

II. COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (CSIR)

1. INTRODUCTION

The CSIR is the national R&D organisation providing scientific industrial research for India's economic growth and human welfare. It has a country-wide network of forty laboratories and eighty field centres covering fundamental and applied R&D in all areas of science and technology barring atomic research, developing and nurturing S&T human resource for the country through extra mural support and promoting scientific talent through awards, fellowships etc.

As CSIR reorients itself to be market driven and move on the path of self-financing, its performance would be conditioned by the performance of the Indian industry and economy. Thus the rate of ECF generation from contract R&D and consultancy came down from 15 to 10%, the actual ECF going up from Rs. 190 crore to Rs. 209 crore. The contribution to creation of new knowledge was satisfactory, patent filings increased significantly, rising from 71 to 91 in the year for foreign patents and from 209 to 264 for Indian patents. The quality of papers contributed also showed a healthy upward trend although the number remained nearly static. CSIR's all round performance during the year was satisfactory. Most significant among its activities has been the winning initiative for revocation of US patent on turmeric, which besides confirming CSIR's pioneering efforts to successfully safeguard traditional Indian knowledge, created an unprecedented positive public goodwill for the CSIR. More importantly this success had some far-reaching effects viz: it demonstrated that CSIR and other Indian institutions were acquiring capabilities to fight the complex techno-legal issues of IPR, both defensively and aggressively, to meet the challenges under the WTO regime; it showed the importance of appropriate documentation and public availability of records of traditional knowledgebase in a systematic manner, which can be provided as evidence of prior knowledge; it reassured the Indian people of the fair and transparent operations of the IPR system.

2. SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS

The S&T Contributions from CSIR are of value to almost all socio-economic sectors. CSIR carries out R&D and provides services of value not only industry but also to other sectors of the economy e.g. agriculture, health, energy, rural development, transport and defence. CSIR's help to domestic industry is not only by way of relevant / competitive technologies but also through search of raw materials and

components, pollution control, productivity enhancement etc. A few of the more significant achievements during the year are reported through the charts and write-up given herein.

2.1 Bio-sciences Including Therapeutics

Scientific Achievements

2.1.1 Regulation of cell growth

In studies on the cell cycle regulated protein tyrosine phosphatases, CCMB has reported that over expression of PTP-S2 shortens the duration of S-phase (DNA replication) suggesting thereby that the duration of DNA replication is being reduced in these cells. It was also seen that over expression of PTP-S2 in Cos 1 cells resulted in cell death by apoptosis in about 30% of transfected cells after 48 hours.

2.1.2 Liposome entrapped mite allergen

Liposomes, which are non-toxic biodegradable and biocompatible lipid vesicles are known to act as adjuvant and antigen materials and can be attached to the outer surface or encapsulated within the internal aqueous spaces. CBT studies aimed at further evaluating liposomes containing mite (*Dermatophagoides farinae*) in different strain of mice, confirm the immuno-adjuvant effect of liposome for immunotherapy in allergic disorders. These studies lead to the conclusion that increase in formation of protecting antibodies IgG and at the same time decrease in specific IgE. Using Liposome Entrapped Allergen (LEA) reduces the risk of systemic reaction associated with conventional allergy immunotherapy.

2.1.3 Functional studies of lectins

In symbiosis, soil microbes (Genus, *Rhizobium*) infect leguminous plants to form root nodules where bacteria inhabit and fix atmospheric nitrogen for the plant, and in return the plants supply food (sugar) to bacteria. The first step for this pleasant dwelling together is the selection of right partner. It has been proposed by many groups, including CBT that bacterial polysaccharides interact with root lectins specifically and that is the basis for recognition of correct partners. CBT has now experimentally demonstrated how the root lectin (PRA II) interacts with specific rhizobial polysaccharides.

2.1.4 Tumor Biology

CCMB is studying the mechanisms involved in the spontaneous regression of a rat histiocytoma, AK-5 in syngeneic hosts. The tumor rejection antigen from the cDNA library developed from the tumor was cloned. The fusion protein from this clone is immunogenic and renders the

animals partially resistant to tumor challenges. The nature of this antigen is being studied further to understand its immunological behaviour and to study the physiological function of the protein.

2.1.5 Brain cytochrome P450(s) enzymes

Studies conducted at ITRC have shown evidence of multiple forms of cytochrome P450 using specific antibodies and enzyme activity in different parts of rat brain. A commonly used pesticide, deltamethrin in coils and mats for mosquito control was found to enhance the activity of brain 7-pentoxoresorufin O-dealkylase (PROD). Prolonged exposure to the pesticide resulted in a significant increase in the activity of brain (EROD 1.3 fold) as well. The addition of anti-P450 antibody in 2B1/2B2 in vitro to the reaction mixture inhibited the enzyme activity of PROD upto 80%, whereas no inhibition was observed in EROD activity when compared to the control where pre-immune IgG was added. The results suggest that deltamethrin preferentially induces isoenzymes involved in the metabolism of deltamethrin and the role of P450 2B1/2B2 mediated metabolism in the neurotoxicity of pesticide.

2.1.6 New approaches in chemotherapy of malaria

It is known that intra-erythrocytic proliferation of malaria parasite is mainly responsible for pathogenesis and pathology of malaria infection. Recent studies at CDRI have demonstrated two distinct biochemical targets for antimalarial drug action:

- a) The process of heme polymerisation whereby the malaria parasite converts hemoglobin to free toxic heme and finally to a polymeric detoxified product called hemozoin which is necessary for growth and survival of the parasite. A novel reaction initiated by blood schizontocidal antimalarials causing depolymerisation of hemozoin has been identified, as a result compounds specifically inhibiting this process may provide novel effective antimalarials.
- b) Stage specific increase in polyamine levels (spermine, spermidine and putrescine), present only in traces in normal erythrocytes, was observed during growth and multiplication of malaria parasite in intraerythrocytic schizogony. Parasite induced putrescine transport system was highly specific and was inhibited by compounds interfering with polyamine biosynthesis. This provides an effective strategy for development of new chemotherapeutic molecules against malaria.

2.1.7 Rapid screen for anti-TB drugs

Recombinant *Mycobacterium aurum* A+, a fast growing non-pathogenic strain, expressing *Escherichia coli* lacZ gene has been constructed at CDRI, with -galactosidase as the reporter system. A good correlation was observed between

inhibition in -galactosidase production and growth of recombinant strain by anti-TB drugs. The assay is highly predictive of activity against *M. tuberculosis*.

2.1.8 Molecular epidemiology of Cholera

In the study on molecular epidemiology of cholera IMT in collaboration with NICED, Calcutta has been able to empirically establish that the clones of *V. cholerae* 01 or 0139 emerge, purge the existing clones and then spread spatially in waves and that the genetic flux in the *V. cholerae* aids in the process. It also showed that the new clone of *V. cholerae* which appeared in Calcutta in September 1993 migrated to Guinea-Bissau within a year and was responsible for the epidemic which began in 1994 there.

2.1.9 Drug induced gastric hyperacidity

IICB had earlier shown that mercaptomethylimidazole (MMI) an anti thyroid drug of thiomide group, is a potent inducer of gastric acid secretion. While studying the mechanism it was observed that the system of isolated parietal cell activate the for acid secretion. H_2O_2 generated by inactivation of the H_2O_2 degrading enzymes can also stimulate acid secretion in the isolated gastric mucosal and gastric gland preparations. The plausible role of H_2O_2 acting like a second messenger to activate the parietal cell has thus been suggested.

2.1.10 Molecular studies on Cytoplasmic Male sterility

The cytoplasmic male sterility (CMS) in plants has been exploited in the seed industry for the production of improved hybrid seeds. A rice mitochondrial gene orf155, characterised at NBRI showed altered transcript size between CMS and maintainer lines. The nucleotide sequence of the gene cloned from mitochondrial genome was compared with that of cDNA of the corresponding transcript. The orf155 possesses 7 editing sites in both the CMS and the maintainer lines.

2.1.11 Plant pathogens

- (i) **Bacterial infection of rice:** CCMB continued the studies on the interaction between the rice plant and the bacterial pathogen *Xanthomonas oryzae* pv. *Oryzae* (Xoo), and reports that incorporation of both the xa-13 and xa-21 resistance genes into susceptible rice cultivars might provide broad-based protection against Xoo.
- (ii) **Microbial resistance to plant antibiotics:** studies on the response of *Dictyostelium* to isoflavonoid phytoalexins has enabled CCMB to propose a novel plant-microbe interaction between leguminous plants and cellular slime moulds. The leguminous plant uses isoflavonoid compounds to manipulate the foraging behaviour of amoebae so as to get rid of potentially pathogenic rhizosphere bacteria from the vicinity of root lesions.

2.1.12 DNA marker for papaya sex identification

In papaya, where male and female plants are separate, a method has been developed to identify sex at seedling stage. The method involved identification of male specific DNA marker using microsatellites as well as RAPD primers.

2.1.13 Somatic embryogenesis in Mango

NCL has succeeded in achieving direct somatic embryogenesis and plantlet regeneration in economically important monoembryonic mango varieties viz. Alphonso, Mundan and Baneshan. The plants have been transferred to field. Long term repetitive somatic embryogenesis have also been obtained which is an important step towards scaling up of protocols. The achievement is significant as complete plantlet have been obtained and field planted.

2.1.14 Azadirachtin and limonoids in the Indian neem tree

A detailed investigation was carried out by CIMAP to document the variation in azadirachtin, nimbin, nimbidin and salanin contents during growth of neem seeds in different agro-climatic zones of India depending upon temperature, humidity and altitude. It has been observed that the percentage of all these limonoids in the seeds keep on increasing right from the formation of fruit till the maturity of the seeds and biosynthesis of these limonoids is very fast while the fruit is being converted from green to the ripe, thereafter the increase is slow, and slightly declines when the fruit is about to fall or has just fallen from the tree suggesting that harvesting at the time of maturity is beneficial.

2.1.15 Antibacterial activity of Indian tree species

CIMAP evaluated the fruits and seeds of three tree species namely Indian walnut (*Albizia lebbek*), drum stick (*Moringa oleifera*), and Indian beech (*Pongamia pinnata*) using tissue discs or fragments directly for antibacterial activity against three bacteria: *Salmonella typhimurium*, *Pseudomonas aeruginosa* and *Mycobacterium smegmatis* (non-pathogenic soil saprophyte spp.). The results indicate the presence of a highly potential anti-mycobacterial compound in the extracts of *Moringa* (drumstick) fruit.

2.1.16 Marine Fouling and Corrosion Studies

Extracts of two terrestrial plants belonging to the family Leguminosae and Lecythidaceae studied by NIO were found to exhibit potent antifouling activity against some important fouling organisms.

Technological Achievements

2.1.17 Universal polymer support for synthesis of oligoribonucleotides

Solid phase synthesis of DNA and RNA requires at least eight different prederivatised polymer supports. The commercial availability of base labile synthons for DNA and

RNA synthesis has necessitated the need to prepare a large number (50-60) of such pre-derivatised polymer supports making DNA and RNA synthesis a time consuming task. CBT has developed a versatile universal polymer support devoid of nucleotidic material and compatible to the existing methods of synthesis and deprotection of oligodeoxyribo and oligobionucleotides. The universal support obviates the need to prepare a large number of pre-derivatised polymer supports. Patent has been applied for the development in India and USA.

2.1.18 Diagnostic probe for leishmaniasis

A probe for early detection of visceral leishmaniasis has been developed at CDRI, by using a pair of oligonucleotide primers constructed from predominant sequence class of kinetoplast DNA minicircle of *leishmania donovani*. An Indian patent has been filed for the development.

2.1.19 Assay for Acute Lymphoblastic Leukemia (ALL)

Childhood acute lymphoblastic leukemia or 'ALL' requires prolonged maintenance therapy for eliminating residual leukemic blast cells which cannot be detected by standard morphological methods. These persisting cells are responsible for relapse and is called 'Minimal Residual Disease' (MRD). Employing a unique 9-O-acetylated sialic acid binding lectin (ATNH), two 9-O acetyl sialoglyconjugates (9-OacSGs) on lymphoblasts have been identified by IICB. A lymphoproliferative assay which is selective for PBMC of 'ALL' and not of other blood disorders has been developed.

2.1.20 Human trial of a non-toxic cholera vaccine

CSIR developed indigenous and genetically engineered oral cholera vaccine named Va1-3 has been cleared for human trials by the Drug Controller. This development has been the result of a collaborative project between IMT, IICB and NICED, Calcutta and is based on a non-reactogenic natural isolate of *V. cholerae* 01.

2.1.21 Novel usage of di-tert-butyl polycarbonate (DTBP)

IICT has been successful in utilizing DTBP for cyclodehydration of n-acylamino acids to substituted oxazoles and enantiopure synthesis of bioactive alkyl amino benzoxazinones which are effective protease inhibitors. Currently, DTBP is used for introduction of acid labile BOC protecting group in amino acids, peptides and proteins.

2.1.22 Isovitamin C by a genetically altered organism

A fermentation process for the production of 2-keto-gluconate – a penultimate intermediate of isoascorbic acid (Isovitamin C) used as antioxidant for the preservation of food products has been developed by RRL-Jammu. The laboratory has demonstrated the process at 500 litre scale to a firm in Hyderabad. The Chemostat studies on the genetically modified *Pseudomonas* clone revealed 40% increase in the productivity of 2-keto-gluconate. The organism mediating the

glucose oxidation process has been improved by cloning another set of glucose dehydrogenase derived from *Acinetobacter calcoaceticus*.

2.1.23 Mini Chrysanthemum – CV. Mother Teresa

A new chrysanthemum cultivar, selected from open pollinated seedlings, named "Mother Teresa" was released by NBRI. It is a small flowered, white Anemone type mini chrysanthemum which has all the qualities to occupy a high position in floriculture trade. It requires neither 'Pinching' nor 'Staking'. It can easily be transported in small containers due to its mini habit.

2.1.24 Application of chloro choline chloride for bulb production of Tulips

IHBT has shown that chloro choline Chloride treatment at the early stage of flower emergence increases the bulb yield per plant by nearly 50%, bulb weight by over 100%, bulb size (circumference) about 20%, bulblet production by 30% and weight of bulblets over 50% as compared to the untreated plants.

2.1.25 *Ocimum carnosum*, a potential source of natural elemicin

Elemicin is highly valued in the pharmaceutical industry besides being an important flavouring agent. It is the base material for the production of 3,4,5 trimethoxybenzaldehyde and is also a starting material for the synthesis of trimethoprim, an ingredient used in the formulation of anti-bacterial drugs. A valuable elemicin source is the herb *Ocimum carnosum*, which RRL-Jammu has established and developed for commercial cultivation.

2.1.26 New varieties of damask rose

IHBT has released two new cultivars of Damask Rose designated as IHBT, Gulab-I (Jwala) and IHBT Gulab-II (Himroz) during the year. Jwala is suitable for sub-tropical plains and mid hills upto 1400 m altitude while Himroz is suitable for temperate zone upto 2500 m altitude.

2.1.27 Production technology for rose oil and rose water

CIMAP has developed a low cost and efficient technology for the production of rose oil and water. A directly fired type rose oil distillation plant of 150 kg flower capacity was designed, fabricated and installed at village Devnagar in Ajmer (Rajasthan). The composition of the major constituents of the rose oil produced with Pushkar (Rajasthan) rose as determined by the GLC has been found to be at par with the composition of the rose oil produced from the flowers of *Rosa damascena* grown by CIMAP in Kashmir.

2.1.28 Tissue Culture for Licorice & Ashwagandha

Tissue culture studies were under taken by NCL for propagation of Neem (*Azadirachta indica*) and Licorice

(*Glycyrrhiza glabra*), Ashwagandha (*Withania somnifera*) using different pathways like micropropagation, direct and indirect induction of somatic embryogenesis and induction of secondary metabolites from callus cultures. Protocols for mass production were developed for Licorice and Ashwagandha. The technique has tremendous potential for selection of variants adoptable to extreme conditions.

2.1.29 Plant transformation Technology

NCL developed plant transformation technology for improved chickpea and pigeonpea and also standardized protocols on regeneration of whole plants from various explants via somatic embryogenesis and organogenesis.

2.1.30 Biodegradation of endosulfan from contaminated soils

A two-member bacterial coculture has been isolated at ITRC from contaminated soil that biodegrades alpha and beta isomers of endosulfan. Degradation of alpha and beta-endosulfan was 18% and 27% respectively in uninoculated conditions and by inclusion this was enhanced to nearly 75% for both the isomers. Biodegradation also caused substantial reduction in the toxicity of endosulfan as tested by ecotoxicity protocols. Another bacterial strain ITRC-1 degraded all four isomers of HCH in flooded conditions, showing formation of 2,5-dichlorophenol by thin layer chromatography technique.

2.1.31 Wildlife management by genetic fingerprinting

- (1) Genetic diversity in Indian big cats: studies at CCMB have led to the identification of Asiatic lions and tigers with high genetic variability which could be used for front line breeding. Also, observations of the Indian big cat species suggest that low genetic variability may be a characteristic feature rather than the result of intensive inbreeding as commonly thought.
- (2) Fertility status of lions, tigers and leopards in India: CCMB has established the fertility status of the male cats based on the semen profiles and hormonal levels. Lions (8), tigers (21) and leopards (15) from the Nehru Zoological Park, Hyderabad, the Sakkarbaug Zoo, Junnagadh and the Nandankanan Zoo, Bhubaneshwar have been successfully electroejaculated and the semen characteristics such as motility, viability, sperm number and morphology among others, were evaluated.

2.2 Chemical Sciences & Technology

Scientific Achievements

2.2.1 Liquid Membrane Modelling

RRL-Jorhat in association with C-MMACS developed a mathematical model incorporating external mass transfer

across the aqueous boundary layer and interfacial chemical reaction and diffusion in the emulsion globule. The model has been validated through a computer simulation exercise describing the experimental extraction kinetics of various cephalosporin antibiotics in an optimised liquid membrane system.

2.2.2 Pillaring of ion-exchanged clays

NCL has employed a novel, ultrasonic technique to regulate and accelerate the pillaring process. In this method, the process of pillaring of alumina and zirconia is complete within a matter of few hours with minimum or no elimination of the parent clay. The conditions, the concentration of pillaring species and the frequency of ultra-sonication have been optimised to achieve alumina and zirconid pillared clays (montmorillonite) which also showed much better thermal and hydrothermal stabilities than reported before.

2.2.3 Transition metal complexes with designed ligands

CSMCRI in continuation of the ongoing effort to design transition metal complexes with specific properties synthesised and characterised the following:

- a) Polypyridyl complexes to study energy transfer processes: hetero bi and tri-nuclear metal complexes of Ru (III)/(II) and Fe (II) incorporating the ligands, pyridyl derivatives of ferrocene, polycarboxylic acids (edta) and 2,2' - bipyridyl were synthesised. All these new complexes showed a moderate to weak electrochemical interaction between the redox centre. A series of mono nuclear ru (3)-polypyridyl triazine) complex synthesised showed excellent catalytic property towards electrocatalytic reduction of carbon dioxide to formic acid.
- b) Coordination polymer for adsorption: a series of polymeric Co(II) and Cu(II) complexes using adipic acid as bridging ligand and 2,2' -bipyridyl as terminal ligand were synthesised and characterised crystallographically. Analysis of the structures show strong intra and inter molecular H-bonding interactions forming two-dimensional network structures.
- c) Biomimetic molecular models: dinuclear Cu(II) complexes of diethylenetriamine, using dicarboxylato and substituted imidazolato ligands as spacer between the metal centres and also some schiff base complexes were synthesised as model systems.
- d) Thermochromic materials: a number of Ni(II) and Cu(II) complexes with the ligands dialkyl-/tetraalkyl-ethylenediamine and diazaclroheptane with various anions have been synthesised and characterised

crystallographically. These complexes exhibit thermochromic transitions (reversible colour change) at liquid nitrogen temperature. The variable temperature single crystal X-ray studies of some samples and the lattice energy computations for the molecular motions involved in the crystal during transition were carried out in collaboration with IICT.

2.2.4 New chemical entities

IICT has focussed research efforts on development of novel synthetic molecules with significant level of biological activity for possible applications in drugs/pharmaceuticals, agrochemicals and performance products. Notable among the molecules taken up are Gonio furfurones, Epothilines/amphidinolides, Azamacrolides [optically active], Macrocyclic lactones, Glycopeptides, Sugar aminoacids, 2-Tetra zolyl-3-aryl propanols.

2.2.5 Synthesis of N-protected precursors of synthetic sweetener Aspartame

N-protected derivatives of L-aspartyl-L-phenylalanine methyl ester are useful as precursors of synthetic sweetener: Aspartame which is 200 times sweeter than sugar and used in industry as artificial sweetener in beverages and food additives. Enzyme assisted reaction of N-[benzyloxy carbonyl]-L-aspartic acid [ZASP] or N-[phenylacetyl]-L-aspartic acid [PASP] with L-phenylalanine methyl ester [PME] was achieved by IICT to produce N-[benzyloxycarbonyl]-L-aspartyl-L-phenylalanine methyl ester [Z-aspartame] or N-[phenylacetyl]-L-aspartyl-L-phenylalanine methyl ester [Ph-aspartame].

Technological Achievements

2.2.6 Foam as a reaction medium

The IICT-CCMB joint efforts, have led to the development of foam as an environment friendly reaction medium for enzyme mediated organic reactions. The typical example is lipase catalyzed transformations of aliphatic acids/ alcohols to corresponding esters. The specific advantages of employing foam are, reduced hydrolysis of products and absence of organic solvents. There are good prospects of applying this option for chemical synthesis.

2.2.7 Clay supported new reagents

Clay supported new reagents preparation and their applications in functional group transformations especially under microwaves was an important area of research at IICT. A general method for the synthesis of iso-thiocyanates from dithiocarbamates has been developed using 'clay-cop'. The method is applicable for the preparation of a variety of iso-thiocyanates including aminoacids. The method avoids the use of toxic chemicals like thio-phosgene and lead nitrate.

2.2.8 Chiral template for enantiomers

Amino acids are of paramount importance in asymmetric synthesis and are used extensively in both the 'chiral substrate' and 'chiral auxiliary' based versions of stereoselective reactions. Under the research programme directed towards the synthesis of enantiopure compounds of biological interest, IICT has developed methods to synthesize a number of bioactive molecules utilizing the easily available amino acids as 'chiral template' to obtain enantiomerically pure compounds of contemporary interest.

2.2.9 Membrane/Adsorptive separation

RRL-Jorhat developed liquid membrane process for selective separation of cephalosporin-C from its mixture with de-acetyl cephalosporin-C generated in the fermentation broth of Cephalosporin acremonium.

2.2.10 Oxidative Coupling of Methane (OCM) to C₂-Hydrocarbons

A highly stable and active, selective catalyst comprising of alkaline and rare earth oxides supported on low surface area microporous catalysts carriers has been developed at NCL. An energy efficient process for the oxidative coupling of methane to C₂-hydrocarbons over this catalyst using a concept of catalyst dilution by inert solids for exothermic oxidative conversion and endothermic thermal cracking reactions to avoid the hot spot formation and heat removal problems has been developed. The novelty of the process is its reduced hazardous nature.

2.2.11 Isomerization of O-dichlorobenzene to M-dichlorobenzene

The isomerization of O-dichlorobenzene is usually carried out with homogenous catalysts (FeCl₃, etc.) which have detrimental effect on the environment with problems of separation. M-dichlorobenzene is a value-added chemical intermediate. NCL has developed a suitable zeolite based catalyst for the isomerization and fixed bed operation. The reaction parameters have been optimized to achieve maximum conversion of odcb and selectivity to mdcb. The novelty in this development is a regenerable catalyst, patented and not reported earlier for such application. The development for an Indian Industry, planning to put up a semi-commercial (pilot) plant of 1000 tons per annum capacity with its own engineering inputs. This will be a non-polluting chemical plant. The development paves way for developing suitable heterogeneous catalysts for isomerization of other organic substrates.

2.2.12 CFC-113a technology for pyrethroids

1,1,1-Trichloro-trifluoroethane [CFC-113a] is a commercially important synthone for the introduction of a two carbon functionality terminating in trifluoromethyl group

in bioactive molecules. The CFC-113a is a key raw material for producing highly potent and less toxic pyrethroid class of insecticides like lambda-cyhalothrin. Its commercial production has become the monopoly of those agencies having access to CFC-113a. The recent restrictions on the use of CFCs under Montreal Protocol has made its availability difficult for the Indian industry.

IICT has entered into an agreement with a private sector company in Mumbai, for development of lambda-cyhalothrin and CFC-113a. The CFC-113a is made by the catalytic isomerization of CFC-113 followed by fractional distillation. The development of process for CFC-113a on pilot scale has been successfully demonstrated on a 3 kg/batch. The requisite catalyst has also been developed by the laboratory.

2.2.13 Electrochemical systems of naphthoquinone

Naphthoquinone (NQ) and its substituted derivatives are industrially significant as intermediates in the synthesis of anthraquinone, dyes and pharmaceuticals. The current process for the production of NQ and its substituted derivatives is by oxidation of Naphthalene. The yield of NQ in this process is less than 40%. CECRI has developed an electro mediated synthesis route where the purity and yield of NQ are high. Further the process enables the synthesis of number of versatile industrially important compounds like aldehydes, as well. Electro organic synthesis of NQ is more convenient, economical and environmental friendly.

2.2.14 Pyridine based chemicals

CFRI successfully demonstrated the process to convert 3-picoline to 3-cyanopyridine and the conversion of 4-cyanopyridine to INH. The maximum yield of 3-cyanopyridine achieved so far is 85% by weight. Zeolite and pillared clay based vanadia catalyst have been prepared and tested for the reaction. Construction of a plant to produce 1000 kg per day nicotinamide from 3-cyanopyridine is in progress.

2.2.15 Cardanyl Acrylate and Poly Acrylate

RRL-Tvm has standardised process know-how for the laboratory scale production of cardanyl acrylate and poly acrylate. The technology was transferred to a small scale firm.

2.2.16 Pervaporation Technology

IICT has acquired specialised expertise in pervaporation technology. It is devising an economically attractive pervaporation process for the separation of paraffins and olefins to upgrade commercial propylene for a company in Visakhapatnam.

2.2.17 Conversion of Methane to Syngas

An energy efficient and safe to operate process for the methane to syngas (CO and H₂) based on simultaneous partial

oxidation, steam reforming and CO₂ reforming of methane over a novel supported nickel catalyst has been developed at NCL. Because of the simultaneously occurring exothermic oxidative conversion and endothermic steam and CO₂ reforming reactions, the process occurs in a most energy efficient and safe manner, requiring little or no external energy. NCL is trying to operate this process in an adiabatic reactor, as the process can be made almost thermoneutral.

2.2.18 Conversion of Natural Gas to Lower Olefins

Natural gas contains methane with appreciable amount of C₂-C₄ alkanes. It is practically important to convert the C₂-C₄ hydrocarbons without their separation from natural gas into ethylene and C₃-C₄ olefins. For this purpose two different processes, one based on the catalytic oxidative conversion of all the hydrocarbons in the presence of a limited oxygen, and the second based on the non-catalytic oxyprolysis of natural gas in the presence of limited oxygen, have been developed at NCL. In both processes, the exothermic oxidative conversion and endothermic thermal cracking reactions, which are occurring simultaneously, are coupled to make these processes most energy efficient.

2.2.19 Menthol Manufacture

A novel technology for the manufacture of menthol from mentha oil has been developed at IIP which gives product of a very high quality at lower processing costs. The technology offers special features of distillation of mentha oil through a more efficient column enabling the higher yield of menthol of high purity meeting international specifications and chemical transformation of menthone to menthol and the isomerisation of undesired to desired isomers of menthol.

2.2.20 Soaker visbreaking technology

IIP has developed a state-of-art indigenous technology for soaker visbreaking, an improved version of the coil visbreaking, for processing of petroleum residues into more value added products. The technology has been developed in collaboration with EIL and optimised at the pilot level. The technology offers advantages of lower operating temperatures and higher residence time leading to nearly 15% savings in fuel consumption in comparison to the coil visbreaking. Almost all the coil visbreakers in the Indian refineries have been revamped based on the data generated at the IIP pilot plant, besides two grass roots plants being put up.

2.2.21 Mini Refinery

IIP has been pioneering the concept of mini refineries for the country. In this direction it has prepared several techno-economic reports for various clients for mini refineries with capacities varying from 0.5 to 2.0 MMTPA. These mini refineries are self contained, skid mounted, low cost and low maintenance units congenial for installation in any location.

2.2.22 Reaction Engineering Laboratory

The IICT has recently established sophisticated experimental facilities for the development of eivrocatalyzed chemical processes for the speciality chemical sector. Laboratory is equipped with a unique bench scale facility for the standardization of catalyst preparation, full range of physiochemical test facilities for characterization of catalysts [heterogeneous], micro and mini flow reactor with online GC/HPLC facilities, reaction calorimeter for standardization of batch processes, accelerated rate calorimeter for assessing the thermal hazards of chemical processes and bench and pilot scale fixed bed reactors with downstream processing facilities.

2.2.23 State-of-art system for chemical reaction studies

IIP has procured a versatile computer controlled general purpose facility comprising micro reactor and pilot plant system used for conducting scale-up studies of chemical processes. The facility is specially useful for reaction studies in liquid / gas phase over fixed catalyst bed at micro level and as well as at pilot scale at temperatures upto 500°C and upto 50 bar pressure.

2.3 ELECTRONICS & INSTRUMENTATION

Scientific Achievements

2.3.1 Electron cyclotron resonance source plasma

CSIO has developed an electron cyclotron resonance (ECR) system for studying microwave plasma in argon, oxygen, carbon tetrafluoride and in a mixture of oxygen and carbon tetrafluoride. A cylindrical Langmuir probe was used to measure the current and its variation with respect to input power (50 - 1000 W), flow rates, probe position in the reactor and pressure. These measurements give optimum operational parameters. It has been observed that ion current increases linearly with microwave power.

2.3.2 Chemical composition of rainfall : monitor

CSIO studied the rainwater composition at event temporal resolution, over a 6- month period, at a site in south east England. The data were used to assess the overall levels of acidic deposition at the site and to identify functional relationships between wet deposition and casual meteorological processes. It was seen that a power-law relationship existed between wet deposition and rainfall amount. A microprocessor based acid rain monitor designed for the study not only fulfilled requirements of various international bodies but also emerged as basic research tool in the field of acid precipitation studies.

2.3.3 High performance CPU without secondary cache

While undertaking the mammoth project to port and parallelise the T-80 weather prediction code on NAL's parallel computer, Flosolver, it was found that there was a large

discrepancy between the advertised peak speed and the realised sustained speed on the intel 1860 processor – a discrepancy which appeared to be general to all RISC processors. Scientists in NAL supported by the CSIR's New Idea Fund (NIF) undertook the project to design a high performance CPU without secondary cache. The basic methodology used was to design the CPU card and RAM interface, develop logical equations, fabricate the printed circuit board, and finally develop, test and analyse the board. The board has now been designed and tested and proved to be functionally working.

Technological Achievements

2.3.4 Electrical double layer capacitors (edlc)

Usually non-aqueous solvents are used as electrolytes in edlc to achieve voltage windows higher than 1.25V. For the first time edlc using aqueous alkaline electrolyte with carbon and/or Ni/NiO as electrodes have been fabricated, by CECRI. Button type, coin type and cylindrical type capacitors and capacitor banks have been fabricated and tested.

2.3.5 Solid state room temperature gas sensor

CEERI is using the properties of high T_c cuprate superconductor to detect NH₃ and NO_x gases at room temperature. A Capacitively-Coupled Field Effect Transistor (CCFET) has been developed as a sensor for the purpose which gives a 10mV output for a 5 ppm NH₃ concentration.

2.3.6 Speed indicating and recording instrument for locomotives

A PC-based speed indicating and recording instrument has been developed by CEERI for diesel and electric locomotives in collaboration with a private industry. The performance of the prototype model has been tested on an electric locomotive of Indian Railways. The salient features of the instruments are: non-contact inductive DC type proximity sensor with IP-6 standards, 6 digit odometer with bright LED display, speed indication, full-function key board for initial data entry, data retrieval and data transfer interface/switch and interactive selection of conditional data for display and analysis. The instrument is useful for indicating and recording relevant train data such as loco speed, time, date etc. in NVROM. The system provides valuable information for locomotive movement and analysis of causes in case of accidents.

2.3.7 Instrumentation for Microelectronics

CSIO with the assistance from UNDP and Government counterpart funding from the CSIR and the DoE has successfully developed the following:

- a) **Molecular Beam Epitaxy (MBE) System** used for growth of semiconductor epitaxial layers, monolithic microwave integrated circuits (MMICs), very high

speed integrated circuits (VHSICs) etc.

- b) **Stepper Optical Lithography (SOL) facility** essential for the fabrication of LSI/VLSI devices and ASICs in all microelectronic foundries.
- c) **Reactive Ion Beam Etching (RIBE) System** based on ECR source used for etching fine anisotropic patterns for fabricating microelectronic (VLSI/VHSIC) devices as well as for micromachining and making fine optical gratings.
- d) **Reactive Ion Etching (RIE) System** necessary for etching a variety of materials like Silicon, Polysilicon, Silicon Dioxide, Nitrides, Silicides, Group III-V Compound Semiconductors, etc. for fabrication of microelectronic and photonic devices. This system also finds applications in the areas of microfabrication and micromechanics.
- e) **RF/DC Sputtering System** which has applications for deposition of thin films in semiconductor industries, optical industries, integrated optics, industrial hard and decorative coatings, etc.
- f) **Electron Beam Controlled Evaporation (EBCE) system** for growth/deposition of high quality thin films of different solid materials. It finds wide applications in areas of microelectronics, optics, superconductors, etc.
- g) **LSI/VLSI Testing System** for general purpose programmable testing of LSI/VLSI devices as well as for sorting of devices having particular specifications.

2.3.8 RF Hyperthermia system for cancer therapy

Hyperthermia is a new emerging technique for treatment of localised cancers. CSIO has designed and developed a Hyperthermia System at 27 MHz for intracavitary applications, in uterine cervix using capacitive type of non-invasive applicator system. A specific control algorithm has been developed for control of temperature measurement.

2.3.9 Receivers for optical communication

CEERI has developed Need Specific Detectors and Receivers for Optical Communication System comprising hybrid optical front-end module and integrated optical receiver module.

2.3.10 Land based Digital Seismic Data Telemetry System

CSIO in collaboration with NGRI has developed an eight-channel Digital Seismic Data Telemetry System based on state-of-art technology. The system is meant to monitor and analyse micro-earthquakes/earthquakes data telemetered from a network of seismic remote stations via digital ground telemetry down to a central recording and analysis base station.

At the base station, the seismic data can immediately be processed and analysed for the purpose of research in the field of earthquake prediction.

2.3.11 Inclinator probe with digital indicator

CSIO has developed a portable and light weight inclinometer which incorporates special features of high accuracy and ruggedness; excellent stability; water proof stainless steel housing; digital data indicator with 4 ½ - digit large LCD display, dust proof enclosure and rechargeable battery.

2.3.12 PC based data acquisition system for thermo physical studies

NAL has successfully developed a PC based data acquisition system for thermophysical studies. The system, built around a temperature controlled furnace with attachments for studying several thermo physical phenomena is available both in the PC based and manual models. The PC based system offers software control of temperature, temperature gradient and the computation of different physical activities.

2.4 ENGINEERING

Scientific Achievements

2.4.1 Control of Fly-rock due to blasting

A blast mat was indigenously designed, manually weaved and used by CMRI to control fly-rock at a limestone mine. The use of bottom hole initiation, adequate stemming equal to burden and hole to hole delay pattern helped in total control of fly-rock and production of an ideal muck profile. Each blast mat was of 6x6m in dimension and the ropes were interlocked with each other. Elimination of fly-rock using blast mats at the peripheral areas of this mine generated scope of cost reduction by minimising ripping and dozing operations which accounted for 20-25 percent of the total cost of production as it was extensively used in these areas to prevent environmental hazard.

2.4.2 Rural roads in Andhra Pradesh

CRRRI has been entrusted the task of preparing a project report for the rural roads component of the Andhra Pradesh Economic Restructuring Project (APERP) funded by the World Bank. The study interalia includes the preparation of master plans, review of design standards, development of policy framework, identification of project scope. Three pilot districts were selected for the purpose to study the upgradation of a selected core network to all weather standards and building up of technical, institutional and financial capacity for sustainable maintenance and management of the core network. This study has proved that the core network identified by CRRRI is cost effective and at the same time ensures 100% village accessibility.

2.4.3 Wind tunnel studies on structural models

SERC-M is now developing experimental techniques for testing of models of dynamically sensitive structures in the atmospheric boundary layer wind tunnel (BLWT) with the aim of improving the analytical tools for analysis of wind sensitive structures. Wind tunnel tests on 1:300 scale model of a coal storage shed without gable walls have been carried out. This enabled the optimisation of structure design to be done by a good bracing system connecting the frames in the front and rear.

2.4.4 Studies on vibration control of structures and foundations

SERC-M has taken up a project to study the dynamic characteristics of selected types of vibration isolators for developing standard criteria for analysis, design and evaluation of isolator supported machine foundations and investigate relative efficiency of base isolation techniques. A test facility for evaluating the dynamic stiffness and damping characteristics of vibration isolators under direct compression has been set up at the centre and trial tests have been carried out on a typical isolator having wide industrial application.

2.4.5 Finite element analysis of large structure using parallel processing

SERC-M has been working on development of parallel processing approaches for finite element analysis of large structures. Efficient mesh partitioning algorithms and a method of domain decompositions were developed for parallel processing. A portable Graphic User Interface (GUI) for the domain decomposition algorithms has been developed using X windows and Motif routines on workstation platforms. The expertise developed has enabled SERC-M to bag several grant-in-aid projects on specific aspects in the field.

2.4.6 Fatigue investigations of offshore structure

Corrosion fatigue behaviour of welded steel tubular joints of offshore structure has been experimentally investigated at SERC-M to formulate guidelines for fatigue-resistant design of offshore platform structures. The effect of cathodic protection on fatigue life of these joints was studied, both under constant amplitude and random loading. A life reduction factor by about 2 to 2.5 times was observed under free corrosion environment as compared to air environment. Adequate cathodic protection is found to help in restoring the in-air fatigue strength of tubular joints, both under constant amplitude and random loading conditions.

2.4.7 Creep damage and life assessment

A method for obtaining the oxidation rate constant under creep conditions has been suggested by NML. This is based on an analysis of the shape of the creep strain time plot. A new concept of a shape factor has been introduced for generating geometry independent master creep curves. The

model has been validated with experimental data on Incone IX-750 and CrMoV steel. A finite Element Method based software has been developed to implement the model developed for specimen to the design of components.

2.4.8 Mining machinery Components

In engineering components design apart material related factors like microstructural features, composition and engineering properties determines performance of a component. These parameters can be manipulated through appropriate metallurgical treatments, to ensure efficient working. RRL-Bhopal has taken up investigations on mining machinery components with a view to improve their life. Systematic metallurgical and tribological studies showed that life of indigenous shovel teeth could be enhanced to be at par with imported teeth.

2.4.9 Industrial roofing system using cold forming steel section

Use of Cold Forming Steel Section (CFSS) in structural construction, such as beams, columns etc. is yet to take off in any noticeable way in India. SERC-M took up a project to develop industrial roofing system using CFSS. Software was developed for determining the allowable axial load capacity and the bending strength of CFSS members as per IS: 801-1975. Comparison of experimental result with applicable BS, AISI & IS codal provision brought to light the inadequacies of the present Indian code.

Technological Achievements

2.4.10 Supersonic combustor development

DRDL, Hyderabad, is developing a hydrogen fuelled supersonic combustion ramjet for the hyperplane, which will be a fully reusable, single stage, hypersonic vehicle. As a part of this programme, NAL has developed the technology for the design of supersonic combustors. A direct connect supersonic combustor test facility, which is suitable for simulation of flight at six times the speed of sound and an altitude of 30 km altitude has been successfully set up and experimentally validated.

2.4.11 Development of powered hang glider

Probably for the first time in the world, a powered hang glider was flown with a rotary Wankel engine. The engine, an air-cooled 35 hp engine, was modified for this application in a project supported by AR&DB at NAL. NAL's flight activities involving the powered hang glider encourage the hope that the great potential of the Wankel engine may eventually be tapped.

2.4.12 Wide Stall Mining Without Stowing

Wide stall mining, an eco-friendly mining method without stowing, has been developed by CMRI for optimal

recovery of coal in developed pillars as well as for improvement in productivity and safety of workers for workings underneath delicate surfaces. The method was tried on experimental basis at Chirimiri mine of SECL for extraction of a 8.4m thick seam underneath a hill. The method is especially useful for regions where stowing materials are not available for packing of the mined-out areas.

2.4.13 Multiblend cement

CBRI has optimised four promising multiblend cement (MBC) formulations using portland cement clinkers and industrial byproduct wastes such as blast furnace slag, flyash and gypsum. These exhibit better strength, durability, impermeability and resistance to aggressive environments as compared to ordinary cements.

2.4.14 Natural rubber latex based cement concrete

SERC-M has developed a process for production of natural rubber latex based cement concrete (NR-LMCC), overcoming the problem of coagulation of the matrix which hinders the workability of concrete. The process has been utilised to develop mixed having higher strength, greater stiffness and more energy absorption compared to control concrete of M20 grade. The product exhibits quality of good adhesion to cementitious substrates, higher durability, impermeability to water, chlorides and carbon dioxide, resistance to salt water exposure and reduced drying shrinkage. The development is the subject matter of a patent application filed in India.

2.4.15 Epoxy concrete for machine bed

Epoxy concrete, a cold curing mixture of a reactable epoxy resin and hardener system (binder) and a carefully selected and graded aggregate system (filler), has potential in replacing cast iron and mild steel structural elements for machine tools. CMERI has taken up the development of epoxy concrete or epon technology for manufacturing beds of grinding machines and other precision machine tools complete with inserts, including pre-machined metallic inserts, by in-situ casting methods. The technology has also been utilised for the manufacture of grinding machine beds with finished or semi-finished guideways, which can be moulded in with the main structure, bolted on to mould-in plates or cast with special formulation.

2.4.16 Corrosion resistance of fly ash cements

It has been reported that fly ash cement in general is less corrosion resistant compared to ordinary portland cement and hence large-scale blending of such cement in reinforced concrete construction is on the decline. CECRI has developed inhibitor admixture that will impart adequate corrosion resistance to flyash dust and facilitate its use in reinforced concrete.

2.4.17 Composition for Quick Setting of Cement

An inorganic chemical composition has been developed by CMRI for use in cement capsules to get instant grip, high strength and better performance compared to capsules available in the market. The know-how of the composition has been transferred to CIL. For effective use, the dry chemical is encapsulated in polythene capsules with closely spaced perforation. These capsules are immersed in water for few minutes before putting them into the holes. It has shown an anchorage strength of 2.5 to 3 tonnes after half-hour of installation.

2.4.18 Flyash for highway embankment construction

CRRI has successfully demonstrated the use of flyash for construction of highway embankments for the 6 to 9 meters high, 1.9 km long approach embankment for the Indo-Japan Friendship Bridge at Nizamuddin in New Delhi. Flyash has been used as a core material in floodzone area for the embankment.

2.4.19 Bio-energy for brick kilns

R&D efforts of CBRI to utilize high caloric value biomass as a partial or total substitute for coal & other fossil fuels for burning of bricks have yielded very encouraging results. Successful commercial trials utilizing agricultural byproducts and forest residues have been conducted at conventional Bull's trench kilns and other small scale intermittent kilns obtaining nearly 950 to 1000°C. The technique has been employed for commercial burning of bricks in Western U.P, Haryana, Punjab and Gujarat where these bio-masses are available in plenty and also in other brick kilns situated far way from coal mine pits.

2.4.20 Cold forming of aluminium bicycle hubs

Cold forming is a process in which a near-net shape product with better mechanical properties can be achieved by forming a material at room temperature. CMERI has developed a suitable cold forming technology for aluminium alloy bicycle hub. The total hub was divided into two parts that were manufactured separately by cold forming process and were joined by friction welding to constitute the complete hub.

2.4.21 Improved iron removal for potable water

CMERI based on the inputs derived from evaluation and monitoring of iron removal plants installed under the RGNDWM has developed an improved version of iron removal plant. Better aeration by CMERI design features double aeration chambers and proper air flow; presettling chamber along with the settling chamber; optimum settling and filtration area that give significantly improved performance.

2.4.22 Decorticator for groundnut seeds

Decortification, a vital step in the production of edible oils from seeds is a candidate area requiring technological upgradation for optimisation of oil yield and quality. To bridge the existing gaps in technology. The MERADO, Pune centre of CMERI under took the development of an efficient single roll decorticator for groundnut seeds. The design developed is versatile and enables decortication of groundnut as well as other seeds by changing the operating variables.

2.4.23 Remotely operated vehicle

CMERI has taken up the design and development of an upgraded version of a Remotely Operated Vehicle (ROV) to operate at a depth of 250 m, as an extension of the earlier sponsored programme of the DOD. The ROV will have application in marine geological survey, photography and collection of samples from the Exclusive Economic Zone.

2.4.24 Draft Tube (DT) Cone

BHEL Bhopal, manufactures hydroturbines of various capacities which presently employ DT cones imported from Japan and Russia. RRL-Bho. developed and demonstrated seamless casting of acrylic polymer to make large thickness DT cones which also eliminated some of the design deficiencies. A prototype cone has been developed for BHEL for their model hydroturbine.

2.4.25 Lignin from paper mill effluents

India has a large number of pulp and paper mills based on agrowastes. These mills have capacity to produce 25-50 tons per day of paper, generate about 150 cubic meter of wastewater per ton of paper produced. The currently practiced processes do not have capability to separate the lignin and other components contributing to the high COD and BOD values to the effluent water.

NCL has developed a process for the treatment of the effluent water to separate the lignin. This process uses a material named as "ECONCL" developed at NCL (Indian Patent application filed). The effluent water when treated with ECONCL separates out the lignin and other Organic impurities as precipitate that settles down fast. The clarified water can be recycled in the pulp making plant. The process has been successfully demonstrated in the laboratory and pilot scale units at NCL.

2.4.26 Bioremediation for Crude Oil contaminated soil

RRL-Jorhat completed bench scale studies on 'bioremediation of crude oil contaminated soil of Borhola oil field' of ONGC. It lead to site characterisation and developing a bioremediation protocol for crude oil contaminated oil fields. The technique developed is expected to help restore the soil health of crude oil contaminated soils.

2.4.27 Eco-friendly coke-less cupola for Agra foundries

A tripartite agreement was signed between Tata-Korf, the Agra Iron Foundries Association (having nearly 250 foundries) and NML for transfer of the coke-less cupola technology involving installation, commissioning, demonstration and diffusion in the Agra region. NML developed environment friendly coke-less cupola technology using liquid fuel or almost sulphur free natural gas will be engineered by Tata-Korf to commercial level for Agra foundries.

2.5 FOOD PROCESSING

Scientific Achievements

2.5.1. Lipase catalysed esterification

CFTRI has studied in detail the role of water of reaction and the micro-aqueous enzyme-water-solvent interphase on the esterification reaction catalysed by lipase. The studies score over usual chemical synthesis and other enzymatic process due to milder reaction conditions, low water environment, lesser concentrations of enzyme, less strenuous reaction conditions as compared to chemical synthesis and clean products. The investigations have generated information on these esterification equilibria useful in developing newer techniques for large scale applications. These studies have also resulted in the development of novel experimental designs for the synthesis of the esters on a bench scale level.

2.5.2. Spices as nutraceuticals

Spices and herbs are extensively used in Ayurvedic system of medicine. Investigations at CFTRI on dietary curcumin (from turmeric) and capsaicin (from chillies) have helped to establish the antiarthritic and antiinflammatory properties of these spices as also explain the mechanisms by which these act on the pathological conditions. CFTRI has demonstrated the prophylactic and therapeutic effects of dietary curcumin and capsaicin in adjuvant induced arthritis model in rats. Studies showed that these spice principles delayed the onset of the disease, decreased inflammation of joints and reduced paw oedema in arthritic animals.

2.5.3. Biofumigants for the control of insect pests

CFTRI has discovered the potent biofumigant activity of a compound FPIC-COO1, present in foods conventionally used as a flavouring agent and also synthetically manufactured. FPIC-COO1 is listed as safe by the Flavour and Essence manufacturers Association, USA. The insecticidal activity exhibited by the compound is seen to be the most potent as compared to other biofumigants being investigated elsewhere, thus having good potential for exploitation against mosquito mats, coils, vapourisers and use as a biofumigant for the protection of stored grain from insect infestation. The

fumigant assumes importance in view of the phasing out of allethrin, phosphine and methyl bromide.

Technological Achievements

2.5.4. Modified atmospheric packaging

Modified atmospheric packaging (MAP) wherein the atmosphere surrounding the commodity is rendered different from normal through manipulation of CO₂, O₂ and N₂ levels in suitable polymeric film packages of desired permeability is one of the effective methods for extending storage life of fruits. Active modification involves creating slight vacuum inside the package and replacing it with a desired mixture of gases to establish an optimum equilibrated modified atmosphere (EMA). The MAP offers potential for long distance transportation including export of commercially important fruits such as mango, banana, lichi, pomogranate and strawberry as well as important vegetables.

2.5.5. Technology protocols for mango export

Mango, considered the king of tropical fruits is a universal delicacy and has high potential for exports. CFTRI has developed specific pre-and post harvest technology packages for export of the famous alphonso and bangalpalli varieties of Indian mangoes by ship in reefer containers. The appropriate pre-harvest technology protocols include orchard management, treatments to control spoilage, optimum stage of maturity for harvest, desapping, grading, and washing followed by post-harvest dip treatments to minimise spoilage, ripening, low temperature storage in containers and packing in specially designed CFB boxes. The process capable of handling one tone mango per hour, helps in increasing shelf life of the produce to 35 days with desirable and acceptable ripening characteristics.

2.5.6. Dehydrated green pepper

Dehydrated green pepper (DGP) has a good potential for export. CFTRI has developed an improved process for dehydration of green pepper which avoids the use of chemicals for the retention of the green colour, a significant breakthrough in the technology development. Fresh tender green berries are subjected to high temperature in short time (HTST) treatment and then dried to a desired level under controlled conditions. The DGP thus obtained has a good flavour with a rehydration ratio of 1:3, and a piperine content of about 5%. A patent has been filed on this method for production of DGP.

2.5.7. Dehydration of meat

Dehydrated meat is a shelf-stable product and storable without refrigeration at ambient temperatures. It is a ready-to-use processed material which can be available at all times for preparation of meat dishes. CFTRI has developed a process for making the convenient ready-to-use meat and lends itself convenient to transportation.

2.5.8. Salt from the brines of Jambusar - quality improvement

Salt produced from subsoil brine available in Jambusar (Bharuch) is reported to be of inferior and inconsistent quality. CSMCRI developed a method which involved external additives and gives acceptable and consistent quality of salt.

2.5.9. National Centre for Food Safety

The food related safety standards are now followed strictly by most of the countries. The health concerns for infants, children and elderly has made it necessary to put in place special regulations applicable to infant and other foods. CFTRI under funding from DBT is setting up a National Centre for Food Safety. The Centre would house modern facilities for various food safety evaluations.

2.6 INFORMATION PRODUCTS

Scientific Achievements

2.6.1. Mathematical Models for Assessment of stability

CMRI has developed mathematical comprehensive analysis models for assessment of stability criterion of wedges formed by four and five joint planes. The graphic software is used to determine rock pressure and optimum support design parameters of underground openings, tunnels and caverns. It also deals with the orientation of the drive of excavation. The stability of abandoned mines, tunnels and caverns can also be assessed with the help of this package.

2.6.2. Benchmarking the best practices of Research and Technology Organisations (RTOs)

In the new environment of globalisation and liberalisation the RTOs are seeking to restructure but have little experience in organising their activities for the new environment. NISTADS after carefully studying RTOs the world over undertook a project aimed at addressing this question by setting up benchmarks and establishing a methodology. An information package has been developed on the methodology and best practices derived from the study.

Technological Achievements

2.6.3. Software for fragment analysis

A fragment image analysis software package - FRAGALYST for post blast fragmentation has been developed by CMRI in collaboration with a private sector software company. This software accepts the digitized image of a pile of fragments and analyses the image for vital size and shape related information of visible fragments in the image. It offers variety of features, which help in visualizing scientific, statistical and geometric analysis of an image.

2.6.4. Software for electromagnetic design

NAL has developed a comprehensive software package, 'Aavrita' for EM design and analysis of radomes, both ground

based and airborne. Aavrita aims at providing design solutions from the EM perspective incorporating variation in the material properties and the fabrication tolerances. Given a radome design, Aavrita is also capable of analysing it with respect to the EM performance parameters such as transmitted power, reflected power, voltage standing wave ratio (VSWR), insertion phase delay (IPD) etc.

2.6.5. Software for cathodic protection in off-shore platforms

The software is the first of its kind in India and has been developed for ONGC, subsequent to denial of the international software from the Norwegian consortium. Off-shore platforms are expensive metallic structures for oil & gas exploration, the longevity of these structures thus depends critically on the extent of cathodic protection provided to them. CECRI has developed an highly useful indigenous software called CPSEA++ which facilitates early recognition of corrosion and areas prone to corrosion, thereby providing timely protection of off-shore structures.

2.6.6. Software for the Analysis of Deflection Data

Under a joint study with C-MMACS, CRRI has developed a Mathematical Model for Multilayer Road System, Types prevalent in India and a software analysis of Falling Weight Deflectometer deflection data. Validation of the software is being carried out.

2.6.7. Engineering database on landslides

CRRI has developed a user friendly engineering database on landslides (EDBLSD) comprising all important factors influencing landslides and the associated impacts. The database would be useful towards developing national policies on mitigation and management of landslides and also assist highway engineers working on hilly regions in preparing at operational strategic plans.

2.6.8. Multi-media database creation

INSDOC has been making endeavours to develop expertise in the area of multimedia databases. It has developed the following multi-media products:

- a) **Multi media Encyclopedia on Carnatic Music:** The database is of hypermedia documents which are linked to each other through hyperlinks. It has been authored in ICON AUTHOR software, provides detailed information in the form of text, picture or sound on the various aspects of Carnatic music.
- b) **Multi media Photo I-card Preparation:** INSDOC has developed a high efficiency system for the preparation which enables online delivery of photo I-cards. It continued the preparation of photo I-cards for electors of 50 assembly constituencies in the National Capital Territory of Delhi.

2.6.9. CD-ROM Activities

INSDOC has published two databases on CD-ROM using in house facilities these are:

- a) National Union Catalogue of Scientific Serials in India (NUCSSI) Database: It is a valuable user friendly menu-driven retrieval information product which helps in locating the availability of S&T serials in the country. The database covers nearly two lakh holdings in over 400 S&T libraries in the country.
- b) Indian Patents (INPAT) Database can be searched by different parameters. It contains nearly 50,000 records on patents granted in India from 1972 to December 1997.

2.6.10. Publication of research journals

NISCOM, continued the publication of the thirteen research journals covering all the major disciplines of science. In all nearly 1400 papers were published in these journals during the year. Some Special issues of these journals brought out during the year were on:

- a) Organic Synthesis-Growing Interface with Adjacent Sciences proceedings of an Indo-German Symposium (Indian Journal of Chemistry, Sections A&B June, 1997);
- b) Condensed matter Physics (Indian Journal of Pure and Applied Physics, November 1997) ;
- c) Role of Eukaryotic Cell Surface Macromolecules (Indian Journal of Biochemistry and Biophysics, February & April 1998 combined issue);
- d) Satellite Oceanographic Modelling (Indian Journal of Marine Sciences, march 1998);
- e) Recent Advances in Technical Textiles (Indian Journal of Fibre and Textile Research, December 1997) ;
- f) The publication of the Chinese editions of Indian Journal of Chemistry, Sections A&B was continued in collaboration with the Shanghai World Publishing Corporation, Shanghai.

2.6.11. Special Publications

NISCOM published two reference proceedings viz; Advances in High Pressure Research in Condensed Matter Physics, Proceedings of International Conference on Condensed matter under High Pressure held at BARC during Nov. 1996, the Physics of Disordered Materials, Proceedings of the International Conference held at Jaipur in January 1997. All the twenty-four issues of the fortnightly newsletter CSIR News for the year were published on schedule.

2.6.12. Popularisation of Science

The Golden Jubilee series of popular science books initiated at NISOM during 1992 have been in great demand, a new title brought out was on 'Holography' by M.G. Joshi. In the Sci-Fun Series of books targeted for children in the age group of 8-10, a new title on 'Bubble Bubble' by HS Ray was published and the manuscripts of two other books, 'Strange Plants' by Parul Sheth and 'Deserts' by Vineeta Singhal, are press ready. Besides this two lavishly illustrated books 'How?' and 'Why?' each containing 100 mind boggling questions (with their answers) in was released under the Q-Series.

2.6.13. Documentation centre for RGNDWM

INSDOC has been approached by Rajiv Gandhi National Drinking Water Mission (RGNDWM) for establishment of its Documentation and Information Centre on a turn key basis. The project phase involving setting up of infrastructural facilities is nearing completion which will be followed by an operational phase of one year. The resource collection for the centre is being built up concurrently. The first issue of the quarterly R&D newsletter entitled "MISSION WATSAN" has been published. The centre is scheduled to be inaugurated shortly.

2.6.14. Electoral Roll Database

INSDOC was assigned by Chief Electoral Officer (CEO), Delhi a project on computerisation of electoral rolls of the National Capital Territory of Delhi. The work involved creation of a database of nearly 45 lakh electors of 40 Assembly constituencies in English and Hindi. The software has been developed in 'Windows' and database design provides improved storage efficiency by introducing dictionary concept. It facilitates conversion of English data into Hindi automatically. The database will simplify the process of updating electoral rolls and bring about overall improvement in the management of electoral rolls data.

2.7 MATERIAL SCIENCES & TECHNOLOGY

Scientific Achievements

2.7.1. RF-SQUID effect in borocarbide superconductors

NPL has observed, for the first time, rf-SQUID effect due to natural grain boundary weak links in a bulk sample of $\text{YNi}_2\text{B}_2\text{C}$ superconductor at 4.2 K, confirming that the superconducting grains are coupled at the grain boundaries through Josephson effect.

2.7.2. Thermal modelling of DC continuous casting

NML has developed an efficient numerical simulation method for the steady-state Direct-Chill continuous casting of aluminium-magnesium (Al-Mg) alloy cylindrical ingots,

results from which show excellent agreement with the published experimental data.

2.7.3. Foaming behaviour of FeO in slags during reduction

RRL-Bhu conducted a number of experiments in a plasma reactor of 50 kW capacity to investigate the influence of FeO content in slag on the foaming taking place in hearth portion of the blast furnace in steel making. It was seen that the maximum foam height increased with decrease of temperature, initial FeO content of slag and initial slag height.

Technological Achievements

2.7.4. High temperature superconducting wires/tapes and tube conductors

Keeping the possibility of use of high temperature superconductors as current carrying conductor in mind, NPL has been developing technology for fabrication of silver clad superconducting wires using high temperature superconducting BPSCCO conductors on:

- a) Fabrication of long length silver clad BPSCCO monofilamentary;
- b) Fabrication of multi-filamentary silver clad BPSCCO tapes and;
- c) Fabrication of high current tube conductors.

It appears that high current leads featuring rods or tubes would be the first applications of ceramic superconductors in electrical power engineering as they offer a major advantage of reduction of heat load at 4°K by more than a factor of 10 with a current of 500-1000 A for various applications. NPL has prepared 10, 20 and 43 cms long tube conductors capable of carrying more than 120-200 A at 77°K in the superconducting state. These can be used as current leads for conventional superconducting magnets, particularly suitable for operation with cryo-coolers.

2.7.5. Carbon fibre epoxy prepregs

By virtue of the numerous advantages they offer prepregs are the most popular 'building blocks' in composite product development. Currently most prepregs used in India are imported. NAL, with support from TIFAC and ADA has developed aerospace grade carbon fibre prepregs know how which has been transferred to IPCL, Vadodara.

2.7.6. Ultra low expansion transparent glass-ceramic

Ultra low expansion transparent glass-ceramic is a strategic material used as a mirror substrate mount for astronomical telescopes, reflector in radiometer of satellites and as standard reference material for dimension control in engineering industry. CGCRI carried out extensive work on the development of the ceramic (equivalent to 'ZERODUR')

and has been successful in producing 5 kg of the strategic material and moulded glass blanks of different sizes. Scale up to a 100 litre melting capacity plant is now contemplated.

2.7.7. Radiation Shielding Windows (RSW) glass

CGCRI has been successful in developing a high density ($\geq 5.0 \text{ g/cm}^3$) RSW glass (both unstabilised and Ce-stabilised in lab-scale (2kg) under the sponsorship of Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy (DAE). Efforts are on to upscale the melting parameters for the preparation of large size (150x150x100 mm) blanks for further evaluation.

2.7.8. Flotation column for industrial applications

A 75mm diameter automated flotation column designed by NML Madras Centre was fabricated and supplied to National Mineral Development Corporation Ltd., Hyderabad. The column incorporates many salient features like precise feed/discharge controls and level controls and is highly automated.

Encouraged by the success and the excellent metallurgical results obtained using this column, NML recently designed and developed a semi-commercial column of 50 mm diameter with a capacity to treat 2-4 tonnes of ores per hour. This column has complete instrumentation for level control, wash water control, automatic sampling etc. It incorporates a special sparger designed and developed at the Centre. The column has been successfully tested for Bharat Gold Mines Ltd., at Kolar Goldfields for their gold ores and for Gujarat Mineral Development Corporation, at Kadipani for fluorspar.

2.7.9. Tiles from ferro-chrome and other industrial wastes

The mixing and grinding for various compositions were chosen and carried out in pot mill to get the desired fineness and the parameters were optimised. The tiles were then fired in an electric furnace at a sintering temperature in the range of 1050-1150°C. The properties of these tiles were evaluated with reference to the European Nation (EN) Standards of ceramic tiles and were found to confirm to the standards in most aspects.

2.7.10. Improvement in efficiency of ferro-chromium process

NML has developed a thermochemical model of the production of FeCr in the Submerged Arc Furnace to predict the quantity of metal that could be produced. An excellent correlation was observed between the quantity predicted by the model and the amount actually produced in a 150 TPA plant. It is estimated that an industrial unit could secure about Rs. 100 lakh per annum from productivity improvement by implementing the process modifications arising from the model.

2.7.11. Masonry cement from industrial wastes

CBRI has taken up work on utilising mining and industrial wastes for production of masonry cement. Performance evaluation of a number of preliminary mixes of desired fineness prepared by varying proportions of wastes as binary and tertiary systems was done and mix proportions optimised with respect to percentage wastes. The product is cheaper than portland cement and found to be equally good for plastering and mortar purposes.

2.7.12. Transmittance Standards for the infrared

Infrared radiation standards are not readily available from any of the standards laboratories in the world. The currently available standards provided by the National Institute of Standards & Technology (NIST), USA, operate in the uv, visible, and near infrared spectral region up to 2.5 μ m only. Now, NIST has established wavelength scale for the calibration of FTIR instruments. NPL has worked on the development transmittance standards at normal as well as oblique angles (10 to 70 degree) of incidence in the infrared (2.5 to 25 μ m) spectral region. The materials employed are silicon germanium, potassium bromide, zinc sulphide, zinc selenide and calcium fluoride. The transmittance/reflectance values of these standards have been intercompared with those measured at NIST and have been found to be in good agreement. These standards are used for the calibration of infrared spectrophotometers/radiometers which are an important tool for analysing the product quality in various industries i.e. chemical, pharmaceutical, food, tobacco etc. and for the evaluation of the performance of infrared scanners, night vision, thermo-vision and remote sensing systems by measuring the true transmittance of their window materials and filters.

2.8 PHYSICAL SCIENCES & EARTH RESOURCES

Scientific Achievements

2.8.1. Modelling of Biogeochemical cycles of the Indian ocean

The study of biogeochemical cycles of the Indian Ocean are important for the estimation of carbon flux and marine fishery potential. A nonlinear dynamical system model developed by C-MMAC consisting of twenty seven parameters has been applied to the Indian Ocean. The model includes the effect of upwelling velocity, photosynthetically active radiation, nonlinear closure terms and grazing threshold. The model tuning is being carried out to capture the chlorophyll seasonal variation in the upper ocean, as obtained from CZCS data.

2.8.2. Crustal deformation using global positioning system

C-MMACS analysed the Global Positioning System measurements data collected in the last 3 years, to estimate

the convergence rate of the observation points in North India with respect to observation point in IISc to assess the stability of the South Indian peninsula using the International GPS Service (IGS) estimated orbits and pole parameters and International Terrestrial Reference Frame (ITRF 96). The results suggest that the point in Delhi has not moved much with respect to Bangalore in the last two and half years, implying that the Indian plate between Delhi and Bangalore is relatively stable. However two points in Garhwal Himalaya, one is Chamba (CHAM) just north of Main Boundary thrust and the Sukhi (SUKI) point north of Chamba, are converging towards the Indian plate at the rate of 14 mm and 18 mm/ per year. Analysis of four South Indian points with respect to Bangalore point yielded average linear strain rate of 0.001 microstrain/year, establishing the stability of South Indian peninsula and least possibility of occurrence of big earthquakes. There is also an indication of volumetric strain of the South Indian peninsula.

2.8.3. Insitu stress measurement

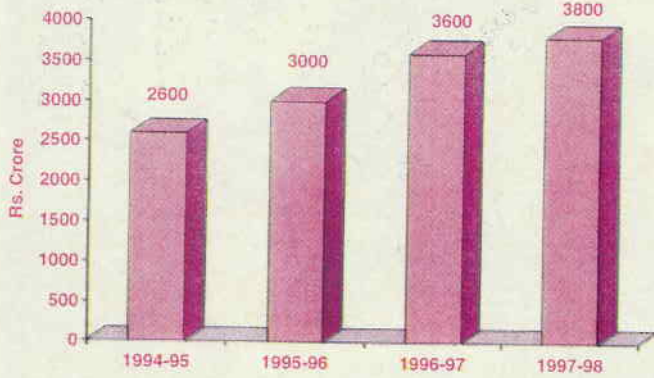
Insitu stress measurements have been carried out by NGRI upto ~600m depth in a very small diameter core-drilled borehole in the meizoseismal area of Latur earthquake for the first time in the world using a miniaturized hydrofracture packer assembly. The results demonstrate that the near-surface principal horizontal stresses are higher than the overburden pressure, indicating that they are of tectonic origin.

2.8.4. Earthquake Studies

NGRI carried out a number of earthquake studies, leading to significant findings, some of these are given here under:

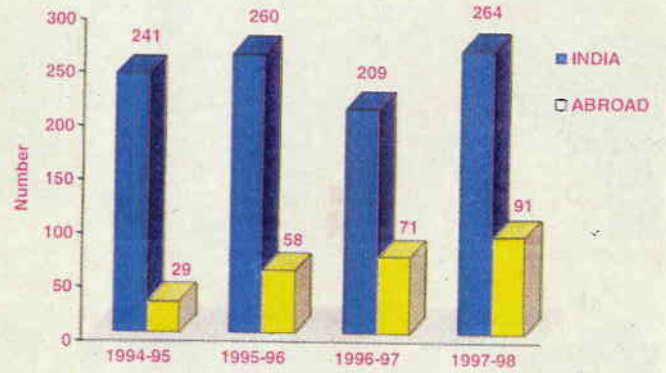
- a) At Koyna the 3-D velocity image suggests that this zone is marked by high velocity in upper crust as well as in deep lithosphere. Hypocentral locations revealed two NNE-SSW trending active faults at a depths of 11 km. The moderate earthquakes were found to nucleate near the surface, but propagating northward and downward, within planar rupture areas of 70-80sq. km. The depth range of 0-1 and 5-11 km were found to give higher magnitude and higher stress drop events.
- b) At Jabalpur study of fault plane solution, isoseismals and aftershocks indicates overthrusting of southern block, of the ENE-WSW trending south Narmada fault at a depth of 35 km. The fault length is estimated to be about 5.7 km. Gravity profiles across epicentral zone of this earthquake delineated a horst structure between north and south Narmada faults which is related to the epicentre. Inferred structure across the Narmada-Son lineament obtained from MT studies could be related to seismogenic fault related to Jabalpur earthquake.

ANNUAL INDUSTRIAL PRODUCTION BASED ON CSIR KNOWHOW



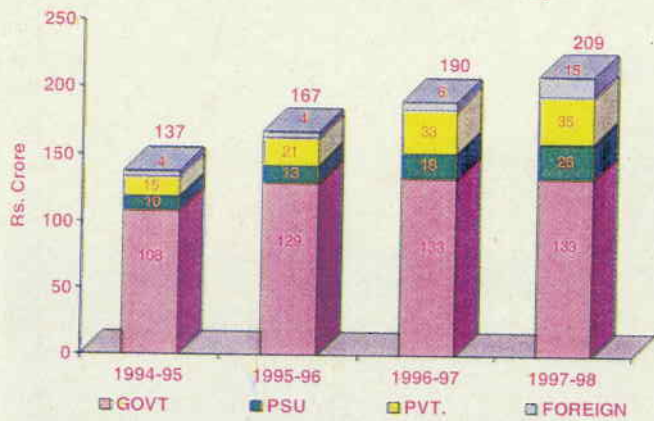
II.1 Annual Industrial Production based on CSIR knowhow

PATENTS FILED



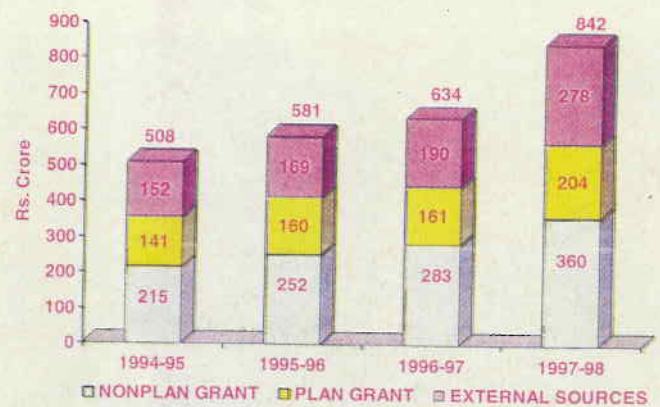
II.2 Patents Filed

EXTERNAL CASH INFLOW Contract R&D and Consultancy



II.3 External Cash Inflow through contract R&D and Consultancy

FUNDING OF EXPENDITURE



II.4 Funding of Expenditure



II.5 DG, CSIR releasing the new cultivar of Damask Rose



II.6 Wildlife management by genetic fingerprinting: collecting blood sample for DNA studies



II.7 Visbreaking Pilot Plant at IIP, Dehradun



II.8 Flyash for highway embankment construction

- c) At Latur site amplification and coda Q_c attenuation evaluated by using after shock digital data showed that the maximum amplitude of site amplification was at villages around Killari. The fault length for the Latur earthquake is found to be 4.8 km. Teleseismic broadband data of Latur and Jabalpur earthquakes reveals that for these earthquakes the corner frequency estimate are relatively consistent. The Latur earthquakes indicates a stress drop and apparent stress which are 5 times more compared to the Jabalpur earthquake.

2.8.5. Oceanographic Studies

i) Coastal Studies

- a) Under the Coastal Ocean Monitoring and Prediction System (COMAPS) extensive chemical and biological observations were made by NIO during pre and post monsoon seasons along Ratnagiri-Mangalore coastal stretch. The studies indicated that the region is free from contamination. Higher values of standing stock and densities of zooplankton were observed during premonsoon than postmonsoon season.
- b) Cycling of combined nitrogen in sediment and water column of mangroves were studied. It was observed that nitrate dominated in the water column while nitrate as well as ammonium occurred in high concentrations in the sediments. Experiments on uptake and assimilation of nitrogenous nutrients by phytoplankton of sediment and water column indicated that ammonium was the most preferred nutrient to be taken up by the autotrophs with high specific rates in the month of May.
- c) Studies on littoral drift and sink along the Indian coast indicated an active removal of sediments in the Gulf of Kachchh, Gulf of Khambhat, Gulf of Mannar, Palk Bay and Sandheads. Strong currents and wave energy concentrations are the causative factors resulting in coastal erosion.
- d) Hydrographic data collected during the pre and post southwest monsoon seasons in Gauthami-Godavari estuary were utilised to estimate residual fluxes of water salt and vertical diffusivity. The residual flux of salt due to tidal pumping appears to be the main factor controlling the salt balance of the estuary.

ii) Offshore Processes

- a) Magnetic survey along a transect running from 1°S , $81^{\circ} 24'\text{E}$ to 7°N , $87^{\circ} 30'\text{E}$ has led to the identification of a cretaceous Magnetic Quiet Zone (CMQ) in the distal Bengal Fan. This has

established a continuous evolutionary record of the Bay of Bengal since India's break up from the eastern Gondwana continent. Bathymetric and magnetic studies in the distal Bengal Fan reveal the presence of seamounts, which are possible locations of polymetallic encrustations.

- b) Under the Joint Global Ocean Flux Study (JGOFS-India) programme, the spatial and temporal variability in air-sea fluxes of carbon dioxide was studied and found that higher biological production results in higher respiration rates. The surface waters of the central Arabian Sea are supersaturated with respect to pCO_2 in atmosphere.
- c) High resolution seismic reflection profiling along the western continental margin of India revealed the presence of characteristic acoustic maskings in the form of wipeouts, reflector terminations and seeps in the inner shelf. These maskings are considered to be methane-rich. Seismic profiles also revealed the presence of bottom simulating reflectors (BSRs) in the mid-lower slope-rise regions, presumably suggesting the presence of gas hydrates.

2.8.6. Central Indian Ocean Basin Studies

In the first phase programme on Environmental Impact Assessment at NIO for nodule mining, studies for evaluating the baseline (undisturbed) conditions have been completed in the test and reference areas. Detailed analyses of the seafloor features, nodule distribution, bathymetry, sediment characteristics and composition, as well as macro, meiobenthic and micro-biological assemblages, have been carried out to understand the present status of the benthic environment. In the second phase, a simulated "Disturbance" was conducted at a pre-selected test site. The result showed that the changes were the greatest within the disturbance zone, whereas the resedimentation from the plume generated by the disturber, was concentrated mainly in the southern and southwestern directions of the zone, which corresponds to the mean direction of currents during that period.

Technological Achievements

2.8.7. Green house gas inventory

The NPL in association with other sister CSIR laboratories has developed the greenhouse gas inventory (GHG) for India since 1991. The 1998 report from NPL is the most comprehensive report to dates. The base year considered for calculations in this report is 1990. The various sectors for which emission estimates have been made are: (i) Energy which includes emissions from Industry and Transport; (ii) the Agriculture sector (rice paddy fields and enteric fermentation from animals and manure, emissions due

to burning of agricultural crop residue and emissions from Wetlands); (iii) Land use changes and forestry sector includes emissions from grassland conversion, change in forests and other woody biomass stock, abandonment of managed lands and finally the net emission from forestry and land use sector; (iv) the Waste sector includes emissions from municipal land filled areas and area in which fruit and vegetable waste are dumped. (v) waste water emissions.

2.8.8. Laser Heterodyne System in Antarctica

A highly sophisticated and High-Tech laser heterodyne system using a tunable CO₂ laser as a local oscillator and sun as a source with one GHz acousto-optic spectrometer (AOS) as back end has been designed and developed at NPL. It was deployed at Maitri station (70° 46' S, 11° 44' E) in Antarctica during 16th Indian Scientific Antarctica expedition (1996-97) to measure the vertical profiles of minor constituents in the stratosphere and troposphere. The observations for ozone line profiles were continued during 1997-98 on all clear blue sky/cloudless sunny days. The ozone line profile thus obtained are in turn used to get vertical height profiles of ozone using inversion technique developed again at NPL for Antarctic conditions. This is the first time that this system has been deployed for Antarctic winter time and data were collected successfully during spring i.e. September-October to study ozone hole.

2.8.9. Identification of deep seated weak zones

Multi-parametric geophysical studies by NGRI in thick sand covered areas of the Thar desert near Jaisalmer have succeeded in identifying deep seated weak zones, oriented broadly in the NNW-SSE and NE direction. These zones, that have played a significant role in the emplacement of dykes during earlier magnetic episodes, are important for assessing groundwater circulation.

2.8.10. Gravity anomaly map

Based on zero free air values, NGRI prepared a new gravity anomaly map for South India. This map can be directly interpreted in terms of subsurface mass inhomogeneities and has brought into focus new anomalies which were not identified earlier from the Bouguer anomaly map due to negative bias.

2.8.11. Comparative assessment of clean coal technologies

CFRI commissioned an exercise to assess the relative merits of thermally efficient technologies for coal conversion to assess their applicability for Indian coals using ASPEN simulator. Eight technologies, four based on gasification and four based on combustion including conventional pulverized coal system were chosen for the study. Conversion efficiency as a function of varying quality of coal with respect to pure coal heat value and ash content and unit cost of power

generation in relation to pulverized coal combustion has been worked out.

2.9 SOCIETAL & HUMAN WELFARE

Scientific Achievements

2.9.1. Neuroendocrine Regulation of Silk Protein biosynthesis

The neurosecretory system of the Muga silkworm with particular emphasis of neurosecretory cells (NEC) at different regions of the brain and their positional arrangements according to the age of the silkworm was studied at RRL-Jorhat. The ultrastructure of the silk gland and brain during developmental stages showed qualitative and quantitative variations in their secretory products which clearly suggests direct control of the neuroendocrine system over silk gland development and silk protein biosynthesis.

Technological Achievements

2.9.2. Leather Technology (LTM)

LTM made a tangible impact on the national scenario, through nearly 160 activities initiated in 17 States, of these 90 activities were completed. The highlights of achievements during the year are as follows:

- a) Twelve carcass utilisation units were commissioned benefiting 300 families.
- b) Field implementation of cleaner leather processing viz. enzyme assisted dehairing, chrome recovery/reuse, chrome management etc. were carried out in several locations.
- c) A demonstration common effluent treatment plant (CETP) was commissioned at Madhavaram. Process control systems and cleaner tannery wet operations were demonstrated at four tanneries in UP and Haryana.
- d) Human resource development activities viz. Programmes for artisanal development, training of shop floor management personnel for leather industry, training of trainers, training of women were carried out at several locations. Twenty cobblers from Chennai and Guntur were trained in modern methods of foot ware manufacture. Two hundred artisans from Athani have been trained in improved tanning of sole leather.

2.9.3. Rehabilitation of tanners in Tamil Nadu

The project aptly named 'Operation Greenstar' was launched on a war footing as a tripartite arrangement between CLRI, NEERI and AISHTMA. Each of the partners was assigned a designated role and responsibility; CLRI for technology for inplant control, NEERI for end of the pipe

treatment and AISHTMA for implementation of the technology.

CLRI carried out an intensive survey of nearly 500 tanneries to identify and establish process information and operational data of each tannery. As a result 36 cluster groups were formed for implementation of the technology intervention packages comprising green technologies for beam-house operations, cleaner tanning techniques and effluent treatment systems. NEERI carried out surveys on estimation of quantity and characteristics of the Waste Waters, based on which designs of new and redesign of existing common effluent treatment plants (CETPs) was undertaken to enable conformance with statutory norms. The design involved high rate transpiration & sludge management system. This enabled about 500 tanneries to be rehabilitated and made up for the loss of employment of the disadvantaged section of the society.

2.9.3. Value added products from tannery wastes

Tannery fleshings and chicken intestines, the two major wastes from tannery and poultry industries pose disposal problems. CLRI has studied the enzymatic hydrolysis of tannery fleshings using chicken intestine protease. The protein hydrolysate obtained could be used in poultry or fish feed formulations. In investigations on chicken intestines as a source of proteolytic and autolytic enzymes for hydrolysis of tannery fleshings, it was seen that about 75% of the total protease activity of the chicken intestines was in the mucosal layer.

2.9.4. Ethnobotanical investigations of Kangra Valley in Himachal Pradesh

NBRI carried out an extensive ethnobotanical investigation in Kangra valley. It has provided new knowledge on the traditional uses of several plant species which can be utilized in tribal development programmes. The inventory provides very useful data for establishing plant based cottage industries in the tribal tracts, especially for herbal drugs, food processing, fibre products and gum resin etc.

2.9.5. Improvement in rose oil distillation unit

IHBT improved upon an existing rose oil distillation unit (400kg capacity per batch) by integrating a compatible cohobation column designed by it with the oil distillation unit resulting in 30% increase in oil recovery.

2.9.6. Mechanisation of tea plucking

IHBT has standardised the mechanical plucking of china hybrid tea by machines keeping in view the two leaves and a bud plucking standard. This will greatly help the tea industry in Himachal Pradesh, which is currently facing the problem of labour shortage.

2.9.7. New propagation technology for tea

IHBT has succeeded in propagation of tea by 4 to 8 node cuttings as against conventional method of single node cutting by treating the node cuttings with different auxins and phenols resulting in 85-90% success in rooting and transfer to field within 9 months as against conventional methods needing nearly 2 years.

2.9.8. Banana Fibre

RRL, Jorhat undertook study on the utilisation of wild banana plants for producing fibres and other useful materials. The main objective was to develop an appropriate technology to extract fibres from the sheaths of banana plants and then convert the fibres into twines and fabrics in conventional jute processing machinery for making eco-friendly products. Based on this work the Government of Sri Lanka has requested RRL, Jorhat to extend technical assistance to develop industries based on banana fibre in Sri Lanka and to impart training to Sri Lankan entrepreneurs.

2.9.9. Fresh water prawn cultivars

The suitability of freshwater prawn *Macrobrachium rosenbergii* for commercial production was tested by NIO with minor modifications of the hatchery for rearing the larvae. Water quality management, feed formulation and feeding schedule for different larval stages and maintenance of hygiene in the hatchery are the factors which control the growth of larvae. Commercial production of larvae with this technique was achieved.

2.9.10. Habilitation of the mentally challenged people

NISTADS conceived and executed a field experiment called SAKSHAM (meaning empowered or enabling) for habilitating the mentally challenged adults to become partially/fully economically independent. A reconnaissance study was conducted by NISTADS to understand the actual condition of the mentally challenged adult after they leave the special schools or vocational centres followed by another study of employing appropriate select technologies which they could pursue as a vocational career to move on the path of economic independence. The technology of mushroom cultivation was selected for field testing the concept. Though mushroom cultivation technology is well known, application of this environment sensitive technology by a group of mentally challenged people made the experiment unique. This was a departure from routine repetitive tasks used for training such people. It proved that mentally challenged were capable of performing more complex functions than is usually believed. The Project has since been selected as one of the innovative projects having societal impact potential by Third World Network of Scientific Organisations (TWNSO), Trieste, and the United Nations Development Programme (UNDP) of sharing of experience among developing countries.

2.9.11. Floriculture Industry in H.P.

Floriculture was most non-existing in Himachal Pradesh (HP) a decade back. Arising from the training imparted to

150 growers of HP by IHBT on commercial floriculture sponsored by the Govt. of HP, DRDA and HIMCON. 150 ha have been brought under commercial floriculture.

The government's growing demand for flowers in various sectors results in a steady growth in the floriculture industry. This has led to the establishment of several nurseries and floriculture units across the state. The government has also initiated various schemes to promote floriculture, such as the 'Floriculture Development Scheme' which provides financial assistance to growers. The government has also set up the Himachal Pradesh Floriculture Board to regulate the industry and promote the growth of floriculture in the state. The government has also initiated various schemes to promote floriculture, such as the 'Floriculture Development Scheme' which provides financial assistance to growers. The government has also set up the Himachal Pradesh Floriculture Board to regulate the industry and promote the growth of floriculture in the state.

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