द्विवार्षिक प्रतिवेदन

Biennial Report

1998 - 2000

Central Salt & Marine Chemicals Research Institute
Gijubhai Badheka Marg, Bhavnagar - 364 002.

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BIENNIAL REPORT

1998 - 2000

केन्द्रीय नमक व समुद्री रसायन अनुसंधान संस्थान, भावनगर
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The Mahatma who rocked the British Empire
&
galvanised the people
by defiantly gathering salt at the Dandi Seashore.
6th April 1930

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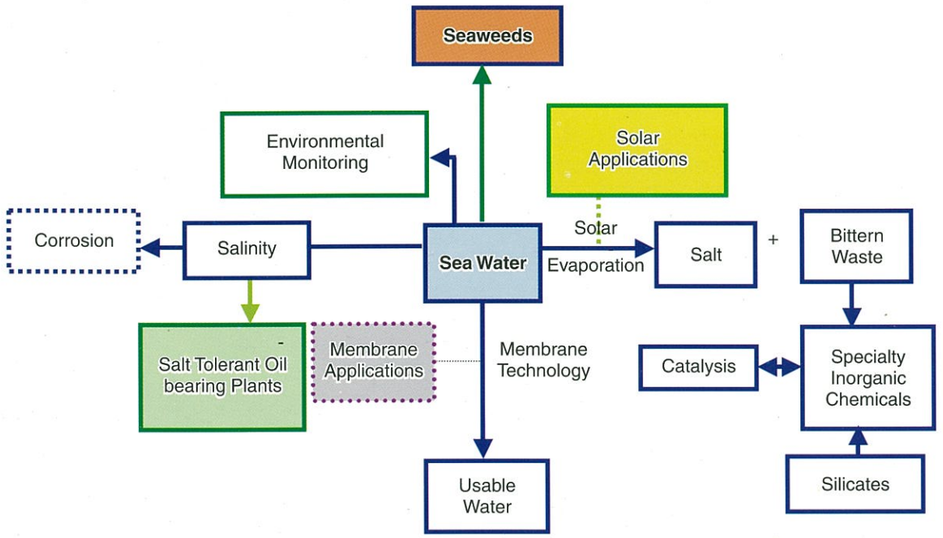
CSMCRI AT A GLANCE



Schematic depiction of the activities of

CENTRAL SALT & MARINE CHEMICALS RESEARCH INSTITUTE

with seawater as the central theme

CSMCRI Biennial Report: 1998-2000

FOREWORD

I have great pleasure in presenting the Biennial Report for the period 1998-2000. We have sought to integrate all of the Institute's activities under a common vision so that all staff have a clear understanding of their research activity in the context of the Institute's overall goal. While seeking to sustain the critical components of the R&D activities, the much needed focus and thrust have been provided.

The Institute has always had a good track record of technology development, the most recent significant achievements being the transfer of know how for Zeolite-A manufacture utilizing Bauxite leachate to NALCO and validation of the performance of CSMCRI's indigenously developed state-of-art TFC RO membrane module through elaborate testing over three years at CPCL, Chennai. CSMCRI is continuing to forge close interaction with industries and several visionary projects are underway although our ECF position could have been better. We are also seeking to understand more rigorously the underpinning science behind our products and processes. An important example of this is the knowledge base created on stability of iodized salt both under storage and under conditions of use. While some of this knowledge base is being developed in-house, a new programme has been initiated to collaborate with academia in fundamental areas as diverse as understanding of the role of additives in gelation, exploring plasma processing of magnesia, supercritical fluid extraction of Jojoba oil, and DNA fingerprinting of elite clones of seaweeds. It has been rewarding to initiate interdisciplinary programmes of work within the Institute and see these bearing fruit. Noteworthy examples of these are: the conceptualization of an electrochemical unit for production of potassium iodate in solution form directly suitable for salt iodisation, an aqueous

herbal extract concentrator, biological purification of salt, and use of liquid seaweed fertilizer for enhanced growth of non-traditional oil-yielding plants. To promote greater awareness, the internal seminar programme has been strengthened.

Yet another thrust of the Institute has been on simple innovations that can have far reaching societal impact. In this connection, the Institute has developed a salt scraper to reduce drudgery and conceptualized a device for sensing brine density from afar in salt works and development of a prototype unit is underway. The Institute's inventions are being protected by patent filing. While the Nation has mourned the massive loss of life and property in the Orissa supercyclone, it has been our privilege to have participated as part of "Team CSIR" and provide over many months high quality drinking water to a large number of villagers in Jagatsinghpur District of Orissa through the Institute's scaled up desalination technologies.

External perception of an Institute is largely dictated by the quality of its publications and the importance of perfection in research is being stressed. This effort should translate into superior quality papers in the coming years. No less important is the role of effective public relations through information dissemination to the public and also participation in seminars and exhibitions. Initiatives have been taken in these areas although much remains to be done. With the retirement of a large number of experienced and gifted staff, it has become imperative to identify and recruit new talent and several appointments have already been made. The Institute today also has many more Project Assistants than in the past.

I would like to place on record my deep sense of gratitude to all my colleagues in the technical and non technical functions, in particular, Dr. S. D. Gomkale from whom I took over the charge of Directorship in March 1999. CSMCRI is also indebted to CSIR for its constant support including that for Modernisation and construction of a new laboratory the Research and Management Councils for their guidance, and the funding agencies and industries for bestowing confidence in us. Finally, our sincere apologies for the delay in publication of this report.

Pushpito K. Ghosh

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अकार्बनिक रसायन

सौर नमक की प्राप्ति एवं गुणवत्ता का उन्नयन

ब्राईन से नमक का प्रभाजित स्फटीकीकरण : संस्थान के ज्ञानाधारित सबसोईल ब्राईन में से उत्तम गुणवत्तावाले नमक के उत्पादन के लिये बहुघटकीय कला साम्यावस्था पद्धति अपनाई गई । प्रायोगिक आंकड़े द्वारा विभिन्न घनत्व के स्तर पर तथा ब्राईन के परिवर्तित आयोनिक संयोजको में नमक स्फटिकों के गुणवत्ता के सिद्धांतो की व्याख्या की गई और उच्च गुणवत्ता वाले नमक की प्राप्ति के लिये शुद्ध ब्राईन के आयोनिक संयोजन का तथा उचित घनत्त्व परास को ज्ञात किया गया ।

भूमिगत ब्राईन में से उच्चत्तर गुणवत्तावाले नमक की पुनर्प्राप्ति : हमारे देश में नमक का वार्षिक उत्पादन 12 मिलियन से भी अधिक है, जिसमें से 30 प्रतिशत से अधिक नमक का उत्पादन भूमिगत ब्राईन से होता है । समुद्री ब्राईन की तुलना में भूमिगत ब्राईन में उच्च घनत्व के कारण नमक विनिर्माताओं को भूमिगत ब्राईन विशेष उपयोगी है । फिर भी कईबार विशिष्ट मात्रा में कैल्शियम की अशुद्धियों के कारण भूमिगत ब्राईन से प्राप्त नमक की गुणवत्ता निम्न स्तर की होती हैं, जो इस नमक को औद्योगिक उपयोग के लिये अयोग्य बनाती है ।

भूमिगत ब्राईन में से औद्योगिक स्तर का नमक बनाने के लिये सीलिकेट उद्योग के बहिःस्त्राव का उपयोग करने की नवीन तकनीक विकसित की गई है । इस प्रक्रिया द्वारा 75 प्रतिशत से भी ज्यादा कैल्शियम अशुद्धियाँ दूर की जा सकी है । विशेष ध्यानाकर्षक बात यह है कि, सोडा राख उद्योग के बहिःस्त्राव का उपयोग कर के औद्योगिक स्तर II का नमक बनाने का लक्ष्य प्राप्त किया है । हाल ही में विकसित नवीन प्रक्रिया का विशेष ध्यानाकर्षक दूसरा पहलू यह है कि इसके साथ ही पोटाश, मेग्नेशिया जैसे समुद्री रसायनों की प्राप्ति भी होती हैं । इस प्रक्रिया का तीसरा ध्यानाकर्षक पहलू यह है कि उच्च नमक सह्यतावाले समुद्री सूक्ष्माणु का उपयोग ब्राईन में से कैल्शियम अशुद्धियों को दूर करने में किया गया ।

कठिन श्रम घटाने तथा उत्पादकता बढ़ाने के लिये नमक स्क्रेपर : नमक एकत्रित करनेका कार्य मजदूरनियों द्वारा किया जाता है और सख्त गरमी में यह कार्य बड़ा कष्ट साध्य होता है । नमक एकत्र करने के लिये स्टान्डर्ड ट्रैकटर के साथ एक संलग्नक के रुप में एक उपकरण विकसित किया गया है जो नमक की क्यारियों में ढीला छोडने से खुरचकर नमक एकत्रित करता है और लम्बा ढ़ेर बनाता है । इस स्क्रेपर की क्षमता प्रति घण्टा 100 टन की है । इस साधन के मुख्य पहलू है : सस्ताई, क्यारियों में 75-100 मि.मी. की परत होने पर भी नमक एकत्रित कर सकना, स्फटीकीकरण के दौरान भी नमक बटोरकर बाहर निकालना । यह उपकरण दुष्कर कार्य को यांत्रिक रुप से करके नमक श्रमिकों के कठिन श्रम को कम करता है ।

आयोडीकृत नमक

मानव शरीर की विभिन्न चयापचय क्रियाकलापों के लिये आयोडीन अत्यंत आवश्यक है । आयोडीन की कमी से कंठमाल (घेंघा) का रोग होता है । मानव शरीर में आयोडीन पहुँचाने के लिये नमक उत्तम वाहक तथा पोटाशियम आयोडेट उत्तम आयोडेटींग एजन्ट है । आयोडीन की कमी को आयोडीकृत नमक द्वारा दूर करने की पूर्ण जानकारी प्राप्त करने के लिये, विभिन्न पाक घटकों के साथ द्रव रुपमें तथा अन्य धातु नमक के सर्म्पक में ठोस रुपमें सुव्यवस्थित अभ्यास किया गया । ठोस तथा द्रव में KiO_3 की स्थिरता, विद्युतरसायन तथा पारम्परिक पद्धति द्वारा शोधने से ज्ञात हुआ कि जलीय नमक, खाद्य पदार्थो में स्थित एस्कोर्बिक एसिड, कार्बोहाईड्रेट/पोलीसेकेराईड की

उपस्थिति में आयोडीकृत नमक में KiO_3 का आयोडीन, उर्ध्वपातित हो जाता हैं। इस निरीक्षण के आधार पर एस्कोर्बिक एसिड, पोटाशियम आयोडाईड, तथा ग्लुकोझ–डी के साथ विभिन्न तापमान पर द्रव तथा ठोस रुपमें आयोडीकृत नमक मे पोटाशियम आयोडेट की अभिक्रिया गतिकी तथा गति स्थिरांक का अध्ययन किया गया ।

मौरेशियस में मुक्तस्त्रावी आयोडीकृत नमक–उत्पादन संयत्र का विकास : मौरेशियस की मेसर्स "सेलियर डी ला क्वेस्ट" के साथ परामर्श पर सौपें कार्य के अंतर्गत संस्थान के वैज्ञानिकों द्वारा मौरेशियस में प्रति–घण्टा एक टन की क्षमतावाला मुक्तस्त्रावी आयोडीकृत नमक का सयंत्र विनिर्मित करके लगाया गया । उत्पादन की गुणवत्ता नियंत्रित रखने के पहलू पर कंपनी के अधिकारियों को प्रशिक्षण भी दिया गया । संस्थान द्वारा विकसित प्रक्रिया में घुलनशील तथा अघुलनशील अशुद्धियों को दूर करने के लिये स्क्रू विभाजन का उपयोग किया जाता है । इस प्रक्रिया में किसी भी प्रकार के पदार्थ का विलेपन प्रयुक्त नहीं होता । नवीन मुक्तस्त्रावी मददकर्ता के उपयोग से अत्यंत आर्द्र वातावरण में भी उत्पादन मुक्तस्त्रावी रुपमें ही प्राप्त होता है । फिर भी प्रक्रिया के दौरान फाईन्स विशेष मात्रा में रिपोर्ट हुए, जिसे इच्छित स्तर तक कम करने के प्रयास जारी हैं ।

पोटाशियम आयोडेट का उत्पादन : उपभोक्ता उद्योगों के लिये पोटाशियम आयोडेट की कीमत घटाने के लिये तथा आयोडाईजिंग एजन्ट में किसी भी प्रकार की मिलावट न होने की सुनिश्चतता के उद्देश्य से एक विद्युत रसायन प्रक्रिया पोटाशियम आयोडेट को द्रव के रुपमें बनाने के लिये विकसित की गई और फेकटरी में उपयोग के लिये तैयार हैं ।

समुद्री रसायनों की संपूर्ण प्राप्ति : समुद्री रसायनों की पुनःप्राप्ति की व्यवहारिक समस्याओं के निराकण के लिये विस्तृत कार्य किये गये हैं । बिटर्न तथा ब्राईन के विस्तृत परास को प्राप्त करने के लिये सल्फेट रहित करने का कार्य अत्यंत आवश्यक लगा । इस प्रक्रिया का अच्छा प्रतिभाव मिला तथा इसे विकसित करने के लिये कुछ अग्रनी उद्योग सहयोग दे रहे हैं । भूमिगत ब्राईन मे सल्फेट कम मात्रा में होने के कारण यह कार्य पद्धति अति किफायती है । इस तरह भूमिगत ब्राईन के दो फायदे हैं: उच्च ब्राईन घनत्व के कारण उच्च उत्पादन क्षमता तथा निम्न मात्रा में सल्फेट की वज़ह से विशेष किफायती है । इस प्रक्रिया में मात्र पोटाश तथा अंतिम बिटर्न में से मेग्नेश्यिम यौगिंको की पुनःप्राप्ति के लिये, कार्नेलाईट के विघटन की ही आवश्यकता है । इस नवीन प्रक्रिया का अन्य लाभ यह है कि निम्न घनत्व – बिटर्न के बदले अंतिम बिर्टन में ब्रोमीन की पुनःप्राप्ति संभाव्य है । विशिष्ट फायदा तो यह है कि बिटर्न में ब्रोमाईड की सांद्रता तीनगुना ज्यादा है । इस प्रक्रिया में उपउत्पाद के रुपमें, सीमेन्ट उद्योग में उपयोगी जिप्सम भी मिलता है । साथ ही GHCL, निरमा, कच्छ के छोटे रण के अगरियाओं के नमक कार्यो पर जोर देते हुए कुछ स्थलों पर इस तकनीक के प्रदर्शन करने का प्रस्ताव है ।

उपसहसंयोजन रसायन तथा उत्प्रेरण

अक्रियात्मक ओलिफीनो का काईरल ईपोक्सीकरण : अक्रियात्मक ओलिफीनो का काईरल उत्प्रेरित ईपोक्सीडेशन व्यापारिक दृष्टि से महत्वपूर्ण है । कृषि रसायन, औषधि विज्ञान, खुशबू और सुगंध संश्लेषण में स्टाईरीन ओक्साइड, क्रोमीन ओक्साइड, ओर ईन्डेन ओक्साईड, जैसे काईरल ईपोक्साईड्स महत्वपूर्ण माध्यमिक उत्पाद हैं । संस्थान ने उत्प्रेरकों की एक श्रेणी विकसित की है जिसने उच्च एनोनश्यिोमेरीक प्रचुरता दिखाई है । कई बार तो खर्चीले सहायक ओक्सीकारकों के

उपयोग किये बिना ही जेकोबसन प्रकार के उत्प्रेरक से भी उच्च एनोनश्यिोमेरीक आधिक्य पाया गया । देशज काईरल ईपोक्सीकरण प्रक्रिया को बड़े पैमाने पर करने के लिये व्यापारिक महत्व के संश्लेषण के लक्ष्य की पहचान की जा रही हैं ।

धातु उत्प्रेरित टैंडम अभिक्रियाएं : टैंडम अभिक्रियाएं, संश्लेषण कार्बनिक रसायनज्ञों के लिए सशक्त युक्तियों में से हैं क्योंकि ये क्रियाधार की संकुलता को तेजी से बढ़ाने के साथ साथ ईच्छित त्रिविमचयनता (स्टीरियो सिलेक्टीव) भी प्रदान करती हैं । उपलब्ध प्रकार्यक समूहों के किफायती प्रयोग से चलित टैंडम विधि परमाणु मितव्ययी भी है । पारम्परिक विधि से भिन्न, टैंडम अभिक्रियाएं, अनेक डायजोकार्बोनिल यौगिकों के संक्रमण धातु–उत्प्रेरित अभिक्रियाओं के प्रयोग द्वारा नये जटिल बहुचक्रीय योगिकों को बनाने के लिये, सम्पादित की गईं । साईक्लोएल्कानोन्स तक सीमित रहकर इसके लिये अनेक डायजोकार्बोनिल यौगिक बनाये गये । उपयुक्त डाईपोलेरोफाइल्स तथा रोह्डियम (II) एसीटेट के साथ उनकी अभिक्रियाओं ने टैंडम साईकिलीकरण – साईकिल वृद्धि किया जिससे जटिल यौगिक और वह भी एक ही चरण तथा अधिकतर उच्च त्रिविमचयनता के साथ बनाये जा सके । इस विधि से प्राकृतिक सेसक्विटरपीनोयड्स के मूल ढाँचे की संरचना के तुल्य कई आक्साट्राईसाईक्लिक यौगिक भी अनेक वलय मापों तथा विस्थापनों के साथ बनाये गये । इस क्रिया विधि में, अन्तर्आणुविक रोह्डियम कार्बिनोएड साईकिलीकरण की प्रारम्भिक शुरुआत, अस्थिर क्षणिक कार्बोनिल येलाईड्स पैदा करता है । डाईपोलेरोफाईल्स की उपस्थिति में ये अस्थिर येलाईड्स माध्यमिक, 1, 3-द्विध्रुवीय साईकिल वृद्विअभिक्रिया करके त्रिविमचयनित उत्पाद बनाते हैं।

यह अभिक्रिया, अनेक पांच तथा छः सदस्यी कार्बोनिल येलाईड्स बनाने के लिये, की गई, टैंडम विधि से कई द्वि–त्रिविमचयनित तथा रीजियोचयनित अभिक्रियायें भी की गईं । अनेक बहुचक्रीय जटिल यौगिक भी इस विधि से बनाये गये जैसे कि स्पाईरो–डाईआक्साट्राई साईक्लिक डाईस्टीरियोमरिक वलय जो आसानी से अलग भी किये जा सकते हैं ।

टैंडम, अन्तर्आणुविक साईकिलीकरण–साईकिलवृद्धि की यह श्रेणी अनेक डाईपोलैरोफाईल्स की उपस्थिति में विशेष आकर्षक है क्योंकि इसमे एक ही चरण तथा साधारण प्रायोगिक दशा में चार काईरल केन्द्र और दो नये C-C बंध बनते हैं।

सगंध यौगिकों का हाईड्रोजनीकरण : गैसोलिन में उच्च संगधांश, ईंधन की गुणवत्ता कम करता है तथा निष्कासित गैसों से अनचाहे उत्सर्जन करने में महत्वपूर्ण योगदान करता है । इसे दूर करने हेतु गैसोलिन के संगंधों के हाईड्रोजनीकरण के लिये सक्षम उत्प्रेरक विकसित करना ईच्छनीय है । सी.एस.एम.सी.आर.आई में हमने रुथेनयिम–निहित मृदा तैयार करके इसका प्रयोग अनेक सगंधो तथा ओलिफीनो के उत्प्रेरित हाईड्रोजनीकरण से उनके संतृप्त उत्पादों को बनाने में किया । इन उत्प्रेरकों की क्षमता का अध्ययन अब वास्तविक पेट्रोलियम के साथ होगा ।

हाईड्रोजन पेरोक्साईड का प्रकाशोत्पादन : आर.सी.आई इन्डिया रिसर्च एवम टेकनोलोजी द्वारा विकसित हाईड्रोजन पेराक्साईड के प्रकशोत्पादन के पुष्ट एवम् दक्ष प्रक्रम का गहन अध्ययन उसके क्रियाविधि के पहलू को समझने के लिये किया गया । जिसमें $Ru(bpy)_3^{2+}$, प्रकाशस्त्रोत तथा अपचायक दोनों रुपमें भाग लेता हैं ।यह एक साम्यावस्था द्वारा नियंत्रित होता हैं तथा सौर ऊर्जा दीघाार्यु रासायनिक उत्पादोमें परिवर्तित होती है ।

डाईनाईट्रोजन का विद्युत रासायनिक सक्रियन : जब से यह अन्वेषण हुआ कि धातु–निहित जैवीय इन्जाइम वातावरणीय नाईट्रोजन को सामान्य स्थिति में फिक्स करते हैं, समस्त वैज्ञानिक डाईनाईट्रोजन को संक्रमण धातुओं द्वारा सक्रिय करने में प्रयासरत हैं । कई संक्रमण धातु संकुल, सहआयाम तथा नमूने–यौगिक नाईट्रोजनीकरण के लिये विकसित किये गये तथा नाईट्रोजन की सक्रियता तथा बंधता पर शोध किये गये । जल–घुलनशील रुथेनियम (III) अमीनोंपालीकार्बोक्सिलिक अम्ल संकुल बनाये गये तथा उनका विभवमिति अध्ययन नाईट्रोजन तथा आर्गन में करके सामान्य दाब पर तुलना की गई। रुथेनियम (III) संकुलो द्वारा ईथिलिन डायामीनके साथ स्थिर विभव ईलेक्ट्रोलिसिस (0.5v सापेक्ष SCE) से डाईनाईट्रोजन को अमोनिया में अपचयित किया गया ।

टाईटेनियम रसायन विज्ञान

प्रकाशोत्प्रेरित अभिरंजको का स्वनिर्मलन : विलेपित अथवा परिक्षेपित रुपमें TiO_2 द्वारा प्रकाशोत्प्रेरित आक्सीकरण की ख्याति, पर्यावरणी संदूषकों जैसे कि हैलोकार्बन, कार्बनिक रंजक/रंजक निस्रावित जल के जैवीय अभीरंजक तथा पृष्ट संक्रियकों को नष्ट करने में बढ़ती जा रही है । संस्थान ने ऐसे प्रकाशोत्प्रेरित सक्रिय सतह का विकास किया है जो यहाँ तक कि सामान्य फ्लोरोसेन्ट ट्यूब लाईट से भी सक्रिय हो जाता है । इस स्वनिर्मलन प्रक्रिया से पारम्परिक भारतीय मसालों से बने टाईलों के तेलीय दाग और धब्बे ज्यादातर खत्म हो जाते हैं ।

टाईटेनियम टेट्राक्लोराईड उत्प्रेरण : $TiCl_4$ जैसे लिविस अम्लों के साथ, अनेक डायजोकार्बोनिक यौगिकों की अभिक्रियायें रिजियो–चयनित बाईसाईक्लो (एन.एम.ओ) अल्केनडायोन्स अच्छी प्राप्ति मे पैदा करती हैं । सैद्धान्तिक, रुप से तो दोनों व्यवस्थाएं संभव हैं, सभी अभिक्रियाओं में केवल बाईसाईक्लिक 1-3 डाईकीटोन ही बना और सेतुशीर्ष डायोन्स लेशमात्र भी नहीं बने । प्राप्त बाईसाईक्लो (एन.एम.ओ) अल्केनडायोन्स प्राकृतिक रुपसे बहुव्यापी हैं ।

नये अकार्बनिक धातु संकुलों का संश्लेषण : ऊर्जा परिवर्तन, और उसके प्रकाश रासायनिक आणुविक युक्तियों तथा बहु–इलक्ट्रान –स्थानान्तरण उत्प्रेरक में उपयोग होने की दृष्टि से पोलीपिरिडिल लिगैन्ड युक्त द्विनाभिकीय संकुल अत्यन्त महत्वपूर्ण हैं । संस्थान ने Ru (II) तथा Os (II) के संकुल 2-4-6 ट्रिस (2-पिरिडिल्स) - 1,3,5 ट्रायाजीन (टी.वी.टी ज़ेड) के साथ बनाया है, जिसमें सेतु–टी.पी.टी.जेड के ट्रायाजीन वलय का धातु–प्रेरित असामान्य हाईड्रोक्सिलेशन पाया गया, जो एकलनाभिकीय संकुलो के साथ नहीं होता है । कुछ संकुलों ने तो कार्बनडाई आक्साइड का आशान्वित अपचयन भी किया है।

संस्थान ने मिश्र संयोजक द्विनाभिकीय संकुल भी बनाये हैं जिसमें धातु केन्द्रों को संतृप्त हाईड्रोकार्बन सेतु से अलग किया गया है । धातु केन्द्रों के बीच आप्टिकल इलक्ट्रान स्थानान्तरण को रोकने के लिये, इन संकुलों मे ऊर्जा बंध, संतृप्त हाईड्रोकार्बन सेतु के कारण काफी ऊँचा है । फिर भी साईक्लोडेविसट्रिन का उपयोग करके धातु केन्द्रों के ऊपर ईलेक्ट्रान स्थानान्तरण पाया गया । जैविक प्रक्रिया में ईलेक्ट्रान स्थानान्तरण से संबधित कुछ अनुत्तरित प्रश्नों को समझने में ये अध्ययन सहायक हो सकते हैं ।

अकार्बनिक–परत तथा सरंध्री संरचनाएं

ठोसावस्था अति आणुविक रसायन विज्ञान : सरंध्री संरचना, संतुष्ट स्थिरता तथा विशिष्ट प्रकार्यकता जैसे कि आकार चयनता और लधु अणुओं का उत्क्रमणीय अधिशोषणवाले स्फटित सह संयोजक बहुलकों की अभिकल्पना तथा बनाना, पदार्थ विज्ञान की एक चुनौती है । दो समसंरचना वाले तटस्थ सहसंयोगी बहुलक $\{[M\text{-}(bpy)(phth)(H_2O)]_n 2H_2O$, M = Co^{+2}, Cd^{+2} bpy = 4,4' बाईपिरीडीन, phth = थेलेट$\}$ बनाये गये जिसमें प्रत्येक कोटर का आयताकार ग्रिड दो bpy तथा दो phth लिगैंडों से बन्द होता है, जो क्षैतिज विस्थापित ढंग से सुपरपोज करके चैनल माप को कम करते हुए जल के दो अणुओं को शामिल करता है । इन पदार्थो की क्रिस्टल संरचना 11.5 x 7.5A^0 माप की आयताकार चैनल दर्शाती है । हाल ही में यह भी दर्शाया गया है कि हाईड्रोजन बंधो के अन्तक्रियन का उपयोग, बाइल अम्ल अन्तर्वेशित संकुलों में नव निर्मित हेलिकल नेटवर्क हेतु किया जा सकता है ।

जियोलाईट – 13 X के लिये विधि : जियोलाईट 13 X आणुविक चालनी का उपयोग व्यापकरुपेण कई कठिन विलगनों जैसे कि आक्सीजनगाढ़ित हवा का उत्पादन तथा उत्पादों में से लेशमात्र पानी, कार्बनडाई आकसाईड और सल्फेट अशुद्धियों, को दूर करने में किया जाता है । अशुद्धि मुक्त जियोलाईट 13 X पावडर बनाने की, सरल ढंग से चालित युनिट वाली विधि विकसित की गई, जिसमें समांग अभिक्रिया पदार्थ (एल्युमिनो सिलिकेट जेल) साधारण ताप पर बनाया गया (उच्च ताप तथा दाब से बचकर), जेल का स्फटीकरण बिना मूल स्फटक के डाले हुए किया गया और अभिक्रिया के प्रचालकों का नियंत्रण वैज्ञानिक समझ से किया गया । बाक्साईट – चिपकित सोडियम एल्यूमिनेट द्रव के उपयोग से भी जियोलाईट 13 X बनाया गया ।

उन्नत श्वेतता वाला जियोलाइट – ए : प्रक्षालक बनने में फास्फेट के बदले में, विशेषकर संहत प्रक्षालक पावडर तथा दण्डों में प्रक्षालक स्तर जियोलाईट – ए का उपयोग अधिक होता है । सोडियम सिलिकेट में Fe की मात्रा तथा जियोलाईट – ए के श्वेतता अनुक्रमणिका के बीच सहसम्बंध स्थापित किये गये तथा कच्चे माल की विशिष्टता का पुनरावलोकन 99% से अधिक, श्वेतता अनुक्रमणिका प्राप्त करने के लिये किया गया । जियोलाईट–ए की टेक्नोलोजी NRDC के जरिये NALCO को पहले से ही दी जा चुकी है और श्वेतता का यह और अधिक संशोधन इस उत्पाद के वाणिज्यिक संभ्भावनाओं को बढ़ाने वाला है ।

हाईड्रोटैल्साईट्स का अध्ययन : अच्छे गुणवत्ता वाले स्फांटेक पदार्थो की प्राप्ति तथा पहचान के लिए, अनेक तैयार प्रचालकों के प्रभावों का अध्ययन विभिन्न भौतिक–रासायनिक तकनीकों, जैसे कि X RD, FT-IR, TEM तथा ^{27}AL MAS-NMR और अधिकतम दशाओं में, किया गया । तैयारी के नये तरीके भी अपनाये गये । माईक्रोव किरणन तथा तात्कालिक अवक्षेपण विधि को एक साथ मिलाकर MgM (III) CO_3 - HT_s (M (III) = A1, Fe तथा Cr) बनाने की एक तेज विधि भी विकसित की गई । अनेक संक्रमण धातु निहित हाईट्रोटैलसाईट्स बनाये गये तथा उनसे फिनाल का चयनित हाईड्राक्सीलेशन किया गया । सबसे अच्छी उत्पाद प्राप्ति CuNiAl-5l-HT उत्प्रेरक से हुई ।

व्यावसाायिक महत्व के कृत्रिम हाईड्रोटेल्साईट्स (SHT) का विकास : कृत्रिम हाईड्रोटेलसाईट्स का उपयोग, औषधि उद्योगों में प्रतिअम्ल के रुपमें, प्लास्टिक एवम् बहुलक उद्योगों में हैलाजन अपभार्जक के रुप में किया जाता है तथा इसकी क्षमता बिन–हैलोजनीकृत

अकार्बनिक ज्वाला मंदन में भी है । SHT का नव–उपयोग क्षार–उत्प्रेरित अभिक्रियाओं में उत्प्रेरक के रुप में तथा निस्रावित जल के उपचार में अधिशोषण के रुप में होता है । तीन प्रकार नामत : औषधि, हैलोजन अपमार्जक तथा अग्निमंदक स्तर के SHT बनाने की विधि, बिटर्न को कच्चे माल के रुपमें प्रयुक्त करते हुए, विकसित की गई । बिर्टन सौर्यनमक के उत्पादन के बाद बचा हुआ मातृद्रव है । मैग्नेशियम हाईड्रोक्साईड बनाने के लिये बिटर्न को कास्टिक सोडा घोल से अभिकृत किया जाता है, जब कि एलम या उपयुक्त एलयुमीनियम युक्त निस्राव कास्टिक सोडा के साथ, एल्युमीनियम हाईड्राक्साईड बनाने के लिये अभिकृत किया जाता है । इसके बाद इनको एक पूर्वगामी उत्पाद पाने के लिये मिलाया जाता है जिसे सामान्य दाब पर जल–उष्मा से उपचारित करके स्फटिक SHT प्राप्त किया जाता है । यह विधि–साधारण प्रचालक इकाई तथा सामान्य दशाओं वाली है ।

उर्वरक उद्योग के उप उत्पाद का उपयोग

उर्वरक उद्योग के उप उत्पाद चूने का मूल्यवान पदार्थो में संशोधन : कैल्शियम कार्बोनेट का उपयोग, रबर मालों मे पूरक के रुपमें, पी.वी.सी केविल मे रोधक, पेन्ट्स, दन्तमंजन पावडर, कागज तथा इलेक्ट्रानिक उद्योगों में बहुतायत होता है । नाइट्रो–फास्फोरस उर्वरक कारखानों से पैदा हुए उप उत्पाद चूने को यथावत रुप में उपयोग में नही लाया जा सकता क्योंकि ये कम शुद्धि, अधिक कण माप, क्षीण सफेदी, कम pH तथा उच्च घनत्व वाला होता है । चट्टानी फास्फेट को कच्चे माल जैसी प्रयोग करने वाली उर्वरक कारखानों की नाईट्रो–फास्फेट इकाई काफी मात्रा में उप उत्पाद चूना पैदा करती है जिसमें >90% $CaCO_3$ निहित है परन्तु इसमें अनेक अन्य अकार्बनिक अशुद्धियाँ होती हैं । सी.एस.एम.सी.आर.आई तथा जी.एन.एफ.सी भरुच की एक सहयोगी परियोजना के अन्तर्गत, उप उत्पाद चूने के संशोधन पर, इसे रबर मालों, पी.वी.सी केविल रोधको तथा पेन्ट्स में प्रयुक्त होने के उपयुक्त बनाने हेतु कार्य सम्पादन किया गया है । रासायनिक उपचार की साधारण विधि के बाद बैच रुप में निस्तापन द्वारा, सी.एस.एम.सी.आर.आई ने इसकी सफलतापूर्वक उपलब्धि प्राप्त की है । इस समय, रबर स्तर के कैल्शियम कार्बोनेट (10 कि.ग्रा/घंटा) बनाने के प्रक्रम का विकास प्रगति में है । पी.वी.सी के बिल रोधकों तथा कागज में प्रयुक्त होने वाले अवक्षेपित कैल्शियम कार्बोनेट (पी.सी.सी) बनाने की स्थितियों को ईष्टतम करने का कार्य भी प्रगति में हैं तथा एक पाईलाट संयत्र निर्माणाधीन है ।

2

बहुलक एवं झिल्ली विज्ञान

प्रतिवर्ती रसाकर्षण

उच्च प्रवाही संघटित पतली फिल्म प्रतिवर्ती रसाकर्षण झिल्लियाँ : प्रतिवर्ती रसाकर्षण प्रौद्योगिकी का उपयोग विशेषतः क्षारयुक्त/समुद्री जल में से, द्राव्य नमक, रोगजनक जीवाणु तथा अन्य फ्लोराईड जैसे नुकशानकारक तत्व दूर करके सुरक्षित पीने योग्य पानी प्राप्त करने के लिये किया जाता है । इस प्रौद्योगिकी का उपयोग सांद्रण, विलगन तथा रसायनों में से महत्वपूर्ण रसायनोंका विभाजन, औषधि विज्ञान, डेरी तथा खाद्य उद्योगो में भी किया जाता है । आज, संघटित पतली फिल्म झिल्लियों का कार्य श्रेष्ठ है जिसने पहले प्रयुक्त की जानेवाली सेलयुलोझ एसीटेट झिल्लियों का अतिक्रमण किया है। संघटित पतली फिल्म झिल्लियाँ पोलीसल्फोन तथा पोलीमाईड से तैयार की जाती है । पोलीसल्फोन का सरंध्र स्तर पोलीमाईड के पतले स्तर को आधार देता है, जो आंतःस्तरीय बहुलकता के कारण झिल्लियों के नमक अस्वीकृति के गुणधर्म का मुख्य कारण है । झिल्ली निर्माण के लिये प्रचालकों मे सावधानीपूर्वक परिवर्तन करके इसकी पारगम्यता में सुधार तथा नमक अस्वीकृतिमें किसी भी प्रकार का समझौता किये बिना इस स्तर को तैयार किया गया है । प्रचालकों के अध्ययन में फिल्म के गुणधर्मो पर विलेपन तथा परिसाधन दर के आधार के साथ स्नान संयोजनों, बाष्पन क्षेत्र का तापमान, परिसाधन तापमान तथा संबंधित आर्द्रता आदि का पतली फिल्म निर्माण पर प्रभाव सम्मिलित है । दूसरा पहलू, पोलीमाईड फिल्म की मोटाई नियंत्रण का था । हालमें परीक्षण की मानक परिस्थितियों में पहले प्राप्त 20-22 GFD पारगम्यता के बदले 94-96 प्रतिशत नमक अवरोधकता के साथ 30-35 GFD पारगम्यता पाई गई। इस विकास के कारण हार्डवेर की कीमत कम होगी जिसके अनुपात में परिचालन कीमत भी कम होगी ।

संघटित पतली फिल्म झिल्लियों का बड़े पैमाने पर विकास : संस्थान में स्वचालित ढलाई एवं कोट्रिग मशीन से 1मी चौडी x 50 मी लंबी सतत संघटित पतली फिल्म झिल्लियाँ निर्मित की गई। पोली सल्फोन विलेपन की आवश्यक सरंध्रता तथा नमक अवरोधक क्षमता तथा पोलीमाइड स्तर की प्रवाहिता प्राप्त करने के लिये नमूना तथा तकनीक पूर्ण किए गए। देश में निर्मित संघटित पतली फिल्म झिल्ली तैयार करके 4" के व्यासवाले सर्पिल साधन में इस झिल्ली का उपयोग करके निम्न दाब पर प्रतिदिन 40,000 लीटर की क्षमताबाला प्रतिवर्ती रसाकर्षण, अपक्षारीकरण यंत्र तैयार किया गया और एम.आर.एल चैन्नई (अब सी.पी.सी.एल) में स्थापित किया गया । इस संयत्र का उपयोग मलीय पानी को संशोधित करने के लिये किया जा रहा है और विस्तृत परीक्षण से पता चला कि इस संयत्र का कार्य संपादन आयातित संघटित पतली फिल्म झिल्लियों के समान ही था । इस योजना को आर्थिक सहायता डी.एस.टी ने प्रदान की ।

4" व्यास x 1 मी वाले संयंत्र में 10 वर्ग मीटर का झिल्ली क्षेत्र होता है जबकि 8" व्यास x 1 मी वाले संयत्र में लगभग 40 वर्ग मीटर का झिल्ली क्षेत्र होता है । अब हाईड्रोनाटिकस ईंडिया कंपनी के सहयोग द्वारा 200 मि.मी (8") व्यास x 1 मीटर लंबाई की देशमें तैयार की गई झिल्लियों का उपयोग करके एक सर्पिल संयत्र सफलतापूर्वक विकसित किया गया है । इस देशज संयत्र द्वारा 95-96 प्रतिशत नमक अवरोधक के साथ 14-18 जी.एफ.डी (क्षार) अवरोधक के साथ उत्पादित जल प्राप्त किया गया । अभी संस्थान में अधिक व्यासवाले संयत्र को तैयार करने के लिये विशेष सुविधाएं की जा रही हैं ।

संघटित पतली फिल्म झिल्लियों द्वारा नमकीन जल के अपक्षारीकरण के अलावा, घरेलु पानी का शुद्धिकरण, सौर ऊर्जा संचालित प्रतिवर्ती रसाकर्षण संयत्र, खाद्यतेल का शुद्धिकरण आदि अन्य कार्यो में भी इनका उपयोग सफलतापूर्वक किया गया ।

विद्युत अपोहन

विषमांग विद्युत अपोहन झिल्ली तकनीक का विकास : आंतर बहुलकी आयन–विनिमय झिल्लियाँ बनाने में क्लोरोसल्फोनिक एसिड तथा क्लोरोमिथाईल इथर जैसे खतरनाक रसायनों का उपयोग होता है । इसलिये विषमांग झिल्लियों का उपयोग करके खतरा रहित तकनीक विकसित करने की परिकल्पना की गई । जिसमें एक बंधक तथा एक पोलीईलेक्ट्रोलेईट वाले ढलाई यंत्र का उपयोग करने पर विचार किया गया । सतत और दृढ, द्विध्रूवी लंबी झिल्लियाँ बनाने के लिये विशेष रुपसे ढलाई यंत्र निर्मित किया गया । इसके तार्किक विस्तृतीकरण द्वारा सर्वव्यापी एकरंध्री झिल्ली का विचार उद्‌भव हुआ । उक्त झिल्ली के गुणधर्मो पर कण तथा रेज़िन भारण का असर जैसे कि त्रिपरिमारिणय स्थिरता, विघटन क्षमता, आयन–विनिमय क्षमता, विद्युत सह्यता, तथा परिवहन संख्या का अध्ययन किया गया और परिणाम स्वरुप देखा गया कि विद्युत अपोहन के अन्य कुछ उपयोग में इन विषमांग आयन विनिमय झिल्लियों का आंतर बहुलक झिल्लियों के स्थान पर उपयोग किया जा सकता है ।

ग्लायफोसेट जड़ीबूटियों के विलवणन के लिये नई प्रक्रिया : ग्लायफोसेट की प्रक्रिया के फलस्वरुप मध्यवर्ती मिश्रण प्राप्त होता है जिसमें 20 प्रतिशत जलीय द्रव के रुपमें प्राप्त इच्छित उत्पाद होता है । इसमें से विद्युत अपोहन तकनीक द्वारा, उत्पाद के नगण्य क्षति के बिना ही लवण की सांद्रता 1% से भी कम करके इच्छित स्तर पाना संभव हुआ ।

चालक अन्तरकों का उपयोग : विलवणन द्वारा अतिशुद्ध उत्पाद की आवश्यकता की मांग को, विद्युत अपोहन यंत्र में, परंपरागत पोलीसल्फोन अंतरकों के स्थान पर, संवाही अंतरकों का उपयोग करने पर इच्छित स्तर प्राप्त करके आवश्यकता परिपूर्ण करना संभव हुआ और इस तरह से ध्रुवण को टाला गया । इस के द्वारा कुछ एमिनो एसिड की नमक सांद्रता 50 पी.पी.एम से भी कम की जा सकी । परिणामस्वरुप परंपरागत प्रक्रिया की जगह पर स्वच्छ विद्युत अपोहन विलवणन प्रक्रिया का उपयोग किया जा सकता है ।

द्वि–ध्रूवीय झिल्लियों का विकास : कुछ क्षार युक्त प्रवाही बहिःस्त्रावों को उपचरित करने के लिये द्वि–ध्रुवीय झिल्लियाँ उपयुक्त हुई । यह झिल्ली तकनीक घुले हुए ऋणायन और घनायन को क्रमशः उनके अम्ल तथा क्षार में परिवर्तित करती है जिनका फिर से उपयोग किया जा सकता है। द्वि–ध्रुवी झिल्लियाँ सतत चादर के रुपमें बनाने की तकनीक सफलतापूर्वक विकसित की गई। इन झिल्लियों पर आधारित विद्युत अपोहन यंत्र का टेट्राब्युटिल एमोनियम ब्रोमाईड में से टेट्राब्युटिल एमोनियम हाईड्रोक्साईड बनाने में उपयोग किया गया । इस यंत्र का उपयोग कुछ अकार्बनिक उच्छिष्ट प्रवाहों को उपचरित करने में भी किया गया ।

आयन – विनिमय रेज़िन्स

देश में विकसित आयन चयनित रेज़िन द्वारा फ्लोराईड विहिनीकरण : संस्थान ने बहुत समय पहले फ्लोराईड विहिनीकरण के लिये उचित आयन चयनित रेज़िन विकसित किया है । यह स्पिन ओफ कार्य क्लोरो–आल्कली उद्योगों में ब्राईन शुद्धिकरण के लिये रेज़िन विकसित करने के प्रयत्नों में था । इस फ्लोराईड विहिनीकरण प्रक्रिया में शुरु मे, $H^+ \leftrightarrow Na^+ \leftrightarrow A1^{+3}$ को सही क्रम में सफलतापूर्वक उपचरित करने के कार्य द्वारा एमिनो मिथाईल फोस्फोनिक एसिड रेजिन का अनुकूलन शामिल है । पहले यही प्रक्रिया कोलम पुनरोत्पादन प्रक्रिया के लिये प्रयुक्त की जाती थी । फिर भी रेजिन पुनरोत्पादन प्रक्रिया को अधिकतम श्रम तथा निम्नतम रसायनके उपयोग के

लिये अधिक सरल बनाने की आवश्यकता महसूस की गई । यह विकसित प्रक्रिया 18 पी.पी.एम फ्लोराईड जलवाली लगभग 240 क्यारियों के जल को उपचरित करती है तथा उपयोग में लाये गये रेजिन को सीधे फिर से परिचालित किया जा सकता है । 1 N एलम के 2.0 बड़े आयतन द्वारा यह विशेषता, इस प्रक्रिया को पहले प्रयुक्त की जानेवाली प्रक्रिया से ज्यादा सरल बनाती है। यह भी देखा गया है कि प्रक्रिया शुरु करने के प्रथम 40 मिनटो में, फ्लोराईड. का गठन लगभग 100 प्रतिशत रहा और रेजिन की क्षमता भी अच्छी 7 pH की रही लेकिन फ्लोराईड निष्कासन की संपूर्ण क्षमता क्षारीय pH पर कम हो गई । बाईकार्बोनेट आयन की उपस्थिति में प्रयोग करके इस की पुष्टि की गई । जबकि क्लोराईड़ तथा सल्फेट आयन के रेज़िन द्वारा फ्लोराईड निष्कासन में थोडा ही प्रभाव देखा गया । इन रेज़िन्स ने उपयोग तथा पुनः उपयोग के 100 परिचालन के अंतमें, उच्च तापमान पर, अपनी उत्पादन क्षमता में 9.5 प्रतिशत की परिचालन कमी तथा संचय में 3.4 प्रतिशत घिसाई दिखाई ।

महा समुद्री तूफान के दौरान उड़ीसा के संकटग्रस्त लोगों के लिये पेय जल

प्रतिवर्ती रसाकर्षण : नवम्बर 1999 में महा समुद्री तूफान के दौरान उड़ीसा के असरग्रस्त, जगतसिंहपुर जिले के नौगाँव एवम् पैकाशी गाँवों में संस्थान ने प्रतिवर्ती रसाकर्षण की संघटित पतली फिल्म झिल्लियों पर आधारित 2 संयत्र स्थापित करके सुरक्षित पेय जल उपलब्ध कराने का कार्य युद्धस्तरीय–त्वरित गति से किया । इस संयत्र से प्रतिदिन 15,000 ली. अच्छी गुणवत्ता वाला, पेय जल उत्पन्न होता है, जो नवम्बर 1999 के बाद आजतक, उक्त गावों तथा आसपास के गाँवों में टेंकर द्वारा लोगों तक पहुँचाया जाता है । इसने असरग्रस्त क्षेत्र के लोगों की सिर्फ जान ही नहीं बचाई पर विशेषरुपसे उस क्षेत्र से संक्रामक रोगों को भी हटाया, और असरग्रस्त लोगों के जीवनस्तर में सुधार की संभावनाओं का भी निरुपण किया ।

विद्युत अपोहन : संस्थान की ओरसे संस्थान की तकनीक के अनुज्ञाधारक, मेसर्स न्युकोम लिमिटेड फरीदाबाद को एक ई.डी तकनीक संयत्र भेट में दिया गया । 50 एल.पी.एच क्षमता वाले, इस संयत्र ने 1800 पी.पी.एम तक के पानी को उपचरित करके, 500 पी.पी.एम, टी.डी.एस वाले पेयजल की 50 प्रतिशत पुनः प्राप्ति की हैं । यह संयत्र केरोसीन द्वारा परिचालित जनरेटरसे कार्य करता है । शुरु में संस्थान के कर्मचारियों ने यह संयत्र चलाया । हमारे अन्वेषण में किसी भी प्रकार के हस्तक्षेप किये बगैर गाँव के लोगों को परिचालनकार्य में प्रशिक्षित किया गया । यह संयत्र प्रारंभ से आजतक किसी भी बड़ी समस्या के बिना कार्यरत है । केरोसीन आदि उपलब्ध कराने का कार्य भुवनेश्वर की क्षेत्रीय अनुसंधान प्रयोगयशाला के सहयोग से किया जा रहा है । यह उल्लेखनीय है कि गाँवों को उपलब्ध कराई गई प्रक्रिया सरल है, इसमें किसी भी प्रकार का जटिल विद्युत नियंत्रण या पूर्वोपचार नहीं है तथा किसी भी प्रकार के विशिष्ट अद्यतन उपकरण के बिना गाँव में चलाया जा सकता है ।

संकट के दौरान विद्युत आपूर्ति का सामना करना एक बड़ी समस्या है । पेय जल उपलब्ध कराने के लिये झिल्ली प्रक्रियाओं तथा पानी लेने के लिये कम से कम एक छोटे पंप की आवश्यकता रहती है । उड़ीसा के समुद्री तूफान के दौरान किये गये अनुभव के आधार पर संस्थान ने इसमें परिवर्तन किया है । स्थानिक (के.पी.ई.एस ईग्लीश हाईस्कूल) के विद्यार्थी द्वारा विकसित तथा निर्देशित टेबल पर एक सरल पंपिंग साधन के आधार पर संस्थान ने बड़े पैमाने पर तथा क्षेत्रीय उपयोग के लिये एक प्रोटोटाईप यंत्र विकसित किया हैं । इस स्वयंसंचालित पम्प का उपयोग विद्युत अपोहन तकनीक द्वारा उड़ीसा में पेय जल उपलब्ध कराने में किया गया ।

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जैव–लवणता

महत्वपूर्ण समुद्री वनस्पति का चयन एवं कृषि

अग्रोफाईट्स की छंटाई, चयन एवं कृषि तकनीक : हमारे देश में अगार के उत्पादन के मुख्य स्त्रोत हैं ग्रेसीलेरिया इडयुल्स और जेलीडियेला एकेरोसा । पहले ग्रेसीलेरिया की प्रचुरता विशेष है, जबकि दूसरे जेलीडीयेला में से उच्च जेल क्षमता वाले अगार की प्राप्ति होती है, जो जैव–विज्ञान के उपयोग के लिये विशेष रुपसें से योग्य है ।

हाल में अगार की बढ़ती हुई मांग ने कुदरती संपदा की अंधाधूंध कटाई को पराकाष्टा पर पहुँचा दिया है । समूद्री वनस्पति की आर्थिक संभाव्यता को बढ़ावा देने, देशकी उच्च जैवविविधता को सुरक्षित रखने के लिये संस्थान ने जल में प्राप्त इन समुद्री वनस्पतियों की कृत्रिम खेती की संभावनाओं पर अन्वेषण किया । रामेश्वरम, मंदपम तथा कारैकुडी से ग्रेसीलेरिया ईडयुल्स एकत्रित करके उनका बायोमास, ऋतुजैविकीय गुणधर्म, अगार का उत्पादन तथा अगार की गुणवता के आधार पर विभाजन करके गुणधर्मो का अध्ययन किया गया । एक रस्सी प्लवन तकनीक (SRFT) पद्धति द्वारा 200 भी लंबी रस्सी पर इसकी कृत्रिम खेती भी की गई । (90 दिन के बाद) 0.45 कि.ग्रा/मी बीज में से 3.9 कि.ग्रा/मी ताज़ा वजन की फसल प्राप्त हुई । रामेश्वर, कारैकुडी द्वीप, इरवैड़ी तथा शेखुकराई से भी ग्रेसीलेरिया एकेरोसा का चयन किया गया और क्रमशः उनकी खेती का अभ्यास करने के प्रयत्न किये गये । इस अभ्यास में कोरल स्टोन पर नाईलोन धागे तथा कीलियों की सहायता से बीजप्रष्फूटन/अंकुरण वर्धन भी सम्मिलित है । 1.2 कि.ग्रा/मी^{2} ताज़ा बायोमास पाया गया । एक तरफ यह परिणाम उत्साहवर्धक है तो दूसरी मुख्य समस्या बीज अंकुरण तकनीक में विपुल मात्रा में कोरल स्टोन की हैं ।

जीवाणु विज्ञान स्तर का अगार : जेलीडियेला एकेरोसा में से निष्कर्षित अगार के उत्पादन एवं गुणवत्ता में पर्याप्त (विशेष) सुधार देखा गया है । इस उत्पाद के दो विशिष्ट उपयोग के दौरान प्रारंभिक अगार मूल्यांकन से देखा गया है कि इस तरह से प्राप्त अगार आंतर्राष्ट्रीय अग्र ब्रान्ड के जीवाणु विज्ञान स्तर के अगार के समकक्ष स्तर का ही है ।

के – केराजिनन उत्पादक समुद्री वनस्पतियाँ : विश्व में के–केराजिनन के उत्पादन के लिये युकोमा का उपयोग किया जा रहा है । इस उद्देश्य से महत्तम कच्ची सामग्री की पूर्ति तांजानिया, ईन्डोनेशिया, फिलीपीन्स की कृषि सामग्री से की जाती है । इस शैवाल को भारतीय जलसंपदा ने स्वीकृत किया है ओर इसे हाल में प्राप्त रिपोर्ट अनुसार अंदामान में उगाया जा रहा हैं । इसकी व्यापारिक कृषि एकरस्सी पर अग्रस्थ प्रवर्धन विभाजन तकनीक द्वारा की गई। संस्थान ने इस कृषि की वैकल्पिक तकनीक, पारदर्शी, छिद्रिल पोलिथिलीन बेग में विकसित की है । इस तरह की तकनीक से चराई की समस्या को दूर किया जा सका है और कच्चा माल शुद्ध रुपमें प्राप्त किया गया । फिर भी यह धारणा है कि इस तकनीक से वृद्धि क्षीण होती, है फिर भी पोलिथिलिन बेग की डिज़ाईन में थोड़ा परिवर्तन करके इस समस्याका निराकरण किया जा सकता है । इसी के दौरान, संस्थान ने उत्तक संवर्धन तकनीक द्वारा एक नया रुपांतर विकसित किया है । जिसनें फार्म के पौधों से विपरीत मूल्यांकन दिखाया है ।

अर्द्ध परिमार्जित केराजिनन : अर्द्ध परिमार्जित केराजिनन का उपयोग पालतू जानवरों के खाद्यों में किया जाता है । यह तत्व जानवरो के खाद्य उत्पादनों को उनकी पसंद का गौंद जैसे चिपचिपे पदार्थ का रुप देता है । जिससें विश्व के बाज़ार में ईसकी मांग बढी हैं । हमारे देश में उपलब्ध हिप्नीया तथा युकोमा समुद्री वनस्पतियो में से इसके निर्माण की प्रक्रिया विकसित की गई हैं । तथा इसके उत्पाद का आन्तर्राष्ट्रीय प्रयोगशाला में परीक्षण किया गया है। इस प्रक्रिया का

उल्लेखनीय पहलू आल्काईन स्त्राव का निष्कासन है।

अल्वा फेसीएटा की कृषि : शीत तथा वसंतऋतु के दौरान जापानी तथा देश में तैयार की गई कृषि जाली का उपयोग करके अंतरज्वारीय दीव के समुद्री तट क्षेत्रमें औषधि विज्ञान में एवं खाद्य शैवाल में महत्वपूर्ण अल्वा फेसीएटा की प्रायोगिक कृषि सफलतापूर्वक की गई । प्रयोगशालामें इन जालियों को बीज़ से भरा गया तत्पश्चात दीव के अंतरज्वारीय समुद्र में स्थानांतारित किया गया । 11 से 12 हप्ते में इनके पौधें 15 से 20 से.मी के होकर, कटाई करने योग्य हो गये । कृषि के समय अल्वा फेसीएटा फसल से बायोमास की औसतन प्राप्ति 550 ग्रा.गीला भार/मी अथवा 110 ग्राम सूखा भार/मी रही । नवम्बर से मार्च के दौरान तीन फसल उगायी गयी जिसकी उपज अनुमानत 1.8 टन सूखाभार/फसल/वर्ष रही । आर्थिक दृष्टि से महत्वपूर्ण इस समुद्री शैवाल का उत्पादन प्रथम बार ही देश में बनी हुई कृषिजालियों द्वारा सफलतापूर्वक प्रदर्शित किया गया ।

जैवप्रौद्योगिकी : आर्थिक दृष्टि से महत्वपूर्ण शैवाल की कृषि के लिये बीज प्रवर्धन एवं सुधार के उद्देश्य से उत्तक संवर्धन, कोष संवर्धन तकनीक का प्रयोगशाला में अध्ययन किया गया । प्रारंभ में उत्तक संवर्धन में प्रयुक्त विभिन्न कार्यो के विकास पर ध्यान केन्द्रित किया गया । विकसित तकनीक में जर्महीन उत्तकों को तैयार करना, कोष प्रर्वतन तथा उपकोष, ईष्टतम कोष परिस्थितियाँ, कोष प्रवर्तन दर तथा वृद्धि में कार्बन स्त्रोतों का असर और युकोमा कोष का संरचना विकास आदि सम्मिलित हैं। पौधों के स्थानांतरण के समय मृत्युदर कम करके, भौतिक तथा रासायणिक मिश्रित उपचार द्वारा 60 प्रतिशत पौधे सुरक्षित रखने का प्रयास किया गया, जो जर्महीन उत्तक संवर्धन के लिये पर्याप्त थे । युकोमां के बड़े पौधे के कायिक भृण समान बंधारण, प्रयोगशाला में विकसित पौधे की शाखा में से तंतुमय रंजक कोष प्राप्त किये गये और प्राप्त भृण पर किये गये संशोधनो से पता चला है कि व्यापारिक खेती के लिये रंजक चयनित जननद्रव्यों की एक पूंजक वृद्धि उपयोगी है ।

सरगासम में से विविध उत्पादनों की संपूर्ण पुनःप्राप्ति : सरगासम एक ऐसा समुद्री शैवाल है जिसमें से कुछ व्यापारिक दृष्टि से महत्वपूर्ण उत्पाद प्राप्त होते हैं । संस्थान ने सरगासम की विविध जातियों में से प्रवाही उवर्रक तथा आल्जेनीक एसीड प्राप्त करनेकी विशिष्ट तकनीकि विकसित की हैं । अन्य महत्वपूर्ण उत्पाद में मेनिटोल प्राप्त किया गया । नई तकनीक से देखा गया कि तीनो उत्पाद्य वस्तुतः एक ही प्रकार की समुद्री शैवाल से प्राप्त किये जा सकते हैं और उस पर प्रायोगिक कार्य शुरु किये गये हैं ।

समुद्री शैवाल के जैवसक्रिय यौगिकों का रासायनिक अध्ययन : उपलब्ध रिपोर्ट अनुसार, विषाणुरोधी, लहूस्कंदनरोधी तथा गांठ रोधी गुणधर्मवाले समुद्री पोलीसेकेराईड्स जैव सक्रियता पर संशोधन कार्य किया गया । विशेष रुपसे हीपेरीन स्कदंनरोधी एजन्ट के रुपमें बिख्यात पशु से प्राप्त, हीपेरिन के स्तर का जैवसक्रिय इन समुद्री शैवाल से प्राप्त करने का मुख्य उद्देश्य रहा और समुद्री शैवाल पर आधारित सल्फेटेड पोलीसेकेराईड्स में बंधारणीय समानता की दृष्टि से रासायनिक जैव विविधता का अभ्यास करने के लिये भारत के विभिन्न समुद्रीतटों से विभिन्न प्रकारकी हरित तथा भूरी एकत्रित शैवालों में से पोलीसेकेराईड्स को अलग करके, उनका रासायनिक विश्लेषण करके उनकी लहूस्कंदनरोधी क्रिया का परीक्षण किया गया । कुछ कार्यो में साहित्य में उपलब्ध रिपोर्ट समतुल्य, विश्वसनीय परिणाम प्राप्त हुए । संस्थान समुद्री जैवसक्रियता में कार्यरत अन्य संस्थाओं के साथ आंतर संस्थान अनुसंधान योजनाओं में भी भाग ले रहा है ।

समुद्री सायनोबेक्टेरीया

समुद्री सायनोबेक्टेरिया की क्षमता का परीक्षण करने के लिये विवध परिमाणों के तनावयुक्त वातावरण में ये रखे गये, और परिणाम स्वरुप देखा गया कि ऐसी परिस्थितियोंमें ये ऐसे पदार्थ (सेकेन्डरी मेटाबोलाइट्स) उत्पन्न करता है जिनकी आर्थिक उपयोगिता विशेष हैं । विस्तृत संशोधन कार्य अंतर्गत आरब समुद्र के समुद्री सायनोबेक्टेरीया से न्युरोपेपटाईड्स पर संशोधन किया गया । 150 प्रजातियों की छंटनी करके, लिंगबिया तथा ओसीलेटोरीया जाति की विषालुताका चूहों पर जैव निर्धारण परीक्षण किया गया । इन जातियों में बाह्य तथा आंतरिक दोनों प्रकार की विषालुता निहित हैं किन्तु आंतरिक विषालुता की तीव्रता ज्यादा पाई गई। लिंगबिया तथा ओसीलेटोरीया की विषाक्त चयापचयता, आल्कोलोयड्स तथा पेपेटाइड्स के रुपमें पहचानी गई । 2D TCC अंगुली चिह्न के अभ्यास किये गये तथा विभिन्न विपरित परिस्थितियों में उगायी गई इन प्रजातिओं के रसायनिक चयापचयता का निरीक्षण किया गया । इनकी विषालुता परीक्षण के लिये द्रुत, संवेदनशील सरल तकनीक (एरटेमीया सेलीना का उपयोग करके) विकसित की गई, तथा प्राप्त परिणामों का DRDE ग्वालियर में चूहों पर जैवनिर्धारण द्वारा (ईन वाईवो) परीक्षण किया गया ।

विभिन्न उद्योगों के बहिःस्त्रावों को रंगविहीन करने के लिये सायनोबेक्टेरीया संवर्धन का उपयोग किया गया और संवर्धन की सहजीविता में उत्साहवर्धक परिणाम प्राप्त हुए । उद्योगों के क्षारयुक्त बहिःस्त्रावों तथा ब्राईन के जैववैज्ञानिक शुद्धीकरण के लिये इन सायनोबेक्टेरीया संवर्धन के उपयोग की संभावनाओं का परीक्षण भी किया जा रहा है ।

जोजोबा की कृषि तथा मूल्यवृद्धि

जैव प्रौद्योगिकी

पौधों में लवण प्रतिरोधक क्रियाविधि : लवण प्रतिबल संकेतन में केल्शियम/कैलमो डुलिन निर्भर प्रोटीन फोसफेटेज़ कैलसिन्युरिन जो पौधों के लवण अनुकुलन में माध्यम है, द्वारा एक महत्वपूर्ण रास्ता खोज लिया गया है । संस्थान हैलोफाईट नमूने का उपयोग करके, लवण प्रतिबल ताा सह्यता में निहित संकेतन प्रक्रिया पर शोध कार्य केन्द्रित करेगा ।

संकरण द्वारा जोजोबा वसा अम्लों के संघटन में विनियोजन एवं संकरो का विकास : चयनित नर एवं मादा पौधे में एक सफल अन्तर्जातीय संकरण की निष्पति की गई । खुले परागित पौधों की तुलना में संकरित बीजो के एक बीज भार एवं तेलांश में सांख्यिकीय दृष्टि से वृद्धि पायी गई । यहां तक कि संकरण के कारण तेलीय संघटन भी विनियोजित हो गया । नर एवं मादा पौधों के उपयुक्त समायोजन द्वारा, तेल के गुणों में सुधार एवम मूल्यवृद्धि लानेकी संभावना रही है। यह कार्य नर पौधे के आनुवंशिकीय रुप का, तेल के गुणों पर प्रभाव का भी संस्थापन करता है।

जोजोबा का सूक्ष्म–संवर्धन एवं कलमों तथा सूक्ष्म कलमों में जड़ प्रेरण : एकलिंगी होने के कारण जोजोबा के बीजों द्वारा उगायी गई वाटिकाओं में उल्लेखनीय भिन्नता पायी जाती है । इसीलिए स्तभ्भ कलमों एवं सूक्ष्म–प्रवर्धन रोपों द्वारा अलैंगिक गुणित जोजोबा वृद्धि, ज्ञात लिंग वाले रोपों को उत्पन्न करने एवं भावी वृक्ष वाटिकाओं में आनुवंशिक समता लाने में सहायक होगा । पूरे विश्व में बहुत से वैज्ञानिक इस पौधे के अलैंगिक संवर्धन पर कार्य कर चुके हैं परन्तु उनके संलेख एवं परिणामों में विचारणीय भिन्नता है । पौधों का जीवन–प्रतिशत सभी जगह अल्प पाया गया ।

प्रस्तुत कार्य में सूक्ष्म–प्रवर्धन के लिये प्रयुक्त आधार माध्यम, दूसरे वैज्ञानिकों से भिन्न था। जड़ प्रेरित आम्सिन मिश्रण के संघटन में भी विनियोजन किया गया । परिणाम स्वरुप जड़ित पौधों की मृत्यु दर में भी उल्लेखनीय कमी आई । इनमें द्रवीय समुद्री शैवाल उर्वरक प्रयोग करने से कलमों की वृद्धि में तेजी हुई । इस तकनीक द्वारा जोजोबा के उत्तम किस्म के ज्ञात लिंग वाले पौधों की प्राप्ति होगी एवं इच्छित नर–मादा अनुपात के साथ, आयोजित खाके में जोजोबा की खेती करने में सुविधा हो सकेगी ।

जोजोबा बीज से तेल का अतिक्रांतिक CO_2 निस्सारण : जोजाबा तेल मुख्य शरीर रक्षक तेल है जिसे साफ करने की प्रक्रिया द्वारा और अधिक मूल्यवान बनाया जा सकता है । भारतीय तकनीकि संस्थान, मुंबई में जोजोबा तेल के अतिक्रांतिक ब्$_2$ निस्सारण पर अध्ययन आरभ्भ किये गये । प्रारंभिक पायलट प्लान्ट स्तर पर अध्ययन द्वारा निकाले गये महत्वपूर्ण निष्कर्ष हैं:

(1) ईस विधि द्वारा 41-48% तक तेल निस्सारण किया जा सकता है । जो विलायक निस्सारण से प्राप्त तेल उपज से तुलनीय है ।
(2) तेल लगभग रंगहीन एवं गन्धहीन होता है ।
(3) GC अध्ययन से पता चला कि कुछ सीमा तक तेल का प्रभाजन भी संभव हैं। CO_2 से अधिक निस्सारण क्षमता और तेल के आगे, इच्छित CO_2 के उच्चतर अनुपात की प्राप्ति के लिये, प्रभाजन में वसा अम्ल के अंश का अति महत्व है ।

जोजोबा शरीर क्रीम बनाने के लिए जोजोबा तेल का एन्जाईमेटिक ट्रान्सइस्टरीकरण : जोजोबा तेल के एन्जाईमेटिक ट्रान्सइस्टरीकरण के लिए एक विलायक हीन एन्जाईमेटिक प्रक्रिया विकसित की गई । इस तकनीकी को प्रमुख विशेषताओं में उल्लेखनीय है कि यह एक सरल समय बचत वाली, विलायक रहित प्रक्रिया है जो सामान्य ताप पर की जा सकती है और इस प्रक्रिया में कोई निस्राव भी नहीं होता । इन्जाइम प्रक्रिया से निर्मित ट्रान्सइस्टरीकृत जोजोबा तेल को सफलतापूर्वक जोजोबा शरीर क्रीम के लिए प्रयोग किया गया और विष–सम्बन्धी मूल्यांकन हेतु भारतीय विष अनुसंधान केन्द्र को भेजा गया।

खारे पानी से सेलिर्कोनिया ब्रेकियेटा उगाने की तटीय लवणीय भूमि की जीव–कृषि : तटीय लवणीय ब्रेकियेटा जो 70% लिनोरीक अम्ल वाले खाद्य तेल का स्त्रोत है, को उगाने की योजना आरंभ्भ की गई । यह पौधा इस प्रकार की बंजर भूमि को दोबारा कृषि–योग्य बनने में सहायक सिद्ध हो सकता है । इस पौधे के अन्य उपयोग भी संभव हैं ।

सेलिर्कोर्निया चीनोपोडिएसी नामक परिवार का सदस्य है । पूरे विश्व में लगभग 50 पौधजातियों से परिपूर्ण यह वंश मुख्यतः एशिया, अफ्रीका, यूरोप एवं उत्तरी अमेरिका के खारी दलदल में उगता है । भारत में सेलिकोर्निया बैक्रियेटा एवं सेलिकोर्निया हरबेसिया नामक दो पौध जातियां पायी गई है परन्तु इनमें पहली जाति प्रधान है । सेलिकोर्निया ब्रेकियेटा एक एकवर्षीय 30-40 से.मी. ऊंचाई वाला युग्मभुजी शाखीय अनिवार्य लवणरागी हर्वे है, जो समुद्र किनारे की खारी दलदल/कीचड पाटों में पाया जाता है । इसका बीज सीधा, दबा हुआ और झिल्लीयुक्त होता है जिसमें 25-30% लिनोलिक अम्ल युक्त खाद्य तेल होता है । स्वाभाविक पर्यावरण में इसीकी बीज उपज लगभग 250 कि.ग्रा प्रति हेक्टेयर होती है । GSFC साइन्स फाउन्डेशन, बरोडा ने इसकी खेती एवं वृद्धि के लिए एक परियोजना प्रायोजित की है जिसका प्रारंभिक लक्ष्य प्रति हेक्टेयर 1.25 टन बीज उत्पादन रखा गया है और जिससे यह सीफायर कारपोरेशन यु.एस.ऐ द्वारा विकसित एस. बिगलोवी के कार्य संपादन के बराबर हो सके । हमारे प्रथम प्रयास में इस

खेती से 450 कि.ग्रा/हेक्टेयर का बीजोत्पादन प्राप्त हुआ ।

जेट्रोफा की कृषि : जैट्रोफा करकस जंगली रुप से उगने वाली बहुवर्षित्र झाड़ी है जिसने तेल को जैवीय–डीज़ल में बदले जा सकने की संभावना के कारण काफी ध्यान आर्कषित किया है । इस तेल के दूसरे उपयोग भी हैं जैसे साबुन बनाने में और दिया जलाने के तेल के रुप में । इस पौधे के औषधीय गुण भी हैं । CSMCRI ने UNDP के अन्तर्गत एक परियोजना में उड़ीसा में सीमान्त भूमि पर इसकी खेती एवं 20 हेक्टयर की एक बीज वाटिका विकसित की है जो उच्च श्रेणी के पौधों के चयन करने में और उनकी लगातार खेती करने में उपयोगी होंगी । एक विषहीन प्रजाति को अपनी जलवायु के अनुकूल कर लेने में भी सफलता की संभावनाऐं हुई हैं ।

स्मुद्री पर्यावरण

समुद्रीतट पर समुद्री जल तथा समुद्रीजीवों पर सोडा ऐश उद्योगों के बहिःस्त्रावों के प्रभाव पर पर्यावरणीय असर एवं मूल्यांकन पर अध्ययन : समुद्रीतट पर सोडा ऐश बहिःस्त्रावों के निष्कासन का, समीप के समुद्रीजल, समुद्री जीवों तथा गुणवता पर प्रभाव का अध्ययन किया गया। पोरबंदर के तट पर एमोनिया तथा नाईट्रेट विशेष उच्च मात्रा में पाये गयें । परिणामस्वरुप फाईटोप्लांकटोन की वृद्धि ज्यादा हुई जबकि झूप्लांकटोन में युट्रेपीकरण के कारण कम वृद्धि पायी गई । इसका उपाय करने के लिये संबंधित उद्योगों को परामर्श दिया गया परिणाम स्वरुप समुद्री पर्यावरण में युट्रोपिक एजन्ट कम हुएं और झूप्लांकटोन के उत्पादन द्वारा बायोमास में निर्धारित वृद्धि हुई ।

(क) समुद्र – तटीय नियंत्रण तथा पूर्वानुमान पद्धति : गुजरात के समुद्रतट के कंडला से पोरबंदर तथा महुवा से अलियाबेट के क्षेत्र को समुद्रतटीय पर्यावरण परिमाणों के अनुसार नियंत्रित किया गया । उक्त कार्य को संपादित करने के लिये समुद्री विज्ञान, रसायण, जैव विज्ञान तथा सुक्ष्म जैव वैज्ञानिक प्रचालकों का अभ्यास किया गया । तटीय क्षेत्र का मिथेन तथा कार्बन डायोक्साईड़ स्तर भी नियंत्रित किया गया । एन्टरोमोरफा, अलवा, सरगासम तथा एवीसेनिया से मिथेन के उत्सर्जन के लिये भावनगर, घोघा, ओखा तथा कंडला पर उगनेवाले प्रचलित तथा अप्रचलित पौधे का अभ्यास किया गया । एन्टरोमोरफा तथा सरगासम के उत्सर्जन दर में वृद्धि पायी गयी जबकि एबीसेनिया के उत्सर्जन दर में कमी पाई गई । कोडीनार तथा कंडला क्षेत्र के समुद्रतटीय जल में अन्य की तुलना में पेट्रोलियम हाईड्रोकार्बन की उच्च सांद्रता पाई गई । अलंग के समुद्रीतट पर सभी परिमाणों: TSS, PHC, Fe, Cu, Pb तथा Hg में महत्तम प्रभावित स्थिति पाई गई । समुद्रतट के परीक्षण के दौरान कई समुद्रीतटों पर शीगेला, सेलमोनेला, तथा वाईब्रियोक्लोर जैसे रोगजनक जीवाणु विशेष मात्रा में पाये गये ।

(ख) समुद्री शैवाल तथा समुद्री रसायन के लिये मरीन डेट़ा सेन्टर : संस्थान के डेटाबेस द्वारा, भारतीय शैवालज्ञों द्वारा विकसित की गई प्रक्रियाओं/प्रौद्योगिकियाँ प्रकाशन, पेटन्ट, पुस्तकें, रिपोर्ट तथा विशेषज्ञों के बारे में जानकारी उपलब्ध है । "फाईकोसर्च नामक त्रिमासिक जरनल प्रकाशित किया जा रहा है । जिसमें समुद्री शैवाल विज्ञान की पेटन्टस, पुस्तक समीक्षा तथा अन्य जानकारी के साथ सभी संशोधन लेखों के सार प्रकाशित होते हैं ।

CSMCRI

Biennial Report: 1998-2000

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INORGANIC CHEMICALS

Upgradation of solar salt yield and quality

Fractional crystallisation of salt from the brine : The Institute knowledge base on phase equilibria of multi-component systems was applied to upgrade salt produced from subsoil brine. From the experimental data, the change in quality of salts crystallized at various density levels with changing ionic composition of brines was explained theoretically and the ionic composition of an ideal brine and proper density ranges for the recovery of high quality salt were identified.

Improving quality of salt recovered from subsoil brines : Annual salt production of the country has crossed 12 million tons, more than 30 per cent of which is produced from subsoil brines. Subsoil brine is attractive to salt manufacturers due to the initial high density compared to that of sea brine. However, the salt produced from subsoil brines is, in most cases, of inferior quality due to the presence of high level of calcium impurity, which makes the salt unsuitable for industrial use.

An innovative route for production of industrial grade salt *in situ* from subsoil brines using the waste effluent of silicate industries has been developed. Removal of more than seventy five per cent of calcium impurities could be achieved through the above process. In a still more attractive approach, the effluent of the soda ash industry has been used to achieve the target of Industrial Grade II salt. This approach is especially attractive as it integrates with recovery of marine chemicals such as potash and magnesia by the novel process developed recently. In a third approach, highly salt tolerant marine microbe have been used to mop up-calcium from brine.

A salt scraper to reduce drudgery and enhance productivity : Salt harvesting is done mainly by women folk and is a grueling task during the hot summer months. The equipment developed is an attachment to a standard tractor and it loosens the salt bed, scrapes it and makes a long ridge of salt. The capacity of the scraper is 100 tons/hour. The special feature of this device is that it is cost-effective, allows salt harvesting even when the bed is only 75-100 mm thick, and eliminates raking operation during salt crystallization. This equipment reduces the drudgery of the salt workers, mechanically performing those operations which are especially arduous.

Iodized salt

Mechanistic studies of iodine loss : Iodine is an essential element required by the human body for various metabolic activities. Deficiency of iodine can lead to "Goitre", an endemic disease. Salt is recognised as the best carrier of iodine in human body and potassium iodate as the best iodating agent. To gain insight into the mechanism of the loss of iodine from iodized salt - both in solution phase in the presence of various cooking ingredients and also in solid phase by coming in contact with other metal salts - a systematic study was undertaken. Investigations on the stability of KIO_3 in solid and solution phases by classical and electrochemical methods revealed that iodine of KIO_3 in iodized salt gets sublimed in the presence of hydrolysable salts, ascorbic acid (Vitamin-C) and carbohydrate which are commonly present in edible items. Based on these observations, studies were undertaken on the kinetics and rate constants of the reaction of potassium iodate in iodized salt with ascorbic acid, potassium iodide and D-Glucose at different temperatures in solution phase as well as solid phase.

Development of free flow iodized salt manufacturing plant at Mauritius : Under a consultancy assignment from M/s. Saliere de L'A Ouest, Mauritius, a one ton per hour capacity plant for manufacture of free flow iodized salt was commissioned by CSMCRI scientists at Mauritius. Personnel from the company were also provided training on quality control aspects. The process developed by the Institute uses screw classifier for removal of insoluble and soluble impurities. The product remains free flowing even under extreme humid conditions, achieved by using a novel free flow aid. However, generation of excessive fines has been reported and efforts are underway to reduce this to the desired level.

Online production of potassium iodate : To reduce the cost of potassium iodate to user industries and also to ensure that there is no adulteration of the iodizing agent, an electrochemical process has been developed to produce potassium iodate in solution form which is ready for use in the factory premises.

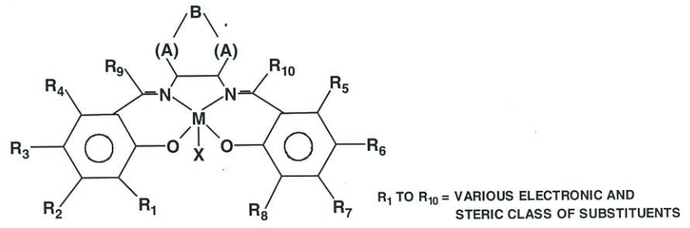
Integrated recovery of marine chemicals

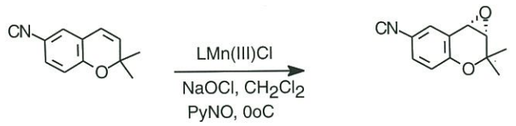
Major strides were taken in making recovery of marine chemicals a practical proposition. To generalize the approach so as to cover a range of brines and bittern, it was felt that desulphatation is an essential operation. The response to this approach has been good and several leading industries are collaborating in the development of the process. Interestingly, this approach is most cost-effective with sub-soil brine in view of its lower sulphate content; thus, sub-soil brine now bestows the twin

advantage of higher productivity on account of higher brine density and greater cost-effectiveness on account of lower sulphate content. The only operations that need to be carried out in a plant are the decomposition of carnallite to recover potash and downstream recovery of magnesium compounds from end bittern. Other benefits of the revamped process are that bromine recovery may be possible from end bittern rather than from low-density bittern, the key advantage being that concentration of bromide in the bittern is threefold higher. The process also yields gypsum, suitable for cement industry, as by-product. Simultaneous demonstration of the technology in several locations is being proposed, with initial thrust on the salt works of GHCL, Nirma and *agarias* in Little Rann of Kutch.

Coordination Chemistry and Catalysis

Chiral epoxidation of non-functionalised olefins. Chiral catalytic epoxidation of non-functionalised olefins is of commercial importance. Chiral epoxides such as styrene oxide, chromene oxide, and indene oxide



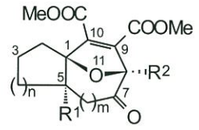


99% Conversion to Epoxide with 100% ee's*

are important intermediates in pharmaceutical, agrochemical, fragrance and flavor syntheses. Internationally, Jacobsen catalyst has been exploited commercially for such transformations. CSMCRI has also developed a series of catalysts which have shown high enantiomeric excess (ee). In some cases, ee higher than that reported for the existing Jacobsen type catalysts was achieved without the use of expensive auxiliary oxidants. Two patent applications have been filed on this invention. A suitable target synthesis of commercial importance is being identified for scale up of the indigenous chiral epoxidation process.

Metal-catalysed tandem reactions. Tandem reactions are among the most powerful strategic tools available to the synthetic organic chemist because they rapidly increase the complexity of a substrate while at the

same time providing the desired stereoselectivity. Also the tandem methodology proceeds with economical use of available functional groups, which bestow atom economy. In contrast to conventional methodology, tandem reactions were performed using the transition metal-catalyzed reactions of various diazo carbonyl compounds to synthesize new complex polycyclic compounds. For this purpose, various diazo carbonyl compounds tethered to cycloalkanones have been synthesized. Their reaction with appropriate dipolarophiles in presence of rhodium(II) acetate led to tandem cyclization-cycloaddition to afford the complex molecules, 1 and 2, in a single step and with high stereoselectively in most cases. The methodology was extended to syntheses of many oxatricyclic compounds with various ring sizes and substituents; such structures form the basic skeleton of many naturally existing sesquiterpenoids, 3. The mechanism involves initial formation of intramolecular rhodium carbenoid cyclization to generate unstable transient carbonyl ylides. In the presence of dipolarophiles, these unstable carbonyl ylide intermediates undergo 1,3-dipolar cycloaddition reactions to afford products stereoselectively.



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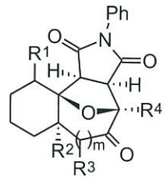

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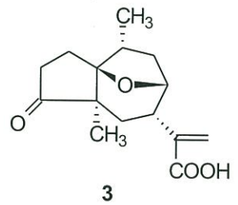
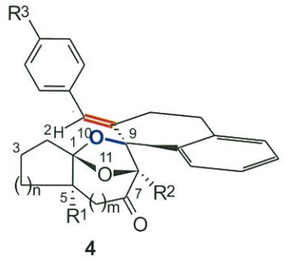


3

The reactions were performed to generate various five- and six-membered carbonyl ylides. Many diastereoselective and regioselective reactions were also achieved cleanly using tandem methodology. Various other complex polycyclic molecules were also synthesized diastereoselectively, e.g, the spiro-dioxatricyclic diastereomeric ring systems, 4 and 5, which are easily separable.



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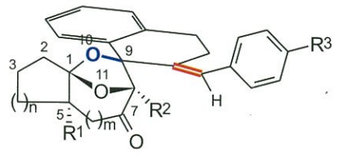


5

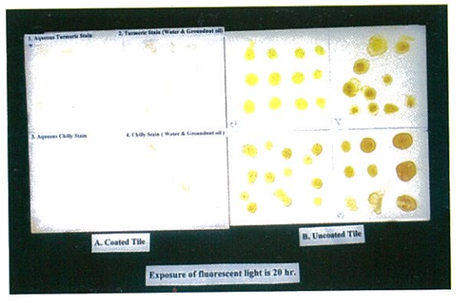
This tandem intramolecular cyclization-intermolecular cycloaddition sequence in the presence of a variety dipolarophiles is particularly attractive as four chiral centers and two new C-C bonds are formed in a single step under mild experimental conditions.

Hydrogenation of aromatic compounds. High aromatic content in gasoline lowers the fuel quality and also contributes significantly to undesired emissions in exhaust gases. To counter this, it is desired to develop an efficient catalyst for the hydrogenation of aromatics in gasoline. At CSMCRI, we have prepared and used Ru-containing clay for the catalytic hydrogenation of different aromatics and olefins to their saturated products. Their efficacy in actual petroleum feed will now be studied.

Photoproduction of hydrogen peroxide. A robust and efficient process of photoproduction of hydrogen peroxide developed at ICI India Research & Technology Centre was studied in-depth to understand the mechanistic aspects of the process. It was found that the process, where $Ru(bpy)_3^{2+}$ participates both as light harvester and as reactant, is controlled by an equilibrium and there is some uphill conversion of solar energy in the form of long lived chemical products.

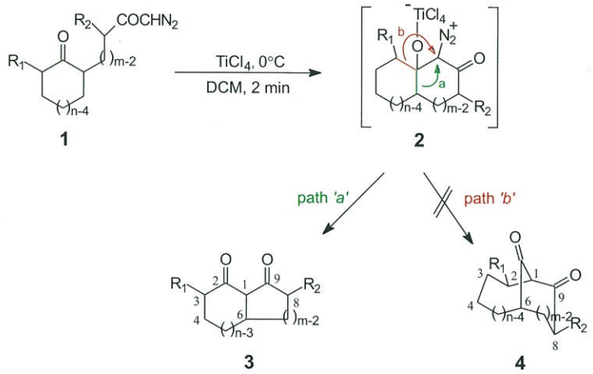
Electrochemical activation of dinitrogen. Since the discovery that metal containing biological enzymes fix atmospheric nitrogen under ambient conditions, scientists throughout the world have been trying to activate dinitrogen at a transition metal center. Several transition metal complexes, cofactors and model compounds to nitrogenases have been developed and the reactivity and bonding of dinitrogen investigated. Syntheses of simple water-soluble ruthenium(III)-aminopolycarboxylic acid complexes was carried out and voltammetric behavior under normal to moderate pressure of dinitrogen was compared with that under argon. Dinitrogen has been reduced to ammonia in the presence of catalytic quantities of Ru(III) complexes by constant potential electrolysis (-0.5 V vs SCE) in presence of ethylene diamine.

Titanium Chemistry



Photocatalytic auto-cleaning of stains. Photocatalytic oxidation with TiO_2, either in coated or dispersion form, is becoming increasingly popular for destruction of environmental contaminants like halocarbons, organic dyestuffs, biological stains from waste water, and surfactants. CSMCRI has developed a photocatalytically-active surface, which is activated even by an ordinary fluorescent tube light. Oily stains on tiles made by traditional Indian spices are largely removed through this self-cleaning action.

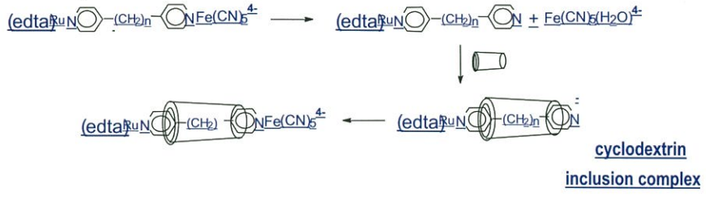
TiCl$_4$ Catalysis. The reaction of various diazo carbonyl compounds, 1, in the presence of Lewis acids such as titanium tetrachloride furnished regioselectively bicyclo[n.m.0]alkanediones, 3, in very good yields. Both the types of rearrangement, i.e., path 'a' and path 'b' are, in principle, possible and in all the reactions only bicyclic 1,3-diketones, 3 ,were produced and no detectable amount of the bridgehead diones, 4, were observed. The resulting bicyclo[n.m.0]alkanedione systems, 3, are ubiquitous in nature.



1 2 3 4

Synthesis of New Inorganic Metal Complexes. Binuclear complexes with polypyridyl ligands are important from the point of view of energy transfer and their application as photochemical molecular devices and multi-electron-transfer catalysts. CSMCRI has synthesized binuclear Ru(II) and Os(II) complexes with 2,4,6-tris(2-pyridyl)-1,3,5-triazine (tptz). Unusual metal-induced hydroxylation of triazine ring of bridged tptz was observed, which did not occur in mononuclear complexes. Some of the binuclear complexes have shown promising electrocatalytic reduction of carbon dioxide.

CSMCRI has also successfully synthesized mixed valence binuclear complexes where the metal centers are separated by saturated hydrocarbon bridge. In these complexes energy barrier due to the saturated hydrocarbon bridge is high enough to prevent optical electron transfer between the metal centers. However, electron transfer across the metal center has been achieved using cyclodextrin. These studies may help in understanding some unanswered questions related to electron transfer in biological systems.



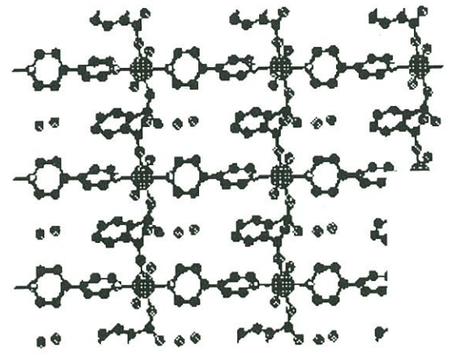
cyclodextrin inclusion complex

Another series of hetero dinuclear complexes has been synthesised using different asymmetric bridging ligands to study their role in tuning the metal-metal interaction.

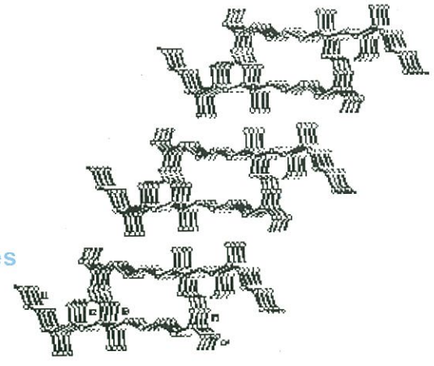
Polymeric network containing complex $[Co(4,4'\text{-bpy})(H_2O)](ClO_4)_2$ was synthesized and structurally characterized. A one dimensional polymer is formed in which metal centers are bridged by 4,4'-bpy, whereas other coordination sites are occupied by water and perchlorate ions.

Inorganic Layered and Porous Structures

Solid State Supramolecular Chemistry. Design and synthesis of crystalline coordination polymers having porous structures, satisfactory stability and specific functionalities such as shape selectivity and reversible small molecule adsorption is one of the challenges in material science. Two isostructural neutral coordination polymers ($[M(bpy)(phth)(H_2O)]_n.2H_2O$; M = Co^{+2}, Cd^{+2}, bpy = 4,4'-bipyridine, phth = phthalate) have been synthesized, which comprise rectangular grids with each cavity enclosed by two bpy and two phth ligands, which superpose in an offset fashion reducing the channel size to include two water molecules. The crystal structure of these materials shows 11.5x7.5 Å rectangular channels. It has also been shown recently that hydrogen bonding interactions can be utilized to construct a novel helical network in bile acid (cholic acid) inclusion complex.

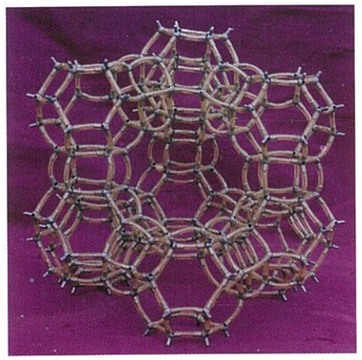


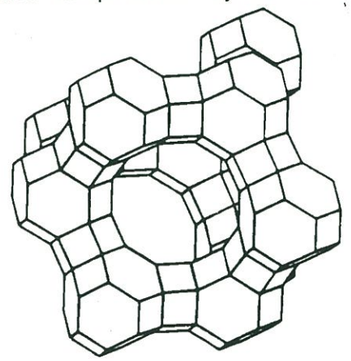
Pluton diagram of the rectangular grids with included latice water molecules



Helical hydrogen bonded network of cholic acid in its inclusion complex with 4-aminopyridine

Process for Zeolite-13X. Zeolite-13X molecular sieve is widely used in several difficult separations such as for production of oxygen enriched air, removal of traces of water, carbon dioxide and sulfur impurities from products. A process for producing impurity free Zeolite-13X powder involving simple unit operations has been developed, wherein the homogeneous reaction mass (aluminosilicate gel) was prepared at ambient temperature (avoiding high pressure and temperature synthesis in



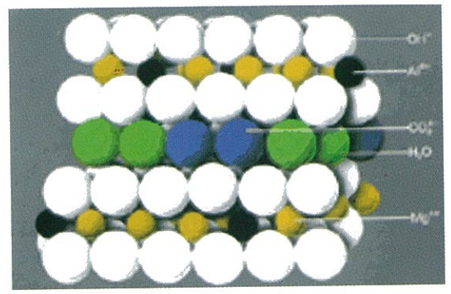


autoclave), crystallization of the gel was carried out without adding seed crystals, and the number of reaction variables was controlled through scientific understanding. Zeolite-13X has also been produced using bauxite-leached sodium aluminate liquor.

Zeolite-A with improved whiteness. Detergent grade Zeolite-A is largely consumed as phosphate substitute builder in detergent formulations, especially in compact detergent powders and bars. A correlation between the Fe content in sodium silicate and whiteness index of Zeolite-A was established and raw material specifications have been revised to achieve whiteness index > 99%. Zeolite-A technology has already been released to NALCO through NRDC and the further improvement of whiteness is likely to expand the market scope of the product.

Studies of hydrotalcites. Effect of various preparation parameters were studied using different physicochemical techniques such as XRD, FT-IR, TEM and ^{27}Al MAS-NMR and optimum conditions for obtaining crystalline material of good quality were identified. In addition, new methods of preparation were explored. A rapid synthesis methodology was developed for MgM(III)-CO_3-HTs (M(III) = Al, Fe and Cr) by coupling an instantaneous precipitation method with microwave irradiation. Various transition metal-containing hydrotalcites were synthesized and exploited for selective hydroxylation of phenol. Best conversion was obtained with a CuNiAl-51-HT catalyst.

Development of synthetic hydrotalcites (SHT) of commercial importance. Synthetic hydrotalcite finds application in pharmaceutical industry as antacid, in plastic/polymer industry as halogen scavenger, and has potential as non-halogenated inorganic flame retardant. Other novel applications of SHT are as catalysts in base-catalyzed reactions and adsorbents in wastewater



Structure of Hydrotalcite
$Mg_{(1-x)}A_x(OH)_2CO_{3x/2}H_2O$

treatment. The process for the preparation of SHT of three grades viz. pharmaceutical, halogen scavenger, and fire retardant grades using bittern as one of the raw materials was developed. Bittern is the mother liquor left after production of solar salt. The bittern is reacted with caustic soda solution to prepare magnesium hydroxide while alum or suitable aluminium-containing effluent is reacted with alkali to produce aluminium hydroxide. These are then mixed to get a precursor product which is subjected to hydrothermal treatment at normal pressure to obtain crystalline SHT. The process employs simple unit operations and moderate process conditions. It is proposed to make further improvements, specifically in reducing impurity ions, by utilizing end bittern which will become available in future.

Waste Utilisation

Upgradation of byproduct lime from a fertilizer industry to value added materials. Calcium carbonate is largely used as filler for rubber goods, in PVC cable insulation, in paints, toothpastes/tooth powders, paper and electronic industry. Byproduct lime produced in nitro-phosphate fertilizer plants cannot be used as such due to its low purity, larger particle size, poor whiteness, low pH and high bulk density. Nitro-phosphate unit of fertilizer industry using rock phosphate as a raw material generates substantial quantity of by-product lime, which is rich (> 90%) in $CaCO_3$ but has many other inorganic impurities. CSMCRI and GNFC have undertaken a collaborative research project to upgrade this by-product lime and make it suitable for application in rubber goods, PVC cable insulation and paints. CSMCRI has achieved this successfully through a simple process of chemical treatment followed by calcination in batch mode. Development of a continuous process for rubber grade calcium carbonate (10 kg/h) is currently in progress. Work is also in progress to optimize the conditions for precipitated calcium carbonate (PCC) to be used in PVC cable insulation and paper and a pilot plant is under fabrication.

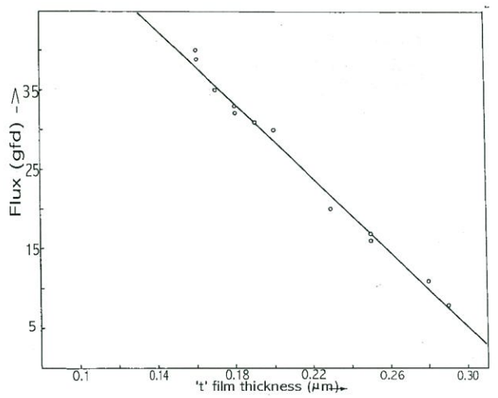
CSIR-NCL Biennial Report: 1998-2000

2

POLYMER & MEMBRANE SCIENCE

Reverse Osmosis

Development of high flux thin film composite (TFC) RO membrane. The Reverse Osmosis (RO) technology has been mainly used to convert brackish/sea water into safe drinking water by removing dissolved salts, pathogenic bacteria and other harmful constituents such as fluoride. It is also applied for concentration, separation and fractionation of valuable chemicals in chemical, pharmaceutical, dairy and food industries. The best performing membranes today are the Thin Film Composites (TFC) which have superceded the earlier generation cellulose acetate membranes. TFC membranes are prepared from polysulfone (PS) and polyamide (PA). The porous sub-layer of PS supports the thin layer of PA, which is introduced through interfacial polymerization, and is primarily responsible for salt rejection characteristics of the membrane. By carefully altering the membrane fabrication parameters this layer could be optimised to improve permeability, without compromising on salt rejection. The parametric studies involved effect of bath composition, evaporative zone temperature, curing temperature, and relative humidity on thin film preparation along with the dependence of coating and curing rates on film characteristics. Another factor was the control of the polyamide film thickness. The improvement in permeability was from 20-22 gfd obtained earlier to the present 30-35 gfd with 94-96 percent salt rejection under standard conditions of testing. This development will reduce the cost of hardware with proportionate reduction in operating cost.



Scaled up TFC module Development. Continuous sheets of 1 meter width x 50 meters length of TFC membrane could be produced on an automatic casting and coating machine. The design and technology is perfected to obtain required porosity of polysulphone coating and the salt rejecting ability and flux of the polyamide layer.

A 40,000 l/day low pressure RO desalination plant employing indigenously scaled up thin film composite membrane in the form of 4" dia spiral modules was installed at MRL (now CPCL), Chennai. The plant is being

used to treat sewage water and the performance was found to be comparable to that of the imported TFC membrane modules after elaborate testing. The project was funded by DST.

While a 4" dia x 1m module accommodates ~ 10 sq m membrane area, an 8" dia x 1m module accommodates about 40 sq m of membrane. The spiral modules preparation using indigenous membranes has now been successfully scaled up to 200 mm (8") diameter x 1 meter length through collaborative arrangement with Hydronautics India. The performance achieved with the indigenously developed elements was in the range of 14-18 gfd product water flux with 95-96 percent salt rejection. In-house infrastructure to undertake large diameter module preparation is being put in place.

Besides desalination of saline water, TFC membrane technology was successfully used in the other applications like domestic water purifier, solar powered RO units, refining of edible oils etc.

200 mm (8½) TFC module based on indigenous membrane

RO plant installed at Kalyanpur village for field testing of indigenous 200 mm (8½) TFC module.

Beneficiaries of the technology

Electrodialysis

Development of technology for heterogeneous electrodialysis membranes. Preparation of interpolymer ion-exchange membrane involves use of hazardous chemicals like chlorosulfonic acid and chloromethyl ether. It was envisaged to prepare heterogeneous membranes through a non-hazardous technique that uses a casting solution containing a binder and a polyelectrolyte. Such membranes have been prepared from PVC binder and ion-exchange resin powder on a specially constructed casting machine. The coating machine was initially constructed for making continuous sheet of reinforced bipolar membranes (see below) and its logical extension to the more ubiquitous monopolar membrane was conceived. The effect of particle size and resin loading on critical membrane properties such as dimensional stability, bursting strength, ion-exchange capacity, electrical resistance, and transport number have been studied. It was concluded that heterogeneous ion-exchange membranes can replace the interpolymer membranes in several ED applications.

New Process of desalting of Glyphosate herbicide. The process of Glyphosate manufacture results in an intermediate mixture which contains up to 20 % dissolved salt in the aqueous solution containing the desired product. It has been possible to reduce the salt concentration to the desired level of <1 % by electrodialysis, without negligible loss of product.

Application of conducting spacers. For demanding applications which require desalting to ultra low levels, it has been possible to meet the desired objective by using conducting spacers in place of the conventional polythene spacers in the ED unit, thereby avoiding polarization. Through this approach, several amino acids could be desalted to < 50 ppm salt concentration. This development allows replacement of conventional methods with the cleaner electrodialytic desalting process.

Development of bipolar membrane. Bipolar membranes are ideally suited to treat some of the saline liquid effluents. This membrane technique converts the dissolved anions and cations into the corresponding acids and bases, respectively, which, in turn, can be reutilized. The technique for preparation of bipolar membranes as a continuous sheet has been successfully developed and ED stacks based on these membranes have been used for preparation of tetrabutyl ammonium hydroxide from tetrabutyl ammonium bromide and also in several inorganic waste stream applications.

Ion-exchange resins

Defluoridation through indigenously developed ion-selective resin. CSMCRI had earlier developed a suitable ion-selective resin for

defluoridation. The work was a spin-off from the efforts to develop a resin for brine purification for chlor-alkali industries. The defluoridation process involves initial conditioning of the amino methyl phosphonic acid resin through successive treatment in the order $H^{+} \leftrightarrow Na^{+} \leftrightarrow Al^{+3}$. The same procedure was being earlier followed for the column regeneration process as well. However, a need was felt to simplify the resin regeneration process to maximize throughput and minimize use of chemicals. The improved process treats nearly 240 bed volumes of water containing 18 ppm fluoride and the exhausted resin bed can be directly regenerated with 2.0 bed volumes of 1 N alum, which represents a marked simplification over the earlier process. It is also found that the complexation of fluoride is almost 100 percent in the first 40 minutes, the resin has good capacity at pH 7 but the overall fluoride removing capacity decreases at alkaline pH. This is supported by the experiments carried out in the presence of bicarbonate ions whereas chloride and sulphate ions have little effect on the fluoride removing capacity of the resin. The resin shows higher uptake at elevated temperatures, a 9.5 percent operational loss in capacity and 3.4 percent cumulative attrition loss at the end of hundred cycles of exhaustion and regeneration.

Providing drinking water to distressed people in super-cyclone affected Orissa

Reverse Osmosis : The super cyclone-affected Jagatsinghpur district in Orissa was attended on war-footing by the Institute by installing in November, 1999 two RO desalination plants based on its indigenous TFC technology. Safe drinking water could be provided to the villagers in and around Naiguan and Paiksai. Wherever required, the water was pouched and also delivered by tankers. These plants produced 15,000 l/d of quality drinking water (see Table below) and the plants were operated for over nine months continuously. This has not only saved human lives in the area but eliminating the possible outbreak of epidemic, but has also demonstrated the potential for improving the quality of life of the affected people.

Electrodialysis (ED) : An ED system was also employed in Jagatsinghpur for desalination. The unit, which had a 50 LPH capacity, was gifted by Nuchem Ltd., Faridabad, a licensee of CSMCRI's ED technology. Water with up to 1800 ppm TDS was desalinated to provide safe drinking water with 500 ppm TDS. The unit was operated with the aid of a kerosene generator set. The unit, which was simple in design, could be maintained in villages without significant infrastructure.

The ED unit was also connected to a novel overhead water tank to eliminate the need for any pumping operation during electrodialysis.

A prototype design of a simple overhead pumping device was made by students of a local school (K.P.E.S. English School) in Bhavnagar and CSMCRI translated this into action by fabricating a larger,field level working prototype.

Nuchem electrodialysis plant based on CSMCRI Technology for supplying drinking water to the super cyclone affected people in Orissa

To, The Director C.S.M.C.R.I. Bhavnagar Gujarat.

Sir,

with lotty gratitude and high reverance, I beg to apprise that the csmcri Bhavnagar unit, Gujrat has installed a drinking water unit at Naiguan, Po. Pandua via. Rahama, Dist Jagatsingpur, Orissa on trial basis. The highest authorities of state and central government have visited the plant and have felt the object need of it so as to supply drinking water to the neighbouring villages by vehicles. About ten thousand people are benefited by this Project and it covers 10-15 villages. As the super cyclone has polluted the environment greatly, it's necessary to continue this aforecited plant for another 4-5 months and we the following sing. signatories request your kind honour to permanently instan it to meet the need

Suvendra nath Swain
School Teacher, Naiguan

Detailed chemical analysis of water before and after treatment with Reverse Osmosis Plant at Naiguan, Orissa
(Analysis by NEERI, Nagpur)

Sr. No	Parameters	Saline Feed Water to RO plant	Filtered product Water from RO plant
	Physical Parameters		
1.	Turbidity (NTU)	1.0	0.8
2.	Conductivity (m s/cm)	10160	125
3.	PH	8.8	7.6
	Chemical parameters (All in mg/L)		
4.	Total Alkalinity	776	36
5.	Total hardness	1242	4
6.	Chlorides	3600	24
7.	Nitrates	17.5	7
8.	Potassium	430	7.8
9.	Sodium	1410	18.9
10.	Sulphates	416.5	5.3
11.	Manganese, Mn	0.271	N.D.
12.	Magnesium, Mg	171	0.457
13.	Calcium, Ca	212	0.664
14.	Lead, Pb	0.032	N.D.
	Bacterialogical CFU/100ml		
15.	Total coliforms	1300	Not detected
16.	Fecal coliforms	820	Not detected

3

BIOSALINITY

Strain selection and cultivation of important seaweeds

Strain selection and cultivation technology of agarophytes. The principal sources of raw material for agar production in our country are *Gracilaria edulis* and *Gelidiella acerosa*. The former is more abundant whereas the latter yields high gel strength agar which may be suitable for bacteriological applications. In recent times the growing market demand for agar has culminated in indiscriminate harvesting of the natural stock. To boost the economic potential of seaweeds, while retaining the country's rich biodiversity, the Institute is exploring the possibility of artificial cultivation of these seaweeds with the best strains available in our waters. *Gracilaria edulis* was selected from Rameswaram, Mandapam and Krusadai island and the seaweeds were characterized and graded based on biomass, phenological characteristics, agar yield and agar quality. Artificial cultivation was also undertaken on 200 m length of rope with the best strain identified, using the SRFT (single rope floating technique) method. 3.9 kg/m fresh weight was obtained after 90 days from 0.45 kg/m seed material. Selection of *Gelidiella acerosa* was also made from Rameswaram, Krusadai island, Ervadi and Sethukarai. Cultivation studies were attempted subsequently. Such studies involved seeding of vegetative fragments on coral stones with the help of nails and nylon thread. Fresh biomass of ca. 1.2 kg/m^2 was obtained. While these results are encouraging, key difficulties such as lack of large scale availability of coral stones and the obvious impracticality of the seeding technique have to be overcome.

Bacteriological Grade Agar. Substantial improvements have been effected both in the yield and quality of agar extracted from *Gelidiella acerosa.* Preliminary evaluation of the product in two specific applications indicates that it compares favorably with leading international brands of bacteriological grade agar.

Gelidiella cultivation on coral stones

Seaweeds yielding κ-Carrageenan. *Eucheuma* is exploited internationally for the production of κ-Carrageenan. Most of the raw material for this purpose is met from the farmed material from Philippines, Indonesia and recently from Tanzania. This alga was adapted in Indian waters and has been reported recently to grow in the Andamans.

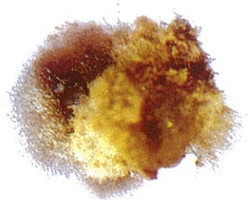
It is cultivated commercially by mono line method using apical vegetative fragments. CSMCRI has developed an alternative method of cultivation in transparent, perforated polythene bags. This approach allows purer raw material to be obtained besides eliminating the problem of grazing. There is, however, attenuation of growth which, it is believed, can be largely overcome by improved design of the bags. Meanwhile, the Institute has developed new variants through tissue culture technique and their performance is being evaluated opposite the existing farm plants.

Semi-refined carrageenan. Semi-refined carrageenan is used in pet food production. It provides the desired characteristic to the food by way of imparting gum-like property which is preferred by animals, and finds a large international market. Processes have been developed for its manufacture from the indigenously available seaweed, *Hypnea,* as well as *Eucheuma,* and the product has been evaluated in international laboratories. A notable feature of the method is the elimination of alkaline discharge.

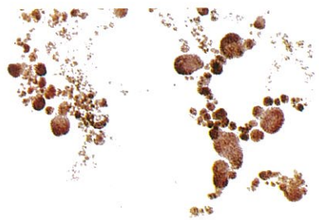
Cultivation of Ulva fasciata. Experimental field cultivation of pharmaceutically important and food algae *Ulva fasciata* was successful in the intertidal region of the Diu coast, during winter/spring months, using Japanese and indigenously prepared culture nets. Cultivation nets were seeded with swarmers in the laboratory and then transferred in the intertidal region of the sea at Diu. The plants reached harvestable size of 15 to 20 cm within eleven to twelve weeks. Average biomass yield of *U. fasciata* was 550 g wet wt./m^2 or 110 g dry wt./m^2 area of the culture net during the cultivation period. Three harvests can be made from November to March, with an estimated yield of 1.8 ton dry wt./ha/yr. For the first time, cultivation of economically important seaweeds in the sea using indigenous culture nets was successfully demonstrated.

Biotechnology. To improve and propagate the seed stock of economically important seaweeds for cultivation, research on development of *in vitro* cell culture techniques has been initiated. The initial work was focused on

Eucheuma explant with callus



Subculture of excised callus



Somatic formation of filamentous callus

development of various protocols involved in routine tissue culture studies. The methods developed include: preparation of aseptic tissues, callus induction and subculture, optimization of culture conditions, effect of carbon sources on callus induction rate and growth, and morphogenesis of callus of *Eucheuma.* To reduce mortality of explants, a combination of physical and chemical treatments was developed to obtain >60 % explants which are aseptic enough to use for tissue culture. With *Eucheuma,* somatic embryo-like structures similar to higher plants were obtained from the branched filamentous-pigmented callus. The somatic embryos observed in the present study could prove useful in clonal propagation of selected germplasm for commercial cultivation.

Integrated recovery of multiple products from Sargassum. Sargassum is an important seaweed which yields several important commercial products. The Institute has developed separately technologies for liquid seaweed fertilizer and alginic acid from Sargassum, albeit of different varieties. Another important product obtained was mannitol. A new process was visualised where all three products can, in principle, be obtained from the same seaweed and experimental work has been initiated.

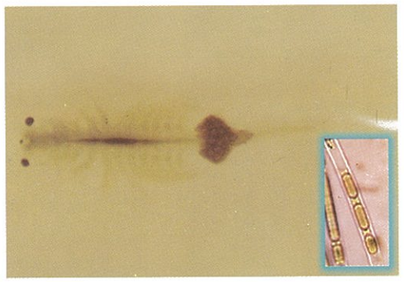
Chemical studies on bioactive compounds of marine algae. Work has been done on bioactive marine polysaccharides, which are reported in the literature to have antiviral, antitumor and blood anticoagulant activities. In particular, since the popular antithrombic agent, Heparin, is of animal origin, there is strong motivation to develop a similar bioactive from marine algae in view of structural similarities between Heparin and seaweed-based sulphated polysaccharides. Green and brown algal species collected from different coastal locations of India have been investigated for studying chemical biodiversity. Polysaccharides have been isolated from such algae, chemically analysed and assayed for blood anticoagulant activity. In few cases, results obtained are promising and comparable to those reported in the literature. The Institute is also participating in the inter-institutional project on screening of marine bioactives.

Marine cyanobacteria

Marine cyanobacteria adapt and exist under varying environmental stress conditions and produce secondary metabolites of economic importance. As part of a wide-ranging programme, studies were carried out on neuropeptides from marine cyanobacteria in Arabian sea. 150 isolates were screened and sublethal toxicity was observed with *Lyngbya sp.* and *Oscillatoria sp.* through mouse bioassay. These species contained both exotoxins and endotoxins, the latter being found to be more potent. The toxic metabolites of *Lyngbya* and *Oscillatoria* were identified as alkaloids

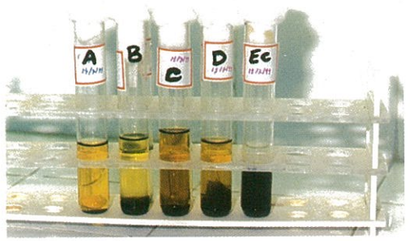
and peptides. 2D-TLC fingerprinting studies were also carried out and variations in the chemotypes of secondary metabolites were observed when these species were grown under different stress conditions. A rapid, sensitive and simple toxicity test was also developed using *Artemia salina* and the findings were confirmed through *in vivo* mouse bioassay at DRDE, Gwalior.

A- *Artemia Salina* grown under normal condition (without *Lyngbia*)



B- A*rtemia Salina* grown with *Lyngbya* showing tumor and abnormal tail

Cyanobacterial cultures were utilised to treat colored effluent from different industries and encouraging results were found with a consortium of cultures. Their utility in treatment of saline industrial effluent and for biological purification of brine is also being investigated.



Effluent treated with different cyanobacterial strains
A *Oscillatoria sp.;* B Consortium; C - *Synechocystis sp.;* D *Lyngbya sp.;* E Control (Tetrathiobenzol)

Phytosalinity

Jojoba cultivation and value addition

Biotechnology

Salt tolerance mechanism in plants. An important pathway has been found in stress signaling through Ca^{+2}/Calmodulin-dependent protein phosphatase calcinurine, which mediates salt adaptation in plant. The Institute will be focusing on signal transduction phenomenon involved in salt stress and tolerance using halophyte model.

Modification in fatty acid composition through cross breeding and development of hybrids in Jojoba. A successful intra-specific hybridization between selected male and female plants was accomplished. There was statistically significant increase in single seed weight and oil content of hybrid seeds as compared to open pollinated samples. Even oil composition gets modified due to cross breeding. This work opens up the possibility to improve the seed and oil characteristics for value addition through proper combination of male-female plants. It also establishes the effect of male genotype on quality of seed oil.

Micropropagation of Jojoba and root induction in cuttings and microcuttings. The plant being dioecious in nature shows considerable variabilty in the seed raised populations. Therefore, asexual multiplication of *Jojoba* through stem cuttings and micropropagation would help in generating known sex seedlings and improve homogeneity in the future populations. Several scientists all over the world have worked on asexual propagation of this plant but the protocol and the results vary considerably.

Tissue culture raised plants from know-sex elite clones of *Jojoba*

Elite female plant of *Jojoba* with inset showing the seeds produced

The survival percentage is reported to be poor. In the present work, the basal medium employed for micropropagation was different from that used by earlier workers. The composition of root-inducing auxin mixture was also modified. The mortality rate of rooted plantlets has been reduced considerably. The growth of cuttings could be enhanced by application of liquid seaweed fertiliser. The technology will provide high quality known sex seedlings of *Jojoba* and allow cultivation with desired male : female in a planned layout.

Supercritical CO_2 extraction of Jojoba oil from seed. Jojoba oil is a premium personal care product whose value can be enhanced by clean processing. Studies were initiated at IIT Mumbai on supercritical CO_2 extraction of Jojoba oil. The important conclusions that emerged from the preliminary pilot plant studies are that: (i) oil can be extracted with a yield of 41-48 %, which is comparable to the yield obtained with solvent extraction, (ii) the oil is nearly colorless and odour-free, and (iii) some degree of fractionation of the oil is possible as estimated by GC studies. The ability to achieve high extraction efficiency with CO_2 and further to fractionate the oil to achieve a higher proportion of the desired C_{20} fatty acid fraction is of considerable importance.

Jojoba oil as expelled (left) and after bleaching (right)

Enzymatic transesterification of Jojoba oil for the preparation of Jojoba Body Cream. A solvent-free enzymatic process was developed for transesterification of *Jojoba* oil. The key features of this step-out technology are that the process is simple, time-saving, solvent-less, conducted at room temperature and generates no effluent. The enzymatically prepared transesterified *Jojoba* oil was used successfully for the preparation of *Jojoba* Body Cream and sent to ITRC, Lucknow for toxicological evaluation.

Bio-farming of coastal saline soils through growing of Salicornia brachiata with saline water. The project envisages development of coastal saline wasteland by growing *S. brachiata,* a source of edible oil, rich in linoleic acid (70%). It could also be useful in rehabilitation of coastal saline wasteland. Other uses of the plant are also possible.

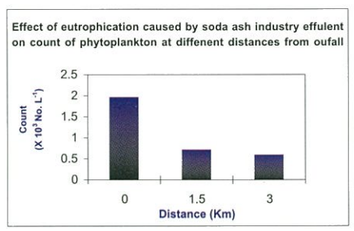
The genus Salicornia belongs to the Chenopodiaceae family . All over the world it is represented by nearly 50 species growing mainly in salt marshes of Asia/Africa, Europe and North America. *S. brachiata* and *S. herbacea* are the two species reported from India, but the former is dominant. *Salicornia brachiata* is an annual, small (30-45 cm), dichotomously branched obligate halophytic herb found in salt marshes/mud flats along the sea coast of the country. The seed is erect, compressed, membranous and exalbuminous. It contains 25-30 % of edible oil which is rich in linoleic acid. The seed yield is around 250 kgs/ha in the natural environment. GSFC Science Foundation, Vadodara has sponsored a project on cultivation and improvement of *Salicornia brachiata,* with an initial target seed yield of 1.25 tons/ha so as to match the performance of *S. bigloevii* developed by Seaphire Corporation, U.S.A. In our first attempts at *ex-situ* cultivation, a seed yield of 450 kg/ha was obtained.

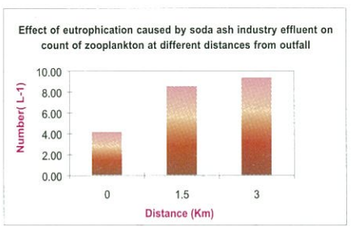

Salicornia plantation at Hathab seacoast

Jatropha cultivation. *Jatropha curcas* is a wildly growing, perennial shrub which has attracted attention due to the prospect of converting the oil into bio-diesel. The oil has other uses such as in soap making and lamp oil. The plant also has medicinal properties. CSMCRI took up a project under UNDP to attempt cultivation in marginal land in Orissa and a seed orchard of 20 ha was successfully raised. The seed orchard will be utilised to make selections of superior genotypes for subsequent cultivation. It has also been possible to adapt a non-toxic variety of the plant.

Marine Environment

Environment impact assessment studies on the effect of soda ash industry effluent on coastal seawater and marine biota. The work was undertaken to assess the effect of soda ash effluent discharge of an





industry on coastal seawater. Seawater quality and marine biota in the vicinity of the effluent discharge on the shore was studied. The concentration of ammonia and nitrate was found to be very high at Porbandar. This gave high growth of phytoplankton whereas zooplankton growth was reduced as a result of eutrophication. Recommendations made to the concerned industry led to remedial measures which, ultimately, resulted in reduction of eutrophic agents in the marine environment with concomitant rise in biomass production of zooplankton.

a) ***Coastal Ocean Monitoring and Prediction System.*** The coastal areas from Kandla to Porbandar and Mahuva to Aliyabet sectors on Gujarat coast have been monitored for pollution-indicating parameters in the sea. Physico-chemical, biological and microbiological parameters have been studied for the above transects. Methane and carbon dioxide levels have also been monitored. The emission of methane from *Enteromorpha, Ulva, Sargassum* and *Avicennia,* populated and unpopulated (control) habitat at Bhavnagar, Ghogha, Okha and Kandla were studied. The rate of emission in *Enteromorpha* and *Sargassum* populated habitats increased while that in *Avicennia* populated habitat decreased. The coastal waters at Vadinar and Kandla regions had comparatively higher concentration of petroleum hydrocarbons. Alang showed maximum stress condition for most of the parameters, e.g., TSS, PHC, Fe, Cu, Pb and Hg. Many of the regions investigated also showed high concentrations of pathogenic bacteria in the sea such as *Shigella, Salmonella* and *Vibriocholerae.*

(b) ***Marine Data Centre for Algae and Marine Chemicals.*** Information on expertise, publications, patents, books, reports and techniques / processes developed by Indian algologists is available through the Institute database. A quarterly journal, Phycosearch, is being published and it contains abstracts of all papers in phycology, besides information on patents, book reviews and other topics.

4

TECHNOLOGY TRANSFER & INFRASTRUCTURE SERVICES

Patents filed

1998-99

1. *The tractor operated Salt-farm ridger (Harvester)*, H.N.Patel, Sudhir Bhatt; No1678/DEL/98.
2. *An eco-friendly process for the electrolytic synthesis of methyl sulphone using an ion exchange membrane cell,* G. Ramachandraiah, Paramita Ray, V.K.Sahi, R.Rangarajan; No. 1506/DEL/98

1999-2000

1. *A process for the preparation of novel chiral catalyst useful in the preparation of chirally enriched epoxides,* R.I. Khureshi, N.H.Khan, S.H.R.Abdi, P.K.Iyer, Sunil Patel, S.D.Gomkale, A.K. Bhatt; No. 1353/DEL/99
2. *An improved process for the preparation of chirally enriched epoxides, an intermediate in the synthesis of optically active drugs,* R.I. Khureshi, N.H.Khan, S.H.R.Abdi, P.K.Iyer, Sunil Patel, S.D.Gomkale, A.K. Bhatt; No. 1352/DEL/99

External Cash Flow

1998-99

Title of the Project	Funding Agency	Amount -Rs.
Grant-in-Aid Projects		
Removal of polyvalent ions like calcium and magnesium from saturated brine	Dept. of Science & Technology, New Delhi	77,756
Collection, identification and chemical investigations of seaweeds (Phase III)	Dept. of Ocean Development, New Delhi	1,155,000
National Marine Data Centre (MDC) at CSMCRI.	Dept. of Ocean Development, New Delhi	1,175,000
Catalytic decomposition of environmentally hazardous chemicals.	Ministry of Environment & Forests, New Delhi.	747,730
Synthesis, electrochemistry, photochemical properties of Ruthenium (II) and Osmium(II) multinuclear metal complexes.	Dept. of Science & Technology, New Delhi	100,000
Organising a national workshop on control of brackishness in drinking water.	STMD, New Delhi.	400,000
Synthesis, characterization and physico – chemical studies of new redox active mono and binuclear complexes with donor acceptor properties.	Dept. of Science & Technology, New Delhi	50,000
Development of Jojoba/ Jatropha cultivation	UNIDO, New Delhi	2,008,000
Development of nitrate selective resins for removing nitrate in potable water.	Ministry of Environment & Forests, New Delhi	20,643
Dearsenification of drinking water from traces of arsenic left over from ion - exchange resins	Dept. of Science & Technology, New Delhi	450,000

Synthesis, characterisation and utilization of chiral metal complexes as active catalysts for enantioselective epoxidation of prochiral alkenes.	Dept. of Science & Technology, New Delhi	600,000
Development of electrolytic water dissociation process to recover acid and alkali from industrial effluent salt solution.	Dept. of Environment & Forest, New Delhi.	83,030
Development of membrane in spiral configuration for commercialisation	Dept. of Science & Technology, New Delhi	725,000
Develo pment of Solid Polymers Electrolyte reactor using indigenous ion-exchange membranes - Application of Solid Polymer electrolyte electrolyzers for the direct conversion of alcohol and acids to aldehyde.	Dept. of Science & Technology, New Delhi	296,000
Culture and Cultivation of Seaweeds for food.	Dept. Of Biotechnology, New Delhi	234,000
Adsorbents for separation of Oxygen/ Nitrogen/ Argon from air.	Dept. of Science & Technology, New Delhi	932,650
NOIS Programme - Hardware and Software costs.	Dept. of Ocean Development, New Delhi	400,000
Development of micro and Ultrafiltration technique using memberane filter for refining vegetable oils.	TMOP, CSIR, New Delhi.	620,000
Coastal Ocean Monitoring And Prediction System programme.	Dept. of Ocean Development, New Delhi	825,000
Studies on cyanotoxins of cyanobacteria in the Arabian Sea	Dept. of Biotechnology, New Delhi.	255,000
Solar power operated RO desalination techiniqu for aras without electricity supply.	DRD, RGNDWM, New Delhi.	374,000
	Sub - total: Grant - in - Aid projects	**11,528,809**

Collaboratve projects		
Indian Reference Material	National Physical Laboratory, New Delhi	60,000
Free Flow Iodised Salt - additional work.	M/s. Hindustan Lever Ltd., Mumbai	365,000
Upgradation of Calcium Carbonate.	M/s. Gujarat Narmada Valley Fertilisers Co. Ltd., Bharuch.	1,200,000
Indigenisation of RO Membrane Technology.	M/s. Madras Refinery Ltd., Chennai - 600 068.	750,000
	Sub-total: Collaborative projects	2375,000
Sponsored projects		
Development of a process for the preparation of Zeolite 13 -X.	M/s. Gujarat Multi -Gas Base Chemicals Pvt. Ltd., Mehsana - 384002.	350,000.00
To develop nanofiltration membranes. .	M/s. ED Membranes (India) Pvt. Ltd., Koteshwara -577622.	30,000.00
	Sub-total: Collaborat ive projects	380,000.00
Consultancy projects		
Environmental Impact Assessment Studies on 'Effect of Soda Ash Industry Effluent'.	M/s.Birla VXL Limited, Porbandar - 360576.	205,000.00
Preparation of feasibility report for solar salt ponds at Qatar.	M/s. DCEL, Mumbai -400018.	550,000.00

To design and develop salt refinery of 1 TPH capacity at Mauritius.	M/s. Saliere De Ouest, Mauritius.	424,231.00
	Sub-total: Consultancy projects	1,169,231.00
Technical assistance		192,250.00
Testing Charges		147,666.00
Premia/Royalty		30,000.00

ECF 1998 - 99 : At a glance

1.	Grant -in-Aid projects	1,15,28,809
2.	Collaborative projects	23,75,000
3.	Sponsored Research projects	3,80,000
4.	Consultancy assignments	11,69,231
5.	Technical Assistances	1,92,250
6.	Job Works	700
7.	Premia / Royalty	30,000
8.	Testing charges	1,47,666
	Total	1,58,23,656

1999-2000

Sr. No.	Project title	Funding Agency	Amount
Grant -in-aid projects			
1.	Coastal Ocean Monitoring And Prediction System (COMAPS)	Dept. of Ocean Development, New Delhi	1,400,000
2.	Collection, identification and chemical investigation of Marine flora (Phase III)	Dept. of Ocean Development, New Delhi	681,900
3.	National Ocean Information System (NOIS) programme: Na tional Marine Data Centre (NMDC) on Marine Chemicals and Algal sources	Dept. of Ocean Development, New Delhi	727,000
4.	Development of ion conducting spacers for effecting energy reduction in electrodialytic demineralisation	Dept. of Science and Technology, New Delhi	50,000
5.	Synthesis, electrochemistry and photochemical and photophysical properties of Ru(II) and Os(II) multinuclear metal complexes	Dept. of Science and Technology, New Delhi	260,000
6.	Studies on cyanotoxins of cyanobacteria in the Arabian Sea	Dept. of Biotechnology, New Delhi	220,000
7.	Synthesis, characterization and physicochemical studies of new redox active mono and binuclear complexes with donor/ acceptor properties.	Dept. of Science and Technology, New Delhi	200,000
8.	Develop ment of electrolytic water dissociation process to recover acid and alkali from industrial effluent salt solutions	Min. of Environment and Forest, New Delhi	129,950
9.	Synthesis, characterization and utilization of chiral metal complexes as active catalyst for enantioselective epoxidation of prochiral alkanes	Dept. of Science and Technology, New Delhi	200,000

10	Recovery of marine chemicals from bittern	1 Dept. of Ocean Development, New Delhi	3,600,000
		2 Gujarat Heavy Chemicals Ltd., Bhavnagar	600,000
		3 NIRMA Ltd., Bhavnagar	400,000
		4 Agrocel Ltd., Bhuj	100,000
		5 Hindustan Lever Ltd. Mumbai	200,000
11	Side chain alkilation of toluene with methanol over hydrotalcite like compounds and their modified forms.	Indian National Science Academy, New Delhi.	237,000
12	Cultivation and processing of phycocolloid seaweeds (Gelidiella acerosa and Eucheuma) and New Technology platforms.	M/s SNAP Natural & Alginate Ltd., Ranipet – 639 403	200,000
13	Studies on halophytes and their development.	GSFC Science Founda tion, Vadodara.	438,200
14	Utilisation of waste land with non traditional oilseed plant species: Development of Jojoba/Jatropha cultivation	UNDP/ Technology Mission on Oils & Pulses, New Delhi	350,000
15	Chiral activators for racemic catalysts in epoxida tion: a novel approach to achieve high enntioselectivity for chiral drug medicine intermediate epoxides.	Third World Academy of Science, Trieste – Italy	307,679
16	Chiral catalytic route for the synthesis of pharmaceutically active enantiopure epoxides.	Third World Academy of Science, Trieste – Italy.	193,681
17	Kinetic studies on electron transfer reaction in mixed valance complexes.	DAAD (GTZ, Germany)	635,600
18	Catalytic hydrocarbonylation	Third World Academy of Sciences, Trieste – Italy.	176,750
		Sub - total: Grant - in - Aid projects	**11,307,760**
	Sponsored projects		
1.	Development of device for visualization of brine density from afar	M/s. Gujarat Heavy Chemicals Ltd., Bhavnagar	200,000
2.	Desalting four samples of varying TDS from 4,000 to 3,00,000 ppm by electrodial ysis	M/s. HIKAL Chemical Industries, Navi Mumbai.	50,000
3.	Preliminary work related with Glass Epoxy Laminate.	M/s. Gujarat Narmada Valley Fertilizers Ltd., Bharuch.	40,000
4.	Development of viable technology for Hypnea cultivation, harvesting and manufacture of semirefined κ–Carrageenan (SRC) there from.	M/s. Pepsico Holdings (I) Ltd., Gurgaon – 122 001.	250,000
5.	To develop nanofiltration membrane for separation of NaCl.	M/s E.D.Membranes (India) Pvt. Ltd., Koteshvar	30,000
		Sub - total: Sponsored projects	**570,000**

	Collaborative projects		
1.	Indian reference material	National Physical Laboratory, New Delhi, (Nodal laboratory)	140,000
2.	Preparation of organo- clay based on indigenous raw materials suitable for manufacture of high quality grease.	Indian Oil Corporation (R&D Centre), Faridabad.	33,075
3.	To generate knowledge base for preparation of free flow iodised salt of required specifications.	M/s. Hindustan ever Ltd., Mumbai.	110,000
4.	Upgradation of calcium carbonate.	M/s. Gujarat Narmada Valley Fertilizers Co. Ltd., Bharuch.	1,040,000
5.	Indegenisation of RO membrane technology	M/s. Madras Refineries Ltd., Chennai.	750,000
		Sub - total: Collaborative projects	**2,073,075**
	Consultancy projects		
1.	To examine the possibility of production of Carrageenan (Kappa) from Indian exotic seaweeds.	M/s. Pepsico Holdings (India) Ltd., Gurgaon.	167,000
2.	To evaluate the quality of effluent from existing bromine plant and to suggest plan for disposal of solid waste and liquid effluent.	M/s. BILT Chemicals Ltd., Secunderabad.	100,000
3.	Design for 1tph capacity salt refinery to produce free flow iodised salt.	M/s. Salie re de Ouest, Mauritius	200,000
4.	Preparation of basic design report for 20 TPH capacity salt washry for Port Victor.	M/s. Gujarat Heavy Chemicals Ltd., Bhavnagar.	300,000
5.	To generate data for kinetic study of iodine loss in iodised salt	M/s. Hindustan Lever Ltd., Mumbai.	150,000
		Sub - total: Consultancy projects	**917,000**

ECF 1999 - 2000 : At a glance

1.	Grant-in-aid projects	1,13,07,760
2.	Sponsored projects	5,70,000
3.	Collaborative projects	20,73,075
4.	Consultancy projects	9,17,000
5.	Technical assistance	1,96,864
6.	Premia/ Royalty	60,000
7.	Testing/ Analytical charges	1,95,250
8.	Process release	50,000
		15,369,949

Library Services

The CSMCRI Library is considered to be a premier one in this region having a rich collection of books, periodicals, reference materials, etc. in the areas of R&D being carried out in the Institute. Not only it caters to the information need of R&D staff of the Institute but also extends the facilities to the research scholars, university staff, representatives of the industries, Government officials and others. A brief account of library collection, facilities, services are given below:

Total collection during 1998-99 :

Sr. No.	Name of Document	Position as on 1/4/98	Addition during 1998-99	Total as on 31/3/99	Addition during 1999-2000	Total as on 31/3/2000
1.	Books	11115	70	11185	105	11290
2.	Back Volumes	21684	152	21836	1964	23800
3.	Translation	420	5	425	1	426
4.	Photocopy	1874	40	1914	50	1964
5.	Patents	300	12	312	11	323
6.	Standards	744	3	747	3	750
7.	Microcards	67	--	67	0	67
8.	Microfilm	1326	--	1326	0	1326
9.	Maps/Charts	263	2	265	0	265
10.	Reprints	2681	5	2686	6	2692
11.	Annual Reports	7956	97	8053	119	8172
12.	CD-ROM	0	0	0	4	4
	Total	**48430**	**386**	**48816**	**2263**	**51079**

Journals subscribed :

			1998-99	1999-2000
1.	Foreign Journals	:	118	079
2.	Indian Journals	:	112	119
3.	Journals received Gratis/exchange	:	40	140

Information Services:

For easy and quick access to current and latest information by the R&D staff, library renders various information services to its readers. Through these services, scientific and technical staff is kept well informed with the current trends in the field of their interest. The services rendered are as follows:

Inter-library loan service.

Reader queries.

Reprints and photocopy mailing.

Bibliographies on selected areas using current contents.

Reference Services

Literature Search Facilities to outsiders :

This library is having specialised up-to-date collection of international abstracting services viz. Chemical Abstract, Biological Abstracts, Current Content, Indian Science Abstracts, Back Volumes of Journals in Chemistry, Chemical Technology, Biological Sciences, etc. The outsiders are also granted permission to consult the documents in the library. This fulfills the aim of maximum utilization of library documents.

During the period under report library has granted permission to outsiders as follows:

		1998-99	1999-2000
Long term permission	:	47	57
Short term permission	:	38	14
Outsiders who consulted the Lib.	:	391	360
Corporate Members	:	8	9

EXTRA-MURAL HUMAN RESOURCE DEVELOPMENT

1998-99

70 extension officers were imparted training on Jojoba cultivation under the Gujarat Agricultural University programme on oil seeds in two batches at Junagadh district in April, 1998. The officers were of the level of Deputy Director to Agricultural Officers involved in various taluka level activities in Gujarat. The training was provided at the Tissue Culture Laboratory. at Bhavnagar and in field at Zanjmer for two days.

Training on Jojoba and Jatropha was imparted to a batch of 28 extension officers of Gujarat under specific state category programme on management of wasteland organised at Water and Land Management Institute (WALMI), Anand on 21st November, 1998.

1999-2000

Training programmes for the benefit of small and medium scale salt manufacturers were organised at various places of the country. The duration of course was approximately 5 to 7 days at each place. Both theoretical and practical training was imparted during such programmes. Through the above course salt manufacturers were trained in the scientific method of salt manufacture which will help them in improving the quality and yield of salt. Small and medium scale salt manufacturers, technical personnel from industrial units. About 1000 participants from each place derived benefit out of such training programmes.

DATELINE

Date	Salient details
10 April 1998	45th CSMCRI Foundation Day celebrated. An exhibition on "Ocean in Service of Mankind" organised on this occassion was inaugurated by Prof. Vidyut Joshi, Vice Chancellor, Bhavnagar University and Chief Guest of the function. Foundation Day lecture on "Ocean - Our last frontier" was delivered by Dr. .B.N.Desai, Former Director, NIO, Goa.
28-29 July 1998	National Workshop on "Control of brackishness in Drinking Water" sponsored by Rajiv Gandhi National Drinking Water Mission, New Delhi. The Workshop was inaugurated by Prof. Vidyut Joshi, Vice Chancellor, Bhavnagar and the Guest of Honour of the function was Dr.M.H.Mehta, Executive Director, GSFC. About 60 participants from various agencies/ organisations participated.
26 Sept.,1998	CSIR Foundation Day was celebrated. Prof. D.V. Khakkar, Dept. of Chemical Engineering, IIT, Mumbai delivered the Foundation Day Lecture on "Making Ultra Strong Polymer Fibers". Mementoes were presented to staff members on completion of 25 years of service. The employees who retired on superannuation during the past twelve months were also presented mementoes in felicitation. Winners of Essay competitions organised for school going children of the employees of the Institute were also awarded prizes on this occasion. Awards for special achievements in Board examinations were also presented. The Institute was open to visitors and the R&D activities of the Institute were explained to the visitors with the help of visual displays and models.
10 April, 1999	**46**th CSMCRI Foundation Day celebrated. The celebration function was inaugurated by Shri Utkarsh B.Shah, President, Gujarat Chamber of Commerce & Industry, Ahmedabad. Shri A.K.Rathi, Director (Environment), Govt. of Gujarat, Gandhinagar delivered the Foundation Day Lecture entitled 'Environmental management: Some issues & Aspects'.

	A Get-together of industrialists and other invitees with the scientists of CSMCRI was organised and a display of the activities of the Institute as posters was arranged. Two presentations entitled 'Overview of CSMCRI capability generated and services rendered over the years' by Dr. S.D.Gomkale and 'Monitoring of marine pollution and the effect of pollution on coastal biota the CSMCRI contribution' by Shri A.Tiwari were mede in the get-together.
11th May, 1999	National Technology Day celebrated. The programme was inaugurated by the Chief Guest, Prof. Subramanian, President, Indian Institute of Chemical Engineers while Dr. Pushpito K. Ghosh, Director, CSMCRI, presided over the function. A technical Session on "Technology needs for industry" was organised. Shri R.S. Pandey, Senior General Manager (Tech), Gujarat Heavy Chemicals Ltd., Sutrapada, Dr. A.N. Misra, General Manager (R&D), Gujarat Alkalies and Chemicals Ltd., Vadodara, Shri Pradeep H. Gohil, General Manager, Excel Industries Ltd., Bhavnagar, Shri K. Sanghavi, President, Bhavnagar Small Scale Chemical Industries' Association, Shri B.R. Kamdar, The Kutch Saurashtra Salt Manufacturers' Association, Jamnagar and Shri Rajubhai Parekh, NGO (Prakriti Trust), Bhavnagar made presentations in the technical session.
26 Sept.,1999	CSIR Foundation Day celebrated. Prof. P. Balaram, Chairman, Molecular Biophysics Unit, Indian Institute of Science, Bangalore, delivered the Foundation Day Lecture entitled "The Developing Interface of Chemistry and Biology". Those staff members who completed of 25 years of service were presented mementoes on the occasion. Members of staff who superannuated during the previous twelve months were also presented felicitated with presentation of mementoes. School going children of the employees of the Institute who secured top positions in the Essay competition organised on this occasion were also awarded prizes during the Foundation Day Function. Awards for special achievements in Board examinations were also presented.

The Institute was kept open for visitors, and the R&D activities of the Institute were explained by the scientists with the help of visual displays and models.

20 Feb., 2000

CSIR's Special Task Force meeting on Catalysis, chaired by Prof. M.M. Sharma, was hosted at CSMCRI. Besides the members, Senior scientists working on catalysis at CSMCRI, Bhavnagar; IICT, Hyderabad; NCL, Pune; IIP, Dehradun; CFRI, Dhanbad and RRL, Thiruvananthapuram, participated in the meeting.

Foreign Scientists' visit to CSMCRI

1998-99

Dr. Cho Soon Haeng, Director, Energy Conservation Department, KIER, Korea, visited the Institue from 21 to 27 December, 1998 under the agreement between Korea Institute of Energy Research (KIER) and CSMCRI. During his stay a detailed discussion was held on the activities of both the Institutes in the field of catalysis and adsorbent development. It was decided that CSMCRI and KIER may work on, (i) catalysts for production of N-methyl pyrole from maleic anhydride, and (II) development of adsorbents for 1-butene recovery from C reformat.

Deputation abroad/visits by CSMCRI scientists

1998-99

- Shri Parameshwar K. Iyer, SRF, visited UK from 12-17 July to attend the 11th International Symposium on Homogeneous Catalysis held at University of St. Andrews, Scotland, UK and presented a paper entitled "Aerobic enantioselective epoxidation of styrene derivatives catalyzed by dissymmetric Ru(III) chiral Schiff base complexes".
- Mrs. Meena Rathod, STA visited Poland on deputation for a period of four weeks from 14th August, 1998 under the CSIR-Pas (Polish Academy of Sciences) Exchange Programme.
- Dr. C.R.K. Reddy, Scientist EI visited Nagasaki Unversity, Nagasaki, Japan upon availing leave due (EL from 21st September to 11th December, 1998) under the award of AEIS Follow-up-Research Fellowship for former foreign students.
- Miss Beena Narayan, SRF attended the 3rd International Conference of the Asian Crystallographic Association held at Universitiy Kebangsaan, Malaysia, from 13-15 October, 1998

1999-2000

- Dr. H.C. Bajaj, Scientist E II of this Institute has been deputed to Korea for one year from 1st June, 1999 for developing catalyst for the synthesis of NMP from maleic anhydride under the CSMCRI-KIER Bilateral Exchange Programme.
- Dr. M.P. Reddy, Scientist E I has been deputed to USA under Sabbatical Leave for one year from 14th June, 1999 for carrying out research work on salt tolerant plants at Purdue University, USA.
- Dr. R.V. Jasra, Scientist F, visited South Korea from 18th June to 18th July, 1999 for furthering technical cooperation between CSMCRI and KIER, Korea in the field of adsorption, separation and catalytic processes under INSA-KOSEF Exchange Programme.
- Dr. R.V.Jasra, Scientist F, visited Kazakhstan from 25th September to 3rd October, 1999 to participate in the Indo-Kazakh Workshop on catalysis.
- Mr. K.M. Majeethia, Scientist F, (from 13th to 23rd December, 1999) and Shri M.R. Gandhi, Scientist EII and Dr. A.M. Bhatt, Scientist E I (both from 4th to 17th February, 2000) visited Mauritius for commissioning of the salt refinery, (based on CSMCRI design provided as a part of the consultancy assignment) under the consultancy agreement with M/s Saliere de L'Ouest, Mauritius to produce free flow iodised salt.
- Dr. R.H. Trivedi, Scientist B, was deputed to Poland under CSIR-Polish Academy of Sciences (PAS) Exchange Programme from 16th January to 11th April, 2000 to undertake study on "Isolation, identification of biologically active compounds from plants, their concentration and functions" at the Institute of Bio-organic Chemistry, Poznan, Poland.

CSIR

Biennial Report: 1998-2000

ANNEXURE

CSMCRI
Biennial Report: 1998-2000

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37. *Seasonal growth and reproduction of marine red alga Asparagopsis delile (Rhodophyta, Bonnemaisoniales) from the Mandapam region, South East Coast of India.* S.Vasuki, M.Ganesan, P.V.Subba Rao and O.P.Mairh, Ind. J. Mar. Sci. 28, 1999, 60-65.

38. *Effect of salinity, light intensity and nitrogen source on growth and composition of Ulva fasciata Delile (Chlorophyta, Ulvales).* M.Ganesan, O.P.Mairh, K.Easwaran and P.V.Subba Rao, Ind. J. Mar. Sci. 28, 1999, 70-73.

39. *Biomass on promising carrageenophytes on the Indian coasts.* S.H.Zaidi and O.P.Mairh, In: G.Subbarangaiah (ed.) "Recent Trends in Algal Research", Publication of Marine Algal Research Laboratory, Waltair (AP), 1999, pp. 47-65.

40. *Current status on the phycocolloids of the Indian seaweeds, their uses and market potentials.* S.H.Zaidi, R.G.Parekh, M.J.Dave and O.P.Mairh, In: G. Subbarangaiah (ed.) :Recent Trends in Algal Research", publication of Marine Algal Research Laboratory, Waltair (AP), 1999. pp. 66-82.

41. *Sulphated polysaccharides of Codium dwarkense Boergs. From the west coast of India : Chemical composition and blood anticoagulant activity.* A K Siddhanta, M Shanmugam, K H Mody, A M Goswami and B K Ramavat. International J. Biol. Macromol. 26:151-154, 1999.

42. *Investigation on the sulphated polysaccharides of Sargassum cinctum of Saurashtra coast.* K. H. Mody, Sai Krishna Murthy A., A. K. Siddhanta, B. K Ramavat and O. P. Mairh. In: G. Subbarangaiah (ed.) Recent Trends in Algal Research. Publication of Marine Algal Research Laboratory, Waltair (A.P), 1999, pp. 83 90.

43. *Studies on the sulphated polysaccharides of Laurencia species of the west coast of India.* A. K. Siddhanta, A. M. Goswami, M. Shanmugam, K. H. Mody, B. K. Ramavat and O. P. Mairh. In: G. Subbarangaiah (ed.) Recent Trends in Algal Research. Publication of Marine Algal Research Laboratory, Waltair (A.P), 1999, pp. 91 98.

44. *Studies on phycocolloides from Chondrococcus hornemanii (Cryptonsemiales, Rhyzophyllidaceae) from Mandapam, South East coast of India.* R. G. Parekh, and O. P. MairhIn: G. Subbarangaiah (ed.) Recent Trends in Algal Research. Publication of Marine Algal Research Laboratory, Waltair (A.P), 1999, pp. 99 105.

45. *Effect of nitrogen sources on the growth and bio-accumulation of nitrogen in marine red alga Kappaphycus striatum (Rhodophyta, Solieriaceae) in culture.* O. P. Mairh, , S. T. Zodape. A. Tiwari and J. P. Mishra. Ind. J. Mar. Sci. 28, 1999, 55- 59.

Papers presented in Symposia/Seminar

1998-99

1. *Aerobic enantioselective epoxidation of styrene derivatives catalysed by dissymmetric chiral Ru(III) Schiff base complexes;* R.I. Kureshy, N.H. Khan, S.H.R.Abdi P. Iyer and S.T. Patel, International Conference

in Homogeneous Catalysis, Univ. of St. Andrews Scottland, U.K., 12-14 July, 1998.

2. *Relative reactivity of N and S-donor ligand for aqua substitution reaction in ethylenediaminetetracetatoruthenium(III) complex in aqueous solution,* H.C. Bajaj, Amitava Das and R. Van Eldik, National Symp. On Frontiers in Inorgnic Chem., IISc Bangalore, July 8-10, 1998.

3. *Stable Rhodium(II) polypyridyl complexes; synthesis, spectroscopic and structural characterisation;* P.Paul, B.Tyagi, A.K.Bhilakhiya, M.M.Bhadbhade and E.Suresh, National Symp. On Frontiers in Inorgnic Chem., IISc Bangalore, July 8-10, 1998.

4. *Catalytic behaviour of vanadium containing molecular sieves for the selective oxidation of ethanol,* S. Kannan and S. Sivasanker, International Zeolite Conference, Baltimore, July, 1998.

5. *Voltametric characterisation of solid polymer electrolyte materials and its applications to electroorganic synthesis;* V.K. Shahi, P.Ray, G. Ramachandriah, R. Rangarajan and D. Vasudevan,; National Symp. on Electrochemistry in Aerospace Systems SEAS-98, ISRO Satellite Centre, Bangalore, 4th and 5th Dec., 1998.

6. *Application of Modern Analytical Techniques in Testing of Fine Chemicals for Quality Improvement in Salt Industry.* V R K S Susarla & G Ramachandraiah, ISAS XIII National Symposium on Recent Trends in Analytical Techniques, Bangalore, 24-25th Nov. 1998.

7. *New Electron Donors for the Catalytic Reduction of N-N bonds of Metal Bound Hydrazine in Aqueous Solution.* R Prakash & G Ramachandraiah, 14th National Symposium on Catalysis, Anna University, Chennai, 16-18 Dec. 1998.

8. *Enantioselective epoxidation of styrene derivatives catalysed by chiral Ru(II) Schiff base complexes.* R.I.Kureshi, N.H.Khan, S.H.R.Abdi, P.Iyer and S.T.Patel, 14th National Symposium on Catalysis, Anna University, Chennai, 16-18 Dec. 1998.

9. *Potentiometric Investigation of the Formation of 1:1 and 1:2 Eu(III)-DOPA complexes in Aqueous Solution.* T V Pathak, P N Bhatt, J P Mehta & G Ramachandraiah, First All Gujarat Research Scholars Meet, M. S. University, Vadodara, Dec. 6, 1998.

10. *Activation and Reduction of Nitrogen-Nitrogen Bonds by Coordinatively Unsaturated Transition Metal Complexes.* R Prakash & G Ramachandraiah, First All Gujarat Research Scholars Meet, M. S. University, Vadodara, Dec. 6, 1998.

11. *Dinuclear complexes of a new bridging ligand containing 2-2 bipyridyl and dioxolene binding sites: synthesis, electrochemical and electron spectroscopic properties,* A.D.Shukla, B.Whikle, H.C.Bajaj, Amitava Dass, M.D.Ward, First All Gujarat Research Scholars Meet, M. S. University, Vadodara, Dec. 6, 1998.

12. *Synthasis and characterisation of Rh(III) complexes and there use in electrocatalytic reduction of carbon dioxide,* P.Paul, B.Tyagi, A.K.Bilakhya, M.M.Bhadbhade and E.Suresh, First All Gujarat Research Scholars Meet, M. S. University, Vadodara, Dec. 6, 1998.

13. *Synthesis, characterisation, electrochemical and photophysical studies of homo/hetero dinuclear complexes of Rh(II) and Os(II) with new dinucleating spacers having complete conjugations between chromophores.* A.K.Bilakhya, B.Tyagi and P.Paul, National Semirar on Metallo-organics, IIT, Madras, Feb. 20-21, 1998

14. *A novel homogeneous hydration of carbon monoxide to formic acid catalyzed by transition metal complex,* R.S. Shukla, R.B. Thorat, S.D. Bhatt and R.V. Jasra, Indo-Russian Workshop on catalysis under ILTP at IIP, Dehradun, India (March 11-12, 1999).

15. *Spin lattice relaxation and conformational studies on some substituted Schiffbase molecules.* P.S.Subramanian, and D.Srinivas, 5th National Symposium on Magnetic Resonance, IIP, Dehradun, Feb. 23-26, 1999.

16. *Molecular structure and magnetic resonance investigations on catalytically active bisdiethyle ethylene salicylideminato Copper(II) complexes.* P.S.Subramanian and D.Srinivas, 5th National Symposium on Magnetic Resonance, IIP, Dehradun, Feb. 23-26, 1999.

17. *Recent Trends in Magnesia Chemicals, H.L.Joshi, National Symposium on Chemistry in the Next Century,* Jai Narain Vyas University, Jodhpur (Rajasthan), 15-17 March, 1999

18. *Homo and hetero dinuclear complexes of Ru(II) and Os(II) with polypyridyl spacers: Synthesis, characterization, electrochemical and photophysical studies,* Parimal Paul, A. K. Bilakhiya, and B. Tyagi,; "Ultrafast Processes in Biology, Chemistry and Physics" organized by National Centre for Ultrafast Processes (NCUFP), Dept. of Chemistry, Chennai, March 11-13, 1999.

19. *Metal-Induced Unusual Hydroxylation at the Triazine Ring in the Dinuclear Complexes of Ru (II) and Os (II), Bridged by 2,4,6-Tris(2-pyridyl)-1,3,5-Triazine.,* Tyagi, A. K. Bilakhiya, P. Dastidar, E. Suresh and P. Paul, "National Symposium on University-Industry Interaction" Dept. of Chemistry, Saurashtra University, Rajkot, March 27-28, 1999.

20. *One dimensional Coordination Polymeric Networks of Co(II)*

Dicarboxylato Complexes and the effect of N-Donor Substitution: Single Crystal Investigations; Suresh E. and Mohan M. Bhadbhade, XXIX National Seminar on Crystallography University of Madras, Dept. of Crystallography and Biophysics, 21-23rd December 1998.

21. *Novel coordination polymeric networks created by cobalt centers with N-N' bi-dendate spacers and their inclusion properties,* Mohan M Bhadbhade, E.Suresh and R.V.Jasra, XXIX National Seminar on Crystallography, University of Madras, Department of Crystallography and Biophysics on 21-23rd December 1998 (Invited talk by Dr.M.M. Bhadbhade).

22. *Chiral Ni(II)Schiff base complex- catalyzed enantioselective epoxidation of prochiral non- functionalised alkenes,* R.I. Kureshy, N.H. Khan, S.H.R. Abdi, S.T. Patel and P. Iyer, National symposium on Chemistry in the next century at Jodhpur, March 1999.

23. *Aerobic enantioselective epoxidation of non-functionalised alkenes catalysed by Chiral Ru(III)Schiff base complexes,* R.I. Kureshy, N.H. Khan, S.H.R. Abdi, S.T. Patel and P. Iyer, Indo-Russian conference at IIP Dehradun 1999.

24. *Synthesis, Characterization and X-ray Structural determination of Chiral Ni(II)Schiff base complex,* R.I. Kureshy, N.H. Khan, S.H.R. Abdi, S.T. Patel, P. Iyer, E. Suresh and P. Dastidar, UGC sponsored national seminar on recent trends in chemical research GND Univ. Amritsar, March 1999.

25. *Electrochemical activation and reduction of hydrazines in aqueous solution using ruthenium catalyst.* R.Prakash and G.Ramachandraiah. National Symposium in Chemistry, National Science Seminar Complex, Indian Institute of Science Campus, Bangalore, 27-30 Jan., 1999.

26. *Studies on transport phenomenon of sulfonated polyethylene-styrene-divinylbenzene interpolymer membrane.* V.K.Shahi, B.S.Makwana, S.K.Thampy and R.Rangarajan. National Seminar on Polymers for the new millennium, University of Madras, March 25-26, 1999.

27. *Application of bipolar membrane in electrodialysis.* B.G.Shah, Punita Vyas, B.S.Makwana, P.M.Gaur, Poster Session: National Symposium on Univ. Ind. Interaction, Saurashtra Univ., Rajkot, 27-28 March, 1999.

28. *Antimicrobial agents derived from clay minerals.* K.H.Mody, O.P.Mairh, H.M.Mody, J.G.Bhatt and R.V.Jasra, National Symposium on University-Industry Interaction (New Trends in Chemical Research and Development), Department of Chemistry, Rajkot, 27-28 March, 1999

29. *Immobilisation of α-amylase on silica.* H.M.Mody, R.V.Jasra, K.H.Mody and O.P.Mairh, National Symposium on University-Industry Interaction (New Trends in Chemical Research and Development), Department of Chemistry, Rajkot, 27-28 March, 1999

30. *Simarouba glauca - a rich source of oleic acid for rehabilitation of marginal lands of the country.* J. Chikara, B.D. Shethia, Mrs. M. Rathod and J.B. Pandya, AOCS-OTAI International Conference on "Exhibition on Oil Seeds and Vegetable Oil Processing", New Delhi, 19-21 Feb. 1999.

31. *Effect of genetic background on C_{12} wax ester plant Simmondsia chinensis under Indian condition.* J.B.Pandya, Mrs.M.Rathod, B.D.Shethia, Mrs.A.Prakash and J.Chikara. AOCS-OTAI International Conference on "Exhibition on Oil Seeds and Vegetable Oil Processing", New Delhi, 19-21 Feb. 1999.

1999-2000

1. *Chiral Co (II) Schiff base complex-catalysed aerobic enantioselective epoxidation of styrene derivatives.* Poster was presented in the National Seminar on the trends in industrial catalysis held at MS University, Baroda during 10-11th Sept. 1999; N.H. Khan, R.I. Kureshy, S.H.R. Abdi, S.T. Patel and P. Iyer.

2. *Chiral Ru(II) Schiff base complex-catalysed enantioselective epoxidation of styrene derivatives.* Poster to be presented in the Modern Trends in Inorganic Chemistry to be held at IISc., Bangalore during January 18-20, 2000; N.H. Khan, R.I. Kureshy, S.H.R. Abdi, S.T. Patel, P. Iyer and R.V. Jasra.

3. *Chiral Ni(II) Schiff base complex-catalysed enantioselective epoxidation of styrene derivatives using NaOCl as an oxidant;* N.H. Khan, R.I. Kureshy, S.H.R. Abdi, S.T. Patel and P. Iyer, E. Suresh and P. Dastidar has been contributed for "An International Symposium on Chirality" held in Robinson College, Cambridge University, Cambridge, U.K. during 5-7 Sept., 1999.

4. *Photocatalytic degradation of removal of brilliant blue dye from aqueous dispersion.* A.K. Bhatt, D.B. Shukla & R.V. Jasra; Poster presented in "National Seminar on Trends in Industrial Catalysis" organized by IIChE and CSI Baroda Chapter at Baroda, Sept. 10-11, 1999.

5. *Heterogeneous catalyst for hydrogenation of benzene,* H.M.Mody, H.C. Bajaj, A. B. Boricha and R V Jasra, A poster presented in "National Seminar on Trends Industrial Catalysis" organized by IIChE and CSI Baroda chapter at M S University, Baroda during Sept. 10-11 1999.

6. *Synthesis of CuPcTs intercalated MgAl hydrotalcite, a new selective oxidation catalyst,* S.Kannan; Poster presented in "National Seminar on Trends Industrial Catalysis" organized by IIChE and CSI Baroda chapter at M S University, Baroda during Sept. 10-11 1999.

7. *Trends in industrial catalysis.* R.S. Shukla, National Seminar on Trends Industrial Catalysis organized by IIChE and CSI Baroda chapter at M S University, Baroda during Sept. 10-11 1999.

8. *Reduction of aflatoxin B_1 and G_1, by vitamin C and lactic acid.* R.J. Verma and R.S. Shukla., National Symp. on Mycology at 2000 and beyond, S.P. University, Vallabh Vidyanagar, Dec., 21-23 , 1999.

9. *Microwave assisted rapid synthesis of Si-MCM-41;* Haresh Mody, Priti Pandya, P.Bhatt and R.V.Jasra, Poster presented in Modern Trend in Inorganic Chemistry held at IISc. Bangalore during 18th to 20th January 2000.

10. *β-CD assisted IVCT in mixed valent [2]rotaxane complex having metal centers linked by interrupted π-electron system;* Amitava Das, Atindra D. Shukla and H.C.Bajaj, Modern Trend in Inorganic Chemistry held at IISc. Bangalore during 18th to 20th January 2000.

11. *Design,synthesis, characterization and single crystal X-ray diffraction studies of multicomponent Zn-tetraphenylporphyrins: novel building blocks for microporous crystalline solids;* Atindra D.Shukla, Paresh C Dave, Eringathodi Suresh, Gopal Pathak, Amitava Das and Parthasarathi Dastidar; Modern Trend in Inorganic Chemistry held at IISc. Bangalore during 18th to 20th January 2000.

12. *Design of novel supramolecular self assembly creating non-interpenetrating rectangular grids with neutral cavity,* E.Suresh, Kamala Boopalan, Raksh V. Jasra and Mohan M. Bhadbhade, Poster presented at Modern Trend in Inorganic Chemistry held at IISc. Bangalore during 18th to 20th January 2000.

13. *Dinuclear Ru(II) and Os(II) complexes of bipyridyl ligands bridged by rigid spacers: synthesis, electrochemical behaviour, absorption spectra and luminescence properties,* A.K. Bilakhiya, B. Tyagi, P. Paul, Modern Trend in Inorganic Chemistry held at IISc. Bangalore during 18th to 20th January 2000.

14. *Development of organoclays for grease formulation and pollution abatement,* R.S.Somani, D.B.Shukla, B.J.Bhalala, A.S.Mehta and R.V.Jasra in Lubricating Grease Conference, Jan 28-29, 2000, Goa

15. *Microwave synthesis of ceramic precursorshydrotalcite like compounds and mesoporous molecular sieves.* R V Jasra, S Kannan, H M Mody and P Pandya. Presented in symposium on Ceramic Matrix Composite Materials (CCM 99) held at S P University Vallabh Vidya, Nagar during December 8-9, 1999.

16. *The effect of conducting spacers on desalting by electrodialysis.* B.S.Makwana, D.K.Chauhan, V.K.Shahi, S.K.Thampy and R.Rangarajan, Trombay Symposium on Desalination and Water Reuse - 1999 held at BARC, Mumbai on 2-3 Dec., 1999.

17. *Treatment of Effluent containing valuable toxic metal ions and its recovery by means of Electrodialysis,* Dr.V.K.Shahi; presented in the New Millennium Conference held at New Delhi in Nov., 1999.

18. *Selective fluorination of organic compounds using spray dried alkali metal fluorides.* A.D.Jethva, M.S.Gohil, S.N.Misra, G.Ramachandraiah and P.K.Ghosh; 15th Gujarat Science Congress 2000 held at MS University, Vadoadar, 12-13 Feb. 2000.

19. *Group I fluorides an excellent fluorinating agent of aliphatic and aromatic organic compounds.* M.S.Gohil, A.D.Jethva, S.N.Misra, P.K.Ghosh, G.Ramachandraiah, and S.Elshemer; 15th Gujarat Science Congress 2000 held at MS University, Vadoadar, 12-13 Feb. 2000.

20. *Nitrogeneous glycerolipids from Ulva fasciata (Ulvaceae, Chlorophyta) of West Coast of India.* A.K.Siddhanta, A.M.Goswami, B.K.Ramavat and B.Achari. International Conference on Chemistry and 36th Annual Convention of Chemists 1999, Calcutta, December 11-16, 1999.

21. *Impact of varying salinities on the biomass increase of Gelidiella acerosa (Forsskal) Feldmann et Hamel.* S.H.Zaidi and O.P.Mairh In Proceedings of National Symposium on Recent trends in marine algal research in India held at Annamalai University, Parangipettai, Tamilnadu from 27 to 29th December, 1999.

Awards / Recognition

Sr. No.	Awards/Recognition	Awardee(s)
1.	INSA Young Scientist Award	Dr. S.Kannan
2.	CSIR Young Scientist Award	Dr. S.Kannan
3.	CSIR Young Scientist Award	Dr. S.Muthusamy
4.	World Intellectual Property Organisation (WIPO) Award	Dr. R.S.Somani, Dr. P.M.Oza, Shri M.R.Gandhi, and Shri V.M.Sheth
5.	Fellow of Royal Society of Chemistry (UK)	Dr. S.K.Adhikary

Appointment, Promotion, Retirement, Transfer, Resignation,: 1998-2000

Appointment

Name	Designation	Date of joining
1. Dr. V.K.Sahi	Scientist C [Gr.IV(2)]	07/01/1999
2. Dr P.Dastidar	Scientist C [Gr.IV(2)]	11/8/1999
3. Dr. M.Ganesan	Scientist B [Gr.IV(1)]	11/8/1999
4. Shri Chandrakant C.K.	Scientist B [Gr.IV(1)]	1/10/1999
5. Shri Pradeep Kumar	Scientist B [Gr.IV(1)]	4/10/1999
6. Shri P. Anjani Kumar	Assistant	25/10/1999
7. Dr. J.V.Prasad	Scientist EI [Gr.IV(3)]	29/10/1999
8. Dr. Amit Bhattacharya	Scientist B [Gr.IV(1)]	30/11/1999
9. Shri D.Jagan Mohan	J.T.A [Gr.III(1)]	17/2/2000
10. Shri S.Ti rupathi	J.T.A [Gr.III(1)]	24/2/2000

Assessment Promotions

Name	Promoted as	With effect from
1. Dr. J.S. Patolia	Scientist EII [Gr.IV(4)]	01/02/1997
2. Dr. S.H.R. Abdi	Scientist EI [Gr.IV(3)]	24/04/1996
3. Dr. S.D. Bhatt	Scientist EI [Gr.IV(3)]	01/02/1997
4. Dr. R.P. Pandya	Scientist C [Gr.IV(2)	03/02/1997
5. Dr. R.S. Somani	Scientist C [Gr.IV(2)]	01/02/1997
6. Dr. A. Prakash Rao	Scientist C [Gr.IV(2)]	08/08/1996
7. Shri T.N. Gupta	Tech. Officer EI [Gr.III(6)]	01/02/1997
8. Shri B.D.Shethia	Tech. Officer C [Gr. III(5)]	1/2/1998
9. Shri A.A.Patel	Tech. Officer B [Gr III(4)]	1/2/1998
10. Shri B.S.Makwana	Tech. Officer A [Gr. III(3)]	12/8/1997
11. Shri E.Suresh	Tech. Officer A [Gr. III(3)]	26/5/1997
12. Dr. (Ms) Pragnya A. Bhatt	Tech. Officer A [Gr. III(3)])	21/4/1997
13. Ms Meena R. Rathod	Tech. Officer A [Gr. III(3)]	16/2/1998
14. Shri R.J.Sanghavi	S.T.A [Gr. III(2)]	19/6/1997
15. Dr. M.Ganesan	S.T.A [Gr. III(2)]	2/7/1997
16. Shri N.K.Waghani	Group II(5)	5/3/1998
17. Shri A.A.Pattani	Group II(2)	8/11/1997
18. Shri Rajesh J.Jani	Group II(2)	31/7/1997
19. Shri G.M.Thakkar	Group II(2)	28/5/1997

Retirement

Name	Designation	Date of retirement
1. Shri K.S. Suwan	Assistant (G)	30/04/1998
2. Dr. G.T. Desai	Scientist EI [Gr.IV(3)]	30/06/1998
3. Shri D.M.Baraiya	Farash	30/06/1998
4. Dr. M.R. Oza	Scientist EI [Gr.IV(3)]	31/07/1998
5. Shri R.N.Vorah	Scientist F [Gr.IV(5)]	30/09/1998
6. Dr. D.H. Oza	Scientist C [Gr.IV(2)]	30/09/19 98
7. Shri D.P. Suru	Tech. Officer B [Gr.III(4)]	30/09/1998
8. Shri G.N.Dave	Scientist B [Gr.IV(1)]	31/10/1998
9. Dr. R.M. Kava	Scientist EII [Gr.IV(4)]	31/01/1999
10. Shri H.N. Patel	Tech. Officer C [Gr.III(5)]	31/01/1999
11. Shri R. Fernandiz	Technician	31/01/1999
12. Shri P.N. Pandya	Technician Gr.VII	28/02/1999
13. Shri C.M. Mandalia	Tech. Officer B [Gr.IV(4)]	31/03/1999
14. Shri H.V. Solanki	Technician	31/03/1999
15. Shri B.M. Chauhan	Jr. Security Guard	31/03/1999
16. Shri C.M. E lias	Group II (5)	30/4/1999
17. Shri K.N. Patel	Scientist EI[Gr. IV(3)]	30/4/1999
18. Shri S.G. Chouhan	Group II(4)	30/6/1999
19. Shri M.C.Parmar	Technician Gr. VIII	30/6/1999
20. Dr. K.Rama Rao	Scientist EII [Gr.IV(4)]	30/6/1999
21. Shri A.A.Shah	Tech Officer C (Gr.III(5)]	30/7/1999
22. Shri R.B.Boricha	Technician Gr. VII	31/8/1999
23. Dr. D.A. Chauhan	Scientist C [Gr.IV(2)]	1/9/1999
24. Dr. (Ms) S.J.Gohil	Scientist EI [Gr. IV(3)]	24/9/1999
25. Dr R.A.Buch	Scientist C [Gr.IV(2)]	30/9/1999
26. Shri K.D.Padia	Scientist F [Gr.IV(5)]	30/9/1999
27. Dr. S.D.Gomkale	Scientist G [Gr.IV(6)]	1/10/1999
28. Shri D.L.Vyas	Group II(5)	29/2/2000
29. Dr. O.P.Mairh	Scientist EII [Gr.IV(4)]	29/2/2000
30. Dr. B.J.Bhalala	Scientist EI [Gr.IV(3)]	29/2/2000

* Voluntary retiremtn

Transfer

Name	Designation	Transferred to	Date
Dr. (Ms) Kadambini Sarengi	Scientist C	Regional Research Laboratory, Bhubaneshwar	18/6/1999
Shri Asin Kumar Jha	Assistant	National Metallurgical Laboratory, Jamshedpur	1/11/1999
Shri D.Sherwood	Scientist C	Central Electrochemical Research Institute, Karaikudi	31/3/2000

Awards / Recognition

Sr. No.	Awards/Recognition	Awardee(s)
1.	INSA Young Scientist Award	Dr. S.Kannan
2.	CSIR Young Scientist Award	Dr. S.Kannan
3.	CSIR Young Scientist Award	Dr. S.Muthusamy
4.	World Intellectual Property Organisation (WIPO) Award	Dr. R.S.Somani, Dr. P.M.Oza, Shri M.R.Gandhi, and Shri V.M.Sheth
5.	Fellow of Royal Society of Chemistry (UK)	Dr. S.K.Adhikary

Appointment, Promotion, Retirement, Transfer, Resignation,: 1998-2000

Appointment

Name	Designation	Date of joining
1. Dr. V.K.Sahi	Scientist C [Gr.IV(2)]	07/01/1999
2. Dr P.Dastidar	Scientist C [Gr.IV(2)]	11/8/1999
3. Dr. M.Ganesan	Scientist B [Gr.IV(1)]	11/8/1999
4. Shri Chandrakant C.K.	Scientist B [Gr.IV(1)]	1/10/1999
5. Shri Pradeep Kumar	Scientist B [Gr.IV(1)]	4/10/1999
6. Shri P. Anjani Kumar	Assistant	25/10/1999
7. Dr. J.V.Prasad	Scientist EI [Gr.IV(3)]	29/10/1999
8. Dr. Amit Bhattacharya	Scientist B [Gr.IV(1)]	30/11/1999
9. Shri D.Jagan Mohan	J.T.A [Gr.III(1)]	17/2/2000
10. Shri S.Ti rupathi	J.T.A [Gr.III(1)]	24/2/2000

Assessment Promotions

Name	Promoted as	With effect from
1. Dr. J.S. Patolia	Scientist EII [Gr.IV(4)]	01/02/1997
2. Dr. S.H.R. Abdi	Scientist EI [Gr.IV(3)]	24/04/1996
3. Dr. S.D. Bhatt	Scientist EI [Gr.IV(3)]	01/02/1997
4. Dr. R.P. Pandya	Scientist C [Gr.IV(2)	03/02/1997
5. Dr. R.S. Somani	Scientist C [Gr.IV(2)]	01/02/1997
6. Dr. A. Prakash Rao	Scientist C [Gr.IV(2)]	08/08/1996
7. Shri T.N. Gupta	Tech. Officer EI [Gr.III(6)]	01/02/1997
8. Shri B.D.Shethia	Tech. Officer C [Gr. III(5)]	1/2/1998
9. Shri A.A.Patel	Tech. Officer B [Gr III(4)]	1/2/1998
10. Shri B.S.Makwana	Tech. Officer A [Gr. III(3)]	12/8/1997
11. Shri E.Suresh	Tech. Officer A [Gr. III(3)]	26/5/1997
12. Dr. (Ms) Pragnya A. Bhatt	Tech. Officer A [Gr. III(3)])	21/4/1997
13. Ms Meena R. Rathod	Tech. Officer A [Gr. III(3)]	16/2/1998
14. Shri R.J.Sanghavi	S.T.A [Gr. III(2)]	19/6/1997
15. Dr. M.Ganesan	S.T.A [Gr. III(2)]	2/7/1997
16. Shri N.K.Waghani	Group II(5)	5/3/1998
17. Shri A.A.Pattani	Group II(2)	8/11/1997
18. Shri Rajesh J.Jani	Group II(2)	31/7/1997
19. Shri G.M.Thakkar	Group II(2)	28/5/1997

Retirement

Name	Designation	Date of retirement
1. Shri K.S. Suwan	Assistant (G)	30/04/1998
2. Dr. G.T. Desai	Scientist EI [Gr.IV(3)]	30/06/1998
3. Shri D.M.Baraiya	Farash	30/06/1998
4. Dr. M.R. Oza	Scientist EI [Gr.IV(3)]	31/07/1998
5. Shri R.N.Vorah	Scientist F [Gr.IV(5)]	30/09/1998
6. Dr. D.H. Oza	Scientist C [Gr.IV(2)]	30/09/19 98
7. Shri D.P. Suru	Tech. Officer B [Gr.III(4)]	30/09/1998
8. Shri G.N.Dave	Scientist B [Gr.IV(1)]	31/10/1998
9. Dr. R.M. Kava	Scientist EII [Gr.IV(4)]	31/01/1999
10. Shri H.N. Patel	Tech. Officer C [Gr.III(5)]	31/01/1999
11. Shri R. Fernandiz	Technician	31/01/1999
12. Shri P.N. Pandya	Technician Gr.VII	28/02/1999
13. Shri C.M. Mandalia	Tech. Officer B [Gr.IV(4)]	31/03/1999
14. Shri H.V. Solanki	Technician	31/03/1999
15. Shri B.M. Chauhan	Jr. Security Guard	31/03/1999
16. Shri C.M. E lias	Group II (5)	30/4/1999
17. Shri K.N. Patel	Scientist EI[Gr. IV(3)]	30/4/1999
18. Shri S.G. Chouhan	Group II(4)	30/6/1999
19. Shri M.C.Parmar	Technician Gr. VIII	30/6/1999
20. Dr. K.Rama Rao	Scientist EII [Gr.IV(4)]	30/6/1999
21. Shri A.A.Shah	Tech Officer C (Gr.III(5)]	30/7/1999
22. Shri R.B.Boricha	Technician Gr. VII	31/8/1999
23. Dr. D.A. Chauhan	Scientist C [Gr.IV(2)]	1/9/1999
24. Dr. (Ms) S.J.Gohil	Scientist EI [Gr. IV(3)]	24/9/1999
25. Dr R.A.Buch	Scientist C [Gr.IV(2)]	30/9/1999
26. Shri K.D.Padia	Scientist F [Gr.IV(5)]	30/9/1999
27. Dr. S.D.Gomkale	Scientist G [Gr.IV(6)]	1/10/1999
28. Shri D.L.Vyas	Group II(5)	29/2/2000
29. Dr. O.P.Mairh	Scientist EII [Gr.IV(4)]	29/2/2000
30. Dr. B.J.Bhalala	Scientist EI [Gr.IV(3)]	29/2/2000

* Voluntary retiremtn

Transfer

Name	Designation	Transferred to	Date
Dr. (Ms) Kadambini Sarengi	Scientist C	Regional Research Laboratory, Bhubaneshwar	18/6/1999
Shri Asin Kumar Jha	Assistant	National Metallurgical Laboratory, Jamshedpur	1/11/1999
Shri D.Sherwood	Scientist C	Central Electrochemical Research Institute, Karaikudi	31/3/2000

Research Council

Prof. V.Krishnan, Acting President, Jawaharlal Nehru Centre for Advanced Scientific Research, Indian Institute of Science Campus, Bangalore 560 012.	Chairman
Dr. Rajju Shroff, CMD, United Phosphorus Ltd., Madhu Park, 11th Road, Khar (W), Mumbai 400 052.	Member
Mr. Kaushal Goel, General Manager, Engineering Projects (India) Ltd., B-10, Ho Chi Minh Sarani, Calcutta 700 071.	Member
Dr. G. Subramanian, Director, National Facility for Marine Cyanobacteria, Bharatidasan University, Tiruchirapalli 620 024 (T.N)	Member
Dr. B.M.Mishra, Head, Desalination Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085	Member
Dr. V.Sampath, Director, ICMAM Project Directorate, NIOT Campus, Velacherry Tambaram Main Road, Pallikaranai, Chennai - 601 302.	Member
Dr. Sushil Kumar, Director, Central Institute of Medicinal andAromatic Plants, P.O CIMAP, Lucknow 226 015 (UP).	Member
Prof. B.M.Mandal, Polymer Science Unit, Indian Association for the Cultivation of Science, 2 A & B Raja Subodh Mullick Road, P.O Jadavpur University, Calcutta 700 032	Member
Dr. S.D. Gomkale, Acting Director, Central Salt & Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavnagar 364 002	Member (Up to March 14, 1999)
Dr. Pushpito K. Ghosh Director, Central Salt & Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavnagar 364 002	Member (From March 15, 1999)

Mr. R.R.Hirwani, Scientist 'F', National Chemical Laboratory, Pune 411 008.	Member (DG's Nominee)
Mr. S.N.Ghosh Scientist, Central Salt & Marine Chemicals Research Institute, Gijubhai Badheka Marg, Bhavnagar 364 002	Secretary

Management Council
(Up to 30.6.1999)

Dr. S.D.Gomkale, Acting Director, CSMCRI, Bhavnagar.	Chairman (Till 14.3.1999) Member (Till 30.9.1999)
Dr. Pushpito K.Ghosh, Director, CSMCRI, Bhavnagar	Chairman (From 15.3.1999)
Dr. R.V.Jasra, Scientist F, CSMCRI, Bhavnagar	Member
Dr. N.V.Desai, Scientist EII, CSMCRI, Bhavnagar	Member
Shri M.R.Gandhi, Scientist EII, CSMCRI, Bhavnagar	Member
Dr. S.H.Zaidi, Scientist C, CSMCRI, Bhavnagar.	Member
Dr. M.D.Zingde, Scientist-in-Charge, NIO Regional Centre, Mumbai	Member
Dr. K.M.Maiti, Scientist-in-Charge, CGCRI Naroda Centre, Ahmedabad	Member
DGSIR or his nominee	Permanent Invitee
Sr. Finance & Accounts Officer / Finance & Accounts Officer, CSMCRI	Member
Controller of Administration/ Administrative Officer, CSMCRI	Member-Secretary

(Since 1.7.1999)

Dr. Pushpito K.Ghosh, Director, CSMCRI, Bhavnagar	Chairman
Dr. S.D.Gomkale, Scientist G CSMCRI, Bhavnagar	Member (Till 0.9.1999)
Shri V.J.Shah, Scientist F, CSMCRI, Bhavnagar	Member (From 1.10.1999)
Dr. R.V.Jasra, Scientist F, CSMCRI, Bhavnagar	Member
Shri S.N.Ghosh Scientist EII, CSMCRI, Bhavnagar	Member
Shri J.B.Pandya, Scientist EII, CSMCRI, Bhavnagar	Member
Shri M.R.Gandhi, Scientist EII, CSMCRI, Bhavnagar	Member
Dr. (Mrs.) Paramita Ray, Scientist C, CSMCRI, Bhavnagar.	Member
Shri S.N.Patel, Technician Group III(2), CSMCRI, Bhavnagar	Membar
Sr. Finance & Accounts Officer / Finance & Accounts Officer, CSMCRI	Member
Controller of Administration/ Administrative Officer, CSMCRI	Member-Secretary

Staff Strength

Category	Persons on roll as on	
	31.3.1999	31.3.2000
Scientific		
Group IV	**94**	**88**
Technical		
Group III	36	38
Group II	102	93
Group I	29	29
Group V	3	3
Total (Technical)	**170**	**163**
Non-technical		
Group A	3	3
Group B	39	39
Group C	19	18
Group D	27	27
Total (Non -technical)	**88**	**87**
Total	**352**	**338**
Scientist Fellow	1	-
Research Associate/Sr. Research Associate	3	4
Research Fellows etc	15	5
Project Assistants & others	21	34
	40	**43**

Budget

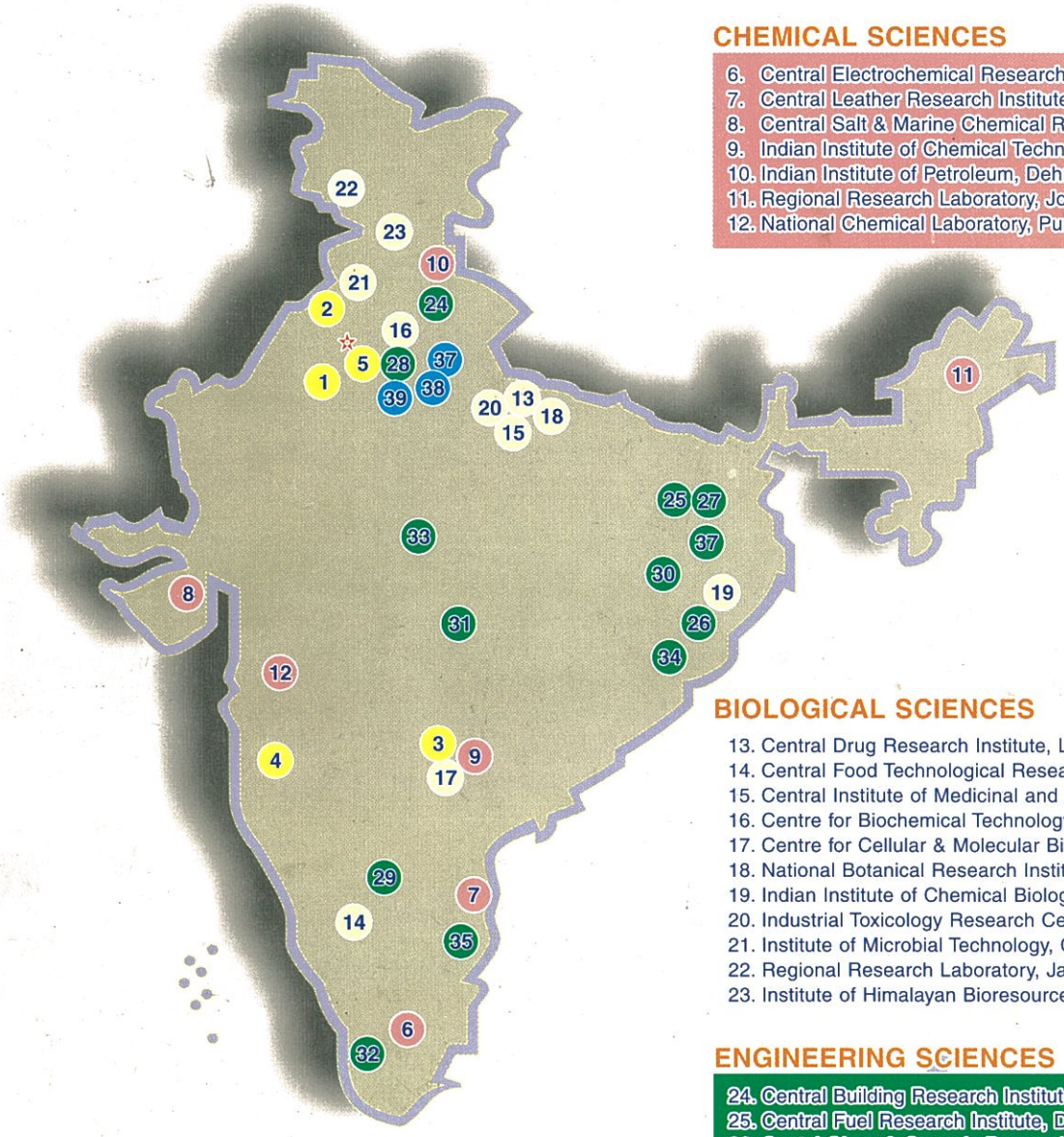
Rs. lakhs

Budget Heads		1998-99	1999-2000
Equipment	(P15, P5(3) etc.)	141	191
Infrastructural facilities	(P5(1), & P5(2))	36	22
Library books	(P5(4))	60	60
Consumables – recurring	(P7)	53	70
Manpower related expenditure	(P1, P2 & P3)	509	517
Residual	(P4, P6 etc.)	85	134
Total (from CSIR)		870	985

TEAM CSIR

THE GREAT CHAIN OF R & D LABORATORIES

☆ **Head Quarters**
CSIR-BRAIN BANK



PHYSICAL SCIENCES

1. Central Electronics Engineering Research Institute, Pilani
2. Central Scientific Instruments Organisation, Chandigarh
3. National Geophysical Research Institute, Hyderabad
4. National Institute of Oceanography, Goa
5. National Physical Laboratory, New Delhi

CHEMICAL SCIENCES

6. Central Electrochemical Research Institute, Karaikudi
7. Central Leather Research Institute, Chennai
8. Central Salt & Marine Chemical Research Institute, Bhavnagar
9. Indian Institute of Chemical Technology, Hyderabad
10. Indian Institute of Petroleum, Dehradun
11. Regional Research Laboratory, Jorhat
12. National Chemical Laboratory, Pune

BIOLOGICAL SCIENCES

13. Central Drug Research Institute, Lucknow
14. Central Food Technological Research Institute, Mysore
15. Central Institute of Medicinal and Aromatic Plants, Lucknow
16. Centre for Biochemical Technology, New Delhi
17. Centre for Cellular & Molecular Biology, Hyderabad
18. National Botanical Research Institute, Lucknow
19. Indian Institute of Chemical Biology, Calcutta
20. Industrial Toxicology Research Centre, Lucknow
21. Institute of Microbial Technology, Chandigarh
22. Regional Research Laboratory, Jammu
23. Institute of Himalayan Bioresource Technology, Palampur

ENGINEERING SCIENCES

24. Central Building Research Institute, Roorkee
25. Central Fuel Research Institute, Dhanbad
26. Cental Glass & Ceramic Research Institute, Calcutta
27. Central Mining Research Institute, Dhanbad
28. Central Road Research Institute, New Delhi
29. National Aerospace Laboratories, Bangalore
30. National Metallurgical Laboratory, Jamshedpur
31. National Environmental Engineering Research Institute, Nagpur
32. Regional Research Laboratory, Thiruvananthapuram
33. Regional Research Laboratory, Bhopal
34. Regional Research Laboratory, Bhubaneswar
35. Structural Engineering Research Centre, Chennai
36. Central Mechanical Engineering Research Institute, Durgapur

INFORMATION SCIENCES

37. National Institute of Science, Technology and Development Studies, New Delhi
38. Indian National Scientific Documentation Centre, New Delhi
39. National Institute of Science Communication, New Delhi

THIS IS A SCHEMATIC REPRESENTATION OF THE MAP OF INDIA (NOT TO SCALE) AND DOES NOT INDICATE INDIA'S TERRITORIAL BOUNDARIES