa rFkk dVkbZ ls _rq esa chtksa mRiknu de gks x;kA dVkbZ o NVkbZ dk nh?kZdkyhu vlj n[kus ds fy, fo'kÔ #i ls dVhxlZ r;kj djus ds fy, blh çdkj dh dVkbZ dcgrj çdkj ls>us ds fy, ç;kx tkjh j[ks x,A

tVkQk esa ladj.k }kjk u;s lek;ktuksa dh lajpuk djuk

dN mRd"V rFkk çkdfrd voLFkk esa mxuokys ik/ks lsegk dh chp ladj.k {kerk dk v/;;u fd;k x;kA blds i'pkr nks vyx&vyx lVks esa o.kZ ladj cuk;s x;sA igys lV esa ,dy ladj.k }kjk ,d J"B ekr ik/k rFkk çkdfrd voLFkk esa mRiUu gkuoky ikp çdkj ds ik/k lsegk&jkst] vkefyeky] 'kfDr ihB] muh rFkk >[ku

uj ik/kksa ds chp vyx&vyx ladj.k djk;s x;sA nljs lV esa p;fur ekr ik/k (CD-9) rFkk mijksDr ikp uj ik/kks ds chp lHkh lHkkfor lek;ktuks esa vkil esa ladj.k djk;s x;sA bud ifj.kkeksa vkxs dh ubZ fjikVZ esa n'kk;s tk,xsA

F1 ds ladfjr ik/kks ls 0;RiUu LrEHk dyek dk ijh{k.k

ladj.k ç;kxks ij igys ds v/;;uks ds vuql/kku esa] fofHkUu mRd"V ik/kks ds ladj.k }kjk mRiUu dh xbZ yxHkx 1500 LrEHk dyek dk igys ik/k'kkyk esa mxk;k x;kA bu uoknfHkn ik/kks dk ikp ekg ds i'pkr çk;kfxd Hkfe esa jki.k fd;k x;kA jki.k djus ds rhu ekg ds i'pkr mudh of) ds vkdMksa ds vk/kkj ij ;g ik;k x;k fd dy v/;;fur vkB lek;ktuks esa ls nks lek;ktuks IC 565733 x IC565734 rFkk IC565735 CP-

9 ij thdr x IC 565739 tkstej esa ij thdr 140 leh rFkk 230 leh esa 'kÔ Ns lek;ktuvks dh ryuk esa J"B of) rFkk vf/kd 'kk[kk,a FkhA vf/kdre Åpkbl] Qyko] LrEHk ?kjko rFkk 'kk[kvksa dh la[;k ¼Øe'k% 140 leh] 230 leh] 41 leh rFkk 6½ IC 565735 x IC565739 esa vfdr dh xbA ;g ladj.k chtksa mRikndrk esa viuh {kerk dk fdl çdkj vfHk0;Dr djxk] blds eY;kadu djuk vHkh 'kÔ gA

tVkQk djdl ds f}xf.kr rFkk f=xf.kr ik/kks dh ifÙk;k rFkk i"ik dh lajpuk esa fHkUurk

tVkQk ds ,df=r to}0;kas ,d vdk;'khy mHk;fyxh ik/kks ik;k x;k tks okLro esa rhu i.kk x.kl= ;Xekokyh dkf'kdkvkokyk (3n) vFkkr f=xf.kr fl) gvkA bl ik/k dh ikni lajpuk dk v/;;u djds bls ckás ,o tfod x.kks dh ryuk lkekU; vFkkr f}xf.kr ik/kks ls dh xbA

SEM l{en'kh ls çkIr fp=ks esa ;g nf"Vxkpj gvk fd f}xf.kr ik/kks esa LVkeVk dh vkofÙk f=xf.kr ik/k ls vf/kd FkhA f=xf.kr ik/kks esa i"ik ds ckány rFkk i[kfM;k vkdkj esa cM+s Fks rFkk L=hdsl j ,o idlsj dk lHkh vkj ls <ds g, FkA i"i mHk;fyxh Fks rFkk mud ijkxdkÔ vfodflr ,o fuÔpu djus esa vleFk

ijkxd.kks ls ;Dr FkA i.k fodflr ekn~k i"i dk vkdkj lk/kkj.k ik/k ds i"i dh ryuk esa cMk Fkk] tcfd bud Qy vkdkj esa lk/kkj.k ik/k ls NkV ik; x;A ,df=r tfod}0;k ds ik/kks u x.kl=k dh voLFkk 2n vFkkr f}xf.kr n'kk;hA lkekU;r% lHkh ik/kks esa v/;;u fd; x; 184 ton0;k ds lfi.k thu lePp; (2c) ds vkdkj dh lhek 0.83 ihth ls 0.90 ihth çfrdkf'kdk rd ikbZ xbA doy mijksDr of.kr FRI ngjknu fdLe FRI-UA-Deh-0705-DA-EL-C3 us f=xf.kr vFkkr 3C voLFkk esa lEi.kZ thu lePp; dh lhek 1.05 ihth ls 1.13 ihth çfrdkf'kdk rd n'kk;hA

tVkQk dk mÙkd lo/ku

mÙkd lo/ku d mPp ykxr dh otg l mld 0;kogkfjd vuç;kx e ck/kk vkrh g vr% gekjk çkFkfed mís'; g fd ge bl çfØ;k dk de ykxr dh cuk;A ,Dl foVk #fVx ,d vk'kk tud rjhdk g ftld mi;kx l mRiknu dh ykxr e dVkrh dh tk ldrh gA gekj io v/;;uk dh fujrjrk }kjk lQyrkiod fodflr ekbØkçkix'ku ç.kkyh tk vx vkj d{k dfydk d mi;kx l fodflr dh xb g mld vrxr 6-12 dfydk; ,d dYpj l çkIr dh tk ldrh g vkj ckj ckj lc&dYpj d ckotn bl e dkb fxjkoV ugh ikb xbA ,Dl foVk ey ç.kkyh e bu foVk #fVx dh çfØ;k dk u dju dh otg l ekbØkçkix'ku pØ e 2-3 g¶rk dh dVkrh gkrh g ftldh otg l ykxr de gk tkrh gA ych dfydkvk dk dkV dj l{e thok.k jfgr jr e jkik x;k vkj 40% dfydkvk e #fVx ikb xbA bl çfØ;k dk vkj vf/kd fodflr dju d fy; vU; ç;kx çxfr ij gA

io çR;{k i.k mRFkku dk; d vUrxr MBy] ch t i=] i.knM vkj i.k ,o i.knM dyl l lh/k dfydk dh mRifr d ç;Ru fd; x;A vyx&vyx Hkkxk l mRiu dfydkvk e ey çfr'kr e fofo/krk ikb xbA cká y{k.kk d vk/kkj ij ik/kk e dkb foy{k.krk ugh ikb xbA

Hkkjh /kkrvk dk tVkQk djdl d i.k iu%tuu vkj vkf.od fo'yÔ.k ij çHkko

fodkl vkj ,VhvkDlhMV mRlpd dh çfrfØ;k ij fofHkUu Hkkjh /kkrvk d çHkko dk eY;kdu dkÔ Lrj ij fd;k x;k ftl l irk yxk;k tk ld fd l;= /kkr ruko ifjfLFkfr;k e tVkQk djdl d ik/k thfor jg ldr g ;k ughA v/;;u d fy; Cd, Cu, Al, Cr o Ni dk mi;kx fd;k x;kA mi;kx dh xb /kkrvk e Cd de l de foÔkDr vkj Ni dkÔ Lrj ij lcl vf/kd foÔd ik;k x;kA Ni ;Dr ueuk dk vkf.od fo'yÔ.k fd;k x;kA v/;;uk l irk pyk fd Ni fd de ek=k (0.01 mM) l iu%tuu e vfHkof) gkrh gA Ni dh 0.01 mM l vf/kd ek=k iu%tuu dk dfBr djrh g vkj Kkr gkrk g fd Ni foÔkDrrk l i.k ;k vkf'kd DNA E;VktufIl dk dkj.k gA cM ik/kk e dIk vlj gkrk g og n[kuk gA

tVkQk o fLopxkl Qlyk dh feVh e l{e tfod ljpuk

nk tfod b/kuokyh Qlyk ¼tVkQk o fLopxkl½ dh jkbtkLQ;j ¼tMk l tMh feVh½ o cYd ¼tMk l nj½ feVh e l{e tho ljpuk dk v/;;u fd;k x;kA lkekU; r%] fLopxkl dh feVh e xke /kukRed cDVjh;k dh ek=k o ekuk vlrlr PLFA tVkQk dh feVh l T;knk ik; x;A nkuk rjhdk l nkuk Qlyk dh l{e tho lenk; ljpuk dk lQyrkiod v/;;u fd;k tk ldrk gA

tVkQk d vo'kÔ vi?kVu d nkjku l{e tho lenk; ljpuk e ifjoru

feêh e tVkQk vo'kÔ& ifÙk;k] dd] Qy] [kky ueuk e l{e tho lenk; ljpuk d fy; FAME o ,Utkbe fo'yÔ.k fd;k x;kA l{e tfod ck;kekl] cDVhfj;y o dod FAME dd mipkfjr feVh e nlj mipkjk l egRoi.k ek=k e T;knk ik; x;A dd mipkfjr feVh e ruko lpd FAME egRoi.k deh ikb xbA

tVkQk djdl ij vkf.od v/;;u

tVkQk djdl dh RAPD vkj SSR ekdjk d ek/;e l CSMCRI accessions d vkf.od y{k.k o.ku

tVkQk djdl dh RAPD vkj SSR ekdjk d ek/;e l lh,l,elhvkjvkb thon0; d vkf.od y{k.k o.ku PCR vk/kkfjr RAPD vkj SSR Mh,u, ijh{k.k] fd;k x;k g vkj bUgh 23 thon0; dk {k= e eY;kdu fd;k tk jgk gA bl v/;;u e RAPD fo'yÔ.k }kjk PP 54.11% ik;k x;k tk igy 52.55% ik;k x;k FkkA eY;kdu e RAPD }kjk vkuof'kd lekurk 0.911 ik;h xb ftldh SSR ekdj }kjk ik;h xb vkuof'kd lekurk (0.90) l if"V gbA CA 15 u] nkuk RAPD rFkk SSR fo'yÔ.k e nlj thon0;k l egÙke lekurk n'kk;hA nkuk RAPD vkj SSR dendrograms 23 thon0; d fy; UPGMA dk mi;kx dj mRiUu fd, x, tk ,d nlj l vPN lc/k fn[kkr gA RAPD fo'yÔ.k e CA 23, vU; cultivars l fHkUu ik;k x;k FkkA SSR }kjk çkIr fooj.kk dk dyLVj fo'yÔ.k }kjk leku ifj.kke çkIr g,A RAPD rFkk SSR MUMkxke e thon0; CA 6, CA 7, CA 8, CA 11 rFkk CA 13 ,dnlj d lkFk vPN lc/k n'kk; ,d xi e vk; tcfd CA 5 dYLVj e l vyx gk x;k vkj vU; ikp thon0;k l vlekurk n'kk;hA NkV dYLVjk e CA 15, CA 16, CA 17 ,d dYLVj e lekfo"V gk x;A CA 19 rFkk CA 20 vU; NkV dYLVj e fey x,A vc ;g n[kuk g fd ; tkudkjh dk çtuu dk;Øe e mi;kx fd;k tk ldrk g ;k ughA

tVkQk e ruko lfg".krk dk lo/ku

eØkQkfeuk tVkQk e Hkkjh ud lku dk dkj.k curk gA eØkQkfeuk feVh ogu ,ukekfQd ,Ldkekf lVl dod gA feVh cht ;k e tcku mÙkd e microscleratia inoculum d #i e jgrk gA lLFkku u tVkQk e vto vkj tfod ruko lgu'khyrk dk c<ku d mí'; l tVkQk l vPNh x.kork d RNA vyxko d fy, ,d rduhd fodfIr dh gA tVkQk e ruko lgu'khyrk dk c<ku d fy, PR thu vkj WRKY TFS dk vkuof'kd #ikrj.k fd;k tk,xkA

tVkQk djdl tufVd ifjoru

tVkQk ik/k e ruko lfg".krk tVkQk djdl d vkuof'kd ifjoru d fy, çkVkdky ekufddr fd;k x;k gA ifjoru çkVkdky d vudyu d fy, cDVhjh;y of) pj.k dh vof/k] cDVhfj;k lly ?kuRo] iÙkh dh me acetosyringane ,dkxrk dk v/;u fd;k x;k gA lg [krh d 4 fnuk d ckn vf/kdre ifjoru n{krk gkfly dh FkhA gene ,dhdj.k dk PCR MkV CykV vkj southern blotting }kjk if"V dh xbZ g tcfd thu dh vfHkO;fDr GUS assay }kjk if"V dh xbA ifjoru d ckn iuthfor putative buds dk c<ko] e/;e ij LFkkukrj.k dj proliferate dh yxHkx 40% tM fey h o 6-8 lIrkg d ckn 50-60% ik/k cp x;A

lenh 'koky vu l/kku

lLFkku e db oÔk l 'koky vu l/kku d ,d çe[k {k= e lenh 'koky vkj l{e 'koky e /;ku dfnr fd;k tk jgk gA bld vfrfjDr to fofo/krk dk v/;;u] oxhdj.k] [krh vkj eY;o/ku dk dk;Hkh fd;k x;k gA ckn e lenh i;koj.k d {k= e Hkh ekuofoKku xfrfof/k;k vkj len e thou d fy, mld ifj.kkek d chp ijLij fØ;k dk egRo fn;k x;k gA vHkh gky gh e] vk/kfud vkf.od thofoKku midj.kk vkj rduhdk dk mi;kx fd;k x;k g vkj bl {k= dh xfrfof/k;k dh of) dju d fy, urRo fd;k tk jgk gA foHkkx u nkuk cfu;knh vkj vuç;Dr vu l/kku rFkk xkgdk d fy, çk|kfxfd;k d LFkkukUrj.k ij ,d lkFk utj j[kh gA fuEufyf[kr [kM e 2008-10 d nkjku gb çxfr ij çdk'k Mkyk x;k gA

vkf.od thofoKku rFkk fØ;k foKku

Dunaliella salina l fofHkUu 0;Dr ued çfjr cDNAs dh Dykfux

Dunaliella salina dk iFkDdj.k ued d fØLVy l fd;k x;k gA bl mPp yo.krk d thuk o çkyhu] glycine betaine dh biosynthesis d v/;;u d fy; ,d vkn'k ueu d #i e ç;kx fd;k tk ldrk gA bl l{e 'koky dh osmoprotectant d #i e ;g igyh fjikV gA (feJk ,V vky. 2008, tjuy vkQ bUMLVh;y ekbØkck;kykth ,UM ck;kVdukykth 35:1093-1101) mPp lrlr ued ruko (5.5M) e *Dunaliella salina* d thu dk substractive ldj.k d tfj,] Dykfu rFkk oxhdr fd;k x;k rFkk vk|kfxd vUoÔ.k d fy, puk x;k gA vuØe vu#irk fo'yÔ.k l ;g Kkr gvk fd dy leg dk 26% p;kip; ,tkbek d ued mÙkjnk;h thuk dk leko'k g vFkkr fructose-1,6-diphosphate aldolase (*AldP*), glucose-6-phosphate dehydrogenase, carbonic anhydrase, phosphoglycerate kinase bR;kfn] tcfd 6% Dyku dkYifud v>kr thu gA leg d 8% Dyku fofHkUu çdkj d ued ruko d #i e 0;Dr gkr gA gkykfd] 6-8% leg d thu ued ruko e 0;Dr çdk'k l'yÔ.k] j{kk ly cpko d #i e dk; djr gA 39% e l 6% transcripton factor vkj 14% ?kV thu d #i e dk; djr g rFkk 'kÔ 19% thu fofo/k lekjkg d #i e dk; djr gA (feJk rFkk >k 2010, ckVfudk efjuk] Lohdr)

l{e 'koky *D. salina* l cká dkf'kdh; cgyd inkFkk dk vyxko rFkk fu#i.k

l{e 'koky *D. salina* l cká dkf'kdh; cgyd inkFkk d vyxko rFkk fu#i.k dh fjikV dh xbi vkj ;g *D. salina* cká dkf'kdh; cgyd (EPSs) inkFk dk 5M NaCl ij vR;f/kd ek=k (944mg/l) e rFkk 0.5M dh yo.krk e U;ure (56mg/l) ek=k e mRiUu djrk gA ik;k lhdkjh lfØ;rk 0.5M ued dh lknrk ij ekik x;kA

FT-IR-LiDVk dk;kRed leg] vlefer C-H c/k dh [khp rFkk diu l aliphatic CH_2-leg] C-C c/k dh [khp l lx/k C-N c/k dh [khp l aliphatic amine, N-H c/k d fgyu l çkFkfed amine, C-X c/k dh [khp l alkyl-halides rFkk C-O-C, C-O c/k dh [khp l dkckgkbMV dh mifLFkfr dk n'kkrk gA FTIR-LiDVk l çkFkfed amine lx/k ;kfxd] halide leg] dh mifLFkfr dh ifV djrk gA HPLC fo'yÔ.k d tfj, pkj ekuk ldjkbMl (glucose, galactose, fructose vkj xylose) dk Hkh irk yxk;k x;k gA *D. salina* dk mi;kx to çk|kfxdh vkj vk|kfxd 'kkÔ.k e ,d EPSs fuekrk d #i e fd;k tk ldrk gA (feJk rFkk >k] 2009, ck;kfjlkl VDukykth] 100: 3382-3386)

vrj&fof'k"V eyrRo foy; vkj dkf;d ldj dk eY;kdu

mi;kxh y{k.kk oky 'koky ldjk dk fuek.k dju d fy, eyrRo foy; dk v/;;u tk 1985 e 'k# gvk Fkk yfdu vHkh rd v/kjk gA oreku v/;;u e fQj l eyrRo foy; d ek/;e l dkf;d ldj mRiknu dh lHkkouk dk irk yxku d fy, ,d ç;kl fd;k x;k gA vYok jVhdyVk vkj vYok Vfu;Vk dk mÙkjnkf;Ro d vk/kkj ij p;u eyrRo r;kjh vkj mud ly;u d fy, fd;k x;k gA igy d fjikV vulkj] vYok jVhdyVk vkj vYok Vfu;Vk l eyrRo dh fo|r ly;u d ek/;e l vrj&fof'k"V dkf;d ldj dk fuek.k fd;k x;k gA dfFkr ldjk dh lajpukRed] dkf'kdk foKku vkj vkf.kod v/;;u d }kjk ldj çdfr dh if"V dh xb gA dfFkr ldj e ird dh ryuk e vf/kd cnyko

fn[kkb fn;kA lykLVke thuke l vkjchlh,y thu dk Mh,u, vuØe.k] ijek.k thuke l vkbVh,l {k= vkj ykDl ,tkbe dh vkblkekfQd vfHkO;fDr d lkFk v/;;u] ldj e ird d fofHkUu ijek.k {k= d thukfed l;ktu dk ldr nr gA blh çdkj lh ,p ,u vkj dy çkVhu dh lkexh nkuk lyf;r Hkkxhnkjk dh vklr ;kT;d FkA ldj dk fodkl nj Hkh irdk d vklr fodkl nj l ey [kkrk gA blfy,] bl v/;;u }kjk lenh 'koky e eyrRo ly;u rduhd dk fodkl] lfg".krk vkj olk vEy ljpuk tl lL;foKkuh; egRoi.k y{k.k d l/kkj d lkFk 0;ogk;rk dk lQyrkiod çn'ku fd;kA

Hkkjrh; ty dh xlhyfj;k 'koky dk vkf.kod thooÙk

rhu vyx vyx thuke lcf/kr vkf.kod ekdjk l xlhyfj;k çtkfr;k d vkf.kod tkfroÙk dk fu"dÔ fudkyk x;kA tkU;DyhvkVkbM Øed) rk d 0;fDrxr ,o lcf/kr ijek.k (18 SrRNA)] feFkkdkUMhvy (Cox2-3 vrjd) rFkk DykjkikLV budkfMx (RuBisCo vrjd) thUl ij vk/kkfjr FkkA

mDr thu Øec) rk d l;Dr fooj.k }kjk fu"dkfÔr tkfroÙk u mPp fLFkjrk lpdkd] çfr/kkj.k lpdkd rFkk cVLVi eY;k d lkFk DyM dk vPN leFku dk fun'ku fd;k gA bl v/;;u d ckj e geu io fjikV e

crk;k Fkk vkj ;g vc çdkf'kr gvk g ¼t- Qkb- dkyk- 2010, 46, 1322-1328½ vkj ,d leh{kd d vulkj ;g Hkkjrh; miegk}hi l viuh rjg dk igyk fjikV g vkj mPp vkdkfjdh ifjoru {kerk;Dr 'koky çtkfr;k dh igpku dju d fy, rFkk mud thooÙkh; o'kkoyh LFkkfir dju d fy, u;k midj.k gA mDr ifj.kke lenh 'koky vkf.kod oxhdj.k rFkk thooÙk dk vkdyu dju e #fpdkjd g vkj Hkkjrh; 'koky d vkf.kod oxhdj.k d ckj e egRoi.k tkudkjh çnku djrk gA

vkuokf'kd fo'yÔ.k vkj ekdjk dh lgk;rk l yky 'koky xkflyfj;k dkVhdVk ¼t vx/k½ d thou pj.kk dh igpku

dkf'kdk foKku vkj vkf.kod ekdj dh lgk;rk l xkflyfj;k dkVhdVk ¼t- vx/k½ d vkblkekfQd vkcknh dk iFkDdj.k vkj vkb,l,lvkj ekdj d mi;kx }kjk bVj vkj bVk Qfld vkuof'kd fofo/krk ij v/;;u fd;k x;k gA xkflyfj;k dkVhdVk dh bUchfMx tul[;k dh vkuof'kd fofo/krk d #i e cg#irk] vklr gVjktk;xkflVh vkj 'kkUuku ohoj lpdkd çfr'kr e 59.80, 0.59 vkj 0.21 Øe'k% FkA bVj&Qfld tkMh okj vklr cg#irk uj vkj eknk d chp 31.6 %, 24.0% uj vkj VVkLikjkQkbV rFkk 25.3% eknk vkj VVkLikjkQkbV d chp nt dh xbA bVk&Qfld vklr cg#irk lcl vf/kd 5.5% eknkvk d chp] 4.2% uj d chp rFkk lcl de 2.4% VVkLikjkQkbV d chp nt dh xbA çkbej l[;k 10 dh lgk;rk l uj fof'k"V 800 bp rFkk 650 bp d eknk

fof'k"V ekdj dh igpku dh xb] bld vykok çkbej l[;k 17 }kjk 2500 bp dk VVkLikjkQkbV fof'k"V ekdj dh igpku dh xb gA nkuk ;ihth,e, vk/kkfjr MuMkxke vkj ihlh, vk/kkfjr DyLVj fo'yÔ.k e lHkh rhu pj.k vyx igpku d #i e ik, x,A dkf'kdk foKku fo'yÔ.k }kjk x.kl= fxurh l nkuk vxf.kr uj vkj eknk ¼,u½ 24 x.kl= vkj f}xf.kr ¼2 ,u½ VVkLikjkQkbV d fy, 48 x.kl= l[;k nt dh xb tk bud vkuof'kd njh dk n'kkrk gA bl v/;;u dh fjikV dh enn l thou pj.k fof'k"V ekdjk d mi;kx l fodkl d çkjfHkd pj.kk e thoupj.kk dh igpku dh tk ldrh g tk bl çtkfr d çtuu dk;Øek d fy, egRoi.k fl) gk ldrh gA (eky- ck;k- fjikV 2011 çl e)

futyhdj.k çfjr vkDlhMfVo LVl vkj mldh xkflyfj;k dkVhdVk e tojklk;fud çfrfØ;k,

xkflyfj;k dkVhdVk d vrjTokjh; {k=e ik, tku d dkj.k de Tokj d nkjku fofHkUu vtoruko mRiUu gkr gA vrjTokjh; 'koky fuEu vkj mPp Tokj d nkjku ,d pØh; rjhd l fu;fer futyhdj.k vkj iutyhdj.k dh çfØ;k l xtjrh g vkj rnulkj bl çdkj d i;koj.k ruko l mRiUu gku okyh tUetkr 'kkjhfjd dkf'kdh; {kfr l edkcyk dju dh {kerk fodflr dj yrh gA oreku ç;kx e xkflyfj;k dkVhdVk e fu;f=r ifjfLFkfr;k e vyx&vyx vof/k 0 fu;=.k] 1, 2, 3 vkj 4 ?kV] 65% vknrk 28°C ij futyhdj.k çfjr fofHkUu tojklk;fud ifjorukdk v/;;u fd;k x;k gA ç;kx e pkj ?k.V d futyhdj.k ij xkflyfj;k dkVhdVk e foy{k.k <x l yxHkx 47% ikuh dh deh n[kh xbA 'k# d nk ?k.V d lid l DykjkfQy] djkfVukbMl vkj Qk;dkfcyhçkVhUl e fu;=.k dh ryuk e of) nt dh xb yfdu bl l T;knk le; d futyhdj.k l Øe'k% deh n[kh xbA nk l rhu ?kV d futyhdj.k d nkjku ,VhvkDlhMV ,tkbek tl lijkvkDlkbM fMLE;Vl ¼,lvkMh½ ,LdkcV ijkvkDlhMl ¼,ih,Dl½] XyVkfFk;ku fjMkDVl ¼th vkj½ vkj XyVkfFk;ku ijkvkDlhMl ¼th,l,p½ e of) nt dh xbA bld vykok] bu ,tkbek d vkblkQkEl] vFkkr ,e,u&,lvkMh ¼~150 kDa½] ,ih,Dl&4 ¼~110 kDa½] ,ih,Dl&5 ¼~45 kDa½] thih,Dl&1 ¼~80 kDa½ vkj thih,Dl&2 ¼~65 kDa½ futyhdj.k d lid e fo'kÔ #i l tokc fn;kA rhu l pkj ?kV d lid l c<h gb çfrfØ;k'khy vkDlhtu çtkfr;k ¼vkjvk,l½ dk mRiknu vkj c< fyfiM ijkvkDlhMlu ftlu fyikvkDlhftul ¼,yvk,Dl½ dh fØ;k'khyrk of) e ;kxnku fd;k] lkFk e nk u, ,yvk,Dl vkblkQkEl çfjr ¼,yvk,Dl&2, ~85 kDa; ,yvk,Dl&3, ~65 kDa½ g,A fu;=.k l ryuk dju ij nkuk Lor= vkj ck/; v?kyu'khy iVhflu vkj Lijfeu dh ,d mPp lki{k lkexh n[kh xb] lkFk e nk ?kV dh futyhdj.k l ,u 6 ih;,Q,,l 20:4 ¼,u&6½ vkj lh 20 :3 ¼,u&6½ olkvEy e of) n[kh xb tk futyhdj.k l mRiUu vkDlhMfVo ruko l ik/k dh lj{kk djrh gA (,uok;j-,Dl- ckVuh-, 2011 Lohdr)

vYok ydVdk e dMfe;e çfjr vkDlhMfVo ruko e vrj çfrfØ;k,

dMfe;e (Cd^{2+}) e tfod dk;d lkFk dkb fjikV ugh g] dlj ij vul/kku d fy, vrjjk"Vh; ,tUlh }kjk doy lenh Mk;Ve l ,d dkQDVj dkckfud ,ugkbMl d #i dMfe;e dk ekuo dkflukstu leg e oxhdr fd;k x;k gA Cd^{2+} fofHkUu tfod d.kk d lkFk ,d vkDlkfQfyd vkj lYQkfQfyd rRok d #i e dkEiyDl cukrk g vkj bl rjg dh çfrfØ;kvk dh ,d foLrr J[kyk g tk tyh; ikfjfLFkfrdh r= e tkf[ke mRiUu dj jgk gA ;gk rd fd dfM;e dh cgr l{e ek=k Hkh vR;f/kd çfrfØ;k'khy vkDlhtu çtkfr ¼vkjvk,l½ mRiUu djd vkDlhMfVo ruko c<kdj lyyj p;kip; dh çfØ;k dk Hkx djrh gA vYok dk tc pkj fnuk d fy, 0.4 feeh $CdCl_2$ d lid e yk;k x;k rk fyikijkvkDlhMl vkj H_2O_2 lkexh e yxHkx nxuh of) gb tk lkefgd #i l fu;=.k dh ryuk e of) ij deh vkj l'yÔd fixeVl e yxHkx 30% dh deh nt dh xbA lijvkDlkbM fMLE;Vl ¼,lvkMh½ ,LdkcV ijkvkDlhMl ¼,ih,Dl½ XyVkfFk;ku fjMkDVl ¼thvkj½ vkj XyVkfFk;ku ijkvkDlhMl ¼thih,Dl½ tl ,VhvkDlhMV ,tkbek e nk l rhu xuk of) nt dh xb] tcfd dVkyl ¼lh,Vh½ e deh ikb xbA bld vykok] bu ,tkbek d vkblkQkEl] vFkkr ,e,u&,lvkMh ¼~85 kDa½] thvkj ¼~180 kDa½ vkj thih,Dl ¼~50 kDa½ dMfe;e d lid e fo'kÔ #i l tokc fn;kA bld vfrfjDr vipf;r XyVkfFk;ku ¼3.01 xuk½ vkj ,LdkcV ¼1.85 xuk½ dh ek=k e dkQh of) gbA dMfe;e d lid l ,lMh,l ikt çkVhu çkQkby e 28, 47 vkj 90 dMh, çkVhu mPp rho tcfd 80, 60, 25 vkj 20 dMh, çkVhu dh rhork e deh n[kh xbA Lijfeu e fcuk fdlh cnyko d nkuk vrtkr vkj eDr ck/; ?kyu'khy iVhflu e of) n[kh xbA fu;=.k dh ryuk e Lijfeu ?kVd e vk/k dh deh nt dh xbA dMfe;e mipkfjr Fkyl d l{eikÔd rRok d fo'yÔ.k l ikVf'k;e ?kVd e deh vkj lkfM;e vkj exuht ?kVd e of) nt dh xb] tcfd dfYl;e] eXuhf'k;e] vk;ju vkj ftad e dkb vif{kr cnyko ugh n[kk x;kA oreku v/;;u e iVhflu d lkFk HkMkj.k l ,VhvkDlhMV ,tkbe vkj ykDl vkblkQkEl dk ,d lkFk çj.k vkj dMfe;e mipkfjr Fkyl e ,u6 ih;,Q,,l dh mifLFkfr vYok ydVdk e dMfe;e }kjk çfjr vkDlhMfVo ruko dh edkcyk dju dh {kerk dh Hkfedk mtkxj djrh gA ¼ck;keVy 2010.23: 315-325½

lYQkgMky t ¼ vxkj dh x.kork l/kkju dk ,d lHkkO; ,tkbe

vxkj e lYQV dh ek=k mldh x.koÙkk d fy, gkfudkjd gkrh gA xkflyfj;kMjk tkmPp ty {kerk rFkk de lYQV d lkFk vxjkt çdkj d Qk;dkdkykbMl çnku djrk g mls lYQkgMkyt d odfYid L=kr d fy, puk x;kA lYQkgMkyt tk xkflyfj;kMjk l 'k) fd;k x;k] mlls 0;kikfjd vxkj dh x.koÙkk e vFkkr ty 'kfDr] fpifpkiu] tfYyx vkj xyukd rkieku e l/kkj ik;k tk ldkA (dkckgkbMV] ikyhej 2011, Lohdr)

lenh 'koky e fyfiMl] olk vEy vkj vkDlhfyfilu

lenh 'koky to lfØ; çkdfrd mRiknk vkj ikÔ.k egRoi.k cgvlrlr olkvEy ¼ih;,Q,,l½ dkckgkbMV] foVkfeu] [kfut vkj vkgkj Qkbcj d le) lkr jg gA igy d ih;,Q,,l v/;;u e fofHkUu lenh 'koky DykjkQk;Vk] jkMkQk;Vk vkj fQvkQk;Vk l lcf/kr çtkfr;k dk v/;;u fd;k x;k FkkA ftle lh&18 ih;,Q,,l dh çcyrk DykjkQk;Vk lnL;k ¼vYok] dkykik] dkfM;e] dfeMkfjl] ekukLVkek çtkfr;k½ lh&20 ih;,Q,,l dh çcyrk jkMkQk;Vk lnL;k ¼xkflyfj;k] g;ifu;k] dlikQkbdl] ikjQk;jk] lkjdkuhek] lkyfj;k] ,Eikfj;k] xkrykfi;k] ykjfl;k] dkyFkje çtkfr;k½ vkj fQvkQk;Vk lnL;k ¼ikMkbuk] LivrkXykle] flLVkslfj;k] lxkle vkj fMDV;kVk½ e nkuk lh&18 vkj lh&20 ih;,Q,,l çcy ik, x, FkA bld vykok] lenh 'koky l Li"V fMtkbu dh enn l bu tfVy efVDll e loJ"B fyfiM vkj olk vEy fu"dÔ.k fof/k dh igpku vkj vudyu dju d fofHkUu fyfiM vkj olk vEy ¼,Q,½ fu"dÔ.k rjhdk dk lenh 'koky d fy, loFkk mfpr i)fr igpku u d fy, ,d rqyukRed eY;kdu fd;k x;kA çR;{k VkLLVjhfQd'ku ¼MhVh½ fof/k u ijijkxr i)fr dh rqyuk e 1.5 l 2 xuk mPp mRiknu fn;kA ;gk] ,d ç;kl d rgr QkDl ij[k }kjk LoLFk lenh 'koky e olh; vEy gMkijkvkDlkbM dk cly Lrj fu/kkfjr fd;k x;k gA lenh 'koky d lHkh rhu oxk e dy olh; vEyk e l olk vEy gMkijkvkDlkbM Lrj 0.01% l 0.03% fofo/k ik;k x;kA bld vykok] dN yf{kr vkDlhfyfil dk ek=kRed fu/kkj.k vkj ih ,pih,ylh l fd;k x;k FkkA ; vkDlhfyfil ih;,Q,,l d vkDlhdj.k l çkIr 'kkjhfjd çfrfØ;kvk] ruko çfrfØ;kvk d fodkl d ;kfxd ldrd #i e FkA

vxj¨t ftylu ij lYQV Á;uk dk çÒko ¼ foLrr Ò©frd jklk;fud v/;;u

fuLlng vxj¨t gkbMkty t¨eyk;e çdkj d inkFk d ,d fo'kÔ oxZ e lcls vf/kd v/;;u fd;k gÁ ck;¨i¨fyej ty gA gkykfd] dN eík ij vÒh Òh Li"Vrk ugh g fd lYQV vÆÁ vkj lYQV yoÆ d dkjÆ vxj¨t dh ty'kfDr D;k de ikÃ tkrh g\ blei dk lek/kku lYQV Á;uk dh miflLFkfr e tyh; vxj¨t/ty dk ,d foLrr Ò©frd jklk;fud v/;;u lfd;k x;kA gekj fu"d"k crkr g fd tyh; vxj¨t e lYQV dh e©tnxh eu doy dk rkj-gfyDl lØeÆ dk fojkxg¨rk g cfYd gfyDl-gfyDl dh ijLij fØ;kÒh deg¨ tkrh gA IR rhorkd vulkj ;g ik;k x;kfd ty uVod e lefUor prÒth; ty lljpuk dk ln<hdjÆ t¨ lYQVued dMkyu d lkFk det¨jg¨r fn[krk gA

d{k d rkieku ij vk;kfud no d lkFk vxkjkt dh fØ;k dk v/;;u

lkekU; r;k vxkjkt dk tyh; ek/;e e mi;kx fd;k tkrk gA fofHkUu /kuk;uh ¼bfeMktkfy;e ;k ihjhMhuh;u fofHkUu vkYdyh J[kyk d lkFk½ rFkk _.kk;uh l;ktukoky vk;kfud no e d{k rkieku ij blds ?kyu'khyrk ij v/;;u fd;k x;kA fijhMhuh;e /kuk;u d flok lU; lHkh e ty lljpuk ikb xbA bl ?kyu'khyrk dk vk/kkj _.kk;u d çdkj rFkk /kuk;u d mHk; ty&Fky vujkxh x.k ij gA 3&feFkkby&bfeMktkfy;e C;Vkby DykjkbM e egÙke RT ?kyu'khyrk (16% w/v) ikb xbA feFkuky vo{ki.k }kjk ?kfyr vxkjkt dk iu% mRiknu fd;k x;k tk vkf.od otu] ikyhMhLijlhVh] m"ek fLFkjrk vkj LQfVde;rk dh íf"V l ey #i d vulkj gh Fkk fdUr CD iVu e FkkMh fofHkUurk ikb xbA ¼xhu dfe 12 (2010) 1029½

d{k rkieku ij vk;kfud no d lkFk ftyVhu dh fØ;k

i'kvk l çkIr ftyVhu d cny lenh 'koky l miyC/k ikyhldjkbMl d mi;kx dh lHkkforrk d fy, v/;;u fd;k tk jgk gA geu egl l fd;k fd ge vk;kfud no d lkFk bldh fØ;k dk v/;;u djuk jlçn gkxkA ftyVhu dh 3&feFkkby&1 vkDVhyhehM tkfy;e DykjkbM [C$_8$mim] [C1] rFkk 1 C;Vkby&3&feFkkbyhfeM tkfy;e vkDVkby lYQV [Cumim] [C$_8$OSO$_3$] d lkFk fØ;k dk v/;;u fd;k x;kA ;g n[kk x;k fd 1L ,dyd u 'k# e vri"B ij ftyVhu d lkFk G-IL l;ktu cuku d fy, fØ;k dh vkj ckn e G-IL dk vr%lekfo"V fd;k g, de lfØ; ,dyd egRoi.k ,d=hdj.k d vklikl cu g, ik;k x;A ¼t-Qk;- de- ch&114 (2010) 8441½

'koky thofoKku vkj [krh

tfyMyk vlhjklk dh [krh

jk¶Vl fof/k ftldk ç;kx Hkkjr e dlikQkbdl dh 0;kolkf;d [krh d fy, lQyrkiod fd;k x;k Fkk] ml c<kdj tfyMyk vlhjklk dh [krh d fy, mi;kx fd;k x;kA jk¶Vl ¼cMk½ fof/k v/;;u d fy, 50 jk¶V ¼1.5 eh x 1.5 vkdkj½ fy; x;A çR;d jk¶V ¼cMk½ 3 feeh ikyhçki;fyu jLlh ¼xjokj oky jki fyfeVM] i.k] Hkkjr½ dh chl lekukrj lenjLFk ykbuk l fufgr FkkA çR;kjki.k d fy, 1.0 xke rktk otu uk;yku d /kkx l ck/kk x;k Fkk vkj ml d ckn ikyhçki;fyu jLlh d cMl d chp Mkyk x;k FkkA çR;d jLlh e 5 leh vrjky e yxHkx dy 25 ik/k ¼yxHkx 25 xke rktk otu½ çR;kjkfir fd; x, FkA ,d jk¶V 20 jfLl;k d lkFk yxHkx 222 xke rktk otu çR;d ehVj d cjkcj FkkA lhfMx dk dk; vçy vkj 9 tu d nkjku fd;k x;k FkkA lHkh ipkl jk¶Vk l ck;kekl dh dVkb 180 fnuk d ckn dh xbl vkj 5.250 ± 1.832 fdykxke çR;d jk¶V d vklr l ck;kekl çkIr gvkA ,d cM e l dkV x, ck;kekl dh fofo/krk dh lhek U;ure 2.0 fdyk xke rktk otu vkj vf/kdre 11.7 fdykxke rktk otu@jk¶V nt dh xbl FkhA çfrfnu dh of) nj Øe'k% 1.0 % l 2.5% d chp FkhA ,d gh ik/k dh dVkb l ck;kekl 33.16 l 66.00 xke rktk otu rd crk;k x;k gA mi;Dr MVk l fl) gkrk g fd tfyfM;yk ,djklk dfô d fy, jk¶V fof/k] igy vUofôr vkj fjikV dh xbl vU; lHkh fof/k;k e J"B gA

xkflyfj;k ,M;fyl dh [krh

geu io f}okfôd fjikV e crk;k g fd xlhyfj;k ,M;fyl dh virVh; [krh jk¶V ij dh tk ldrh gA rri'pkr bl ij v/;;u fd;k x;kA 30 jk¶Vl] 500 xke@jk¶V dh nj l cvkb tu vkj flrEcj 2008 d chp dh xbl FkhA dVkb dk dk; cvkb d 60 fnu d ckn fd;k x;k FkkA igy Qly dh dVkb vxLr&flrEcj 2008 d nkjku fd;k x;k Fkk vkj vklru 14.3 ± 3.4 fdyk rktk otu@jk¶V dh nj l dy 428 fdykxke ck;kekl çkIr gvk FkkA nljh Qly d fy, vklru 12.9 ± 3.3 fdyk rktk otu@jk¶V ck;kekl vkj dy ck;kekl 586.2 fdykxke FkkA ogh ç;kx vxy oÔ e fd;k x;kA ftlll leku ifj.kke feyA

eMie e virVh; lenh fdukj ij 'koky dh [krh

igy l dh tk jgh lenh 'koky dlikQkbdl dh virVh; [krh ij v/;;u dk vkx c<ku d fy, [krh dk dk; fd;k x;kA bFkuky d fy, 'koky dh [krh d fy, MNRE dh vkj l ifj;ktuk dh Lohdfr feyu ij bl dk; dk xfr feyh gA vkx v/;;u d fy, ikd [kkMh e rhu LFky iln fd; x, gA igyk LFkku len rV l 1.2 fdeh nj 3 ehVj xgjkb ¼mPpre mPp Tokj½ e Fkk tcfd nljk LFkku 2 fdykehVj dh njh vkj 8.5 ehVj dh xgjkb ij FkkA virVh; [krh l çkIr ck;kekl dh ryuk dju d fy, lkFk e ikuh d fdukj e ¼0.4 ehVj dh xgjkb vkj 0.075 fdeh rV l nj½ Hkh [krh dk ç;kx fd;k x;k FkkA of) nj fu;=.k d fy, dlikQkbdl d 60 jk¶Vl ,d rjQ rFkk nljh vkj 78 jk¶Vl çR;kjkfir fd, x,A mlh çdkj dlikQkbdl d 10 jk¶Vl ikuh d ikl fdukj e ,d gh le; e j[k x,A bu v/;;uk d ifj.kke crkr g fd virVh; ty {k= e mxkb xbl 'koky u ikuh d fdukj d ikl e mxkb xbl 'koky dh ryuk e T;knk mit n'kk;hA rnijkr foLrr virVh; {k= e bldh [krh lHko gA rk lkFk gh virVh; {k=k d tkf[kek d lkFk ,lh [krh ,d cMh rduhdh pukrh gA

xtjkr vkj rfeyukM rV ij lenh 'koky to fofo/krk

oreku e] dPN dh [kkMh e }hi d lenh 'koky to fofo/krk dh fuxjkuh dk dk; çxfr ij gA dPN dh [kkMh d nf{k.kh Hkkx d lkFk tkeuxj rV fofo/k 42 }hik vkj vf}rh; ck;kVk gku d lkFk ,d fofo/k rVh; i;koj.k gA bue l cgr lkj }hi mPp Tokj d nkjku len e Mc jgr g vkj de Tokj d nkjku FkkMh vof/k ¼3-4 ?kV½ dN ?kV d fy, ikuh l ckgj vkr gA vrjTokjh; {k= vkj mFky tyeXu bykdk e vDVcj l eb d chp lenh 'koky dh fofHkUu çdkj dh fdLe mxrh gA lenh 'koky dk fodkl fofo/krk vkj forj.k d lnHk e e[; Hkfe rV dh ryuk e }hik e vf/kd gkrk g A to fofo/krk dh j{kk d Øe e bu }hik dk n'k d igy lenh jk"Vh; m|ku d #i e 1982 e vf/klfpr fd;k x;k FkkA lenh jk"Vh; ikd oU; thou lj{k.k vf/kfu;e] 1972 d rgr çkdfrd ikfjfLFkfrdh r= dh j{kk d fy, ljf{kr gA 42 }hik e dkyHkkj }hi] cn okfMukj rV 5900 gDVj l vf/kd {k= d lkFk lcl cM }hik e l ,d g] mldk fiNy nk lky d fy, lo{k.k fd;k x;k vkj 'koky dh 93 fofHkUu çtkfr;k dk ,df=r fd;k x;k FkkA 14 çtkfr;k xtjkr rV d fy, ub Fkh] 11 çtkfr;k Hkkjr d fy, vkj 1 çtkfr lHkor% fo'o d fy, ub g ft l] geu dkfM;e fLijkfyl uke blds ÝkMl d lfiy çdfr d dkj.k fn;k x;k gA ;g ,d egRoi.k ub [kkt gA ek/;fed p;kip;k ¼jDr ,Vhdkvxy,UV½ nf"Vdk.k l tlk thul dkfM;e dh db çtkfr;k l blds lpuk nh xb gA vU; }hik d fy, vFkkr vktkn] Hknj] /kkuh] fnndk] [kkjk pLuk] fijkru e ;g v/;;u tkjh gA eUukj dh [kkMh vkj rfeyukM d rV d e[; Hkfe l lenh 'koky to fofo/krk dk dk; Hkh bl leh{kk/khu vof/k e tkjh j[kk x;k gA jke'oje vkj ofYyukDde d chp d rV dk {k=&1 e oxhdr fd;k x;k gA 16 LV'ku] ofYyukDde vkj dU;kdekjh d rV d {k=&2 e ftle 12 LV'ku 'kkfey g vkj edn vkj pUub dk {k=&3 e j[kk x;k gA io nk {k=k dk cM ieku ij lo{k.k fd;k x;k vkj vçy 2008&ekp 2009 e 116 l vf/kd lenh 'koky çtkfr;k dk ,d= fd;k x;k tcfd vçy 2009&ekp 2010 d nkjku 34 çtkfr;k vkj ,d= dh xb FkhA bu lHkh çtkfr;k d VDlkukfedy ijrk dh tkp dh tk jgh gA çtkfr;k dh ljpukRed lekurk l mRiUu gku okyh vLi"Vrk dk nj dju vkj o'kkoyh dh tkudkjh vkj fLFkfr çkIr dju d fy, vk.kfod nf"Vdk.k ij vk/kkfjr oxhdj.k Hkh fu;kftr fd;k tk jgk gA

eMie e lenh 'koky l jl fudkyu dk l;=

e l l ,Dok,xh çlLdj.k çkboV fyfeVM }kjk eMie] rfeyukM e 'koky l jl fu"dÔ.k dju d fy, 70 VhihMh dk l;= LFkkfir fd;k x;k g tk rktk 'koky l ,d lkFk ikÔd rRo /kuh jl vkj ikyhldjkbMl ¼dlik djkxhuu½ /kuh xU;Yl d fu"dÔ.k dh vUrjk"Vh; iVUV djkb xb fof/k ij vk/kkfjr gA vHkh gky gh e jl fuek.k dju okyh diuh u ikjl ckM d rgr jl cpu d fy, xBc/ku fd;k gA dN ek=k e fu;kr dk Hkh irk pyk gA lenh 'koky l çkIr xU;Yl dk i'kvk d fy, mi;kx d fy, gekj }kjk ykblUl çkIr ,tUlh rFkk mud lg;kxh ç;kl dj jg gA blh nkjku ik/k d fodkl fu;=d d ek=kRed ,o y{k.kRed dk; dk çdkf'kr fd;k x;kA

xkflyfj;k Mjk l vxj¨t dk fu"d"kÆ

fiNy f}okf"kd çfronu e (2006-2008) ;g crk;k x;k fd vxj¨t fu"d"kÆ d fy, ,d uà çfØ;k fodflr dh xÃFkh, t¨ 'kf) djÆ dh ijijkxr Åtk xgu BMfi?kyu ¼,uth bUVlho Ýht & Fkk LVi½ çfØ;k l vyx FkhA bl uà çfØ;k ij iVUV d fy; Áonu fd;k x;k gA (Òkjrh; iVV Áonu ucj : 0567/DEL/2009 fnukfdr 24/03/2009)

uà çfØ;k dk mi;¨x djd ik;yV l;= e 1 fdy¨ l 5 fdy¨ ieku ij vxj¨t cuk;k x;kA blle çkdfrd rFkk lof/kr nkuk xkflyfj;k Mjk dk mi;kx fd;k x;kA ÁÃlhthÃch, uà fnYyh vkj lhlh,ech, gnjkckn rFkk vU; dN ç;kx'kkykvk d oKkfudk }kjk çkIr mRikn dk eY;kdu fd;k x;kA rri'pkr ekuo thuke d DNA ij v/;;u fd;k x;k ftle ty fo|r lpkj.k v/;;uk l Kkr gvk fd çkIr mRikn] 0;olkf;d #i l miyC/k vxjkt d lerY; FkkA mRikn dh xkárk e l/kkj gr dN l/kkj çLrkfor fd;k x;A

blhl lcf/kr ,d v/;;u e çkdfrd #i l ik,

tkuoky xkI ykfj;k Mjk d uj, eknk ,o Li¨j¨Qk; I h i©/kk I vxj¨t dk fu"dÔ.k fd;k x;k Fkk, vkj ;g ik;k x;k fd eknk ,o Li¨j¨Qk; I h i©/kk e vxj¨t dh ek=k ,o mudk tyh; 'kfDr uj i©/kk I fudky g, vxj¨t dh ryuk e vf/kd FkhA Hkfo"; e mRikn dh fo'kÔrk ij gh ugh cfYd of) nj rFkk rkdr ij Hkh /;ku fn;k tk,xkA Òkjrh; tye ik, tkuoky vyx ifjokjk I I cf/kr 12 I enh 'koky ueuk e I yy¨t çekÆ vueku yxk;k x;k Fkk] çR;d ueuk e I (α) vYQk vkj chVk (β) I yy¨t d¨ foÒkftr fd;k x;kA

I enh 'koky dk to vUoÔ.k

fiNy f}okfÔd çfronu (2006-08) e crk;k x;k v/;;u dh fjikV dh fujrjrk e] xkfI yfj;k ,Mfy I] th Øk I] th QkyhQjk vkj th dkfrdkVk I fu"dfÔr vxkj dk eY; ,d cgrj çfØ;k dk mi;kx djd fd;k x;kA bI I irk pyk fd th Ifydkfu;k eUukxyDVu dk Ikr gA (t- ,i- Ikbdkykth 20 (2008) 397 &. 22 (2010) 623)

ikfyefjd Ikexh }kjk Ieæh 'koky ikfy Idjf;MI I'k¨/ku

ekbØ¨oo fofdjÆ dk mi;¨x dj I¨fM;e ÁfYtuV dk ,e/th vuikr dk fu/kkjÆ dju dh gkbM¨fyfI I fØ;kfof/k d fy, ,d rth I g¨u okyh fof/k d¨ fodfI r fd;k x;k g ikyh eu¨;j¨uhd ,fIM (PMA) vkj ikyh Xyj¨fud ,fIM (PGA) dk vuikr ,e/th (0.38) fu/kkfjr gvk t¨ d ,e@th ¼0.39½ ikjifjd fof/k d }kjk çkIr vuikr d Ieku FkkA

u; inkFk dh çkfIr gr Ieæh 'koky ikfy Idjkf;MI d I'k¨/ku

vxj¨t d IkFk Xokfuu d¨ t¨Mdj ,d u;k ¶y¨j¨IV cgyd IÜyf"kr fd;k x;kA mI dh mRI tu rhork Ieku Iknrk e Òh 'k) Xokfuu dh ryuk e 85% T;knk ikÃ xbA (dkckgkbMªsV- ikyh- 81: 878-884, 2010) ekbØkoo fofdj.kk d vk/kkj ij ,fIM e ?kyu'khy ikyh euk;fjd vkj ikyh Xyl fud ,fIM dk tkMdj pH Ionu'khy rFkk ikuh e v?kyu'khy LoYcy inkFk cuku dh Ijy fof/k fodfI r dh xbA fdfVu] fdVkIu] xvkxe K-, 1- vkj h- djkftuu] Iyykt vkj LVkp tI ikyhIdjkbMI dk ?kkyu d fy, u; çdkj d vk;fud rjy inkFk dk IÜyfÔr fd;k x;kA (eØkeky- ck;kIkbUI 2009, 9, 376-382, 2009; t- eV- de- 2009)

Ienh I{e tlofoKku

Ih,I vkbZvkj uVod d rgr pY jgh ifj;ktuk e 1300 Ienh cDVhfj;k xtjkr rV d fofHkUu LFkkuk I iFkd fd; x; gA ftue I 110 {kkjLugh rFkk 31 dkcfud foyk;d Ifg".k cDVhfj;k gA ; IHkh vkbIkyVI Ih,I,eIhvkjvkb e LFkkfir cDVhfj;k Ixgky; dUn e 0;ofLFkr #i I j[k x; gA bu IHkh vkbIkyVI dk fu;fer to jkIk;fud rFkk I{e to oKkfud ijh{k.kk d mijkr budh igpku o Ik vEy feFkkby ,LVj rFkk 16S rRNA dh vuØe }kjk dh tk jgh gA

dfÔ ikfjr= rFkk rVh; yo.kh; enk fdekfyFkkvkvkVkfQd thok.k dh fofo/krk vkj Ienk; dh Ijpuk dk vkf.od fo'yÔ.k

cDVhfj;k feêh e mPp fofo/krk d IkFk CO_2 dh xfr'khyrk e egRoi.k ;kxnku nr gA ryukRed Ienk; vkj dfÔ ,o rVh; ctj uedhu feêh ¼de vkj mPp yo.krk½ d chp fdekfyFkkvkvkVkfQd dh Ijpuk o fofo/krk dk v/;;u dk;kRed ekdj thu CbbL ¼tk fjC;ykt-1,5-bisphosphate carboxylase/oxygenase dk ,UdkM djrk g½ }kjk vkj ij ekbØkfc;y Ienk; dk v/;;u 16S rRNA thu }kjk fd;k x;k gA cbbL (IC) thu IHkh rhu çdkj dh feêh e feyk] tcfd Qke IA doy mPp yo.kh; feêh e ik;k x;k gA cbbL IC thu IHkh çdkj dh feêh I çkIr cDVhfj;k I ifjyf{kr fd;k x;k gA db ekukQkbyfVd o'k Qke IC o'kkoyh I çtkfr;k tk dfÔ ikfjr=] Tokyke[kh; jk[k vkj Ienh okrkoj.k I igy I gh Kkr cbbL g] mII lcf/kr gA dfÔ Hkfe e fdekfyFkkVkD l dk] tcfd ctj uedhu feêh e QkVkvkVkVkfQd Dykjk¶yDlh vkj lYQkbM vkDlhdkjdk dk çHkRo ik;k x;kA ;g v/;;u yo.kh; enk ikfjr= d to jklk;fud pØ e fdekfyFkkvkVkVkfQd vkj QkVkvkVkVkfQd thok.k fofo/krk dh Hkfedk dh ub vrnf"V çnku djs ldrk gA ;g dk;kRed vkj o'kkoyh ekdj thuk d ç;kx l rVh; dfÔ o yo.kh; ctj feêh d chp fdekfyFkkvkVkVkfQd thok.kvk d lenk; dh lajpuk vkj fofo/krk ij igyh ryukRed tkp gA

Dykj {kkj vk|kfxd çokg dk tfod mipkj

tk Dykj {kkj vk|kfxdrk d nkjku fudyrk g mldk ,d {kkj Lugh thok.k bUVhjkdkD l QflVy *R 5* }kjk tfod fujkdj.k fd;k tk jgk gA egvk d Qy rFkk xUuk dk dkcu d #i e bLreky fd; tku ij bl vkbIkyV }kjk rhu ?k.V e {kkj cfg%L=ko dk fuf"Ø; dju dh {kerk pH 12.0 l 7.0 d chp e ikb xbA

dkcfud foyk;d lfg".k cDVhfj;k dk v/;;u

dPp ry l nfÔr feêh d ueuk l dy 36 dkcfud foyk;d lfg".k cDVhfj;k dk iFkd fd;k x;k gA budk VkY;bu c>hu vkj gDlu e dYpj djd budh igpku dh xbA vkbIkyVl e 10% foyk;d d lkFk lkr fnu rd log P_{ow} 0.24 l 8.8 rd foyk;d lfg".krk ikb xbA cflyl flfjvl AK1871 l foyk;d] 'kk/kd rFkk {kkjh; çkfV,t dh mRifÙk gkrh gA 59 xuk 'kf) dj.k rhu pj.k 'kf) dj.k çfØ;k }kjk gkfly fd;k x;kA bl çkfV,t dh lfØ;rk pH dh foLrr jt (6.0-9.0) rFkk (40-70° l) rkieku ij feyhA bl çkfV,t dh lfØ;rk pH 8.0 rFkk 60° C rkieku ij b"Vre ik;k x;kA

leæh l{e 'koky¨ l tfod b/ku

leæh 'kokyk l tfod b/ku d vul/kku d fy, ge y¨xk u 9 Òkxhnkjk d lkFk CSIR -NMITLI ifj;¨tuk dh 'k#Ár ,d fuf'pr y{; d lkFk dh gA ;|fi, l{e 'kokyk dh tfod b/ku mRiknu dju dh {kerk d ckj e cgr l nkos g¨r Á jg gA çkFkfed vkdMk dk i;klr ieku ij mRiknu d ek/;e l vkj ;FkkFkoknh rjhd l tehuh okLrfodrkÁ dk irk yxk;k tk,A fyfiM mRikndrk vkj mRiknu dh mPp {kerk d Á/kkj ij dN Á'kkoknh çtkfr;k d¨p;fur fd;k x;kA ok; lØfer ln"kÆ, fofdjÆ l ud lku] fuEu fodkl nj] 'koky¨d toÒkj d mPp mRiknu d fy, lcl cMh pu©rh gA rnijkr ck;kekl dh dVkbZ ¼tyeDr½] fyfiM d fy, vuçokg çfØ;k Hkh cMh pukrh gA ;|fi NMITLI ifj;ktuk rgr] LoikfÔr 'koky e l fyfiM mRiknu ij /;ku dfUnr fd;k x;k gA LoikfÔr rFkk feJikfÔr of) dk ryukRed eY;kdu dk v/;;u fd;k x;kA LFkk;h ifjfLFkfr e lo/ku d fy,] LoikÔh l feJikÔh fLFkfr e tku l ck;kekl e of) d vykok] fyfiM ek=k e 14.5% l 1% CDA dk l/kkj ik;k x;kA (0684/DEL /2010 fnukd 22 ekp 2010) çdfr e tgk fyfiM ;Dr l{e 'koky mxr g o lLFkyk dk [kktu ij v/;;u 'k# fd;k x;kft lls çdfr l dN tkudkjh fey ldA

leæh lk;u¨cDVhfj;k l lh- Qk;d¨bfjfFku dk mRiknu

fiNy v/;;uk e fLi#fyuk lyVfl l d¨ mPp xÆoÙkkoky ,d uhy jx d Ø¨e¨ç¨Vhu, lh-Qk;d¨lk;fuu d fy, lo/ku dh lpuk nh xb gA mlh Øe e] lh-Qk;d¨bfjfFku mRiknu d fy, lk;u¨cDVhfj;k d mi;¨x d fy,, gky gh e xtjkr d leæhrV l lk;u¨cDVhfj;k d¨ iFkd fd;k x;kA bld¨ fofÒUu jx d çdk'k e, toÒkj ij çHkko dk Ádyu dju d fy, lo£/kr fd;k x;kA ihlhÁj ço/ku vkj vuØe d fy, lk;u¨cDVhfj;k d ueu l thu¨fed Mh,u, d¨ iFkd fd;k x;kA 16S rRNA d thu vuØe d Á/kkj ij, iFkd fd; g, dh igpku L;M¨,ukchuk gÃA çdk'kh; vudyu v/;;u Òh Qk;d¨bjhfFku d egÙke mRiknu d fy, ijk fd;k x;kA 'k) Qk;d¨bjhfFku 568 vkj 541nm e vf/kdre vo'k¨"kÆ fn[kk;k g, vkj 578 nm ij çfrnhfIr dk vf/kdre çn'ku fd;kA vo'k¨"kdrk vuikr A568/A280 ('k) rk vuikr) dh ,d ekU;rk g] tk ge 6.86 çkIr gbA 'k) Qk;d¨bjhfFku dk mRiknu 46.8% vkj 'k"d Òkj d Á/kkj ij 13.6 g-1 feyhxke FkkA Ih-Qk;d¨bfjfFku dh fLFkjrk Òh 'kU; 0 ± 15° vkj 35 ± 5° C ij tyh; foy;u lek/kku e [kk| ifjj{kd d IkFk v/;;u fd;k x;kA fofÒUu [kk| ifjj{kdk dh x;h tkp e, IkbfVd ,fIM (4 feyhxke@feyhxke) d¨ n[kk x;k fd ; 35 ± 5 fMxh IfYI;I ij 45 fnuk d fy, tydr #i e HkMkj.k d fy, IcI vPNk gA (bUVju'kuy t- ck;k- eØkeky 2010. 47:597–602)

thokÆÁ dh ,tkbeh {kerk

pje okrkojÆ I iFkd fd;g, cDVhfj;k I vk|kfxd #i I egRoiÆ ,tkbek fd tI ,ekby t, ykbi t, vkj ç"Vh,t dh{kerk dk irk yxk;k x;kA pH 9-10 ij vkj 60° C ij thokÆ SM2014 dk fodkI mudh pje Ifg"Æ ruko Igu dh{kerk d ckj e crkrk gA ,d vudyh r= d #i e, vIrIr oIh; vEy¨ vkj IrIr oIh; vEy¨ (C18:0, C16:0, C14:0, C12:0) dk vuikr ifjo£rr g¨ tkrk gA 16S rRNA thu vuØe d¨ U;fDy;¨VkbM CykLV fd;k x;k r¨ *Bacillus licheniformis* d IkFk IcI vf/kd 94 % Iekurk feyhA (Qkfy;k ekbØkch;y 55 (2010) 614)

rki IfØ; vYQk ,ekby t dk mRiknu ,o fu#iÆ

,ekby t] LVkp Á/kkfjr m|¨xk d fy, IcI egRoiÆ gkbM¨fyVhd ,tkbek e ,d gA çfØ;kÁ d¨ 0;kikfjd cuku d fy, ;g t#jh g fd, vYQk ,ekby t ftyVhfudjÆ (100-110° C) ,o (80-90° C) æohdjÆ dh çfØ;k e IfØ; jgA ILFkku d çk;kfxd IkYV Qke I rki IfØ;] vkj rki fLFkj vYQk ,ekby t mRiknu djuokyh cfIYI tkfr dk iFkd fd;k x;k tk vudy ek/;e e 452 umi[+] ,ekby t dh mi t nrh gA ,ekby t d vf/kdre xfrfof/k 8.0 pH vkj 110° IfYI;I rkieku ij ik;k x;kA vifj"dr ,tkbe dh Ipkf/kd IfØ;rk pH 6.0 vkj 11.0 d chp vkj 60° IfYI;I ij rki fLFkj ik;k x;kA bu xÆk u Idr fn;k fd iFkd fd;k x, vYQk ,ekby t ,tkbe LVkp æohdjÆ vkj vU; [kk| çILdjÆ d fy, mi;Dr gA (bUVj t- ck;k eØkeky 47 (2010) 288)

foyk;d Ifg"Æ rki-yoÆ IkUæh; IfØ; Igu'khy ç¨Vh;t dk 'kf) dj.k] y{k.k] fu#iÆ vkj mi;¨fxrk

(8 - 12) pH, (20-80° IfYI;I) d rkieku rFkk yoÆrk rd (20% rd) dh 0;kid jt dh {kerkoky cká d¨'kdh; ç¨fV,t d mRiknu d fy, cfIYI tkfr dk v/;;u fd;k x;kA tc ,tkbe d¨ uku Á;fud (80 Vohu vkj VkÃVu ,DI) vkj Á;fud IjQdVV (I¨fM;e IYQV n¨nP¸y) vkj fojtu ,tV (I¨fM;e gkbi¨Dy¨jkbV) d IkFk 50° IfYI;I ij ,dÄV d fy, j[kk x;k] r¨ Òh ;g IfØ; jgk ftI I bIdh pje fLFkjrk dk irk pykA bI ,tkbe dh ç¨Vh;¨fyfVd xfrfof/k Áx bu foV¨ xfrfof/k dfIbu tk,e¨xkQh }kjk /k/kyk g¨ tkrk g vkj yxÒx 71 dMh, d ÁÆfod otu dk ,d e¨u¨ ejh; ç¨Vhu d #i e çxV d IkFk bIdh if"V dh xbA ç¨Vh,t d Km vkj Vmax dk eku 0.57 feyhxke/feyhyhVj vkj 445.23 ;fuV/feyhyhVj çkIr gvkA bId vykok, vifj"dr ,tkbe ,fj;y vkj IQ ,DIy dh rjg okÆfT;d B¨I fMVtUV d IkFk mRÑ"V Ixrrk fn[kkrk gA jDr, gYnh, pkdyV vkj VekVj dh pVuh d nkx ;Dr diM ij fd, x,, ,tkbe I diM/k¨u d dk;çn'ku] fMVtUV m|¨x e bIdh mi;¨fxrk dh IÒkouk dh if"V djrk gA

CHAPTER
çdjÆ 4

CSMCRI IN THE SERVICE OF SOCIETY

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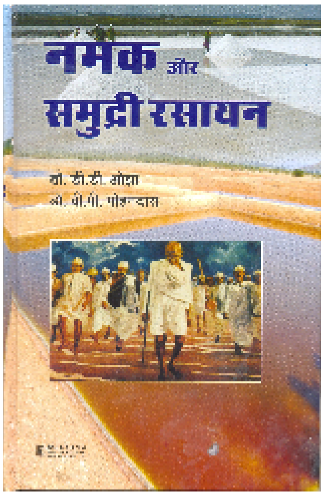
CSMCRI IN THE SERVICE OF SOCIETY

Information dissemination



A book on salt & marine chemicals in Hindi for public information

CSMCRI has received enthusiastic response from the media for the various technological innovations undertaken at the institute. This has happened on account of their societal relevance and the news reports have had great impact in reaching out to the masses. Another way to reach out to the masses is through information dissemination in Hindi and regional languages. A book on salt & marine chemicals authored jointly by Dr. D. D. Ozha, Sr. Scientist, Ground Water Department, Jodhpur and Dr. V. P. Mohandas, Head, Salt & Marine Chemicals, CSMCRI was brought out and released at a special function. A half day seminar in Hindi on salt & marine chemicals was also organized on this occasion with 10 technical presentations in Hindi delivered by well known researchers in this area.


CSMCRI discovers microbe to manufacture biodegradable plastic (March 29, 2010; PTI)

Chalks assume new avtaar, go dust-free

Super-salt: Pure and value for money

Grasim, DCW License Tech; Kenyan Co Interested Too

Filming of CSMCRI's biodiesel activities by ZDF TV Channel, Germany

natureINDIA

Mercury in red

Climate Feedback

Worth the salt

CSMCRI has developed commercially viable technologies in biofuel, fertiliser, heavy chemicals and genetically modified cash crops

"I read an interesting article in Business India about the work being done by your organization." D.P.Srivastava, Ambassador of India, Prague (Oct 16, 2009)

CSMCRI in News papers for its various research discoveries

Continuing programme on imparting of training to self help groups (SHGs) for seaweed farming and expanding the horizon of cultivation

The institute has been promoting the cultivation of economically important seaweeds as means of livelihood improvement. During the period of review, emphasis was given to *Gracilaria edulis* cultivation in Tamil Nadu. Further, cultivation of *Kappaphycus alvarezi* was expanded to Hamsaladevi and Adavaladevi in Andhra Pradesh following licensing of the knowhow to an entrepreneur there.

The grown *Gracilaria edulis* have been harvested by cultivators at Erwadi, Ramanathapuram district, Tamil Nadu

Initiation of *Kappaphycus* cultivation in Andhra Pradesh (site: Hamsaladevi)

Training on high quality solar salt production, LRK

A letter from women salt producers group, Maliya

Solar salt production adopting the latest technology developed by CSMCRI, Bhavangar has helped in improving the quality and yield of salt. We have been trained periodically by the scientists of the institute for good quality salt production. The salt which was lifted by the local traders for a mere Rs. 50 – 60/- per ton is now being fetched Rs. 150 – 200/- net per ton. We are highly grateful to CSMCRI scientists for their guidance and we hope that we will continue to receive their guidance in future also. (Group Leaders' Signature)

Proliferation of high purity solar salt technology in the marginal sector

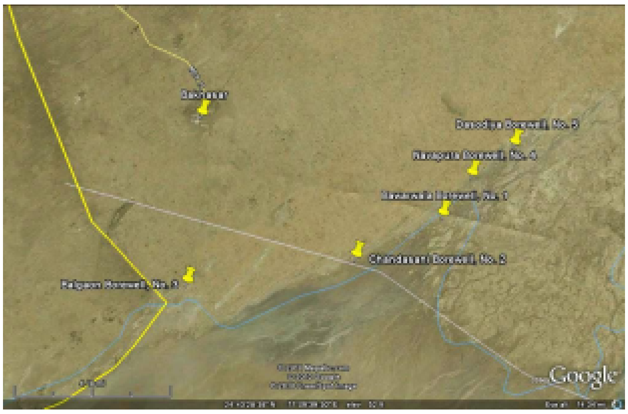
Site selected for construction of model salt farm, Rajula (left) and field training program, Rajula (right)

The programs on improving the quality and yield of salt introduced in LRK (Little Rann of Kutch) for the benefit of marginal agarias is still being implemented by SEWA (Self Employed Women's Associaion, Ahemdabad) with whom we started the program more than 8 years back. The program had started with the adoption of 30 marginal agarias and has now reached 500 marginal units as reported by SEWA. We continued our training programs in LRK during 2008-10. We have further reported in the biennial report 2006-08 about our association with the NGO, ANANDI (Area Networking & Development Initiatives), and upgradation of solar salt production in the Maliya region. During 2008–10 we continued our activities with ANANDI. 225 agarias of the Maliya region joined the cluster development program and several training programs were organized at a centralized location.

Looking to the success of the above programmes implemented in cluster mode along with NGOs, the Industries Commissionerate, Government of Gujarat has supported the adoption of a cluster of 150 marginal salt works for salt quality upgradation. The project is to be implemented jointly with Agariya Heet Rakshak Manch (AHRM), Ahmedabad.

Survey to assess whether the Rann of Kutch (Indo-Pak border, Barmer District, Rajasthan) is suitable for salt manufacture

Salt production needs to be made widespread to minimize the costly process of transporting salt. In fact, transportation cost is generally higher than the value of the produce. At the instance of the state government of Rajasthan, we conducted a survey of about 4200 acres of the salty land in the Indo-Pak border of Barmer district. The site is suitable for construction of solar salt works from all the angles, the only drawback being its remoteness.

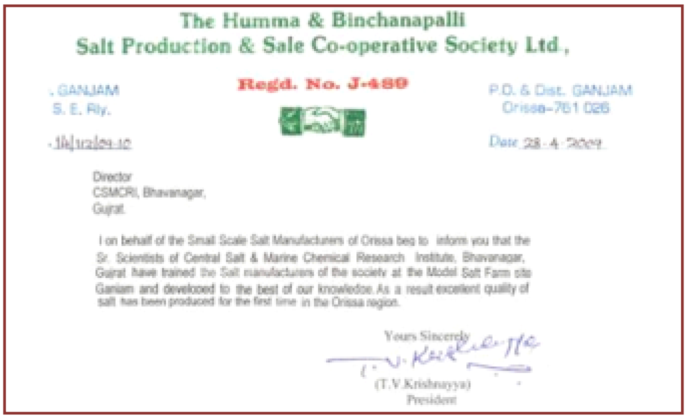


Bakhasar site at Indo-Pak border, Barmer district, Rajasthan

Commissioning of model salt farm at Orissa

It was reported earlier that we are in the process of establishing a model salt farm in Orissa for the benefit of the local salt manufacturers. A suitable site for the establishment of such a farm was identified in Humma region of Ganjam district. Accordingly, a model salt farm of 10 acre area was developed at the selected site. High quality industrial grade salt having the specifications Ca = 0.05 – 0.07%, Mg = 0.03 – 0.05% and SO_4 = 0.15 – 0.25% with > 99% NaCl – which has hitherto not been accomplished in Orissa – was manufactured in the farm. A 100 ft. borewell was also constructed to demonstrate the production of salt from subsoil brines with two-fold improvement in productivity. This too is yet another first in Orissa. Arrangements are being made by Govt. of Orissa to provide 3 phase power connection to the salt farm so that the borewell can be made fully operational. The state authorities and Humma & Binchanpalli

Model salt farm, Orissa



The Humma & Binchanapalli
Salt Production & Sale Co-operative Society Ltd.,

Regd. No. J-489

GANJAM
S. E. Rly.

P.O. & Dist. GANJAM
Orissa-761 026

Date 28-4-2009

Director
CSMCRI, Bhavanagar,
Gujrat.

I on behalf of the Small Scale Salt Manufacturers of Orissa beg to inform you that the Sr. Scientists of Central Salt & Marine Chemical Research Institute, Bhavanagar, Gujrat have trained the Salt manufacturers of the society at the Model Salt Farm site Ganjam and developed to the best of our knowledge. As a result excellent quality of salt has been produced for the first time in the Orissa region.

Yours Sincerely

(T.V.Krishnayya)
President

Salt Production & Sales Cooperative Society were appreciative of the efforts made by CSMCRI in training the Orissa salt manufacturers.

CSMCRI and Health

Water Mission

Mobile water purification unit in action at Hingalganj during West Bengal cyclone Aila (inset is CSMCRI RO bus)

A mobile unit inaugurated by Prof. C.N.R. Rao

A letter from Development Officer, Parganas

Let No: 1282 /HNG Dated: 24/06/2009

The valuable service that your team has given for the welfare of the distressed person of Hingalganj Development Block, North 24- Parganas, W.B. can't be measured by any means. The Team gave excellent service and supplied 30,000 lts to 35,000 lts of R.O. water per day since 12.06.09 to till date and nearly 20,000 people of Dulduli, Sahebkhali, Gobindakati, Jogeshganj and Kalitala G.P. got supply of R.O. water per day.

Sd/- Block Development Officer
Hingalganj, North 24-Parganas.

Innovative desalination and water purification plant on wheels

It was reported previously that the institute designed a mobile unit consisting of RO, ED & UF desalination and water purification plants and water testing apparatus. The key feature of the mobile unit, which was inaugurated by eminent scientist, Professor C. N. R. Rao, FRS, is that the power required for the units is obtained from the van engine itself. The key motivations include: (i) creating awareness among the public on indigenous water purification technologies, (ii) providing on the spot demonstration of the capabilities of the various water purification units – all the way from disinfection to fluoride/arsenic removal to seawater desalination, (iii) being in a state of readiness to respond swiftly to emergency situations, and (iv) creating a model to serve a cluster of villages. One of the first missions the mobile unit was deployed for was mitigation of acute drinking water problems in North 24 Parganas, West Bengal in the aftermath of cyclone *Aila*. The unit was stationed in the BSF camp and provided more than 30,000 LPD of potable water through desalination of saline pond water. The RO permeate water pressure was adequate to fill the jerry cans placed in boats. These were then distributed to the affected people in several locations.

Installation of new water purification plants

In partnership with DST, State S & T Councils, Air Force, and NGOs, the institute set up several brackish water RO desalination plants of various capacities (500-4000 liters water/hour) in Andhra Pradesh, Gujarat. Karnataka, Rajasthan and Afghanisthan. A 2000 LPH seawater RO plant was also set up in Kenya based on CSMCRI's indigenous membrane and 2-stage design.

KENSALT LIMITED
P.O. Box 81665 - 80100, Mombasa,Kenya
Tel: + 254 41 3433004/110/3434787
Fax: + 254 41 3433719
Email: kensalt@wananchi.com

KENSALT

Our ref: Your ref:

16/06/08
DR P.K.GHOSH, DIRECTOR
CSMCRI
BHAVNAGAR
INDIA.

Dear Sir

We are pleased to inform you that Reverse Osmosis plant supplied by you is working satisfactory since 12th May 2008.

The feed TDS of sea water = 35,000 - 44,000 ppm
The product TDS of fresh water = 325 - 520 ppm
The flow rate of water = 1700 - 2000 litres/hour

We are doing the necessary fresh water washing everyday at the end of the plant working. Also we are maintaining a check on the suspended solids with the feed sea water.

We will let you know the performance of the plant after six and twelve months working also.

Thank You
Yours Sincerely

D.Sengupta
Group General Manager (East Africa)
KENSALT LTD.

From: Debesh Sengupta
[mailto:debeshsengupta@hotmail.com]
Sent: 09 February 2010 13:28
To: PUSHPITO GHOSH
Subject: R O PLANT

Dear Dr Ghosh
It was nice meeting you on the 4th Feb at the CSMCRI office.
As I explained to you the Reverse Osmosis plant you supplied us at KENSALT LTD is working satisfactorily at our Gongoni saltworks in Kenya. We have a little problem of our feed concentration of sea water which is fluctuating between 35,000 to 38,000 ppm TDS when the output goes down. But otherwise we do not have any major problem.
We are interested in procuring one more unit for Kenya of the capacity of 6000 liters per hr. If you could kindly send the detailed quote we shall be obliged.

Debesh Sengupta

Inauguration (extreme left) of 2500 LPH plant was setup in partnership with DST and Rajasthan State Science and Technology, September, 2010, Theekariakalan village, Nagaur-Dist., Rajasthan. Feed :10,000 ppm; Product water :300 ppm (Left) and Siripuram village, Nalgonda district, AP (August 2009) 4000 LPH plant set up with DST and AP State Council support for removal of brackishness and fluoride (Right)

Utilising waste heat and sub-soil brine to produce potable water

Generally, the salt farms are located in the remote desert (Gulf area) without basic facilities such as electricity, transportation, etc. In these areas, the available ground water is salty (brine) which is a gift of nature for salt manufacturers. However, this invites the other difficulty with challenges for survival due to scarcity of drinking water. The salt producers sometimes have to travel long distances in search of potable water. Occasionally, drinking water is provided

A unit to produce drinking water by desalination of sub-soil brine utilizing waste heat from diesel engine

through tankers from sources far away from the salt farms. The supply, unfortunately, is not always regular and there are months when the land is extremely slushy and it is difficult for vehicles to ply in these remote areas. There was thus a need for an alternative and more dependable solution. While searching for such a solution, it occurred to us that agarias in the Little Rann of Kutch produce salt from sub-soil brine and use diesel sets to pump the brine into the salt pans. Moreover, such pumps run 24x7 during the production season. We thereafter devised a unit which could utilize the waste heat from diesel engine to carry out desalination of sub-soil brine. The exhaust gas from diesel engine, having temperature > 150 °C, is passed through parallel heat exchangers made out of copper for efficient heat transfer from gas to brine. The brine temperature reaches around 90°C and gets evaporated. The trapezoidal tank is closed with an aluminium sheet cover to collect the vapour formed. The top cover having high surface area works as condenser, such condensation being further facilitated by sprinkling continuously the sub-soil brine of temperature around 22-25 °C over the condenser. Due to this temperature difference the vapors get condensed on the inner surface of the closed tank. The condensed drops roll down the inner surface of the condenser and are collected through a channel provided inside the condenser. The water finally makes its way into earthen goblets to keep it cool. The unit produces around 1.5 liters of water per hour and thus can produce sufficient water over 24 hours to cater to the drinking and cooking water needs of a small family.

Clean write chalk

In the biennial report 2006 – 08 we have reported the further improvements made in the quality of the writing chalk which has been under development for several years. IISER, Mohali introduced the chalk in their institute and the response of the faculty has been encouraging.

From: Stores & Purchase,IISER MOHALI
[mailto:stores@iisermohali.ac.in]
Sent: 04 February 2010 17:41
To: Pushpito K. Ghosh
Subject: RE: [Fwd: Re: Receipt of DD]

Faculty members are quite satisfied with the quality of Chalk. It is much better from the other chalks like Kores, Soigne etc.

Kulwant Singh

Increase in average airborne particulate matter conc. during writing

Chalk Type	Increase on writing (μg m^{-3})	
	$PM_{2\text{-}5}$	PM_{10}
Local Gypsum	0.85	10.96
Imported chalk	0.72	6.91
'Clean Write'	0.44	5.19

The improvements also enabled the institute to license the knowhow to M/s. Arasan Phosphate Ltd., Tuticorin who are producing it under the brand name 'Clean Write'. As part of our continuing efforts to understand the benefits of our chalk, the assistance of NEERI, Nagpur was sought to study the dust generation in classrooms. An important conclusion emerging from the study was that: *The use of local gypsum chalk led to the highest increase and CSMCRl's 'Clean Write' chalk the least in airborne particulate concentration during writing with respect to both* $PM_{2\text{-}5}$ *and* PM_{10} (Data courtesy Dr. C.V. Chalapati Rao, NEERI).

Phase identification in kidney stones

In the previous biennial report preliminary results were provided on the elucidation of the major constituents in kidney stone. During the period of review, the study was expanded to include a comparative assessment of kidney stones procured from Bhavnagar city and those provided by AIIMS, New Delhi. Detailed analysis of the powder XRD data for all kidney stones were carried out using JCPDF database for phase identification, determination of unit cell parameters, crystallite size and strain. The common constituents found in all the kidney stones from Bhavnagar city and AIIMS are whewellite (calcium oxalate monohydrate) and weddellite (calcium oxalate dihydrate). However, relatively larger unit cell and crystallite sizes were noted for the samples from AIIMS, compared to those from Bhavnagar. In addition to that an uncommon phase, dolomite ($CaMg(CO_3)_2$) along with mixed phases of whewellite, weddellite and apatite (hydroxyl and carbonate apatite), are found in the stones from Bhavnagar city. Kidney stones from AIIMS also showed a new phase called sruvite ($MgNH_4PO_4 6H_2O$). Further study using SEM, TEM and TGA is in progress.

Method of foolproof detection of iodine in iodized salt

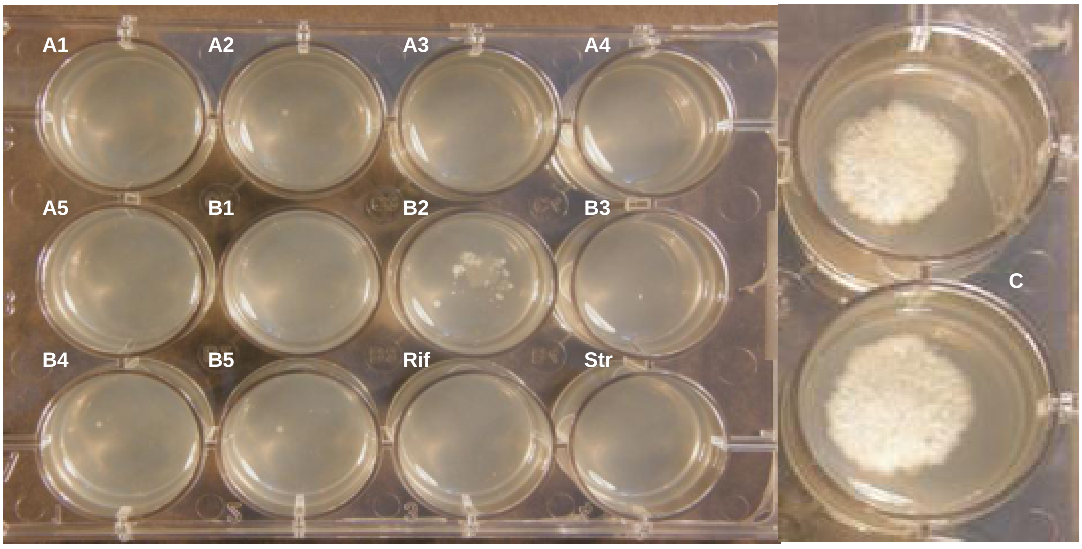
Iodized salt compositions formulated with potassium iodate typically have iodate content of 20-40 ppm (µg/g) which translates to iodine content of 15-30 ppm. The technique of iodide estimation in brine by ion chromatography with amperometric detection was applied to iodate estimation in salt. The method involved reduction of iodate to iodide with excess sodium bisulphite followed by estimation of iodide. No other pre-treatment was necessary for iodate estimation in the concentration range of interest for iodized salt. Quantitative analysis was feasible for iodate concentrations $\gtrsim 5$ ppm in salt. Iodized salt formulations containing iodide and iodate together were also analysed and the two constituents were quantified separately. Interferences from impurities normally present in salt were insignificant. An important advantage of the present method is that it eliminates the possibility of misleading results from potential adulterants which can impart positive iodometric test while, at the same time, keeping the analytical procedure simple.

Continuing participation in inter-laboratory CSIR programme on bioactive molecules from indigenous plant sources

In continuation of our earlier report (2006-2008) extracts and fractions of different plant parts were sent to testing labs for routine as well as confirmatory bioassays. 31 parts from 12 plant spp. were processed for the preparation of crude extracts. 140 such crude extracts were prepared and sent for bioevaluation to different laboratories. Extracts and fractions were also sent for reconfirmation of certain activities reported in previous years. Highlights of these are given below.

Continuing efforts on anti-tubercular lead

The extract from *Salicornia brachiata* halophyte having anti-tubercular activity has been granted international patents as reported previously. Five samples of the plant were collected over a period of 8 months (2009-2010) from the Gujarat coast during its growth phase and extracts were prepared independently by two separate groups within the institute. The results of bioassay reconfirmed that all extracts are anti-TB active, that independent processing by two labs led to the same positive result, and there was no seasonal variation in bioactivity. It is known that roots of this plant are contaminated with certain bacterial colonies. Studies are underway to rule out artifacts arising from them.



The anti-TB activity was tested at 50 μg/ml of each extract using *Mycobacterium tuberculosis* as test organism. Rifampicin and streptomycin were used as positive control. The screening was done on MB7H10 agar containing OADC. The above observation has been made after one month of incubation at 37 °C. C is culture without drug / compound

Continuing participation in MoES programme on drugs from the sea

In continuation of our earlier reported work, a total of 314 seaweed samples [Green: 78, Brown: 70, Red: 166] were collected and identified. Of these, 123 were repeat collections, albeit from new locations. The collections were from Gujarat and Tamil Nadu coasts. 141 methanol extracts and 195 aqueous extracts were sent to the three laboratories conducting bioassay, namely, CDRI, Lucknow (anti-cancer, antihyperlipidemic, anthelmintic; anti-leishmanial); ACTREC, Mumbai (anti-cancer); ALM PGBIMS, Madras University, Chennai (anti-HIV). 395 bioassay results were received. Several extract samples (31) were reported to be exhibiting promising bioactivities - CDRI (23 extract samples; antihyperglycemic 14, antifilarial 04, antihyperlipidemic 05) and ACTREC (total 08 extract samples showing anticancer activity). Follow up actions are underway to confirm the bioactivities.

Contribution to Agriculture

Distribution of elite *Jatropha* cuttings in Rajasthan

The Ministry of New and Renewable Energy has identified the CSMCRI accession , CP-9 (IC-565735), for cultivation in Rajasthan . Accordingly rooted cuttings of this accession were mass propagated in the CSMCRI project site at Gopalpur (Orissa) drawing on the plantations in Mahuda and Humma .12500 such cuttings were provided to the state rural department in Banswada ,Rajasthan .

Jatropha cuttings

Continuing studies on the impact of patented seaweed sap on agricultural productivity

In continuation of the 1000 acres trial with *Kappaphycus* sap carried out by Pepsico in the Renuka Sugar Mills command area in Karnataka, a further study over 5000 acres was undertaken during 2009 in Uttar Pradesh through a collaborative arrangement between M/s Aquagri (licensee) and farmers in the TEIL command area. An average of 18% enhancement in the yield of cane was registered.

Since concerns are occasionally raised for *Kappaphycus alvarezii* seaweed cultivation in view of its "exotic" tag, the institute also took up studies on sap production from indigenous *Gracilaria edulis*. This seaweed was selected as it too, like *Kappaphycus*, is cultivable on large scale and can be readily processed for sap besides recovery of agar from the granule. A study was carried out by the institute in farmers' fields at Sakari, Dhulia District, Maharashtra with the specific aim of comparing *Kappaphycus* and *Gracilaria* saps on sugarcane productivity. The incremental yield increase was comparable (29-32%) for the two saps. Interestingly the sugar recovery from cane increased to 10.43% – from 10.0% – with *Gracilaria* sap (data courtesy Dwarkadhish sugar factory, Maharashtra). Similarly, experiments were also conducted in the farmers' fields in Bhavnagar covering a variety of other crops. As can be seen from the table below, many crops responded well to both saps. The farmers carried out all agricultural operations (like fertilizer applications, irrigation, inter-culture operation, etc.) uniformly, as per their practices, i.e., sap was applied over and above the normal inputs.

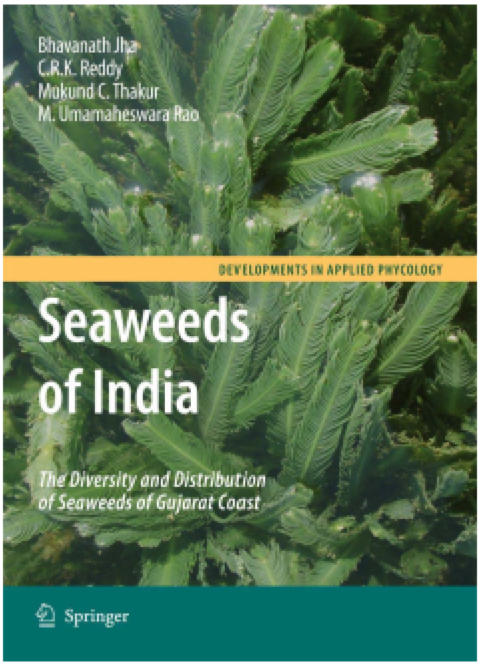
Effect of seaweed saps on productivity of different crops (Trials in Bhavnagar farmers' fields, except sugarcane trial conducted in Sakri, Maharashtra)

Crops	Sap	Yield		Percent increase in yield over control	Neat sap used (L/ha)
		Control	Sap Treated		
G.green (K-851)	K	635.0 (kg/ha)	815.0	28.3	30.0
	G	635.0 (kg/ha)	759.0	19.6	30.0
Onion red	K	14.8 (t/ha)	17.3	17.2	90.0
	G	14.8 (t/ha)	16.7	12.9	90.0
Onion white	K	34.0 (t/ha)	43.2	27.1	135.0
	G	34.0 (t/ha)	42.7	25.6	90.0
Pearl millet	K	2.5 (t/ha)	2.8	12.0	32.5
	G	2.5 (t/ha)	2.8	11.6	32.5
Wheat (GW-496)	K	3.8 (t/ha)	4.3	12.9	97.5
	G	3.8 (t/ha)	4.3	13.2	97.5
Sugarcane	K	66.3 (t/ha)	86.0	29.7	150.0
	G	66.3 (t/ha)	87.4	31.8	150.0

K = *Kappaphycus* sap; G = *Gracilaria* sap

Biodiversity and Environment

Seaweed biodiversity of Gujarat coast



A book published by CSMCRI scientists

In the previous report we have emphasized the importance of studies on primary data collection on seaweed biodiversity as the checklists available were based on secondary data collected from the literature. The information gathered through survey of the Gujarat coast during December 2006-December 2008, was compiled in the form of a book entitled: *Seaweeds of India: The Diversity and Distribution of Seaweeds of Gujarat Coast*. The book was brought out by Springer Publications and has been well received. This book is a milestone in seaweeds research in India as it covers a total of 198 species from the Gujarat coast, with some of the species being reported for the first time. The information reported therein serves as reliable baseline data and would help in monitoring and evaluating the impact of coastal developmental activities aimed at long term economic gains. It would also help in assessing environmental changes which may occur as a result of global warming and climate change. Subsequent volumes will cover other coastal locations in India and, hopefully, overseas also.

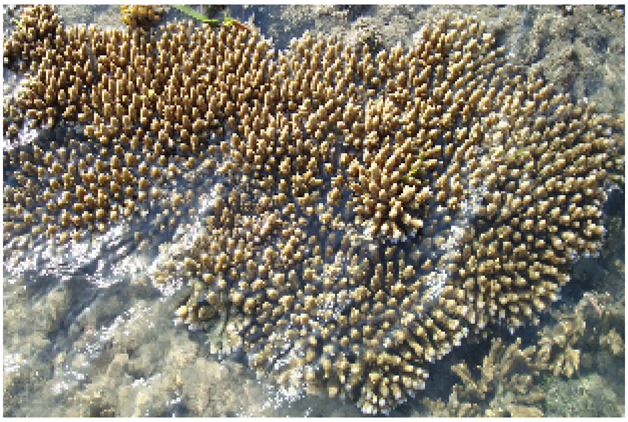
Continuing studies on invasion potential of *Kappaphycus alvarezii* on corals at Kurusadai Island

In response to many reports showing concern about *Kappaphycus* invasion on *Acropora* corals at Kurusadai Island, Gulf of Mannar marine biosphere reserve, a survey was conducted to study the extent of *Kappaphycus* invasion at 27 selected locations around Kurusadai Island and the mainland during May-August 2008 and July 2009. The study revealed that growth of *K. alvarezii* was confined to two different patches of 105 m × 55 m and 8 m × 9 m located at the southeastern part of Kurusadai Island. The actual extent of the *K. alvarezii* canopy coverage was 76.7 m^2, accounting for less than 0.0035% of the total coral reef area. The daily growth rate of the *K. alvarezii* at Kurusadai was 0.7%. *K. alvarezii* was not observed in the coral reef area of the adjoining Pullivasal and Poomarichan Islands or the Palk Bay area cultivation sites. The lack of functional reproductive cycle, low spore viability, and the absence of microscopic phases

Acropora corals with sporadic growth of *K. alvarezii* (left) and without *K. alvarezii* (right) in Kurusadai Island in the life cycle of this alga coupled with the abundant presence of herbivores may restrict the further spread of this alga and its invasive potential at Kurusadai Island is considered remote. Continuous monitoring of this area is in progress to assess the possible colonization in other habitats in Kurusadai and adjacent Islands in the Gulf of Mannar (*Algae, 25(2010)205*).

Coral-bacterial diversity study

The abundance and species diversity of *Vibrio* associated with coral reef ecosystem of Kurusadai Island, Tamil Nadu, was evaluated in 2008. Nonpathogenic and diversified *Vibrio* species were identified which, in general, reflects the healthy coral-bacterial association of that ecosystem. Overall, the study indicated that, corals of Kurusadai Island are relatively healthy. Systematic and regular study of this ecosystem will help to isolate novel coral associated bacteria, facilitate to understand the type of interaction and reason for bacterial shift in the coral ecosystem, if any. Ultimately, the goal is to make advanced assessment of any potential threat to the coral ecosystem.

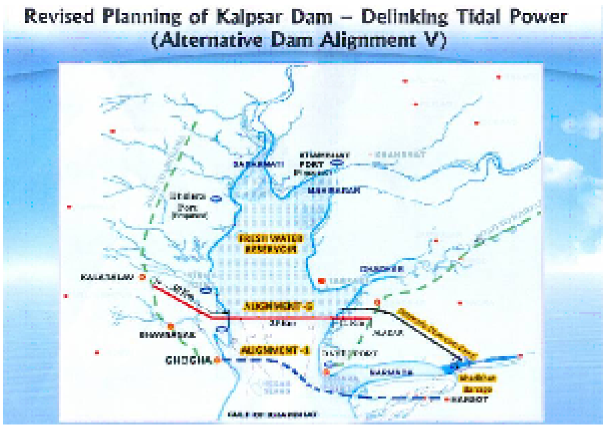


Healthy *Acropora* corals spawn naturally

Assessment of baseline environmental quality for Kalpasar project

CSMCRI was assigned, by the Kalpasar authority, Government of Gujarat, the task of assessing the environmental quality and social status of the proposed location of the Kalpasar project. The work was undertaken as a part of the overall effort to generate baseline data to make a reliable assessment of the possible impact of this large and visionary project. A total of 11 sampling stations were fixed along Gulf of Khambhat. The riverine/estuarine environment was also studied for six rivers and an estuary. The dam alignment is shown at left while the sampling stations are indicated at right.

The baseline environmental quality was assessed through field studies within the impact zone for assessment of biological and physico-chemical parameters in air, ground water, soil, river and coastal environment. The studies were conducted over three seasons during July 2009-May 2010. Simultaneously, socio-economic status of the project area, and also the likely impact on salt production, was studied through examination of primary and secondary data. A comprehensive report is under preparation.



Dam alignment (left) and 11 sampling locations along Gulf of Khambhat (right) for Kalpsar project

Likely impact of Kalpasar project on salt production and livelihood

At the instance of Kalpasar Technical Cell (KTC), Govt. of Gujarat a survey was conducted for the present status of salt pans coming under the proposed Kalpasar project for assessing the social, economical and environmental impact of these salt pans falling in the vicinity of the project area. The areas surveyed were Dahej, Gandhar, Aladar, Paniyadra, Khambhat, Jambusar and Dholera, and Bhavnagar as per the project map provided by the Kalpasar department. The GPS readings of all the salt pans were accurately measured and plotted in the Google map and compared with the Kalpasar project map. It was observed that out of the 123 salt pans in the region, 8 are falling within 5 meter Elevation Level (EL) and are likely to be submerged when the project is implemented. The socio-economic status of the labourers engaged in salt production activities in the region was also surveyed.

Marine monitoring for BEAIL pipeline project

Marine monitoring of the coastal water off Kantiyajal was undertaken to assess the impact of treated effluent disposal on marine ecology.

Continuing studies in India & abroad with CSMCRI's Jatropha biodiesel (CSM-JME)

It was stated in the previous report that the institute had tied up with the Forest Department, Government of Gujarat to test the utility of CSMCRI's patented B100 *Jatropha* biodiesel in forest vehicles. The motivation behind the work was the low carbon footprint besides direct advantages in terms of reduced emissions and enhanced safety on account of the high flash point of the fuel; and, of course, the fact that no engine modification of any kind is necessary.

Forest vehicle running with CSMCRI's *Jatropha* biodiesel

Subsequent to the testing carried out by the Bhavnagar Forest Division, trials were initiated in Sasan Gir lion sanctuary. The results have been satisfactory and no difficulty of any kind has been reported by the Forest officials. In addition to the above collaboration, 7500 litres of *Jatropha* biodiesel was prepared and sent to Automobile Research Association of India (ARAI) for evaluation & formulation of National Biofuel Policy. 3000 litres was also supplied to M/s Mahindra & Mahindra for performance evaluation. The company has indicated that they have tested many biodiesels and the CSMCRI biodiesel is “much better”. 400 litres of CSM-JME was also provided to Dipartimento Di Energetica, Politecnico Di Torino, Italy for their studies vis-à-vis rapeseed biodiesel & fossil diesel.

The German TV channel ZDF visited CSMCRI in Sep 2009 to cover our *Jatropha* activities - all the way from cultivation activities on wasteland to actual running of a school bus with neat *Jatropha* biodiesel. According to the channel, the programme was watched by 2 million people in Germany.

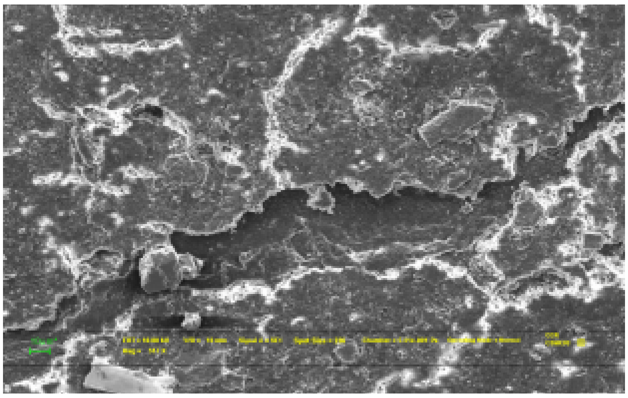
Bioethanol production from red seaweeds

E10 gasohol (left) from bioethanol produced from red seaweeds and (right) car running on E10 gasohol

Seaweed polysaccharides were successfully converted to ethanol as a by-product. Studies were subsequently initiated at bench scale. 2.5-3% ethanol concentration was achieved in the fermented broth within 72-96 h at bench scale with reproducible results. Ethanol was recovered through fractional distillation and the final product was converted into E10 gasohol with which an Ambassador car was run successfully on April 10, 2010.

Continuing studies on polyhydroxyalkanoate (PHA) biodegradable plastic production from the by-product streams of Jatropha biodiesel process

The production of PHA employing the still bottom of glycerol recovery unit of *Jatropha* biodiesel process was described in the previous report. The PHA degraded partly within 50 days when buried in the soil as would be evident from the accompanying figure. It was decided to attempt the utilization of the glycerol by-product stream (GL-7) directly without recourse to glycerol recovery. A marine microbe, *H. hydrothermalis*, was found to be efficient for this purpose. Efforts are underway to devise a practical means of scale up *(Patent filing no.1838/DEL/2009 dated 7 Sept 2009; Int. J. Biological Macromolecules, 47 (2010) 283).*



SEM image of degraded PHA

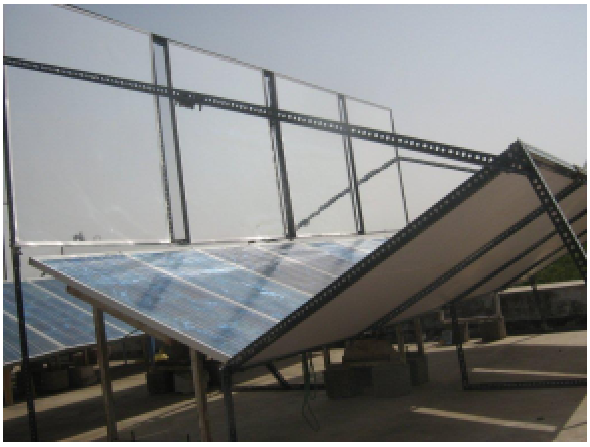
Single stage PHA production by the marine bacteria

JOCH	10 mL
GL7	2.00 g
pH	7.7
Total volume	100 mL
Carbon content in medium after autoclaving	0.78 g
Nitrogen content in medium after autoclaving	0.097 g
Temperature of growth medium	28-37 °C
Seed culture (grown in Zobell's marine medium)	1 mL
Incubation time	96 hours
Cell dry weight	0.353 g
Weight of PHA isolated	0.265 g
Yield of PHA based on cell dry weight	75.1%
Carbon content of PHA produced (@55.58% w/w)	0.147 g
% of carbon in medium which ends up in PHA	18.8%

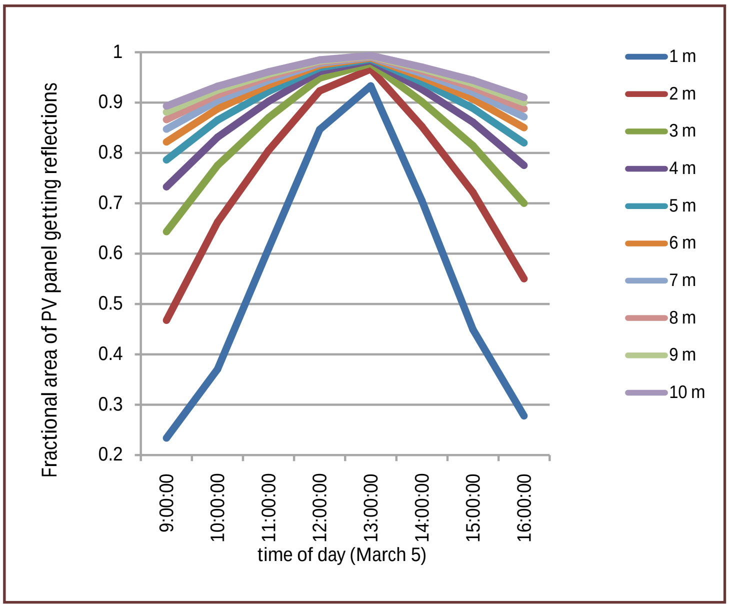
Continuing research on concentrated solar insolation

Retrofitting of PV (photo-voltaic) assembly with V-trough reflectors for enhanced power output

In 2006, CSMCRI along with Barefoot College, Tilonia set up the first community scale solar driven RO plant in India at village Kotri, (26.92° N and 75.2° E), Rajasthan. During 2007 and 2008, improvements were made in the RO assembly to raise its efficiency. During 2009, we focused on raising the power output from the existing PV array to boost the water output further. For this purpose, the panels were retrofitted with V-trough system, for which the reflector geometry was optimized with the help of computational analysis. An important observation was that radiation losses can be minimized at high aspect ratio of the panels. Doubling of power output was achieved at peak insolation as measured both through direct



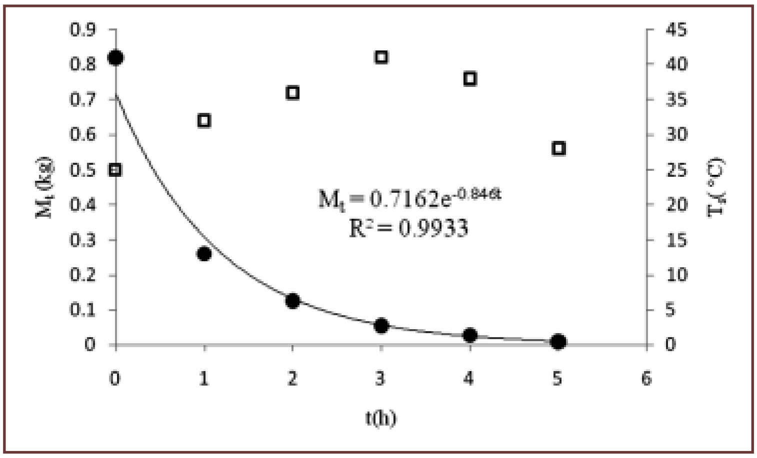
PV assembly with V-through reflectors (left) and RO plant (right)



Indirect natural convection solar dryer with enhanced efficiency

power measurement and by changes in the pressure-volume work at the RO end. One limitation of the technique is the runaway temperature of the modules under adverse conditions such as low wind velocity and high ambient temperature. To overcome the problem, studies were initiated on metal-embedded phase change materials to soak up the heat. The concept was demonstrated in the institute premises. The V-trough assembly with temperature control will be incorporated in five solar-powered community scale RO units in partnership with FORRAD and through funding support from Coca Cola India Foundation.

Indirect natural convection solar dryer with enhanced efficiency



Indirect natural convection solar dryer (left) and reduction of moisture with time (right)

Drying of food items under the open sun is a common practice in locations with abundant sunshine. However, even in such places complete drying to the permissible level of moisture can take considerable time, especially in non-summer months. We designed and developed an indirect, natural convection batch-type solar dryer fitted with North-South reflectors to enhance the solar insolation on the collector. This helped to reduce the collector area and also raised its efficiency in view of the higher temperature attained leading to more effective heat transfer to the flowing air. For an experiment conducted in March 2010 on a 0.534 m^2 (collector area) manually tracked dryer fitted with reflectors, the profile of moisture loss observed between 11.00 AM-4.00 PM is shown in the figure. The decay was exponential and the average value of drying efficiency was 13.0% for 1 kg loading of moist papad (80% moisture content) and final moisture content of 11% in dried papad. In parallel, work was initiated on an auto-tracked domestic recirculation solar dryer cum oven and it was possible to attain baking temperatures. A prototype unit is under construction.

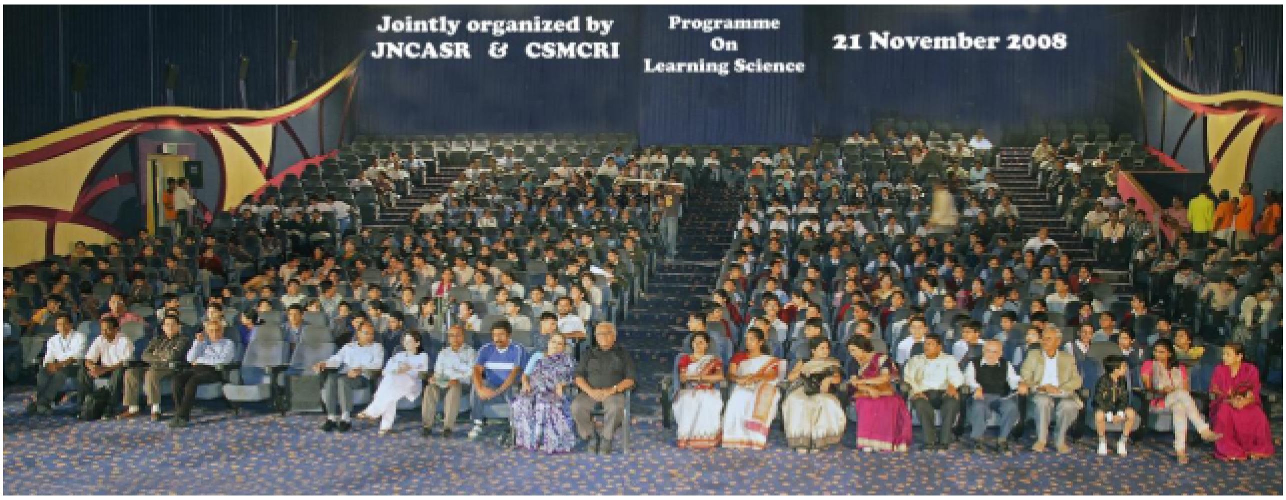
Providing affordable analytical services to academia

As part of the CSIR policy to extend its analytical facilities to academic institutions, industries and others, CSMCRI has not only catered to internal requirements but assisted all those who have sought the institute's help. 75% discount was given to those from academic institutions, 60% to those from government laboratories and 40% to small scale industries.

Arousing interest in Science among school children

Programme on Learning Science

Eminent scientist and Chairman of the Scientific Advisory Committee to the Prime Minister, Padmavibhushan Professor C. N. R. Rao, F.R.S. and eminent educationist, Mrs. Indumati Rao, inspired the school children of Bhavnagar by conducting the "Programme on Learning Science" here on November 21, 2008. The programme was organized jointly by the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) and CSMCRI. Professor Rao spoke on the work of some of the greatest scientists the world has seen. He also briefly spoke about his own research work in the area of material science.



CSIR Programme on Youth Leadership in Science (CPYLS)

As in previous years, the CPYLS programme was organized for toppers in the Class X examination in Gujarat of different boards. Eminent theoretical physicist from TIFR, Mumbai, Professor Pankaj Joshi, was the chief guest of the programme held in November 2008. He gave an inspiring lecture on "Unsolved challenges of the universe". One of the parents wrote: "*Following the detailed discussion I had with my son Rishi after the conclusion of your event and thereafter viewing the CD's sent by your goodself as a memoir, I am convinced that your Institute is doing a fantastic job. I thank you for providing my son Rishi an opportunity to acquaint himself with science and interact with the stalwarts who have contributed something worthy towards promoting your cause and the betterment of mankind.*"; Shri Sanjiv Desai, Editor-in-Chief, Union Times Today, 9-1-2009). In 2009, the inaugural address was delivered by Dr. Arun Dave, Director, Lok Bharti Sanosara. He spoke on "*The wonderful world of Science*".

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ckbu dk rkieku yxHkx 90° l rd igprk g vkj okf"ir gk tkrk gA Hkki dk ,df=r dju d fy, leych Vd dk ,Y;fefu;e 'khV l <dk tkrk gA 'khÔLFk vkoj.k dk mPp lrgh {k= gkrk g tk l?kfu= ¼dUMul j½ d #i e dk; djrk gA vkx] bl l?kuu ij 22-25° l rkiekuoky Hkfexr ckbu dk lrr fNMdko fd;k tkrk gA bl rjg rkieku e vrj d dkj.k Hkki cn Vd dh vkrfjd lrg ij l?kfur gkrh gA ftl l?kfu= e miyC/k djkb xb puy }kjk ,df=r fd;k x;kA vr e bl rjg l çkIr ikuh feVh d ik= e igp tkrk g tk bl BMk j[krk gA bl ;fuV }kjk çfr?k.Vk 1.5 yhVj ty miyC/k gkrk g vkj bl rjg ;g ;fuV 24 ?k.Vk e NkV ifjokj dh i;ty rFkk [kkuk idku d fy, i;kIr ty mRiknu dj ldrk gA

fy[ku dk LoPN pkd

oÔ 2006-08 d f}okfÔd çfronu e geu crk;k Fkk fd fy[ku d pkd dh x.koÙkk e vkx Hkh l/kkj fd;k x;k g ftl ij fiNy db oÔk l dk; fd;k tk jgk FkkA vkbvkb, lbvkj] ekgkyh u mud lLFkku e pkd dk mi;kx 'k# fd;k vkj f'k{kdk dh çfrfØ;k mRlkgo/kd jgh gA ble fd, x, l/kkj l lLFkku e ll vjklu QkLQV fyfeVM] rrhdkfju dk rduhdh tkudkjh dk ykblUl nu e leFk gvk] tk vc 'Dyhu 0gkbV' ckUM uke l mRiknu dj jgk gA gekj pkd d Qk;n dk le>u d gekj ç;kl d vrxr geu uhjh] ukxij l ox e jtd.k fxju dh ek=k dk v/;;u dju d fy, lgk; ekxh FkhA bl v/;;u dk egRoi.k fu"dÔ Fkk fd LFkkuh; ftlle pkd dh ryuk e lh,l,elhvkjvkb "Dyhu 0gkbV" pkd l fy[kr le; Øe'k% PM 2.5 rFkk PM 10 e de jtd.k ik; x,A ¼fooj.k lktU; & Mk lh oh pyki rh jko] uhjh½

xn dh iFkjh e voLFkk igpku

fiNy f}okfÔd çfronu e xnk iFkjh e fufgr e[; ?kVdk d ckj e çkjfHkd fjikV çLrr fd;k x;k FkkA leh{kk vof/k d nkjku bl foLrr djr g, Hkkouxj 'kgj l fdMuh iRFkj rFkk vf[ky Hkkjrh; vk;foKku lLFkku] ub fnYyh }kjk miyC/k djk, x, fdMuh iRFkjk dk ryukRed v/;;u fd;k x;kA voLFkk igpku] ;fuV ly ijkehVj dk fu/kkj.k] LQVhd dn rFkk ruko d v/;;u d fy, JCPDF MVkcl dk mi;kx djd lHkh fdMuh iRFkjk dk ikoMj XRD fo'yÔ.k fd;k x;kA Hkkouxj 'kgj vkj ,El (AIIMS) ub fnYyh l çkIr xn dh iFkjh] lHkh e leku ?kVd foMhykbV ¼dfYl;e vkDlkyV ekukgkbMV½ rFkk oMyhV ¼dfYl;e vkDlkyV MkbgkbMV½ ik; x,A rFkkfi AIIMS l çkIr dhMuh iRFkjk e] Hkkouxj dh ryuk e cMk bdkb ly rFkk vkdkj ik;k x;kA rnijkr ,d vlkekU; voLFkk] Mkykekb V ($CaMg(CO_3)_2$), ooyhV rFkk oMyhV] ooyhV vkj ,iVkbM ¼gkbMkDlhy rFkk dkckuV ,iVkbM½ tlh feJ voLFkk Hkkouxj l çkIr fdMuh iRFkjk e ikb xbA AIIMS d iRFkjk u ,d ub voLFkk lokbV ($MgNH_4PO_4 6H_2O$) fn[kkbA budk SEM, TEM rFkk TGA }kjk v/;;u tkjh gA

vk;kMhdr ued e vk;kMhu dh lJy igpku d fy, çfØ;k

vkerkj ij ikVf'k;e vk;kMV d lkFk ljfpr vk;kMhdr ued e vk;kMV dh ek=k 20-40 ppm (µg/g) gkrh g tk 15-30 ppm vk;kMhu e ifjofrr gkrh gA ued e vk;kMV dk vueku dju d fy, ,EijkeVhd fMVD'ku d lkFk vk;u ØkeVkxkQh rduhd dk ckbu e vk;kMkbM dk vueku yxku e mi;kx fd;k x;kA bl çfØ;k e vfrfjDr lkfM;e ckblYQkbV d lkFk vk;kMV dk vk;kMkbM e vop;u 'kkfey gA rRi'pkr vk;kMkbM dk vueku fd;k tkrk gA vk;kMhdr ued d fy, vk;kMV dh lknrk jt dk vueku yxku d fy, fd lh Hkh çdkj d iokipkj dh vko';drk ugh gA ued e vk;kMV lknrk ≥5 ppm d fy, ek=kRed fo'yÔ.k lHko FkkA vk;kMkbM rFkk vk;kMV ;Dr vk;kMhdr ued dk Hkh fo'yÔ.k fd;k x;k rFkk nk ?kVdk ek=k vyx l fu/kkfjr dh xbA lkekU; #i l ued e fLFkr v'kf) ;k ux.; FkhA bl i)fr dk egRoi.k ykHk ;g g fd ;g ldkjkRed vk;kMheVhd ijh{k.k d lkFk feykoV rFkk Hkked ifj.kke dh lHkkouk dk lekIr djrh g vkj lkFk gh ;g fo'yÔ.k çfØ;k vR;r ljy gA

Lon'kh ik/kk l tolfØ; v.kvk ij lh,lvkbvkj d vkrj&ç;kx'kkyk dk;Øe e lrr Hkkxhnkjh

fiNy f}okf"kd çfrosnu (2006-08) dh fujrjrk e] ck;kekl ,o fnup;k dh if"V d fy, fofHkUu ik/kk d vd rFkk Hkkxk dk ijh{k.k ç;kx'kkyk e Hkk t x,A vd fudkyu d fy, 12 ik/kk d 31 Hkkxk dh çfØ;k dh xbA ,l 140 dPp vd r;kj djd mud to eY;kdu gr fofHkUu ç;kx'kkykvk e Hkt x,A ik/kk d vd rFkk Hkkx dN fuf'pr xfrfof/k;k d iu% if"Vdj.k d fy, Hkt x, tk fiNy o"kk e fjikV dh xb FkhA bue l e[; fuEuku lkj gA

{k;fojk/kh vkS"k/k ij lrr ç;kl dk urRo

io fjikV vulkj {k;fojk/kh lfØ;rkoky lfydkfu;k cfd,Vk gykQkbV d vd d fy, vrjjk"Vh; iVUV Lohdr dh xb gA xtjkr d rVh; çn'k l] 8 ekl dh vof/k (2009-10) e ikp ik/kk dk of) le; e gh ueu ,df=r fd, x, rFkk lLFkku dh ç;kx'kkykvk e Lor= #i l nk xi }kjk mul vd r;kj fd, x,A to ijh{k.k d ijh.kkek u iu% if"V dh g fd lHkh vd {k; fojk/kh vkS"k/k d #i e lfØ; g vkj nk ç;kx'kkykvk u Hkh ogh ldkjkRed ifj.kke n'kk; vkj budh tofofo/krk e ek leh cnyko Hkh ugh ik;k x;kA ;g Kkr g fd ik/kk dh tM dN thok.k dkykfu;k l nf"kr gA bul mRiUu leL;kvk d fujkdj.k ij v/;;u tkjh gA

len l vkS"k/k d MOES dk;Øe e lrr Hkkxhnkjh

gekj io fjikV fd, x, dk; dh fujrjrk e dy 314 lenh 'koky d ueu ¼gj 78] xgj Hkj 70] yky 166½ ,df=r fd, x, rFkk mudh igpku dh xbA bue l 123 ueu nkgjk; x, Fk tk ub txgk l ,df=r fd, x, FkA ; ueu xtjkr rFkk rfeyukM d lenhrVk l ,df=r fd, x,A 141 eFkuky vd rFkk 195 tyh; vd to ijh{k.k gr CDRI ¼dUlj fojk/kh] ,UVh gk;ij fyfiMfed] dfeuk'kd] ,UVh&yf'kefu;y½ y[kuÅ] ACTREC, ecb ¼dUlj fojk/kh½] ALM PGBIMS, enkl ;fuofl Vh] pUub ¼HIV fojk/kh½ dk Hkt x,A 395 to ijh{k.k çkIr fd, x,A dN vdk (31) e vk'kktud tolfØ;rk ikb xb&CDRI ¼23 vdk e ,UVh gk;ij Xyk;lfed 14] Qk;yfj;k fojk/kh 04] ,UVh gk;ij fyfiMfed 05½ rFkk ACTREC ¼dy 08 vd ueuk u dlj fojk/kh lfØ;rk n'kk;hA½ tolfØ;rk dh if"V d fy, vkx dkjokb tkjh gA

df"k e ;kxnku

jktLFkku e fof'k"V tVkQk dfVxl dk forj.k

uohu vkj uohdj.kh; Åtk e=ky; u jktLFkku e ijthdr CP-9 CIC 565735 dh df"k d fy, lh,lvkbvkj,e lhvkjvkb dk vfHkfu/kkj.k fd;k gA rnulkj bl ijthdr dfVxl dk lh,lvkbvkj,e lhvkjvkb ifj;kstuk LFky xkikyij ¼mMh lk½ e çe/ku fd;k x;k vkj egMk rFkk gEek e m|ku cuk;k x;kA jktLFkku d ck lokMk d jkT; xkeh.k foHkkx dk 12,500 ,l dfVxl miyC/k djk, x,A

iVVhdr lenh 'koky lLi dk df"k mRiknuk ij çHkko ij tkjh v/;;u

igy dukVd e 1000 ,dM tehu ij xUu ij fd, x, v/;;uk dh fujrjrk e] 2009 d nkjku mÙkjçn'k e eLl ,Dok,xjh rFkk fdlkuk chp lg;kxkRed 0;oLFkk d ek/;e l v/;;u tkjh j[kk x;kA ;g v/;;u 5000 ,dM tehu ij fd;k x;k vkj xUu dh mit e vklru 18% of) nt dh xbA ;kX; gS rFkk xU;vy e l vxkj çkflr d lkFk lLi mRiknu d fy, vklkuh l çfØ;k dh tk ldrh gA

dlikQkbdl vYojth lenh 'koky dh [krh dh fon'kh;rk ij dHkh dHkh leL;k gkus l lLFkku u Lon'kh xlhyfj;k ,M;Yl e lLi mRiknu dju d ckj e v/;;u 'k# fd;kA bl 'koky dk p;u fd;k x;k D;kfd ;g Hkh dlikQkbdl dh rjg cM iSeku ij df"k lLFkku }kjk egkjk"V d /kfy;k ftyk d ldkjh xko e Hkh v/;;u fd;k x;kA v/;;u dk y{; Fkk dlikQkbdl rFkk xlhyfj;k lLi dh ryuk nkuk lLi }kjk of) 'khy mit dh of) ryuh; (29-32%) FkhA fo'kS"k jkpd ckr rk ;g Fkh fd xlhyfj;k lLi l mipfjr xUu e l 'kdjk dh çkflr 10.0% l 10.43% c<hA ¼foo j.k lkt; & }kjdk/kh'k lxj QDVjh] egkjk"V½

fd lku d [kr e fofHkUu Qlyk ij nkuk lh d çHkko d v/;;u gr ç;kx fd, x,A db Qlyk u nkuk lh dk vPNk çfrHkko fn;kA fd lkuk u mudh çFkk vu lkj lHkh dfô dk;&mojdk dk mi;kx] flpkb] vkrj lo/ku

çfØ;k, vkfn leku #i l gh fd, vFkkr lh dk mi;kx mudh mDrku lkj lkekU; fØ;kvk d lkFk gh fd;k x;kA

tofofo/krk ,oe i;koj.k

xtjkr d lenrV dh lenh 'koky tofofo/krk

fiNyh fjikV e geu lenh 'koky tofofo/krk d çkFkfed fooj.k ,df=dj.k d v/;;u d egRo ij tkj fn;k FkkA D;kfd miyC/k tkudkjh ¼pdfyLV½ lkfgR; e f}rh; fooj.k ,df=dj.k ij vk/kkfjr gA fnlEcj 2006 l fnlEcj 2008 d nkjku xtjkr d rV lo{k.k }kjk ,df=r tkudkjh dk "Hkkjr d lenh 'koky ¼xtjkr rV d lenh 'koky dh fofo/krk ,oe forj.k" uked iLrd d #i e ldfyr fd;k x;kA ;g iLrd fLçxj çdk'ku }kjk çdkf'kr dh xb g vkj lljyrk l çklr gA ;g iLrd Hkkjr e lenh 'koky vuq lu/kku e ehy d iRFkj d leku g D;kfd ble xtjkr rV dh dy 198

çtkfr;k dk 'kkfey fd;k x;k gA bue l dN igyh ckj fjikV dh xb gA ble çLrr dh xb tkudkjh fo'oluh; vk/kkjHkr fooj.k d #i e dk; djrh g rFkk nh?kdkfyd vkfFkd ykHk d mí'; l dh tk jgh rVh; fodkl xfrfofo/k;k d çHkko dk fu;eu o eY;kdu dju e lgk;d fl) gkxhA ;g tkudkjh of'od rkieku rFkk tyok; ifjoru d ifj.kke Lo#i gkuokyh i;koj.kh; ifjoru dk eY;kdu dju e Hkh lgk;d gkxhA ckn d lLdj.kk e Hkkjr d vU; rVh; LFkkuk vkj vk'kk g fd fon'kh LFkkuk dk Hkh 'kkfey fd;k tk,xkA

d#lMkb }hi e dlikQkbdl ,Yojth dk dkjy ij lHkkO; vkØe.k ij v/;;u

eb&vxLr 2008 rFkk tykb 2009 d nkjku d#lMkb }hi eUukj dh [kkMh d lenz d vkjf{kr thoeMy ij dlikQkbdl dh vØkikjk dkjy l e vkØe.k d ckj e fjikV d çfrHkko d #i e d#kMkb }hi rFkk e[;Hkfe d vklikl 27 p;fur LFkkuk ij dlikQkbdl d vkØe.k dh lhek d v/;;u d fy, ,d lo{k.k fd;k x;kA bl v/;;u l Kkr gvk fd d#lMkb }hi d nf{k.kioh Hkkx e dlikQkbdl dk vkØe.k 105 eh x 55 eh rFkk 8 eh x 9 eh nk vyx ip rd gh lhfer FkkA d- vYokjth dh okLrfod lhek 76.7 eh² Fkh tk dy dkjy e d- vYokjth dk nfud of) nj 0.7% FkkA ikd [kkMh

d dfô LFky ;k iYyho lky rFkk iejhpku }hik dh dkjy pVkuk e d- vYokjth ugh ikb xbA dk;kRed çtuu pØ dk vHkko] de ch tk.k rFkk thoupØ e l{e pj.kk dk vHkko] 'kkdkgkjh dh cgrk;r mifLFkfr d dkj.k bl 'koky dk vkx çlkj lhfer gvk gkA vr% d#lMkb }hi ij bld vkØe.k dh lHkkouk vYi gA ¼eMy ,V ,y 2010 vkYxh 25(4) : 205-216½ gkykfd d#lMkb rFkk eUukj dh [kkMh e vklUu }hi leg e lHkkfor vU; fuokfl;k dh cLrh d eY;kdu d fy; lrr fuxjkuh dk dk; çxfr e gA (vkYxh (2010) 205)

dkjy&thok.k fofo/krk dk v/;;u

oÔ 2008 e rfeyukM d d#lMkb }hi dh dkjy jhQ ikfjfLFkdh d lkFk tM ohch;k dh cgrk;r rFkk çtkfr fofo/krk dk eY;kdu fd;k x;kA jkxjfgr rFkk cgfo/k çtkfr igpkuh xb tk lkekU; #i l ml ifjr= l tM dkjy thok.k dk rnjLr cukrk gA l i.k v/;;u ;g n'kkrk g fd d#lMkb }hi d dkjy LoLFk gA ;|fi

Hkfo"; e bl ikfjfLFkdh dk Øec) ,oe fu;fer v/;;u dkjy l tM uohu thok.kvk dk iFkd dju e] dkjy ikfjfLFkdh e thok.k ifjoru d dkj.k rFkk ijLij fØ;k dk le>u e vkj dkjy ikfjfLFkdh d lHkkfor [krj dk ioeY;kdu dju e lgk;d fl) gkxkA

dYilj ifj;ktuk d fy, vk/kkjj[kk i;koj.k eY;kdu

xtjkr ljdkj] dYilj çkf/kdkj }kjk lh,l,elhvkjvkb dk] dYilj ifj;ktuk d fy, çLrkfor LFky dk lkekftd rFkk i;koj.kh; voLFkk dk

eY;kdu dju dk; lkik x;k gA bl fo'kky ldYiuk dh ifj;ktuk d lHkkfor çHkkok dk fo'oluh; vk/kkjHkr eY;kdu dju d fy, vk/kkj j[kk fooj.k r;kj djus d Hkkx#i ;g dk; 'k# fd;k x;kA [kHkkr dh [kkMh e 11 ueu d LFky fu/kkfjr fd, x,A 6 ufn;k rFkk ,d une[k d fy, unh rVh; @une[kh; i;koj.k dk v/;;u fd;k x;kA çHkkoh {k= d ok;] Hk t y] feVh] unh rFkk rVh; i;koj.k dk tofoKkuh;] Hkkfrd & jklk;fud çkpkyk dk eY;kdu d fy, vk/kkjj[kk i;koj.k eY;kdu fd;k x;kA ; v/;;u tykb 2009 & eb 2010 d nkjku rhuk _rvk e fd, x,A lkFk gh lkFk ifj;ktuk {k= d lkekft d&vkfFkd fLFkfr rFkk ued mRiknu e çHkko dk v/;;u çkFkfed rFkk f}rh; fooj.kk d ijh{k.k }kjk fd;k x;kA ryukRed fjikV r;kj dh tk jgh gA

ued mRiknu rFkk thou ij dYilj ifj;ktuk dk gkuokyk çHkko

xtjkr ljdkj d dYilj Vduhdy ly }kjk] çLrkfor dYilj ifj;ktuk d vklikl d {k= d lkYV iku ij bl ifj;ktuk lkdkj gku ij gkuokyk lkekft d] vkfFkd] i;koj.kh; çHkko dk eY;kdu dju d fy, lkYV iku dh oreku fLFkfr ij ,d lo{k.k fd;k x;kA bld vrxr ngt] xk/kkj] vykoj] ikuh;knk] [kHkkr] tclj] /kkyjk rFkk Hkkouxj dk dYilj foHkkx }kjk miyC/k djk, x, ifj;ktuk d uD'k d vuljkj {k=k dk lo{k.k fd;k x;kA lHkh lkYV iku l dk thih,l jhMhx ukik x;k rFkk xxy ei ij vkyf[kr fd;k x;k vkj mldh dYilj ifj;ktuk uD'k d lkFk ryuk dh xbA ;g Kkr gvk fd bl {k= d 123 lkYV iku e l 8 ifj;ktuk d 5 ehVj ,yho'ku yoy vrxr vkr g] tk ifj;ktuk d dk;kUo;u d le; Mcu dh lHkkouk gA bl {k= e ued mRiknu dju d dk; e çoÙk etnjk d lkekft d rFkk vkfFkd fLFkfr dk Hkh lo{k.k fd;k x;kA

BEAIL ikbiykbu ifj;ktuk d fy; lenh vuoh{k.k ¼ekuhVjhx½

dkUrh; ty d rVh; ty dk lenh vuoh{k.k d fy,] mipfjr cfg%L=ko dk lenh ikfjfLFkdh ij çHkko dk eY;kdu dju dk dk; 'k# fd;k x;kA

lh,l,elhvkjvkb d tVkQk ck;kMht y (CSM-JME) dk Hkkjr e rFkk fon'k e v/;;u tkjh j[kuk

fiNyh fjikV e crk;k x;k Fkk fd lLFkku u xtjkr d oufoHkkx d lkFk lg;kx l lh,l,elhvkjvkb d iVUVhdr B100 tVkQk ck;kMht y }kjk oufoHkkx d okgu pykdj mldh mi;kfxrk dk ijh{k.k fd;k x;kA bl dke d fy, çfjr djuokyh fo'kÔrk, & de mRltu vkj b/ku d mPp ¶y'kfcn d dkj.k c<rh lj{kk d lh/k ykHk d vykok de dkcu infpUg FkhA okLro e bld fy, bftu e fd lh Hkh çdkj dk ifjoru dju dh vko';drk ugh gA Hkkouxj ou foHkkx }kjk ijh{k.k fd, tku d ckn lkl.k xhj 'kj vH;kj.k e ijh{k.k 'k# fd;k x;k] ftl d ifj.kke lrkÔçn jg g vkj ou vf/kdkfj;k u Hkh fd lh çdkj dh dkb dfBukb d ckj e lfpr ugh fd;k gA mDr lg;kx d vykok] 7500 yhVj tVkQk ck;kMht y cukdj vkj jk"Vh; tob/ku uhfr d eY;kdu ,o xBu d fy, Hkkjr dh vkVkekckby fjlp ,lkfl,'ku ¼,vkj,vkb½ dk Hkt k x;kA 3000 yhVj ck;kMht y dk; fu"iknu eY;kdu d fy, e lI efgUnk ,UM efgUnk dk Hkt k x;kA diuh u lfpr fd;k fd mUgku db ck;kMht y dk ijh{k.k fd;k g vkj lh,l,elhvkjvkb ck;kMht y cgrj gA 400 yhVj CSM-JME fMikVeUVk Mh ,ujtVhdk ikyhVduhdk Mh Vkjhuk bVkyh dk mud ck;kMht y rFkk thok'e b/ku d ryukRed v/;;u d fy, Hkt k x;kA

fl rEcj 2009 e teu Vhoh puy ZDF u ctj Hkfe e dfô l ydj 'k) tVkQk ck;kMht y }kjk Ldyc l pyku rd dh gekjh tVkQk xfrfof/k;k dk 'kfVx dju d fy, lh,l,elhvkjvkb dk nkjk fd;kA bldk çlkj.k teuh e 2 yk[k ykxk u n[kkA

yky lenh 'koky e l ck;bFkuky dk mRiknu

lenh 'koky ikyhldjkbM dk lQyrkiod bFkuky e] lg mRikn d #i e ifjofrr fd;k x;kA rri'pkr cp Ldy ij v/;;u 'k# fd;k x;kA yky 'koky e l mRikfnr ck;kbFkuky e l yky 'koky e l mRikfnr ck;kbFkuky e 2.5-3% bFkuky lknrkokyk E 10 xlkgky cuk;k x;k vkj E 10 }kjk dkj pyk;h xbA ;g dk; cp Ldy ij 72-96 ?k.V e fd;k x;kA çHkkoh fuL;nu }kjk bFkuky iu% çklr fd;k x;kA ftl vfre mRikn E 10 xlkgky e ifjofrr fd;k x;k vkj blhd }kjk 10 vçy 2010 dk ,Ec lMj dkj lQyrkiod pyk;h xbA

tVkQk ck;kMhtsy çfØ;k dh lg mRikn ls iksyhgkbMkDlh;vYdukWV (PHA) tofuEuhdj.kh; ¼ck;kMhxzMcy½ lykfLVd d mRiknu ij lrr v/;;u

fiNyh fjiksVZ esa crk;k x;k gS fd tVkQk ck;kMhtsy çfØ;k ds Xyk;lsjky çkfIr ds fuEu vklou dk mi;ksx djds PHA dk mRiknu fd;k tkrk gSA ;g PHA feVh esa nQu djus ij 50 fnu esa u"V gks tkrk gS Xyk;lsjky lg mRikn çokg (GL-7) dk Xyklsjky mRiknu ds #i esa mi;ksx fd, cxSj blds çR;{k mi;ksfxrk ds ckjs esa fu.kZ; fy;k x;kA ,d lenh l{ke tho H. gkbMkFkeyhlbl mí';s ds fy, dk;{ke ik;k x;kA ¼iVsUV Qkby fd;k x;k u 1838/My/2004 fnukad 7 flrEcj 2009] bUVju'kuy tuZy vkQ ck;ksyksthdy ekbØks ekyD;Ysl 47 (2010; 283-287½ blds cMs iSekus ij 0;ogkfjd mi;ksx dh ;kstuk cukus ds ç;kl tkjh gSA

dfnr lkxj vkriu ij lrr vuqla/kku

fcztyh mRiknu c<kus ds fy, V-xrs ijkoSrdksa ds lkFk PV dk fjVªkfQfVax

oÔ 2006 esa lh,l,elhvkjvkb vkSj cjQV dkyst] frykfu;k u lkekftd Lrj dk Hkkjr esa loçFke lkSj Åtkz pkfyr vkj vks lykbUV jktLFkku ds dkVjh xkao ds ikl LFkkfir fd;k ¼26.92 N rFkk 75.2 E½A oÔ 2007 rFkk 2008 ds nkjku] vkj vks lykbUV esa mlds {kerk c<kus ds mís';s ls lS/kkfUrd , x,A 2009 esa geus ekStnk PV foU;kl ls fcztyh c<kus rFkk mRikfnr tsy c<kus ds ckjs esa viuk /;ku dsfUnzr fd;kA blds mís'; dh ifrZ ds fy,] iuYl dk V xrs ç.kkyh ds lkFk fjVªkfQV fd;kA blds fy, ijkoSrd T;kfefr dk vuqeku dEI;Vj fo'yÔ.k dh enn ls fd;k x;kA egRoiw.kZ ç{k.k ;g Fkk fd iuYl ds mPp igyw vuqikr ij fofdj.ku ud'kk dk de fd;k tk ldrk gSA mPp ifjo'k rkieku vkSj gok ds de ox tSls çfrdwy ifjfLFkfr;ksa esa ekM;wy dk jukso rkieku bl rduhd dh ,d e;kZnk gSA bl leL;k dk fuokj.k djus ds fy,] xehZ lks[kus ds fy, /kkrq vr%fufgr Qzt pUt lkexzh ij v/;;u 'kq# fd;k x;kA bl vo/kkj.kk dks lLFkku ifjlj esa fun'ku fd;k x;kA FORRAD dh lgHkkfxrk esa dkdkdyk bfUM;k QkmUM'ku dh foÙkh; lgk;rk ls lkenkf;d Lrj ds ikap lkSj Åtkz pkfyr vkj vks lykbUV esa rkieku fu;=.k ds lkFk V xrs ç.kkyh dk lfEefyr fd;k tk;xkA

mUur n{krk ds lkFk vçR;{k çkdfrd lkSgu lkSj Mk;j

çpj ek=k esa miyC/k /kiw esa [kk| phtksa dk lq[kkuk ,d vke vH;kl gSA gkykfd ,sls LFkkuksa esa Hkh vuse; Lrj rd vknrk lqi.k lq[kkus esa dkQh le; yxrk g&fo'kÔ #i ls xehZ ds fnuks ds vykok ckdh le; eA geus lxkgd ij lkSj bUlqy'ku c<kus ds fy, mÙkj nf{k.k ijkoSrdksa ds lkFk cp Vkbi dk ,d vçR;{k çkdfrd lkSgu lkSj Mk;j fMtkbu djds fodflr fd;k gSA ;g] lxkgd dk {k= de djus rFkk gok esa cgrh jgh vf/kd çHkkoh xehZ dk #ikrfjr djds mPp rkieku c<kus esa mlds l{kerk c<kus esa lgk; djrk gSA ekp 2010 esa 0.534 M² ij fd;s x;s ç;ksx ds fy, ijkoSrdksa ds lkFk QhV eU;vy Vd Mk;j dk çkr% 11.00 cts ls 4.00 cts rd mi;ksx djds vknzrk lq[kkus dk fujh{k.k fd;k x;k vkSj lq[kkus dh dk;{kerk dk vkslru eY; 1 fdyks ue ikiM ¼80% vknz½ lq[kkus ds fy, 13.0% Fkk vkSj lq[kk ikiM esa vfre vknzrk 11% FkhA lkFk gh blds vuq#i] xehZ ds fnuks esa cdhx rkieku çkIr djus ds fy, ,d ?kjsyw vkVk VdM lkyj Mk;j de vkou ij dk;Z 'kq# fd;k x;kA ,d çkVkVbi ;fuV dh lajpuk fuek.k/khu gSA

'kf{kd lLFkkuks dk de [kp ij fo'yÔ.k lsok, çnku djuk

'kf{kd lLFkkuks] m|kxks ,oe vU; esa viuh fo'yÔ.kkRed lfo/kkvks dks foLrkj djus dh lh,lvkbvkj uhfr ds Hkkx#i] lh,l,elhvkjvkb us doy vkrfjd vko';drkvks ds fy, ugha yfdu mu lHkh dks ftUgsa u lLFkku u enn ekxh gS mudks lfo/kk çnku dh gSA 'kf{kd lLFkkuks dks 75% NwV] lsdkjh ç;ksx'kkykvks dks 60% rFkk y?k m|kxks dks 40% NwV ij ;s lok, çnku dh tkrh gSA

'kkykvk d fo|kfFk;k e foKku d çfr vfHk#fp ink djuk

foKku f'k{kk ij dk;Øe

21 uocj 2008 dk foKku f'k{kk ij dk;Øe e ç[;kr oKkfud] ç/kkue=h dh oKkfud lykgdkj lefr d v/;{k] inefoHkÔ.k çk lh ,u vkj jko] ,Q vkj ,l rFkk ç[;kr f'k{kkfon Jherh bUnerh jko u xtjkr d fo|ky;k d fo|kfFk;k dk vfHkçfjr fd;kA ;g dk;Øe lh,l,elhvkjvkb rFkk tokgjyky ug# lUVj Qkj ,MokUl lkbfUVfQd fjlp] cxyj }kjk l;Dr #i l dk;Øe fd;k x;kA çkQlj jko u foÙo d çfl) ,o egku oKkfudk d dk;k d ckj e tkudkjh nhA mUgku Hkkfrd ¼eVhjh;y½ foKku d {k= e viu vul/kku dk;k d ckj e Hkh l{ki e ckr dh rFkk mUgk u yfux lkbUl foÔ; ij xtjkr jkT; d 8 rFkk 9 J.kh d fo|kfFkvk] mud foKku f'k{kdk rFkk vkpk;k dk 0;k[;ku ndj ykHkkfUor fd;kA lLFkku }kjk çk lh ,u vkj jko rFkk Jherh bUnerh jko }kjk fyf[kr foKku dh pkj iLrd fo|ky; d fy; HkV d #i e nh xbA

foKku e ;ok urRo (CPYLS) ij lh,lvkbvkj dk dk;Øe

fiNy oÔk dh rjg bl oÔ Hkh xtjkr d fofHkUu ckMk d nlo h d{kk dh ijh{kk e v0oy jguoky Nk=k d fy, CPYLS dk;Øe dk vk;ktu fd;k x;kA uoEcj 2008 e vk;kftr bl dk;Øe e Vhvkb,Qvkj] ecb d ç[;kr l)kfUrd Hkkfrd foKkuh çk idt tk'kh fo'kÔ vfrfFk d #i e vkef=r FkA mUgk u cãkM dh vuly>h pukfr;k d ckj e ç.kkn;d 0;k[;ku fn;kA bl dk;Øe e mifLFkr ,d ekrkfirk u fy[kk g & "vkid dk;Øe d lekiu d ckn eu ej cV _fô l foLrr ppk dh vkj vkid }kjk lLej.k d #i e Hkth xb dk;Øe dh lhMh n[ku d ckn e> foÜokl gk x;k g fd vkidk lLFkku ,d foy{k.k dk; dj jgk gA ej i= _fô dk [kn foKku l ifjfpr djku rFkk ftUgku ekuo tkfr dh mUufr dk c<kok nu dh fn'kk e dN ;kxnku fn;k g ,l fnXxtk d ckrph djku dk vol j çnku dju d fy, vkidk 'kØxtkj gA" Jh ltho nlkb] e[; likndj] ;fu;u VkbEl VM] fnukd ¼ 9-1-2009.

oÔ 2009 e] bl dk;Øe d mn?kkVu lekjkg e ykdHkkjrh l.kklj k d fun'kd Mk v#.k no u "foKku dh vnHkr nfu;k" ij 0;k[;ku fn;kA

fgUnh foHkkx

l?k ljdkj dh jktHkkÔk uhfr dk dk;kUo;u dUnz ljdkjh dk;ky; e dk;jr çR;d vf/kdkjh ,o depkjh dk nkf;Ro g] pkg ç'kklfud {k= gk ;k oKkfud ,o rduhdh {k=A ç'klu dh ryuk e oKkfud {k= e fgUnh dk ç;kx FkkMk dfBu g ysfdu ç'klu e fgUnh d mi;kx d fy, lgk;d lkfgR; i;kIr ek=k e miyC/k g tcfd oKkfud {k= e ;g ,d pukrhi.k dk; gA lh,l,elhvkjvkb e jktHkkÔk uhfr d vf/kn'kkRed lHkh dk;k ¼ukeiV] i='khÔ] Qke dk f}HkkÔhdj.k] jkLVj cukuk&v|ru j[kuk] i=kpkj e of)] /kkjk 3(3) vrxr ;Fkk lHko vuikyu] oÔ tk nkjku pkj frekfg;k e fu;fer #i l fgUnh dk;kUo;u lfefr dh cBd rFkk dk;'kkyk dk vk;ktu] vkrfjd fujh{k.k vkfn½ d lkFk lkFk oKkfud dk;k e Hkh fgUnh d mi;kx d fy, çkRlkgu fn;k tk jgk gA

oÔ 2008-10 e fgUnh foHkkx }kjk fuEufyf[kr dk; lIiUu fd, x,A

rduhdh dk;

- vkj vk rFkk lenh 'koky d 'kk/ki=k d lkjk'k dk fgUnh vuokn fd;k x;kA
- oÔ 2007 d nkjku çdkf'kr iVUV lkjk'k dk vuokn fd;k x;kA
- lh,l,elhvkjvkb i=d rFkk vkj vk ekckby oku d ikLVl fgUnh e r;kj fd, x,A
- lh,l,elhvkjvkb {kerk, ,o vuql/kku mRØe] Hkkjrh; to L=krk l vikjifjd Åtk dh [kkt i=d f}HkkÔh #i e çdkf'kr fd, x,A
- lLFkku dh oclkbV fgUnh e r;kj dh xbA
- lLFkku dk f}okfÔd çfronu 2006-08 dk fgUnh vuokn fd;k x;kA

dk;'kkyk@oKkfud lxkf"B;k

- oÔ 2008-10 e vdkcfud jlk;u ,o mRçj.k] çrhorh jlkdÔ.k foHkkx] o'yfÔd foKku foHkkx] fo|r f>Yyh çfØ;k,] dk;'kkyk ¼od'kki½ foHkkx rFkk lLFkku d lHkh foHkkx d ç/kku vf/kdkjh d fy, lxkf"B;k dk vk;ktu fd;k x;k Fkk ftue foHkkxh; xfrfof/k;k d ckj e fgUnh e ikoj ikbUV çLrfr;k dh xbA
- lh,lvkbvkj uVod ifj;kstuk ij 19.2.2009 dk vk;kftr lxk"Bh e rhu uVod ifj;ktuk d ckj e fgUnh y[k r;kj djd Hktk x;kA

jktHkkÔk çpkj çlkj

- depkfj;k e jktHkkÔk d mi;kx d çfr tkx#drk ink dju rFkk jktHkkÔk d mi;kx e of) dju d mí'; l 14 flrEcj] fgUnh fnol d miy{; e vk;kftr fgUnh lIrkg d nkjku lekpkj okpu] dkO; iBu] i=y[ku] vkuykbu Dohtt] rLohj D;k ckyrh g \] oKkfud xfrfof/k;k d ckj e ikoj ikbUV çLrfr;k vkfn dk vk;ktu fd;k x;kA
- Jfry[ku] lk¶Vo;j lh&Md iul [kjhnk x;kA
- lHkh depkfj;k dk mud dk;kulkj ¼oKkfud] rduhdh] ç'klfud½ vxth&fgUnh 'kCndkÔ miyC/k djk, x,A lkFk gh uVjkt bUQklh] chdkuj jktLFkku l vxth&fgUnh o fgUnh&vxth b&'kCndkÔ [kjhnk x;kA
- iLrdky; e fgUnh iLrd [kjhnu d fy, ,d lph r;kj djd ¼# 20,000/-½ iLrd [kjhn x,A
- cxyj d ç[;kr oKkfud ,o iã foHkÔ.k rFkk Hkkjr d ç/kkue=h d oKkfud lykgdkj çk lh ,u vkj jko d HkkLdj y{; e çdkf'kr y[k ij lLFkku d depkfj;k d fy, lkjk'k çfr;kfxrk dk vk;ktu fgUnh foHkkx }kjk fd;k x;kA ftl e çFke ijLdkj Mk ¼Jherh½ chuk R;kxh] oKkfud u çkIr fd;kA ¼lkjk'k fuEuku lkj gA½

द्विवार्षिक प्रतिवेदन 2008-2010

i l k ugh] igpku cukvk

viuh {kerkvk l vkx fudydj dN dju dk vkrj] 74 oÔh; 0;Lr Hkkjrh; oKkfud çk lh ,u vkj jko ;okvk dk i l l ugh cfYd] viuh çfrHkk l igpku cuku dk dgr gA fo'o dh vf/kdre çfrHkk Hkkjr e gA ge gj lky g tkjk oKkfudk dk r;kj djuk gkxkA og viuh vlk/kkj.k lQyrk d fy, Hkkjr dk vkj oKkfudk dh deh d fy, vkb Vh {k= dk ftEenkj ekur gA ;okvk dk fon'kk e u cl dj Hkkjr dh lok djuh pkfg,A oKkfud vkj lxhrK çfrHkkvk dh mi{kk l 0;fFkr çk jko ;okvk dk foKku dh mUufr d fy, çfjr djr gA

■ jk"Vh; lj{kk fnol ij Lykxu çfr;kfxrk vrxr fgUnh e lj{kk Lykxu çLrr djuoky çFke rhu fotrk depkfj;k dk ijLdr fd;k x;kA ¼Lykxu fuEuku lkj gA½

2009

uke] inuke	Lykxu	çfr;kfxrk e çkIr LFkku
?ku';ke tkno] tvkj,Q	deLVh g , lh feLVh ft le t#jh g l¶Vh dh fgLVh eke ; lc [ky g dfedy ykp dk ft le t#jh g l¶Vh d gku dk	çFke
ckypn Mkxh] MtV'ku LVMUV	FkkMh bEl;jhVh dj nrh g] fjlp dk [kjkc FkkMh vlko/kkuh dj nrh g thou dk cckn bflfy, dgr g] vkt dh lj{kk dy dh eLdku] fcuk lj{kk thou dk uD'kkuA	f}rh;
euhÔdekj] ifj;ktuk lgk;d	vçku] xkxYl] ekLd dk j[kuk viu ikl D;kfd viuh lj{kk g viu gkFk ;gh g lPp vulk/kkudrk dh igpkuA	rrh;

2010

uke] inuke	Lykxu	çfr;kfxrk e çkIr LFkku
eukt dekj dljokuh] ,lvkj,Q	vkx yxu ij Hkkxu tk;] rjr lj{kk mik; viuk;A gkxh ugh dkb n?kVuk Hkkjh] j[kkx ;fn vfXu'ked ;=k dh tkudkjhA	çFke
lryky tloky] rduhdh lgk;d	tk lj{kk d lkFk ukrk tkMxk ok vkuokyh gj n?kVuk dk ekMxkA	f}rh;
vQlkuk ;edok] rduhf';u (1)	tk cpk; viuk vx] lkjh [kf'k;k mld lx	rrh;

- oÔ 2010 d nkjku foHkkxh; dk;k e jkt HkkÔk fgUnh dk fo'kÔ ç;kx djuoky fuEufyf[kr depkfj;k dk d'k vokM fn; x;A

1. Jh ;K'k f=onh & Lkgk;d ¼lk½ xM 1] ç'kklu foHkkx
2. Jh t;'k ekdk.kh & rduhdh lgk;d] flfoy foHkkx
3. Jh fnid Bkdj & ofj"B Rkduhf';u (1)] flfoy foHkkx
4. Jh Hkjr ijekj & ofj"B Rkduhf';u (1)] foÙk ,o y[kk foHkkx
5. Jh jfo iVy & lgk;d ¼fo ,o y½ xM 3] foÙk ,o y[kk foHkkx
6. Jh v'kkd pkgk.k & ofj"B Rkduhf';u (2)] xjt vuHkkx

çf'k{k.k@fujh{k.k

- lLFkku e fgUnh çf'k{k.k d fy, 'kÔ depkfj;k dk jkt HkkÔk foHkkx] xg e=ky; }kjk fodflr yhyk lk¶Vo;j }kjk çck/k çf'k{k.k çkIr dju d fy, fun'ku fn;k x;kA
- dUnh; fgUnh çf'k{k.k lLFkku] ub fnYyh }kjk fnukd 15.01.2009 dk vk;kftr ijh{kk e lfEefyr lLFkku d 12 depkfj;k dh ijh{kk LFkkfud rkj ij yh xbA lh,l,e lhvkjvkb LFkkiuk fnol d miy{; e vk;kftr lekjkg e fgUnh Vd.k ijh{kk fo'kÔ ;kX;rk d lkFk mÙkh.k djuoky fuEufyf[kr 6 depkfj;k dk çek.ki= ,oe d'k ,okM fn; x,A

1. Jherh yhyEek tku] ofj"B vk'kfyfid] foÙk ,o y[kk vuHkkx
2. Jherh vYik Vh f=onh] Lkgk;d xM 3] HkMkj ,o Ø;
3. Jh lj'k ,p dylfj;k] ofj"B Rkduhf';u (2) ç'kklu foHkkx
4. Jh Hkjr ,e ijekj] ofj"B Rkduhf';u (1)] foÙk ,o y[kk vuHkkx
5. Jh çekn ,u edokuk] rduhf';u (1)] vkb Vh ly
6. lJh ljyk d ljo;k] rduhf';u (1)] ued o lenh foHkkx

- jkt HkkÔk foHkkx {k=h; dk;ky;] ecb dh vulf/kku vf/kdkjh] Jherh lk/kuk f=ikBh }kjk lLFkku e fgUnh dk;kUo;u d ckj e fujh{k.k fd;k x;kA ftUgksu fgUnh i=kpkj e of) d ckj e lHkh depkfj;k d fy, 0;k[;ku fn;kA
- jkt HkkÔk dk;kUo;u lfefr d lnL;k }kjk çfrekl ,d vkrfjd fujh{k.k djd fgUnh dk;kUo;u d ckj e vko';d ekxn'ku fn;k x;kA

lkekftd mí';

- 14 flrEcj] fgUnh fnol d volj ij depkfj;k d cPp & ftUgksu J.kh 1 l 12 oh rd e fgUnh foÔ; e lokf/kd vd çkIr fd; gk mUg iqjLdr fd;k x;kA
- CPYLS 08 ,o 09 d lHkh çfrHkkfx;k dk fgUnh e oKkfud tkudkjh çkIr gk l d bl mí'; l "foKku çxfr" foKku if=dk dh okfÔd lnL;rk fnyokb xbA
- e[;ky; d fun'kkuqlkj lo f'k{kk vfHk;ku vrxr depkfj;k d 5 l 9 oh d{kk rd e vH;kljr cPpk d fy, ox 'k# fd, x,A
- Lor=rk fnol d miy{; e Hkkouxj d fo|ky;k d fo|kfFk;k d fy, n'kHkfDr xhr çfr;kfxrk dk vk;ktu fd;k x;kA blse 38 'kkykvk d cPpk u Hkkx fy;kA lHkh çfrHkkfx;k dk çek.ki= fn; x; rFkk fotrkvk dk iqjLdr fd;k x;kA

- lh,lvkbvkj dh foKku f'k{kd vfHkçj.k ;ktuk vrxr 2009-10 d fy, rhu dk;Øe vk;kftr fd, x,A Hkkouxj ftyk dh çkFkfed] ek/;fed 50 'kkykvk d foKku] xf.kr f'k{kdk rFkk Hkkouxj dh lkbl dkyt d çk/;kidk d fy, vyx vyx rhu dk;Øek dk vk;ktu Øe'k% fnukd 30 uoEcj rFkk 1-2 fnlEcj 2009, fnukd 26-27 fnlEcj 2009, fnukd 22-23 Qjojh 2010 dk fd;k x;kA çkFkfed] ek/;fed f'k{kdk d fy, ekMy çfr;kfxrk dk Hkh vk;ktu fd;k x;k FkkA lHkh çfrHkkfx;k dk çek.ki= rFkk mud fo|ky;k d fy; oKkfud fl)kUrk ij vk/kkfjr f[kykSu dh dhV] ekuo vfLFk ddky çnku dh xbA lex dk;Øe dh lhMh r;kj djd lHkh çfrHkkxh fo|ky;k dk nh xbA ;g lhMh Hkkouxj ftYy dh lHkh egRoi.k 'kkykvk dk Hkh nh xbA ftlls lHkh 'kkykvk d cPp ykHkkfUor gk ldA oÔ 2009-10 d vrxr vk;kftr rhuk dk;Øe e dy feykdj 112 f'k{kdk ,o çk/;kidk rFkk 56 'k{kf.kd lLFkk ykHkkfUor g,A

ANNEXURE

Research Output and Other Activities

1. Research Papers Published

2008 – 2009

Analytical Chemistry

1 New macrocyclic Cu(II)-bischelates with paddle wheel Cu_2-acetate cage. Mosae Selvakumar, P.; Suresh, E.; Subramanian, P. S. *Inorg. Chim. Acta*. **2008**, 361, 1503.

2 A novel three-component reaction involving quinoline, dimethyl acetylenedicarboxylate and C-H acids leading to the synthesis of pyrroloquinoline derivatives. Nair, V.; Devipriya, S.; Suresh, E. *Snthesis-Stuttgart* **2008,** 7, 1065.

3 Construction of heterocycles via 1,4-dipolar cycloaddition of quinoline–DMAD zwitterion with various dipolarophiles. Nair, V.; Devipriya, S.; Suresh, E. *Tetrahedron* **2008**, 64, 3567.

4 Molecules to supermolecules and self assembly: a study of some cocrystals of cyanuric acid. Marivel, S.; Suresh, E.; Pedireddi, V. R. *Tetrahedron Lett*. **2008**, 49, 3666.

5 An efficient synthesis of indolo[3,2-a]carbazoles via the novel acid catalyzed reaction of indoles and diaryl-1,2-diones. Nair, V.; Nandialath, V.; Abhilash, K. G.; Suresh, E. *Org. Biomol. Chem*. **2008**, 6, 1738.

6 Catalytic destruction of 4-chlorophenol in water. Chaliha, S.; Bhattacharyya, K. G.; Paul, P. *CLEAN-SOIL AIR WATER* **2008**, 36, 488.

7 Synthesis of novel heterocyclic calixarenes via the Diels-Alder reaction of calix[4]bis(spiroienones). Ganga, V. B.; Suresh, E.; Suresh, C. H.; Varma, R. L. *Indian J .Chem. B*. **2008**, 7, 1071.

8 Stereocontrolled synthesis of novel spirocyclic oxa-bridged cyclooetanoids through sequential transformations of pentafulvenes. Krishnan, K. S.; Kuthanappillil, J. M.; John, J.; Suresh, C. H.; Suresh, E.; Radhakrishnan, K. V. *Syntheis-Stuttgart* **2008,** 13, 2134 .

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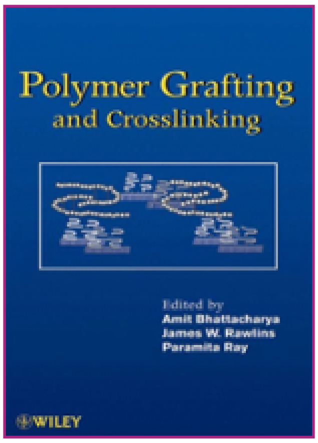

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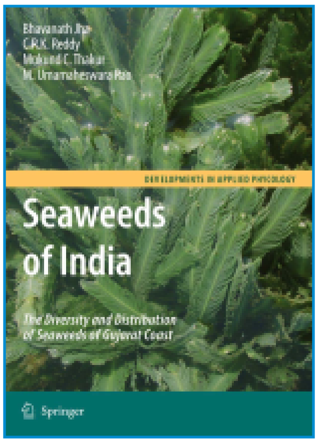

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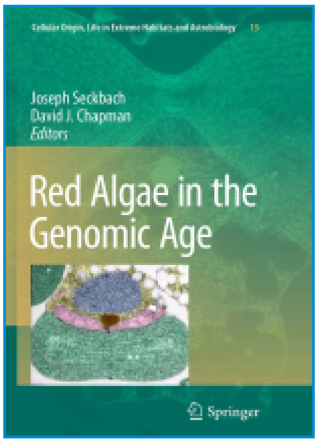

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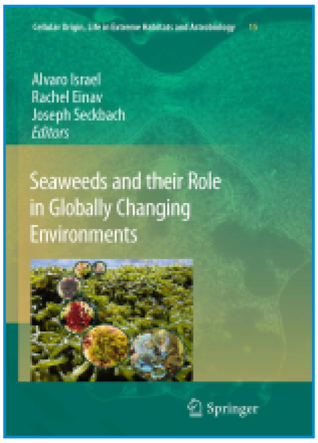

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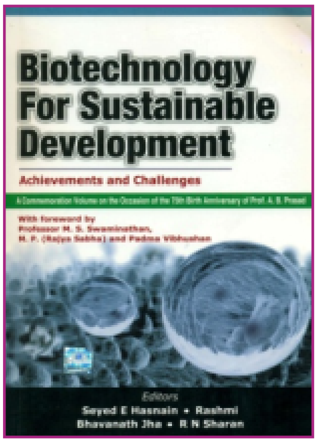

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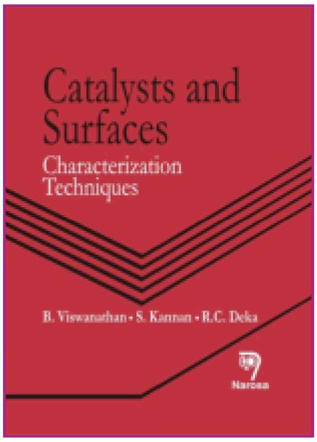

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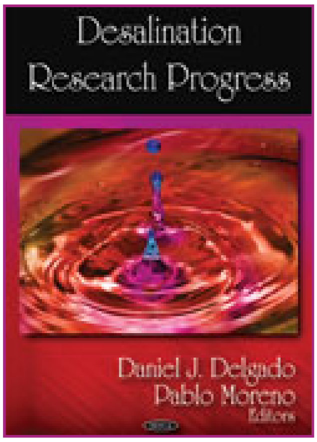

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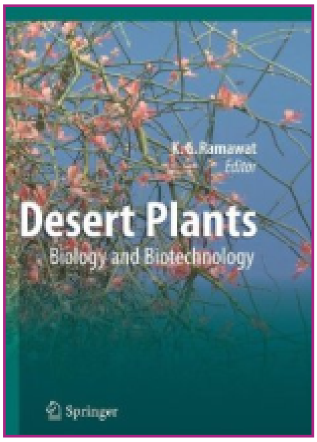

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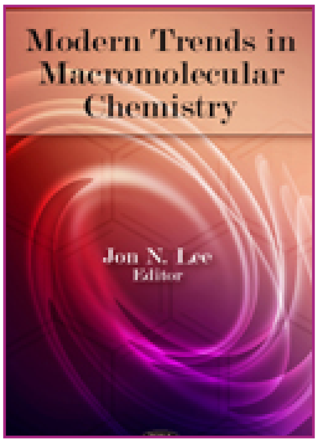

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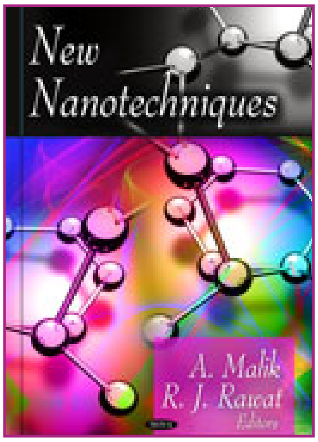

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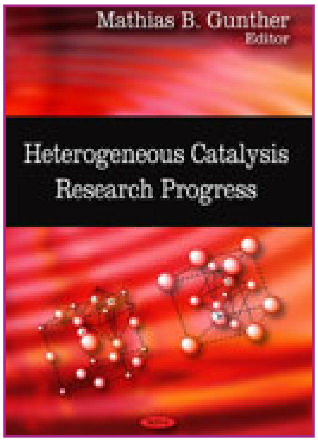

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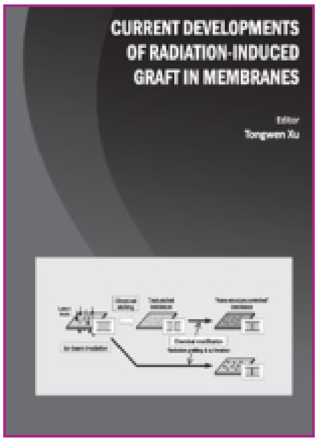

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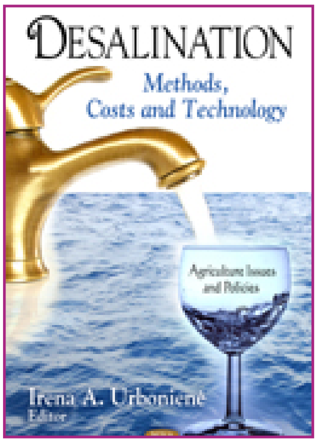

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3. Patents – Granted / Filed

2008-09
Foreign Patent Granted

Sr. No.	Title	Inventors	Patent No
1	A process for the eco-friendly synthesis of bromobenzene	A.V. Bedekar, P.K. Ghosh, S. Adimurthy and G. Ramachandraiah	RU 2,321,576
2	A process for the eco-friendly synthesis of bromobenzene	A.V. Bedekar, P.K. Ghosh, S. Adimurthy and G. Ramachandraiah	CN ZL2003-80111001.3
3	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	CN ZL2002-802456.7
4	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	JP 4,206,343
5	Process for the preparation of a molecular sieve adsorbent for the size/shape selective separation of air	R.V. Jasra, C.D. Chudasama and J. Sebastian	KR 827,634
6	An improved process for the preparation of nonhazardous brominating reagent	P.K. Ghosh, S. Adimurthy, G. Ramachandraiah, A.V. Bedekar and D.B. Shukla	RU 2,323,873
7	An improved process for the preparation of nonhazardous brominating reagent	P.K. Ghosh, S. Adimurthy, G. Ramachandraiah, A.V. Bedekar and D.B. Shukla	US 7,459,139
8	An improved process for the preparation of nonhazardous brominating reagent	P.K. Ghosh, S. Adimurthy, G. Ramachandraiah, A.V. Bedekar and D.B. Shukla	EP 1,633,676
9	An improved process for the preparation of nonhazardous brominating reagent	P.K. Ghosh, S. Adimurthy, G. Ramachandraiah, A.V. Bedekar and D.B. Shukla	CN ZL2003-826559.1

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10	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	SA 2006/07831
11	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	US 7,442,393
12	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	SA 2006-07831
13	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	AU 2003-259,548
14	A novel use of herbal extracts of *Salicornia* species active against tuberculosis and process for the preparation	M.R. Rathod, B.D. Shethia, J.B. Pandya, P.K. Ghosh, P.J. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	AF 13,914
15	Animal powered mechanical device for water desalination	N. Pathak, P.K. Ghosh, S.L. Daga, V.J. Shah and S.N. Patel	US 7,387,728
16	Animal powered mechanical device for water desalination	N. Pathak, P.K. Ghosh, S.L. Daga, V.J. Shah and S.N. Patel	SL 13,743
17	Animal powered mechanical device for water desalination	N. Pathak, P.K. Ghosh, S.L. Daga, V.J. Shah and S.N. Patel	AP 1,923
18	Preparation of non hazardous brominating reagents	G. Ramachandriah, P.K. Ghosh, A.S. Mehta, S. Adimurthy, A.D. Jethva and S.S. Vaghela	AU 2002-228,289
19	Preparation of non hazardous brominating reagents	G. Ramachandriah, P.K. Ghosh, A.S. Mehta, S. Adimurthy, A.D. Jethva and S.S. Vaghela	EP 1,465,835
20	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 and A.U. Hamidani	JP 4,149,999

Sr. No.	Title	Inventors	Patent No
21	A process for the 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. Deriya, R.H. Dave, K. Halder, R.B. Yadav, S.L. Daga, K.M. Majeethia and U.P. Saraiya	CN ZL2001-823809.2
22	A process for the 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. Deriya, R.H. Dave, K. Halder, R.B. Yadav, S.L. Daga, K.M. Majeethia and U.P. Saraiya	IL 161,524
23	Process for the preparation of a molecular sieve adsorbent for the adsorptive dehydration of alcohols	R.V. Jasra, J. Sebastian and C.D. Chudasama	US 7,407,906
24	Process for the preparation of a molecular sieve adsorbent for selectively adsorbing nitrogen and argon from gaseous mixture with oxygen	J. Sebastian and R.V. Jasra	EP 1,485,200
25	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.G. Kumar	MX 260,163
26	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.G. Kumar	AU 2003-288,642
27	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	AU 2003-300,719
28	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 ZL2003-801100930.2

Sr. No.	Title	Inventors	Patent No
29	A process for generation of finely divided calcium carbonate from calcium carbonate rich industrial byproducts	R.V. Jasra , P.M. Oza, R.S. Somani, M.V. Sheth, J.R. Chunawala, V.V. Thakar, Y.M. Badheka, J. Ayyer and V.B. Patel	JP 4,191,038
30	An eco-frendly method of preparation of high purity tetrabromobisphenol-A	G. Ramachandraiah, P.K. Ghosh, A.S. Mehta, R.P. Pandya, A.D. Jethava, S.S. Vaghela and S.N. Mishra	IL 148,144
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	CN ZL2003-80110956.7
32	A 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	AU 2002-232,114
33	Process for recovery of palladium from spent catalyst	R.V. Jasra, P.K. Ghosh, H.C. Bajaj and A.B. Boricha	US 7,473,406
34	An improved electrochemical method for oxidation of bromide to bromine	G. Ramachandraiah, P.K. Ghosh, V.R.K.S. Susarla and S.S. Vaghela	AU 2003-226,644
35	Integrated method for production of carrageenan and liquid fertilizer from fresh seaweeds	K. Eswaran, P.K. Ghosh, A.K. Siddhanta, J.S. Patolia, C. Periyasamy, A.S. Mehta, K.H. Mody, B.K. Ramavat, K. Prasad, M.R. Rajyaguru, S. Kulandaivel, C.R.K. Reddy, J.B. Pandya and A. Tewari	PH 1-2005-500,340

2008-09
Indian Patent Granted

Sr. No.	Title	Inventors	Patent No
1	A device for casting ion exchange membranes	N. Pathak, P.A. Patel, G.S. Trivedi, B.J. Shah, S.L. Daga, R. Rangarajan, S.K. Adhikari, P.M. Gaur and B.B. Parmar	IN 218,641
2	A process for the preparation of improved organophillic clay useful as gellants for making viscous organic systems	S.D. Gomkale, R.V. Jasra, A.S. Mehta, B.J. Bhalala, D.B. Shukla, R.S. Somani, A.K. Bhatnagar, A.M. Rai, K.P. Naithani and B.D. Mittal	IN 220,178
3	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	IN 221,049
4	A process for the generation of precipitated $CaCO_3$ from $CaCO_3$ rich industrial by product	R.V. Jasra, P.M. Oza, R.S. Somani, J.R. Chunawala, M.V. Sheth, V.V. Thakar, Y. M. Badheka, J. Ayyer and V.B. Patel	IN 221,619
5	A process for the 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. Deriya, R.H. Dave, K. Halder, R.B. Yadav, S.L. Daga, K.M. Majeethia and U.P. Saraiya	IN 222,095
6	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 and A.U. Hamidani	IN 224,130
7	Integrated method for production of carrageenan and liquid fertilizer from fresh seaweeds	K. Eswaran, P.K. Ghosh, A.K. Siddhanta, J.S. Patolia, C. Periyasamy, A.S. Mehta, K.H. Mody, B.K. Ramavat, K. Prasad, M.R. Rajyaguru, C.R.K. Reddy, S. Kulandaivel, J.B. Pandya and A. Tewari	IN 224,938
8	An improved process for cultivation of algae	C.R.K. Reddy, O.P. Mairh, G.R. Kumar, K. Eswaran, P.V. SubbaRao, K.H. Mody and P.K. Ghosh	IN 225,394
9	A membrane-based device for the concentration of aqueous herbal extract solution	P.K. Ghosh, V.J. Shah and J.B. Pandya	IN 227,099

Sr. No.	Title	Inventors	Patent No
10	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. Dodiya, B.S. Srivastava, R. Srivastava, A. Srivastava and V. Chaturvedi	IN 227,532
11	An improved process for the preparation of ammonia	R. Prakash, V.K. Shahi, P. Ray, G. Ramachandraiah and R. Rangarajan	IN 230,375
12	Catalytic oxidation of bromide in sea water, bittern and solutions containing bromide ions	A. Hussain, S.D. Gomkale, R.S. Shukla, H.J. Padhiyar, R.B. Thorat and A.S. Mehta	IN 230,998
13	A process for the preparation of formic acid by catalyzed hydration of carbon monoxide	A. Hussian, R.S. Shukla, R.B. Thorat, S.D. Bhatt, R.V. Jasra and H.J. Padhiyar	IN 230,997
14	A process for the preparation of pure potassium iodate for salt iodisation	P.K. Ghosh, G. Ramachandraiah, V.R.K.S. Susarla, P.M. Gaur, S.S. Vaghela and S.N. Patel	IN 231,850
15	A process for purification of sodium chloride containing sodium sulphate impurity	K.D. Padia, K.J. Langalia, S.H. Mehta, R.H. Trivedi, M.R. Gandhi and P. Natarajan	IN 232,395
16	An improved process for the recovery of palladium from spent catalyst	R.V. Jasra, P.K. Ghosh, H.C. Bajaj and A.B. Boricha	IN 232,461
17	An eco-friendly process for the electrolytic synthesis of methyl sulfone from methyl sulfoxide using an ion exchange membrane cell	G. Ramachandraiah, P. Ray, V.K. Shahi and R. Rangarajan	IN 232,919
18	Process for the preparation of a molecular sieve adsorbent for selectively adsorbing nitrogen and argon from a gaseous mixture with oxygen	J. Sebastian and R.V. Jasra	IN 233,195
19	A process for the manufacture of zeolite-A useful as a detergent builder	R.S. Somani, P.M. Oza, M.R. Gandhi and V.M. Sheth	IN 233,467
20	Preparation of non hazardous brominating reagents	G. Ramachandriah, P.K. Ghosh, A.S. Mehta, S. Adimurthy, A.D. Jethva and S.S. Vaghela	IN 225,718

2008-09
Foreign Patents Filed

Sr. No.	Title	Inventors	Patent Application No
1	A process for purification of calcium carbonate rich by-product generated in industrial processes	R.V. Jasra, P.M. Oza, R.S. Somani, J.R. Chunnawala, M.V. Sheth, V.V. Thakkar, Y.M. Badheka and J. Ayyer	JP 2008-105146
2	An improved process for preparation of fatty acid methyl ester (biodiesel) from *Jatropha curcas* oil	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. Dodiya, M.G. Patel, D.R. Parmar and S.N. Patel	RU/2008115448 OA/1200800293
3	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. Chunnawala, D.L. Ghelani, H.N. Ranpara, D.J. Barochiya, S. Chandra, M.K. Dhar, C. KesavaRao and K. Kumar	CN/200580051917.3 CA/2629083
4	Process for manufacturing finely precipitated silica	R.V. Jasra, H.M. Mody, R.S. Somani, H.C. Bajaj, D.B. Shukla and N.R. Vyas	WO/PCT/IN08/00257 US/12/112551
5	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	US/12/084755
6	A novel iodizing agent and preparation of iodized salt there from that releases iodine in the stomach	P.K. Ghosh, S.H. Mehta, J.R. Chunawala, M.V. Sheth and M.R. Gandhi	US/12/086542
7	Catalytic epoxidation of styrene with molecular oxygen using metal ion exchanged zeolites	R.V. Jasra and J. Sebastian	KR 10-2008-7014366
8	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	IL/192926 BR/PI0621296-4 AU/200337403 MX/A/2008/009820 CN/200680052181.6 JO/345/2008 JP/2008-552901 EP/06727340.9

Sr. No.	Title	Inventors	Patent Application No
9	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	IL/192952 BR/PI0621297-2 AU/2006337405 MX/A/2008/009819 JO/345/2008 CN/200680052178.4 JP/2008-552902
10	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	WO/PCT/IN08/00568 US/12/205697
11	Improved κ-carrageenase production and a method of preparation thereof	Y.N. Khambhaty, K.H. Mody and B. Jha	PH/1-2008-502142 ID/W00200803231 JP/2009-502229 CN/200680054085.5 KR/10-2008-7026331
12	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. Ramachandriah, J.R. Chunawala, M.V. Sheth and G.S. Gohil	WO /PCT/IN08/00615 US/12/239621
13	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	WO/PCT/IN08/00614 US/12/240762
14	A stable iodine-water concentrate formulation to iodinate drinking water for the effective prevention of iodine deficiency disorders	G. Ramachandriah, D. Livingston, A. Hussain and D.B. Shukla	WO/PCT/IN08/00619 JO/430/2008 TH/0801005022
15	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	WO/PCT/IN08/00627 US/12/240043
16	Nutritious, tasty and affordable drink from sap of *Kappaphycus alvarezii* seaweed and its preparation thereof	P.K. Ghosh, M.R. Rajyaguru, J.S. Patolia, P.V. Subbarao, M.T. Shah, S.T. Zodape, S.V. Joshi, A.V.R. Reddy, C.V. Devmurari, S. Bandyopadhyay and G.C. Sahoo	KR/10-2009-7000733 EP/07805642.1 PH/1-2009-500205 ID/W00200900266 TZ/P/09/00225 CN/200780030248.0
17	Preparation of organic-inorganic hybrid chiral sorbent	S.H.R. Abdi, R.I. Kureshy, N.H. Khan, R.V. Jasra, V.J. Mayani and S. Agarwal	US/12/443065 MX/A/2009/003355

2008-09
Indian Patents Filed

Sr. No.	Title	Inventors	Patent Application No
1	Improved process for the synthesis of *p*-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	2513/DEL/2008
2	A process for the preparation of molecular sieve adsorbent useful for the selective adsorption of oxygen from its gaseous mixture with argon	R.V. Jasra, S.A. Peter and A.S. Moharir	2539/DEL/2008
3	Method for micro-propagation of *Jatropha curcas* plants from leaf explants	M.P. Reddy, N. Kumar, G.V. Singh, A. Harikrishna and S. Singh	2537/DEL/2008
4	A cost effective process for preparation of iodate salt solution for direct iodization of common salt	G. Ramachandraiah, S.V. Sarma, S.P. Dave, M.P. Joshi, M.P. Reddy and P.K. Ghosh	0176/DEL/2009
5	An improved process for the eco-friendly preparation of 3,5-dibromo-4-hydroxybenzonitrile	S. Adimurthy, G. Ramachandraiah, G.V. Joshi, R. Patil, M.R. Gandhi, M. Subbareddy and P. Maiti	0349/DEL/2009
6	Improved process for the preparation of agarose polymer from seaweed extractive	R.V. 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	0567/DEL/2009
7	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	0618/DEL/2009
8	A manually operated continuous flow type drinking water disinfector using concentrated solar radiation	S.R. Thimmannabhat, P.K. Ghosh, S.N. Patel and J.N. Bharadia	0615/DEL/2009

Sr. No.	Title	Inventors	Patent Application No
9	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	0611/DEL/2009
10	A method of preparation of enantioselective composite membrane	K. Singh, H.C. Bajaj and P.G. Ingole	0629/DEL/2009
11	A process for the preparation of molecular sieve adsorbent for the size/shape selective adsorption of carbon dioxide from its gaseous mixture with nitrogen	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	0602/DEL/2009
12	A method for immobilizing lipase onto microporous ultrafiltration polymer membrane	K. Singh, A. Bhattacharya and S. Gupta	0619/DEL/2009
13	A process for the preparation and use of pentasil type zeolite for the selective adsorption of carbon dioxide from flue gases	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	0654/DEL/2009
14	Genotype independent method for micro-propagation of *Jatropha curcas* from shoot tips and nodal segments	M.P. Reddy, A.H. Singh, S. Singh, V.A. Gopalakrishnan, N. Kumar and R.P. Chintalapati	0657/DEL/2009
15	Barium and potassium exchanged zeolite-X adsorbents for CO_2 removal from a gas or gas mixture and preparation thereof	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	0662/DEL/2009
16	An improved domestic size solar oven for multiple household applications	R.S. Thimmannabhat, P.K. Ghosh , S.N. Patel and J.N. Bharadia	0667/DEL/2009

2009-2010
Foreign Patent Granted

Sr. No.	Title	Inventors	Patent No
1	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	JO 2336
2	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.G. Kumar	GB 2,440,138
3	Low sodium salt of botanic origin	P.K. Ghosh, K.H. Mody, M.P. Reddy, J.S. Patolia, K. Eswaran, R.S. Shah, B.K. Barot, M.R. Gandhi, A.S. Mehta, A.M. Bhatt and A.V.R. Reddy	MX 266,374
4	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 and E. Suresh	CA 2,538,493
5	Green catalytic process for the synthesis of acetyl salicyclic acid	R.V. Jasra, B. Tyagi and M.K. Mishra	US 7,544,831
6	Process for preparing detergent builder zeolite-A from kimberlite tailings	R.V. Jasra, R.S. Somani, H.M. Mody, H.C. Bajaj, J.R. Chunawala, H.N. Ranpara, D.J. Barochiya, D.L. Ghelani, S. Chandra, M.K. Dhar, K. Rao and K. Kumar	US 7,560,093
7	Low sodium salt of botanic origin	P.K. Ghosh, K.H. Mody, M.P. Reddy, J.S. Patolia and K. Eswaran	CNZL 2004-80042970.2
8	A membrane based device for the concentration of aqueous herbal extract	P.K. Ghosh, V.J. Shah and J.B. Pandya	CNZL 2003-80110866.8
9	An improved process for preparation of fatty acid methyl ester (biodiesel) from *Jatropha curcas* oil	P.K. Ghosh, S. Adimurthy, M.R. Gandhi, N.K. Veghala, M.R. Rathod, B.D. Sahethia, J.B. Pandya, R.A. Parmar, P.J. Dodiya, M.G. Patel, D.R. Parmar and S.N. Patel	OA 00322

Sr. No.	Title	Inventors	Patent No
10	Herbal extract 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. Dodiya, B.S Srivastava, R. Srivastava, Anil Srivastava, and Vinita Chaturvedi	AU 2005-247,206
11	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	JP 4,361,876
12	A process for the eco-friendly synthesis of bromobenzene	A.V. Bedekar, P.K. Ghosh, S. Adimurthy and G. Ramachandraiah	EP 1,697,286
13	An improved process for the preparation of nonhazardous brominating reagent	G. Ramachandraiah, P.K. Ghosh, S. Adimurthy, A.V. Bedekar and D.B. Shukla	JP 4,335,207
14	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.N. Ranpara, D.J. Barochiya, D.L. Ghelani, S. Chandra, M.K. Dhar, K. Rao and K. Kumar	ZA 2007-05,224
15	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	JP 4,387,312
16	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	JP 4,384,989
17	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	CA 2,473,900
18	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	CA 2,551,104
19	An improved electrochemical method for oxidation of bromide to bromine	G. Ramachandraiah, P.K. Ghosh, V.R.K.S. Susarla and S.S. Vaghela	IS 171,208

Sr. No.	Title	Inventors	Patent No
20	An improved process for the recovery of palladium from spent catalyst	R.V. Jasra, P.K. Ghosh, H.C. Bajaj and A.B. Boricha	JP 4,417,907
21	An improved process for the preparation of fatty acid methyl ester (bio-diesel) from triglycerides 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. Dodiya, M.G.Patel, D.R. Parmar and S.N. Patel	RU 2,379,332
22	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. Deriya, R.H. Dave, K. Halder, R.B. Yadav, S.L. Daga, K.M. Majeethia and U.P. Saraiya	CA 2,464,642
23	Process for the preparation of a molecular sieve adsorbent for selectively adsorbing nitrogen and argon from a gaseous mixture with oxygen	J. Sebastian and R.V. Jasra	CN ZL2003-810534.9
24	An improved process for the preparation of fatty acid methyl ester (bio-diesel) from triglycerides 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. Dodiya, M.G. Patel, D.R. Parmar and S.N. Patel	US 7,666,234
25	A catalytic process for the preparation of isolongifolene	R.V. Jasra, B. Tyagi and M.K. Mishra	JP 4,468,891
26	A process for the eco-friendly synthesis of bromobenzene	A.V. Bedekar, P.K. Ghosh, S. Adimurthy and G. Ramachandraiah	AU 2003-288,582

2009-2010
Indian Patent Granted

Sr. No.	Title	Inventors	Patent No
1	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.G. Kumar	IN 234,809
2	Process for generation of finely divided calcium carbonate from calcium carbonate rich industrial byproduct	R.V. Jasra, P.M. Oza, R.S. Somani, J.R. Chunnawala and M.V. Sheth	IN 235,621
3	A process for the preparation of improved heterogeneous ion-exchange spacer	G.S. Trivedi, P. Ray, B.G. Shah, S.K. Adhikary, R. Rangarajan and P.K. Ghosh	IN 236,262
4	Process for preparing aldol derivatives from alkenes using catalyst	R.V. Jasra, V.K. Srivastava, R. S. Shukla, H.C. Bajaj and S. D. Bhatt	IN 238,190
5	Process for preparing 2,4,4,6- tetrabromo 2,5-cyclohexadienenone	A.V. Bedekar, G. Ramachandraiah and P.K. Ghosh	IN 238,400
6	A process for eco-friendly synthesis of bromobenzene	A.V. Bedekar, P.K. Ghosh, S. Adimurthy and G. Ramachandraiah	IN 238,883
7	A 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	IN 238,892

2009-10
Foreign Patents Filed

Sr. No.	Title	Inventors	Patent Application No
	Preparation of organic-inorganic hybrid chiral sorbent	S.H.R. Abdi, R.I. Kureshy, N.H. Khan, R.V. Jasra, V.J. Mayani and S. Agarwal	KR 10-2009-7008745 CN 2007-80044113.X
2	Molecular sieve adsorbent for the selective adsorption of oxygen from its gaseous mixture with argon	R.V. Jasra, S.A. Peter and A.S. Moharir	WOPCT/IN2009/000399
3	A method of removing phospholipids from rice bran oil (edible grade) by membrane process	K. Singh, V. Kumar and J. Shah	US 12/587046
4	An improved process for the preparation of *p*-nitrobenzyl bromide	M.K. Agrawal, P.K. Ghosh, M.R. Gandhi, S.C. Upadhyay, S. Adimurthy, G. Ramachandraiah, P. Patoliya, G. Joshi, H. Brahmbhatt and R.J. Sanghavi	WO/PCT/IB2009/ 007264
5	Process for manufacturing finely precipitated silica	R.V. Jasra, H.M. Mody, R.S. Somani, H.C. Bajaj, D.B. Shukla and N.R. Vyas	KR10-2009-7025162 CN 2008-80018780.5
6	Pentasil type zeolite for the selective adsorption of carbon dioxide from flue gases	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	WO/PCT/IN2009/000753
7	Molecular sieve adsorbent for the size/shape selective adsorption of carbon dioxide from its gaseous mixture with nitrogen	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	WO/PCT/IN2010/000027
8	An improved process for the eco-friendly preparation of 3,5-dibromo-4-hydroxyben-zonitrile (Bromoxynil)	S. Adimurthy, G. Ramachandraiah, G. Joshi, R. Patil, M.R. Gandhi, Mallampati Subba Reddy and P. Maiti	WO/PCT/IN2010/000111

Sr. No.	Title	Inventors	Patent Application No
9	Improved process for the preparation of agarose polymer from seaweed extractive	R.V. 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	WO/PCT/IB2010/000588
10	A method of preparation of enantio-selective composite membrane	K. Singh, H.C. Bajaj and P.G. Ingole	WO/PCT/IN2010/000188
11	Barium and potassium exchanged zeolite-X adsorbents for CO_2 removal from a gas or gas mixture and preparation thereof	R.V. Jasra, R.S. Somani, B. Tyagi, S.A. Peter, R.S. Pillai, U. Sharma, P.D. Hirani and R. Mukhopadhyay	WO/PCT/IN2010/000187
12	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	WO/PCT/IB2010/000687
13	A manually operated continuous flow type drinking water disinfector using concentrated solar radiation	S.R. Thimmannabhat, P.K. Ghosh, S.N. Patel and J.N. Bharadia	WO/PCT/IN2010/000199
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, C. Prasad, 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, D.R. Chaudhary, B. Rebary and K.S. Zala	WO/PCT/IN2010/000192
15	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	WO/PCT/IN2010/000194

2009-2010
Indian Patents Filed

Sr. No.	Title	Inventors	Patent Application No
1	Improved V-trough solar concentrator system for enhanced power output from conventional photovoltaic array powering a community scale reverse osmosis desalination unit	S. Maiti, P.K. Ghosh, S.T. Rajan, S. Daga, J.N. Bharadia, K.G. Vyas, P.S. Bapat, P.A. Patel, S.N. Patel, L.M. Kachadia, G.S. Trivedi, P.K. Harsora, H.M. Tadvi	1550/DEL/2009
2	Integrated process for the production of Jatropha methyl ester and byproducts	P.K. Ghosh, S. Mishra, C. Prasad, M.R. Gandhi, S.C. Upadhyay, P. Paul, A.P. Singh, K.M Popat, A.V Shrivastav, S.K. Mishra, N. Ondhiya, R. Maru, G. Dyal, H. Brahmbhatt, V. Borisha, R. Doongar, B. Rebary and K.S. Zala	1838/DEL/2009
3	A Process for integrated production of ethanol and seaweed sap from *Kappaphycus alvarezi*	K.H. Mody, P.K. Ghosh, B. Sana, G. Gnanasekaran, D.B. Shukla, K. Eswaran, H.R. Brahmbhatt, B.G. Shah, S.K. Thampy and B. Jha	1839/DEL/2009
4	Preparation of polymeric compositions for arsenic removal from ground waters	P.S. Anand, K.M. Popat, D. Gangadharan and A.P. Gohil	0319/DEL/2010
5	Preparation of highly efficient heterogeneous catalyst for asymmetric nitroaldol reaction	S.H.R. Abdi, R.I. Kureshy, N.H. Khan, H.C. Bajaj, V.J. Mayani and A.K. Shah	0573/DEL/2010
6	Preparation of inorganic hydrogels with alkali halides	A. Singh and B. Ganguly	0579/DEL/2010
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, C. Prasad, 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	0684/DEL/2010
8	Nanocrystalline and mesoporous titanium dioxide and its preparation from titanium carbonate	A.B. Panda, H.C. Bajaj, N. Sutradhar and A. Sinhamahapatra	0772/DEL/2010
9	A process for the preparation of bioactive sub-fraction from flowers of *Simarouba glauca* active against filariasis	B.D. Shethia, M.R. Rathod, J.B. Pandya, P.J. Dodiya, P.K. Murthy, S. Dixit, R.L. Gaur and V.K. Bose	0774/DEL/2010

4. Papers / Lectures Presented in Seminars / Symposia

2008 – 2009

Analytical Science Division

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Colorimetric sensors for sulphate and phosphate ions	3rd Mid-Year Symposium of CRSI, **July, 2008**	National Institute of Pharmaceutical Research, Punjab	A. Das
2	Calixarene based fluorescence molecular sensor synthesis and their ion recognition study	Symposium on Modern Trends in Inorganic Chemistry-XIII, **December, 2008**	Indian Institute of Science, Bangalore	S. Patra and P. Paul
3	Facile oxidation of benzylic and secondary alcohols with recyclable bromide-bromate reagent	International Conference on Frontiers in Chemical Research (ICFCR–2008), **December, 2008**	Mangalore University, Mangalore, Karnataka	G. Joshi and S. Adimurthy
4	Synthesis, characterization and X-ray crystallographic studies of two psuedopolymorphs of dipyridynium salt (BDPC) and its tetrachlorocobaltate analogue	International Conference on Frontiers of Functional Materials, **January, 2009**	University of Culcutta, Kolkata	K.K. Bisht and E. Suresh
5	Molecular data protection	National Symposium on Radiation and Photochemistry, **February, 2009**	Nainital, Uttarakhand	M. Suresh, A. Ghosh and A. Das
6	Synthesis, characterization & X-ray crystallographic studies of three-dimensional microporous chiral coordination polymers structured by enantiopure α-amino acid bridges and exodentate N-donor pillars	National Seminar on Crystallography, (NSC–38) **February, 2009**	University of Mysore, Karnataka, India	A.C. Kathalikkattil and E. Suresh

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
7	Computational study towards understanding the conformation and destruction of organophosphorus nerve agent GV	11th CRSI National Symposium in Chemistry, **February, 2009**	NCL, Pune	M.A.S. Khan, M.K. Kesharwani and B. Ganguly
8	Colorimetric sensors for fluoride and phosphate ions	National Symposium in Chemistry, **February, 2009**	NCL, Pune	A. Das
9	Free resonance energy transfer in interwoven host-guest complexes	National Symposium on Radiation and Photochemistry (NSRP–2009), **March, 2009**	Kumayun University, Nainital	A. Das
10	Dye sensitized electron injection to the nano-particulate TiO_2	CSIR–NSFC Joint Workshop on Nano–Materials and their Applications, **March, 2009**	CGCRI, Kolkata	A. Das

Salt and Marine Chemicals Discipline

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Upgrading the salt quality produced by the marginal salt producers at Maliya	A Workshop on Improving the Quality of Salt Produced by Marginal Agarias **16, September, 2008**	Panchayat Hall, Maliya	V.P. Mohandas
2	Characterizing solution and gel structure of agarose in the aqueous sodium sulfate solutions	3rd National Conference on Thermodynamics of Chemical and Biological Systems **15-17, October, 2008**	Nagpur	A. Kumar
5	Room temperature ionic liquids: Physicochemical characterization, aggregation and hydration characteristics	National Seminar on Emerging Trends in Chemical Science Research **20, January, 2009**	NSETCSR, VV Nagar, Gujarat	A. Kumar
4	Production of good quality salt from subsoil brines of Rajasthan	A Workshop on Salt arranged by Salt Dept., Govt. of India **13-14, February, 2009**	Municipal Seminar Hall, Nawa	V.P. Mohandas

Inorganic Materials and Catalysis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Porous reference materials	Workshop on Metrology in Chemistry, **May, 2008**	NPL, New Delhi	R.S. Shukla
2	Hydrotalcite as highly active solid base catalyst for synthesis of jasminaldehyde by condensation of 1-heptanal with benzaldehyde	14^{th} International Congress on Catalysis, **14-17, July, 2008**	Seoul, Korea	S.K. Sharma, P.A. Parikh and R.V. Jasra
3	Eco-friendly multi-functional catalyst system for selective synthesis of 2-methylpentanol from ethylene in single pot	14^{th} International Congress on Catalysis, **14-17, July, 2008**	Seoul, Korea	S.K. Sharma, P.A. Parikh and R.V. Jasra
4	Formation of calcium carbonate sub-micron particles by mechanochemical preparation	VI^{th} International Conference on Mechano-Chemistry & Mechano-Alloying (INCOME–2008), **1-4, December, 2008**	NML, Jamshedpur	R.S. Somani, K. Patel and R.V. Jasra
5	Synthesis of delaminated LDH: A smart two step approach	2^{nd} DAE-BRNS International Symposium on Materials Chemistry, **2-6, December, 2008**	BARC, Mumbai, Maharashtra	C.A. Antonyraj, P. Koilraj and S. Kannan
6	Equilibrium adsorption study of methane, nitrogen, oxygen and argon on to ZSM-5 having different SiO_2/Al_2O_3 ratio	2^{nd} DAE-BRNS International Symposium on Materials Chemistry, **2-6, December, 2008**	BARC, Mumbai, Maharashtra	G. Shethia, R. Pillai, G. Dangi, R.S. Somani, H.C. Bajaj and R.V. Jasra
7	Synthesis of carbon nanospheres by a chemical reduction solvothermal process using carbon tetra chloride as carbon source	International Conference on Nanomaterials and Applications-2008, **9-11, December, 2008**	Shivaji University, Kolhapur, Maharashtra	S.Y. Sawant, R.S. Somani and H.C. Bajaj *(First Prize for Best Poster Presentation)*

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
8	Highly enantio-selective cyanoformylation of aldehydes using chiral V(V) salen complex with imidazole as a co-catalyst	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	S. Agrawal, A. Sadhukhan, N.H. Khan, R.I. Kureshy, S.H.R. Abdi and H.C. Bajaj
9	Enantio-selective synthesis of *N*-protected 1, 2-amino alcohols via aminolytic kinetic resolution of aryloxy epoxides catalyzed by Co(III) salen complex in ionic liquid	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	A. Sadhukhan, K. JeyaPrathap, R.I. Kureshy, S. Agrawal, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
10	Ionic liquid as green catalyst as well as media for cyanoethylation of aldehydes	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	M. Kumar, S. Agrawal, N.H. Khan,R.I. Kureshy, S H.R. Abdi and H.C. Bajaj
11	Synthesis of metal schiff base complexes as a catalysts in selective oxidation of isophorone	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	P.G. Ingole, S.V. Jadhav, K. Singh and H.C. Bajaj
12	Baeyer-Villiger oxidation of cyclic ketones using microwave synthesized mesoporous tin MFI catalysts	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	K.M. Jinka, S.E. Park and R.V. Jasra
13	Monodentate bulky phosphite based rhodium complex: A catalyst for regioselective hydroformylation of aryl alkenes	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	A.A. Dabbawala, H.C. Bajaj and R.V. Jasra

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
14	Phosphate uptake studies over carbonate containing ZnAlZr ternary LDHs	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	P. Koilraj and S. Kannan
15	Intercalation of $HRh(CO)(TPPTS)_3$ complex in the interlayer space of hydrotalcite to prepare a heterogeneous catalyst for hydroformylation of alkenes	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	S.K. Sharma, P.A. Parikh and R.V. Jasra
16	A rhodium-hydrotalcite based eco-friendly multi-functional catalyst system in the effective synthesis of C8 aldehydes and alcohol from propylene: Kinetic investigations	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	S.K. Sharma, R.S. Shukla, P.A. Parikh and R.V. Jasra
17	Isomerization of allylbenzene over layered double hydroxides as solid base catalysts	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	C.M. Jinesh, C.A. Antonyraj and S. Kannan
18	Hydroxylation of phenol over copper containing layered double hydroxides	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	C.A. Antonyraj, M. Gandhi and S. Kannan
19	Synthesis and application of multi-functional material	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	V.J. Mayani, 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)
20	Silica modified with chiral auxiliaries for their potential application as chiral stationary phase	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	V.J. Mayani, S.H.R. Abdi, R.I. Kureshy, N.H. Khan, A. Shah and H.C. Bajaj
21	Synthesis of surface modified TiO_2 using supercritical water and ethanol and its photocatalytic activity	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	R.J. Tayade, H.C. Bajaj and A.B. Panda
22	Epoxidation of limonene using cobalt (II)-exchanged NaY zeolite based heterogeneous catalysts with molecular oxygen	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	M.V. Patil and R.V. Jasra
23	Kinetic investigations on the hexagonal mesoporous silica based rhodium complex, heterogeneous catalyst system working as nanophase reactor in the hydroformylation of 1-hexene	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	N. Sudheesh, S.K. Sharma, R.S. Shukla and R.V. Jasra
24	TiO_2 coating of cenospheres by sol-gel method and their use for the photocatalytic degradation of methylene blue (MB) and *p*-nitroaniline (PNA) under the solar irradiation	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	P.K. Surolia and R.V. Jasra
25	Partial oxidation of methane by molecular oxygen catalyzed by heterogeneously supported MoO_3 on HZSM-5	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	M.D. Khokhar, R.S. Shukla and R.V. Jasra

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
26	Synthesis of surface modified TiO_2 using supercritical water and ethanol and its photo-catalytic activity	19th National Symposium on Catalysis for Sustainable Energy and Chemicals, **18-21, January, 2009**	NCL, Pune, Maharashtra	N. Sutradhar, A. Sinhamahapatra, R.J. Tayade, H.C. Bajaj and A.B. Panda
27	Porous reference materials for determination of the porous textural properties	7th International Conference on Advances in Metrology, AdMet-2009, **18-20, February, 2009**	NPL, New Delhi	R.S. Shukla

Reverse Osmosis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Preparation of polyvinyl alcohol based thin film composite nanofiltration membranes: Application in the removal of hardness from brackish water	International Conference on "Advances in Polymer Technology", **25-27, September, 2008**	Cochin, India	J.M. Gohil and P. Ray
2	Studies on the use of eco-friendly binder for the preparation of ion exchange membranes and their applications in desalination	International Conference on "Electroactive Polymers: Materials and Devices", **12-17, October, 2008**	Jaipur, India	J.M. Gohil and P. Ray
3	Synthesis of nano scale metal cluster on surface functionalized polymeric microspheres and their antibacterial studies	International Conference on Functional Materials, **27-29, November, 2008**	IITM, Chennai	D. Gangadharan, G. Gnanasekaran, K.M. Popat and P.S. Anand
4	Synthesis of silica-polyamide nanocomposite membrane of silica nanoparticles and *m*-phenylenediamine - trimesoyl chloride based polyamide	APA International Conference (Advances in Polymer Science & Technology), **December, 2008**	New Delhi, India	G.L. Jadav, H. Brahmbhatt, S. Gothwal and P.S. Singh

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
5	Microstructural study of crosslinked polyamide membrane materials	XV[th] International Conference on Positron Annihilation, **18-23, January, 2009**	S.I.N.P., Kolkata, W. Bengal	Yogesh, D. Dutta, S. Chatterjee, B.N. Ganguly and A. Bhattacharya
6	Membrane technologies for green industrial process separations	International Convention on Colorants, **5-6, February, 2009**	Mumbai	A.V.R. Reddy

Electro membrane Processes

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Electro-dialysis method under societal mission to provide safe drinking water to the calamity affected people	EURO–MED Conference, **2008**	King Hussen Bin Talal Convention Center, Dead sea, Jordan	S.K.Thampy and B.S. Makwana

Marine Biotechnology and Ecology

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	*Salicorniabrachiata:* A model plant to study abiotic stress tolerance	International Conference on Trends in Cellular and Molecular Biology, **2008**	Jawahar Lal Nehru University, New Delhi	B. Jha and P.K. Agarwal
2	Cloning and characterization of a glutathion-S-trasfererasegene from *Salicorniabrachiata*	International Conference on Trends in Cellular and Molecular Biology, **2008**	Jawahar Lal Nehru University, New Delhi	A. Sharma, P.K. Agarwal and B. Jha
3	Attempts to prepare nano-structured materials composed of iota carageenan and ionic liquid	Annual Conference of Cellulose Society of Japan, **10-11, July, 2008**	Kyoto University, Japan	K. Prasad, Y. Kaneko and J.I. Kadokawa
4	Preparation of robust gelling materials from carrageenans as well as their composites with cellulose using an ionic liquid	57[th] SPSJ Symposium on Macromolecules, **24-26, September, 2008**	Osaka Science University, Japan	K. Prasad, Y. Kaneko and J.I. Kadokawa

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
5	Salinity induced changes in antioxidant enzymes and biochemical components in the red alga *Gracilaria corticata*	Vth Asian Pacific Phycology Forum on "Algae in a changing world", **10-14, November, 2008**	Wellington University, New Zealand	M. Kumar, P. Kumari, V. Gupta, C.R.K. Reddy and B. Jha
6	Dissolution and gelation of α-chitin in ionic liquids	Conference of the West Branch Chemical Society of Japan, **15-16, November, 2008**	Nagasaki Technical University, Japan	K.Prasad, Y.Kaneko and J.I. Kadokawa
7	κ-carrageenase from a marine *Pseudomonas elongata*	XXIII Carbohydrate Conference, **22-24, January, 2009**	Bhavnagar University, Bhavnagar	Y. Khambhaty, K.H. Mody and B. Jha
8	Xyalanase from marine bacterium	XXIII Carbohydrate Conference, **22-24, January, 2009**	Bhavnagar University, Bhavnagar	G. Menon and K.H. Mody

Wasteland Research

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Flow cytometry studies on ploidy and genome size of intect plants and regenerating tissues of *J. curcas* L	National Symposium in Plant Biotechnology, **8-10, February, 2008**	M. Sukhadia University, Udaipur	Ch.R. Prakash, R.P. Aruna, J. Chikara and M.P. Reddy

2009-10

Analytical Science Division

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Hydrolysis and retro-aldol cleavage of 2-(1-adamantyl)-3-hydroxybutanoate: Competing reaction	XXI Croatian Meeting of Chemists and Chemical Engineers, Split, **April, 2009**	Trogir, Croatia	M. Matković, N. Basarić, B. Ganguly, A. Singh and K. Mlinarić-Majerski
2	Synthesis and spectral characterization of novel trimetallic double stranded helicates	International Conference on Inorganic Ring System (RIS -12), **August, 2009**	NIO, Goa	S. Nadella and P.S. Subramanian
3.	Self assembled Ni(II) double stranded helicate with novel circulahelicate with nano scale cavity	International Conference on Inorganic Ring System (RIS -12), **August, 2009**	NIO, Goa	P. Mosae, Selvakumar, E. Suresh and P. S. Subramanian
4	Synthesis and crystal structure for macrocyclic rings and macrocycle-like Cu_2 bis-chelate rings	International Conference on Inorganic Ring System (RIS -12), **August, 2009**	NIO, Goa	N. Carpenter, M. Selvakumar, E. Suresh and P.S. Subramanian
5	Transmission electron microscope: A versatile tool	Nanotechnology and Nano-biotechnology Workshop, **October, 2009**	Model College, Mumbai	D.N. Srivastava
6	Recognition of anionic and cationic analytes of biological relevance	Symposium on Modern Trends in Inorganic Chemistry-XIII, **December, 2009**	Indian Institute of Science, Bangalore	A. Das
7	Colorimetric detection of Hg^{2+} in aqueous medium by diametrically disubstituted cyclam unit	National Seminar on Confluence of Supramoleculer Chemistry and Nano-science, **January, 2010**	Gujarat University, Ahmedabad	P. Mahato, A. Ghosh and A. Das
8	One pot synthesis of alpha-bromo ketones from olefins and carboxylic acids from methyl arenes using green brominating reagent under aqueous conditions	International Conference on Emerging Trends in Chemistry (ETIC-2010), **January, 2010**	University of Pune, Maharashtra	R.D. Patil and S. Adimurthy *(Best Paper Award for Oral Presentation)*

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
9	Silver(I) co-ordination frameworks from two exodentate bis (pyridyl) ligands: Synthesis, characteriztion and X-ray crystallographic investigation	International Conference on Materials for the Millennium; MatCon 2010, **January, 2010**	Department of Cochin University of Science and Technology, Kochi, Kerala	A.C. Kathalikkattil and E. Suresh
10	Effect of steric crowding on ion selectivity for calix-crown hybrid ionophores: Experimental, molecular modelling and crystallographic studies	National Seminar on Confluence of Supra-molecular Chemistry and Nano-science, **January, 2010**	Gujarat University, Ahmedabad	S. Patra, D. Maity, A. Sen, E. Suresh, B. Ganguly and P. Paul
11	Calixarene based fluorescent molecular sensors for selective complexation with Fe^{3+},Cu^{2+} and Ca^{2+}	National Seminar on Confluence of Supra-molecular Chemistry and Nano-science, **January, 2010**	Gujarat University, Ahmedabad	A. Chakraborty, S. Patra and P. Paul
12	Calixarene based fluorescent molecular sensors : Synthesis, crystal structures and ion recognition property	12th Chemical Research Society of India (CRSI), National Symposium in Chemistry, **February, 2010**	IICT, Hyderabad	R. Gunupuru, S. Patra and P. Paul
13	NMR and electrochemical investigation on series of trinuclear double stranded metallohelciates	12th Chemical Research Society of India (CRSI), National Symposium in Chemistry, **February, 2010**	IICT, Hyderabad	S. Nadella, P. Selvakumar and P.S. Subramanian
14	Green bromine for diverse applications	National Workshop on Green Chemistry. **17-18, February, 2010**	The Sant Gadge Baba Amravati University, Amravati Maharastra	S. Adimurthy
15	Zn(II)-2-2':6,2"-terpyridine based complex as fluorescent chemosensor for PPi, AMP and ADP	Gujarat Science Academy, **March, 2010**	Gujarat University, Ahmadabad	P. Das
16	Coupled PeT and resonance energy transfer in a pyrene-anthracene based [2] pseudorotaxane	Gujarat Science Academy, **March, 2010**	Gujarat University, Ahmadabad	A.K. Mandal, M. Suresh, M. Agarwal and A. Das

Salt and Marine Chemicals Discipline

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Atomic absorption spectroscopy- A technique for the estimation of trace metal elements in a sample	Workshop on Strengthening the Quality Control in the Laboratories of Salt Dept., Govt. of India **29, August, 2009**	Salt Department Seminar Hall, Gandhidham	R.J. Sanghavi and B. Rebary
2	R&D innovations on salt	International Salt Summit **23, January 2010**	Nirma Institute of Technology, Ahmedabad	V.P. Mohandas and Scientists of SMC Disc.
3	Production of high quality industrial grade salt from brines	Seminar on Orientation Course for Salt Manufacturers and Salt Department Officials **22, February 2010**	Salt Department Seminar Hall, Tuticorin (TN)	V.P. Mohandas

Inorganic Materials and Catalysis

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Solar photo-catalytic degradation of methylene blue dye using coated semiconductor nano-particles	National Seminar on Nano-sized Semiconductor Materials, **2009**	Manchar, Pune, Maharashtra	N. Thillai Sivakumar, R.J. Tayade and S. Maiti
2	Development of value-added products: Alternatives for solid waste utilization from nitrophosphate fertilizer and diamond mining industry	First International Conference on Recycling and Reuse of Materials (ICRM – 2009), **17-19, July, 2009**	Kottayam, Kerala	R.S. Somani, H.M. Mody, J.R. Chunnawala, M.V. Sheth, R.V. Jasra and H.C. Bajaj
3	Highly enantio-selective synthesis of chiral β-aminoalcohols using chiral monomeric and polymeric Ti (IV) salen complexes as catalysts	Symposium of the Chemical Research Society of India, **23-24, July, 2009**	Shri Govindram Seksaria Institute of Technology and Science, Indore, M. P.	R.I. Kureshy, M. Kumar, K. JeyaPrathap, S. Agrawal, B. Dangi, N.H. Khan, S.H.R. Abdi and H.C. Bajaj
4	Microwave synthesized mesoporous vanadium MFI catalyst for epoxidation of styrene using molecular oxygen	Workshop on Applications of Nanoporous Materials (PRE ZMPC-2009), **30, July - 1, August, 2009**	Inha University, Incheon, South Korea	J.K. Mohan

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
5	Adsorption of CO, CH_4 and N_2 on nickel ion exchanged zeolite NaX	12th International Symposium on Inorganic Ring Systems (IRIS-12), **16-21, August, 2009**	Goa	G. Sethia, R.S. Somani and H.C. Bajaj
6	Green thrust in CSMCRI's R&D	Indo-Hungarian Workshop on Green Chemistry, **14-15, September, 2009**	IISc., Bangalore	H.C. Bajaj
7	Ligand design in asymmetric catalysis: Chiral schiff bases - A case study	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	S.H.R. Abdi
8	Recyclable chiral dimeric V(V) salen complex catalyzed enantioselective addition of trimethylsilyl cyanide to *N*-benzylimines	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	R.S. Saravanan, N.H. Khan, R.I.Kureshy, S.H.R. Abdi, and H.C. Bajaj
9	Photocatalytic degradation of methylene blue dye using TiO_2 coated optical fiber	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	N. ThillaiSivakumar, H.C. Bajaj and R.J. Tayade
10	Oxidation of methane by molecular oxygen catalyzed by heterogeneously supported MoO_3 and Ga_2O_3 on HZSM-5	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	M.D. Khokhar, R.S. Shukla and R.V. Jasra*(First Prize for Best Poster Presentation)*
11	A novel di-cationic reusable chiral Cr(III) salen catalyst for aminolytic kinetic resolution (AKR) of *trans* aromatic epoxides	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	K. Jeya Prathap, R.I. Kureshy, N.H. Khan, S.H.R. Abdi and H.C. Bajaj

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
12	Co-SSZ-51 catalyzed epoxidation of styrene using molecular oxygen	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	J.K. Mohan, S.M. Pai, B.L. Newalkar, N.V. Chaudhary and R.V. Jasra
13	Liquid phase epoxidation of styrene with molecular O_2 over sulfated Co-Y-ZrO_2 solid catalyst under microwave and thermal heating	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	B. Shaik, B. Tyagi and H.C. Bajaj
14	Solvent free isomerization of α-pinene using zirconia-silica mixed oxides	National Symposium on Emerging Horizons in Catalysis, **25-26, September, 2009**	M.S. University, Vadodara, Gujarat	K.B. Sidhpuria, B. Tyagi and R.V. Jasra
15	Synthesis and characterization of semiconductor nano material for photocatalytic degradation of pollutants in water	National Seminar on Nanosized Semiconducting Materials, **5-7, November, 2009**	Annasaheb Awate Arts, Commerce and Hutatma Babu Genu Science College, Pune	R.J. Tayade
16	Solar photocatalytic degradation of methylene blue dye using coated semiconductor nanoparticles	National Seminar on Nanosized Semiconducting Materials, **5-7, November, 2009**	Annasahebawate Arts, Commerce and Hutatma Babu Genu Science College, Pune	S.N.Thillai, R.J. Tayade and S. Maiti *(First Prize for Best Poster Presentation)*
17	A simple dechlorination route to synthesis of carbon nanostructures with unique morphologies using solvothermal method	Advanced Nanomaterials and Nanotechnology (ICANN-2009), **9-11, December, 2009**	Centre for Nanotechnology, IIT, Guwahati	S.Y. Sawant, R.S. Somani and H.C. Bajaj
18	Enantioselective synthesis of chiral β-aminoalcohols via aminolytic kinetic resolution of racemic *trans* epoxides catalyzed by Cr (III) salen complex in ionic liquid	National Conference on Chemistry for the Protection of Environment (NCCPE), **18-19, December, 2009**	Department of Chemistry, Priyadarshini Institute of Engineering and Technology, Nagpur, Maharashtra	M. Kumar, R.I. Kureshy, N.H. Khan, S.H.R. Abdi, and H.C. Bajaj

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
19	$Fe(Cp)_2PF_6$: An efficient catalyst for direct Mannich reaction under solvent free-condition	National Conference on Chemistry for the Protection of Environment (NCCPE), **18-19, December, 2009**	Department of Chemistry, PIETy, Nagpur, Maharashtra	P. Bera, R.I. Kureshy, N.H. Khan, S.H.R. Abdi, and H.C. Bajaj
20	Microwave assisted solvent-free synthesis of α, α'-bis (substituted benzylidene) cycloalkanones catalyzed by sulfated zirconia	International Conference on Materials for the Millennium, **11-13, January, 2010**	Cochin University of Science and Technology, Kochi, Kerala	S.V. Jadhav and H.C. Bajaj
21	Mesoporous sulfated zirconia: Synthesis, characterization and catalytic application towards solvent free synthesis of acetal and ketal	International Conference on Materials for the Millennium, **11-13, January, 2010**	Cochin University of Science and Technology, Kochi, Kerala	A. Sinhamahapatra, M. Ghose, N. Sutradhar, H.C. Bajaj and A.B. Panda
22	$HRh(CO)(PPh_3)_3$ encapsulated hexagonal mesoporous silica as heterogeneous catalyst for hydroformylation : Effect of surfactant chain length	International Conference on Materials for the Millennium, **11-13, January, 2010**	Cochin University of Science and Technology, Kochi, Kerala	N. Sudheesh, J.N. Parmar, S.K. Sharma and R.S. Shukla
23	$Co/P(Biph)_3TS$ catalyzed hydrofor-mylation of higher olefins in the aqueous biphasic system	International Conference on Materials for the Millennium, **11-13, January, 2010**	Cochin University of Science and Technology, Kochi, Kerala	A.A. Dabbawala, H.C. Bajaj and E. Monflier
24	Effective removal of chromate anion using as-synthesized CoAl LDHs and its potential application in oxidation reactions	International Conference on Materials for the Millennium, **11-13, January, 2010**	CochinUniversity of Science and Technology, Kochi, Kerala	C.M. Jinesh, S. Sivashunmugam, D.S. Bhadoria, C.A. Antonyraj and S. Kannan
25	Adsorption of Hg^{2+} from aqueous solution of mercury chloride on thiol - functionalized silica gel with different loading of marcapto propyl trimethoxysilane	6^{th} All Gujarat Research Scholars Meet (AGRSM-VI), **31, January, 2010**	M.S. Univeristy, Vadodara, Gujarat	V. Manu, H.M. Mody and H.C. Bajaj

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
26	Antibacterial activity of organically modified Indian bentonite and attapulgite clay	6th All Gujarat Research Scholars Meet (AGRSM-VI),**31, January, 2010**	M.S. Univeristy, Vadodara, Gujarat	R.R. Pawar, R. Jain, A. Bhatt, P. Sakaria, J. Bhatt, K.H. Mody, H.M. Mody and H.C.Bajaj
27	Characterization, beneficiation and application of attapulgite samples from Gujarat state	6th All Gujarat Research Scholars Meet (AGRSM-VI),**31, January, 2010**	M.S. Univeristy, Vadodara, Gujarat	P.L. Sakaria, A.S. Bhatt, R.R. Pawar, H.M. Mody, J.G. Bhatt and H.C. Bajaj
28	Preparation of enantioselective composite polymer membrane for optical resolution of α-amino acids.	6th All Gujarat Research Scholars Meet (AGRSM-VI),**31, January, 2010**	M.S. Univeristy, Vadodara, Gujarat	P.G. Ingole, K. Singh and H.C. Bajaj *(Second Prize for Best Poster Presentation)*
29	Inorganic materials based novel catalysts in the reactions of the C_1 chemicals	Seminar on Advances in Chemical Sciences, **31, January, 2010**	Department of Chemistry, Municipal Arts and Urban Bank Science College, Mehsana, Gujarat	R.S. Shukla
30	Adsorptive separation for CO_2 capture using modified zeolites	Afro-Asian Conclave for Young scientists, **11-13, February, 2010**	JNCASR, Bangalore	R.S. Somani
31	Catalytic isomerization to perfumery chemicals by layered double hydroxides and their modified forms as solid bases	Indo-Hungarian Workshop on Future Frontiers in Catalysis, **16-18, February, 2010**	Indian Institute of Technology, Chennai	S. Kannan
32	In situ powder X-ray diffraction – An excellent tool for materials characterization	National Workshop on X-ray Diffraction Techniques and Applications-NWXRD-2010, **17-19, March, 2010**	Saurashtra University, Rajkot	S. Kannan

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
33	Synthesis of propylene carbonate from propylene oxide and carbon dioxide: Effect of hydrotalcite and solvent	XXIV – Gujarat Science Congress, **21, March, 2010**	Gujarat University, Ahmedabad, Gujarat	C. Murugan and H.C. Bajaj
34	Two dimensional nano LDH sheets – A versatile material for diversified applications	A Nano Material Research Awareness Program (NMRAP-10), **26, March, 2010**	Bhavnagar University, Bhavnagar	S. Kannan
35	Novel UV-LED photo-catalytic reactor setup for degradation of methylene blue dye using titanium dioxide nanotube	National Workshop on Development of Novel Materials for Hydrogen Production and Photocatalysis, **26-27, March 2010**	Bhubaneswar	N. Thillai 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	Diffusion of water in nanofiltration membrane	International Conference in Neutron Scattering, **6-7, May, 2009**	Tennessee, USA	V.K. Sharma, P.S. Singh, S. Gautam, S. Mitra and R. Mukhopadhyay
2	Indigenous TFC reverse osmosis membrane technology for water desalination – Going from lab to field	IWA Membrane Technology Conference & Exhibition, **1-3, September, 2009**	Beijing, China	P.K. Ghosh, S.L. Daga, A.V.R. Reddy, V.J. Shah, S.V. Joshi, J.J. Trivedi, A.P. Rao, N. Pathak, P. Ray, P. Singh, C.V. Devmurai, G.S.Trivedi and K. Eswaran
3	Fouling resistant hollow fiber membranes for drinking water purification and water reclamation	IWA Membrane Technology Conference & Exhibition, **1-3, September, 2009**	Beijing, China	A.V.R. Reddy, P. Ray, P. Singh, T.J. Trivedi, B.K. Thakur, J.J. Trivedi, A.P. Rao and C.V. Devmurari

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
4	Membranes for water recovery from industrial effluents and other waste waters	IWA Membrane Technology Conference & Exhibition, **1-3, September, 2009**	Beijing, China	A.V.R. Reddy, P. Singh, P. Ray, S.V. Joshi, J.J. Trivedi, A.P. Rao, T.J. Trivedi, B.K.Thakur and C.V. Devmurari
5	Small angle neutron scattering investigation of polydimethyl siloxane-pervaporation membranes	Conference on neutron scattering and mesoscopic systems, **12-14, October, 2009**	Goa, India	G.L. Jadav, V.K. Aswal and P.S. Singh
6	Influence of hydrophilic silica nanoparticles to the conformation of hydrophilic polymer chain in dilute solution system	Conference on neutron scattering and mesoscopic systems, **12-14, October, 2009**	Goa, India	P.S. Singh, V.K. Aswal and J. Kohlbrecher
7	Thin film composite hollow fiber membranes: Preparation, characterization and fouling resistant properties for water purification	International Workshop on Advances in Membrane Technology for Water Treatment, Clean Energy and Environment, **7-9, December, 2009**	CGCRI, Kolkata	K. Parashuram, P. Ray, C.V. Devmurari, P. Singh, J.J. Trivedi and A.V.R. Reddy
8	Application of nanofiltration membranes for water reclamation: Treatment of pharmaceutical waste waters	APA International Conference on Polymer Science and Technology: Vision and Scenario, **17-20, December, 2009**	New Delhi	P. Ray, P.S. Singh, S. Saradva, B. Thakur, P. Kallem, J.J. Trivedi, A.P. Rao, G.S. Trivedi and A.V.R. Reddy
9	Separation of rose pigments through photo-modified membranes: A novel approach	Asian Polymer Association International Conference on Advances in Polymer Science & Technology, **27-20, December 2009**	IIT, New Delhi	Yogesh and A. Bhattacharya

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
10	Membrane technologies for desalination and water reclamation: Case studies of CSMCRI	National Conference on Water: Membranes and other purification technologies, **9-10, January, 2010**	Vadodara	A.V.R. Reddy, S.L. Daga, J.J. Trivedi, P.Ray, P.S.Singh, C.V.Devmurai, A.P. Rao, N.Pathak and G.S.Trivedi
11	Preparation, characterization and organic fouling and acid stability of poly (acrylonitrile-co-methacrylicacid) ultrafiltration membranes	National Conference on Water: Membranes and other purification technologies, **9-10, January, 2010**	Vadodara	Y.G. Dave and A.V.R. Reddy
12	Fouling control of submersible membranes by surface modification for water purification application	National Conference on Water: Membranes and other purification technologies, **9-10, January, 2010**	Vadodara	R.V. Matte, D.D. Patel and A.V.R. Reddy
13	Membrane technologies for water recovery from industrial waste waters	InDA-APDA Conference on Desalination and Water Purification, **10-12, March, 2010**	Chennai	P. Singh, P. Ray, J.J. Trivedi, K. Parashuram, S. Sharma, A.P. Rao and A.V.R. Reddy
14	Preparation and surface modification of hollow fiber membranes for drinking water disinfection and water reclamation	InDA-APDA Conference on Desalination and Water Purification, **10-12, March, 2010**	Chennai	P. Ray, P.S. Singh, K. Parashuram, S.R. Maurya, J.J. Trivedi, C.V. Devmurari, N.N. Rao, S. Waghmare and A.V.R. Reddy

Electro membrane Processes

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Production of ultra pure water by continuous electro deionization (CEDI) process using indigenously developed interpolymer ion exchange membranes with improved design of the system	IWA Membrane conference, **September, 2009**	Beijing, China	S.K.Thampy, B.S. Makwana, G.R. Dasale and P.K.Ghosh
2	Sol-gel based zwitterionic polymer electrolyte membranes for CO_2 separation	XXVI EMS Summer School on Membrane Technology for CO_2 Separation **29, September - 2, October, 2009**	GKSS Research Centre, Germany	B.P. Tripathi, S.P. Nunes and V.K. Shahi
3	Heterogeneous-homogeneous composite bipolar membrane for the conversion of sodium salt of homologous carboxylates into its corresponding acid and base by electro-dialysis	National Seminar on Emerging Trends in Polymer Science and Technology, **8-10, October, 2009**	Saurashtra University, Rajkot, Gujarat	T. Chakrabarty, S. Prakash, V.K. Shahi and M. Kumar
4	Organic-inorganic composite cross-linked zwitterionic polymer electrolyte membranes for fuel cell applications	National Seminar on Emerging Trends in Polymer Science and Technology, **8-10, October, 2009**	Saurashtra University, Rajkot, Gujarat	B.P. Tripathi, M. Kumar and V.K. Shahi
5	Cross-linked poly(vinyl alcohol)-poly (acrylonitrile-co-2-dimethylamino ethylmethacrylate) based anion-exchange membranes for electro-membrane applications	6^{th} All Gujarat Research Scholars Meet, **31, January, 2010**	M.S. University, Vadodara Gujarat	S. Singh, M. Kumar and V.K. Shahi
6	High conducting sulfonated poly(ether ether ketone)-ionic liquid composite membrane for fuel cell applications	6^{th} All Gujarat Research Scholars Meet, **31, January, 2010**	M.S. University, Vadodara Gujarat	A.N. Mondal, M. Kumar and V.K. Shahi
7	Cost calculation of various capacity electro-dialysis plants for the desalination of brackish water	Euro-Med conference, **2010**	Tel Aviv, Israel	S.K. Thampy and B.S. Makwana

Marine Biotechnology and Ecology

Sr No	Title of the paper	Name of the Seminar/ Conference	Venue	Author(s)
1	Wonders of algal fluorescent pigments	Recent Developments in Cultured Algae, **4-5, April, 2009**	Andhra University, Visakhapatnam	S.K. Mishra, A. Shrivastav, A.D Jain, S. Mishra and P.K. Ghosh
2	Preparation of superior quality products from Indian agarophytes	7th Asia-Pacific Conference on Algal Biotechnology, **1-4, December, 2009**	Delhi University, New Delhi	R. Meena, K. Prasad and A.K. Siddhanta
3	Grafting of hetero-polysaccharides with hydrophilic polymers	CARBO-XXIV, **7-9, December, 2009**	Lachoo Memorial College of S & T, Pharmacy Wing, Jodhpur, Rajasthan	G.K. Mehta, R. Meena, K. Prasad and A.K. Siddhanta
4	Preparation of biopolymer based nano-composites	National Seminar on Nanotechnology : Today & Tomorrow, **8, March, 2010**	Chem. Engg. Dept. Institute of Technology, Nirma University, Ahmedabad, Gujarat	K. Prasad
5	Isolation and screening of polyhydroxyalkano-ate (PHA) producing bacteria using Jatropha biodiesel co-products as a sole source of nutrients	XXIV Gujarat Science Congress, **21, March, 2010**	Gujarat University, Ahmedabad, Gujarat	B. Shethia, A. Shrivastav, S.K. Mishra, I. Pancha, D. Jain and S. Mishra *(Best Paper Award for Oral Presentation)*
6	A thermoactive α-amylase from a Bacillus sp. isolated from CSMCRI salt farm	XXIV Gujarat Science Congress, **21, March, 2010**	Gujarat University, Ahmedabad, Gujarat	B. Shethia, A.Shrivastav, S.K. Mishra, I. Pancha, D. Jain and S. Mishra

5. Inter Agency Linkages

2008-09

(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	30.943
2	Design, synthesis, characterization of single and double stranded metallohelicates and molecular thread: A Chiro-optical device for recognition	DST, New Delhi	3.00
3	Micropropagation and selection of improved germplasm for cultivation of *Gracilaria dura* (C. Agardh) J. Agardh producing quality agar/agarose for high and application	DBT, New Delhi	3.43
4	Structural property correlation studies of gelling biopolymer agar in aqueous media	DST, New Delhi	3.50
5	Development of membrane bio-reactor for the synthesis of structured lipids from groundnut oil and long chain polyunsaturated fatty acid by inter-esterification using lipase immobilized on membrane	DBT, New Delhi	5.51
6	New synthesis and characterization of chiral inorganic metal complexes as active catalysis for enantioselective synthesis of chiral β-amino alcohols via epoxide-ring opening reaction	DST, New Delhi	3.00
7	Intergeneric protoplast fusion and molecular characterization of somatic hybrids of agarophytes	DST, New Delhi	4.00
8	Non-hazardous bromination with bromine/bromate couple obtained as intermediate of bromine recovery plants: exploratory studies on diverse applications	DST, New Delhi	6.00
9	Design, synthesis and characterization of metal organic framework with rectangular topology and their application	DST, New Delhi	2.00
10	Acetylcholinesterase (ache) inhibitors: the neurotoxic phosphotriesterase substrates and related nerve reagents-conformation, dynamics, hydrolysis and the therapeutic pharmacophores	Department of Atomic Energy, Mumbai	2.697

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
11	Development of enantioselective polymer membrane for optical resolution of chiral compounds	DST, New Delhi	1.50
12	Design, study of DREB and MYC/MYB transcription factors from *Salicornia brachiata* for abiotic stress tolerance in plants	DST, New Delhi	4.00
13	Disinfection of river/pond/ground waters by novel disinfecting polymers	Ministry of Environment & Forests, New Delhi	1.747
14	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	2.15
15	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, Tamil Nadu	1.50
16	Development of transgenic groundnut (A*rachis hypogaea L*.) of enhanced abiotic stress tolerance	DBT, New Delhi	6.19
17	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	10.00
18	Functional modification of agar and kappa-carrageenan for their wider utility in diverse applications	DST, New Delhi	9.50
19	Synthesis of nano-structured polymer composite pervaporation membrane: Characterization of physico-chemical properties and studies on the separation properties for volatile organic compounds (VOCs) removal from water	DST, New Delhi	4.50
20	Molecular polymorphism among different strains of *Dunaliella* (Chlorophyceae; Chlamydomonadales)	DST, New Delhi	10.00
21	Theoretical investigations of adsorption of additives onto the crystal surface of sodium chloride and on other alkyl halides	DST, New Delhi	0.50

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	5.00
23	Sensitized nanoparticles as new hybrid photo-driven devices	DST, New Delhi	5.00
24	Synthesis of monodispersed organic-inorganic hybrid nano-structured materials	DST, New Delhi	11.00
25	High performance nanocomposite polyelectrolyte membranes with low electro-osmotic drag for energy and electrochemical devices	DST, New Delhi	6.50
26	Fluorescent molecular sensors design, synthesis and cation recognition study	DST, New Delhi	2.00
27	Synthesis of chiral hydrocyanins cyclic intermediates for industrially important bio-active compounds through chiral catalytic route	DST, New Delhi	1.50
28	Synthesis of carbohydrate based natural surfactants and evaluation of their performance	DST, New Delhi	1.50
29	Sea water RO desalination plant of 6000 LPH capacity using hollow fibre module for pretreatment	DST, New Delhi	15.00
30	Inhibition of quorum sensing and bacteria communication: Potential for antifouling agents from marine algae	DBT, New Delhi	5.05
31	Sensors for fluoride, calcium and magnesium ions	DST, New Delhi	4.50

(B) COLLABORATIVE PROJECTS

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
1	Development of adsorbents for the recovery of CO_2 from power plant fuel gas	Gujarat Narmada Valley Fertilizers Company Ltd., Bharuch	8.846
2	To Prepare bio-diesel from Jatropha seeds of different origin and carry out performance evaluation by various users	Office of the Forest Sasan-Gir General Motors India Pvt. Ltd., Halol, Mahindra & Mahindra Ltd., Nasik	8.856
3	Exploratory study for conversion of carbide lime of DSCL, Kota, into precipitated calcium carbonate (PCC)	Tripartite Collaboration DSCL, New Delhi & NRDC, New Delhi & CSMCRI, Bhavnagar	4.84
4	Development of a coagulant–cum–disinfectant for water purification	Kanoria Chemicals & Industries Ltd., New Delhi	2.55
5	Developing 2 acre Jatropha plantation at Talegaon, Maharashtra	General Motors India Pvt. Ltd., Halol	13.10
6	Biofuel from eroded soil in India (Germany)	Daimler Chrysler, Germany	1.23

(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	N M S Pharma, Bhavnagar & Pepsico India Holding Ltd., Gurgaon	4.448
2	Supply of RO plants of different capacities to various parties	RSMML, Jaipur; CGCRI, Kolkata; Tata projects Ltd., Hyderabad; CMFRI, Cochin	76.733

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
3	Improving methods of cultivation of *Kappaphyscus alvarezii* and enlarging the range of cultivars	AquAgri Pvt. Ltd., New Delhi	14.89
4	Developing process for producing activated clay for suitable hydrocarbons purification from Gujarat natural bentonite clays	GMDC Science & Research Centre, Ahmedabad	7.50
5	Beneficiation studies of attapulgite for their application in bleaching, oil well drilling & pharmaceutical industries	GMDC Science & Research Centre, Ahmedabad	6.67
6	Development of nanoclays based on bentonite deposits of Gujarat	GMDC Science & Research Centre, Ahmedabad	7.85
7	Development of cleaning method for contaminated membranes for chlor alkali cell	Shriram Vinyl & Chemical Industries, Rajasthan	2.74
8	Improving the quality of salt from Magadi site	M/s. Tata Chemicals Ltd., Mithapur	5.81
9	To study proof of concept for the Merseberg process starting with fluorogypsum	Honeywell International India Pvt. Ltd., Gurgaon, Haryana	4.07

(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	1.288
		Indian Rayon, Veraval	4.75
		Gujarat Construction Ltd., Ahmedabad	4.50
		Cambay Chem Ltd., Ahmedabad	1.199
2	Appointment of CSMCRI as advisor/ Consultant for setting up a 20 MLD desalination facility at Nagaur, Rajasthan	RSMML, Udaipur	3.875
3	Feasibility Study on SOP and MOP	Gujarat State Fertilizer & Chemicals Ltd., Vadodara	3.98

Sr. No.	Project Title	Funding Agency	Amount Received (Rs. in Lakhs)
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	3.42
5	Survey of the area in Rann of Kutch on the Indo-Pak border in Barmer district of Rajasthan and assessing its suitability for salt manufacture	The Commissioner of Industries, Industries Department, Jaipur	5.75
6	To assess the performance of salt washery and storage system at Solarish salt work, Singach	Solarish ChemTech Industries Ltd., Binaga	2.50

2009-10

(A) GRANT–IN–AID PROJECTS

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
1	Collection, identification and chemical investigation of marine flora	Ministry of Earth Sciences, New Delhi	24.856
2	Genetic improvement of *Jatropha curcas* for adaptability and oil yield	TNBD, New Delhi	15.78
3	New synthesis and characterization of chiral inorganic metal complexes as active catalysis for enanioselective synthesis of chiral β-amino alcohols via epoxide-ring opening reaction	DST, New Delhi	3.50
4	Studies on bioaccumulation / biosorption of heavy metals by marine algae of Gujarat coast	Ministry of Earth Science, New Delhi	1.595
5	Sea water RO desalination plant of 6000 LPH capacity using hollow fibre module for pretreatment	DST, New Delhi	15.00
6	Utilisation of distiller waste (aqueous $CaCl_2$/NaCl) of soda ash industry for production of muriate of potash from bittern generated as by-product of salt industry	Ministry of Chemicals & Fertilizers, New Delhi	14.21
7	Design, synthesis and characterization of metal organic framework with rectangular topology and their application	DST, New Delhi	3.00
8	Acetylcholinesterase (AChE) inhibitors: the neurotoxic phosphotriesterase substrates and related nerve reagents-conformation, dynamics, hydrolysis and the therapeutic pharmacophores	Department of Atomic Energy, Mumbai	2.697
9	Development of enantio-selective polymer membrane for optical resolution of chiral compounds	DST, New Delhi	3.00
10	Study of DREB and MYC/MYB transcription factors from *Salicornia brachiata* for abiotic stress tolerance in plants	DST, New Delhi	7.00

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
11	Disinfection of river, pond, ground waters by novel disinfecting polymers	Ministry of Earth Sciences, New Delhi	5.577
12	Two dimensional sheets and interlayers of hydrotalcite-like materials-potential scope of environmental remediation	Ministry of Environment & Forests, New Delhi	4.510
13	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	2.962
14	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	4.438
15	High performance nanocomposite polyelectrolyte membranes with low electro-osmotic drag for energy and electrochemical devices	DST, New Delhi	5.00
16	Synthesis of monodispersed organic-inorganic hybrid nano-structured materials	DST, New Delhi	3.00
17	Sensitized nanoparticles as new hybrid photo-driven devices	DST, New Delhi	2.64
18	Development of chiral catalysts for asymmetric hydroformylation of olefins for the synthesis of chiral drug intermediates	DST, New Delhi	8.00
19	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	4.51
20	Design, synthesis and DNA interaction studies with novel photosensitizer molecules as efficient photodynamic therapeutic reagents.	DBT, New Delhi	20.59
21	Design, synthesis, characterization of single and double stranded metallohelicates and molecular thread: A chiro-optical device for recognition.	DST, New Delhi	0.655

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
22	Structural property correlation studies of gelling biopolymer agar in aqueous media	DST, New Delhi	0.85
23	Design and fabrication of UV-LED based photocatalytic reactor for the purification of contaminated water	DST, New Delhi	5.00
24	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	215.00
25	Pigment biomarkers and spectral fingerprints of mono-specific algae for development of detection algorithms of algal blooms from remote sensing data	Department of Space Application Center (ISRO), Ahmedabad	10.00
26	Sensors for biologically important ions and molecules	DST, New Delhi	20.00
27	A two stage indigenous RO process of 6000 LPH capacity for seawater desalination (2 Nos)	DST, New Delhi	184.82
28	Enhancing power output from commercial silicon PV modules by concentration and selective filtration of incoming solar radiation	DST, New Delhi	11.50
29	Non-hazardous bromination with bromine/bromate couple obtained as intermediate of bromine recovery plants: exploratory studies on diverse applications	DST, New Delhi	5.50
30	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	1.45
31	Photo-regulation of permeability across the membrane: preparation, characterization and separation study	Dept. of Atomic Energy Pay & Accounts Office, Mumbai	0.929
32	The WRKY family transcription factors in Jatropha: Genome-wide cloning and functional analysis	DST, New Delhi	6.64
33	Remotely monitored and controlled high capacity RO plant for desalination of sea water	DST, New Delhi	10.44

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
34	Structure-property correlation studies of imidazolium based room temperature ionic liquids in ethylene glycol derivatives: Thermodynamic and spectroscopic investigations	DST, New Delhi	9.50
35	Synthesis of carbohydrate based natural surfactants and evaluation of their performance	DST, New Delhi	3.40
36	Synthesis of bulk and nano structured magnesium oxide using natural brine/bittern as precursor: Characterization and comparative studies on surface morphology and chemical reactivity	DST, New Delhi	4.00
37	Sea water RO desalination plant of 6000 LPH capacity using hollow fibre module for pretreatment	DST, New Delhi	15.00
38	Synthesis of nano-structured polymer composite pervaporation membrane: Characterization of physicochemical properties and studies on the separation properties for volatile organic compounds (VOCs) removal from water	DST, New Delhi	4.00

(B) COLLABORATIVE PROJECTS

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
1	To prepare bio-diesel from jatropha seeds of different origin and carry out performance evaluation by various users.	Office of the Forest Sasan-Gir General Motors India Pvt. Ltd., Halol, Mahindra & Mahindra Ltd., Nasik	10.934
2	Development of adsorbents for the recovery of CO_2 from power plant flue gas	NTPC, Noida (UP)	16.71
3	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	22.665

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
4	Developing 2 acre Jatropha plantation at Talegaon, Maharashtra	General Motors India Pvt. Ltd., Halol	9.745
5	Exploratory study for conversion of carbide lime of DSCL, Kota, into precipitated calcium carbonate (PCC)	Tripartite Collaboration DSCL, New Delhi & NRDC, New Delhi & CSMCRI, Bhavnagar	5.00
6	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	73.60

(C) SPONSORED PROJECTS

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
1	Know how demonstration for various technologies transferred by CSMCRI to entrepreneurs on charge basis	N M S Pharma, Bhavnagar; Pepsico India Holding Ltd., Gurgaon, Eco Organics, Mumbai	4.448
2	Supply of RO plants of different capacities to various parties	RSMML, Jaipur; CGCRI, Kolkata; Tata projects Ltd., Hyderabad; CMFRI, Cochin	76.733
3	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, Tamil Nadu	0.45
4	Feasibility studies for the preparation of detergent grade zeolite-A from bauxite	M/s. Reminco Resource Pvt. Ltd., Ahmedabad	5.51
5	Feasibility studies on concentration of aqueous acetic acid solution from PTA-RIL plant effluent by RO & ED techniques	M/s. Reliance Industries Ltd., Surat	2.44

(D) CONSULTANCY PROJECTS

Sr. No.	Project Title	Funding Agency	Received amount in year 09-10 (Rs. in lakhs)
1	Marine environmental monitoring work	J H Kharawala Pvt. Ltd., Ahemdabad	0.680
		Indian Rayon, Veraval	2.24
2	Appointment of CSMCRI as Advisor/Consultant for setting up a 20 MLD desalination facility at Nagaur	RSMML, Udaipur	3.875
3	Feasibility study on SOP and MOP	Gujarat State Fertilizers & Chemicals Ltd., Vadodara	3.15
4	Exploring the possibility of valuable chemicals from ZLD projects of tannery sector	Tamil Nadu Pollution Control Board, Chennai	6.92
5	Survey and assessment of mangrove population in Gulf of Khambhat – Kalpasar Project	Executive Engineer, Kalpasar Technical Cell, Bhavnagar	0.828
6	Assessment of baseline, environmental quality and social status on coastal, tidal and marine areas of Kalpasar Project	Kalpasar Technical Cell, Gandhinagar	48.97
7	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	6.58
8	Exploratory studies on free flowing sodium nitrite	Deepak Research & Development Centre, Pune	0.978
9	High strength Plaster of Paris	J K Chemicals, Jamnagar	0.561
10	Removal of nitrobenzene impurity from pigment manufactured by M/s. Atul Ltd.	M/s. Atul Ltd., Atul	0.498

6. Human Resources Development

1. Training Programmes Attended by CSMCRI Staff (2008-09)

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
1	Leadership Development Programme (LDP)	CSIR-HRDC-Ghaziabad, New Delhi	April 20 to May 2 2008	S. Kannan, P.M. Solanki
2	Induction Training Programme for Scientists B and C	CSIR-HRDC-Ghaziabad, New Delhi	May 23 to June 1 2008	Puyam Singh
3	Fifth Training Programme on Enhancement of Managerial Efficiency for Scientists	CSIR-HRDC-Ghaziabad, New Delhi	June 9-13, 2008	H.C. Bajaj
4	Programme on TRIZ (Theory of Inventive Problem Solving) Methods	CSIR-HRDC-Ghaziabad, New Delhi	Aug. 25-27, 2008	Arvind Kumar
5	Training Programme for Assistant (Admn..)	CSIR-HRDC-Ghaziabad, New Delhi	Sep. 1-5, 2008	D.R. Thangadi, A.S. Badheka
6	Leadership Development Programme (LDP)	CSIR-HRDC-Ghaziabad, New Delhi	Nov. 18-30, 2008	B. Jha
7	Awareness Programme on RTI	CSIR-HRDC-Ghaziabad, New Delhi	Jan. 29-30, 2009	D.B. Shukla
8	Leadership Development Programme (LDP)	CSIR-HRDC-Ghaziabad, New Delhi	Feb. 1-13, 2009	R.S. Shukla, Girish Desale
9	Programme on Reservation in Service	CSIR-HRDC-Ghaziabad, New Delhi	Mar. 2-5, 2009	K. Rajagopalan, C.B. Gohil, S. Sharma
10	Programme for PS/PA	CSIR-HRDC-Ghaziabad, New Delhi	Mar. 17-19, 2009	V.M. Rajan, V.J. Gohil
11	Leadership Development Programme (LDP)	CSIR-HRDC-Ghaziabad, New Delhi	Mar. 22 to Apr. 3, 2009	P.S. Subramanian

2. Training Programmes Attended by CSMCRI Staff (2009-10)

Sr. No.	Title of the programme	Organizer	Date	Name of the staff
1	Programme on Initiative & Innovation for Managerial effectiveness	CSIR-HRDC-Ghaziabad, New Delhi	June 15-17, 2009	K. Rajagoplan
2	Induction Training Programme for Newly Recruited Scientists	CSIR-HRDC-Ghaziabad, New Delhi	July 27 to Aug. 1 2009	Babulal Rabary, Rajesh Patidar
3	Training Programme for Assistant (Admn.)	CSIR-HRDC-Ghaziabad, New Delhi	Oct. 28-30, 2009	Y.R. Trivedi, D.R.Thengadi
4	Training Programme for Section Officer (S&P)	CSIR-HRDC-Ghaziabad, New Delhi	Nov. 11-13, 2009	Joy M. Kottaram
5	Training Programme on Life After Retirement	CSIR-HRDC-Ghaziabad, New Delhi	Nov. 23- 25, 2009	B.G. Shah, R.H. Trivedi, B.D. Shethia, A.K. Saha, U.P. Saraiya

3. M.Sc / M.Tech / M.E Thesis Submitted (2008-09)

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
1	Ms. Kavita Sukhadia	M.Sc.	Molecular characterization and diversity analysis of γ-irradiated mutants of *Jatropha curcas* using RAPD fingerprinting	Dr. M.P. Reddy	BRD School, SP University, VV Nagar
2	Ms. Neetu Gupta	M.Sc.	Up-gradation of salt produced from sea water/subsoil brine	Dr. A.M. Bhatt	Bhavnagar University, Bhavnagar
3	Ms. Jadav Rushita	M.Sc.	Molecular characterization of half sib mutant population of *Jatropha curcas* obtained from mutant population using RAPD fingerprinting	Dr. M.P. Reddy Dr. D.R. Choudhary	PM Patel College, Anand

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
4	Mr. Vivek Gandhi	M.Sc.	Studies on cellulase from marine bacteria	Dr.(Mrs) K.H. Mody	BRD School, SP University, VV Nagar
5	Ms. Arti Dwivedi	M.Sc.	Ruthenium based heterogeneous catalyst system for selective oxidation of cyclohexane by molecular oxygen	Dr. R.S. Shukla	Devi Ahilya Vishva Vidyalaya, Indore
6	Ms. Prachiben Bhadreshbhai Pathak	M.Sc.	JaCasDmarD-base: a database for the maintenance and managing the DNA marker data for *Jatropha curcas* L.	Dr. M.P. Reddy	GH Patel PG Department of Computer Sciences and Technology, VV Nagar
7	Ms. Virha N.Kesharia	M.Sc.	Micropropagation and regeneration of *Jatropha curcas*	Dr. M.P. Reddy	GH Patel PG Department of Computer Sciences and Technology, VV Nagar
8	Mr. Midhun Chandran	M.Sc.	Synthesis and characterization of titanium nanotube for degradation of dyes and organic compounds	Dr. R.J. Tayade	Cochin University, Kochi
9	Mr. Lishil Silvester	M.Sc.	Aldol condensation of furfural and acetone and ensuing hydrogenation over binary hydrotalcites and their Pd-modified forms	Dr. S. Kannan	Cochin University, Kochi
10	Mr. Tharun Jose	M.Sc.	Eco-friendly self aldol condensation of C_3-C_7 linear aldehydes in a solvent free environment using amine functionalized chitosan as a solid base catalyst	Dr. R.S. Shukla	Cochin University, Kochi

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
11	Mr. Balchand Dangi	M.Sc.	Highly enantioselective syntheses of chiral β-aminoalcohols using chiral monomeric and polymeric Ti(IV) salen complexes as catalysts	Dr.(Mrs.) R.I. Kureshy	GS Institute of Technology and Science, Indore
12	Mr. Sheikh Sadie Ahmed	M.Sc.	Enantioselective cyanoformylation of aldehydes using chiral Ti(IV) salen complexes	Dr. N.H. Khan	Devi Ahilya Vishva Vidyalaya, Indore
13	Mr. Deep Singh Bhadoria	M.Sc.	Removal and recovery of chromate using nitrate containing Co-Al LDHs	Dr. S. Kannan	Devi Ahilya Vishva Vidyalaya, Indore
14	Mr. Vaibhav Jain	M.Sc.	Cross species amplification and diversity analysis of genus *Jatropha* using novel microsatellites isolated from *Jatropha curcas* L."	Dr. M.P. Reddy	Devi Ahilya Vishva Vidyalaya, Indore

4. M.Sc / M.Tech / M.E Thesis Submitted (2009-10)

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
1	Mr. Sandip Kumar Nandi	M.Sc.	Synthesis and characterization of sulfated zirconia-silica	Dr. H.M. Mody	ISM University, Dhanbad
2	Mr. Malay Ghosh	M.Sc.	Synthesis, characterization and application of solid acid catalyst for different industrially important organic reactions	Dr. A.B. Panda	ISM University, Dhanbad

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
3	Mr. Dhaval Vadhavana	M.Sc.	Effects of organic amendments using *Jatropha* cake— a by-product of biodiesel process—on soil physicochemical, microbial and bio-chemical properties in *Jatropha curcas* plantation	Dr. Arup Ghosh	Ashok Rita College, VV Nagar
4	Ms. Anuradha Roy	M.Sc.	Sonochemical synthesis, characterization and catalytic activity of sulfated zirconia solid acid catalyst for esterification of caprylic acid	Dr.(Mrs) Beena Tyagi	Devi Ahilya Vishva Vidyalaya, Indore
5	Ms.Zahabiya Dhankot	M.Sc.	Studies on salicylic acid induced some physiological & biochemical parameters of *Jatropha curcas*	Dr. J. Chikara	BRD School of Biosciences, VV Nagar
6	Ms. Vacha D.Bhatt	M.Sc.	Molecular characterization and comparative diversity analysis using dominant and codominant markers among elite germplasm of *Jatropha curcas* L.	Dr. J. Chikara	Virani Science College, Saurashtra University, Rajkot
7	Mr. Bhavik J Patel	M.Sc.	Studies on pruning and sea weed sap on in vitro cultures of *Simmondsia chinensis*	Dr.(Ms) Aneesha Singh	Saurashtra University, Rajkot
8	Ms. Kruti Jani	M.Sc.	Regeneration of *Jatropha curcas* and *Simmondsia chinesis*	Dr.(Ms) Aneesha Singh	M B.Patel Science College, Anand.
9	Mr. P.Yowan Jeba Raj	M.Sc.	Anion/metal ion directed helicates. Synthesis, spectral characterization and single crystal X-ray structure	Dr. P.S. Subramanian	Manonmaniam Sundaranar University, Tirunelveli

Sr. No.	Name of the Research Fellow	Degree	Title of the Thesis	Name of Supervisor	Name of the University
10	Ms. Molly Thomas	M.Sc.	Kinetic study of degradation of dyes in presence of UV-LED based photocatalytic reactor	Dr. R.J. Tayade	Devi Ahilya Vishva Vidyalaya, Indore
11	Ms. Kanchan Kushwaha	M.Sc.	Water vapour sorption on porous materials	Dr. R.S. Somani	Devi Ahilya Vishva Vidyalaya, Indore
12	Ms. Kavita Meena	M.Sc.	Isolation, purification and identification of marine bacteria producing carboxymethyl cellulase and alginase	Dr. (Mrs) K.H. Mody	Vikram University, Ujjain
13	Mr. Arpan D Bhatt	M.Sc.	Report on microsatellite markers characterization and analysis	Dr. M.P. Reddy	Nirma University, Ahmedabad
14	Mr. Nishant G. Bhadiyadra	M.Sc.	Chemical mutagenesis in *Jatropha curcas* using DES and their molecular characterization by RAPD fingerprinting	Dr. M.P. Reddy Dr. J. Chikara	Virani Science College, Saurashtra University, Rajkot
15	Mr. Danik D. Patel	M. Tech	Preparation of novel thin film composite membranes for desalination	Dr. A.V.R. Reddy	SVNIT, Surat
16	Mr. Rahul V Matte	M. Tech	Studies on submersible membrane based water purification systems	Dr. A.V.R. Reddy	SVNIT, Surat
17	Mr. Bhavin Khatri	M. Tech	Desalination of sub-soil brine using exhaust gas heat of diesel engine	Dr. G.R. Desale	Nirma University, Ahmedabad
18	Ms. Shruti D. Raval	M.E.	Design, fabrication and performance study of a solar powered adsorption chiller	Dr.(Mrs) S. Maiti	MS University, Vadodara

5. Ph.D. Thesis Submitted (2008-09)

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
1	Mr. Jaydevsinh M. Gohil	Studies on the use of polyvinyl alcohol in pressure and potential driven membranes	Dr (Mrs.) Paramita Ray	Bhavnagar University
2	Mr. Lakshminarayanan P.	Development of receptors for recognition of halides and water clusters: Further functionalization of receptors with fluorophoric units	Dr. Pradyut Ghosh	Bhavnagar University
3	Mr. V. Veeraguranathan	Studies on uptake and assimilation of nitrogen sources in Indian agarophytes	Dr. M. Ganesan	Madurai Kamaraj University
4	Mr. K. Suresh Kumar	Studies on cultivation and the biochemical constituents of *Kappaphycus alverezi* (Doty) doty	Dr. P.V. Subba Rao	Bhavnagar University
5	Ms. Pathak Kavita	Heterogeneous and homogeneous chiral catalysts for synthesis of chiral drug intermediates	Dr. S.H.R. Abdi	Bhavnagar University
6	Mr. Achyut Bhatt	Chiral metal complexes as catalysts in the synthesis of chiral pharmaceuticals under homogeneous and heterogeneous conditions	Dr. R.V. Jasra	Bhavnagar University
7	Mr. Hasmukh Patel	Synthesis and characterization of nanoclays for polymeric nanocomposites paints and adsorption applications	Dr. R.V. Jasra	Bhavnagar University
8	Mr. K. Ganesan	Studies on edible species of *Entromorpha* from Gujarat coast	Dr. P.V. Subba Rao	Bhavnagar University

6. Ph.D. Thesis Submitted (2009-10)

Sr. No.	Name of the Research Fellow	Title of the Thesis	Name of Supervisor	Name of the University
1	Mr. Nitish Kumar	Studies on regeneration and genetic transformation in *Jatropha curcas*	Dr. M.P. Reddy	Bhavnagar University
2	Mr. Santosh Agarwal	Asymmetric synthesis of pharmaceutically important cyanohydrins through chiral catalytic route using chiral Lewis acid based metal complexes	Dr. N.H. Khan	Bhavnagar University
3	Mr. D.V.N. Sudheer Pamidimarri	Studies on molecular diversity in Jatropha and development of molecular makers	Dr. M.P. Reddy	Bhavnagar University
4	Mr. Vishal J. Mayani	Chirally modified silica for separation and asymmetric catalysis	Dr. S.H.R. Abdi	Bhavnagar University
5	Mr. Manoj Agarwal	Studies of in situ generation of hypohalous acids from stable salt mixture through acid activation and their application in eco-friendly halogenations reactions	Dr. P. K. Ghosh	Bhavnagar University
6	Ms. Sweta Singh	Studies on micropropagation and molecular analysis of *Jatropha curcas* provenances	Dr. M.P. Reddy	Bhavnagar University
7	Arunima Saxena	Selective transport and separation of bio-molecules using charged membranes	Dr. V.K. Shahi	Bhavnagar University
8	Natear Singh	Molecular cloning of peroxisomal ascorbate peroxidase (*pAPX*) gene from *Salicornia brachiata* and it's over expression in peanut (*Arachis hypogaea* L.) for abiotic stress tolerance	Dr. B. Jha	Bhavnagar University
9	Sumitra Dutta	Microbial diversity and characterization of alkaliphilic bacteria	Dr. B. Jha	Bhavnagar University

7. Awards and Recognitions

2008-09

Sr. No	Awards and Recognition	Awardee(s)
1	Dr. P.K. Bhattacharyya Young Scientist Award 2008 in recognition to outstanding contribution in the field of inorganic photochemistry	Dr. D. Amilan Jose
2	CSIR Award for S&T Innovation for Rural Development 2008 - (Innovations in the area of salt for rural development)	Dr. P.K. Ghosh and Scientists of Salt & Marine Chemicals Discipline
3	Elected as a Fellow of National Academy of Sciences (FNASc), India (2008-2009)	Dr. P. V. Subba Rao
4	Top Reviewer in 2007-09, for exceptional contribution to the quality and success of Food Hydrocolloids. Elsevier Ltd., Oxford, UK	Dr. Kamalesh Prasad

2009-10

Sr. No	Awards and Recognition	Awardee(s)
1	D M Trivedi Life Time Award for contribution to Indian Chemical Industry (Education & Research) - 2009	Dr. P.K. Ghosh
2	Elected as Fellow of the National Academy of Sciences (FNASc), India (2009-10)	Prof B. Jha
3	Member, Editorial Board, Journal of Applied Phycology (Springer) (2009-10)	Dr. C.R.K. Reddy
4	Secretary, Catalysis Society of India	Dr. S. Kannan
5	CRSI Bronze Medal	Dr. Amitava Das
6	Elected as the Fellow of Indian Academy of Sciences (FASc)-2010	Dr. P.K. Ghosh
7	Elected as the Fellow of Indian Academy of Sciences (FASc)-2010	Dr. Amitava Das
8	Young Scientist Award by Bioved Research Society Allahabad, India - 2009	Mr. Ajeet Singh

Membership of Scientific Societies and Committees

S No	Name of the scientist	Name of the committee
1	Dr. S. Kannan	1. Negotiation Committee & Task Force Committee for E-journals Consortium (CSIR) - Member 2 National Executive Committee & Secretary, Catalysis Society of India
2	Dr. R.S. Shukla	1. Life Member of National Academy of Sciences, India, Allahabad from 1991 2. Life Member of Catalysis Society of India, from 1996 3. Member, Inorganic Chemicals Sectional Committee CHD-1 of Bureau of Indian Standards, New Delhi, from 2001
3	Dr. K. Eswaran	1. Member, Research Advisory Committee, Gulf of Mannar, Biosphere Reserve Trust 2. Joint Secretary, Seaweed Research and Utilization Association
4	Dr. A.K. Siddhanta	1. Member on the Editorial Board (2008-2012) of Indian Journal of Marine Sciences, NISCAIR, CSIR, New Delhi 2. Member of the Bhavnagar University Court (Senate) (October 2008 - October 2013) 3. Fellow of the Indian Chemical Society (Life Member) - 1989 4. Life Member (1995) of Seaweed Research and Utilization Association, Chennai 5. Life Member (1998) of Indian Society of Chemists and Biologists, Lucknow
5	Dr. P.K. Ghosh	1. Chairman, Programme Advisory Committee (Water Technology), Department of Science & Technology, Govt. of India 2. Chairman, Inorganic Chemical Sectional Committee, Bureau of Indian Standards (BIS), New Delhi 3. Chairman, Programme Advisory Committee (Inorganic Chemistry), Department of Science & Technology, Govt. of India 4. Member, High Level Expert Committee, Ministry of New and Renewable Energy, Govt. of India 5. Coordinator, Bioresource-based energy, Indo-Brazil Science Council 6. Member, Research, Design & Development Appraisal Committee, Ministry of New and Renewable Energy, Govt. of India 7. Member, Task Force in Green Chemistry, Department of Science & Technology, Govt. of India

S No	Name of the scientist	Name of the committee
		8. Member, Expert Committee, Petroleum, Chemicals and Petrochemical Investment Region, Haldia, West Bengal 9. Member, Task Force for Reinvigorating Indian Agriculture through S&T, Ministry of Science & Technology, Govt. of India 10. Member, Board of Directors, Hindustan Salts & Sambhar Salts Ltd., Jaipur 11. Member of Board of Governors, Gujarat Institute of Desert Ecology, Bhuj 12. Member, Advisory Board, GSFC Science Foundation 13. Member, Gujarat Council of Biotechnology, Govt. of Gujarat 14. Member, Board of the School of Chemistry, University of Hyderabad, Hyderabad 15. Member, Management Board of OASTC, Bhavnagar University, MoES

8. Deputation abroad: CSMCRI Scientists & Research Scholars

2008-2009

Sr. No	Name	Purpose of Visit	Duration
1	Mr. A.A. Patel	For commissioning of RO plant at Malindi, Mombasa, Kenya	29/04/2008 to 17/05/2008
2	Mr. M.R. Gandhi	To collect the information on salt production process at Magadi from the lake brine that contains soda ash and sodium fluoride in addition to salt, Magadi-Africa	19/05/2008 to 25/05/2008
3	Dr. K. Eswaran	To survey the coastal areas of Mauritius and Rodrigues for the development of seaweed industries in Mauritius. Under Mauritius Research Council's project on "Development of Seaweed Industry" in Mauritius Rodrigues, Mauritius	23/06/2008 to 30/06/2008
4	Dr. Bishwajit Ganguly	For discussion on India–Croatia project entitled "Pores and channels by assembly of cyclic beptides: Design, molecular modeling and synthesis" at the host institution-Rudjer Boskovic Institute, Zagreb, Croatia under Indo-Croatia Programme of Cooperation in S&T	24/06/2008 to 04/07/2008
5	Dr. P.K. Ghosh	Visit to Mauritius for interactions with senior officials to identify specific areas of collaboration and to formalize arrangements	25/06/2008 to 29/06/2008
6	Dr. V.K. Shahi	Sir C.V. Raman Research Fellowship Program 2008-09 – Awarded by CSIR, India to carry out a project entitled "To enhance the understanding of organic-inorganic nanocomposite polyelectrolyte membranes" at Virginia, USA	01/08/2008 to 31/01/2009
7	Dr. Amitava Das	To pursue the collaborative research work on "Sensitized nano-particles as new hybrid photo-driven devices" under DST-UKIERI Project, Sheffield University, UK	11/08/2008 to 25/08/2008
8	Miss Amrita Ghosh	To carryout research in developing the hybrid material where the photoactive complexes shall be anchored on the nanoparticulate TiO_2 surfaces and to use them for DNA interaction studies under DST-UKIERI Project, Sheffield University, UK	11/08/2008 to 07/11/2008

Sr. No	Name	Purpose of Visit	Duration
9	Dr. A.V.R. Reddy, Shri S.L. Daga	To work out the detailed work plan for the joint strategic project on "Low energy membrane for water desalination" between CSMCRI, Bhavnagar and CSIRO, Australia	05/10/2008 to 10/10/2008
10	Dr. Amitava Das	To pursue the collaborative research work on "Sensitized nano-particles as new hybrid photo-driven devices" under DST-UKIERI Project, Sheffield University, UK	21/10/2008 to 05/11/2008
11	Dr. P.K. Ghosh	Visit to Israel as a Member of Indian delegation for attending Indo-Israel S&T Meeting held at Jerusalem, Israel	08/11/2008 to 10/11/2008
12	Mr. Manoj K. Gupta	For participation in Vth Asian Pacific Phycological Forum (APPF), and presented a paper entitled "Salinity induced changes in antioxidant enzymes and biochemical components in the red alga *Gracilaria corticata*" Wellington, New Zealand	10/11/2008 to 14/11/2008
13	Dr. Indrajit Mukhopadhyay	To participate in a program organized by Chubu Science & Technology Centre Foundation-CSTC, at Nagoya Institute of Technology, Japan	15/11/2008 to 15/06/2009
14	Dr. P.K. Ghosh	To deliver a plenary lecture at the "Jatropha International Congress" during 17-18 December, 2008 and also to participate in a one day pre-congress workshop 'Jatropha Biology Quality and Plantation", Singapore	16/12/2008 to 18/12/2008

2009-2010

Sr. No	Name	Purpose of Visit	Duration
1	Mr. Mosae Selvakumar Paulraj	Visit to Germany under the short term DAAD Fellowship for Ph.D. students of India, Germany	01/05/2009 to 31/10/2009
2	Mr. Bijay Prakash Tripathi	Visit to Germany under the short term DAAD Fellowship for Ph.D. students of India, Germany	01/05/2009 to 31/10/2009
3	Miss Anupama Srivastava	Visit to Germany under the short term DAAD Fellowship for Ph.D. students of India, Germany	01/05/2009 to 31/10/2009
4	D.R. Chaudhary	BOYSCAST Fellowship - Visited School of Environment and Natural Resources, The Ohio State University, Columbus, USA	20/05/2009 to 19/05/2010

Sr. No	Name	Purpose of Visit	Duration
5	Dr. P.S. Singh	Bavarian Research Fellowship (Bavarian Research Foundation, International Program) to carry out a research project entitled "Enhanced CO_2 separation using modified inorganic membranes" at Institute of Chemical Reaction Engineering, University of Erlangen-Nürnberg, Erlangen, Germany	01/06/2009 to 30/11/2009
6	Miss Amrita Ghosh	For participation in the 59th Meeting of Noble Laureates & Students at Lindau, Germany, followed by one week visit to various research institutions in Germany	26/06/2009 to 13/07/2009
7	Mr. Moorthy Suresh	For participation in the 59th Meeting of Noble Laureates & Students at Lindau, Germany, followed by one week visit to various research institutions in Germany	26/06/2009 to 13/07/2009
8	Dr. S. Kannan	Sir C.V. Raman Research Fellowship Program 2009-10 – Awarded by CSIR, India, to do research work in collaboration with Prof. Thomas E. Mallouk, Dept. of Chemistry, The Pennsylvania State University, USA on "Layered materials for anion exchange & heterogeneous catalysis"	01/07/2009 to 30/11/2009
9	Shri B.P. Rathod, Shri A.M. Makwana	For installation of 5 new RO plants and checking of earlier 6 RO plants supplied by CSMCRI at NCA-Kabul, Afghanistan	16/07/2009 to 31/07/2009
10	Mr. Jinka Krishna Mohan	Lecture presentation entitled "Microwave synthesized mesoporous vanadium MFI catalyst for epoxidation of styrene using molecular oxygen" at Pre ZMPC Workshop on "Application of Nanoporous Materials", Inha University, Incheon, S. Korea	30/07/2009 to 01/08/2009
11	Dr. A.V.R. Reddy	For participation and presenting three accepted papers at IWA Membrane Technology Conference & Exhibition 2009, Beijing, China	01/09/2009 to 03/09/2009
12	Miss Amrita Ghosh	To carryout research in developing the hybrid material where the photoactive complexes shall be anchored on the nanoparticulate TiO_2 Surfaces, Sheffield University, UK	10/10/2009 to 30/11/2009
13	Mr. Priyadip Das	To carryout research in developing the hybrid material where the photoactive complexes shall be anchored on the nanoparticulate TiO_2 Surfaces, Sheffield University, UK	10/10/2009 to 30/11/2009

Sr. No	Name	Purpose of Visit	Duration
14	Prof. B. Jha	Indo-German Collaboration in Biotechnology for implementation of the joint research project entitled “Inhibition of quorum sensing and bacterial communication: Potential for antifouling agents from marine algae”, Munich, Germany	19/10/2009 to 18/12/2009
15	Ms. Iti Gontia	Under Indo-German Collaboration in Biotechnology for implementation of the joint research project entitled “Inhibition of quorum sensing and bacterial communication: Potential for antifouling agents from marine algae”, Munich, Germany	19/10/2009 to 18/12/2009
16	Mr. M.R. Gandhi	As a member of Indian delegation of Ministry of New and Renewable Energy, Govt. of India under an MoU on cooperation in the development of bio-fuels between the Ministry of New and Renewable Energy, Govt. of India and the Department of Energy, USA	26/10/2009 to 30/10/2009
17	Dr. N.H. Khan	Visit to Department of Chemistry, Inha University, South Korea for pursuing research work on the development of chiral metal complexes for different organic transformations viz., asymmetric nitroaldol reaction and oxidation reaction under homogeneous and heterogeneous reaction conditions	01/11/2009 to 01/11/2010
18	Dr. Amitava Das	To pursue the collaborative research work under the joint collaborative project on “Sensitized nano-particles as new hybrid photo-driven devices” at the University of Sheffield, UK	16/11/2009 to 30/11/2009
19	Dr. Shaik Basha	Award of IRCSET-EMPOWER postdoctoral fellowship by Irish Research Council of Science Engineering Technology (IRCSET) to carry out research work on treatment of wastewater containing pharmaceutical compounds by novel integrated photocatalytic adsorbents, at School of Biotechnology, Dublin City University, Dublin, Ireland	19/11/2009 to 13/05/2011
20	Dr. P.K. Ghosh	Visit to Hungary as a part of Indian delegation to attend the Indo-Hungarian workshop on green chemistry held at Budapest, Hungary	23/11/2009 to 24/11/2009
21	Dr. D.B. Shukla	For participating and presenting a paper entitled 'Synergy of intellectual property and traditional knowledge : Holy grail for protection and sustainable future” at the 2nd International Conference on Drug Discovery and Therapy, Dubai -UAE	01/02/2010 to 04/02/2010

9. Visitors from abroad to CSMCRI

2008-2009

Sr. No	Name / Organization	Purpose of Visit	Duration
1	Dr. Philip Bolton, Dr. Carl Clayton, Reckitt Benckiser, Dansom Lane, UK	To solve some of its technical challenges in its development of new household products	14/05/2008
2	Dr. Poonam VeerRamjeawon, The Mauritius Research Council, LaMaison de Crne, Mauritius	To meet the concerned scientists working on seaweeds and also to get firsthand experience on the seaweed cultivation and liquid fertilizer among other applications.	15/05/2008 to 17/05/2008
3	Mr. Felipe Miguel, Mr. Horacio Sanchez-Grane, PULL Argentina S.A.Carlos, Argentina	For exploring collaboration options, technical advice and licensing of CSMCRI bio-diesel process technology	29/05/2009 to 30/05/2009
4	Mr. Ehsanullah, Mr. Muhannad Nabi, Norwegian Church Aid (NCA), Kabul, Afghanistan	To have discussion on the maintenance of RO plants for the future NCA programme	24/06/2008 to 26/06/2008
5	Mr. Sverre Norleif Hjelleset, Mr. Abdul Hadi Mrufi, NCA, Kabul, Afghanistan	Purchase of five desalination plants - Negotiate terms and conditions for delivery and payment and make a purchase agreement	03/09/2008 to 04/09/2008
6	Dr. Jim A Thomas, The University of Sheffield, UK	To carry out research under DST –UKIERI collaborative project	22/09/2008 to 1/10/2008
7	Mr. David Salm Butts, DSB International Inc., South Jordan, USA Mr. GuyWilkins, Solar Salt Engineering, OGDEN, VTAN 84403	To have interaction with CSMCRI scientists in the area of salt and salt related aspects. Also for SOP project of the Archean Group of Companies, Chennai	10/11/2008 to 11/11/2008
8	Dr. Armand Diama, Assistant Professor Universite De Cocody Abidjan, Coted'Ivoire	To carryout research work under the award of INSA –JRD Tata fellowship for research training in India on gas adsorption system	16/01/2009 to 14/04/2009
9	Mr. Ait H. Amar, Mr. M.Abderrezak, Mr. B. Kalache, Mr. M.M. Reda, Hamrour, Algerian Energy Company (AEC), Algerie. (SONATRACH)	To discuss about the possibility to build and operate a world–class RO membrane manufacturing facility in Algeria	19/01/2009

Sr. No	Name / Organization	Purpose of Visit	Duration
10	Dr. Samir Gupta, MONASH University, Australia	Visit to CSMCRI to interview some of the scientists closely associated with key inventions	21/01/2009
11	Mr. Murayama Takashi, Mr. Shiva Tetsuya, Mr. Suzuki Yasuyuki, Mr. Hisao Yakushiji, ITOCHU Corporation TOKAA, Tokyo 107-8077, Japan	For the meeting concerning SOP Project	22/01/2009
12	Dr. H. Hassan Hamid, Mr. Abdul H.Mrufi, Norwegian Church Aid (NCA), Kabul, Afghanistan	For supervision of packing and transportation of 5 RO plants	16/02/2009 to 17/02/2009
13	Mr. David J. Tulauskas GM Asia Pacific, GM (China) Investment Co. Ltd., Shanghai, China	To review GM existing agreement and all other matters pertaining to proposed contract	16/02/2009
14	Dr. Heinz Scherzberg, Dr. Heiner Marx, Dr. Bernd Schultheis, K-UTECAG, Salt Technologies, Sondershausen 1, Germany	For discussions regarding setting up a plant for the production of SOP from GRK bittern through an integrated route	17/02/2009
15	Mr. Mlitan A. Mohamed, The University of Sheffield, UK	To carry out research under DST –UKIERI collaborative project	26/02/2009 to 25/05/2009
16	Dr. Jim A. Thomas The University of Sheffield, UK	To carry out research under DST –UKIERI collaborative project	22/03/2009 to 29/03/2009
17	Prof. Dr. Anton Hartmann, Department of Microbe- Plant Interactions, National Research Centre for Environment & Health, Munich, Germany	For the implementation of the joint research project under Indo-German agreement on biotechnology	29/03/2009 to 3/04/2009

2009-2010

Sr. No	Name / Organization	Purpose of Visit	Duration
1	Mr. Hong Yan, Director, National University of Singapore, Singapore. Mr. Ramachandran Srinivasan Country General Manager (India), JOil(S) Pte. Ltd.	For discussion on possible collaboration in the area of Jatropha	13/04/2009 to 14/04/2009
2	Dr. Philip A. Davies, Dr. Abul K.Hossain, Aston University School of Engineering and Applied Science, Birmingham, UK	For collaboration purpose on water distillation and allied projects	19/09/2009 to 20/09/2010
3	Prof. Dr. Klaus W. Becker, University of Hohenheim, Stuttgart, Germany Ms. Ines K.Rüchel, Mr. Andreas S. M. Essen, Germany Mr. Oliver Gurr, SPIEGEL TV Media GmbH, Hamburg, Germany	Project discussion on Jatropha. Also visit to CSMCRI with TV-team of the esteemed German TV Station "2 Deutsches Fernsehen" for broad casting a scientific report on the project work	22/09/2009 to 25/09/2010
4	Mr. Nguyen T. Long, Mr. Nguyen H.Tho, Mr. Do T.Hieu, South Basic Chemicals Co., Ltd., Ho Chi Minh City, Vietnam	Discussion on zeolite technology	05/10/2010 to 06/10/2010
5	Mr. Mohammad H. Hamid, Mr. Abdul Wasi, Kabul Office, Kabul City, Afghanistan	RO plant inspection–Supply of 4 desalination plants to NCA–AP, Afghanistan	18/11/2009
6	Dr. Jim A. Thomas, Department of Chemistry, The University of Sheffield, UK	To carry out research under DST –UKIERI collaborative project	04/12/2009 to 13/12/2009
7	Mr. Michel Walker, Department of Chemistry, The University of Sheffield, UK	To carry out research under DST –UKIERI collaborative project	06/01/2010 to 03/03/2010
8	Prof. Dr. Anton Hartmann Head, Department of Microbe-Plant Interactions, German Research Centre for Environment & Health (GmbH), Neuherberg, Munich, Germany	For the implementation of the joint research project under Indo-German agreement on biotechnology	14/02/2010 to 20/02/2010

Sr. No	Name / Organization	Purpose of Visit	Duration
9	Ms. Zongli Xie, Clayton, Australia Dr. Jurg Schutz, Belmont, CSIRO Materials Science and Engineering, Geelong, Australia Mr. Alan Gregory, CSIRO Sustainable Ecosystems, Corporate Park, Australia Dr. Manh Hoang, CSIRO Materials Science and Engineering, Clayton, Australia	Meeting and workshops to progress the AISRC water treatment research between CSIR India and CSIRO, Australia	03/03/2010 to 07/03/2010
10	Dr. K. Shankar, Fulbright Program Coordinator, United States-India Educational Foundation, Mumbai	Meeting regarding Fulbright fellowship opportunities for Indian nationals for 2011-2012	19/03/2010
11	Dr.Arun Goyal, Indo-US Foundation for Research Education, Energy & Environment 330, Duluth, MN 5503, USA	To have discussions on bio-fuels	24/03/2010 to 25/03/2010
12	Dr. Jim A. Thomas, The University of Sheffield, UK	Visit to CSMCRI under DST-UKIERI collaborative project	24/03/2010 to 31/03/2010

10. Distinguished Visitors & Lectures

2008-09

Date	Speaker	Title of the lecture
07-04-2008	Dr. Manash Chatterjee, Founder & Director, Benchbio Pvt. Ltd., Valsad, Gujarat	Allele detection platform: A non GMO method to create varieties
25-06-2008	Prof. Uliyar V. Mani, M.S. University, Vadodara	Nutrition transition in India : Its impact on health & disease
30-06-2008	Prof. S. Natarajan, IISc, Bangalore	Metal organic framework compounds: Some recent results
01-08-2008	Dr. Gautam Palit, M.D., CDRI, Lucknow	The evolving process of drug designing for psychiatric disorders
10-12-2008	Dr. (Ms.) Krishna P. Gupta, Indian Institute of Toxicology Research, Lucknow	Tumor prevention by natural compounds
12-12-2008	Dr. Rajendra Singh Thakur, TIFR, Mumbai	Resolution enhancing strategies in solid state NMR
23-12-2008	Dr. Hirendra Nath Ghosh, Scientific Officer G, BARC, Mumbai	Femtosecond vibrational spectroscopy probing electron transfer (ET) and proton coupled electron transfer (PCET) reactions in solution
30-12-2008	Prof. Baishnab C. Tripathy, JNU, New Delhi	Over expression of PORC for resistance to excess light & oxidative stress
30-01-2009	Prof. Naresh Jotwani, Director, Institute of Solar Energy, Gandhinagar, Institute of Petroleum Technology, Gandhinagar	Solar energy as potential source of alternative energy
13-02-2009	Dr. Jayasankar E. Variyar, Vice President, R&D, Cholayll Pvt. Ltd.	Powder processing of highly active powders
30-03-2009	Prof. Dr. Anton Hartmann, Munich, Germany	Relevance of N-acylhomoserine lactone autoinducers and inhibitors for the ecology of bacteria and their interaction with higher organisms

2009-10

Date	Speaker	Title of the lecture
29-06-2009	Dr. S. Bhattacharya, Department of Mathematics, IIT, Kharagpur	Mathematical modeling on membrane separation processes
15-09-2009	Prof. Panchanan Pramanik, Department of Chemistry, Indian Institute of Technology, Kharagpur	Soft chemistry for nano-materials and their application
6-10-2009	Dr. Sudhanshu Misra, Consultant to Marubeni Specialty Chemicals, Advanced Materials Group, Founder, Nexplanar Corporation, USA	Nanotechnology and advanced materials for emerging technologies - Focus on semiconductors and cleantech
23-10-2009	Prof. K. Satyanarayana, Dy. Director- General and Editor, Indian Journal of Medical Research, ICMR, New Delhi	Some unethical practices and authorship issues in research
28-10-2009	Dr. K. Rama Rao, Ex-scientist-CSMCRI, Mandapam	Marine algal research at CSMCRI -1960 to 2000
25-12-2009	Dr. Vasant Fadke, Nagpur	Joy of chemistry
26-12-2009	Dr. Krishnesh Mehta, NID, Ahmedabad	Science motivation
16-02-2010	Prof. Dr. Anton Hartmann, Munich, Germany	N-acylhomoserine production and phenotypic variation by rhizosphere bacteria
12-03-2010	Dr. Markus Schubnell, Specialist in DMA & other thermal system, Mettler Toledo, Switzerland	Recent advances in thermal analysis
24-03-2010	Prof. Arun Goyal, President and CEO Indo-American Algae [A Green Energy & Environmental Company], and Indo-American Systems, Minneapolis/Duluth	Carbon concentration mechanism(s) in plants and algae: Biotechnology for improved photosynthesis and biomass production for biofuels and high-value chemicals
19-03-2010	Dr. K. Shankar, Fulbright Program Coordinator, United States - India Educational Foundation American Center, 4 New Marine Lines, Mumbai	Information on Fullbright fellowship
26-03-2010	Prof. Vilas Gajanan Gaikar, Institute of Chemical Technology (Formerly UDCT), Mumbai	Improving separation efficiency of functionalized polymers by molecular modeling

11. Invited Talks / Lectures Delivered By CSMCRI Scientists

2008-09

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
1	New concepts, inventions and technology implementation for social good: Case studies from CSMCRI	Keynote Lecture: Symposium on "Science, Technology and Business for Social transformation", April 27, 2008	Hindustan Unilever Limited, Bangalore	Dr. P.K. Ghosh
2	Colorimetric sensors for sulphate and phosphate ions	3rd Mid-year Symposium of CRSI, July 25-26, 2008	National Institute of Pharmaceutical Research, Punjab	Dr. Amitava Das
3	Inventing in mature technologies: Recent case studies from CSMCRI	Dr. K.K.G. Menon Memorial Lecture, September 19, 2008	UICT, Mumbai	Dr. P.K. Ghosh
4	Inventing in mature technologies: Recent case studies from CSMCRI	Invited Lecture: Technology Centre, October 15, 2008	Reliance Industries Limited, Vadodara	Dr. P.K. Ghosh
5	CSMCRI's engagement in energy from bio-resources	Invited Lecture: 74^{th} Annual meeting of Indian Academy of Sciences, November 1, 2008	IIT, Delhi	Dr. P.K. Ghosh
6	The CSMCRI Jatropha experience and its impact	Plenary Lecture: Jatropha International Conference-2008, December 12, 2008	Singapore	Dr. P.K. Ghosh
7	Molecular sensors: Synthesis, characterization and ion recognition property	International Conference on Frontiers of Functional Materials, January, 2009	Calcutta University, Kolkata	Dr. P. Paul
8	Molecular sensors: Synthesis, characterization and ion recognition study	University of Calcutta, January 6, 2009	Kolkata	Dr. P. Paul
9	Quest for energy from India bio-resources	Invited Lecture. Young Scientists of Asia Conclave, January 15, 2009	TWAS Regional Office for Central & South Asia, JNCASR, Bangalore	Dr. P.K. Ghosh

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
10	Microwave irradiated solvent free synthesis of a sucrose based surfactant	National Seminar on Emerging Trends in Chemical Sciences Research, January 20-21, 2009	S.P University, Vallabh Vidya Nagar, Gujarat	Dr. K. Prasad
11	Functional modifications of seaweed polysaccharides	National Conference CARBO XXIII, January 22-24, 2009	Bhavnagar University, Bhavnagar	Dr. A.K. Siddhanta
12	There is great joy in inventing and greater joy when the inventions make an impact on society: Illustrations from recent work at CSMCRI, Bhavnagar	Chemburkar Memorial Lecture, January 31, 2009	Community Science Centre, Vadodara	Dr. A.K. Siddhanta
13	Understanding morphology of alkali halides in presence of impurities employing DFT methods	National Chemical Laboratory, February 5, 2009	Pune	Dr. B. Ganguly
14	Preparation of sustainable materials from polysaccharides and carbohydrates	National Seminar on Green Chemistry, February 5-6, 2009	V.N. South Gujarat University, Surat, Gujarat	Dr. K. Prasad
15	Colorimetric sensors for fluoride and phosphate ions	National Symposium in Chemistry, February 6-8, 2009	National Chemical Laboratory, Pune	Dr. Amitava Das
16	$^{13}C[^{1}H]$ NMR as quantitative tool: Analytical method development using spin lattice relaxation agent and its advantages and disadvantages	M.S. University, February 21, 2009	Vadodara	Dr. P.S. Subramanian
17	NMR and EPR spectroscopy as tools for structural elucidation in solution	Charu Chandra College, February 24, 2009	Kolkata	Dr. P. Paul
18	Joy of invention	Dr.P.C.Mahalanabis Memorial Lecture, February 29, 2009	W. B. State S&T Council & Burdwan University, WB	Dr. P.K.Ghosh

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
19	NMR of paramagnetic complexes: Contacts and pseudocontact shifts and NMR of fluxional molecule	Bhavnagar University, March 5, 2009	Bhavnagar	Dr. P.S. Subramanian
20	Free resonance energy transfer in interwoven host-guest complexes	National Symposium on Radiation and Photochemistry, March 12-14, 2009	Kumayun University, Nainital	Dr. Amitava Das
21	Dye sensitized electron injection to the nano-particulate TiO_2	CSIR-NSFC Joint Workshop on Nano-Materials and their Applications, March 24-28, 2009	CGCRI, Kolkata	Dr. Amitava Das

2009-10

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
1	Development of value added products: Alternatives for solid waste utilization from nitrophosphate fertilizer and diamond mining industry	First International Conference on Recycling and Reuse of Materials, July 17-19, 2009	Kottayam, Kerala	Dr. R.S. Somani
2	Technology aggregation and licensing experience	Invited Lecture: July 18, 2009	IIM, Ahmedabad	Dr. P.K. Ghosh
3	Translating inventions into practice and the critical role of engineers	Invited Lecture: July 24, 2009	Nirma Institute of Technology, Ahmedabad	Dr. P.K. Ghosh
4	Iodide and iodate determination in table salt by ion chromatography-amperometric detection	Salt analysis training, August 28, 2009	Gandhidham, Gujarat	Dr. Babulal Rebary
5	Transmission electron microscope: A versatile tool	Model College, October 10, 2009	Mumbai	Dr. D.N. Srivastava
6	Synthesis and characterization of semiconductor nanomaterial for photocatalytic degradation of pollutant in water	Commerce & Hutatma Babu Genu Science College, November 5, 2009	Pune	Dr. R. J. Tayade

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
7	Enabling infrastructure for providing product access and reach	Invited Lecture: International Knowledge Millennium Conference, November 10, 2009	ICICI Knowledge Park, Hyderabad	Dr. P.K. Ghosh
8	Experience in the area of bio-fuels and its relevance in the rural context	Invited Lecture: India-LAC Conference, November 30, 2009	ICAR, New Delhi	Dr. P.K. Ghosh
9	Recognition of anionic and cationic analytes of biological relevance	Modern Trends in Inorganic Chemistry-XIII, December 7-10, 2009	India Institute of Science, Bangalore	Dr. Amitava Das
10	Computational explorations from surfaces to biomolecules	IACS, December 11, 2009	Kolkata	Dr. B. Ganguly
11	Green chemistry: Applications, research activities and recent trends	Invited Lecture: December 15, 2009	Madurai Kamaraj University, Madurai	Dr. P.K. Ghosh
12	Cross-linked poly (vinyl alcohol) (PVA)-polyacrylonitrile-co-2-(dimethylamino) ethylmethacrylate (PAN-DMAEMA) based anion-exchange membranes for electrochemical	Polymer Congress December 17-20, 2009	Asia Polymer Association, New Delhi	Dr. V.K. Shahi
13	Calixarene based molecular sensor: Synthesis and ion recognition study	National Seminar on Confluence of Supra-molecular Chemistry and Nano-science, January 22, 2010	Gujarat University, Ahmedabad	Dr. P. Paul
14	Inorganic materials based novel catalysts in the reactions of the C_1 chemicals	State Level Seminar on Advances in Chemical Sciences, Gujarat, January 31, 2010	Department of Chemistry, Mehsana	Dr. R.S. Shukla
15	Catalytic isomerization to perfumery chemicals by layered double hydroxides and their modified forms as solid bases	Invited Lecture: Indo-Hungarian Workshop on Future Frontiers in Catalysis, February 16-18, 2010	Indian Institute of Technology, Chennai	Dr. S. Kannan

Sr No	Title of Talk / Lecture	Name of the Seminar / Conference / Institute	Venue	Presenter(s)
16	Green bromine for diverse applications	National Workshop on Green Chemistry, February 17, 2010	The Sant Gadge Baba Amravati University, Amravati, Maharashtra	Dr. S. Adimurthy
17	Electrochemical processes related to water and energy: Recent work at CSMCRI	Professor K.S.G. Doss Memorial Lecture, 15th National Convention of Electrochemists, February 18, 2010	Vellore Institute of Technology, Vellore	Dr. P.K. Ghosh
18	In-situ powder X-ray diffraction - An excellent tool for materials characterization	Invited Lecture: National Workshop on X-ray Diffraction Techniques and Applications-NWXRD-2010, March 17-19, 2010	Saurashtra University, Rajkot	Dr. S. Kannan
19	Two dimensional nano LDH sheets - A versatile material for diversified applications	Invited Lecture: A Nano Material Research Awareness Program-NMRAP-10, March 26, 2010	Bhavnagar University, Bhavnagar	Dr. S. Kannan

12. Knowledge Resource Centre (Library)

The CSIR-CSMCRI KRC is considered to be premier one in this region having rich collections of books, periodicals, reference materials in print and electronic form 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 KRC also extends services to the visiting research scholars, university staff, R & D staff of the industries, government officials and others. A brief account of KRC collection, facilities, services are as under:

COLLECTION OF KRC

Sr. No.	Particulars	Available as on 31-3-2008	Addition during 2008-09	Addition during 2009-10	Collection as on 31.3.2010
1	Books	11893	52	30	11975
2	Back Vols.	26551	396	400	27347
3	Translation	429	-	-	429
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	**46479**	**448**	**430**	**47357**

JOURNALS/DATABASES/E-JOURNALS SUBSCRIPTION

International Journals	68
National Journals	76
Online Bibliographic Databases	02 (Sci-Finder and ASTM DL)
Bibliographic Database on CD	01

Apart from the above the KRC has received the access of online journals through CSIR-E-Journals Consortium from the Elsevier, Springer, ACS, RSC, Wiley Blackwell, Oxford University Press publishers. The KRC 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, KRC 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 KRC. This fulfills the aim of maximum utilization of KRC documents. About 300 visitors, 15 external members and 1 corporate member under external membership visited the KRC during 2008-10.

TRAINING PROGRAM

The KRC has organized training programs on JCCC@INSTIRC and SciFinder database for the internal users for better utilization of information products used in R&D. About 100 participants including scientists, technical staff and research scholars attended the workshop.

13. Dateline CSMCRI

2008-09

Date	Salient Details
1 April, 2008	MoU signed for knowhow with M/s Allergen Inc., California, USA on proprietary information on breast implant materials and manufacturing processes
10 April, 2008	MoU signed for knowhow with M/s Grassim Industries Ltd., Nagda (M.P.) for making high purity industrial grade salt
10 April, 2008	CSMCRI Foundation Day Function. Professor H. C. Trivedi, Vice Chancellor, Bhavnagar University, Bhavnagar was the Chief Guest. He delivered the Foundation Day Address. Prof R. V. Mehta, Ramanna Fellow, Department of Physics, Bhavnagar University, Bhavnagar was the Guest of Honor. Professor Mehta delivered a lecture on "Science and Technology of Ferro-fluids"
16 April, 2008	MoU signed for knowhow with M/s Tata Projects Limited, Mumbai & Corporate Office at Mithona Towers, Secunderabad in the area of water purification, including membrane preparation desalination and fluoride/ arsenic removal and development of integrated process for high recovery of potable water from brackish water containing excess fluoride together with removal of excess fluoride from eject stream
May, 2008	First time high purity salt of > 99.5 % is achieved
13 May, 2008	MoU signed for knowhow with M/s DCM Shriram, New Delhi for conversion of carbide lime obtained from acetylene to precipitated calcium carbonate at laboratory and pilot plant scale
13 May, 2008	MoU signed for knowhow with M/s Reckitt Benckiser, U.K. on areas relating to house hold care, personal care and health care
22 May, 2008	MoU signed for knowhow with Commissioner of Industries, Govt. of Rajasthan, Jaipur in the area of salt manufacture, starting from survey of land, for the construction of salt works, to the production of high quality industrial grade salt
16 June, 2008	MoU signed with DBT, New Delhi on micro propagation and selection of improved germplasm for cultivation *Gracilaria dura* (C. Agardh) J. Agardh producing high quality agar / agarose for high end application
29 August, 2008	MoU signed with National Research Development Corporation, New Delhi for authorization of CSIR technology transfer
September, 2008	Successful testing of indigenous 8 inch module TFC RO membrane

Date	Salient Details
3 September, 2008	MoU signed with M/s Norwegian Church Aid, Kabul, Afghanistan for purchase and installation of 5 desalination plants FOB in Bhavnagar and install the plants at NCAs cost in five village of Qaramqol and Qorghan districts of Faryab Province
12 September, 2008	MoU signed with Executive Engineer, Kalpasar Technical Cell, Gandhinagar for feasibility report on “Studies on present status of salt pans and assessment of social, economic and environmental impact (positive or negative) in context to the proposed site of Kalpasar reservoir”
14 September, 2008	Hindi day celebrations. Essay competitions, kavyapathan, tashvirkyaboltihai, samacharpathan, Hindi typing, shrutlekhan, scientific presentations in Hindi were arranged
26 September, 2008	CSIR Foundation Day Function. Prof. Anil K. Gupta, Executive Vice Chair, National Innovation Foundation, IIM–A was the Chief Guest. The topic of his Foundation Day Address was “The Salt of Earth : Few Stories of Minds on Margins”
20 October, 2008	MoU signed with PPG Industries, Inc. Pittsburgh, U.S.A. on precipitated silica modification for its use as a thixotrope
6-7 November, 2008	CSIR Programme on Youth for Leadership in Science (CPYLS) program arranged. Prof. P. Joshi, TIFR Mumbai was the Chief Guest. He delivered inaugural lecture on “New perspectives on understanding universe”. 93 meritorious students of Standard X from various boards attended the programme. Two days counseling session for them was also arranged
28 November, 2008	MoU signed with M/s DCW Ltd., Caustic Soda & PVC Divisions. Sahupuram Tamil Nadu on high purity industrial grade salt
12 January, 2009	MoU signed for knowhow with Gujarat State Fertilizers & Chemicals Limited, Vadodara for preparation of detailed techno economic feasibility report for:- 1) Sulphate of Potash (SOP) production having annual capacity of 10,000 MTPA 2) Muriate of Potash (MOP) production having annual capacity of 10,000 MTPA from natural bittern
30 January, 2009	MoU signed with M/s Jayashree Rajan, Bhavnagar for design, construction and operation of domestic size multipurpose solar oven with manual solar traction arrangement
12 February, 2009	MoU signed with M/s Pepsico India Holding Private Limited, Haryana & M/s Aquagri Processing Private Limited, Bangalore on cultivation of *Kappaphycus alvarezii* seaweed
15 February, 2009	MoU signed for knowhow with M/s Aquagri Pvt. Ltd., Bangalore for improving methods for cultivation of *Kappaphycus alvarezii* and enlarging the range of cultivation

Date	Salient Details
4 March, 2009	National Safety Day celebrated. Safety pledge was taken by all the staff. Mr. Kundan Kumar, Additional Divisional Railway Manager, Bhavnagar gave a lecture on “Safety procedures adopted in the railways” The Fire-fighting team of Bhavnagar Municipal Corporation demonstrated the First Aid Firefighting appliances and their methods of usage to all staff members. Prizes were given to staff for different competitions conducted in Hindi, Gujarati and English
9 March, 2009	MoU signed with M/s Arasan Phosphates Pvt. Ltd. Kadampur, Tamil Nadu for low dust extruded chalk
20 March, 2009	MoU signed with M/s Arasan Phosphates Pvt. Ltd. Kadampur, Tamil Nadu for high strength Plaster of Paris (Alpha Plaster)
31 March, 2009	MoU signed with M/s Infusil India Pvt. Ltd., Bangalore for technology for making ultra-pure water

2009-10

Date	Salient Details
10 April, 2009	First time successful synthesis of bioethanol from red seaweed
10 April, 2009	CSMCRI Foundation Day Function. Prof S K Brahmachari, Secretary, DSIR and DG, CSIR was the Chief Guest. He gave the Foundation Day Address
13 May, 2009	MoU signed with DCM Shriram Consolidated Limited, New Delhi on exploratory work for converting carbide lime (CL) obtained from acetylene generators of DSCL to precipitated calcium carbonate (PCC) at laboratory (500 gms) and pilot plant scale (5 Kg batch)
3 June, 2009	MoU signed with Executive Engineer Kalpasar Technical Cell, Gandhinagar for assessment of baseline environmental quality and social status of coastal, tidal and marine areas of Kalpasar project
16 June, 2009	MoU signed with Institute of Diploma Studies, Nirma Univ. of Sci. and Tech., Ahmedabad on testing of nanoclays for polymers and clay nanocomposites
29 June, 2009	A quarterly Hindi workshop was conducted for the benefit of the staff of Analytical Science Discipline. Dr. Parimal Paul, Dr. Babulal Rebari and Mr. Rajesh Patidar and Mr. Rambabu delivered lectures to promote Hindi in the routine work
14 September, 2009	Hindi day celebrations. Essay competitions, kavyapathan, tashvirkyaboltihai, samacharpathan, Hindi typing, shrutlekhan, scientific presentations in Hindi were arranged

Date	Salient Details
23 September, 2009	MoU signed with M/s Aquila Organcis Pvt. Ltd., Mumbai on preparation of styrene oxide from styrene and hydrogen peroxide, hydrogenation of styrene oxide to phenyl ethyl alcohol and methylation of phenyl ethyl alcohol to phenyl ethyl methyl ether by DMS
26 September, 2009	CSIR Foundation Day. Dr. S Sunderasan, Salt Commissioner, Govt. of India was the Chief Guest. The topic of his Foundation Day Address was "Salt Industry in India"
October, 2009	First time identification and isolation of salt-tolerant genes for jeera (cumin)
23 October, 2009	MoU signed with Executive Engineer, Gulf of Khambhat, Development Project (Water Resource), Bhavnagar on survey and assessment of mangrove population in Gulf of Khambhat
29-30 October, 2009	CSIR Programme on Youth for Leadership in Science (CPYLS) program organized. Dr. Arun Dave, Director, Lokseva University, Lok Bharati Sanosara, was the Chief Guest. 84 meritorious students of Standard X from various boards attended the programme. Two days counseling session for them was also arranged
30 November to 2 December, 2009	A science motivation programme was organized for secondary science teachers of Bhavnagar district. The teachers had displayed their working model of their choice. An interactive session was arranged with the scientists
12 December, 2009	MoU signed for knowhow with M/s Indian Seaweed Company Limited, Vijayawada, AP for the large scale raft cultivation of *Kappaphycus alvarezii* on bamboo rafts
14 January, 2010	MoU signed with M/s General Motors Co., Michigan, USA for development of Jatropha, a drought- resistant, non-edible shrub, can be produced on non-arable wasteland with minimal agronomic inputs and produce significant quantities of jatropha oil for conversion to biodiesel
5 February, 2010	MoU signed with Wipro Limited (Wipro Waters), Navi Mumbai for desalination – sea water and brackish water Areas of Interest: (I) Treatment solutions in midsized plants, modular decentralized systems and hydrids (solar & wind) (ii) Research & innovation in the area of improving membrane efficiency, reducing energy consumptions, use of alternative energy (solar & wind), innovative sea water intake systems, rejects management
4 March, 2010	National Safety Day was celebrated. Safety pledge was taken by all the staff. Mr. Rishikesh Chormare, Safety Officer, gave a presentation on 'Material Safety Data Sheet'. Prizes were given to staff for different competitions conducted in Hindi, Gujarati and English

14. Seminars / Workshop / Events / Meetings Organized

67th CSIR Foundation Day Celebrations: Prof Anil K. Gupta, Executive Vice Chair, National Innovation Foundation, IIM-A was the Chief Guest and delivered foundation day address on *"The Salt of Earth: Few Stories of Minds of Margins"* on 26th September 2008.

68th CSIR Foundation Day Celebrations: Dr. S. Sunderasan, Salt Commissioner, Jaipur was the Chief Guest and delivered the foundation day address on *"Salt Industry in India"* on 26th September 2009.

55th CSMCRI Foundation Day Celebrations: Prof. H.C. Trivedi, Vice-Chancellor, Bhavnagar University, Bhavnagar was the Chief Guest and delivered the foundation day address on 10th April 2008. Prof. R.V. Mehta, Ramanna Fellow, Dept. of Physics, Bhavnagar University, Bhavnagar was the Guest of Honor and he gave a scientific lecture on *"S&T on Ferro Fluids"*.

56th CSMCRI Foundation Day Celebrations: Prof. Samir K. Brahmachari DG, CSIR and Secretary, DSIR was the Chief Guest and delivered the CSMCRI foundation day address on 10th April 2009.

15. Appointments

Name and date of joining	Area and Qualifications
 **Dr S K Mandal** (05-05-2008)	**Biological Science** • Ph D in Marine Sciences, Bhavnagar University, Bhavnagar • MSc in Marine Sciences, Calcutta University, Kolkata • Area of work: Marine Ecology & Environment
 **Mr. S C. Upadhyay** (23-7-2009)	**Chemical Engineer** • Bachelor in Chemical Engineering, NIT Durgapur • Masters in Business Administration (Operation Management), IGNOU • Post Graduate Diploma in Marketing Management, IGNOU • Area of work: Salt & marine chemicals, Process design & engineering and technology development
 **Dr. Divesh N. Srivastava** (27-7-2009)	**Chemical Science** • Ph D in Chemistry, Banaras Hindu University, Varanasi • MSc Physical Chemistry, Banaras Hindu University, Varanasi • Area of work: Electron microscopy, Electro-analytical chemistry
 **Miss Aneesha Singh** (06-11-2009)	**Biological Science** • Ph D in Botany, Bhavnagar University, Bhavnagar • MSc in Life Science (Botany) • Area of work: Biotechnology (Plant tissue culture)
 **Mr. Sanjay D Patil** (07-12-2009)	**Mechanical Engineer** • ME Mechanical Engineer, RGPV University, Bhopal • BE Mechanical Engineer, NMU, Jalgaon • Area of work: RO Engineering & Design
 **Mr. Rishikesh Chormare** (07-01-2010)	**Safety Officer** • BE Fire & Safety, Rajiv Gandhi Prodhayagiki Vishwavidhyala, Indore • Area of work: Safety

Name and date of joining	Area and Qualifications

Mr. Hiren Raval
(01-2-2010)

Chemical Engineer

- ME in Chemical Engineering from MS University, Vadodara
- Executive Diploma in International Business, Nirma University, Ahmedabad
- Area of work: Polymer technology

Dr Vaibhav Kulshrestha
(01-2-2010)

Chemical Science

- Ph D in Material science, University of Rajasthan, Jaipur
- MSc Dr. BR Ambedkar University, Agra
- Area of work: Membrane technology

Mr. Hariom Gupta
(03-2-2010)

Chemical Science

- MSc in Physics, CCS University, Meerut, UP
- M Phil in Magnetic Resonance, Lucknow University, UP
- Area of work: NMR

Mr. S. Shyam Sundar
(18-2-2010)

Business Administration

- Masters in Business Administration, Sheffield University, UK
- MSc in Mathematics, Anna University, Chennai
- Area of work: R & D Planning

Mr. Sourish Bhattacharya
(15-3-2010)

Biochemical Engineer

- B Tech in Biotechnology, West Bengal University of Technology, Kolkata
- M Tech in Fermentation Technology, Institute of Chemical technology, Mumbai
- Area of work: Mass cultivation, Fermentation technologies, Design and scale up of processes

Retirement / Voluntary / Transfer

Sr. No.	Name	Designation	Date
1	Mr. Thomas Mathew	Sr. Steno	30-04-2008
2	Mr. H. K. Chudasama	Assistant (S&P) Gr.I	31-05-2008
3	Mr. M. D. Vala	Tech. Gr.II (4)	31-05-2008
4	Mr. C. M. John	Private Secretary	31-05-2008
5	Mr. M. B. Lakhani	Tech. Gr.II (2)	31-05-2008
6	Mr. M. J. Baraiya	Tech. Gr.II (3)	31-07-2008
7	Mr. K. R. Gody	Tech. Gr.II (3)	30-09-2008
8	Mr. B. R. Iyer	Sr. Steno	10-06-2008 (VRS)
9	Mr. B. K. Dave	Jr. Security Guard	31-10-2008
10	Dr. S. T. Rajan	Scientist Gr.IV (5)	31-01-2009
11	Mr. Avanish Kumar	SO (F&A)	03-02-2009 (Transfer)
12	Mr. J. N. Parmar	Tech. Gr.II (4)	31-03-2009
13	Mr. A. Sathakku	Tech. Gr.II (4)	31-03-2009
14	Mr. S. L. Daga	Scientist Gr.IV (5)	31-05-2009
15	Mr. K. S. Patel	Jr. Security Guard	31-07-2009
16	Dr. M. P. Reddy	Scientist Gr.IV (5)	30-09-2009
17	Mr. V. M.Makwana	Assistant (S&P) Gr. I	10-10-2009 (VRS)
18	Dr. P.M. Gaur	Scientist Gr (IV) 2	24-12-2009 (Death)
19	Mr. J. H. Devmurari	Tech. Gr.II (3)	31-12-2009
20	Mr. L. J. Fernandes	Tech. Gr. II (3)	31-01-2010
21	Mr. A. K. Saha	Gr. III (6)	31-01-2010
22	Mr. V.R.K.S. Susarla	Scientist Gr.IV (4)	28-02-2010
23	Mr. Babu Duda	Safaiwala	28-02-2010
24	Dr. A. S. Mehta	Scientist Gr. IV (6)	28-02-2010
25	Mr. N. R. Dave	Tea Maker	31-03-2010

Obituary

The Director and staff of CSMCRI deeply mourn the sudden and sad demise of their colleagues. Mr. S. A. Chauhan (2nd May 2008); Dr. P. M. Gaur (24th December 2009)

16. Research Council

Prof. V. Krishnan — **Chairman**
Hindustan Lever Research Professor & Head,
Chemical Biology Unit, JNCASR, Jakur Campus P O,
Bangalore 560 064

Prof. G. Subramanian — **Member**
Ex-Director
National Facility for Marine Cyanobacteria,
BharatidasanUniversity, E-204, VasanthVihar Apartments,
Cross West Extension, Thillai Nagar, Tiruchirapalli 620 018

Dr. Devang Vipin Khakhar — **Member**
Professor & Head, Department of Chemical Engineering
Indian Institute of Technology, Mumbai, Powai, Mumbai 400 076

Prof. K. C. Upadhyay — **Member**
School of Life Sciences, Jawaharlal Nehru University,
New Delhi 110 067 Res. 24 Dakshinapuram,
JNU New Campus, New Delhi 110 067

Dr. Sumit Bhaduri — **Member**
Head, Research & Development, Reliance Industries Ltd.,
Swastik Mill Compound, Corporate Park, V.N. PuravMarg,
Chembur, Mumbai 400 071

Shri V. M. Naik — **Member**
Deputy Head of Laboratory, Unilever Research India
Hindustan Lever Research Centre, No. 64, Main Road,
Whitefield, Bangalore 560 066

Prof. M. Ravindran — **Member**
"Vigna Raja', Pondicherry Road, Kottur,
Chennai 600 085

Dr. S. Sivaram — **Member**
Director, National Chemical Laboratory,
Pune 411 008

Dr. P. S. Ahuja — **Member**
Director, Institute of Himalayan Bioresource Technology
Post Box No. 6, Palampur 176 001

Dr. Pushpito K. Ghosh — **Member**
Director, Central Salt & Marine Chemicals
Research Institute, G. B. Marg, Bhavnagar 364 002

Dr. A. S. Mehta, Secretary — **Member**
Scientist, Central Salt & Marine Chemicals
Research Institute, G. B. Marg, Bhavnagar 364 002

17. Resources - Staff and Budgetary Details

Staff Details

Category	Particulars	Persons on Roll 31.3.2009	Persons on Roll 31.3.2010
Scientific	Group IV	**92**	**96**
Technical	Group III	38	38
	Group II	66	64
	Group I	20	20
	Total (Technical)	**124**	**122**
Non – Technical	Group A	05	10
	Group B	28	22
	Group C	26	24
	Group D	0	0
	Total (Non - Technical)	**59**	**56**
	Total 'A'	**275**	**274**
	Ad-hoc Scientist	0	0
	Scientist Fellow (QHS)	5	6
	EMR and Project related temporary personnel		
	Research Associate ((RA)/Sr. RA)	3	1
	Senior Research Fellows (SRF)	30	34
	Junior Research Fellows (JRF)	52	33
	Project Assistants	136	141
	Other (Project Related)	10	7
	Apprentice	23	29
	Total 'B'	**259**	**251**
	Total A + B	**534**	**525**

CSIR Allocation

Financial Year	2008-09 Rs. in Lakhs	2009-10 Rs. in Lakhs
A. Revenue (National Labs.)		
Total Salaries	1167.553	1380.575
Budget (Including P04/P05/P06/P70-Staff Qtr.)	147.200	171.000
P-07 Chemical/Consum. & Other Res.	175.000	280.000
Total Revenue Budget	**1489.753**	**1831.575**
B. Capital (National Labs.)		
Budget (Including W & S/ Staff Qtrs. Capital)	21.980	98.22
P-50 Land Cost	0.000	0.000
P-50 (App. & Equipment/Computer Equipment/Off. Eqpt.)	203.000	153.000
P-50 (Furniture & Fittings/Workshop Machinery)	1.399	2.000
P-50 (Library Books/Library Journals)	93.500	95.000
P-50 Vehicles	20.644	0.000
P-26 (ICT) (Infrastructure/Facilities)	30.627	0.000
Total Capital	**371.150**	**348.220**
Total REV.+CAP. (A+B)	**1860.903**	**2179.795**
C. Total Network & RSP Projects	1416.399	826.870
Total National Lab. (A+B+C)	**3277.302**	**3006.665**
P-61 NMITLI	13.396	15.780

Revenue other than CSIR Allocation

Financial Year	2008-09 Rs. in Lakhs	2009-10 Rs. in Lakhs
Sponsored R&D	126.340	82.087
Collaborative/ Cooperative R&D	36.941	125.169
Grant-in-Aid R&D	160.717	670.411
R&D Consultancy	35.663	43.896
SMM	0.300	0
SUB TOTAL (ECF)	**359.961**	**921.563**
Analytical/Tech services	4.355	13.363
Knowhow transfer/Royalty	57.233	41.552
Sale of lab products	0.0006	0.050
Conference/ Seminar/Workshop	3.000	0.02450
SUB TOTAL (credited to CSIR/lab Reserve)	**64.589**	**54.990**
Amount collected as service tax (Repaid to government)	27.798	18.550
GRAND TOTAL	**452.348**	**995.103**

Laboratory Reserve

Financial Year	2008-09 Rs. in Lakhs	2009-10 Rs. in Lakhs
Opening cash balance	261.643	189.924
Receipt during the year	150.734	173.408
Investment encashment on maturity	525.000	775.000
Total Receipt (A)	**937.377**	**1138.332**
Expenditure during the year	172.453	344.764
Reinvestment	575.000	700.000
Total Expenditure (B)	**747.453**	**1044.764**
Closing cash balance (A-B)	**189.924**	**93.568**

18. Management Council

(01 April 2008 to 31 December 2009)

• **Dr Pushpito K Ghosh**, Director	**Chairman**
• Dr. A.S. Mehta, Scientist Gr. IV(5)	Member
• Dr. H.C. Bajaj, Scientist Gr. IV(5)	Member
• Dr. (Mrs.) Parmita Ray, Scientist Gr. IV(3)	Member
• Shri J.R. Chunawala, Scientist Gr. IV(3)	Member
• ShriShobhit Singh Chauhan, Scientist Gr. IV(1)	Member
• Shri E. Suresh, Tech. Gr. III(6)	Member
• Sr. F&AO (SG) / Sr. F&AO / F&AO	Member
• Sr. COA / COA / AO	Member- Secretary

(01 January 2010 to 31 March 2010)

• **Dr Pushpito K Ghosh,** Director	**Chairman**
• Dr. S. Sivaram, Director, NCL, Pune	Member
• Dr. Bhavnath Jha, Scientist Group IV(6)	Member
• Dr. (Mrs) K.H. Mody, Scientist Group IV(5)	Member
• Dr. D.B. Shukla, Scientist Group IV(5)	Member
• Dr. G.R. Desale, Scientist Group IV(3)	Member
• Dr. (Mrs) Subarna Maiti, Scientist Group IV(2)	Member
• Shri. R. J. Sanghavi, T.O. Group III(3)	Member
• CoFA / F & AO	Member
• Sr. COA / COA / AO	Member- Secretary

Acknowledgements

We thank the following staff and students who have helped in original photos collection, formatting, proof-reading, proof correction & Hindi translation of Biennial Report 2008-10

Dr. Divesh N. Srivastava	Dr. H.C. Bajaj
Dr. Puyam S. Singh	Dr. C.R.K Reddy
Mr. K.G. Vijay Anand	Mr. Churchil A. Antonyraj
Dr. Beena Tyagi	Students of DIMC
Dr. K. Eswaran	Dr. B. Rebary
Dr. J.J. Trivedi	Dr. Rajesh Patidar
Dr. Saroj Sharma	Dr. A.K. Siddhanta
Dr. V.K. Shahi	Dr. Sandhya Mishra
Dr. D.R. Chaudhari	Dr. Avinash Mishra
Dr. Aruna Ravi Prakash	Dr. Pradeep Agarwal
Dr. Anita Singh	Mr. Ravi Singh B.
Dr. R.S. Shukla	Mr. Mahendra K. Shukla


ACS Publications
MOST TRUSTED. MOST CITED. MOST READ.
THE JOURNAL OF PHYSICAL CHEMISTRY B
ChemComm
Research in Microbiology
Journal of Plant Growth Regulation
United States Patent and Trademark Office
An Agency of the Department of Commerce
United States Patent
Evidence for a plant-associated natural habitat for Cronobacter spp.
Paclobutrazol Arrests Vegetative Growth and Unveils Unexpressed Yield Potential of Jatropha curcas
Synthesis of delaminated LDH: A facile two step approach
A simple chemosensor for Hg2+ and Cu2+ that works as a molecular keypad lock
US 7,560,093 B2
US 7,459,139 B2
US 7,473,406 B2
US 7,666,234 B2

CSMCRI IN MEDIA

केन्द्रीय नमक व समुद्री रसायन अनुसंधान संस्थान

CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE

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