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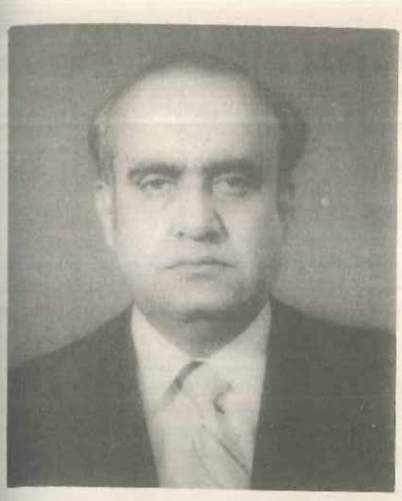


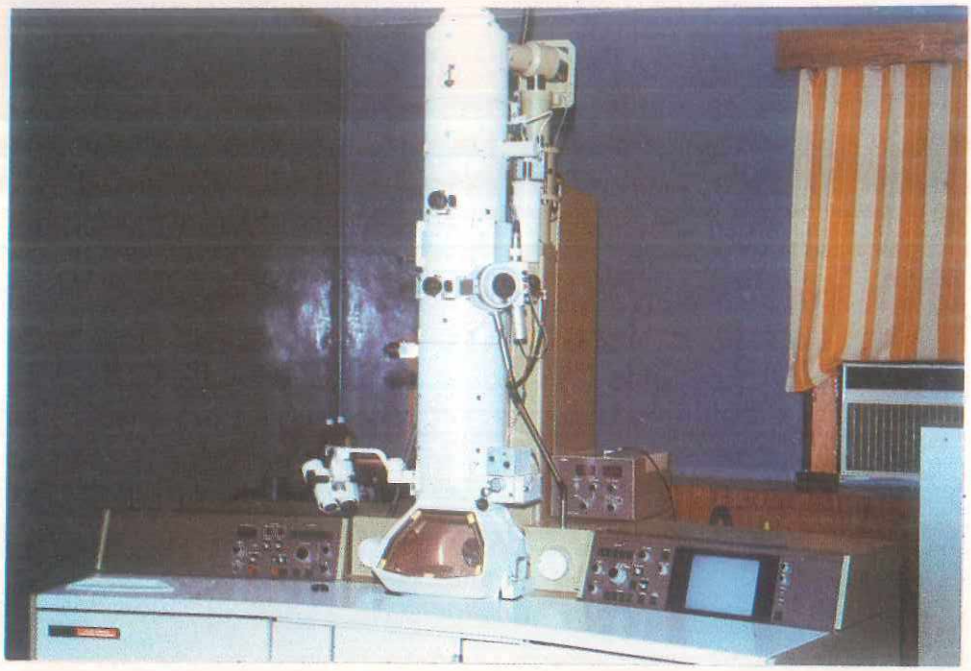
A Change at the Helm .....

In the middle of 1989, Dr. L.K. Doraiswamy retired as Director, NCL, and was succeeded by Dr. R.A. Mashelkar. Under the inspired guidance of Dr. Doraiswamy, lasting more than a decade, the laboratory made significant strides in R&D. It saw many vicissitudes , the most significant being its entry into the high-tech area of chemical technology and production. It was to his foresight and vision that NCL owed its successes in the development and transfer of technologies with novel features. The high point of his tenure as Director was the commercialization of xylofining technology at IPCL, Vadodara; this is perhaps the first indigenously-developed technology in the high-tech area in chemical production. Dr. Doraiswamy was the first scientist of NCL to become its director, after serving in it in various capacities. He truly belonged to the laboratory in more than one sense. His interests encompassed numerous other aspects of the NCL community besides its research activities. It is to him, for example, that the colony residents owe the excellent connecting roads and the shopping centre.

NCL could not have been more fortunate in the choice of the new director. Dr. Mashelkar, after making a name for himself as a teacher of chemical engineering and a chemical engineer, had been the head of the chemical engineering division for eleven years when he became the director. By then he had won recognition as a talented leader and organizer of research leading to processes and papers marked by originality and novelty. Noticing the lacunae in the field of polymers in India, he made a determined bid to institute an awareness of the importance of innovation in this area in the country, and the changed scene of polymers in the country today is the proof of his success in his endeavour. But his true strength as a director lies in his broad vision that covers the entire spectrum of research activities at NCL. The laboratory has already been marching ahead with greater confidence under his stewardship, and has won a few enviable firsts. It now looks forward to a future marked by achievement of greater successes and greater heights of excellence.

S. H. Iqbal
Editor

Ethyl benzene Plant at Vizag (Hindustan Polymers Limited)



Transmission Electron Microscope

Drag Reducers for Oil Transport

RESEARCH AND DEVELOPMENT PROJECTS

I. CATALYSIS

I.I Vapour phase oxidation of ethylene to ethylene oxide (I-I-467 C)

A computer-controlled high-pressure internal recycle reactor (Berty reactor) unit for laboratory scale testing of ethylene oxidation catalysts under commercial process conditions and collection of process design data was installed and commissioned. The NCL-developed ring catalyst (ENCEILOX-2) for ethylene oxidation to ethylene oxide was tested in this unit. The catalyst showed desirable activity, selectivity (80% for ethylene oxide at about l0% conversion) and mechanical strength.

I.2 Application of homogeneous catalysis and C1 chemistry

Homogeneous catalysis by soluble transition metal complexes has played a major role in the development of several technologies for bulk petrochemicals as well as new speciality chemicals in the last decade. Most commercial processes via C_1 chemistry are aimed at the utilization of CO and syngas (CO + H_2) as feedstocks and in this area, homogeneous catalysis has played a dominant role.

During the year facilities were developed for CO generation and compression, ensuring all safety aspects; high pressure reactors (up to 700 bar pressure) and all the facilities necessary for carrying out high pressure carbonylation, hydroformylation and oxycarbonylation reactions were set up; a high-pressure, high-temperature IR cell for in-situ analysis of catalytic complexes and investigation of reaction mechanisms was set up.

Novel homogeneous catalysts were developed for the following processes/reactions.

- carbonylation of methanol to acetic acid/methyl acetate.
- carbonylation of ethanol to propionic acid/ethyl propionate.
- carbonylation of methyl acetate to acetic anhydride.
- oxidation of C_4 mixture to methyl ethyl ketone.

Basic research is being carried out on,

a) role of ligands, solvents, co-catalysts and promoters on the activity and selectivity of carbonylation, hydroformylation and oxidative carbonylation reactions.

b) reaction mechanism and kinetic modelling of carbonylation reactions, and

c) modelling and simulation of catalytic gas-liquid reactions/reactors.

I.3 Methyl Ethyl Ketone (MEK) (I-23-267 Sp)

A catalytic process for the direct oxidation of n-butenes to MEK, with a possibility of simultaneous separation of isobutylene was developed. A pilot plant based on this process was set up and data for scale up was collected.

I.4 Development of FCC catalyst (I-26-267 C)

In this project jointly carried out with Indian Oil Corporation Limited, Faridabad, laboratory scale preparations were made successfully up to 0.25 kg. batch levels. The activities and stabilities of the catalysts were equivalent to the commercial catalysts being used in the country.

I.5 Development of naphtha reforming catalyst (I-28-467 C)

A platinum-alumina reforming catalyst developed at NCL was tested at IPCL for more than 3000 hrs. in their pilot plant. This catalyst was subsequently manufactured by IPCL and loaded in one of their commercial reactors and is functioning very well. This catalyst was developed within a record time of three years.

I.6 Development of catalyst for ethylbenzene (I-32-467)

At Hindustan Polymers Limited, Vaizag, a plant for the production of ethylbenzene (20,000 TPA) using NCL's technology was set up. The ENCILITE-2 used in the above plant (2.5 tonnes) was manufactured by United Catalysts (I) Limited, Vadodara. This one-step process starting from ethanol has 95% selectivity for ethylbenzene.

1.7 Development of hydrodewaxing catalyst (I-34-247 C)

Optimisation of the process based on NCL catalyst formulation was completed using feedstock from Madras Refineries Limited, Madras. The process engineering for commercialising this catalyst/process at MRL in 1990 is being carried out by Engineers India Limited, New Delhi.

I.8 Acetic acid via carbonylation of methanol (I-35-006 Sp)

The laboratory scale development and design of a pilot plant of 2 TPD capacity was completed. This pilot plant is expected to be commissioned in 1990/91. The process involves the use of a novel low cost/low pressure catalyst, and will be the first one to be commercialised in the world. It has great export potential.

I.9 Development of catalyst for the production of cumene (1-38-004 C)

In this scheme for the development of a zeolite catalyst for the production of cumene from benzene and propylene, sponsored by Herdillia Chemicals Private Limited, Bombay, various catalyst samples were prepared and tested for activity and selectivity.

Zeolites belonging to mordenite and faujasite classes were identified as potential catalysts for this reaction. Both atmospheric and high pressure studies were carried out. A new wide-pore catalyst was synthesized and tested. It showed a high selectivity to cumene.

I.10 Conversion of methane into value added chemicals (1-41-006 G)

Oxidative pyrolysis of natural gas and methane for their direct conversion to ethylene (at 600-1000°C) was thoroughly investigated. No coke deposition was observed. High concentration of ethylene (10 mol %) in product stream (at 80% selectivity based on carbon balance) was achieved in the oxidative pyrolysis of Indian natural gas.

Investigation of the catalytic oxidative coupling of methane to C_2-hydrocarbons led to the development of a series of highly stable (long life) promoted alkaline earth metal oxide catalysts showing very high catalytic activity/productivity and high selectivity for ethylene and ethane. A number of catalyst samples developed in the Soviet Union were also tested for their performance in oxidative coupling of methane.

I.11 Propionic acid (Sp)

NCL has developed a laboratory scale process, the first in the world, for propionic acid via carbonylation of ethanol using a low pressure/low cost catalyst. GAAC, Ahmedabad, are planning to install a commercial plant of 3000-4000 TPA capacity, based on this process.

I.12 Carbamates by a non-phosgene, non-MIC route (Sp)

NCL has developed a catalytic process for the synthesis of carbamates, not involving phosgene and methyl isocyanate (MIC). The laboratory scale work has been completed and a pilot plant is proposed to be set up at Excel Industries, during 1990. This is the first time a non-phosgene, non-MIC route is proposed for carbamates. This approach is also useful in developing processes for other carbamate derivatives and isocyanates.

I.13 Polycarbonates via non-phosgene route (C)

This is an exploratory project undertaken in collaboration with IPCL, Vadodara, with the aim of developing a non-phosgene route for polycarbonates, particularly via oxidative carbonylation of phenol. Laboratory scale work is in progress.

Besides the above mentioned sponsored projects undertaken in collaboration with industries, NCL is also working on developing new routes for the manufacture of methylene diphenyl diisocyanate (MDI), toluene diisocyanate (TDI), methyl methacrylate (MMA), acrylate esters, acetic anhydride and vinyl acetate monomer. The emphasis is on developing non-hazardous and more economical routes for these bulk chemicals.

I.14 Studies on synthetic zeolites

Many novel zeolite catalysts were synthesized, notably the Ga, Fe, Ti and Zr substituted high silica zeolites, for use as catalysts.

I.15 High pressure catalysis

NCL is also actively engaged in developing catalytic processes involving high pressure

hydrogenation reactions. Considerable work has been done on hydrogenation of nitrocompounds, hydrogenation of aldehydes and esters, and hydrogenation of olefins and acetylenes.

A project on "Analysis and Design of Multiphase Catalytic Reactors", with specific interest in high pressure chemical reaction engineering, was undertaken in collaboration with the University of Erlangen, West Germany.

I.I6 Zeolites in organic synthesis

N-Alkyl carbonimidodithioic acid esters do not react easily with carbon nucleophiles under Lewis acid catalysis. Now spectacular results have been achieved in such reactions using zeolite catalysts.

I.I7 Organometallic chemistry and catalysis

a) Rhodium chemistry

Binuclear rhodium (II) complexes of the type $Rh_2(N\text{-}S)_4L$ containing bridging five-membered heterocyclic ligands were synthesized and characterized. The heterocyclic ligands are coordinated to two rhodium atoms through an exocyclic sulphur atom and a nitrogen atom in the ring and one of the rhodium atoms possesses an axial ligand. The Rh-Rh interaction was confirmed by Laser-Raman spectra and X-ray crystal studies.

b) Ruthenium chemistry

The precursor ruthenium carbonyl complexes $RuHCl(CO)(PPh_3)_3$ and $RuH_2(CO)(PPh_3)_3$ were prepared by improving on the known methods. The novel ruthenium hydrido carboxylates synthesized were found to be good dehydrogenation catalysts for primary, secondary and cyclic alcohols.

Stable Ru-C bonded complexes were synthesized by the Ru-H insertion reaction using activated olefins. Symmetric and asymmetric acetylenes were found to react with the Ru-H bond to yield monomeric and dimeric insertion products, respectively.

c) Group IV metal chemistry

Organometallic compounds of titanium (IV), tin(IV) and lead (IV) containing novel Schiff bases derived from S,S'-dimethyldithiocarbazate ligands were synthesized and their coordination behaviour was studied using spectroscopic techniques.

I.I8 Basic studies

i) A "shuttle cock-shuttle box" model for explaining shape selectivity behaviour of medium pore zeolites, such as commercially important ZSM-5 and other pentasil zeolites, in sorption and diffusion processes was proposed. This model emphasizes the importance of molecular configuration and compressibility (or flexibility) of sorbate molecules and their possible orientations over the critical molecular size in sorption.

ii) Acidity distribution and catalytic properties of B_2O_3, MgO and P_2O_5 modified H-ZSM-8 zeolites were investigated. Extensive studies were carried out for comparing the catalytically important zeolites (viz. HY, CeNaY, CeNaX, HKL, HM, H-ZSM-5, H-ZSM-8 and H-ZSM-II) for their acidity and acid strength distribution, catalytic properties, shape selectivity and coke deposition in catalytic processes.

iii) Influence of intercrystalline mass transfer on catalytic reaction over Pt.H-ZSM-5-Al_2O_3 catalyst and the effect of coke deposition in the above catalyst on its acidity distribution, catalytic properties and intercrystalline diffusivity were investigated.

iv) Oxidative coupling of methane to C_2-hydrocarbons was investigated in homogeneous gas phase over a number of inert support materials, alkali metal promoted MgO and CaO catalysts and rare earth metal oxides catalysts. The La_2O_3 promoted MgO and CaO catalysts showed very high stability (long life) and excellent performance in methane coupling. Temperature oscillations were observed for the first time in the oxidative coupling of methane over La_2O_3.BaO.MgO catalyst in the range 570-670°C.

v) A novel but simple method for measuring basicity and base strength distribution on basic solid catalysts, used in oxidative coupling of methane to C_2-hydrocarbons, at temperatures used in the catalytic process, by step-wise thermal desorption of CO_2 at temperature in the range 50° to 1,000°C was developed. Basicity and basic strength distribution on a number of basic solid catalysts were determined.

vi) Silanation of $AlPO_4$-5 by $SiCl_4$ resulting in Si-

substituted $AlPO_4$-5 was investigated. Si-$AlPO_4$-5 with very high acidity and catalytic activity was obtained from $AlPO_4$-5 by reacting it with $SiCl_4$ at temperatures in the range 300-600°, without collapse of the crystal structure. During the silanation, both Al and P in $AlPO_4$-5 were partly substituted by Si.

vii) Kinetics of leaching of silver from spent silver catalyst by dilute nitric acid was thoroughly investigated. A kinetic model for leaching in the preparation of Raney nickel catalyst was also developed.

viii) Modelling and simulation of physico-chemical systems rests on the laws of physics of macroscopic systems, which, while adequate for most situations, are suspect in certain cases. Two situations of practical interest where a more rigorous description is necessary are finite size systems and those operating far from thermodynamic equilibrium.

Application of macroscopic theories to describe these types of systems often leads to inaccurate description and incorrect results and more detailed microscopic approach is necessary in such cases. However, the lack of proper knowledge of the microscopic variables affecting the system behaviour and the relatively large number of such variables preclude the use of such theories.

A matter of fact observation that many of these variables vary on a time scale much faster than others helps us to classify the variables into two categories, viz., fast variables and those varying on a much slower time scale.

The conventional averaging procedure eliminates the fast variables retaining only the slowly varying ones and leads to a macroscopic description. It is possible to include the eliminated fast variables as noise into the system description. This however requires the use of the probabilistic approach.

The present work was aimed at developing and adopting this new formalism to practical systems of interest. A large number of systems were analysed in the context of stochastic formulation to show the existence of noise- induced transitions.

In any modelling and simulation activity the use of computer methods is an inseparable component. While a large number of methods to tackle different types of model equations are used in practice, there is a constant need to bring about improvisation in these methods, especially since computer time costs have become prohibitive.

Newer methods that avoid convergence, and stability problems associated with numerical schemes and those that lessen the time requirements are thus keenly pursued. Recently a new integer approach to solution of mathematical equations has been developed. The concept, based on techniques practised by Indian mathematicians during the early and medieval periods, eliminates many of the problems faced in the use of conventional algorithms.

The concept which has been proved scientifically needs further exploitation from the viewpoint of incorporating it in a usable software. Further efforts in this direction are being made.

Control of process variables is usually effected by using the conventional PID controllers although in recent years new concepts such as Internal Model Controls (IMC's) have been increasingly employed. The IMC framework allows for the design of linear systems from first principles, but is inadequate for nonlinear systems.

A new formalism that allows for the design of nonlinear controllers has been developed and exemplified for such important processes as pH control, nonisothermal operations in CSTR and reversible reactions in CSTR.

Publications

1. Tambe, S.S. and Kulkarni, B.D.,
Non isothermal effectiveness factors in bidispersed catalyst under conditions of external transport resistance,
Current Sci., 57, 1267 (1988).

2. Bhattacharya, A., Gholap, R.V. and Chaudari, R.V.,
Gas absorption with exothermic bimolecular reaction in a thin liquid film : Fasts reactions,
Can. J. Chem. Eng., 47, 599 (1988).

3. Patil, R.P., Kelkar, A.A. and Chaudhari, R.V.,
Carbonylation of ethanol using homogeneous Ir complex catalyst :
Effect of ligands and reaction conditions,
J.Mol.Cat., 47, 87 (1988).

4. Grover, G.S. and Chaudhari, R.V.,
Liquid phase catalytic oxidation of butene to methyl ethyl ketone : A kinetic study,
J. Mol. Catalysis, 49, 143 (1988).

5. Gupte, S.P. and Chaudhari, R.V.,
Oxidative carbonylation of aniline on Pd/C catalyst : Effect of promoters, solvents and reaction conditions,
J. Catalysis, 114, 246 (1988)

6. Gholap, R.V. and Chaudhari, R.V.,
Absorption of CO with reversible reaction in cuprous chloride solutions,
Ind. Eng. Chem. Res., 27(11), 2105 (1988).

7. Deshpande, R.M. and Chaudhari, R.V.,
Kinetics of hydroformylation of 1-hexene using homogeneous HRh(CO)(PPh3)3 catalyst,
Ind. Eng.Chem.Res., 27(11), 1996 (1988).

8. Ratnasamy, P.,
Crystal symmetry and sphere selectivity in ZSM-5 catalysis,
Catalysis Today, 3, 531 (1988).

9. Doraiswamy, L.K. and Gokarn, A.N.,
Less known behavior of gas-solid reactions:The expanding core model in catalytic and non-catalytic systems,
Chem.Eng. & Tech., 11, 438 (1988).

10. Akolekar, D.B. and Choudhary, V.R.,
Crystallization of silicate - I : Factors affecting crystal size and morphology,
Materials Chem. Phys., 20, 299 (1988)

11. Choudhary, V.R., Sansare, S.D. and Thite, G.A.,
Adsorption of reaction species for hydrogenation of nitrobenzene on copper chromite at catalytic conditions,
J.Chem.Tech.Biotech., 42, 249 (1988).

12. Choudhary, V.R., Chaudhari, S.T. and Rajput, A.M.,
Oxidative coupling of methane to C2-hydrocarbons in homogeneous reaction and over solid supports and catalysts : Catalysis and advances in chemical technology,
3rd Indo-Soviet seminar on catalysis,Baku,Vol.I, 10 (1988)

13. Choudhary, V.R. and Sane, M.G.,
Hydrogenation of o-nitro phenol on Pd-carbon in three phase stirred autoclave : Influence of Pd-loading on carbon and solvent on the reaction,
Proc.9th National Symp. on catalysis, Madras(Dec. 1988)

14. Gopinathan, S., Budhkar, A.P., Pardhy, S:A. and Gopinathan, C.,
Ruthenium(II) complexes of nitrogen and sulphur containing heterocyclic ligands,
Synth. React. Inorg. Met-Org.Chem., 18, 823 (1988).

15. Sivasanker, S. and Padalkar, S.R.,
Mechanism of dehydrocyclisation of n-alkanes over platinum - alumina catalysts,
Appl.Cat., 39, 123 (1988).

16. Sivasankar, S., Hegde, S.G., Awate, S.V., Padalkar, S.R. and Kulkarni, S.B.,
Creation of acid sites by La ions in L zeolites,
React.Kinet.Cat.Lettr., 36(1), 173 (1988).

17. Sivasanker, S., Waghmare, K.J., Reddy, M. and Ratnasamy, P.,
Catalytic dewaxing of petroleum oils over pentasil metallosilicate zeolites,
Proc. Intl.Congr.Cat., 120 (1988).

18. Ernst, S., Kumar, R., Neuber, M. and Weitkamp, J.,
Characterization of the effective pore width of the molecular sieve solids by means of catalytic test reactions,
Stud.Surf.Sci. and Catal.,37, 531 (1988)

19. Kumar, R., Ernst, S., Kokotailo, G.T. and Weitkamp, J.,
Proving the shape selective properties of zeolites ZSM-12 and EU-1 by catalytic test reactions,
Stud.Surf.Sci. & Catal.,39, 451 (1988).

20. Ernst, S., Kumar, R. and Weitkamp, J.,
Synthesis and catalytic properties of zeolite ZSM-23,
Catalysis Today, 3, 1 (1988).

21. Ernst, S., Kumar, R. and Weitkamp, J.,
Shape selective catalysis in zeolites ZSM-22 and ZSM-23 : Influence of pore shapes on reaction selectivities,
Proc. 9th I.C.C. Calgary, Canada,1, 388 (1988).

22. Ernst, S., Kumar, R. and Weitkamp, J.
A suitable catalyst for isomerisation and hydrocracking of long chain n-alkanes,
Proc.9th Natl.Symp.on Catal., MRL, Madras, (1988).

23. Ratnasamy, P., Kotasthane, A.N., Shiralkar, V.P., Thangaraj, A. and Ganapathy, S.,
Isomorphous substitution of iron in the faujasite lattice,
ACS Symp., Adv. in Zeol. Synth. (1988).

24. Choudhary, V.R., Srinivasan, S.R. and Akolekar, D.B.,
TPD of benzene from NaY,CeNaY and CeNaX zeolites,
Zeolites, 9, 115 (1989).

25. Choudhary, V.R., Chaudhari, S.K. and Gokarn, A.N.,
A kinetic model for leaching process in preparation of Raney-Ni-catalyst,
Ind.Eng.Chem.Res., 28, 33 (1989).

26 Choudhary, V.R. and Akolekar, D.B.,
Influence of intercrystalline mass transfer on catalytic reactions on Pt H-ZSM-5-Al2O3 catalyst,
J.Catal., 116, 130 (1989).

27. Choudhary, V.R. and Akolekar, D.B.,
Shuttle cock - shuttle box model for shape-selectivity of medium pore zeolites in sorption and diffusion,
J.Catal.,117, 542 (1989).

28. Chakrabarti, A., Gunjikar, V.G. and Choudhary, V.R.,
Thermal analysis of ethyl cellulose : Influence of atmosphere and addition of diethyl phthalate as plasticizer,
Thermochim.Acta, 145, 173 (1989)

29. Choudhary, V.R., Chaudhari, S.T., Rajput, A.M. and Rane, V.H,.
Oxidative coupling of methane to C2-hydrocarbons over La promoted MgO catalysts,
J.Chem.Soc. Chem. Commun., 555 (1989).

30. Choudhary, V.R., Chaudhari, S. T., Rajput, A.M. and Rane, V.H.
Oscillations in oxidative coupling of methane to C2-hydrocarbons over La2O3-BaO-MgO catalyst,
J.Chem.Soc.Chem.Commun., 605 (1989).

31. Choudhary, V.R., Singh, A.P. and Akolekar, D.B.,
Single and multi component diffusion of hydrocarbons from their iso-octane solution in H-ZSM-5,
Chem. Eng.Sci., 44, 1047 (1989).

32. Gopinathan, S., Deshpande, S.S. and Gopinathan, C.,
Novel ruthenium(II) Schiff base complexes,
Synth. React. Inorg. Met-Org. Chem., 19, 321 (1988).

33. Gopinathan, S., Unni, I.R. and Gopinathan C.,
Ruthenium(II)
and rhodium(I) complexes of 2-hydroxypyridis,
Ind.J.Chem., 28A, 331 (1988).

34. Weitkamp, J., Kumar, R. and Ernst, S.,
Synthesis, characterisation and catalytic properties,
Chem.Eng.Tech. (1989).

35. Sivasanker, S., Reddy, K.M. and Ratnasamy, P.,
The role of zeolite in hydrocracking: Studies using petroleum fractions and model compounds,
Proc.Catalysis in Petroleum Ref.Conf., Kuwait(Mar 1989).

36. Rajiv Kumar and Ratnasamy, P.,
Isomerisation and formation of xylenes over ZSM-22 and ZSM-23 zeolites.,
J.Catal., 16, 440 (1989).

37. Gopinathan, S., Pardhy, S.A. and Gopinathan, C.,
** Schiff base complexes of ruthenium(II) with tridentate N-methyl-S-methyl dithiocarbazate ligands,
Trans. Met. Chem., 12, 414 (1987).

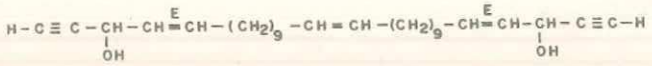
*** Not included in AR 1987-88*

2. DRUGS AND DRUG INTERMEDIATES

2.1 Synthesis of anticancer agents

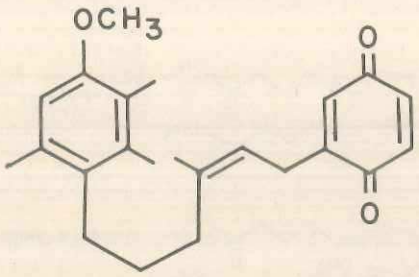
2.1.1 Duryne

Duryne is a cytotoxic polyacetylene derivative isolated from the marine sponge *cribrochalinadura*. An elegant synthesis of duryne possessing the central E and Z double bond was separately achieved for the first time, by making use of dialkylated acetylene.



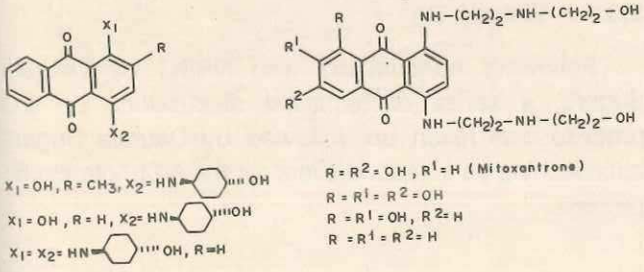
2.1.2 Panicein A

Isolated from marine sponge *Halichondria panic*, panicein A shows biological activity against several microorganisms. An E/Z mixture of this aromatic sesquiterpenic quinone was synthesized for the first time by Wittig olefination.



2.1.3 Mitoxantrone analogues:

Different synthetic mitoxantrone analogues, which are synthetic anti-leukaemic agents, were prepared and checked for their biological activity.

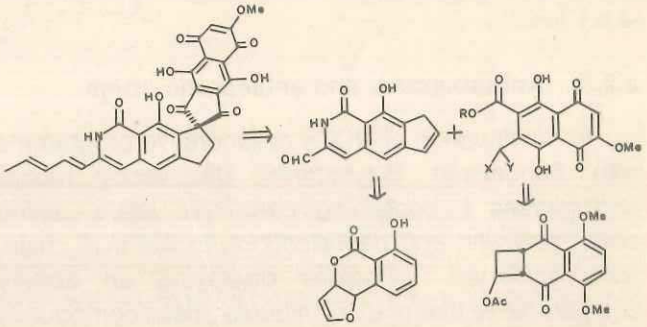


Although these analogues showed good anti-cancer activity *in vitro*, they were found to be inactive *in vivo*.

2.1.4 Fredericamycin A

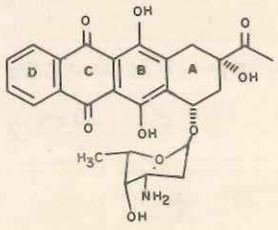
Fredericamycin A is an anticancer antibiotic produced from the strain of Streptomyces griseus The molecule contains a cyclopentanoisoquinolone moiety fused to a cyclopentano-naphthoquinone nucleus in a spiro fashion. The novel 1,4-diketo spiro (4.4)-nonane skeleton has attracted the attention of synthetic organic chemists throughout the world.

A model spiro-compound was synthesized by a novel photo-chemical route involving n,n* triplets as intermediates. Attempts were made for the synthesis of hetero-analogues of the spiro-frame of fredericamycin A. An expeditious photocyclization route to rationally functionalized isoquinolone and naphthoquinone moiety is under way.



2.1.5 Synthesis of (-)-4-demethoxydaunomycin

The total synthesis of (-)-4-demethoxydaunomycin has been accomplished by coupling the aglycone with N-tri-fluoro-acetyl-1,4-dia-*o*-*p*-nitrobenzoyl-L-daunosamine. The strategy for the aglycone part involves the use of Marschalk reaction for the construction of A ring on BCD frame.



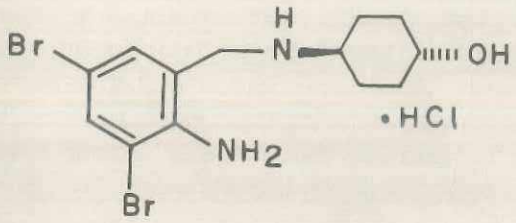
2.2 Synthesis of drugs and drug intermediates

2.2.1 Carbamazepine

A seven-step laboratory process for the preparation of carbamazepine, an analgesic and anti-convulsant drug, was developed starting from orthonitrotoluene. The process was demonstrated to Resonance Laboratories Pvt. Ltd., Bangalore.

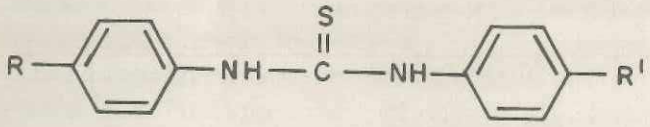
2.2.2 Ambroxol hydrochloride

Laboratory scale know-how for this expectorant, was developed and the process was demonstrated to Jagsonpal Pharmaceuticals, New Delhi. An efficient and improved process for the key intermediate, viz., 3,5-dibromo-2-aminobenzaldehyde, was also developed.

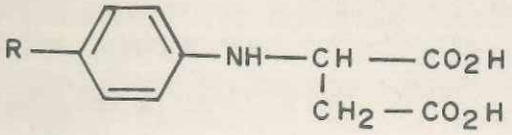


2.2.3 Antitubercular and antileprotic drugs

In continuation of NCL's collaborative programme with Sunderland Polytechnic, UK, many monoarylthioureas I, containing carboxylic acids, amino acids, penicillin and cephalosporin in the side chain, were screened. Besides displaying an activity comparable to that of diarylthiourea, these compounds showed better pharmacokinetic properties. Similarly, N-substituted phenyl aspartic acids II showed very good activity. The compound from series I are being checked for their *in vitro* activity against M.Leprae.



I



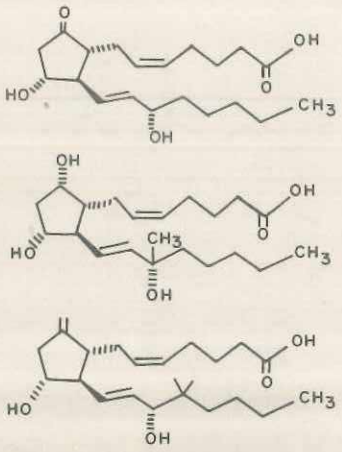
II

2.2.4 D-(-)Phenylglycine

A simple and efficient process for D(-)phenylglycine was developed. It involved a quantitative resolution of the dl-acid using second order asymmetric transformation. Scale-up studies on D(-)phenylglycine were taken up on a one kilogramme scale to acquire additional data for reaction and processing. New analytical methods at different stages were also developed. Optimization and further collection of design data for the production plant are expected to be taken up at the sponsor's site when the pilot plant is ready.

2.2.5 Prostaglandins

A new project on prostaglandins/analogues, identified by WHO as useful in family welfare in India, was sponsored by Astra IDL, Bangalore. After careful evaluation of the different methodologies available, the syntheses of I, II and III were planned and the necessary components for a critical step in the synthesis (i.e., a three-component coupling) were synthesized. The coupling itself and the resolution involved in the synthesis are in progress.



2.3 Vitamins

2.3.1 Vitamin B_6

Following negotiations with NRDC by Daurala Sugars, a series of technical discussions on the process was taken up, followed by Daurala Sugars approaching as a second client for the NCL Vitamin B_6 process.

2.3.2 Vitamin E

From rough cost calculations of various routes to the vitamin, starting from p-toluenesulfonyl acetic ester, it appears that the $C_9+C_1+C_9$ strategy is commercially feasible. The synthesis of the C_9 fragment was, therefore, undertaken.

2.4 ß-Lactam antibiotics

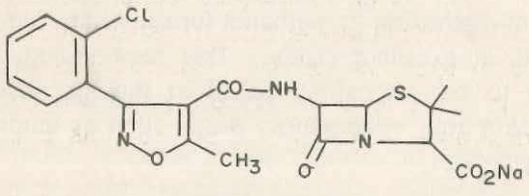
2.4.1 7-Aminodeacetoxy cephalosporanic acid (7-ADCA)

ß-Lactam antibiotics (Penicillins and cephalosporins) are among the most important life-saving drugs in use today. As they are less toxic and more effective they dominate antibiotic therapy. Their annual import is increasing. They can be manufactured from the key intermediate 7-ADCA by acylation of the amino group. No indigenous technology is, however, available for 7-ADCA. Efforts were, therefore, directed to the development of a commercially viable process starting from penicillins.

The laboratory process for the conversion of penicillin G to 7-ADCA involves three steps. These are: (i) oxidation of penicillin to penicillin sulfoxide, (ii) ring expansion of penam to cephem system, and, (iii) deacylation to yield 7-ADCA. Development of a laboratory process for cephalosporin G was sponsored by Hindustan Antibiotics Ltd., Pune, and further work on standardization and scale up is in progress.

2.4.2 Cloxacillin sodium

This orally active semi-synthetic penicillin was prepared on a laboratory scale by condensation of the isoxaole derivative with 6-APA. The process for the preparation of 3(2'-chlorophenyl)-5-methyl-4-isoxaloyl carboxylic acid chloride was standardized on 200 gm scale. Lupin Laboratories have shown interest in sponsoring the work.

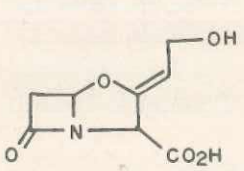


2.4.3 3,4,5-Trimethoxybenzaldehyde

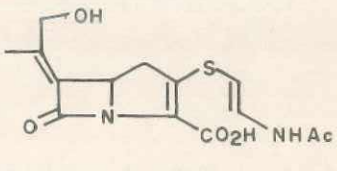
3,4,5-Trimethoxybenzaldehyde is a key intermediate required for the manufacture of trimethoprim, an antimicrobial agent widely used in combination with sulfamethoxazole. A convenient process starting from gallic acid/hydrolysable tannin was worked out for the production of 3,4,5-trimethoxybenzaldehyde.

2.4.4 Non-traditional ß-lactam antibiotics

The ability of some resistant strains of bacteria to produce ß-lactamase, which deactivates ß-lactam antibiotics, necessitates a continuous search for new and better antibiotics. In the past decade this effort led to the discovery of clavulanic acid, asperonomycins, monobactams and many other antibiotics. Work was initiated on the total synthesis of clavulinic acid and asperonomycin by new methodologies.



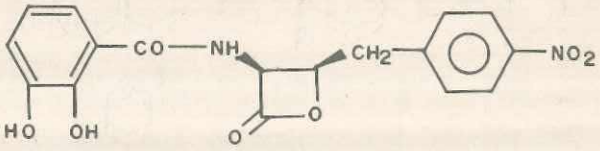
Clavulanic Acid



Asparenomycin

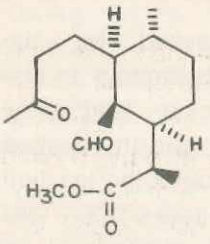
2.4.5 Obafluorin

Obafluorin is a broad spectrum ß-lactone antibiotic with unprecedented biological activity. Its synthesis was initiated, starting from the readily available glycine.



2.5 Methodologies in organic synthesis

2.5.1 Artemesinin



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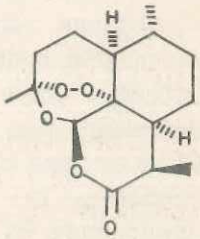


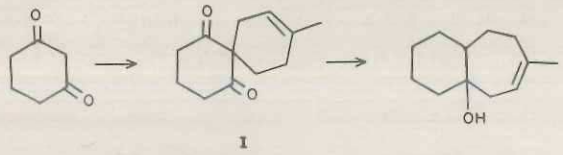
II

The total synthesis of (I), a key precursor to artemesinin (II) was achieved. (I) has already been converted to artemesinin by others; this, therefore, constitutes a formal synthesis of artemesinin. The synthesis is shorter and completely stereospecific as compared to known methods, thus enhancing the utility of the methodology from a practical point of view.

In a different route to artemesinin, a key intermediate was synthesized.

2.5.2 Ionophores and macrolides

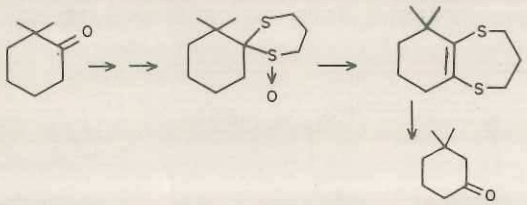
The chemistry and rearrangement reaction of (I) as a model precursor for the synthesis for calcimycin was taken up and is being investigated.



I

2.5.3 α-Sulfinyl carbanion chemistry

Following the discovery of the new methodology for α-lipoic acid synthesis, some aspects of the chemistry of α-sulfinyl carbanion were studied, an outcome of which is a new method for ketone transposition.



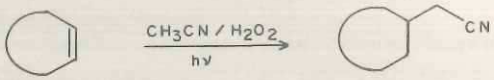
2.5.4 Microbial transformation to biologically active products and development of biotechnology

Different cultures were screened for the asymmetric hydrolysis of dl-phenylhydantoin to the optically active D(-) phenylglycine carbamoyl derivative. Two cultures that could give the desired D(-) form were identified. Optimization of the reaction conditions to give maximum conversion and development of relevant analytical methods is in progress.

2.5.5 Photoinduced cyanomethylation of olefins

Development of a methodology for the direct cyanomethylation of olefins is highly desirable from the synthetic viewpoint. A method was developed using hydrogen peroxide as an initiator and acetonitrile as a source of cyanomethyl radicals for the first time.

The reaction is readily initiated by hydroxyl radicals generated on photoinduced decomposition of H_2O_2 dissolved in acetonitrile containing an olefin. A number of cycloalkenes were cyanomethylated to produce the desired homologated nitriles by two carbon units in reasonably good yields.



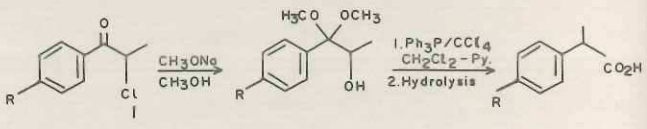
Simplicity and the use of readily available common reagents are the attractive features of this methodology. The application of both inter-and intramolecular versions of this reaction in the synthesis of natural products is under way.

2.5.6 α-Arylpropionic acids

These acids are well known anti-inflammatory drugs and are extensively used all over the world. Intense R&D activities, therefore, are directed towards the development of innovative synthetic approaches to the synthesis of these compounds.

A convenient methodology based on 1,2-aryl migration was recently uncovered employing α-hydroxypropiophenone dimethyl acetals (II) as the starting materials. These (II), on treatment with Ph_3PCCl_4 in methylene chloride containing pyridine, yielded α-arylpropionic acids (III) in high yields.

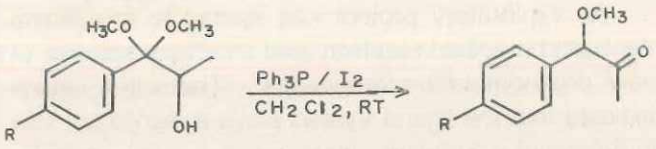
The reaction of α-chloropropiophenones (I) with sodium methoxide in methanol furnished the required acetals in excellent yields. This methodology was found to be extensively useful in the synthesis of important anti- inflammatory drugs such as ibuprofen and naproxen.



2.5.7 1,2-Carbonyl transposition

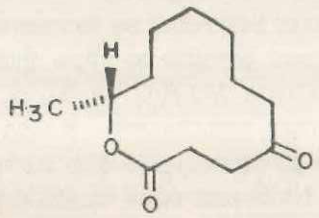
Development of a convenient 1,2-carbonyl transposition methodology has always remained a difficult task in synthetic organic chemistry. A wide variety of methods are on record; however, they are either multistep processes or involve the use of inaccessible reagents.

In this context, a facile transformation of α-hydroxy-propiophenone acetals (I) under the influence of catalytic amount of HI into α-methoxy α-arylpropan-2-ones (II) constitutes a new efficient methodology. The novelty of this process lies in the generation of HI *in situ* by the reaction of Ph_3PI_2 used in catalytic amounts. The present method is much superior to those reported earlier for these transformations.



2.5.8 Macrolides

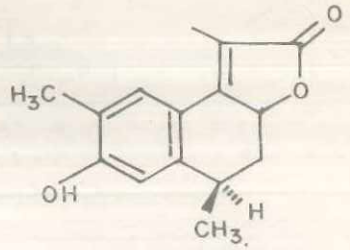
A short convergent synthesis of (+) patulolide A, a 12- membered macrolide with high antifungal activities, was achieved in 10 steps, starting from 1-bromo pentanol and 4-hydroxypent-1- ene. The synthesis of (+) patulolide is nearing completion.



(+) Patulolide

2.5.9 Heritol synthesis

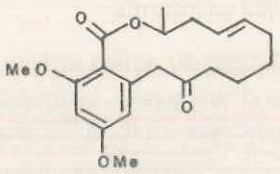
Heritol is a novel ichthyotoxin isolated from the mangrove plant *Heritiera littaralis*. There is a great need for new biodegradable agrochemicals which are compatible with the environment. Heritol has the potential of being a biodegradable natural pesticide owing to its occurrence in nature.



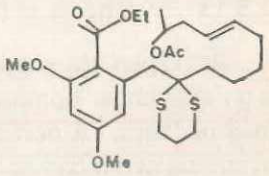
Consequently, the total synthesis of this natural product was undertaken starting from *o*-cresol.

2.5.10 Monocillins

Monocillin IV, nordinone and nordinonediol form a group of macrolides exhibiting antifungal activity. The synthesis of monocillin IV was initiated and an advanced intermediate 2 was prepared, which on hydrolysis and lactonization is expected to lead to the desired compound.



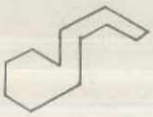
Monocillin IV



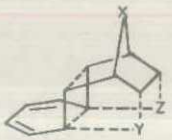
2

2.5.11 Stereocontrol in medium cyclic ring

Control and prediction of stereochemistry in medium cyclic rings is a complex and challenging task in organic synthesis today. Some work was initiated on a conceptually new and novel approach to solve this problem via conformational protection (x,y,z, conformational protecting of group in 2) and deprotection methodology. Thus strain and functionalities were used to freeze a 12-membered ring in a particular conformation. A novel aspect of selectivity, e.g., π -facial stereoselectivity in Diels-Alder reaction, was uncovered in 1, which will be useful in the above studies. Currently, synthetic strategies for deprotection of conformation are under active investigation.



12-member ring



X = CH_2, O, CO
Y = Z = CO
1, X = CH_2, Y=Z=CO

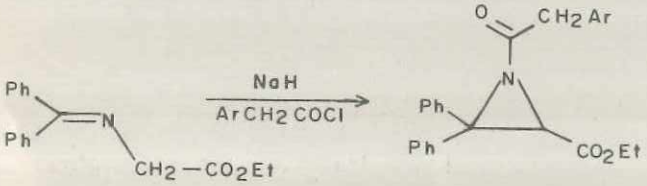
Singlet oxygen induced transformation in protected 12-membered ring frame was also studied. During the course of this investigation, unprecedented β-cleavage in cyclobutyl ketones, photo- ketalisation and dual epimerization, etc., were discovered.

2.5.12 Oxa-di-π-methane (ODPM) studies

ODPM-methodology was found to be useful for the synthesis of various cyclopentanoids. However, the methodology does not seem to have been applied to its heteroanalogues. Efforts are under way to synthesize the model compounds and study their ODPM rearrangements. These studies will be very useful in the synthesis of a variety of biologically active compounds.

2.5.13 Synthesis of N-acylated aziridines

Aziridines are important biologically active agents, e.g., anticancer compounds, and are useful synthetic intermediates. A new and convenient method for the synthesis of 3,3-diphenyl- aziridine-2-carboxylates from glycine Schiff base derivatives was developed.

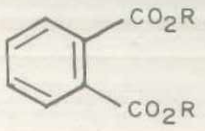


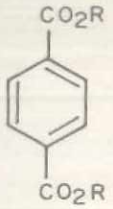
2.5.14 Enantioselective synthesis by microbial reduction

Stereoselective reduction of a prochiral ketone to alcohol with the help of *Sclerotium rolfsii* biomass was studied with ethyl acetoacetate. The (+) alcohol showed 95-97% enantiomeric excess.

2.5.15 Synthesis of chiral stationary phases for GC analysis

Development of methodologies for the evaluation of enantiomeric excess or diastereomeric excess of products in an asymmetric synthesis is one of the frontier areas of research in analytical chemistry. Work is in progress to develop chiral stationary phases for the resolution of racemates.





R = Me, Et, i-Pr, cyclohexyl, Menthyl, isopinocamphyl, longifolyl etc.

2.5.16 Organometallics

An exploratory project was started to investigate the ligand modified reactivity and structural features of new organometallic compounds. The initial results indicate that the ligand indeed plays a significant role in determining bonding characteristics and thereby influences reactivity.

The chemistry of low-valent molybdenum complexes was studied in some detail. Although Mo(O) was not established as a catalyst for acetylene trimerisation, a new compound containing tris/pyrazolyl ligand on a $Mo(CO)_3$ moiety did catalyse trimerisation of dimethyl acetylenedicarboxylate in 50% yield. A new class of allyl compounds were synthesized and characterized. They exhibited interesting fluxional behaviour as monitored by DNMR techniques. It was possible to show that an agostic bonding of the type Mo-H-C exists in a few new organomolybdenum compounds. It was possible to predict and design compounds with such interaction. Solid state ^{13}C NMR was used to study this unusual bonding.

A mild and convenient route to multiple-bonded dimolybdenum species was discovered. The multiple bond had a bond order greater than 3, as evidenced from the Raman spectra as well as the XPES spectra. The compound was crystalline. This may be the first compound featuring a quadruply bonded molybdenum containing six-membered bidentate chelate.

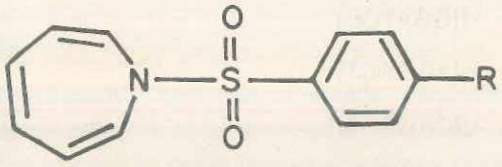
In an attempt to exploit the modified reactivity at the 2- position of 1-tetralone complexed with $Cr(CO)_3$,

Pd-catalyzed allylation was carried out successfully using allyl carbonates without adding the base. Uncomplexed 1-tetralone did not react under such conditions. The yields were high and monoalkylation was preferentially achieved.

2.6 Basic and Exploratory Research

2.6.1 Organic azides

Continuing the quest for new biologically active heterocycles, several substituted azepine derivatives 1 were synthesized in significant yields by the thermolysis of arylsulphonylazides in benzene in an atmosphere of nitrogen. A kinetic study of the reactions rationalized the effect of substituents on the formation of azepines under these conditions.



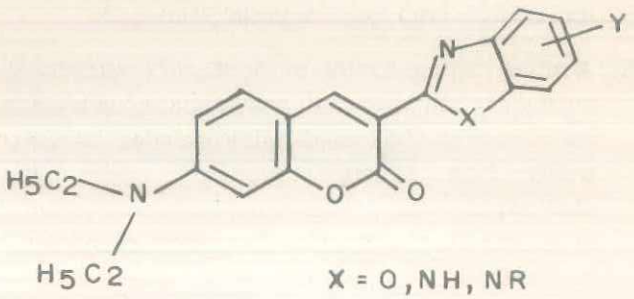
1

R = Cl , Br , CH_3 , NO_2

2.6.2 Synthetic dyes

A novel synthesis of unsymmetrical azo-compounds, inaccessible by conventional diazo-coupling reaction, was developed. It involved the reaction of substituted acetanilides with nitroarenes in a hydrocarbon solvent in presence of a base under phase transfer catalysis (PTC) conditions.

The structure elucidation of commercial Intrasil Brilliant Yellow 10 GF revealed it to be a benzoxazolyl coumarin derivative. The dye was synthesized by a commercially viable process starting from N,N-diethyl-m-aminophenol. Its performance as a dye-laser was evaluated and was found to be comparable with commercial dye-lasers in wavelength range 523-535nm. Several new laser-dyes 1 were synthesized. Their efficiency of lasing vis-a-vis their structure is being evaluated.



X = O , NH , NR

Y = Cl , COPh

2.6.3 1,3-Dithiolane photochemistry

1,3-Dithiolane constitutes an important functional group in organic chemistry. However, its photo-chemistry remains underexplored. The photosensitized electron transfer photochemistry of 1,3-dithiolanes was examined. Irradiation of a solution of 1,3-dithiolane, 1-cyanonaphthalene in O_2-saturated aceto-nitrile-water furnished good yields of 1,3-dithiolane-1-oxide.

2.6.4 Aminoacids and peptides

(a) **Enalapril and Lizinopril**: Enalapril and Lizinopril are well known antihypertensive drugs related to angiotensin converting enzyme inhibitors. The synthesis of Boc-Ala-Pro-OBzl, a key dipeptide intermediate was accomplished. Further coupling of ethyl-2-oxo-4-phenylbutanoate and resolution of isomers is under way.

(b) **Cyclosporin A related peptide synthesis**: N,N'-Bis- morpholinphosphinic chloride (BMP-Cl) was successfully employed as a coupling reagent for synthesis of cyclosporin A related peptides. Some di- and tetrapeptides related to cyclosporin A were synthesized by this method. The eleven amino acid chain was obtained using various di-, tri- and tetrapeptide fragments involving azide coupling method. Structural and conformational aspects of these peptides are being studied.

2.6.5 Studies in microanalysis

A modified Ingram-Belcher method was being developed for the microdetermination of carbon and hydrogen. This would be extended to other elements later. The empty combustion tube technique was used in combination with flash combustion. The other features were the vertical tube design and very short analysis time. The procedure was greatly simplified and a number of experiments were carried out.

2.7 Industrially important organic chemicals

(a) A novel method for the formylation of unstable N-arylhydroxylamines with acetic formic anhydride was developed to yield N-formanilides in better yields than hitherto reported. The latter compounds are key intermediates in the synthesis of several drugs and are widely used as analytical precipitants.

(b) A facile synthesis of N-benzyl-N-ethylaniline in good selectivity was developed by reductive alkylation aniline as starting material.

(c) A high yielding and innovative method for the preparation of pentoxyphyllin (an important vasodilating agent) from theobromine under phase transfer catalysis was developed.

2.8 Asymmetric synthesis - New methodology

The nitroacetyl group could be an attractive synthon for peptides, especially those involving unnatural α-aminoacids, or those with α, α-dialkyl substituents. The use of this synthon has not so far been reported. The presumed reason for this is the lack of synthetic methodology for the preparation of N-nitroacetyl aminoacids and peptides under mild conditions.

A general method was discovered for the synthesis of nitro acetic acid amides under mild conditions, and applied to the preparation of N-nitroacetyl L-proline ester. The Pd-catalyzed diastereoselective mono- and bis-alkylation of the above proline derivative was carried out. The diastereomeric excess was of the order of 30%.

2.9 Push-Pull system

There is considerable interest and some controversy in current literature regarding noncovalent interactions involving the sulfur atom. The interest stems from their potential role in determining the structures of biomolecules containing sulfur and from their possible use in designing crystals with specific material properties. Since the bulk of the experimental evidence for these interactions is structural, rather than energetic, the interpretations have been disputed.

Unambiguous spectral evidence was provided for an intramolecular attractive interaction between sulphur and nitro group in a cyclic 1-alkylamino-1-alkyl thio-2-nitroethene system. The interaction was highly orientation dependent and its magnitude was of the order of a typical N-H...O hydrogen bond.

Attractive interaction on a lesser scale was also observed when the nitro group was replaced by a carbonyl.

2.10 Bioorganic chemistry

2.10.1 Chemical synthesis of oligonucleotides

(a) Using synthetic methods developed here, several oligo deoxynucleotides were prepared, both by solution phase and solid phase phosphotriester approaches. All the protected nucleosides and nucleotides required were synthesized. The following were prepared.

1. d(GGATCC)
2. d(AGGCCT)
3. d(CACGTG)
4. d(ATATATATAT)
5. d(GTAATACCCCTATATAC)
6 d(GTATATAGGGGTATATAC)

Some of these sequences have drug binding properties and some have interesting secondary structures, such as the hair-pin cruciform type. These properties and features are under investigation.

(b) Methods were also developed for the chemical synthesis of the more challenging RNA sequences. These methods depend on the use of -t-butyldimethyl silyl protecting groups for 2'- hydroxyl protection. By employing phosphotriester approach, in both solution and solid phase technique, several RNA sequences were synthesized.

1. r(AUAU)
2. r(CACA)
3. r(ACAC)
4. r(AUAUAU)
5. r(AAGGCCUT)

RNA synthesis is a very challenging task and not more than three laboratories in the world are actively engaged in it. Our method has the advantage that,

(i) it is applicable both for solution and solid phase approaches; (ii) large amounts of RNA required to do structural work can be prepared; and, (iii) it allows synthesis of unnatural 2'-5'RNA sequences. The hybridization and stability properties of these RNA fragments and their interaction with small ligands are being studied.

2.10.2 Chemical synthesis of modified oligonucleotides

Chemically modified oligonucleotides are playing an increasingly important role in the elucidation of nucleic acid structure in relation to its function and to provide handles for covalent attachment of various ligands. The synthesis of 6:2' anhydrocyclo nucleotides and fluorophore conjugated nucleic acid was taken up. Anhydronucleotides of A and U were synthesized.

A strategy for the chemical synthesis of oligonucleotides in which specific adenies are labelled at C8 position with dansyl fluorophors was developed. This method can be used to prepare homogeneous nucleic acids with high density fluorescent labels. The method can be extended to attach several other chromophores, drugs, metal complexes and peptides to synthesize nucleosides and oligonucleotides with interesting biological properties and uses.

1 d(ATA*TATATAT)

2. d(ATA*TA*TATAT) (*) Dansyl n = 2,4 & 6

3. d(ATA*TATA*TAT)

Polyamines - Nucleic acid interactions

Two macrocyclic polyamines $17N_3$ and 21 N_4 with functionalised side chains were synthesized. The side chains are planned to carry nucleophilic groups or metallocomplexes. Since macrocyclic polyamines are known to bind to phosphate residues these molecules are designed as "chemical nucleases" (artificial enzymes). Functional, linear polyamines similar to spermine and spermidine were being synthesised to investigate their interaction with nucleic acids.

2.11 Synthetic carbohydrate chemistry

Synthesis of complex carbohydrates: Several naturally occurring di- and trisaccharides were synthesized by a mild, new methodology which involved the activation of anomeric 2- thiopyridyl group of sugar by methyl iodide. Bacterial polysaccharides (eg., Panose), blood group substances and disaccharide component of ivermectin were synthesized by this new methodology. A general methodology was thus established for stereoselective synthesis of alpha-linked oligosaccharides and 2-deoxy saccharides.

Publications

1. Choudhary, A.R., Kalkote, U.R., Natu, A.A. and Ayyangar, N.R., A nonphosgene route for the synthesis of sym-N, N-diethyldiphenyl urea, *Chemistry & Industry, 589 (1988).*
2. Deshpande, V.H., Khan, R.A. and Ayyangar, N.R., Synthesis of hormothamnione, *Tetrahedron Lett., 29, 2347 (1988).*
3. Choudhary,A.R., Kalkote U.R., Natu,A.A. and Ayyangar, N.R., A simple and economic method for the alkylation of benzanilides, *Synth.Commun., 18, 2011 (1988).*
4. Ravindranathan, T., Hiremath, S.V., Rajgopal Reddy, D and Tejwani, R.B., Carbonylmethylthiomethyl - Hydantoin - a potential chrial intermediate for (+) Biotin, *Synth. Commun., 18(15), 1855 (1988).*
5. Ayyangar, N.R. and Bhide, S.R., Separation of eight alkaloids and meconic acid and quantitation of five principal alkaloids in gum opium by gradient reversed- phase high performance liquid chromatography, *J.Chromatogr., 436, 455 (1988).*
6. Sonawane, H.R., Nanjundiah, B.S., Kulkarni, D.G. and Ahuja, J.R., A unique 1,2-shift selectivity in 2-hydroxypropiophenone dimethyl acetals:Generation of new methodologies for methyl-2-arylpropionate and 1,2-carbonyl trans-position, *Tetrahedron., 44, 7319 (1988).*
7. Wakharkar, R.D., Deshpande, V.H., Landge, A.B. and Upadhye, B.K., Synthesis of microminutin and 4-methyl microminutin, *Org.Prop.Proc.Int., 20(5), 527 (1988).*
8. Ayyangar, N.R., Chanda, B., Wakharkar, R.D. and Kasar, R.A., A short convergent synthesis of (+/-) patulolide A, *Synth.Commun.,18,2103 (1988).*
9. Hari Babu, M., Deshpande, V.H. and Samuel, A.G., Isomerisation of tetrahydroartocarpin to thermodynamically more stable tetrahydromulberin (Tetrahydrokuwanon C), *Indian J.Chem., 27B, 945 (1988).*
10. Badam, L., Deolankar, R.P., Rojatkar, S.R. and Nagasampagi, B.A., In vitro antimalarial activity of medicinal plants of India, *Ind. J. Med. Res., 87, 379 (1988).*

11. Bhat, U.G. and Nagasampagi, B.A.,
Alumina-catalysed reactions of Parthenin and its derivatives,
Ind.J.Chem.,27B, 989 (1988).

12. Kulkarni, S.N., Phadke, A.S. and Salunkhe, A.M.,
An efficient and simple synthesis of some key intermediate for artemisinin,
Ind. J. Chem., 27B, 955 (1988).

13. Kulkarni, S.N., Kamath, H.V. and Bhamare, N.K.,
Enamines Part V:Synthesis of substituted phenyl benzyl ketones and 2-arylisatogens,
Ind. J. Chem., 27B, 667 (1988).

14. Kulkarni, S.N., Kamath, S.V., Devasthale, S.V. and Hooper, M.,
Antitubercular compounds, Part VII : Towards the synthesis of novel antimicrobacterial agents,
Ind. Drug, 25, 464 (1988).

15. Kulkarni, S.N., Phadke, A.S. and Salunkhe, A.M.,
Synthesis of norphytene using p-toluene sulphonyl acetic ester,
J. Ind. Chem. Soc., 65, 273 (1988).

16. Kulkarni, S.N. and Arur, P.V.,
Antitubercular compounds; Part VIII-Synthesis of thio-urea derivatives containing diphenyl sulphone-2-carboxylic acid moiety,
Ind. Drug, 26, 1 (1988).

17. Kabalka, W.G., Lambert, S.J. and Jinaraj, V.K.,
Synthesis of iodine-125 labelled w-iodoundecenyl cholesteryl ether,
Int.J. Radiation, Application and Inst., part A, Applied Radiation and Isotopes, 39, 1113(1988).

18. Ravindranathan, T., Hiremath, S.V., Rajgopal Reddy, D. and Gosavi, K.,
A convenient synthesis of 1,3-dibenzyl-5-methylene hydatoin,
Synthesis, 1, 38 (1989).

19. Ayyangar, N.R. and Bhide, S.R.,
Separation of 1-napthylamine from the five known inpurities and sub-ppm level detection and quantitation of 2-naphthylamine by normal -phase high performance chromatography,
J.Chromatogr., 464, 201 (1989).

20. Pandey, B., Zope, U.R. and Ayyangar, N.R.,
Facial stereoselectivity in Diels-Alder reaction of hexacyclo[7.4.2.01,9,03,7,04,14,06,15] pentadeca-10, 12-diene-2, 8-dione,
Synth. Commun., 19, 585 (1989).

21. Pandey, B. and Dalvi, P.V.,
Baeyer-Villiger oxidation of hexacyclo [7.4.2.01,9.03,7.04,14.06,1,15] pentadecane-10,12-diene-2,8-dione and related studies,
J.Org.Chem., 54, 2968 (1989).

22. Deshpande, V.H., Upadhye, B.K. and Wakharkar, R.D.,
Synthesis of (+/-) duryne,
Tet.Lett., 30, 1991 (1989).

23. Wakharkar, R.D., Chanda, B. and Lachke, A.H.,
Microbial reduction of ethyl acetoacetate using Sclerotium rolfsii,
Biotechnol. Lett., 11, 483 (1989).

24. Rojatkar, S.R., Bhat, V.S., Kulkarni, M.M., Joshi, V.S. and Nagasampagi, B.A.,
Tetranortriterpenoids from Azadirachta indica,
Phytochemistry., 28, 203 (1989).

25. Bhat, U.G. and Nagasampagi, B.A.,
Molecular rearrangement of parthenin by formic acid,
Ind.J.Chem., 28B, 342 (1989).

26 .Panse, G.T. and Kamat, S.K.,
N,N'-bis-morpholinophosphinic chloride as a coupling reagent in peptide synthesis,
Ind.J.Chem., 28B, 716 (1989).

27. Ayyangar, N.R., Biswas, S.S. and Deo, M.D.,
Comparison of percentage composition of cis-trans isomers of permethrin and its intermediate by gas liquid chromatography and1H NMR,
Ind.J.Tech., 27, 317 (1989).

3. BIOTECHNOLOGY

3.1 Fermentation of molasses to ethanol (4-1-167)

The *Encillium* process for the production of ethanol from molasses using an immobilized catalyst (*Encillium*) has been scaled up in a 300 L bioreactor. Further trials are being continued with the participation of selected distilleries.

3.2 Xanthan fermentation (4-9-007)

A project on the production of xanthan gum using *Xanthomonas campestus* was taken up in collaboration with Gesellschaft fur Biologichs Forschung (GBF), FRG.

3.3 Microbial technology

(a) Germ plasm resource pools for biotechnology

Selective isolation and identification of novel microbial cultures (actinomycetes and fungi) and alkalophilic strains was continued with particular emphasis on the identification of *Chainia* strains, *Conidiobolus* species and alkalophilic bacilli with xylanase producing potential.

(b) Cellulase-free xylanase from an alkalophilic *Bacillus*

High-activity xylanase production by an alkalophilic *Bacillus* was standardized on laboratory scale and preliminary characterization of the enzyme was carried out. An Indian patent application for cellulase-free xylanase production based on these studies has been filed.

(c) Molecular cloning of xylanase from bacteria and streptomyces

Preparation of a genomic library of xylanolytic *Chainia* as well as a xylanase secreting alkalophilic and thermophilic *Bacillus* was taken up. Experimental studies to probe *Chainia* genomic library for the presence of xylanase genes and also transformation of *Chainia* protoplasts are in progress.

Characterization of xylanase from a thermo-tolerant *Streptomyces* having a tryptophan and cysteine residue at the active site was completed.

A patent application was submitted describing low molecular weight xylanase production by alkalophilic and thermophilic Bacillus.

(d) Microbial nucleases

Single strand-specific (SI) nuclease from *Aspergillus oryzae* was purified to get a homogeneous product and its active site characterization was completed. Screening for additional SI nucleases of fungal origin as well as purification and immobilization of PI nuclease from *Penicillium citrinum* are in progress.

(e) Chitinase/chitin synthetase complex in dimorphic *Benjaminiella poitrasii* and hyper chitinase producing *Myrothecium verrucaria*

Further studies on chitin synthetase/chitinase of wild type as well as morphological mutants of *B. poitrasii* showed higher specific activity of chitin synthetase in yeast phase compared to mycelial phase. Greater sensitivity of mycelial phase to specific chitin synthetase inhibitors like nikkomycin was observed while overall turnover of chitin was greater in the yeast phase than in mycelial phase. A four- fold enhancement of chitinase production in *M. verrucaria* 903 was achieved and the enzyme was partially characterized.

(f) D-Xylose fermentation by *Candida shehatae*

Fermentation on agricultural residues subjected to saccharification was investigated using *C. shehatae* alone and in co-cultures with *Saccharomyces cerevisiae*. The co- cultures showed 10-13% increase in ethanol production under the fermentation conditions employed.

(g) National Collection of Industrial Microorganisms (NCIM)

The maintenance of authentic microbial cultures and their distribution was continued. In addition, research projects related to enhanced ethanol production by yeasts supplemented with additives such as skim milk and chitin; mutagenesis and extracellular enzyme production in *Cellulomonas* and *Aspergillus niger*; development of Agrobacterium and *Bacillus thuringensis* strains for plant genetic transformations; and intergenic protoplast fusion between *Cellulomonas* and *Zymomonas* were undertaken.

(h) Ethanol biotechnology

Selection of better flocculent variants suited to molasses fermentation in suitable enrichment/ chemostat cultures was undertaken. Selected variants were suitably conserved. As a part of the collaborative programme with bioengineering and process development research groups, flocculent yeast cultivation and ethanol fermentation were investigated to optimize the parameters for scaling up the technology for ethanol production based on the flocculent yeast strain.

3.4 Structural and evolutionary biology

a) Work was taken up on X-ray crystallography and molecular graphics of low molecular weight proteins. Low molecular weight xylanase was isolated in the pure form. Further work is directed towards the solution of structure of xylanase using NMR, CD spectra of low molecular weight xylanase and the crystallisation of xylanase.

b) In the studies on molecular evolution a new treeing algorithm was developed for generating evolutionary trees based on sequence proteins and nucleic acids. The history of early eukaryotes was retrieved based on 5S rRNA sequences.

3.5 Plant molecular biology and plant genetic engineering

3.5.1. Genetic manipulation of seed storage proteins in rice and pigeon pea

The immediate objective of this long term project is to gain structural information of storage proteins and genes encoding them. The highlights of the work carried out during last year are as follows:

a) Development of sensitive and rapid RIA and ELISA for quantitation of storage proteins:

A novel simple iodination method for rice prolamin, a hydrophobic alcohol soluble protein, was developed. This protein was then quantitated by sensitive and rapid RIA. The latter was also used for screening a large number of pigeon pea cultivars for quantitation of globulin content. ELISA procedure employing conjugation of pigeon pea globulin antibodies and the enzyme peroxidase together to dextran was also devised to detect proteins at concentrations as low as 0.1 ng. These immuno-assays will have a significant potential in agricultural biotechnology.

b) Construction of genomic library and identification of specific clones:

Genomic library of rice and pigeon pea was constructed in charon 40 vector.

Using oligonucleotide and heterologous gene probes, clones coding for glutelin and prolamin in rice, and for vicilin in pigeon pea was identified.

Work is now in progress on (a) isolating the cDNA clones for glutelin and prolamin storage proteins in rice and vicilin storage protein in pigeon pea, (b) sequencing the genomic clones, and (c) standardizing gene expression assays.

3.5.2 Plant genome organization with special reference to rice

Work on repeated DNA sequences in rice had been initiated in 1978. It was shown for the first time that the content of repetitive DNA in rice was 50% and that these sequences remained unterspersed with single copy DNA sequences at a DNA fragment length as high as 20 kilobasepairs. Absence of interspersion of repeated and single copy DNA sequences was considered a very unique feature of rice genome.

Thermal stability experiments revealed that Cot 0.1 and Cot 50 DNAs had high T_m values of 95.5°C and 89.0°C, respectively, indicating that rice repetitive DNA sequences were highly G+C rich. Using 'A'and 'C' methylation specific restriction enzymes, predominance of adenine methylation was found in total rice DNA as well as repetitive DNA. Furthermore, the presence of methylated adenine was tissue specific; it was more in rice shoot DNA as compared to embryo DNA.

Long repetitive rice DNA was cloned in pBR35 and a few clones were characterized with respect to insert size and restriction mapping. The BamH-PstI fragment of about 0.4 kbp in one clone (pRL7) was sequenced and was found to have a partial homology with 25.5 ribosomal DNA. Genomic alterations (modulation) seen in transition from embryo to shoot are probably the first reported alterations in plants.

3.6 Conservation of endangered plant species - seed biology and tissue culture programme (17-1-001G)

Of the nine endangered plant species identified, success was achieved in developing tissue culture methods for the conservation of three.

Tissue culture plants produced by methods developed for *Delphinium, Vanilla walkeriae* and *Cyathea spinulosa* were successfully transferred to field for trials. Conditions for short term storage of *in vitro* shoot cultures were standardized. Similar work to conserve *Pterocarpus santalinus* is in progress.

3.7 Plant tissue culture for agriculture and forestry : Technology transfer, biotechnological evaluation and clonal multiplication of eucalyptus, bamboo and salvadora. (17-3-001 G)

Plantlets were produced and supplied to various agencies for field trials; growth data on eucalyptus, bamboo and salvadora were obtained. Collection of budwood from elite trees in different locations and isolation of fresh cultures was continued. Cultures established from different elite trees of the eucalyptus and salvadora species are being maintained *in vitro*.

Phase II of the project for establishment of regional centres was initiated with two agencies, viz., Tamil Nadu Forest Corporation and Grasim Forest Research Institute, Karnataka, which were identified by NABARD for the purpose. This is the outcome of the success achieved in phase I, particularly with eucalyptus and salvadora.

3.8 Development of a reproducible technique for production of coconut plants by tissue culture (17-5-001G)

Tender leaves, young roots and tender rachillae (mature plant) from saplings and mature plants were used as inoculum. Leaf explants from saplings and mature plants proliferated *in vitro* consistently giving rise to subculturable, globular structures in high frequency. A nondestructive method described by Central Plantation Crops Research Institute, Kasargod, was tested and found successful.

A method for growing excised root cultures arising from leaf explants was developed.

3.9 Genetic modification of plants using protoplast technology

a) Callus obtained from mesophyll protoplasts of two varieties of moth bean were differentiated into plants and successfully transferred to field. Field trials are in progress.

b) Callus of pigeon pea was obtained from protoplasts.

3.10 Isolation, cloning and characterization of PEP carboxylase gene

Genomic DNA of restrictable quality was isolated from the mesophyll cells of sugarcane. It was restriction digested to completion with Eco RV and the 7.0 kb fragment was cloned into the Eco RV site at blunt ended pUC 19. The recombinants are being screened with a 3' c-DNA probe of PEP carboxylase.

Publications

1. Lachke, A.H. and Deshpande, M.V., Sclerotium rolfsii : Status in cellulase research, *FEMS Microbiol. Revs., 54, 177 (1988).*

2 Deshpande, M.V., Eriksson, K.E. and Pettersson, L.G., Selective assay for exo-1,4-ß-glucanases, *Meths. in Enzymol. (Biomass), 160, 126 (1988).*

3 Deshpande, M.V., Eriksson, K.E. and Pettersson, L.G., An assay for selective determination of exo-1.4-ß-glucanases in a mixture of cellulolytic enzymes, *CSIR Commemorative Volume-In search of knowledge, CSIR contribution (Chemical Sciences),2, 49 (1988).*

4. Pundle, A., Prabhune, A. and SivaRaman, H., Immobilization of *Sacharomyces uvarium* cells in porous beads of polyacrylamide gel for ethanolic fermentation, *Appl. Microbiol. Bitotech., 29, 426 (1988).*

5 Lachke, A.H., 1,4-b-D-Xylan xylohydrolase of Sclerotium rolfsii, *Methods in Enzymology (Biomass), 160, 679 (1988).*

6. Lachke, A.H., Srinivasan, M.C., Rajan, J.V. and Tambe, S.A., Biotechnology development in India : Some policy issues, *Research Policy, 17, 235 (1988).*

7 Rao, M., Gaikwad, S., Mishra, C. and Deshpande, V., Induction and catabolite repression of cellulase in Penicillium funiculosum, *Appl.Biochem. and Biotechnol., 19, 129 (1988).*

8. Deshpande, V.V. and Eriksson, K.E., 1,4, ß-glucosidases of Sporotrichum pulverulentum, *Methods in Enzymology, 160, 415 (1988).*

9. Gaikwad, S., More, M. and Deshpande, V., Evidence for the essential histidine residue at the active site of glucose/xylose isomerase from Streptomyces, *Biochem. Biophys. Res. Comm., 155, 270 (1988).*

10. Deshpande, V., Seeta, R., Mishra, C. and Rao, M.,
Stability and recovery of Penicillium funiculosum cellulase under use conditions,
Appl. Biochem. and Biotechnol., 19(1), 11 (1988).

11. Mishra, C. and Rao, M.,
Mode of action and synergism of cellulase from P.funiculosum,
Appl.Biochem. and Biotechnol., 19, 139 (1988).

12. Dhar, M.S., Dabak, M.M., Gupta, V.S. and Ranjekar, P.K.,
Organization and properties of repeated DNA sequences in
rice genome,
Plant Science, 55, 43 (1988).

13. Dabak, M.M., Ranade, S.A., Dhar, M.S., Gupta, V.S. and Ranjekar, P.K.,
Molecular characterization of pigeonpea genome,
Ind.J. Biochem. Biophys., 25, 230 (1988).

14. Mawal, M.R., Mawal, Y.R., Ranadive, S.N. and Ranjekar, P.K.,
A rapid and sensitive immunochemical method for quantitation of proteins,
Bioscience Reports (UK), 427 (1988).

15. Ranade, S.A., Lagu, M.D., Patankar, S.M., Dabak, M.M., Dhar, M.S., Gupta, V.S. and Ranjekar, P.K., Identification of dispersed MboI repeat family in five higher plant genomes,
Bioscience Reports (UK), 8, 434 (1988).

16. Patankar, S. and Ranjekar, P.K.,
Constitutive heterochromatin during meiosis and mitosis in Allium cepa and *Rhoeo discolor,*
Cytologia (Tokyo), 53, 275 (1988).

17. Ranjekar, P.K. and Barnabas, J.,
Genetic manipulation of plants '40 years of research - A CSIR overview',
Series II, CSIR, New Delhi (Sept. 1988).

18. Pawar, H.S., Kannan, K., Srinivasan, M.C. and Vartak, H.G.,
Purification and characterization of glucose (xylose) isomerasefrom Chainia sp.,
Biochem.Biophys.Res.Commun., 155(1), 411 (1988).

19. Gupta, P.K.,
Advances in biotechnology of conifers,
Curr. Sci., 57, 629 (1988).

20. Seeta, R., Deshpande, V. and Rao, M.,
Role of ß-xylosidase in hemicellulose hydrolysis by xylanase from *Penicillium funiculosum,*
Biotechnol.and Appl.Biochem., 11, 128 (1989).

21. Gaikwad, S.M., Pawar, H.S., Vartak, H.G. and Deshpande, V.,
Streptomyces glucose/xylose isomerase has a single active site for glucose and xylose,
Biochem. Biophys. Res. Commun., 159, 457 (1989).

22. Keskar, S.S., Srinivasan, M.C. and Deshpande, V.,
Chemical modification of a xylanase from a thermotolerant streptomyces: Evidence for essential tryptophan and cysteine residues at the active site,
Biochem. J., 261, 49 (1989).

23. Rao, M., Seeta, R. and Deshpande, V.,
Comparative evaluation of cellulases: Role of individual components in hydrolysis,
Biotechnol. and Appl. Biochem., 11 (1989).

24. Rao, M. and Mishra, C.,
Glucohydrolase from Penicillium funiculosum,
Appl. Microbiol. Biotechnol., 30, 130 (1989).

25. Patil, S.G. and Patil, B.G.,
Chitin supplement speeds up the ethanol production in cane molasses fermentation,
Enzyme Microb. Technol., 11, 38 (1989).

26. Patil, S.G., Gokhale, D.V. and Patil, B.G.,
Novel supplements enhance the ethanol production in cane molasses fermentation,
Biotechnol. Lett., 11, 213 (1989).

4. MATERIALS SCIENCE

4.1 Solar/semiconductor grade polycrystalline silicon (7-II-047)

A 1.0 TPA silicon pilot plant was run satisfactorily for collecting data on preparation of silicon intermediate ($SiHCl_3$, i.e., trichlorosilane-TCS), its purification and subsequent cracking to high purity silicon (impurities in 2-3 ppb range).

The special features of the investigation were : (i) the fluidized bed TCS preparation unit giving 1.5 kg./hr product with optimized TCS-STC composition; (ii) TCS purification to ppb level achieved with three fractionating columns, used successively, with the output of 3 kg./hr; and, (iii) the six rod reactor used to produce 1.0 TPA of electronic grade polycrystalline silicon.

4.2 High performance ceramics

4.2.1 BA/Sr hexagonal ferrites

Ultrafine particles of hexagonal Sr-ferrite ($SrFe_{12}O_{19}$) were synthesized by wet-chemical (coprecipitation) method. Instead of good quality (AR) metal chlorides, cheaper grade (LR) nitrates of Sr and Fe and NaOH were used to obtain chemical homogeneity of the product. The atomic ratio Fe/Sr was fixed in the range of 10.8:1 to 12:1 by mixing the solutions of appropriate molarity in the required volumes for coprecipitation.

Sodium hydroxide solution was used instead of the mixture of sodium carbonate and sodium hydroxide, used in earlier studies, to precipitate out the mixed hydroxides of iron and strontium (pH 13). Extra care was taken to account for the solubility of strontium hydroxide in water by optimizing the Fe/Sr ratio under controlled precipitation conditions.

The coprecipitate was washed until the pH was around 8.0 and dried at about 100°C and then calcined at as low a temperature as 750°C for the formation of $SrFe_{12}O_{19}$. XRD, DTA/TG/DTG, SEM/EPMA and Mossbauer studies were conducted to examine the ferritization process occurring at sufficiently low temperatures. Accurate measurements of magnetic parameters of the green compacts revealed the value of intrinsic coercivity $_iH_c$ 6100.

Considering that the cheapest raw materials were used in the synthesis of Sr-ferrite, the performance parameters obtained were very good, and a high value of intrinsic coercivity could be achieved.

4.3 Amorphous silicon alloys for photovoltaic applications (G)

Investigations of the effect of short-range-order (SRO) on the opto-electronic properties of amorphous tetrahedral semiconductor alloys were continued under the Indo-US Science and Technology Initiative Programme sponsored by DST, New Delhi. The influence of the dopant atom concentration on the SRO in a-Si:H alloys was studied with laser Raman spectroscopy.

The doped films were deposited in the conventional RF- PA-CVD reactor at the University of Poona. The dopant gas concentration was taken as a measure of the dopant-atom concentration in the a-Si:H film. Raman spectra measurements were also performed on undoped samples deposited at NCL and Solar Energy Research Institute, Golden Co., USA.

The analysis of Raman results obtained on the undoped a-Si:H films as a function of substrate temperature (Ts), (i.e., 40°; Ts : 350°C) indicated a high degree of SRO (i.e., minimum of bond angle fluctuations) in films deposited at Ts = 250°C. The Raman spectra of film deposited at 250°C were very similar to the spectrum of crystalline density of vibrational states.

The typical dip in the region of LA-LO vibrational modes was correlated to the presence of major proportion of six-fold rings which is a typical characteristic of intermediate range order in the films deposited at 250°C.

Raman measurements made on the a-Si:H:B and a-Si:H:P samples deposited at Ts = 250°C displayed dopant concentration dependent increase in the bond angle fluctuations as well as the filling up of the dip between LA and LO bands. These changes are attributable to the dopant-atom induced disorder (increase in 5-fold rings) and the fluctuations in the hydrogen microstructure. The dopant atom induced degradation of SRO is proposed as the technique to degrade the doping efficiency in a-Si:H alloys.

4.3.I Surface and interface of GaAs

The electrical quality of the GaAs surface has imposed performance constraints upon nearly all GaAs devices and prevented the development of a GaAs-based MISFET technology. Although much progress has been made in understanding the poor electronic quality of the GaAs surface, no complete successful scheme has been devised which passivates the GaAs interface both electronically and chemically while permitting the growth of an insulating barrier. The following passivating schemes were developed.

a) GaAs/plasma polymerised thiophene

Passivation of the GaAs surface is made possible by an overlayer provided by a thin film of plasma polymerised thiophene. Reduction of surface recombination velocity and the surface barrier at the interface between the polymer and GaAs has been reported.

b) GaAs/ZnSe heterointerface

The GaAs/ZnSe heterojunction (HJ) had a lattice mismatch of 0.25% but high quality epitaxial HJs were grown by a new method known as liquid-gas interface growth technique. The valence and conduction band discontinuities were determined for HJs by means of photoelectron spectroscopy (PES). PES was also used to obtain the Ga3d and Zn3d valence bond maximum binding energy differences for bulk ZnSe.

The core level separation E_{CL} between the Ga3d and Zn3d core levels for a thin GaAs/ZnSe was determined. From the core level binding energy shifts, attempts were made to identify the chemical species formed at the interface between GaAs/ZnSe. The quality of ZnSe layers was assessed by x-ray and electron diffraction techniques.

4.4 High temperature superconductivity (7-I2-004)

A major part of the work was the study of the structure-property correlation in Y-Ba-Cu-O and Bi-Sr-Ca-Cu-O systems. The study of the effect of substitution of various cations, isovalent as well as nonisovalent at Y, Ba and Cu sites was carried out to determine the variations in the structural, magnetic and conductivity properties. Substitution of Ca at the Y site helped in increasing the density thereby reducing the weak link effects observed due to the segregation of nonsuperconducting phases at the grain boundaries.

A detailed study of the Y-Ba-Cu-O phase diagram revealed that many more single phase compositions can be synthesized in the region near I:2:3 by critical control and adjustment of the preparation parameters. The compositions like I:4:6, 2:6:9, 3:7:I0 and others showed a structure isomorphous to that of standard I:2:3 and possessed similar or, in certain cases, better electrical and magnetic properties.

The observations made during the course of the synthesis of I:2:3 and I:2:3-like materials led to a method better than the conventional ceramic route. The results of this method were tested; they proved to be better than those prepared by the ceramic route. The reproducibility of results by the improved technique was found to be nearly I00%.

A study of the $Bi_2Sr_2Ca_{n-1}Cu_nO_{2n+4}$ systems was carried out for $n=I,2,3$. The optimization of the conditions for the preparation of these materials was in progress. The results of the interface study of single phse 2:2:I:2 with indium and silicon were encouraging. It was observed that even though the resistivity data for $n=3$ material showed zero resistance at IIOK, the bulk did not contain I00% $n=3$ material, but some traces of the $n=2$ also accompanied it.

The effect of doping of a small amount of antimony in $n=3$ surprisingly increased the T_c to I33K. The results were reproducible. Apparently antimony doping helped in stabilizing the 2:2:2:3 phase.

4.5 Theoretical chemistry

A significant open shell coupled-cluster (CC) response approach was developed for the calculation of static properties. It was extremely suitable for describing the dynamical as well as nondynamical, correlations for open shell systems. CC methods were highly accurate in the calculation of electronic energies for both closed and open shell systems.

With a response approach, the CC method can also be applied for the calculation of static property. A response approach was developed for closed shell systems initially. The present work represents the first attempt at a general formulation of a response approach for open shell systems in a CC framework.

Apart from this, further studies were made regarding the bivariational CC approach developed here earlier. Attempts are being made to install an

ab initio package leading to CC software for accurate electronic structure calculation.

The influence of 2-methylthiolation on the conformational preferences of the isopentenyl substituent on the N^6 position in adenine was theoretically studied. The results explained the regulatory significance of hypermodification of nucleic acid bases naturally occurring in the anticodon loop in tRNAs. Conformational preferences of the modified ureiodoadenine bases could be understood in terms of model modified nucleic acid base n^6-(N-alanylcarbonyl) adenine.

4.6 Structural Chemistry

4.6.I X-ray crystallography

The structures of over twenty organic, inorganic, organometallic and biologically important compounds were solved.

A lot of work is reported on intermolecular C-H....X/C....H-X (where X is O,N,F,Cl, etc.) interactions, but very little on such intramolecular interactions. With the help of Cambridge Crystallography Data Base up-to-dte information was collected on these interactions. It was concluded that these intermolecular as well as intramolecular interactions are also important (like hydrogen bonds) in stabilizing the crystal and molecular structure.

Many structures contain more than one molecule in an asymmetric unit. After studying data reported during a year (I988) in Acta Crystallographica for about 60 structures, it was concluded that in most of the cases the molecules in an asymmetric unit have some sort of simple mathematical relations with each other.

4.6.2 Magnetic properties measurements

Magnetic properties of various soft and hard ferrites were evaluated using B-H autoplotter and LCR bridge. Remanence, coercivity, saturation magnet- ization of BxH products were computed from the recorded B-H loops of ferrite samples. These included samples from Morris Electronics Limited, Pune.

Magnetic susceptibility of various tension metal ion-complexes, catalysts and ferrite samples was measured using Cahn-I000 magnetic balance in the temperature range of 77K to 300K.

In addition to analysing samples from within and outside NCL, the following basic work was carried out.

i) Detection of F-centres and R-centres in oxide ceramics (structural and electronic) by using EPR spectroscopy.

ii) Hyperfine and superhyperfine structure of Mn^{2+} ions in polycrystalline CdO.

iii) ESR studies of superconducting samples (CEERI, Pilani) below the transition temperature.

4.6.3 Mössbauer spectroscopy

Structural studies on many representative samples of barium and strontium ferrites, iron oxide catalysts and iron complexes/ligands were carried out using Mössbauer spectroscopy.

4.6.4 Mass spectrometry (MS)

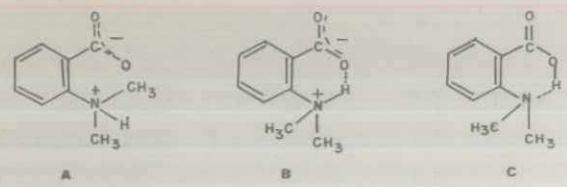
Basic research was carried out on the reactive states of ions. Comparison of EI and CI mass spectra of N-substituted IH-azepines and isomeric aromatic substrates indicated that substituted azepines are stable to EI at low temperatures retaining the 8 electron seven-membered cyclic system prior to their fragmentation.

The EI data was supported by low eV and metastable scan techniques. The chemical ionisation mass spectra of N-ethoxycarbonyl-IH-azepines and N-phenylcarbomates were complicated owing to thermal decomposition reactions at high temperature.

4.6.5 Spectrochemical studies

a) Dimethylanthranilic acid exists in a variety of structural forms in solution depending on the nature of the solvent. Using a Fourier deconvolution technique, the bands ascribable to the individual forms were separated from the complex overlapping profile in the region I750-I550 cm^{-1}.

While a hydrated Zwitterion exists in water (A), intramolecularly hydrogen bonded dipolar species (B) are found largely in alcohol, dimethyl sulphoxide and acetonitrile. Neutral intramolecularly hydrogen bonded species (C) are predominant in carbon tetrachloride, benzene and dioxane, monomeric non-hydrogen bonded species alone exist in cyclohexane.



A B C

b) The unsymmetrical profile of the free hydroxyl band of alcohols was known to arise from rotational isomers (rotation around C-O bond). Individual isomer concentrations could not be determined due to the strong overlap of the component bands (band separation, 10-15 cm^{-1}).

Using a Fourier deconvolution technique and the relevant computer software, the component bands could be sharpened leading to easy separation. Equilibrium constants calculated at 30°C for various primary alcohols are : ethanol, 1.4; propanol, 1.7; butanol, 1.6; pentanol, 1.5; hexanol, 1.47.

4.6.6 Thermal analysis

Thermodynamic studies were carried out on samples received from the ferrite project and other R&D projects of the laboratory. The phase changes and reaction kinetics of the compounds were studied. The stability, and degradation temperature of polymers were recorded in various gas atmospheres.

4.6.7 Structural chemistry

The platinum compounds cis-platin and carboplatin are found to be effective drugs in the treatment of cancer. In the search for less toxic and more effective anticancer drugs, some platinum compounds, structurally similar to cis-platin and carboplatin were studied.

The crystal structures of two such compounds, dichlorobis(ethylene diamine)platinum(II) and (ethylene diamine) 1,1-cyclobutanedicarboxylatoplatinum (II) were determined. The structure of a palladium compound, bis(thiophene-2-carboxyladehyde-4-phenyl thiosemi-carbazonato)palladium (II), which is a potential drug, was also determined.

The structure determination of two more platinum compounds, bis(t-butylamine)1, 1-cyclobutane-dicarb-oxylato-platinum(II) and cis-diiodo bis (t-butylamine) platinum(II), was also taken up. The structure of a potential antitubercular drug, thiazolidone, was charac-terized using X-ray structure analysis. The structure of a peptide, Boc-L-leu-gly-Ome, was determined and that of another, Boc-L-leu-D-Phg-Ome, is in progress.

In addition to this, isolation and purification of the low molecular weight xylanase from actinomycete *Chainia Sp.* was continued in order to obtain large quantities of the enzyme for crystallization experiments.

4.7 Properties measurements

Basic research on the heats of mixing of the following binary systems was carried out to understand the intermolecular interactions.

i) n-Butylamine + dibutylether

ii) Isobutylamine + dibutylether

iii) Sec-butylamine + dibutylether

iv) Tert-butylamine + dibutylether

Isothermal vapour liquid equilibrium (VLE) data were obtained for the binary systems of 1,2-dichloroethane with methyl, ethyl, propyl, butyl alcohols and also with n-hexane, n-heptane and n-octane. Wilson, NRTL, UNIQUAC, T.C. TEST, computer programmes were developed for processing the VLE data.

Under a DST sponsored project the vapour pressures of 20 systems of electrolyte solutions were measured. The heats of mixing of 12 systems of the same were also measured. Most of the data was measured for the first time and can be used for design of absorption heat pumps and in process design and development.

In the water evaporation control project, sponsored by Department of Rural Development, Ministry of Agriculture, work was undertaken on the evaluation of mixed monolayers of C_{16}-OH + C_{18}-OH (1:3), C_{18}-OC_2H_4OH + C_{22}-OC_2H_4OH (1:9) in the wind tunnel at 39.00 km/h wind velocity. These synthetic mixtures were compared with commercial products, viz., Acilol 1618 and Linoxyd CS-40.

It was observed that C_{18}-OC_2H_4OH + C_{22}-OC_2H_4OH monolayer promises to effect a very high evaporation reduction (80%) as compared to that of alcohol mixtures and other commercial products (60%). Preparation of these alkoxy ethanol mixtures was started.

Publications

1. Rao, V.J., Phulkar, S. and Sinha, A.P.B.,
Fermi level pinning and chemical interactions at metal/MO-CVD grown GaAs interfaces:Schottky barrier height,
Thin Solid Films, 164, 21 (1988).

2. Chandrachood, M.R., Mulla, I.S. and Sinha, A.P.B.,
Superconductivity in $Y_{1-x}Ce_xBa_{2-x}Cu_{306.5+}$ compositions,
Bull. of Mater. Sci., 6, 6 (1988).

3. Chandrachood, M.R., Mulla, I.S. and Sinha, A.P.B.,
Studies on superconductivity in $YLa_xBa_{2-x}Cu_3O_7$ compositions,
Solid State Commun., 68, 1005 (1988).

4. Tewari, R.,
Theoretical studies on conformational preferences of model modified nucleic acid base N6-(N-alanylcarbonyl) adenine,
Int.J. Quantum Chem., 34, 37 (1988).

5. Tewari, R.,
Conformational preferences of modified nucleic acid bases
N6-(2-isopentenyl) adenine and 2-methylthio-N6-(2 isopentenyl) adenine by the quantum chemical PCILO calculations,
Int. J. Quantum Chem., 34, 133 (1988).

6. Shinde, R.F., Mitra, A., Setty, M.S. and Date, S.K.,
Grain growth studies in thick films of cadmium oxide,
Mat. Letters, 7, 302 (1988).

7. Joshi, S., Koinkar, V.N., Godbole, V.P., Choudhari, S.M., Ogale, S.B. and Date, S.K.,
Pulsed laser depostion of iron oxide and ferrite films,
J. Appl. Phys., 64, 5647 (1988).

8. Sinha, A.P.B., Mulla, I.S. and Chandrachood, M.R.,
Possible new defect 1:2:3 compounds in RE-Ba-Cu-O system,
Progress in High Temp. Superconductivity, VII (1988).

9. Gokhale, S., Ahmed, N., Mahamuni, S., Rao, V.J., Nigvekar, A.S. and Kulkarni, S.K.,
XPS and XRD investigations of Dy/Si interface,
Surface Science, 210, 85 (1989).

10. Rao, V.J., Manorama, V. and Bhoraskar, S.V.,
Passivation of pinned n-GaAs surfaces by a plasma-polymerized thin film
Appl.Phys.Lett., 54, 1799 (1989).

11. Mulla, I.S., Sinha, A.P.B., Chandrachood, M.R., Tripathi, C.C., Ramakrishnan, K., Singh, A.K. and Srivastava, O.N.,
Investigations on formation of new structural phase through stoichiometric deviations in Y sublattice in $YBa_2Cu_3O_7$,
Solid State Commun, 70, 651 (1989).

12. Kulkarni, P., Mahamuni, S., Chandrachood, M., Mulla, I.S., Nigvekar, A., Sinha, A.P.B. and Kulkarni, S.K.,
Reactivity of Bi-Sr-Ca-Cu-O superconductor surface with indiumstudied by photoelectron spectroscopy,
Appl.Phys.Lett., 55(22), 2262 (1989).

13. Pal, S.,
Multireference coupled-cluster response approach for the calculation of static properties,
Phys. Rev., A39, 39 (1989).

14. Pal, S.,
Linearised bivariational coupled-cluster approach : General scheme for the derivation of static properties,
Phys. Rev., A39, 2712 (1989).

15. Mattie, R., Rittby, M., Bartlett, R.J. and Pal, S.,
Applications of multireference coupled-cluster theory,
Lect.Notes in Chemistry(Springer Verlag),50, 143 (1989).

16. Rittby, M., Pal, S. and Bartlett, R.J.,
Multireference coupled-cluster method:Ionization potentials and excitation energies for ketene and diazomethane,
J.Chem.Phys., 90, 3214 (1989).

17. Nawathey, R., Vispute, R.D., Chaudhauri, S.M., Kanetkar, S.M., Ogale, S.B., Mitra, A. and Date, S.K.,
Pulsed laser-induced vaporisation from the surface of a binary oxide (zinc ferrite) and its implications for synthesis of thin films
J.Appl.Phys., 65, 3197 (1989).

18. Ghaisas, S.V., Kulkarni, S.A., Kanetkar, S.M., Ogale, S.B., Date, S.K. and Mitra, A.,
Surface modification by electric field generated plasma at an liquid/solid interface,
J.Phys.(D) - Appl.Phys., 22, 364 (1989).

19. Sinha, A.P.B., Chandrachood, M.R. and Mulla, I.S.,
Preparative procedures for T_C cuprate superconductors - Part I,
Bull. of Indian Association of Physics Teachers (1989).

Publications (Structural Chemistry)

1. Rajopadhye, N.R., Bhoraskar, S.V. and Badrinarayanan, S.,
XPS study of reduction effects in Nb doped PZT ceramics,
Surface and Interface Analysis, 10, 392 (1988).

2. Rajopadhye, N.R., Bhoraskar, S.V., Badrinarayanan, S. and Sinha, A.P.B.,
Photoacoustic and X-ray photoelectron spectroscopic studies in reduced lead zirconate titanate ceramics,
J.Mat. Sci., 23, 2631 (1988).

3. Badrinarayanan, S., Mandale, A.B. and Sinha, S.,
Surface segregation in $Cu_{70}Zr_{30}$ Metglass: An Auger electron spectroscopic study,
Surface and Coating Technology, 34, 133 (1988).

4. Chandrachood, M.R., Mulla, I.S., Kuber, M.V. and Sinha, A.P.B.
Superconductivity in compound $Y_{1-2x}Ce_xBa_{2+x}Cu_3O_{6.5+}$ system,
Bulletin of Mat. Sci., 11(1), 67 (1988).

5. Jose, C.I., Belhekar, A.A. and Agashe, M.S.,
Structural changes of 2-dimethylamino benzoic acid in solution - a spectral deconvolution study,
Spectrochim Acta., 44A, 899 (1988).

6. Ogale, S.B., Koinkar, V.N., Joshi, S., Godbole, V.P., Date, S.K., Mitra, A., Venkatesan,T. and Wu, X.D., Deposition of iron oxide thin films by pulsed laser evaporation,
Appl.Phys. Lett., 53(14), 1320 (1988).

7. Kulkarni, P.S., Mirajkar, S.P., Bambal, R.B. and Ayyangar, N.R.,
The reactive states of ions : Antiaromatic seven-membered N-substituted-1H-azepines and isomeric aromatic substrates,
Org.Mass Spectrom., 23, 240 (1988).

8. Sohoni, J.S., Rojatkar, S.R., Kulkarni, M.M., Dhaneshwar, N.N., Tavale, S.S., Guru Row, T.N. and Nagasampagi, B.A.,
A new eudesmenolide 2-hydroxycostic acid from Sphaerarthus indicus Linn. X-ray molecular structure of 4,5 epoxy 7- hydroxy eudesmanolide,
J.Chem. Soc. Perkin (I), 157 (1988).

9. Bhat, U.G., Puranik, V.G., Dhaneshwar, N.N., Tavale, S.S., Guru Row, T.N. and Nagasampagi, B.A.,
New germacrane derivative from Nanothamus sericeous. X-ray molecular structure of (1R,4R,5R,6R,10R) -1,10;4,5-diepoxy-11.-hydroxygermacrane-6-yl(Z) -2-methylbutenoate.,
J.Chem.Soc. Perkin, (I), 657 (1988).

10. Phadnis, A.P., Patwardhan, S.A., Dhaneshwar, N.N., Tavale, S.S. and Guru Row, T.N.,
Clerodan diterpenoids from Polyathia longifolia,
Phytochemistry, 27, 2899 (1988).

11. Dhaneshwar, N.N., Tavale, S.S. and Guru Row, T.N., Structure of Intrasil Brilliant Yellow,
Acta Cryst., C44, 1858 (1988).

12. Puranik, V.G., Guru Row, T.N., Tavale, S.S., Thimma Reddy, R. and Nayak, U.R.,
Structure of two pseudoisomorphic derivatives of pseudoneo longifolol,
Acta Cryst., C44, 2111 (1988).

13. Dhaneshwar, N.N., Tavale, S.S., Guru Row, T.N., Zope, V.R., Pandey, B.B. and Ayyangar, N.R.,
Structure of hexacyclo [7.4.2.$0_{1,9}$.$0_{3,7}$.$0_{4,14}$.$0_{6,15}$] penta deca-10,12-diene-2,8-dione,
Acta Cryst., C44, 2191 (1988).

14. Puranik, V.G., Tavale, S.S., Guru Row, T.N. and Sehra, J.C., Molecular structure of 4-(dimethylmaleimido) phenylmethacrylate,
Makromol. Chem., 189, 1935 (1988).

15 Pathak, G. and Pradhan, S.,
Enthalpies of mixing of di-n-butylether with isomeric butanols: Enthalpies of hydrogen bonded complexes,
Proc. Indian Acad. Sci., 100(6), 519 (1988).

16. Chaudhari, S.K. and Katti, S.S.,
Excess molar volumes of binaries of ethylbenzene with chlorobenzene, nitrobenzene, aniline and benzyl alcohol,
Ind.J. Chem., 27, 797 (1988).

17. Singh, P., Mandale, A.B. and Badrinarayanan, S.,
Surface oxidation of holmium: XPS, UPS and SEM studies,
J. Less Common Metals, 141, 1 (1988).

18. Singh, P.,
Structure and growth of Mn Sb and MnBi thin films,
Mat. Letters, 7, 293 (1988).

19. Swaminathan, K., Sinha, U.C., Bhatt, R.K., Sabata, B.K. and Tavale, S.S.,
Structure of tinosporide a diterpenoid furanolactone from Tinospora cordifolia Miers,
Acta Cryst., C45, 134 (1989).

20. Viswanathan, N., Gawod, D.H., Puranik, V.G., Tavale, S.S. and Guru Row, T.N.,
Revised structure of a product of the reaction of dimedone with phenylglyoxalic acid,
Curr.Sci., 58, 30 (1989).

5. AGROCHEMICALS

5.1 Carbamate insecticides

A novel innovative synthetic route was developed for commercially important carbamate insecticides such as carbaryl (Sevin) and 0-2-sec-butylphenyl N-methylcarbamate (BPMC), without employing hazardous chemicals like phosgene and methylisocyanate.

Other routes for such carbamates were also investigated. Of the three rearrangement routes involving methyl migration to electron deficient nitrogen species from acetyl azide (Curtius), acetamide (Hofmann) and acetohydroxamic acid (Lossen), which can generate MIC *in situ* for the purpose of instant trapping with the appropriate phenols in the medium to produce the desired carbamate insecticide, only the Curtius method proved to be a success.

While it was possible to generate MIC from acetamide *in situ* by the Hoffman route and trap it with ethanol (but not with l-naphthol) ethyl N-methyl-carbamate formed can, however, be transesterified with l-naphthol to carbaryl in a separate step), there was no evidence of MIC being produced in situ from acetohydroxamic acid in the Lossen approach.

5.2 Pyrethroids and other related compounds

Several *p*-substituted benzyl (±) cis-2, 2-dimethyl-3-(2,2-dichlorovinyl) cyclopropane carboxylates, exhibiting promising insecticidal and larvicidal properties at microdosage level were synthesized from (±)cis-DV acid.

3-Phenoxybenzyl/isopropyl 2-alkyl/aryl-4-oxo spiro (2,5) octane and spiro (2,4) heptane-l-carboxylates were synthesized for screening for insecticidal properties.

t -lactone of IR-cis-2,2-dimethyl-3-(2,2,2-tribromo-l-hydroxyethyl) cyclopropane carboxylic acid, a key intermediate for deltamethrin was obtained by an interesting sequence of chemical transformations of (+)-3-carene.

5.3 Entomology

Several enriched plant extractives or their combinations were being investigated for use in mosquito, termite and cyclops control. The overall objective was to develop a succession of the combinations at NCL to provide biorational supplements for pest/vector management programme.

The design of controlled delivery systems was a major endeavour. A gel dispense system was earlier developed for aquatic larvicides. These "satellite" hydrogel dispensor were also being adapted for cyclops control. This project was funded by the National Water Mission.

Control of cyclops, the guineaworm vector, was achieved using an easily available, inexpensive, natural product.

Development of innovative, essentially non-insecticidal products and strategies for control of termites and the Jumping louse were undertaken with the specific needs of the building and construction industry, and social forestry, in mind.

Basic research was concentrated in the following areas: chemical influences in host specificity/ resistance; general studies on insect physiology and behaviour; endogenous and exogenous factors determining pheromone release; and basic bionomics, physiology and ecology of the psyllid, *Heteropsylla cubana* and local termite fauna.

A few novel exploratory endeavours were (i) a collaborative study with the genetic engineering group of the Biochemical Sciences Division aimed at transfer through plasmids of microbial toxins or specific inhibitory allelopathic chemicals to postcrop complex; and (ii) identification and isolation of entomopathic principles from microbial broths.

5.4 Ranitidine

Two laboratory-scale methods were developed for the preparation of l-methylamino-l-methylthio- 2-nitro-ethene – the crucial nitroenamine intermediate for ranitidine. The first method follows the conventional route from l,l- bismethylthio-2-nitroethene and leads to a 60-68% yield of the required product, based on recovered starting material.

The second method is based on a radically new approach and makes use of the catalyzed condensation of nitromethane with N-methyl carbonimido dithioic acid ester.

5.5 Homobrassinolide

A collaborative project between NCL and Godrej Soaps Pvt. Ltd., Bombay, for the synthesis of homobrassinolide, a plant growth promoter, was completed. Starting from stigmasterol 30g of homobrassinolide were prepared in eight steps and supplied to Godrej. The product was found to be active in ppm concentration under controlled laboratory conditions. The company started elaborate field trials on a variety of agricultural crops.

5.6 Development of Neemrich-II technical and its formulation

Neem oil, neem cake and neem seeds were processed for the isolation of active-rich fraction containing azadirachtin and related compounds. A simple process was developed from neem seeds for Neemrich-I and Neemrich-II exhibiting different insect control activities. The process was scaled up to 20 kg (seed level) and a stable formulation was prepared from the product.

Field trials were conducted on tobacco crop at Central Tobacco Research Station, Rajahmundry, and on cotton crop at Nimbkar Agricultural Research Institute, Phaltan, with encouraging results.

Publications

1. Phadnis, A.P., Patwardhan, S.A., Pawar, P.V. and Sharma, R.N.,
   Products active on mosquitoes II. Synthesis of biologically active diethers of 3,7-dimethyl-1, 8-octanediol,
   Ind.J. Chem.,27B, 600 (1988).

2. Phadnis, A.P., Nanda, B., Patwardhan, S.A., Pawar, P. and Sharma, R.N.,
   Products active on mosquitoes III: Synthesis of biologically
   active, 3,7-dimethyl-6-octene-1, 8-diol diethers,
   Ind.J.Chem.,27B, 867 (1988).

3. Nayak, U.R., Dalavoy, V.S. and Deodhar, V.D.,
   convenient preparation of dehydrocycloisolongifolene and its conversion into 5-oxoisolongifolene,
   Ind.J.Chem.,27B, 891 (1988).

4. Vaidya, S.P. and Nayak, U.R.,
   Unique Jones suidation of 12-iodolongibronane-4-ol involving unpreceedented neighbouring group participation : Formation of novel
   7-carboxy-4,7-dimethyl-bicyclo(2.2.1) septane-2 (3'3'-dimethyl) propionic acid,
   Ind.J.Chem., 27B, 969 (1988).

5. Puranik, V.G., Tavale, S.S., Guru Row, T.N., Reddy, R.T. and Nayak, U.R.,
   Structure of two psendoisomorphic derivatives of psendoneolongifolol,
   Acta Cryst.C 44, 2111 (1988).

6. Hebbalkar, D.S. and Sharma, R.N.,
   Photoperiod linked patterns of daily mating behaviour in the bud Dysdercus koenigii F (Hemiptera pyrrhochoridae),
   Curri. Sci.,57(9), 472 (1988).

7. Sharma, R.N.,
   Innovative strategies including controlled release technology for management of some arthropod vectors of disease,
   Proc.II Symp. on vectors and vector borne disease, 196 (1988).

8. Sharma, R.N., Rao, J.V., Tungikar, V.B., Vartak, P.H. and Hebbalkar, G.D.,
   Combination of insect growth regulation and controlled release techniques for management of specific arthropod vectors,
   Proc.II Symp. on vectors and vector borne disease, 199 (1988).

9. Sharma, R.N., Tare, V.S. and Bhonde, S.B.,
   Bioactivity of some organotin compounds,
   In Tin and Malignant Cell Growth Ed, Zuckerman J.J, 201 (1988).

10. Ramachandran, R., Mukherjee, S.N. and Sharma, R.N.,
    Hormetic effect of azadirachtin on Triboleum castaneum (Herbst) (Coleoptera tenebrionidae),
    Ind. J. Exptl. Biol.,26(11), 913 (1988).

11. Phadnis, A.P., Patwardhan, S.A., Dhaneshwar, N.N., Tavale, S.S. and Guru Row, T.N.,
    Clerodane diterpenoids from Polyalthia longifolia,
    Pytochem.,27,2899 (1988).

12. Patwardhan, S.A. and Abhyankar, S.M.,
    Toxic and hazardous gases - IV,
    Colourage,16(June 1988).

13. Joshi, G.S., Bhosale, S.S. and Kulkarni, G.H.,
    Pyridinium chloro chromate oxidation studies on(+)-3-carene derivatives,
    Curr. Sci.,57, 478 (1988).

14. Joshi, G.S., Deshmukh, A.R.A.S. and Kulkarni, G.H.,
    Synthesis of -methylene--butyrolactone,
    Synth. Commun.,18, 559 (1988).

15. Joshi, G.S. and Kulkarni, G.H.,
    Synthesis of 3-phenyl, 3,4-dihydroxy 7,7-dimethyl bicyclo[4.1.0] heptane-Useful synthon for 1R-cis pyrethroids, from (+)-3-carene,
    Chem. and Ind.,11, 370 (1988).

16. Mitra, R.B., Kulkarni, G.H., Muljiani, Z. and Khanna, P.N.,
    Synthesis of some new 1R-cis pyrethroids from (+)-3-carene,
    Synth. Commun.,18(10), 1139 (1988).

17. Arbale, R.A., Naik, R.H., Hinge, V.K., Kulkarni, G.H. and Mitra, R.B.,
Synthesis of methyl 1S-cis-2,2-dimethyl-3-n-alkyl cyclopropane carboxylates and 2,2-dimethyl-3-n-alkylcyclopropyl methanols from (+)-3-carene,
Ind. J.Chem.,27B, 253 (1988).

18 Kulkarni, G.H. and Arbale, A.A.,
Synthesis of insecticidally active 3-phenoxybenzyl and (RS)-cyano-3-phenoxybenzyl(+/-)-trans-2-(2,2-dichlor ovinyl)-spiro (2,5) octane-1-carboxylates,
Synth. Commun.,18,2147 (1988).

19. Joshi, G.D., Gore, K.G. and Kulkarni, G.H.,
Formation of an interesting product during oxidation of 3,6,6-trimethyl-4-formyl bicyclo(3,1,0) hex-3-ene with potassium permanganate,
Chem.and Ind., 761 (1988).

20. Hazra, B.G., Pore, V.S. and Maybhate, S.P.,
An improved procedure for the dichloroacetamidation of primary and secondary amines,
Organic Preparation and Procedure International, 21(2)(1989).

21. Hazra, B.G., Pore, V.S., Maybhate, S.P., Natekar, M.V. and Rao, A.S.,
Regioselective acylative cleavage of cyclic formal of chloramphenicol,
Synth.Commun.,1763 (1989).

22. Mitra, R.B., Subbarao, A., Gumaste, V.K. and Likhite, S.M.,
Demethylation of N-methylisocyanurate, N-methyluracils andN-methylxanthines by thiophenolate anions,
Ind. J.Chem.,28B, 311 (1989).

23. Kulkarni, G.H. and Toke, S.M.,
Synthesis of lactone IR-cis-2,2-dimethyl-3- (2,2,2-tribromo- 1-hydroxyethyl) cyclopropane carboxylic acid, a key intermediate for deltamethrin, from (+)-3-carene,
Synth.Commun.,19,(1&2), 13 (1989).

24. Bhosale, S.S. and Kulkarni, G.H.,
Stereospecific synthesis of methyl/t-butyl(+) 1R trans-2,2- dimethyl-3-(2-p-chlorophenyl ethynyl) cyclopropane carboxylate from (+)-3-carene,
Curri. Sci.,58, 561 (1989).

6. TIME TARGETED PROJECTS

6.1 *Encilium*

Optimal conditions for the growth of a flocculent variety of yeast strain were established. Yeast was grown from slant stage in a 300 litre reactor and fermentation was carried out for l00 days. It was established that 90% fermentation efficiency can be achieved by using this yeast. A preliminary design for the commercial process was worked out.

6.2 Ethylene oxide

The evaluation of the catalyst was continued in the new high pressure, computer controlled Berty reactor assembly. Facilities were being established for the scale up of the catalyst preparation procedures. It was observed that some of the catalyst compositions could be used for the installation of small capacity plants for making high-value chemicals from ethylene oxide. The know-how and engineering for such small plants were made ready for commercial application.

6.3 *p*-Diethylbenzene

p-Diethylbenzene is used as a solvent in the manufacture of p-xylene. Owing to the setting up of large production capacities in India for terephthalic acid and dimethylterephthalate, for which p-xylene is a raw material. The demand for p-diethylbenzene has grown considerably and is being met by imports at present. A zeolite based catalyst with more than 95% selectivity for p-diethylbenzene was developed. Pilot plant trials using this catalyst are under way.

6.4 2-6-Diethylaniline

2-6-Diethylaniline (2,6 DEA) is an important intermediate in the manufacture of herbicides like butachlor. The entire requirement of this chemical is met by imports. A process was standardized using ethylene and aniline as raw materials, and was demonstrated on bench scale. A plant for the manufacture of 600 TPA of 2,6 DEA was designed. This technology developed for Navin Chemical Enterprises, Bombay, is expected to be commercialised soon.

6.5 Morpholine

The project, undertaken on behalf of Navin Chemical Enterprises, Bombay, envisages the reaction of diethyleneglycol with ammonia to give morpholine. Both, vapour and liquid phase catalytic processes were investigated and the latter was found to be more promising. Investigations were continued to increase the conversion and selectivity, so that the process can become commercially viable.

6.6 l,4-Butanediol

Follow-up work on exploratory work was undertaken to examine the feasibility of a commercial process. The process parameters were optimized. A very high selectivity (>95%) was obtained at total conversion of l,4-butynediol. Further data on different aspects of the process, like catalyst recycle, kinetics, product isolation, etc., are being collected.

6.7 Sorbitol

Exploratory work on the development of a low pressure process for hydrogenation of glucose to sorbitol, indicated the feasibility of the process. A noble metal catalyst used in this process was found to give negligible formation of mannitol. Extensive investigations are in progress to optimize the process parameters, catalyst recycle, etc.

A process for making powder was developed and is ready for release.

6.8 Glyphosate

After completing the laboratory scale work (500 gms./batch), further work on pilot plant scale has been taken up.

6.9 N-methylpiperazine and aminomethyl piperazine

Exploratory studies indicated the technical. feasibility of the laboratory-scale process. Pilot plant studies are being initiated so that the process can be demonstrated to Diamines and Chemicals Ltd., Baroda, for commercialising the process.

6.l0 Aniline

Work on a process for low pressure (in the range 6.0-20.0 Kg/Cm^2) liquid phase hydrogenation of nitrobenzene was initiated. Preliminary investigations were successful and aniline of the required specification could be obtained. Optimization of process parameters and investigations on catalyst recycle is in progress.

6.11 Phenylglycine

Ficom Organics Ltd., Bombay, had sponsored work on the development of a process for phenylglycine. After the completion of laboratory-scale work, pilot plant studies were carried out for confirming the process conditions for obtaining the product of the required quality.

6.12 7 ADCA

The pilot plant work for the above product was carried out jointly with Hindustan Antibiotics Ltd., Pimpri, Pune, at their factory.

6.13 Novel technologies based on gas-solid non-catalytic reactions

Calcium cyanamide of a quality better than the imported sample was obtained. The route, based on urea-lime, was found to be engineering intensive. The equipment for the three process steps was identified. The process standardized on a 150 gm scale is being scaled up to 5.0 kg. scale.

Kinetic runs for sponge iron preparation using catalysts were carried out.

7. POLYMERS

7.1 Polyphenylene sulphide (18-1-567 C)

Studies were conducted to optimize process conditions. Downstream polymer isolation steps and solvent recovery work were investigated. Two routes were followed; one was based on methanol and the other on aqueous system. The economics of solvent recovery by the two routes were worked out. Studies were intiated on polymer isolation and improvement of solvent recovery. Preliminary work was initiated on treatment of the downstream waste.

Pilot plant trials were taken to optimize the conditions standardized in the laboratory scale studies at Sri Ram Fibres (SRF), Madras. The reactor design, was studied and modifications were suggested.

Conventionally, molecular enhancement of a polymer is done by thermal treatment below the melting point of the polymer. This process is known as solid state polymerization (SSP). Molecular enhancement of PPS was studied by this method. Scale up from 100 gm. to 1 Kg. batch was completed and conditions were determined for SSP laboratory trials. Optimum temperature and time cycles were finalised. Trials were taken at the Bombay unit of SRF to check the suitability of a unit for carrying out SSP on a commercial scale. Modifications for the unit were suggested.

A professional end user involved in PTFE coating was identified and work on PPS coating applications development was initiated.

7.2 Controlled release urea (18-7-006 C)

The project aimed at developing coatings to reduce the leaching rate of urea under irrigated conditions was taken up in collaboration with the Rashtriya Chemicals and Fertilizers Ltd., Bombay. One of the major challenges in this work is that the coating material has to be very cheap since the product itself is very cheap and its production is subsidized.

A large number of naturally occurring waxes and gums as well as synthetic polymers were investigated as potential coating materials.

7.3 Durable polymers for Jaipur Foot (18-8-006 G)

Polyurethane (PU) polyols were developed for rigid foam, flexible foam and elastomer formulations. Specific PU formulations were selected and demonstrated for use as rigid foam to replace wood in ankle block, and as flexible foam to replace microcellular rubber in heel block and fore foot insert, and as elastomer to replace rubber as the shell material. Five sets of PU inserts consisting of rigid foam ankle blocks, and flexible foam heel and forefoot blocks were prepared from the selected PU formulations. Jaipur Foot samples were prepared at Santokba Durlabhji Memorial Hospital (Jaipur) using these inserts and rubber shell material. Initial testing on laboratory equipment showed that the load deflection performance of the Jaipur Foot with PU inserts was generally comparable to that of existing Jaipur Foot. The foot with PU inserts was, however, lighter by about 15%.

7.4 Polycarbonate synthesis via non-phosgene route (18-9-056 C)

Melt transesterification of bisphenol-A (BPA) with diphenyl carbonate and modified BPA with dimethyl carbonate (DMC) was studied. Additives to minimize colour and polycondensation kinetics were studied.

Essentially colour free prepolymer of polycarbonate was prepared by melt polycondensation of BPA with DPC. Further heating of the prepolymer at 280°C under reduced pressure yielded polycarbonate in the mw range 20,000-30,000. BPA (modified) was converted to first stage oligomer with DMC by transesterification using a titanium catalyst.

7.5 Low cost/alternate building materials and components (18-10-005)

Sealants and water proofing compounds based on polyurethane, using readily available inexpensive, indigenous polyols were prepared and sent to Central Building Research Institute, Roorkee, for evaluation of physical properties.

All the laboratory tests performed showed that both the sealant compound and the water-proofing compound met all specifications required for the application of these products in the building industry.

7.6 New polymer support for penicillin acylase (18-11-006 C)

This project was taken up as a joint development programme between NCL and Hindustan Antibiotics

Limited (HAL), Pimpri. The first phase of the project dealt with the identification and characterization of a new polymer support to replace the derivatized cellulose matrix used at HAL currently to covalently bind penicillin acylase. This phase was successfully completed. A number of polymer supports were synthesized and screened for enzyme adsorption, activity retention and operational stability. Immobilized enzymes based on the two most promising supports were checked in greater detail to identify the best system. This system was screened through 600 cycles of Penicillin-G to 6-APA conversions. It was found to be usable through 550 cycles of operation as against 100 cycles with the system currently in use at HAL.

The second phase of the project, involving scale-up of the process to plant level, was initiated.

7.7 Drag reducing polymers for oil transport (18-13-006)

The objective of the project was to develop drag reducing polymers for the transportation of crude oil and its products through pipe lines. It also involved the development of computer software for the pipeline transportation of the North Gujarat crude oil.

One polymer developed by NCL showed a performance better than that of a commercially produced polymer. It was also found to be better in terms of shear stability.

The synthesis of the polymer was demonstrated to the sponsoring company, Lubrizol India Ltd., who will be taking up pilot scale production of the polymer.

The software developed was handed over to Institute of Petroleum Technology, Bombay. Efforts were under way to make the application of the software more extensive.

Work in this area was continued for the development of polymers with better performance.

7.8 Liquid crystalline polymers (18-17-006 G)

This grant-in-aid project funded by the Dept. of Science and Technology, New Delhi, was undertaken to demonstrate the technical feasibility of generating commercially viable liquid crystalline polymers on laboratory scale. A catalyst suitable for high temperature transesterification reaction was identified. Structure-property relations are being worked out to identify the desired structural elements.

7.9 Metal replacement by polymers in engineering components of two-wheelers (G)

A new fibre reinforced thermo plastic (FRTP) composite material was successfully developed for the rotor fan of Bajaj scooters.

Field trials with two components designed and developed under the project were successfully completed. One of these components has been introduced in the market on certain scooter models.

A design modification was suggested in the injection moulded engineering plastic component. In laboratory trials the redesigned plastic component demonstrated better fuel efficiency than its metallic counterpart under conditions of normal road travel (30-50 kms/hour).

7.10 Polymer alloys, resins for composites phase II

Continuous melt compounding trials for polyethylene terephthalate / polymethyl methacrylate were successfully demonstrated and the injection molding of these blends was carried out, for generating a property data base. In addition a number of blends of thermoplastic polyesters with nylons, polyphenylene sulphide and other compatible polymers were successfully demonstrated on batch scale. The thermal and crystallization studies of these blends were carried out to elucidate the effect of blending on the crystalline morphology of the blends.

7.11 Development of FRTP compounds and polymer blends and alloys for specific applications

A special reinforced grade of a polymer was developed for use in the injection molded rotor fans for Bajaj Auto Ltd. and in fans being moulded by Kirloskar Kisan Equipment Ltd. The first commercial sale of the compound has taken place.

Tests on the cable compounds developed showed that they met the specifications. Processing trials were started.

7.12 Membranes for gas separation (G)

The project funded by the Department of Science and Technology was aimed at developing polymers

possessing higher fluxes/separation factors for the separation of the gas under investigation.

A low pressure sorption balance to investigate sorption of gases in polymers was set up. Standardization of the equipment was taken up. A large number of aromatic polyesters were synthesized and characterised by wide angle x-ray diffraction measurements to study the effect of chain substitution on the interchain spacings. The next step would be to characterize these polymers for their sorption properties.

7.13 Development of specific reagent combination for beneficiation of (i) alumina rich ores, (ii)phosphate slimes, and, (iii) partially oxidized sulphide ores (G)

The problem of main chain degradation during functionalization of acrylamide to hydroxamate group bearing acrylamide could not be overcome. Polyacrylamides bearing glycolic acid groups were synthesized. The degree of substitution was determined by ^{13}C NMR CP-MAS spectroscopy in the solid state. Pyrene labelled polyacrylic acids and hydroxamate bearing acrylamides were synthesized for studying conformations at the mineral-water interface by fluorescene spectroscopy (work to be carried out at Columbia University). Polymers bearing 1-10% sarcosine functionality, prepared by hydrolyzing poly(vinyl pyrrolidone) were sent to University of Florida for their evaluation as dispersing agents in selective flocculation of phosphate bearing slimes.

Glycolic acid bearing polyacrylamides showed promising results in the flocculation of phosphate slimes. Solid state NMR techniques were applied to determine the degree of substitution in polyacrylamides.

7.14 Polymer characterization

Determination of molecular weight distribution of water soluble polymers poses unique challenges. The separations are column specific and the resolution is poor. It was observed that incorporation of a small amount of a suitable surfactant in the mobile phase resulted in a very satisfactory resolution of several polyacrylamides, probably due to the better control of the hydrophilicity/ hydrophobicity of the polymer backbone stationary phase.

A novel technique of characterization of water soluble polymers by gel permeation chromatography was developed.

7.15 Controlled release science and technology (G)

Further evaluation of ENCECAP CF1/ENCECAP CF2 was organized. Large block trials were conducted at Nimbkar Agricultural Research Institute, Phaltan, for bioefficacy of these formulations in cotton and sorghum cultivation. Acute inhalation toxicity of ENCECAP CF1 was studied at the Indian Institute of Toxicology, Pune. NCL continued to participate in the All India Coordinated Project on white grub organized by ICAR for the third year in succession. ENCECAP CF2 was modified based on field results and supplied for evaluation.

Systematic release kinetics from starch-UF granular formulations prepared at different urea/starch ratios and different loadings were conducted. Release rates of a series of model compounds (both solids/liquids) with varying water solubility, encapsulated in starch-UF matrix, were evaluated.

Large block trials on cotton/sorghum substantiated previous experimental results. Results showed a doubling of the period of protection and significant increase in yield. The significantly lower inhalation hazard for ENCECAP CF1, even at an active ingredient concentration of 50%, was demonstrated. Multilocation trials against white grub established its efficacy against soil borne pests.

An interesting relationship between degree of crosslinking of the matrix and solubility characteristics of active ingredient on release kinetics was observed.

7.16 Polymer modifications : Epoxidized natural rubber

A study of different experimental parameters on latex epoxidization of natural rubber was concluded. Various methods to break down the molecular weight of rubber (mastication pretreatment with formic acid) were unsuccessful. Epoxidization of natural rubber at different H_2O_2/HCO_2H ratios, temperature and latex concentration 20- 60% were studied.

An experimental program to epoxidize natural rubber films in the solid state and their characterization was initiated. Preliminary studies on casting of film of uniform thickness and characterization of epoxidized films were completed.

Contrary to previous reports in the literature, the present studies established the feasibility of epoxidation of a latex with higher rubber concentration at a shorter reaction time with smaller quantities of formic acid. The polymer properties and microstructure were unaffected.

7.17 High performance polymers : Synthesis, structure and property

2,6-Dimethyl phenol can be oxidatively polymerized using copper halide/amine catalyst to polyphenylene ether, a high performance polymer. Using a solvent system (in which the polymer precipitates) and various amines, the kinetics of oxidative polymerization were evaluated.

A systematic study of the effect of amine structure on oxidative polymerization of 2,6-dimethyl phenol was not available in the literature. This study identified the best amine in terms of rate/molecular weight. An interesting relationship between amine structure, pK_a and reactivity was observed.

7.18 Basic studies

Electrically conducting polymers known to date were prepared by exposure of the virgin polymer to vapour of strong electron acceptors such as arsenic pentafluoride, sulfur trioxide, etc., which are highly toxic. The major limitations in these polymers were their environmental stability and embrittlement after doping with accompanied loss of conductivity during handling. An interesting alternative route to increase the conductivity of polyphenylene sulfide was investigated. An enhancement in conductivity by 10 to 12 orders of magnitude was observed by doping the polymer with iron and copper salts using the simple solution doping technique. This yielded a stable semiconducting polymer (10^{-3} s/cm) which remained stable under ambient conditions for more than a year.

Publications

1. Amalnerkar, D.P., Radhakrishnan, S., Minoura, H., Siguira,T. and Ueno, Y.,
   Photoelectrochemical studies on CdS:Cu:Cl electrodes -importance of photoconductivity effects,
   Solar Energy Materials, 18, 37 (1988).
2. Nadkarni, V.M., Shingankuli, V.L. and Jog, J.P.,
   Blends of thermoplastic polyesters with amorphous polyamide I. Thermal and crystallization behaviour,
   Polym. Eng. Sci., 28, 1326 (1988).
3. Mahajan, S.S., Wadgaonkar, P.P. and Chavan, N.N.,
   Polyamides containg oxyethylene linkage : Synthesis and charac-terization,
   Intern. J.Polym.Mater., 12, 101 (1988).
4. Sarwade, B.D., Wadgaonkar, P.P. and Mahajan, S.S.,
   Synthesis and characterization of aromatic polyazomethine containing s-triazene rings in the main chain,
   Eur. Polym. J., 24, 1057 (1988).
5. Mahajan, S.S., Sarwade, B.D. and Wadgaonkar, P.P.,
   Chemical modification of poly(2,6-dimethyl-1,4 -phenylene oxide) by electrophilic substitution reaction with isocyanates,
   Polym. Bull., 20, 153 (1988).
6. Gundhiah, S.,
   Synthesis and characterization of polyelectrolytes for mineral separation,
   Mineral and Metallurgical Processing Journal SME-AIME, 5, 90 (1988).
7. Rao, B.S.,
   Novel bismaleimides via epoxy-carboxy addition reaction : Synthesis, characterization and thermal stability,
   J.Poly. Sci. Polym. Lett.Ed., 26, 3 (1988).
8. Ravishankar, S.A., Pradip, Deo, M.G., Kulkarni, R.A. and Gundiah, S.,
   Selective flocculation of iron-oxide-kaolin mixture using a modified polyacrylamide flocculant,
   Bull. Mater. Sci., 10, 423 (1988).
9. Tembe, G.L., Pilai, S.M., Ravindranathan, M. and Sivaram, S.,
   Selective dimerization of ethylene to butene-1 using titanium- tetra-n-butoxide-triethylaluminium catalyst system,
   Ind. Eng.Chem.Res., 27, 1971 (1988).
10. Nadkarni, V.M.,
    Materials replacement by plastics in engineering applicattions,
    Chemical Age of India, 39(6), 365 (1988).
11. Dhupe, A.P., Gokarn, A.N. and Doraiswamy, L.K.,
    A novel regenerable sorbent for SO_2,
    Chem.Eng.Sci., 43, 2103 (1988).
12. Vaidya, U.R. and Nadkarni, V.M.,
    Polyurethane polyols from glycolysed PET waste : Effect of glycol type on kinetics of polycondensation,
    J. Appl. Poly. Sci., 38 (1989).
13. Ghadage, R.S., Ponrathnam, S. and Nadkarni, V.M.,
    Thermotropic mesomorphic polyesters I.Copolyesters of 1,4-benzene dicarboxylic acid, 1,4-benzene diol and flexible diols,
    J. App. Poly. Sci., 37, 1579 (1989).
14. Rao, B.S.,
    Norbornene end capped bisimide resins via epoxy-carboxy addition reaction,
    J. Polym. Sci., Polym. Lett. Ed., 27, 133 (1989).

15. Shinde, B. M. and Patil(Mrs.), N.J.,
Synthesis and reactivities of diisocyanate and polyamides therefrom,
J. Polym. Mater., 6, 25 (1989).

16. Idage, S.B., Idage, B.B., Shinde, B.M. and Vernekar, S.P.,
Polyimides containing arylene sulfone ether linkages,
J. Polym. Sci., Polym. Chem. Ed., 27, 583 (1989).

17. Mahajan, S.S., Sarawade, B.D. and Gunjikar, V.G.,
Thermal degradation of isocyanate modified poly(2,6-dimethyl-1, 4-phenylene oxide),
Polym.Degrdn. Stab., 26, 51 (1989).

18. Sarawade, B.D., Wadgaonkar, P.P. and Mahajan, S.S.,
Synthesis and properties of polyurethanes containing s-triazine rings in the main chain,
J. Polym. Sci.Polym. Chem. Ed., 27, 3263 (1989).

19. Radhakrishnan, S. and Joshi, S.G.,
Stabilization of high conductivity in iodine doped polyphenylene sulphide,
J. Poly. Sci. Poly. Lett., 27, 127 (1989).

8. PROCESS DESIGN

8.1 Regular packing development (19-1-006 C)

The objective of the project was to develop and characterize regular packings with low HETP values and low pressure drop per unit height of the column for use in vacuum distillation columns.

Two types of the packings were characterized in a pilot plant under various operating conditions.

The packings were found to be better than Pall rings, the conventional random packings. Typically, their HETP is 50% lower and pressure drop about 25% lower than those encountered with Pall rings under identical conditions.

The pilot plant facilities would be used for generation of specific data required for the commercial installation of these packings.

8.2 Heat pumps (19-2-006 C)

An experimental water-to-water heat pump and a heat pump assisted drying unit were operated for demonstration and research purposes.

Computer programmes for the assessment of integrating mechanical vapour compression heat pumps to ethanol distillation and sugar evaporation units were developed.

A new methodology was developed for designing a heat pump that could be advantageously integrated with a heat exchanger network. A user friendly software package is being prepared.

8.3 Modelling and simulation

A novel approach was developed for evaluating the sensitivity of a given heat exchanger network. This approach, based on the partial linearity inherent in heat exchanger networks, reduced the computation time by an order of magnitude.

A new expression was developed for the excess free energy of aqueous single electrolyte solutions, based on the concept of ionic hydration. Simple equations were developed based on this approach for the vapour pressure and activity coefficients which are accurate and applicable even to concentrated solutions.

The problem of diffusion in zeolites cannot be tackled by conventional methods due to the fact that in zeolite channels molecules often cannot cross each other. A new approach was developed based on formulating the diffusion process as a Markov process. The results indicated that such an analysis forms the starting point for treating diffusion in zeolites.

8.3.1 Computer simulation of IPCL plants

The final report on the project on naphtha reformer simulation was submitted and follow-up work was taken up. Extensions in model capabilities in terms of the prediction of the lumps of hydrocarbons with nine or more carbon atoms were worked out. Similarly a model for precipitation polymerization of arylamide for fibre precursor was developed and optimization strategies were provided.

8.3.2 Diammonium phosphate (DAP) granulator modelling

A simple mathematical model for the continuous drum granulator for a DAP plant was developed incorporating all possible physico-chemical processes like slurry coating of recycle fixes, agglomeration and particle growth, ammonia fixation, and moisture desorption under conditions encountered in a commercial granulator. This model was being readied for comparison with plant data.

8.3.3 Other process simulation activities

Mathematical models were also developed for the simulation of absorbers for treatment of acid gas.

8.3.4 Software development activities

A simple prototype expert system for plant fault diagnosis, equipment and material selection of interest to the chemical industries was being put together. Specific domain knowledge bases for material selection and for equipment faults and failure were being built up.

Publications C·E

1. Kulkarni, B.D.,
   An arithmetic analytical approach to solution of problems in basic and applied sciences,
   Appl.Math.Lett.,13 (1988).

2. Grover, G.S., Devotta, S. and Holland, F.A.,
   Performance of an experimental absorption cooler using LiCl and LiCl/LiBr solutions,
   Ind. Eng. Chem. Res. (1988).

3. Welsby, P., Pezzani, M., Devotta, S., Diggory, P.J. and Guy, J.J.,
Capacity modulation of an experimental motor driven heat pump,
Applied Energy, 31, 59 (1988).

4. Welsby,P., Devotta, S. and Diggory, P.J.,
Steady and dynamic state simulation of heat pumps. Part I :Literature review,
Applied Energy, 31, 189 (1988).

5. Welsby, P., Pezzani, M., Devotta, S., Diggory, P.J. and Guy, J.J.,
Steady and dynamic state simulations of heat pumps, Part II :
Modelling of a motor driven water to water heat pump,
Applied Energy, 31, 239 (1988).

6. Gopichand, S., Devotta, S., Omideyi, T.O. and Holland, F.A.,
Heat pump assisted distillation, Part 10 : Potential for industrial applications,
Int. J. Energy Research, 12(6), 569 (1988).

7. Grover, G.S., Devotta, S. and Holland, F.A.,
Thermodynamic design data for absorption heat pump systems operating on water-lithium chloride. Part 2 : Heating,
Heat Recovery Systems & CHP, 8(5), 419 (1988).

8. Grover, G.S., Devotta, S. and Holland, F.A.,
Thermodynamic design data for absorption heat transformers Part III :Operating on water-lithium chloride,
Heat Recovery Systems & CHP, 8(5), 425 (1988).

9. Bhattacharya, A., Gholap, R. and Chaudhari, R.V.,
Steady state gas absorption followed by an exothermic bimolecular reaction in a thin liquid film,
J. Chem. Engg., 66, 599 (1988).

10. Bhattacharya, A., Gholap, R.V. and Chaudhari, R.V.,
An analysis of the nonisothermal gas absorption accompanied by an exothermic consecutive reaction in the liquid phase,
Chem. Eng. Sci., 43, 2890 (1988).

11. Bhattacharya, A.,
An analysis of mixing of chain centres in photochemical reactors,
Indian Institute of Science Jl., 68(9), 375 (1988).

12. Sukhatme, S.P. and Devotta, S.,
Classification of heat transfer equipment design, Ed. Shah, R.K., SubbaRao, E.C., Mashelkar, R.A.,
Hemisphere, Washington DC (1988).

13. Welsby, P., Pezzani, M., Devotta, S. and Diggory, P.J.,
Steady and dynamic state simulations of heat pumps, Part III :Comparison between simulation and experiments,
Applied Energy,32 , 1 (1989).

14. Grover, G.S., Devotta, S. and Holland, F.A.,
Performance of an experimental absorption cooler using aqueous LiCl and LiCl/LiBr solutions,
Ind. Engg. Chem. Res., 28(2), 250 (1989).

INFRASTRUCTURE ACTIVITIES

Division of Technical Services (DTS)

Planning, monitoring, research co-ordination, industrial liaison, technology transfer, documentation, market survey, publicity and public relations are the major activities of the DTS. The division is closely associated with the scientific divisions and helps in drawing up research programmes.

Planning, monitoring and research co-ordination

The research programme for the coming year was prepared and placed before the Research Council (RC) for ratification and later before the Management Council (MC) for final approval.

Besides organising the RC and MC meetings, DTS prepared final proposals for sponsored, collaborative, grant-in-aid and consultancy projects for the approval of the MC. A proposal was also prepared for setting up a tissue culture facility at NCL under the Department of Biotechnology's grant.

The 8th Five Year Plan for chemical sciences (for the CSIR Planning Division) and separately for NCL was prepared.

Financial analysis and cash in-flow for NCL were worked out.

Enquiries from private and government agencies, the parliament, NRDC, CSIR headquarters, sister laboratories and AGCR/CSIR Audit Groups were duly answered. Similarly the Lok Sabha and Rajya Sabha Questions were handled.

A computer programme was developed to evaluate the profitability of R&D projects.

Industrial liaison, technology transfer, etc.

A new format was made for the non-technical notes on NCL processes and the cost estimates were updated. Cost calculations were done on a trial basis for ten projects. The project profiles of 35 processes were updated.

Detailed discussions were held with numerous potential buyers of NCL know-how. In some cases visits were paid to the sites of the prospective entrepreneurs along with the concerned scientists to have on-the-spot studies of their needs and capabilities.

Arrangements were made for the registration of Neemrich and CR Carbofuran at C.I.B., Faridabad, by going over and discussing the matter with the officials of C.I.B.

Publicity, public relations

In all ten press releases were brought out to give publicity to important events concerning the laboratory and its staff. A press conference was also arranged on the eve of CSIR Foundation Day 1989.

An Open Day was arranged on the CSIR Foundation Day (26/9/88).

About 2800 visitors (including VIP's and groups of school and college students) were taken round the laboratory.

Workshops, exhibitions, etc.

An international workshop on, "Awareness of Rapid Advances in Science and Technology" (Biotechnology and Allied Sciences) [ARAST-1] was organised at NCL for the Commonwealth Science Council.

National Integration Day was observed on 17 November 1989.

DTS team organized a pavilion for the CSIR at the 76th Indian Science Congress Exhibition in Madurai from 7th to 23rd January 1989. The CSIR pavilion received the First Prize along with a memento.

NCL participated in the BIOTEK 88 exhibition held at the Ashoka Hotel in New Delhi from 1st to 12th October 1988.

Two sets of 20 exhibits on NCL technologies were prepared one of which was sent to the Public Relations Unit of CSIR.

International collaboration

Correspondence was maintained with the chief scientific organisations of ten countries to further scientific collaboration. Eight specific proposals for exchange of scientists and information were prepared and sent to CSIR.

Visits of twenty-one foreign scientists to the laboratory were arranged.

Analytical services

Three hundred and fifteen letters and more than two hundred and seventy-five visitors were attended to in connection with analysis of samples at NCL.

Research Fellows, Research Guides, etc.

Routine activities were continued for the registration of staff and research fellows for degree work and for the registration of some staff as research guides of selected universities.

Reports, etc.

The biennial report for 1986-88 and the Achievements pamphlet for the same years were compiled and printed.

The quarterly NCL Bulletin was brought out. Copies of the Bulletin, Annual Report and the NCL Brochure were dispatched to people on the respective mailing lists and to interested parties on request.

A monthly progress report was sent to the CSIR Planning Group in the required format.

Information for CSIR News and quarterly reports of Research Utilization Data were routinely sent to the CSIR headquarters.

A pictorial representation of "Major NCL Projects - Milestones" was prepared in the form of a brochure. A similar brochure was prepared on "Milestones on Major Projects in the Area of Catalysis in CSIR Laboratories".

Utilisation certificates and expenditure statements were sent to DST on high pressure liquid chromatograph, dispersible and non-dispersible analysers, thermodynamic properties, etc.

Thrust area reports for Catalysis and Polymer Science and Engineering were compiled.

Patents

The activity of filing Indian patents for significant work carried out and applying for the corresponding foreign patents in selected countries was continued. Other activities connected with patents included renewal of patents, submission of Form 58 (as per the requirements of the Patents Act 1970) and liaising between the laboratory scientists and the Patents Unit of CSIR regarding opposition to accepted patents as mentioned in the government gazette.

Extramural activities

A proposal was drawn up for World Bank assistance in upgrading the management system at NCL.

The CSIR/UGC JRF Examination was conducted in January 1989 as per the requirements of the CSIR.

An Orientation Training Programme for Scientists B of CSIR laboratories and institutes was conducted.

Arrangements were made to grant cash awards to brilliant students belonging to the SC/ST categories in the local schools and junior colleges under the CSIR scheme in this regard.

National Science Day was observed on 28 February 1989 by screening some short films on scientific subjects and organising a Science Essay Contest for children.

Assistance was provided to four companies in organising demonstrations-cum-lectures at NCL for the benefit of the NCL scientists.

Publications

1. Rajan, J.V. and Lachke, A.H.,
Information and infrastructural needs for biotechnology development: The case of cellulose and hemicellulose utilisation,
Bulletin of Sciences,4(1), 40 (1988).

2. Rajan, J.V. and Ayyangar, N.R.,
Sources and causes of pollution and its diseases in chemical industry,
Chemical Business, 1(10), 5(Jan. 1988).

3. Joglekar, H.G.,
Pilot plant: A key factor in development of pharmaceutical industry,
Presented at a seminar organised by the Indian Institute of Chemical Engineers, Guwahati Regional Centre, at Guwahati.

4. Tambe, S.A.,
Technology development and transfer at NCL. Presented at the Entrepreneurship Development Programme,
CECRI, Karaikudi, 18-24 April 1988.

5. Lachke,A.H., Rajan,J.V., Srinivasan,M.C. and Tambe,S.A.
Biotechnology development in India: Some policy issues.
Research Policy (North Holland), No.4, Vol.17 (August 1988).

Documentation services

National Information Centre for Chemistry and Chemical Technology

The NCL library is functioning as a National Information Centre for Chemistry and Chemical Technology (NICHEM) with financial support from DSIR, New Delhi. Under this project more emphasis has been given on computerisation of library and information activities. The undermentioned activities were computerized.

1. Database for books and monographs: The library created a book data base named NCLDL with 3000 records with the help of CDS/ISIS software. The creation of a book database in Unix environment was started. Very soon this database would be made available for on-line use.

2. Database for periodicals: The library created a periodical database named NCLPL with 652 records using CDS/ISIS software. The periodicals received on subscription, gratis and exchange were stored in this database.

3. Database for Indian chemical patents: A database for Indian chemical patents named ICPA with 547 records was created using CDS/ISIS software. This database was used for publishing a monthly journal "Indian Chemical Patents Abstracts". This journal was distributed amongst 300 users (NCL scientists and outside organisations).

4. Development of LIS package: Action was initiated in collaboration with WIPRO, to develop a library and information software package. The book accessioning module to record details of books was completed. A program for RPT & SOPL was developed for prining monthly additions to books.

NISSAT Access Centre for International Datacentres (NACID):

The library is also functioning as a NACID centre for Western Region with financial support from DSIR, Ministry of Science and Technology, New Delhi. Computerised telex and PSTN modes for searching international databases online are used. The centre has access to DIALOG and STN, database vendors situated in the USA. On-line searches on about a dozen topics were conducted during 1988-89.

Library services

a) Document procurement: The library houses 1,22,899 publications consisting of books, periodicals, patents, standards, technical reports, etc. During the period under review the following documents were added to the library.

1.	Books	631
2.	Periodicals (bound)	2213
3.	Patents and Standards	1451
4.	Photocopies & Translations	286
5.	Technical Reports	14
6.	Theses	51

586 titles were received in the library of which 481 were procured on payment and the remaining on gratis and exchange basis.

b) Document circulation: In addition to NCL staff, library facilities are extended to persons from industries, government departments, universities, colleges and to other interested users. 5729 outsiders visited and made use of the library during 1988-89.

During the period under review 14,491 documents were issued to users. Interlibrary lending facilities amongst the libraries situated in and around Pune are maintained. Under this arrangement about 59 documents were borrowed and 95 documents were loaned to other libraries.

Documentation work:

a) Circulation of current journals: 1135 current journals were circulated among heads of divisions.

b) Current awareness services: NCL library brings out a monthly journal "Indian Chemical Patents Abstracts" and circulates it to 300 users from NCL and other organizations.

c) SDI Services: C.A. Selects and S.D.I. service prepared by Chemical Abstracts Service, USA, on the following topics are procured and copies are distributed amongst NCL scientists to keep them abreast in the respective subject fields.

1) Polymers
2) Zeolites
3) Organometallics

4) Catalysis (Applied and Physical Aspects)
5) Controlled Release
6) Fungicides
7) Herbicides
8) Insecticides

Reprographic services

One lakh six thousand five hundred and fifty-four photocopies of references needed by the users were prepared during the period under review. Of these 42,498 were supplied to NCL scientists free of charge and 64,056 to outside parties on payment.

Inspection centre for Indian patents:

NCL library is an Inspection Centre for Indian Patents. 2,515 Indian patents were received in this centre during 1988-89.

Glass blowing

NCL has a well-equipped modern glass blowing section with highly-skilled staff. Custom-designed fabrications of glass apparatus to suit the needs of the scientific personnel is undertaken besides regular maintenance, repair and modification of glass apparatus.

The sophisticated fabrications include silicon reactors, BET units, high vacuum units, cryostats for magnetic susceptibility units, heat exchangers, etc. The section has of and on lent a helping hand to local educational institutions when required.

In all, jobs worth Rs. 3,20,000/- (approx.) were executed during the year.

High pressure laboratory

The group provided and maintained facilities for carrying out reactions at higher than atmospheric pressures and at high temperatures and for compressing various gases in cylinders. It also undertook work on specific projects of the process development division.

During the period under review 288 experiments were carried out for various research and development projects of the laboratory.

APPENDIX

1. SERVICES RENDERED TO INDUSTRY, RESEARCH INSTITUTES, UNIVERSITIES, ETC.

The laboratory has been extending its assistance, whenever possible, to industry, R&D units, educational institutes and project engineering organizations by way of, (1) consultancy on project development, trouble shooting and establishment of in-house R&D units; (2) undertaking specified developmental work on sponsored basis; (3) rendering *ad hoc* assistance on industrial problems of standardisation, optimization, analysis, material testing and trouble shooting; (4) associating with project engineers in preparing feasibility reports and making turn key offers on NCL technologies; (5) collaborating with industry for the development of complex and high-risk technologies of the laboratory on semi-commercial scale ; and, (6) participating in the industry's negotiations for the import of technologies and in their assimilation.

The norms and nature of such assistance are as follows :

1.1 Modes of technological assistance to industry by the NCL

1.1.1 Consultancy

Assistance of NCL experts in various branches of chemistry is made available to the chemical industry through consultancy offered by NCL.

1.1.2 Sponsored schemes

Industry can utilize the facilities, expertise and infrastructure of the NCL by sponsoring time-bound research and development projects on specific processes and problems. The criteria and terms for undertaking sponsored work at the NCL have been detailed elsewhere in the report.

1.1.3 *Ad hoc* assistance

NCL can render assistance to industry on exploratory work, standardization, optimization, feasibility studies, analysis and testing, etc., on payment of *ad hoc* fees depending upon the nature of the problems. Such assistance is usually extended for short periods.

1.1.4 Pilot plant work (Level II data)

NCL can undertake pilot plant studies for collection of Level II data (see 3.1) needed for the establishment of a commercial plant, based on laboratory data either obtained at NCL or available with the party. Such work may be taken up on behalf of the party on either sponsored or *ad hoc* basis.

1.1.5 Designs for commercial plants

Based on the Level II data collected in the pilot plant NCL can undertake to prepare chemical engineering designs for a commercial plant of desired capacity on payment of mutually agreed upon fees.

1.1.6 Assistance to small scale chemical industries

In consultation with various government and financial agencies concerned with the development of small scale chemical industries, the NCL cell for assistance to small scale chemical manufacturers started its activities keeping the following objectives in view.

(a) rendering help/advice/consultancy in solving inplant technological problems, (b) providing assistance in the assessment of know-how from the technological point of view, (c) assisting in the development of know-how on a short- term sponsorship basis, (d) maintaining a data bank and a liaison with the industry, (e) monitoring the assistance rendered,and, (f) organising short term courses, lectures and seminars for the benefit of small scale manufacturers.

1.1.7 R&D collaboration with industry

NCL is collaborating with industry on some important projects that are engineering intensive and which involve the development of complex technologies with high investment risks. In such cases based on the developmental work at NCL a proving pilot/semicommercial plant is set up at the collaborating industry's site. Data obtained on this plant is used in the scale up and design of the full scale commercial plant.

1.2 Supply of cultures

During the year under report 1037 cultures from the National Collection of Industrial Microorganisms were supplied to various institutes.

1.3 Analytical services

A large number of analyses were carried out, on payment, for universities, research institutions, government departments, private parties, etc.

1.	ESCA	80
2.	Mass spectrometry	53
3.	GC/MS	08
4.	IR/UV	133
5.	Magnetic susceptibility/measurement	20
6.	Microanalysis	72
7.	Thermal analysis	15
8.	Inorganic analysis, atomic absorption etc.	31
9.	Physical properties	14
10.	Moisture content	39
11.	NMR	67
12.	SEM/EPMA	93
13.	Analysis of special nature	08
14.	VPC/GLC/HPLC	25
15.	X-ray diffraction	81

The total receipts on account of analysis/testing carried out during the period amounted to Rs.1.13 lakhs.

1.4 Training

During the period, 12 representatives of various industries and students from IIT's and Institutes were given training in chemistry of natural products, analytical instruments, molecular biology & genetic engineering technique, plant tissue culture technique, microbiological technique, gel electrophoresis, chemical engineering, polymer sciences, pilot plant and modern glass blowing, etc.

2. SPONSORED & COLLABORATIVE WORK

2.1 Criteria for undertaking sponsored work and normal terms and conditions

The laboratory welcomes sponsored work if it fits into the following general criteria :

(i) The proposed work is within the scope of the present areas of activity of the NCL and the laboratory has the necessary facilities and expertise to carry out the work, subject to consideration of internal workload.

(ii) There is an innovative R&D content in the proposed work.

(iii) The technology to be developed will have sufficient socioeconomic impact after completion.

(iv) The technology to be developed is not repetitive and is not already established indigenously.

(v) The project is of a kind that the sponsor or only a few parties can implement. Technologies of wider interest are usually developed by the laboratory on its own.

The broad terms and conditions for charging expenses and fees for sponsored schemes are as follows :

a) The sponsor pays for or provides the staff required for the investigation.

b) The entire expenditure on chemicals and raw materials is borne by the firm.

c) Special glass apparatus, equipment, instruments and auxiliaries required for the investigation are supplied by the firm or purchased at their expense. The firm will be free to take back non-consumable items on completion of the investigation.

d) A fixed charge of Rs.22,500/- per scientist per annum is payable towards services, depreciation and incidentals. The charge is payable irrespective of whether the scientist is from the NCL or deputed by the sponsor.

e) A minimum provision of Rs.15,000/- per year is made for contingencies, sundry expenses and daily wage labour. The charge will vary according to the nature and scale of work.

f) In addition to the above, a fee is payable by the sponsor as know-how fees for the proposed development which is charged as a percentage of the total expenditure. The percentage of the fee charged depends upon the status of the sponsor. Concessions are given to medium scale and small scale firms in this regard.

g) The investigation will be carried out for a period of one year in the first instance. However, if the scheme is extended further the charges payable will be as per the prevailing rates of the sponsorship charges at that time.

h) The annual payment for the project is made in two equal instalments in advance, at intervals of six months.

i) Depending upon the nature of work, laboratory bearers/unskilled workers may also be recruited at the cost of the firm.

j)Prior to undertaking work on the scheme, sponsor executes an agreement on a ten rupees stamp paper with the NCL/CSIR embodying various terms and conditions of the scheme.

2.2 Sponsored projects concluded during 1988-89

Process	Party
1. Ambroxol	Jagsonpal Pharmaceuticals Ltd., New Delhi
2. Carbamazepine	Resonance Lab., Bombay
3. Controlled release coating formulation and packing system for fruits	Rallis India Ltd., Bombay
4. Development of catalyst and process for isobutyl benzene	Filtra Materials Res. Pvt. Ltd., Thane
5. Development of polymeric (urethane type) plasticizer	Indo-Nippon Chemicals Ltd., Bombay
6. High fructose corn syrup	I.O.C.L., Bombay
7. Synthesis of poly-acrylamide.	Ficom Organics Ltd., Bombay

2.3 Sponsored projects continued during 1988-89

Process	Party
1. Actetic acid by carbonylation of methanol & exploratory studies on conversion of methanol to acetic anhydride,VAM & acet-aldehyde	G.A.A.C., Ahmedabad
2. Amorphous silicon alloys for photovolatic applications	D.S.T., New Delhi
3. Conservation of endangered species	D.O.Envrnt.,New Delhi
4. Controlled release abate or other suitable chemicals for guinea worm control	Dept.of Rural Development , New Delhi (GOI)
5. Development of novel shapeselective Zeolite catalyst	U.N.D.P.
6. Devp. of specific reagent for beneficiation of 1) alumina rich iron ores 2) Phosphate shines and 3) sulphide ores	D.S.T., New Delhi
7. Disperse and nondisperse IR Analysers	D.S.T., New Delh
8. High pressure liquid chromatography	D.S.T., New Delhi
9. Long chain alcohol and alkoxy ethanol mixed monolayer for water evaporation control	Dept.of Rural Development, New Delhi (GOI).
10. Measurement of thermodynamic properties of electrolytes and their mixtures	D.S.T., New Delhi
11. Membrane separation	D.S.T., New Delhi
12. Metal replacement by polymeric materials in engineering compo—nents in two wheelers	D.S.T.,New Delhi
13. Methyl ethyl ketone	NOCIL, Bombay
14. Multifunctional additives & software for crude oil transportation	O.N.G.C., Bombay
15. New polymer support for penicillin acylase enzyme	H.A.L., Pune
16. Phenylglycine Dane salt	Ficom Organics Ltd., Bombay
17. Polymer alloy resins	D.S.T, New Delhi
18. Polymeric flocculants and dispersants for selective flocculation of tungsten fibres	Dept. of Mines, New Delhi
19. Polymers for Jaipur foot	D.S.T., New Delhi
20. Production of coconut by plant tissue culture	Dept.of Biotech.,New Delhi

21. Studies in carbonylation reaction	Deccan Sugar Inst., Pune
22. Tech. transfer, biotechnological evaluation & clonal multiplication of Eucalyptus, Bamboo & Salvadora	NABARD, Bombay

2.4 Sponsored projects newly undertaken during 1988-89

Process	Party
1. Application of efficient photochemical reactions for the synthesis of biologically active compounds and rel. study	D.S.T., New Delhi
2. Catalytic polimerization of olefin	D.S.T., New Delhi. (Under Indo-USSR collaboration)
3. Chemical synthesis and structural studies of oligonucleotides	D.S.T., New Delhi
4. Development of urethane type plasticizer	Indo-Nippon Chemical Co. Ltd., Bombay
5. Development of Neemrich II technical and its formulation	Indofil Chemicals Company, Bombay
6. Development of organotransition compounds stable to atmospheric exposure	D.S.T., New Delhi
7. Liquid crystalline polymers	D.S.T., New Delhi
8. Methane conversion into value added chemicals	D.S.T., New Delhi (Under Indo-USSR collaboration)
9. Microencapsulation of GOAL	Indofil Chemical Company, Bombay
10. Molecular cloning & sequence analysis of low mol. wt. xylanase from streptomyces an bacillus & their comp. analysis	DBT, New Delhi
11. Prostaglandins	Astra-IDL Ltd., Bangalore
12. Starch-matrix encapsulation of carbofuran	D.S.T., New Delhi
13. Synthesis of fluorescent & peptide conjugated oligonucleotides for application as probes for genetic deseases	DBT, New Delhi
14. Synthesis of biologically active compounds	D.S.T., New Delhi
15. Tissue culture pilot plant production unit facility	DBT, New Delhi
16. Use of RFLP & allied techniques for rice genetic & breeding ressearch	DBT, New Delhi
17. X-ray structure analysis and biomolecule conformation.	CSIR Young Scientist Grant
18. Zeolite catalyst for organic chemicals production	D.S.T., New Delhi. (Under Indo-USSR collaboration).

2.5 Collaborative work

Whenever possible and desirable, the laboratory collaborates with industry on industrially important projects that are engineering intensive and involve development of complex technologies with high investment risk.

The terms and conditions for such collaborative work depend upon the type of process that has to be developed. However, in general, the following terms are applicable to collaborative work.

(i) The scale of development will be decided by consultation between the NCL and the collaborating firm.

(ii) Initial time targets will be fixed for the completion of major activities. These would, however, be reviewed periodically in joint meetings with the collaborator taking into account the progress made and the bottlenecks being faced.

(iii) If some work has been carried out at NCL prior to the collaboration the collaborating firm will pay for such inputs.

(iv) For further development work on laboratory/pilot plant scale to be carried out at NCL, the expenses will be worked out by mutual agreeement between NCL and the collaborating firm. In certain cases the funding may be done in part or full by a government agency such as NRDC, DST, etc.

(v) The collaborating firm will put up a large pilot plant/semi-commercial plant at its site. All the expenditure incurred will be borne by the collaborating firm and it will have to make its own arrangements for the fabrication.

(vi) Normally NCL on its own will furnish a process package with basic chemical engineering design data for the semi-commercial plant. In some cases a project engineering firm may be associated in the work. The charges for such designs will depend upon the process and the size of semi-commercial plant to be installed and will be included in the share of the expenses to be borne by the collaborator as under (iv). In case the collaborator is involved in the preparation of the process package, his inputs will be taken into account while deciding the total expenditure payable by him as under (iv).

(vii) NCL scientists will be deputed for assisting in setting up and commissioning the semi-commercial plant. The collaborator will pay for such deputation according to the CSIR norms and will bear all expenses of the scientists on travel, boarding, lodging and local transport.

(viii) The collaborating firm will have to make its own arrangements for the fabrication, setting up and commissioning of the full scale commercial plant (which will be based on the design data collected on the semi-commercial plant). NCL will be associated in this matter on an advisory consultancy basis for which the terms and conditions will be spelled out in a separate agreement between NCL and the collaborator at an appropriate time.

(ix) The collaborating firm will be charged some royalty on the net sales from the semi-commercial plant (if used for commercial production) and the commercial plant.

(x) Within 90 days of the successful commissioning of the semi-commercial plant the collaborating firm will have to exercise its option for the commercial exploitation of the process. If the firm does not exercise its option within the said 90 days or after opting for it fails to establish commercial production within a specified period (2-3 years), NCL will be free to release the technology to other parties. In such an eventuality the collaborator will be compensated to the extent of the amount he has paid to NCL for the development of the project.

(xi) The collaborating firm will enjoy a limited exclusivity of about 5 years from the successful operation of the semi-commercial plant or about 3 years from the establishment of regular production on the commercial plant, whichever is earlier. The period of exclusivity would, however be reduced or the process will be non- exclusive if it is funded by NRDC, DST or some other government agency. It would also be governed by the rules and regulations of such agencies.

(xii) After the completion of the period of exclusivity NCL will be free to offer the process know-how to other parties. In case the collaborating firm fully participates in the transfer of technology, it will equally share premia/royalties received from these other parties. If the process is released to other parties before the expiry of the exclusivity period with the concurrence of the collaborator, the terms and conditions for such releases will be decided by mutual agreement. However, in such cases, if the collaborator does not fully participate in the transfer of technology, he will be compensated only to the extent of the expenses paid by him to NCL for the development of the project.

(xiii) Notwithstanding clause (xi), in cases of national importance where Government may direct CSIR/ NCL to release the developed technology to a third party in the interest of defence, atomic energy, space research or for prevention of import of foreign technology, CSIR/NCL, in consultation with the collaborator, will be free to release the technology to the said third party.The benefits arising from such releases will be shared by the collaborator in accordance with the provisions of clause (xii).

(xiv) NCL does not undertake guarantees for collaborative work since such work is carried out in constant association and consultation with the collaborator.

(xv) NCL and the collaborating firm will periodically exchange the information generated on the project by way of reports. They will also periodically hold meetings to review the progress of the project.

(xvi)The collaborator shall provide insurance cover against injury/death to all the staff (other than NCL regular staff) working on the project at NCL, as also to the NCL staff deputed to the firm's site for pilot plant/semi-commercial plant/commercial plant work.

(xvii) The collaborating firm will keep confidential all the data received and generated under the collaborative agreement. NCL will also keep such information confidential subject to clauses (x) to (xiii).

These are the broad terms for undertaking collaborative work at NCL and can be modified to a certain extent depending upon the merits of the case. An agreement on stamp paper is executed between NCL/CSIR and the collaborator, embodying the terms and conditions agreed upon by the two parties.

2.5.1 Collaborative projects concluded during 1988-89

Process	Party
1. Catalytic dewaxing of lube fraction	MRL, Madras
2. Development of brass inolide	Godrej Soaps Pvt. Ltd., Bombay
3. Polyphnylene sulphide	Sri Ram Fibers, Madras
4. SCPE	D.C.M.,New Delhi
5. Synthesis of polyphenylene sulphide	Sri Ram Fibres, Madras

2.5.2 Collaborative projects in progress during 1988-89

Process	Party
1. Alkylation of benzene by ethanol to ethylbenzene	ACC, Bombay
2. Controlled release urea	R.C.F.L., Bombay
3. Drag reducer for product pipeline	Lubrizol India Ltd., Thane
4. Ethylbenzene	Hindustan Poly. Ltd., Vizag
5. Exploratory work on development of hydroprocessing, hydrocracking/ hydrodewaxing of petroleum fractions using NCL zeolite catalyst	U.C.I.L., Bombay
6. Fluidized catalytic cracking(FCC) catalyst	I.O.C.,Faridabad
7. Heat pumps	Salford Univ., U.K.
8. New polymer support for penicillin acylase enzyme	H.A.L., Pune
9. Polycarbonates synthesis via non-phosgene route	I.P.C.L.,Baroda
10. Production of middle distillates	B.P.C.L., Bombay
11. Regular packing development	Engineers India Ltd., New Delhi
12. Synthesis of 7-ADCA	H.A.L., Pune
13. Vapour phase oxidation of ethylene to ethylene oxide / glycol	Engineers India Ltd.,New Delhi

2.5.3 Collaborative projects newly undertaken during 1988-89

Process	Party
1. Development of brass -inolide	Godrej Soap Pvt. Ltd., Bombay
2. Development of catalyst and process for cumene	Herdillia Chemicals Ltd., Bombay
3. Development of non-phosgene route for carbamate insecticides	Excel Industries Ltd., Bombay
4. Development of polymer blend alloys	B.M. Thakkar & Co. Pvt. Ltd., Bombay
5. Fischer-Tropsch synthesis (under Indo-USSR collaboration)	D.S.T., New Delhi

3. TECHNOLOGY TRANSFER

3.1 Levels of transfer

The processes developed at the laboratory are worked out and offered at three levels, depending upon the complexity involved in the process, the engineering content and the material volumes to be handled in an economic unit.

Level 1 covers chemicals of low volume production and which involve simple reactions/process steps.

Here the work is carried out on a less than 5 kg/batch scale and the know-how comprises the process, the analytical methods, and process control tests, the specifications of raw materials, and products, and a list of major equipment with suggestions on sizes and materials of construction.

Level 2 includes chemicals involving complex and engineering-intensive technologies. At this level, in addition to the level 1 work, pilot plant trials on a scale of 10-100 kg/batch or 2-20 kg/hr are carried out and the chemical engineering design data, including scale up studies, are collected. The know-how is offered in the form of a process package conforming to schedule 1A of the American Institute of Chemical Engineers Code.

Level 3 relates to turn-key offers through project engineers with financial guarantees of commercial plant, similar to any other turn-key offer.

3.2 Processes released during 1988-89

Process	Licencee
1. 8-Chlorotheophylline	Trichem Laboratories, Bombay
2. Detection kit for narcotics	Hindustan Antibiotics Ltd., Pimpri, Pune
3. Nicotine sulphate	Sunita Agro Industries Pvt. Ltd., Bombay.
4. Sugarcane variety Co-740by PTC technique	EID Parry (India) Ltd., Madras
5. Theophylline, amino-phylline and caffeine	Thecaf India Ltd., Bombay
6. Vitamin B_6	Daurala Sugar Works, New Delhi

4. CONSULTANCY

Assistance of NCL experts in various branches of chemistry is made available to the chemical industry through consultancy services offered by NCL. Public and private sector firms and small scale chemical industries have been benefited by such consultancy. The services are made available not only to the firms that have purchased NCL know-how, but also to other established chemical companies.

According to the guidelines of the CSIR three types of consultancy are offered: (a) advisory, (b) engineering, and (c) general technical. Under these services, NCL scientists assist in solving chemical problems, detailed engineering designs, equipment procurement, process and product improvement, plant modifications, commissioning, technology absorption, etc., on certain fee.

4.1 Consultancy in porogress during 1988-89

Title	Consultee
1. Institutional consultancy for recovery of waste heat	Andhra Pradesh Rayons Limited, Warangal
2. Institutional consultancy on software package for steam audit	Adarsh Chemicals & Fertilizers Ltd., Surat
3. Institutional consultancy on modelling and simulation of diammonium phosphate plant	Hindustan Lever Ltd., Bombay
4. Institutional consultancy on polymeric materials for two & three wheelers	Bajaj Auto Ltd., Akurdi, Pune
5. General technical consultancy of advisory nature	Hindustan Organic Chemicals Ltd., Rasayani
6. Institutional consultancy on catalysis	Standard Alkali, Thane-Belapur road, Thane
7. Institutional consultancy on polyester fibre	Indian Organic Chemicals Ltd., Madras
8. Analysis of technical grade pesticides viz. DEET, DDVP and Perm-ethrin	United Phosphorus Ltd. Bombay
9. Advisory consultancy for testing of perfumery chemicals	Quest International, Bombay
10. Modernisation of process and plants of Govt. Opium and Alkaloid Works at Neemuch and Ghazipur	Govt. of India, Min. of Finance, Dept. of Revenue, New Delhi

11. Physico chemical determination of catalyst	Alchemie Research Centre, Bombay
12. Interpretation of data on physico-chemical analysis of catalyst	Hindustan Lever Ltd., Bombay
13. Sodium hypochlorite	Modi Alkalies & Chemicals Ltd., New Delhi
14. Advisory consultancy relating to testing of FCC catalyst, reformer feed, evaluation of refromer catalyst, optimisation studies & TBP analysis of distillates	Bharat Petroleum Corporation Ltd., Bombay
15. Advisory consultancy, technical advice and assistance relating to manufacturing processes for pharmaceuticals/agro-chemicals	Excel Industries Ltd., Bombay
16. Advisory consultancy for Neemrich II	Indofil Chemicals Co., Bombay
17. Advisory consultancy relating to (a) Development and improvement of the company's existing bulk drugs processes, development of new drugs & suggestions for diversification	J.B. Chemicals and Pharmaceuticals Ltd., Bombay
18. Advisory consultancy/ technical assistance relating to setting up & operation of methanol to acetic acid pilot plant	Gujrat Alcohol and Allied Industries Ltd., Ahmedabad
19. Advisory consultancy on establishment of PTC lab and propagation of disease free sugarcane	EID Parry Ltd., Madras
20. Advisory consultancy on commercial use of reprocessed PTFE	Hindustan Organic Chemicals Ltd., Rasayani
21. Advisory consultancy on phenolic resins	Bakelite Hylam, Bombay
22. Advisory consultancy on heat pumps	Sanjivani Sahakari Sakhar Karkhana, Kopargaon
23. Advisory consultancy on analysis of FCC catalyst	Hindustan Petroleum Corporation Ltd., Bombay
24. Advisory consultancy to cover technical advice & assistance relating to application of catalysts in the chemical industry	Filtra Materials Research Pvt. Ltd., Thane
25. Advisory consultancy on pilot plant for methylamine	Rashtriya Chemicals Fertilisers Ltd., Bombay
26. Development of piperazine and other chemicals	Diamines and Chemicals, Kalol

5. LECTURES AND SEMINARS

5.1 Lectures delivered by visiting scientists in the laboratory

	Scientist	Subject
Bio 1.	Dr.(Ms.)Natasha Bohorova, Bulgarian Academy of Sciences, Institute of Genetics, Safia, Bulgaria	Application of tissue and cell cultures in genetics and breeding
Bio 2.	Dr.M.P.Chitnis, Cancer Research Institute, Tata Memorial Centre, Bombay	Drug resistance in cancer and its circumvention
Org 3.	Dr.M.S.Chorghade, Senior Research Chemist, Dow Chemicals, USA	Synthesis of complex carbohydrates
Ino 4.	Dr.S.Csicery, UNDP Expert, USA	Shape selectivity in zeolites
Phy 5.	Prof.P.Ganguly, Indian Institute of Science, Bangalore	High power super conductivity
Org 6.	Prof.Andrew Greene, Universite Joseph Fourier de Grenoble, Grenoble, France	i) Synthesis of natural products by new methods,Part I ii) – do –, Part II
Org 7.	Prof.M.Hooper, Dept. of Pharmaceutical Chemistry, Sunderland Polytechnic, Sunderland, UK	i) Novel antimalarials from parthenin ii) Progress in antimyco- bacterial agents
Ino 8.	Prof.K.G.Ione, Institute of Catalysis, Novosibirsk, USSR	Zeolite synthesis
Bio 9.	Prof. Lee, Head, Dept. of Occupational Health, University of Manchester, UK	Lead poisoning and recent trends in metal toxicity
Org 10.	Prof.Y.S.Rao, Visiting Scientist, Osmania University, Hyderabad	Chemistry of butenolides/oxazolones

	Scientist	Subject
Ino I1.	Prof.L.V.C.Rees, Imperial College of Science and Technology, South Kensington, London, UK	Adsorption on zeolites (2 lectures)
org I2.	Prof.B.Fraser-Reid, Duke University, N. Carolina, USA	Novel carbohydrate transformation discovered en route to natural products
org I3.	Dr.W.A.Smit, Zelinsky Institute of Organic Chemistry, USSR Academy of Science, Moscow, USSR	Elaboration of a novel strategy for the synthesis of polycyclic compounds
Ino I4.	Prof.J.C.Vedrine, Institute de Recerches sur la Catalyst, Cedex, France	i) ESR of Fe in zeolites ii) Diffusion in zeolites
org I5.	Dr.K.Wojciechowski, Institute of Organic Chem., Warsaw, Poland	Application of the vicarious nucleophilic substitution in indole chemistry
org I6.	Dr.J.S.Yadav, Indian Institute of Chemical Technology, Hyderabad	Enantioselective synthesis of natural products
Ino I7.	Prof.K.Zamaraev, Institute of Catalysis, Novosibirsk, USSR	Isomorphous substitution in zeolites

5.2 The following NCL scientists gave lectures/training at various institutions

	Scientist	Subject	Venue
1.	Dr.N.R.Ayyangar	Indian dyestuff industry : Retrospect and prospect	HOC, Rasayani
2.	Dr.J.Barnabas	i) Evolutionary molecular biology	National Institute of Advanced Studies, Bangalore
		ii) Kinship relationship of molecular sequences over evolutionary time	Workshop on ARAST on biotechnology and allied sciences, NCL, Pune
3.	Dr.A.Bhattacharya	Modelling and simulation of catalytic naphtha reforms	I.I.Ch.E., Pune Regional Centre on computer in chemical industry, NCL, Pune
4.	Dr.K.N.Ganesh	i) Chemical principles of molecular recognition	Seminar on modern biology, Mahabaleshwar
		ii) Molecular recognition in biological systems	–do–
		iii) NMR of synthetic oligonucleotides	Indian Institute of Science, Bangalore
5.	Dr.S.S.Katti	i) Monomolecular film properties of n-long chain alcohols, alkoxy ethanols and their mixtures (series of I2 lectures)	Chemistry Dept., Shivaji University,Kolhapur
		ii) Physical properties of soluble monolayers (series of 3 lectures)	–do–
6.	Dr.A.F. Mascarenhas	i) Potential application of tissue culture for propagation of bamboo	International bamboo workshop, Cochin
		ii) Applications of plant tissue culture - problems and prospects	Univ. of Poona, Pune
7.	Dr.V.M. Nadkarni	Structure development in injection moulding of thermoplastics	IIT, Bombay
8.	Dr.U.R.Nayak	i) Electron - deficient nitrogen in organic synthesis	National symposium on organic synthesis, Malti-Chem Research Centre, Vadodara
9.	Dr.B.Pandey	i) Photochemical strategies for the synthesis of biologically active compounds	Univ. of Hyderabad, School of Chemistry,

	Scientist	Subject	Venue
		ii) Strain and reactivity as partners for selectivity	National Organic Symposium, Hassan
		iii) Photochemical methodologies for the total synthesis of Fredericamycin A	National photochemistry and laser chemistry meeting, RRL, Trivandrum
10.	Mr.M.B.Patil, Mr.N.B.Dahibhate	i) Practical training of CDS/ISIS software	Workshop on computer applications in libraries and information centres, Jaykar Library, Univ. of Poona, Pune
		ii) Training course on computer applications in libraries	Jaykar Library, Univ. of Poona, Pune
11.	Dr.S.Rajappa	i) How does one synthesise a new drug?	Ahmednagar College, Ahmednagar
		ii) Innovation in drug research	–do–
		iii) Nitroenamines : Structure and configuration	Univ. of Poona, Pune
		iv) Does the nitro group feel attracted towards sulfur?	First NOST symposium, Hassan
12.	Dr.P.K.Ranjekar	i) Genetic engineering : Fundamentals and applications	Research Society Meeting, B.J.Medical College, Pune
		ii) New vectors and new approaches to gene transfer into higher plants	Mahabaleshwar seminar on modern biology : Emerging trends in biotechnology, Mahabaleshwar
		iii) Strategies of gene cloning and gene transfer in higher plants	National symposium on recent developments in microbial gene technology, Osmania Univ., Hyderabad
		iv) Genetic manipulation of seed storage proteins in rice and pigeon pea	One day seminar, Botany Dept., Univ. of Poona, Pune
13.	Dr.V.J.Rao	i) Schottky barriers and interfaces of metal GaAs contacts	National seminar on GaAs and III-IV compounds, IIT, Kharagpur
		ii) Course on solid state chemistry to 3rd and 4th semester M.Sc. inorganic and physical chemistry students	Under NCL-Univ. of Poona collaborative programme

	Scientist	Subject	Venue
14.	Dr.P.Ratnasamy	Zeolite catalysts in organic chemical technology	IIT, Bombay
15.	Mr.R.S.Singh	i) Computer applications in library and information centres	Workshop conducted by Jayakar Library, Univ. of Poona, Pune
	Mr.R.S.Singh and Mr.N.B.Dahibhate	ii) Software package CDS/ISIS	NEERI, Nagpur
16.	Dr.S.Sivasanker	i) Fundamental aspects of fluid catalytic cracking ii) Catalysis	Hindustan Lever Ltd., Bombay 9th ICC-Ibero-American symposium, Calgery, Canada
17.	Dr.H.R.Sonawane	i) New methodologies in the synthesis of bioactive organic molecules	National symposium on recent trends in organic synthesis, University of Poona, Pune
		ii) Two lectures on synthesis of anti-inflammatory arylpropionic acids	Chemistry workshop sp. by UGC, Univ.of Poona, Pune

5.3 Seminars/workshops/special training courses,etc. organised by/at NCL

1. The National Information System for Science and Technology (NISSAT) and CSIR have jointly undertaken the responsibility of training personnel from PME groups and library officers of CSIR laboratories on CDS/ISIS software. NCL has been entrusted the responsibility of organising training courses for eight laboratories viz. NIO (Goa), NGRI (Hyderabad), NCL (Pune), CSMCRI (Bhavnagar), IIChT (Hyderabad), NEERI (Nagpur), RRL (Bhopal) and ERDA (Baroda). Two courses have already been organised for this package. First course during 22nd-25th August 1988 for PME scientists and second curse during 29th August to 3rd September 1988 for library officers. Fourteen PME scientists and nine library officers attended these courses.
2. First Indo-Hungarian symposium on surface science and catalysis was organised at the NCL. Ten Hungarian scientists and thirty scientists from all over India participated (November 11-12, 1988).
3. The fourth annual conference of the International Society for Hybrid Microelectronics was held in the NCL. The theme of the conference was "Materials and Components for HMC's and Surface Mounting Technology", an area of great relevance to our country (December 7-9, 1988).
4. A workshop on Biotechnology and Allied Sciences was held at the NCL as part of the Awareness of Rapid Advances in Science and Technology (ARAST I). Renowned scientists from all over the world attended the workshop and participated in the deliberations (January 23-27, 1989).
5. Indo-US Workshop (with Japanese participation) on electronic ceramics and materials was held in the NCL (February 14-16, 1989).
6. A five day Hindi workshop was conducted for scientists of the NCL. In all, 33 scientists took part in the workshop. They were appraised of the constitutional position on Hindi and the Govt. policy in this respect. Besides this, general lectures on routine topics such as noting and drafting, types of correspondence and scientific and technical terminology were also held (March 13-17, 1989).
7. A training workshop on cloning and analysis of a specific plant DNA fragment and Agrobacterium mediated gene transfer in plants sponsored by Department of Biotechnology, New Delhi (March 28 - April 17, 1989).

6. STAFF STRENGTH (as on 31-3-89)

(i) Scientific

Director	1
Scientists in Director's grade	3
Scientist G	1
Dy.Director / Sci.F	11
Scientists E. II	16
Scientists E. I	61
Scientists C	173
Scientists B	101
Scientists A	6
SSAs	50
JSAs	15
Lab. Assistants Gr. VIII (SLAs)	7
	445
(ii) Technical	273
(iii) Non-technical	157
(iv) Group D technical	167
(v) Group D non-technical	57
	1099

(vi) Research Fellows, CSIR Pool Officers, Research Associates, Guest Workers, etc.

(a) Research associates	4
(b) Senior research fellows	72
(c) Junior research fellows	39
(d) CSIR pool officers	10
(e) Guest workers	9
	134

7. STAFF NEWS

7.1 Awards/Honours

1. Dr.L.K.Doraiswamy was awarded the prestigious 'Chemical Engineering 1988 award for personal achievement in chemical engineering'. This award is given every two years to the top three chemical engineers of the world for their personal achievements. Dr.Doraiswamy is the first Indian, and probably the first scientist from the developing countries to receive this award.

2. Dr.S.K.Date was invited to join the scientific community of the European Journal of Solid State and Inorganic Chemistry.

3. Dr.S.Devotta has been offered an honorary appointment of visiting fellow in the Dept. of Chemical and Gas Engineering at the University of Salford, UK from 1.10.88 to 30.9.90. This is in connection with the joint research programme between NCL and Salford University.

4. Dr.B.D.Kulkarni was awarded the Herdillia award for 1988 by the Indian Institute of Chemical Engineers for excellence in basic research in chemical engineering.

5. Dr.R.A.Mashelkar was awarded the "Vishwakarma Medal" by the Indian National Science Academy for his outstanding work in the spinning of synthetic fibres and on superabsorbing polymers, which has had considerable impact on industry.

6. Dr.P.Ratnasamy was invited to join the international advisory board of Zeitschrift für Physikalische Chemie, Berlin, GDR.

7. Dr.P.Ratnasamy has been selected as a fellow of Indian Academy of Sciences, Bangalore.

8. Dr.S.Sivaram was awarded the VASVIK award for 1987 in recognition of his outstanding contributions in the field of chemical sciences and technology.

9. Dr.S.Sivaram was invited to be a contributing Editor of the Heart-Cut Column in CHEMTECH, an ACS publication, 1989 and a member of the Editorial Board of Polymer Bulletin, a Springer Verlag Journal, 1988-91.

7.2 Deputations/visits abroad

1. Dr.J.Kuruvilla was deputed to the University of Delaware, USA, under the UNDP project on development of novel shape selective zeolite catalysts (Six months from April, 1988).

2. Dr.P.Ratnasamy was deputed to Belgium, Italy and France under a UNDP project for studies in the field of the R&D of synthesis and industrial application of zeolites (25th April to 4th June 1988).

3. Dr.K.N.Ganesh was deputed to USSR under the Indo-USSR exchange programme (Two weeks from 12th May 1988).

4. Dr.S.Sivasanker and Dr.B.S.Rao were deputed to Japan, Mexico, USA and Canada under a UNDP project for studies in the field of the R&D of synthesis and industrial applications of zeolites (23rd May to 2nd July 1988).

5. Dr.L.K.Doraiswamy, Dr.S.Sivaram and Mr.R.R. Hirwani were deputed to USSR under the Indo-Soviet integrated long term programme of cooperation in science and technology in the area of catalysis (Two weeks from 31st May 1988).

6. Dr.Pradeep Kumar was deputed to the Federal Republic of Germany for study/training under DAAD programme (6th June to 30th September 1988).

7. Dr.A.P.B.Sinha was deputed to Singapore as a member of delegation constituted by the DST for attending the first Asian Pacific Conference on High Superconductivity (27th June to 3rd July 1988).

8. Dr.L.K.Doraiswamy was deputed to Europe, UK and USA for a study tour under the UNDP project 'Development of novel shape-selective zeolite catalysts' (4th July to 8th August 1988).

9. Dr.M.K.Dongare was deputed to Singapore to attend the international seminar on solid state ionic devices at the National University of Singapore (18th to 23rd July 1988).

10. Dr.K.N.Ganesh visited USA under the sponsorship of NIH, USA and presented a paper at the international symposium on magnetic resonance in biological systems held at the University of Madison, Wisconsin (August 1988).

11. Dr.N.R.Ayyangar visited Moscow under Indo-USSR programme (1st to 14th September 1988).

12. Dr.(Mrs.)Vidya Gupta visited USA and spent six months in the laboratory of Prof.Timothy Hall at College Station, Texas under the CSIR Raman Research Fellowship for a study visit in emerging high priority areas tenable abroad (Six months from October 1988).

13. Dr.S.D.Sansare was deputed to the USSR under the Indo-Soviet integrated short term programme of cooperation in science and technology, in the

area of catalysis (Four months from 13th October 1988).

14. Dr.V.R.Choudhary, Dr.B.D.Kulkarni, Dr.S.D.Prasad and Mr.V.R.Chumbale were deputed to USSR under the Indo-Soviet integrated short term programme of cooperation in science and technology in the area of catalysis (13th to 31st October 1988).

15. Dr.M.C.Srinivasan was deputed to USA to attend the International Culture Collaboration Conference-IV at the University of Maryland (30th October to 4th November 1988).

16. Dr.T.Ravindranathan was deputed to USA for attending the Corey symposium at Harvard University and to Sweden for discussions with Prof.S.Bergstrom on the prostaglandins project at NCL (November 4-17, 1988).

17. Dr.L.K.Doraiswamy was deputed to Italy for attending the Spacing Committee Meeting of the ICC Trieste (November 7- 8,1988).

18. Dr.K.V.Krishnamurthy and Dr.Prabhat Singh were deputed to Japan for equipment training on operation of transmission electron microscopy (TEM) (20th November to 4th December 1988).

19. Dr.V.R.Choudhary was deputed to West Germany under the CSIR-DAAD revisitation programme (Three months from 21st November 1988).

20. Dr.C.P.Joshi left for USA to take up post-doctoral research fellowship at the Ohio State Biotechnology Centre, Ohio State University, Columbus, Ohio (December 1988 to November 1990).

21. Dr.B.M.Khan was deputed to Pakistan for participating in the third international training course on recombinant DNA techniques at the Centre for Advanced Molecular Biology, University of Punjab, Lahore, on being selected for the UNESCO/Rostsca Young Scientist Award for 1987 (December 10- 31, 1988).

22. Dr.Doraiswamy was deputed to USA for receiving the Chemical Engineering Magazine's 1988 Award for personal achievement in chemical engineering. The deputation was also for discussing the transfer of NCL's major technologies to US manufacturing firms at New York and Chicago (December 25-31, 1988).

23. Dr.M.Hari Babu was deputed to USSR under the Indo-Soviet integrated long term programme of cooperation in science and technology (Six months from 11th January 1989).

24. Dr.S.Krishnan and Mr.R.S.Singh were deputed to France, Netherlands, UK and West Germany for a survey on existing data bases and software for storage and retrieval of chemical reaction data and to prepare reports under a consultancy contract with UNDP (14th January to 1st February 1989).

25. Dr.A.F.Mascarenhas was deputed to London, UK, under the academic links and interchange scheme project on tissue culture between NCL and Wye College, London. He also gave lecture on tissue culture of forestry in India at the Wye College (Two weeks from 15th January 1989).

26. Dr.M.V.Deshpande was deputed to UK for training in biosensor development at the University of Cambridge under the TCTP of British Council (Six months from 1st February 1989).

27. Dr.S.Devotta was deputed to UK under the Indo-UK MOU project on heat pumps (Three weeks from 16th February 1989).

28. Dr.A.A.Natu was deputed to USSR under the Indo-Soviet integrated long term programme of cooperation in science and technology in the area of basic biology (Ten weeks from 23rd February 1989).

29. Dr.S.Pal visited quantum theory project, University of Florida, Gainesville, FL, USA (1st March to 15th June 1989).

30. Dr.S.G.Hegde was deputed to USA under the UNDP project on novel shape selective zeolite catalysts (Six months from 2nd March 1989).

31. Mr.M.P.Suryawanshi was deputed to West Germany and Switzerland for equipment training (3rd to 20th March 1989).

32. Dr.P.N.Joshi has been deputed to Belgium under the UNDP project 'Development of novel shape selective zeolite catalysts' (Six months from 3rd March 1989).

33. Dr.B.M.Khan has been deputed to USA to take up the Biotechnology Overseas Associateship at Harvard University (One year from 3rd March 1989).

34. Dr.I.Balakrishnan, was deputed to Belgium under the UNDP project on novel shape selective catalysts (Six months from 3rd March 1989).

35. Dr.A.P.Budhkar has been deputed to Sweden under the UNDP project 'Development of novel shape selective zeolite catalysts' (Six months from 3rd March 1989).

36. Dr.S.Sivasanker was deputed to Kuwait for presenting a paper at the Catalysis in Petroleum Refining Conference (5th to 9th March 1989).

37. Mr.K.J.Waghmare has been deputed to Berlin, GDR under the Indo-GDR programme of science and technology (6th March to 29th May 1989).

38. Dr.P.K.Ranjekar was deputed to USA for attending the 1989 annual meeting of the Rockefeller Foundation's international programme on rice biotechnology at Columbia, and the 19th Stadler genetics symposium on gene manipulation in plant improvement at the University of Missouri (7th to 16th March 1989).

39. Mr.I.S.Mulla was deputed to Italy for participating in the experimental workshop on high temperature superconductors at Trieste, sponsored by UNESCO (30th March to 14th April 1989).

7.3 Participation of NCL scientists in symposia, seminars, workshops, etc.

	Symposia/Conference/Workshop	Scientist/s
1.	Conference on super computers and application organised by CDAC and CSI, Hotel Executive Ashoka, Pune	Dr.A.Bhattacharya
2.	Third Indo-Soviet seminar on catalysis, Baku, USSR	Dr.V.R.Choudhary Dr.B.D.Kulkarni Dr.S.D.Sansare Dr.S.D.Prasad
3.	International conference on ferrites (ICF.5), Bombay	Dr.S.K.Date Dr.C.E.Deshpande Dr.P.P.Bakare
4.	Second Indo-USSR seminar on solidstate chemistry, IISc., Bangalore	Dr.S.K.Date
5.	National seminar on modes of access to online databases and applications of CD-ROM and other optical disks, Bangalore	Mr.V.G.Deodhar
6.	Training course on accessing international databases, NAL, Bangalore	Mr.V.G.Deodhar
7.	Course on applications of information technology in biochemical libraries and information centres, University of Poona, Pune	Mr.V.G.Deodhar Ms.M.S.Naigaonkar Mr.M.D.Panse Ms.M.P.Chirmule
8.	International conference on Raman spectroscopy, Calcutta	Dr.S.T.Kshirsagar
9.	International symposium on biological nitrogen fixation associated with rice production	Mr.Y.Mawal
10.	Workshop on Jojoba sponsored by Dept. of Non-Conventional Energy Sources, organised by IIP, Delhi	Ms.U.J.Mehta
11.	National workshop on X-ray emission spectroscopy, Indira Gandhi Centre for Atomic Research, Kalpakkam	Dr.(Ms.) A.Mitra Dr.(Ms.) N.R.Pavaskar
12.	Administrative management course, CECRI, Karaikudi	Mr.H.Nagarajan
13.	National symposium on physical organic chemistry, Madurai Kamraj University, Madurai	Dr.B.S.Nanjundiah
14.	National symposium on organic synthesis, Malti-Chem Research Centre, Vadodara	Dr.U.R.Nayak

15.	International conference on bibliographic databases and network, New Delhi	Mr.M.B.Patil Mr.V.G.Deodhar
16.	International symposium on high temperature superconductivity, University of Rajasthan, Jaipur	Dr.(Ms.)N.R.Pavaskar Mr.I.S.Mulla
17.	X-ray fluorescence techniques, Bombay	Dr.(Ms.)N.R.Pavaskar
18.	Symposium on genetic engineering research in India, IISc., Bangalore	Ms.V.Pethe
19.	Nineteenth Stadler symposium on gene manipulation in plant improvement	Dr.P.K.Ranjekar
20.	Third annual meeting of Rockefeller Foundations' international programme on rice biotechnology	Dr.P.K.Ranjekar
21.	DBT-ICAR workshop in plant molecular biology and agricultural biotechnology, Nuclear Research Laboratories, IARI, New Delhi	Dr.P.K.Ranjekar
22.	Indo-US workshop (with Japanese participation) on electronic ceramics and materials, NCL, Pune	Dr.M.S.Setty Dr.S.K.Date Dr.V.J.Rao Mr.P.D.Godbole
23.	National symposium on environmental impacts on animals and aquaculture, Kalyani University, Kalyani	Dr.R.N.Sharma Mr.S.G.Deshpande
24.	National seminar on advances in economic zoology, Jodhpur	Dr.R.N.Sharma
25.	Workshop on devolution of administrative and financial autonomy in CSIR labs/institutes, NAL, Bangalore	Dr.K.R.Srinivasan Dr.S.S.Tambe
26.	Entrepreneurship development programme, CECRI, Karaikudi	Mr.S.A.Tambe
27.	WHO sponsored training programme, NIDC, Delhi	Mr.P.H.Vartak

7.4 Plenary lectures/key-note addresses/invited lectures given by NCL scientists

	Scientist		Subject
I.	Dr.V.R.Choudhary	i)	Invited lectures at the Institute of Technical Chemistry-I, University of Erlangen-Nurenberg, Erlangen (FRG)
		a)	Oxidative conversion of methane to C_2-hydrocarbons in homogeneous gas phase reaction and over solid catalysts and supports (December 1988)

Scientist		Subject
	b)	Single and multicomponent sorption/diffusion of hydrocarbons from their iso-octane solution in H-ZSM-5 zeolite (January 1989)
	c)	Shape selectivity of pentasil zeolites in sorption and diffusion: A shuttle cock shuttle box model (February 1989)
	ii)	Invited lecture on 'Shape selectivity of pentasil zeolites in sorption/diffusion : A shuttle cock - shuttle box model' at BASF Aktiengeseltschaff, Ludwigshafen (FRG), (January 1989)
	iii)	Invited lecture on 'Oxidative conversion of methane to C_2- hydrocarbons in homogeneous reaction and over solid catalysts and inert supports' at Technische Chemie, Ruhr University, Bochum (January 1989)
	iv)	Invited lecture on 'Shape selectivity of pentasil zeolites in sorption/diffusion : A shuttle cock - shuttle box model' at the Institute of Physical Chemistry, University of Hamburg, Hamburg (FRG), (February 1989)
	v)	Invited lecture on 'R and D activities in the area of heterogeneous catalysis in NCL, Pune' at the Institute für Technische-Verfahrenste Technik, Universitat-Karlsruhe, Karlsruhe (FRG), (February 1989)
2. Dr.S.K.Date		Invited to co-chair the technical session on thin films at the international conference on ferrites (ICF-5), Bombay (January 1989)
3. Dr.L.K.Doraiswamy		Presided over the SAEST conference on solid state electrochemistry at the University of Poona, Pune (September 1988)
4. Dr.A.F.Mascarenhas		Invited lecture on application of plant biotechnology in agriculture, forestry and germ plasm conservations, BIOTEK INDIA-88, the international exhibition and conference on biotechnology, New Delhi (October 1988)
5. Dr.V.M.Nadkarni	i)	Invited lecture on polymer blends and alloys : A review at DST workshop on polymers and composites, IISc., Bangalore
	ii)	Invited lecture on computer modelling and simulation of PET met spinning at IIT, Delhi, special course for industry organised by Textile Science and Engineering Department (December 1988)
6. Dr.P.K.Ranjekar		Invited talk on rice biotechnology research at NCL, one day seminar on rice biotechnology at Directorate of Rice Research Centre, Hyderabad
7. Dr.V.J.Rao		Plenary lecture at the Society for Advancement of Electrochemical Science and Technology conference on solid state electrochemistry, University of Poona, Pune (October 1988).
8. Dr.T.Ravindranathan		N.V.Krishna Rao memorial lecture 1988 on synthesis of biological compounds - a practical approach, Osmania (February 1988)

	Scientist		Subject
9.	Dr.R.N.Sharma		Chaired the session on aquatic biology and vectors at Kalyani (May 1988)
10.	Mr.R.S.Singh		Chaired session I : Bibliographic database, INFOTEX conference on application of mini and micro computers in documentation, information and libraries at CLRI, Madras (September 1988)
11.	Dr.S.Sivaram	i)	Invited by the National Academy of Adminitration, Musorie to conduct a lecture-cum-discussion on petrochemicals and polymers-policy options for senior IAS officers drawn from different states in India
12.	Dr.S.Sivasanker		Talk on catalysis during the 9th ICC- Ibero-american symposium at Calgery, Canada (1988)
13.	Dr.M.C.Srinivasan		Invited talk on endangered microbial species, culture collections and germ plasm resource pools - An overview, VI International - Congress of Culture Collections, Maryland, USA (October 1988)

7.5 Membership of committees

	Scientist	Capacity	Name of the committee
1.	Dr.N.R.Ayyangar	Member	Research Advisory Committee of Rallis India Ltd., Bangalore
		Member	CSIR Cell on Drugs and Vaccines Committee
		Member	Dye Intermediates Sectional Committee, PCDC II and Anthraquinone Sub-Committee, PCDC-II:4:BIS
2.	Dr.B.V.Bapat	Member	Test Sub-Committee PCDC I8 : I of ISI, New Delhi
3.	Dr.J.Barnabas	Member	Editorial Board of (i) Biotechnology Letters, (ii) Biotechnology Techniques; Science and Technology, England
		Member	Research Council of National Botanical Research Institute, Lucknow
		Member	Management Council of National Botanical Research Institute, Lucknow
		Member	Research Advisory Committee for Applied Biology, Division of Indian Petrochemicals Corporation Ltd. Research Centre, Gujarat
		Member	Advisory Council of CSIR Centre for Biochemicals, New Delhi
		Member	Management Council of CSIR Centre for Biochemicals, New Delhi
		Member	Advisory Committee in Biological Sciences for S.S.Bhatnagar prize
		Member	Biochemistry Research Committee of Council of Scientific and Industrial Research, New Delhi
		Member	Scientific Advisory Committee to National Institute of Virology, Pune
		Member	Sectional Committee on General Biology, Indian Academy of Sciences
		Member	Sectional Committee IX : Indian National Science Academy
		Member	Executive Committee and the Council of the Maharashtra Association for the Cultivation of Science
		Member	Editorial Board of the Indian Journal of Biochemistry and Biophysics
		Member	Editorial Board for Proceedings of Indian Academy of Sciences - Animal Sciences
		Organiser & one of the co-ordinators	Mahabaleshwar Seminar on Modern Biology in collaboration with Tata Institute of Fundamental Research, Bombay and Indian Institute Science, Bangalore

	Scientist	Capacity	Name of the committee
		Member	Advisory Committee for Space Sciences (Indian Space Research Organization), Bangalore
4.	Dr.S.K.Date	Member	CSIR Committee on High-tech Ceramics to finalize Research Programmes during the VIII Five Year Plan period(1990-95)
		Member	CSIR Task Force Group of High Temperature Superconductors
		Member	CSIR Committee on Standard Reference Materials
5.	Dr.V.R.Choudhary	Member	Board of Studies in Chemical Technology, Faculty of Nagpur University, Nagpur
6.	Dr.S.Devotta	Treasurer	Association of British Council Scholar (Western India) Pune Chapter, I988-89
		Organising Secretary	Institution of Chemical Engineers (Pune Regional Centre) Silver Jubilee Year (1988-89) Lecture Series
7.	Dr.L.K. Doraiswamy	Member	Scientific Advisory Committee, Ministry of Chemicals and Fertilizers
		Member	Scientific Advisory Committee, Ministry of Chemicals and Petroleum
		Member	Programme Advisory Committee for Chemical Engineering, Department of Science and Technology
		Member	Vithal Mallya Scientific Research Foundation
		Member	Committee on Chemicals and Plastics, Department of Electronics
		Member	Hindustan Lever Research Foundation – Chemical Sciences Group
		Member	VASVIK Award Board of Advisors (Chemical Sciences and Technology Committee)
		Member	Indian Chemical Manufacturers Association Awards Committee
		Member	Governing Council, University of Poona, Pune
		Member	Technology Development Advisory Group for Fermentation Technology and Industrial Application of Biotechnology (Food and Fermentation Directorate)
		Member	Public Liability Insurance to Compensate Victims of Industrial Accidents, Ministry Environment and Forest
		Member	Working Group for the Formulation of the 8th Plan for the Department of Scientific and Industrial Research
		Member	Special Group to Assist the Steering Committee (Planning Commission) on Industry for the 8th Plan

Scientist	Capacity	Name of the committee
Dr. L.K. Doraiswamy (Contd.)	Member	Board of Awards for Import Substitution and Technology Development (Two years from 15.3.1989)
	Member	Governing Body of CSIR and Society of CSIR (Three years from 9.1.1989)
	Member	Managing Committee of the CSIR Centre for Mathematical Modelling and Computer Simulation (C-MMACS) established at the NAL, Bangalore
	Member	Advisory Committee on Exports for R&D, Gujarat Alkalies and Chemicals Ltd., Baroda
	Member	Inter-Ministerial Committee on Hazardous Chemicals, Ministry of Environment and Forest
	Member	Expert Group of Indian National Science Academy for Preparing Report on the Govt. of India Technology Policy Statement
	Member	Board of Trustees, Regional Computer Centre (Pune)
	Member	Electronics Material Development Agency (EMDA), Department of Electronics
	Member	Council of Development of Materials for Electronics (CDOME), Department of Electronics
	Member	High Power Advisory Committee for Planning and Implementation of Science and Technology Project of Central University, Pondicherry
	Member	Central Committee of Science and Technology for Technology Mission on Drinking Water in Villages and Related Water Management, Ministry of Agriculture, Department of Rural Development
	Member	Governing Council of Deccan Sugar Institute, Pune
	Member	R&D Advisory Committee, Hindustan Antibiotics Ltd.,Pune
	Member	Working Group on Technology Input and Promotion of High Tech. Industries, Planning Commission
	Member	Award Committee-Dr.K.G.Naik Gold Medal, M.S.University of Baroda
8. Dr.K.N.Ganesh	Member	Authors Team for Chemistry Text Books Writing, NCERT 1987-89
	Member	Monitoring Committee on Oligonucleotide Synthesis, CSIR Centre for Biochemicals, New Delhi
	Member	TAB (Biological Science) Sub-Group on Protein Engineering

	Scientific	Capacity	Name of the committee
9.	Dr.S.Gundiah	Member	Governing Council of Indian Rubber Manufacturers' Research Association,Bombay
		Member	Standing Committee in the Area of Plastics and Polymers in Buildings
10.	Dr.S.H.Iqbal	Member	Finance Committee of the National Facility for Animal Tissue and Cell Culture, University of Poona
		Member	Advisory Committee for CSIR Exhibition to Advise on the Exhibition Policy and Organisation of Exhibition in India and Abroad
		Member	Management Council of the Indian National Scientific Documentation Centre (INSDOC), New Delhi
11.	Dr.S.S.Katti	Member	Indian Society for Surface Science and Technology
		Member	National Advisory Committee for Research and Development for Evaporation Control
		Member	Working group of the Inter-national Water Resources Association
12.	Dr.K.V.Krishnamurthi	Founder Member	Plant Tissue Culture Association (India)
		Member	Indian Scientific Translators' Association (India)
		Member	INSDOC Panel of Translators
13.	Dr.B.D. Kulkarni	Member	Research Advisory Committee of the IPCL R&D Programme
		Member	Working Group on CSIR Centre for Mathematical Modelling
14.	Dr.M.G.Kulkarni	Member	Expert Committee of the University of Poona for Polymer Science and Engineering
15.	Dr.A.F.Mascarenhas	Member	Research Advisory Council of ICAR on Biotechnology
		Member	Research Advisory Council, RRL, Trivandrum
		Member	Research Advisory Council of Poona University on Biotechnology
		Member	Indo-US Panel on Biomass
		Founder Member and Member Secretary	Plant Tissue Culture Association of India
		Secretary	Asia S.Pacific Network Commonwealth Science Council (U.K.)

	Scientific	Capacity	Name of the committee
16.	Dr.R.A.Mashelkar	Editor(India)	Chemical Engineering Science, Pergaman Press (UK)
		Editor(India)	Chemical Engineering Communications, Gordon Breach (USA)
		Editor(India)	Rheological Acta, Dr.Dietrich Stinkopff Verlag (Germany)
		Editor(India)	J.Non-Newtonian Fluid Mechanics, Elsevier (Holland)
		Editor	Advances in Transport Processes, Wiley Eastern/ Wiley Halsted (New Delhi/New York)
		Member	Editorial Board, Indian Journal of Technology
		Member	Sadhana, Proceedings of Indian Academy of Sciences (Engineering Sciences)
		Member	Editorial Advisory Board, Polymer Materials, Oxford and IBH Publishing Company
		Member	Editorial Advisory Board, Latin American Applied Research INTEC,Argentina
		Member	Science Advisory Council to Prime Minister of India
		Member	Board of Directors, Hindustan Fluorocarbons Ltd.,Hyderabad
		Member	Board of Directors, Indian Petrochemicals Corporation Ltd., Baroda
		Member	Science and Engineering Research Council, Department of Science and Technology
		Member	Research Advisory Committee, Hindustan Lever Research Centre
		Member	Sectional Committee (Engineering Sciences) of Indian Academy of Sciences
		Member	Sectional Committee (Chemical Engineering and Technology and Materials) of National Academy of Engineering
		Member	Governing Body, Sri Chitra Tirunal Medical Centre, Trivandrum
		Member	Assessment of R&D Centre of Indian Petrochemicals Corporation Ltd., Baroda (COPU Committee of Govt. of India)
		Member	BOYS CAST Programme, Department of Science & Technology President Society for Polymer Science in India (1986-89)
		Member	Academic Committee of National Defence Academy
17.	Dr.V.M. Nadkarni	Member	Bureau of Indian Standards, Plastics Pipes Sub-Committee
		Member	Editorial Board, International Polymer Processing Journal, USA

	Scientist	Capacity	Name of Committee
17.	Dr. V.M. Nadkarni (Contd.)	Member	Confederation of Engineering Industry, R&D Sub-Committee and Engineering Services Sub- Committee
		Member	Editorial Advisory Board, Hanser-Verlag Publishers Monograph Series on Progress in Polymer Processing
18.	Dr.P.K. Ranjekar	Member	Task Force Committee in Plant Molecular Biology and Agricultural Biotechnology, Dept. of Biotechnology, New Delhi
19.	Dr.V.J.Rao	Member	National Advisory Committee of the International Conference on the Physics and Technology of Compensated Semi-conductor, IIT, Madras
20.	Dr.P.Ratnasamy	Member	Editorial Board of the Fuel Science and Technology (Journal brought out by CFRI, Dhanbad)
21.	Dr.T.Ravindranathan	Member	Expert Group on Drugs for Safety in Chemical and Petrochemical Industries
		Member	Safety Survey Committee Expert Group II Private Sector- Chemical Unit formed by Ministry of Industry, Govt. of India (1986)
22.	Dr.M.S.Setty	Organising Secretary	4th Annual Conference of International Society for Hybrid Microelectronics-India (1988)
		Member	All India Committee for Status Report on Hybrid Microcircuits Technology in India
23.	Dr.R.N.Sharma	Member	Indian National Trust for Arts and Cultural Heritage (INTACH)
		Member	Society of Pesticides Science
		Member	Society for Malaria and other Communicable Diseases
24.	Dr.S.Sivaram	Member	Technology Advisory and Review Committee of Risk Capital and Technology Finance Corporation Ltd., a fully owned subsidiary of Industrial Credit and Investment Corporation of India
		Member	Management Council, RRL, Jammu for 1988-91
		Member	Programme Advisory Committee, SERC Thrust Area Programme in Organic Chemistry, DST, 1987-91
25.	Dr.M.C.Srinivasan	Member	Executive Council of Microbial Type Culture Collections, Institute of Microbial Technology, Chandigarh
		Member	World Federation of CultureCollections
		Member	Project Advisory Committee of DST on Plant Sciences
26.	Dr.A.J.Varma	Member	Sub-Committee on Chemical and Metallurgical Research of RDSO, Ministry of Railways
		Member	Steering Committee of Naval Chemical and Metallurgical Laboratory, Ministry of Defence

7.6 Post-graduate degrees received by NCL staff members and research fellows/guest workers

Sr. No.	Name	Degree	University	Subject	Guide
1.	Mr.D.B.Akolekar	Ph.D.	Poona	Sorption, diffusion and catalytic reactions on zeolite-like materials	Dr.V.R.Choudhary
2.	Mr.M.V.Badiger	Ph.D.	Bombay	Transport phenomena in polymeric media	Dr.R.A.Mashelkar
3.	Mr.K.B.Bastawade	Ph.D.	Poona	Studies on xylanase from *Chainia* sp.	Dr.H.G.Vartak
4.	Mr.A.M.Bodhe	Ph.D.	Poona	Enzyme inhibitors	Dr.H.G.Vartak
5.	Mr.A.P.Budhkar	Ph.D.	Poona	Studies on thiosemicarbazones, some nitrogen, sulphur containing heterocyclic ligands and their metal complexes	Dr.C.Gopinathan
6.	Ms.M.P.Chirmule	M.Lib. I.Sc.	Poona	Standardization in library and information services-A-state-of-the-art-report	Prof.M.R.Riswadkar*
7.	Mr.N.S.Dabke	Ph.D.	Bombay	Stochastic analysis of chemically reacting systems: Role of external fluctuations	Dr.L.K.Doraiswamy
8.	Ms.M.P.Degaonkar	M.Sc.	Poona	Study of some complexes of Gr.IV metals mainly titanium, tin and lead	Dr.C.Gopinathan
9.	Ms.S.S.Deshpande	M.Sc.	Poona	Carbonyl chemistry of Group VIII metals	Dr.C.Gopinathan
10.	Mr.G.D.Ghadge	Ph.D.	Poona	Microbial enzymes (alkaline proteinase from *Conidiobolus* sp.)	Dr.H.G.Vartak
11.	Mr.G.S.Grover	M.S.	Salford (UK)	A study of heat energy recycling systems	Prof.F.A.Holland*
12.	Ms.G.D.Hebbalkar	M.Sc.	Poona	Manipulation of insect behavioural physiology by selected synthetic chemicals	Dr.R.N.Sharma
13.	Mr.R.Jaganathan	Ph.D.	Poona	Modelling of three phase catalytic reactors	Dr.R.V.Chaudhari
14.	Mr.G.S.Joshi	Ph.D.	Poona	Synthetic studies in biologically active compounds	Dr.G.H.Kulkarni
15.	Mr.J.M.Khire	Ph.D.	Poona	Studies on extracellular, specific D-xylose isomerase from *Chainia* sp.	Dr.H.G.Vartak
16.	Mr.R.J.Kudchadkar	M.Sc.	Poona	Study of electrical and structural properties of Zn_{1-x} Ti_xO_2 thick film oxygen sensors	Dr.M.S.Setty

Sr. No.	Name	Degree	University	Subject	Guide
17.	Ms.S.S.Kulkarni	M.Sc.	Poona	Studies in the preparation of I,3-butylene glycol using aqueous solution of acetaldehyde	Dr.A.N.Gokarn
18.	Mr.A.S.Mamman	M.Sc.	Poona	Diffusion of pure liquid hydrocarbons in high silica pentasil zeolites	Dr.V.R.Choudhary
19.	Mr.J.Mathew	M.Sc.	Poona	Thermomechanical behaviour of modified asphalts	Dr.V.M.Nadkarni
20.	Ms.M.Mawal	Ph.D.	Poona	Studies of seed storage proteins in legumes with special reference to pigeonpea	Dr.P.K.Ranjekar
21.	Mr.R.B.Naidu	M.Sc.	Poona	Studies on plant tissue culture-studies on protoplasts of *Vigna unguiculata*	Dr.A.F.Mascarenhas
22.	Mr.V.R.Patwardhan	Ph.D.	Salford (UK)	Nonazeotropic mixtures as working fluids for heat pumps	Prof.F.A.Holland*
23.	Mr.P.Ramaiah	Ph.D.	Poona	Utilization of natural products and development of improved organic preparations and procedures	Dr.A.S.Rao
24.	Mr.D.D.Ravetkar	Ph.D.	Poona	Transport phenomena in multiphase polymeric systems	Dr.R.A.Mashelkar
25.	Ms.R.Seeta	Ph.D.	Poona	Enzymatic hydrolysis of cellulose	Dr.M.C.Srinivasan
26.	Mr.B.Seetaramarao	Ph.D.	Poona	Microbial enzymes : Immobilized whole cell systems in fermentation	Dr.C.SivaRaman
27.	Ms.L.Sivadasan	M.Sc	Poona	Synthesis of some biologically active compounds	Dr.A.V.Rama Rao*
28.	Mr.I.I.Sutar	Ph.D.	Poona	Studies on protolytic enzyme	Dr.H.G.Vartak
29.	Ms.S.Tamhankar	Ph.D.	Poona	Condensed chromatin in higher plants	Dr.P.K.Ranjekar
30.	Mr.P.Venkateswara Rao	Ph.D.	Salford (UK)	Theoretical and experimental studies on heat pump assisted system	Prof.F.A.Holland*

* Guides not from NCL

7.7 NCL scientists recognised by different universities as research guides

1.	Dr. Ayyangar, N.R.	Bombay, Poona, Shivaji
2.	Dr. Barnabas, J.	Poona
3.	Dr. Brahme, P.H.	Poona
4.	Dr. (Mrs.) Chanda, B.	Poona
5.	Dr. Chaudhari, R.V.	Poona, Shivaji, Bombay
6.	Dr. Choudhary, V.R.	Poona, Shivaji, Bombay
7.	Dr. Date, S.K.	Poona
8.	Dr. Deshpande, M.V.	Poona
*9.	Dr. Doraiswamy, L.K.	Banaras, Bombay, Calcutta, Jadhavpur, Nagpur, Poona, Salford (U.K.)
10.	Dr. Deshpande, V.H.	Poona
11.	Dr.(Mrs.) Deshpande, V.V.	Poona
12.	Dr. Ganesh, K.N.	Poona, Osmania
13.	Dr. Gokarn, A.N.	Poona
14.	Dr. Gopinathan, C.	Marathwada, Poona, Shivaji
15.	Dr. Gundiah, S	Karnataka, Poona
16.	Dr. Harish Narain	Shivaji
17.	Dr. Hazra, B.G.	Poona
*18.	Dr. Jose, C.I.	Poona
19.	Dr. Katti, S.S.	Bombay, Poona, Shivaji
20.	Dr. Krishnamurthy, K.V.	Poona, Shri Venkateshwara, Shivaji
21.	Dr. Kshirsagar, S.T.	Poona
22.	Dr. Kulkarni, B.D.	Poona
23.	Dr. Kulkarni, G.H.	Nagpur, Poona
24.	Dr. Kulkarni, M.G.	Poona
*25.	Dr. Kulkarni, S.N.	Bombay, Karnataka, Poona, Shivaji
26.	Dr. Lachke, A.H.	Poona
27.	Dr. Mahajan, S.S.	Poona
28.	Dr. Mascarenhas, A.F.	Poona
29.	Dr. Mashelkar, R.A.	Banaras, Bombay, Nagpur, Poona, Salford(U.K.)

30.	Dr.(Mrs.) Nadgauda, R.S.	Poona
31.	Dr. Nadkarni, V.M.	Poona, IIT, Delhi
32.	Dr. Nagasampagi, B.A.	Poona
33.	Dr. Nanjundiah, B.S.	Poona
34.	Dr. Natu, A.A.	Poona
*35.	Dr. Nayak, U.R.	Poona, Shivaji
36.	Dr. Pande, B.	Poona
37.	Dr. Panse, G.T.	Poona, Shivaji
38.	Dr.(Mrs.) Patwardhan, S.A.	Poona, Shivaji
39.	Dr. Patwardhan, V.S.	Poona, Shivaji
40.	Dr. Rajappa, S.	Poona, Bombay
41.	Dr. Ranjekar, P.K.	Poona, Shivaji
42.	Dr.(Mrs.) Rao, M.	Poona
43.	Dr. Rao, B.S.	Bombay, Shivaji, Poona
44.	Dr. Rao, V.J.	Poona
45.	Dr. Ravindranathan, T.	Bombay, Marathwada, Shivaji, Poona
46.	Dr. Setty, M.S.	Poona
47.	Dr. Sharma, R.N.	Poona, Shivaji
48.	Dr. Shankar, V.	Poona
49.	Dr.(Mrs.) Siva Raman, H.	Poona
50.	Dr. Sivasanker, S.	Shivaji
51.	Dr. Sonawane, H.R.	Marathwada, Poona
52.	Dr. Shrinivasan, M.C	Poona, Shivaji
53.	Dr. Tewari, R.	Poona
54.	Dr. Umapathy, P.	Poona
55.	Dr. Varma, A.J.	Poona
56.	Dr. Vernekar, S.P.	Poona, Shivaji

* Retired as on 1.3.90

8. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

1. Mawal, Y.R., Mawal, M.R., Sainani, M. and Ranjekar, P.K.,
Seed storage proteins and their genes in plants,
National workshop on advances in plant genetics and gene manipulations in higher plants, Hyderabad, March, 1988.

2. Mawal, Y.R., Mawal, M.R. and Ranjekar, P.K.,
Homology and divergence of rice glutelin with fourteen other seed storage protein genes of six flowering plants,
International conference on research in plant sciences with reference to the future, Delhi, March, 1988.

3. Bakare, S.D., Deshpande, K.G. and Gorhe, N.M.,
Microcontrollers - a revolution at door step,
Symposium on microprocessors - an aid and tool to instrumentation of tomorrow, Bombay, March, 1988.

4. Tambe, S.A. and Srinivasan, K.R.,
Technology development and transfer at NCL,
Entrepreneurship development programme, CECRI, Karaikudi, April, 1988.

5. Gokhale, S., Rao, V.J., Nigvekar, A.S. and Kulkarni, S.K.,
GaAs/Dy interface investigation : An XPS, UPS and HREELS study,
Third Asia Pacific Physics Conference, Hong Kong, June, 1988.

6. Devasthale, S.V., Hooper, M., Kulkarni, S.N. and Yates, M.D.,
The design development of novel broad spectrum antimicrobial compounds from thiourea,
Thirteenth International Leprosy Congress, Hauge, Netherlands, September, 1988.

7. Hooper, M., Kulkarni, S.N., Phadke, A.S., Salunkhe, A.M. and Yates, M.D.,
A structure activity study of succinic acid derivatives as novel antituberculosis agents,
Thirteenth International Leprosy Congress, Hauge, Netherlands, September, 1988.

8. Singh, R.S.,
Creation of database for Indian chemical patents using CDS/ISIS,
INFOTEX conference on application of mini and micro computers in documentation, CLRI, Madras, September, 1988.

9. Mascarenhas, A.F.,
Application of plant technology in agriculture, forestry and germ plasm conservation,
Biotech India 1988, New Delhi, October, 1988.

10. Khale, A., Srinivasan, M.C. and Deshpande, M.V.,
Dimorphism in *Benjaminiella poitrasii* : Inositol prevents the morphological change caused by ethanol and isopropanol,
Fiftyseventh Annual meeting of the Society of Biological Chemists (India), New Delhi, October, 1988.

11. Choudhary, V.R., Chaudhari, S.T. and Rajput, A.M.,
Oxidative coupling of methane to C_2-hydrocarbons in homogeneous reaction and over solid supports and catalysts,
Third Indo-Soviet seminar on catalysis, Baku (USSR), October, 1988.

12. Panse, G.T. and Kamat, S.K.,
Synthesis of versatile signal peptide derivative,
Fiftyseventh Annual General SBC Convention, CSIR Centre for Biochemicals, Delhi, October, 1988.

13. Kulkarni, S.N., Kamath, H.V. and Bhamare, N.K.,
Reduction studies of *o*-nitroaryl enamines. A new synthesis of 4(H) quinolones,
Indian Council of Chemists, Tirupathi, October, 1988.

14. Bakare, S.D., Deshpande, K.D. and Gorhe, N.M.,
A novel Lilliputian controller for automatic mains failure control for diesel generated set,
National symposium on instrumentation, Mysore, November, 1988.

15. Bakare, S.D., Deshpande, K.D. and Gorhe, N.M.,
An innovative software approach for programming beam energy compensation of IRS 4000 infra red spectrophotometer,
National symposium on instrumentation, Mysore, November, 1988.

16. Bakare, S.D., Deshpande, K.D. and Gorhe, N.M.,
A single chip microcontroller based chart drive system for Y.T. recorder,
National symposium on high speed instrumentation, Chandigarh, December, 1988.

17. Nitya Vittal, Phadke, S.D., Setty, M.S., Karekar, R.N. and Aiyer, C.R.,
Study of manganite composition and Ag loading effects for thick film thermistor applications,
Fourth annual conference ISHM-India, Pune, December, 1988.

18. Kudchadkar, R.J. and Setty, M.S.,
Examination of $Zr_{1-x}Ti_xO_2$ systems for thick film oxygen sensors,
Fourth annual conference ISHM-India, Pune, December, 1988.

19. Mandhare, M.M., Afzalzadeh, R., Gangal, S.A., Setty, M.S. and Karekar, R.N.,
Performance comparison of thin and thick film microstrip antennas in X-band,
Fourth annual conference ISHM-India, Pune, December, 1988.

20. Rao, V.J., Manorama, V. and Bhoraskar,S.V.,
Nearly ideal interfacial properties of organic sulphide coated n-GaAs surfaces,
International conference on semiconductor materials and devices, New Delhi, December, 1988.

21. Choudhary, V.R. and Sane, M.G.,
Hydrogenation of *o*-nitrophenol on Pd-carbon in three phase stirred autoclave : Influence of Pd-loading on carbon and solvent on the reaction,
Proc. 9th National symposium on catalysis, Madras, December, 1988.

22. Dhaneshwar, N.N., Tavale, S.S. and Guru Row, T.N.,
Structure of hexacyclo [7.4.2.$O^{1,9}$.$O^{3,7}$.$O^{4,14}$.$O^{6,15}$] pentadeca-10,12-diene-2,8-dione,
National seminar on crystallography, BHU, Varanasi, December, 1988.

23. Puranik, V.G., Tavale, S.S. and Guru Row,T.N.,
Molecular rearrangement of photoparthenin by BF3-etherate- acetic acid complex : X-ray crystal structure of a novel product,
National seminar on crystallography, BHU, Varanasi, December, 1988.

24. Puranik, V.G., Tavale, S.S. and Guru Row, T.N.,
Structure of methyl -benzamido-ß-mercaptophenyl ß-phenyl propionate,
National seminar on crystallography, BHU, Varanasi, December, 1988.

25. Dhaneshwar, N.N., Tavale, S.S. and Guru Row, T.N.,
Structure of spiro [camphane-2-m-dithiane]-10-methyl-sulphoxide,
National seminar on crystallography, BHU, Varanasi, December, 1988.

26. Date, S.K., Deshpande, C.E., Kulkarni, S.D. and Shrotri, J.J.,
Synthesis of ultrafine particles of Sr-ferrite by chemical coprecipitation with sodium hydroxide,
International conference on ferrites (ICF-5), Bombay, January, 1989.

27. Koinkar, V.N., Nawathey, R., Choudhari, S.M., Kanetkar,S.M., Ogale, S.B. and Date, S.K.,
Synthesis of ferrite films by pulsed laser evaporation process,
International conference on ferrites (ICF-5), Bombay, January, 1989.

28. Date, S.K. and Deshpande, C.E.,
Chemical passivation and thermal stabilization of unstable 3d monoxides (MnO,FeO),
Second Indo-USSR seminar on solid state chemistry, IISc., Bangalore, January, 1989.

29. Godbole, P.D., Deshpande, S.B., Date, S.K., Nawathey,R. and Ogale, S.B.,
Sol-gel synthesis of ultrafine barium titanate using BTM and Ba(NO) and its characterization,
Indo-US workshop on electronic ceramics and materials, Pune, February, 1989.

30. Ayyangar, N.R.,
New development in dyes and dye intermediates,
Seminar held under the auspices of Gujarat Dyestuff Manufacturers Association, Ahmedabad, February, 1989.

31. Nanjundiah, B.S.,
Conformation - specific photochemistry in isotropic trend media. Norish type II reactions of epimeric 2-acetyl-3,3- dimethyl norbornanes,
National symposium on current trends in physical organic chemistry, Kamraj University, Madurai, February-March, 1989.

32. Singh, R.P. and Singh Ajeet,
Photoactive pigments for understanding the mechanism of photodegradation of E-P copolymer,
Symposium on mechanisms of polymerisation processes, Madras, March, 1989.

33. Sivaram, S.,
Hydrogen effects in olefin polymerization catalysts, Symposium on mechanisms of polymerization processes, Madras, March, 1989.

9 PATENTS IN FORCE AS ON 31-3-1989

Indian patents sealed

1. 154669(581/DEL/80)
Catalyst and process for the conversion of alcohol to hydrocarbons.
Kulkarni(Ms), S.B., Ratnasamy, P., Balkrishnan, I., Rao, B.S., Chandwadkar(Mrs),A.J and Kotasthane, A.N.

2. 154702(900/DEL/80)
Improved process for the conversion of toulene to xylenes.
Kulkarni(Ms), S.B., Ratnasamy, P., Kotasthane, A.N., Chandwadkar(Mrs),AJ, Babu, G.P. and Chandavar, K.H.

3. 155205(843/DEL/80)
A process for the preparation of catalyst .
Kulkarni(Ms),S.B.,Ratnasamy, P., Kotasthane, A.N., Chandwadkar(Mrs),AJ, Babu, G.P. and Chandavar, K.H.

4. 155892(290/DEL/81)
Process for the catalytic conversion of alkylaromatic hydrocarbons into paraxylenes.
Kulkarni(Ms), S.B., Ratnasamy, P., Kotasthane, A.N., Chandwadkar(Mrs),AJ, Rao, B.S., Kulkarni, S.J.. and Hegde, S.G.

5. 155893(291/DEL/81)
Process for the preparation of a catalytic composite material.
Kulkarni(Ms), S.B., Ratnasamy, P., Shiralkar, V.P., Balkrishnan, Kavedia, C.V.

6. 157061(630/DEL/81)
Improved process for the disproportionation of toulene to benzene and xylene.
Kulkarni(Ms), S.B., Ratnasamy, P., Shiralkar, V.P., Balkrishnan, Babu, S.B. and Chandavar, K.H.

7. 157390(707/DEL/81)
An improved process for the preparation of aromatiic hydrocarbons from ethyl alcohol in a single step conversion.
Kulkarni(Ms), S.B., Ratnasamy, P., Balkrishnan, I., Rao, B.S., Chandwadkar(Mrs), AJ and Kotasthane, A.N.

8. 157487(702/DEL/81)
A process for the preparation of cellulose acetate suitable for making membranes for use in reverse osmosis.
Ghadge, N.D., Sabne, M.B. and Gujar, K.B.

9. 158085(478/DEL/82)
A process for the preparation of stable manganous oxide (MnO).
Murthy, M.N.S., Deshpande, C.E., Bakare, P.P. and Shrotri(Mrs), J

10. 158254(732/DEL/80)
Catalyst and process for the alkylation of benzene to ethyl- benzene.
Ratnasamy, P., Kulkarni(Ms), S.B., Babu, G.P., Chandavar, K.H. an Shiralkar, V.P.

11. 158255(44/DEL/82)
An improved process for the catalytic alkylation of benzene to ethylbenzene.
Kulkarni(Ms), S.B., Ratnasamy, P., Shiralkar, V.P., Babu, G.P. an Chandavar, K.H.

12. 158491(476/DEL/82) An improved process for the preparation of N-Akyldiisopropanol-amines.
Nerlekar, P.G. and Moghe, P.P.

13. 158574(670/DEL/82)
A improved process for the preparation of thermoplastic polyurethane polymers. Ghatge, N.D. and Jadhav, J.Y.

14. 159164(370/DEL/83)
A process for the catalytic conversion of methanol to hydrocarbons mainly olefins.
Ratnasamy, P., Balakrishnan, I., Kulkarni,(Ms) S.B., Rao, B.S., Shiralkar, V.P., Hegde, S.G. and Borade, R.

15. 159405(57/DEL/83)
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reactions.
SivaRaman, H., Rao, B.S., Shankar, V., Pundle, A.V. and SivaRaman, C.

16. 159406(58/DEL/83)
A catalytic process for the conversion of methanol to olefins.
Kulkarni(Ms), S.B., Ratnasamy, P., Balakrishnan, I., Rao, B.S., Shiralkar, V.P., Hegde, S.G. and Kotasthane, A.N.

17. 159407(115/DEL/83)
A process for the preparation of composite catalyst material.
Kulkarni(Ms), S.B., Ratnasamy, P., Balakrishnan, I., Shiralkar, V.P., Kotasthane, A.N., Rao, B.S. and Borade, R.B.

18. 159409(296/DEL/83)
A process for the preparation of homogeneous metal chiral ligands catalysts using natural alkaloides.
Gogte, V.N., Natu, A.A. and Ahuja(Ms), R.R.

19. 159420(539/DEL/83)
A novel process for the preparation of isocyanate terminated (Te-lechelic) diene prepolymers by free radical polymerization technique.
Ghatge, N.D., Vernekar, S.P. and Vadgaonkar, P.P.

20. 159595(628/DEL/83)
A process for the manufacture of benzene and xylene admixtures from alkyl aromatic hydrocarbons.
Ratnasamy, P., Kulkarni(Ms), S.B., Meshram, N.R. and Hegde, S.G.

21. 159819(507/DEL/84)
An improved process for the preparation of monoalkyl esters ofazelaic acid.
Mitra, R.B., Joshi, R.S. and Lunkad, K.F.

22. 160038(437/DEL/83)
A process for the conversion of alkanols to hydrocarbons.
Ratnasamy, P., Balakrishnan, I. and Rao, B.S.

23. 160170(587/DEL/84)
An novel process for the manufacture of 2, 4-dichloro-5-pentade- cylphenoxy acetic acid.
Amarnath, N., Ghatge, N.D. and Moghe, P.P.

24. 160212(275/DEL/83)
A process for the preparation of crystalline catalyst composite material designated Encilite.
Ratnasamy, P., Borade, R.B., Kulkarni(Ms), S.B. and Hegde, S.G.

25. 160279(61/DEL/85)
Process for the preparation of a catalyst useful for selective conversion of ethylene into aromatic hydrocarbon containing 6-8 carbon atoms.
Ratnasamy, P, Kulkarni(Ms), S.B., Balakrishnan, I., Rao, B.S. and Shiralkkar, V.P.

26. 160579(251/DEL/85)
A process for preparing base polymer for ion exchange membranes
Saini R., Nadkarni V.M., Dutta A., Ghosh S., Kshirsagar S.N. and Mashelkar R.A.

27. 160256(60/DEL/85)
Process for the preparation of new catalyst composite material useful for conversion of alkanols to hydrocarbons.
Ratnasamy, P, Kulkarni(Ms), S.B., Kotasthane, A.N. andShiralkkar, V.P.

28. 160829(116/DEL/84)
A process for the preparation of substituted alkyl cyclohexyl, cyclohexylalkyl, aralkyl, aryloxyalkyl esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid by transesterification.
Mitra, R.B., Joshi, B.N., Natekar(Ms), M.V., Arabale, A.A. and Shinde, D.D.

29. 160841(115/DEL/84)
A process for the preparation of 2, 2-dimethyl-3-(n-propyl)cyclo-propane acetic acid by reaction of hydrazine hydrate with 2, 2- dimethyl-3-(2-oxopropyl) cyclopropane acetic acid.
Mitra, R.B., Joshi, B.N., Natekar(Ms), M.V., Arabale, A.A. and Shinde, D.D.

30. 160974(191/DEL/84)
Preparations of substituted alkyl, cyclohexyl, cyclohexylalkyl, aryl, aralkyl, esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopro-pane acetic acid derived from (+) 3-carene as potential miticides
Mitra, R.B., Joshi, B.N., Natekar(Ms), M.V., Arabale, A.A. and Shinde, D.D.

31. 161321(664/DEL/84)
Improvements in or relating to the preparation of 3-methyl-but-2-ene-YL acetate.
Mitra, R.B., Kulkarni, G.H., Joshi, R.S., Khanna, P.N., Lunkad, K.F. and Shaha, S.C.

32. 161612(537/DEL/84)
An improved process for the preparation of SYM N, N'disubstituted diarylurea compounds.
Ayyangar, N.R. and Choudhary, A.R.

33. 161822(585/DEL/83)
An improved process for the preparation of 4-amino-3- nitrobenzophenone.
Ayyangar, N.R., Lahoti, R.J., and Thomas, D.

Indian patent applications accepted

1. 160748(837/DEL/84)
A process for separation of stigmasterol derived products from phytosterols of sugarcane wax.
Mitra, R.B., Kapoor(Ms), V.M. and Hazra, B.G.

2. 163187(279/DEL/85)
Process for conversion of methanol to olefins.
Ratnasamy P., Balakrishnan I., Rajiv Kumar and Hegde S.G.

3. 163626(224/DEL/85)
Improvements in or relating to the process for the isolation of useful sterols from sugarcane wax
Mitra R.B. and Kapadia V.H.

4. 163810(506/DEL/84)
A process for synthesis of 22, 23-diihydroxy-24S-ethyl-3 - 5 cy-clo-5 a-cholestan-6-ones from phytosterols of sugarcane wax.
Mitra, R.B., Kapoor(Ms), V.M. and Hazra, B.G.

5. 164459(569/DEL/86)
A process for the production of kerosene from light olefins.
Gopinathan C., Kuruvilla J., Gopinathan(Mrs.) S., Hundekar A.M.,
Pandit S.K., Unny I.R., Depshpande(Mrs.)S.S., Pardhy(Mrs).S.A. and Ratnasamy P.

Indian patent applications filed

1. (267/DEL/85)
A device for obtaining NMR spectra in undeuterated solvents of FT(fourier transform) instruments Deshpande K.G.

2. (430/DEL/85)
Novel dispensors for controlled release of aquatic larvicides Sharma R.N., Vartak H.G., Gund(Miss) P.D., Bhaldar I.V.,
Rao J.V., Powar V.K. and Mitra R.B.

3. (632/DEL/85)
A process for the preparation of novel lanthanum iron silicates designated as Encilite-2
Ratnawamy P., Kulkarni(Miss) S.B., Shiralkar V.P., Kotasthane A.N Chandwadkar(Mrs) A.J

4. (634/DEL/85)
Improvements in or relating to the preparation of 3-acyloxy and 3-arolyloxy-isoxazole derivatives.
Mitra R.B., Subba Rao G.D., Toke S.M. and Patil S.G.

5. (735/DEL/85)
A process for the preparation of methyl(+)-cis-3,3-dimethyl-2-for cylcyclopropane-1-carboxylate.
Mitra R.B., Muljiani(Miss) Z., Gadre(Mrs) S. and Joshi(Mrs) V.

6. (1051/DEL/85)
A process for the preparation of novel geraniol based diethers useful as insect control agents.
Patwardhan(Mrs.)S.A., Sharma R.N., Phadnis A.P., Gund(Miss) P.D. , Bhaldar I.V.

7. (1053/DEL/85)
A process for the preparation of novel geraniol based diethers useful as insect control agents
Patwardhan(Mrs.)S.A., Sharma R.N., Phadnis A.P., Gund(Miss) P.D., Bhaldar I.V.

8. (1126/DEL/85)
Process for the preparation of geraniol based saturated diethers useful as new insect control agents
Patwardhan(Mrs.)S.A., Sharma R.N., Phadnis A.P., Gund (Miss) P.D. Bhaldar I.V.

9. (109/DEL/86)
An improved process for the preparation of codeine from morphine
Ayyangar N.R., Choudhary A.R., Kalkote U.R. and Sharma V.K.

10. (187/DEL/86)
An improved process for the preparation of 2-bromol-1-phenylethan ol
Bhosale S.S., Natekar(Miss) M.V., Joshi P.L., Dixit K.N., Vaidya A.S. and Rao A.S.

11. (195/DEL/86)
Improvements in or relating to the process for the preparation of lactone of 2,2-dimethyl 1-3-(2,2,2-trichloro-1-hydroxyethyl) cyclopropane carboxylic acid.
Mitra R.B., Kulkarni G.H., Khanna P.N., Bhawal B.M. and Deshmukh A.R.A.S.

12. (196/DEL/86)
Improvements in or relating to the process for the preparation of 1,1,1-trichloro-4-methyl-pent-3-ene-YL diazoacetate.
Mitra R.B., Kulkarni G.H., Khanna P.N., Bhawal B.M. and Deshmukh A.R.A.S

13. (281/DEL/86)
Improved process for the production of trichlorosilane (TCS) from silicon tetrachloride.
Neurgaonkar V.G., Sinha A.P.B., Srivastava P.R., Phadnis S.B. andPires J.A.

14. (282/DEL/86)
A process for the preparation of crystalline aluminophosphate catalysts.
Ratnasamy P., Kulkarni(Miss) S.B., Kamble(Mrs.) K.R. and Shiralkar V.P.

15. (571/DEL/86)
An improved process for the ethylation of morphine to ethylmorphine
Ayyangar N.R., Choudhary A.R., Kalkote U.R. and Sharma V.K.

16. (837/DEL/86)
Process for the preparationof glucose isomerase.
Dhamankar(Miss)V.S., Gaikwad S.M., Khire J.M., Modak S.P., Powar V.K. and Vartak H.G.

17. (935/DEL/86)
Process for the preparation of crystalline phosphoalumino silicate catalysts.
Ratnasamy P., Kulkarni (Miss) S.B., Kamble (Mrs.) K.R. and Hegde S.G

18. (1092/DEL/86)
A process for the preparation of low molecular weight xylanase from Chainia strain
Srinivasan M.C., Vartak H.G., Rele(Mrs) M.V. and Bastawade K.B.

19. (1136/DEL/86)
A process for the preparation of catalyst composite material useful for naphtha reforming
Sivakumar S., Ratnasamy P., Budhkar A.P., Padalkar S.B. and Waghmare K.J.

20. (1141/DEL/86)
An improved process for the preparation of 2-(3-phenoxyaryl) alkanols
Mitra R.B. and Kapoor(Miss) V.M.

21. (117/DEL/87)
Synthesis of alpha(RS)-cyano-3-phenoxybenzyl (+)cis-2,2-dimethyl-3 -(2,2-dichlorovinyl) cyclopr opane caboxylate, a highly potent insecticide belonging to the synthetic pyrethroids group.
Mitra R.B., Kulkarni G.H., Khanna P.N., Bhawal B.M. and Deshmukh A.R.A.S.

22. (292/DEL/87)
A process for the preparation of alpha-aryl propionic acids
Sonawane H.R., Kulkarni D.G. and Ayyangar N.R.

23. (316/DEL/87)
Process for the preparation of a catalyst composite material
Ratnasamy P. and Sivasankar S.

24. (325/DEL/87)
Process for the preparation of a catalyst composite material
Ratnasamy P. and Sivasankar S.

25. (651/DEL/87)
A facile enzymatic resolution process for the preparation of
R-(-)-1,1,1-trichloro-2-hydroxy-4-methyl-3-pentene.
Muljiani (Miss) Z., Modak S., Gadre (Mrs) S. and Mitra R.B.

26. (660/DEL/87)
An improved process for the preparation of elastomers having random distribution of functional groups from olefinic polymers
Balaraman K.S., Gopichand S., Gundiah S., Mashelkar R.A., Vaidya S.H., Varma A.J. and Krishnan G.R.V.

27. (784/DEL/87)
An improved process for the preparation of a high silica zeolite catalyst compostie material
Rajik Kumar

28. (847/DEL/87)
An improved catalyst useful for the preparation of carboxylicacids
Kelkar A.A., Jagannathan R., Kolhe D.S. and Chaudhari R.V.

29. (848/DEL/87)
An improved process for the preparation of carboxylic acids.
Kelkar A.A., Jagannathan R., Kolhe D.S. and Chaudhari R.V.

30. (881/DEL/87)
A process for the preparation of controlled release agrochemical granules.
Hbaskar C., Shukla P.G., Rajagopalan N. and Mitra R.B.

31. (985/DEL/87)
An improved process for the conversion of natural gas into middle distillates.
Ratnasamy P. and Sivasankar S.

32. (991/DEL/87)
An improved process for the preaparation of chloramphnicol2,
2-dichloro-N[2-hydroxyl1(hydroxymethyl)-2(4-nitr ophenyl)] ethyl acetamide.
Hazra B.G., Pore V.S., Maybhate S.P. and Natekar M.V.

33. (1053/DEL/87)
An improved process for the preparation of 4-phenyl-5-dichloro- acetamido-1,3-dioxane.
Hazra B.G., Pore V.S., Maybhate S.P. and Natekar M.V.

34. (1113/DEL/87)
A process for the production of kerosene and diesel from naphtha
Gopinathan C., Kuruvilla J., Gopinathan(Mrs.)S., Hundekar A.M., Pandit S.K., Unny I.R., Deshpande(Mrs.)S.S. and Pardhy(Mrs)S.A.

35. (1119/DEL/87)
Improvements in or relating to the process for preparation of 3-aroyloxy isoxazole derivatives (Divisional to application No.634/DEL/85).
Mitra R.B., Subba Rao A., Ray G.D., Toke S.M. and Patil S.G.

36. (1152/DEL/87)
Improvements in or relating to the preparation of 2,4,4-tetrachlo robutyronitirile
Ayyangar N.R., Moghe P.P. and Naik S.N.

37. (1159/DEL/87)
An improved process for preparation of high temperature super conductors
Mulla I.S., Sinha A.P.B. and Chandrachood M.R

38. (182/DEL/88)
Process for the preparation of a novel crystalline aluminosilicate
Kotasthane A.N., Chandwadkar(Mrs.)A.J and Ratnasamy P.

39. (222/DEL/88)
An improved reforming process
Ratnasamy P. and Sivasankar S.

40. (261/DEL/88)
An improved process for the preparation of 1,1,1-trichloro-4-meth yl-pent-3-ene-2YL diazoacetate (Divisional to 196/DEL/86).
Mitra R.B., Kulkarni G.H., Khanna P.N., Bhawal B.M. and Deshmukh A.R.A.S

41. (263/DEL/88)
Improved process for carbonylation of alcohols to carboxylic acid
Kelkar A.A. and Chaudhari R.V.

42. (367/DEL/88)*
A process for the preparation of high silica large port modernite
Chandwadkar, A.J. and Ratnasamy

43. (475/DEL/88)*
A process for the preparation of a crystalline ferrosilicate catalyst composite material
Rajiv Kumar and Ratanaswamy, P.

44. (477/DEL/88)*
An improved device for converting solar energy to thermal energy
Sathaye, S.D., Potdar, H.S., Soni, H.S. and Sinha, A.P.B.

45. (509/DEL/88)*
Process for the preparation of a novel crystalline alumino silicate Encilite - 12
Gade, N.R. and Kotasthane, A.N.

46. (526/DEL/88)*
An improved reforming process for the catalytic conversion of petroleum fractions to a mixture of hydrocarbons rich in aromatics
Sivasankar, S. and Ratnasamy, P

47. (641/DEL/88)*
A onestep process for the hydroxylation of aromatic compounds
Umapathy, P., Patil, S.D. and Mohandas, T.R.

48. (714/DEL/88)*
An improved process for the preparation of high temperature superconductors
Mulla, I.S., Sinha, A.P.B. and Chandrachud, M.R.

49. (840/DEL/88)*
Preparation of methyl ethyl ketone by oxidation of butenes.
Grover, G.S., Rode, C.V. and Chaudhari, R.V.

50. (870/DEL/88)*
A process for the conversion of methane to ethylene by oxidative methane pyrolysis.
Choudhary, V.R., Choudhari, S.T. and Rajput, A.M.

51. (913/DEL/88)*
Process for the preparation of improved catalyst composite material suitable for hydrocarbon conversions.
Sivasanker, S., Kulkarni, M.R., Budhkar, A.P., Ratnasamy, P., Ray, S.K., Santra, M. and Ghosh, S.

52. (919/DEL/88)*
An improved process for the conversion of methane to ethylene by catalytic and non-catalytic oxidative pyrolysis
Chaudhary, R.V., Chaudhari, S.T., Rajput, A.M. and Rane, V.H.

53. (941/DEL/88)*
An improved process for the preparation of propionic acid.
Kelkar, A.A., Kolhe, D. and Chaudhari, R.V.

54. (957/DEL/88)*
An improved process for catalytic oxidative conversion of methane to C2-hydrocarbons in presence of free oxygen.
Choudhary, V.R., Chaudhari, S.T., Rajput, A.M. and Rane, V.H.

55. (959/DEL/88)*
Process for the preparation of novel crystalline aluminosilicate
Joshi, P.N., Shiralkar, V.P. and Ratnasamy, P.

56. (960/DEL/88)*
An improved process for prepartion of carboxylic acid anhydrides
Kelkar, A.A. and Chaudhari, R.V.

57. (963/DEL/88)*
An improved process for the preparation of high intrinsic coercivity Sr-ferrite powder.
Date, S.K., Deshpande, C.E., Shrotri, J.J. and Kulkarni, S.D.

58. (964/DEL/88)*
Process for the preparation of a catalyst composite material.
Rajiv Kumar and Ratnasamy, P

59. (984/DEL/88)*
A process for the preparation of an extracellular cellulase free xylanase from an alkalophilic bacillus.
Srinivasan, M.C., Rele, M.V., Balakrishnan, H. and Choudhary, M.D

60. (1050/DEL/88)*
A process for the preparation of crystalline microporous alumino phosphate useful as catalyst and adsorbent.
Choudhary, V.R., Sansare, S.D. and Pandit, M.Y.

61. (1051/DEL/88)*
A process for oxidative conversion of methane to C2 hydrocarbons using rare earch metal promoted alkaline earth oxides and catalysts.
Choudhary, V.R., Choudhary, S.T., Rajput, A.M. and Rane, V.H.

62. (1107/DEL/88)*
Process for the preparation of a crystalline ferrialuminosilicate
Kotasthane, A.N., Shiralkar, V.P. and Ratnasamy, P.

63. (1156/DEL/88)*
A process for the preparation of a novel catalyst useful for preparation of carboxylic acid anhydrides.
Kelkar, A.A. and Chaudhari, R.V.

64. (1169/DEL/88)*
An improved process for the production of cumene
Rao, B.S., Balakrishnan, I., Chumbhale, V.R. and Ratnasamy, P.

65. (1170/DEL/88)*
A process for preparation of crystalline microporous alumino silicates useful as catalyst and adsorbent.
Choudhary, V.R. and Akolekar, D.B.

66. (6/DEL/89)*
An improved process for preparation of 1-substituted amino- 1-substituted thio-2-nitro alkenes.
Deshmukh, A.R.A.S., Bhawal, B.M., Shiralkar, V.P. and Rajappa, S.

67. (7/DEL/89)*
A novel process for conversion of microporous alumino-phosphates to crystalline

silicoaluminophosphate catalysts.
Choudhary, V.R., Sansare, S.D. and Pandit, M.Y.

68. (283/DEL/89)*
CE An improved process for the preparation of alkyl carbamates
Chaudhari, R.V., Gupte, S.P., Kelkar, A.A. and Kolhe, D.S.

69. (284/DEL/89)*
An improved proecess for the preparation of aryl-N-alkyl carbamates
org
Kulkarni, G.H., Naik, R.H. and Rajappa, S.

70. (285/DEL/89)*
A process for the preparation of para substituted benzyl cis 2,2-dimethyl-3-(2,2-dichlorovinyl) cyclopropane carboxylates, highly
potent insecticides belonging to the synthetic pyrothroids group
Kulkarni, G.H., Panse, D.G. and Naik, R.H.

Foreign patents in force

1. British patent No. 2034301 (application No. 7935813).
2. Netherlands patent application No. 7907332. Patents No. 1 and 2 correspond to Indian Patent No.150391 (application No.761/DEL/78).

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3. Algerian patent application No.7124.
4. Australian patent application No. 30020/84.
5. GDR patent No. 232841 (application No.WPB 013/266785/3).
6. GDR patent application No. 245656 (application No.WPB 013/286037/2).
7. Egyptian patent application No.763/84.
8. European patent application No. 84302893.7 (accepted, grant awaited).
9. Indonesian patent application No. 1073.
10. Japanese patent application No. 44979/85.
11. Libyan patent application No.2314.
12. Pakistan patent application No.129327 (application No.251/DEL/84) accepted.
13. Thailand patent application No. 2565. Patents 3 to 13 correspond to Indian patent No.160212 (application No. 275/DEL/83) and 160038 (application No.437/DEL/83).

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14. USSR application No. 4202710/26. Inventors certificate. This corresponds to Indian patent No. 160212 (application No.275/DEL/83) only.

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15. European patent application No.85308747.6 (designated countries UK, France, Belgium, West Germany, Italy and Switzerland).
16. Japanese patent application No. 299733.
17. Canadian patent application No. 500350.
18. Australian patent application No.51247/85.
19. Mexican patent application No., 2860372/2. Patents 15 to 19 correspond to Indian patents No.160756 (application No.60/DEL/85) and No.163187 (application No.279/DEL/85).

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20. US patent application No.476461 5 (application No.940517), granted.
21. European patent application NO.86309L80.7 (designated countries UK, France, Netherlands, Austria, Switzerland and West Germany).

    Patents 20 and 21 correspond to Indian patent application No.109/DEL/86.

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22. US patent application No.18194.
23. Japanese patent application No. 84975/88.
24. European patent application No. 88303117.1 (Designated countries UK, France, Netherlands, Austria, Switzerland and Italy). Patents 22 to 24 correspond to Indian patent application No.292/DEL/88.

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25. US patent application No.2l448.

26. Brazilian patent application No.880378l.

27. Japanese patent application No.l73626/88.

28. European patent application No. 88306884.3 (designated countries UK, France, Belgium, Netherlands, West Germany and Italy).
Patents 25 to 28 correspond to Indian patent applications No.847/DEL/87 and 848/DEL/87.

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29. Brazilian patent application No.890ll73.

30. European patent application No. 89300850.8 (Designated countries UK, France, Belgium, Netherlands, West Germany and Italy).
Patents 29 and 30 correspond to Indian patent application No.367/DEL/88.

3l. European patent application No.8930l537 (Designated countries UK, France, Belgium, Netherlands, West Germany and Italy).

32. Argentina patent application No.890328.
Patents 3l and 32 correspond to Indian patent application No.526/DEL/88.

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33. European patent application No. 89304707.6 (Designated countries UK, France, West Germany, Switzerland, Belgium and Netherlands).
Corresponds to Indian patent application No.6/DEL/89.

RESEARCH UTILIZATION

TABLE 1 : PRODUCTS MANUFACTURED ON THE BASIS OF NCL KNOW-HOW

(T - Metric Tons)

Sl. No.	Name of the Process / Product	Field of Utilization	Name of the manufacturer (year of commencement of production)	Production		
				Qty./value Rs.in Lakhs 1988-89	Qty./value Rs. in lakhs Upto March '88	Capacity installed nature of release and remarks
1	2	3	4	5	6	7
1.	Acetanilide	Intermediate	Hindustan Organic Chemicals Ltd., PO:Rasayani 410 207 (through project engineers R.L. Dalal & Co., Bombay 400 018) (1969)	3428.00 T 1576.88	38402.49 T 8252.29	2000 T Non-exclusive
2.	Acrylic acid/ acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., PO: Petrochemicals, Dist. Vadodara 391346 (1984)	2900.00 T 1500.00	5948.00 T 2150.31	2,000 MA; 3,000 EA; 11,000 BA; 1,000 2EHA Sponsored
3.	Antipriming compositions	Antipriming in locomotives	Research Designs and Standards Organisation, M&C Wing, Lucknow 226 011 (1964)	1.00 T 0.20	188.08 T 18.87	26 T Non-exclusive
4.	Butenediol	Pesticides, polymers	Hindustan Organic Chemicals Ltd., Rasayani (1986)	33.10 T 26.48	50.47 T 32.80	150 T (semi-commercial pilot plant) Collaborative work
5.	tert-Butyl catechol	Synthetic rubber	Percynic Chemicals, Ind.Estate Building, Lalbaugh, Bombay 400 012 (1972)	4.56 T 8.49	102.00 T 115.79	50 T Non-exclusive
6.	Butyl titanate	Varnishes, enamels	i) Synthochem, 33 A, Laxmibainagar Industrial Estate, Indore 452 006 (1973)	27.68 T 31.14	440.52 T 306.14	99 T Non-exclusive
			ii) Super Urecoat Industries Pvt. Ltd., Plot No.1216/44,Phase IV, GIDC, Naroda 382 330 (1987)	25.98 T 31.09	4.87 T 6.00	N.A. Non-exclusive

1	2	3	4	5	6	7
Inorg$_1$	7. Calcium hypophosphite	Pharmaceuticals	Hypophosphite & Co., 79-F, Princess Street, Bombay 400 002 (1967)	6.00 T 8.00	212.00 T 167.30	24 T(including hypophosphites) Sponsored
Org$_5$	8. Catechol	Pharmaceuticals	Percynic Chemicals, Bombay (1972)	0.05 T 0.53	106.21 T 64.04	50 T Non-exclusive
Poly$_1$	9. Cation exchange resin-styrene DVB base	Demineralization of liquids	Bharat Process & Mechanical Engineers Ltd., Dakhindari, Calcutta 700 048 (1969)	 –	28662.18 Cft 98.39	10,000 Cft Non-exclusive
C.E$_3$	10. Chlorobenzenes (MCB)	Industrial chemicals	Hindustan Organic Chemicals Ltd., PO: Rasayani (1976)	7455.00 T 1017.61	63297.41 T 6901.21	7500 T Sponsored
Poly$_2$	11. Citrate plasticizers tributyl/acetyl tributyl citrate	Plasticizers	Citroflex P. Ltd., Neville House, J.N. Herdia Marg, Ballard Estate, Bombay 400 038 (1985)	– –	666.60 T 117.15	1200 T Sponsored
Org$_6$	*12. Detection kit for narcotics	Detection of narcotic drugs	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1989)	N.A. N.A.	– –	Exclusive for 5 years
Org$_7$	13. Diethyl-*m*-aminophenol	Dye intermediate	Sahyadri Dyestuffs & Chemicals, Divn. of Deepak Nitrite Ltd., Pune 411 030 (1976)	– –	808.03 T 939.45	150 T Sponsored
E.O$_2$	14. Dihydroiso-jasmone and peach aldehyde	Perfumery chemicals	S.H. Kelkar & Co. Ltd., Shastri Marg, Mulund, Bombay 400 080 (1965)	1.29 T 8.36	63.26 T 30.08	2 T Non-exclusive
Org$_8$	15. Dimethoate	Pesticides	i) Mico Farm Chemicals Ltd., Lotus Court, 165 Thambu Chetty Street, Madras 600 001 (1979)	– –	89.70 T 65.43	100 T Non-exclusive
			ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979)	365.37 T 317.87	889.02 T 698.52	350 T Non-exclusive

1	2	3	4	5	6	7
			iii) Khatau Junker Ltd., 3000,GIDC Estate, P.B.No 40, Ankaleshwar 393 002 (1985)	200.72 T 169.20	150.00 T 101.00	600 T Non-exclusive
CE4	16. Dimethylaniline (continuous process)	Industrial chemical	Navin Chemical Enterprises, Divn. of Maftlal Industries Ltd., Dewas 455-002 (1976)	1056.00 T 481.64	4302.38 T 1510.07	1500 T Sponsored
CE5	17. Endosulfan	Pesticides	Bharat Pulverising Mills Pvt. Ltd., Shriniketan, 14 Queens Road, Bombay 400 020 (1980)	– –	2300.00 T 2200.00	1200 T Non-exclusive
CE6	18. Ethion	Pesticides	Shaw Wallace & Co. Ltd., Calcutta (1979)	195.93 T 174.38	343.33 T 282.35	150 T Non-exclusive
CE7	19. Ethylenediamine	Bulk organic chemical	Diamines & Chemicals Ltd., The Bharat Vijay Mills Ltd. Premises, Kalol 382 721 (1982)	1700.00 T 1244.00	4528.00 T 2842.00	2000 T (ethylenediamine and polyamines)
CE8	20. Ethylene oxide condensates	Surface active agents	Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400 016 (1965)	N.A. N.A.	27404.14 T 7249.22	2500 T Non-exclusive
Phy1	21. Ferrites-Hard	Electronics	Dr. Shet Magnetics P. Ltd., 1069, V Block, 1st Floor, Rajaji Nagar, Bangalore 560 010 (1978)	– –	4.00 T 5.28	20 T Non-exclusive
Org9	*22. Flematic skin oil	Veterinary drug	TTK Pharma Ltd., 8 Old Trunk Road, Madras 600 043 (1988)	1150.00 Ltrs. 1.48	– –	N.A. Non-exclusive
Org10	*23. Gum steek adhesive	Adhesive	Esdee Paints Pvt. Ltd., Kolshet Road, Thane 400 607 (1988)	,5000.00 Ltrs. 4.25	– –	5000 Ltrs. (Process developed under consultancy)
Org11	24. Ibuprofen	Drug	The Chemical Industrial & Pharmaceutical Laboratories Ltd. (CIPLA), 289, Bellasis Road, Bombay Central Bombay 400 008 (1983)	– –	21.46 T 208.08 (from 1986 onwards)	16 T (licensed) Sponsored

1	2	3	4	5	6	7
25.	Immobilized enzyme	Pharmaceutical	Hindustan Antibiotics Ltd., Pimpri, Pune (1984)	0.27 T 48.96	2.58 T N.A.	1.44 T Captive consumption (Enzymatic conversion of Pen.G. to 6APA; prodn. 21T valued at Rs. 420 lakhs)
26.	β-Ionone	Perfumery, intermediate for vitamin A	S.H. Kelkar & Co. Ltd., Bombay (1975)	0.55 T 3.05	3.44 T 15.41	4.6 T Non-exclusive
27.	Jalshakti	Water absorbing polymer	Indian Organic Chemicals Ltd. Chemicals Division, Khopoli 410 203 (1986)	– –	33.90 T 34.57	1000 T Sponsored (pilot plant for 100 TPA in operation)
28.	Maleic hydrazide	Agrochemical	Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur 458 001 (1978)	0.40 T 0.32	3.12 T 1.83	1 T Non-exclusive
29.	*p*-Menthane hydroperoxide	Synthetic rubber	Camphor & Allied Products Ltd., PO: Clutterbuckganj, Dist. Bareilly 243 502 (1976)	15.17 T 11.83	245.74 T 142.49	60 T Exclusive
30.	Methyl chlorosilane	Intermediate	Hico Products Ltd., Bombay (1983)	N.A. N.A.	1228.00 T 504.94	Collaborative Non-exclusive
31.	Monochloro-acetic acid	Intermediate for weedicides, carboxymethyl cellulose, etc.	Hico Products Ltd., Bombay (1975)	N.A N.A.	3743.37 T 588.98	720 T Non-exclusive
32.	Monoethylaniline	Intermediate for explosive	The Atul Products Ltd., Atul 396 020 Dist Valsad (1975)	147.97 T 57.71	1029.31 T 370.40	150 T Non-exclusive
33.	1-Naphthyl acetic acid	Agrochemicals, plant growth regulator	Micro Chemicals (India), Mandsaur (1975)	0.90 T 0.90	7.00 T 5.20	1.50 T Sponsored

1	2	3	4	5	6	7
34.	Nicotine sulphate from tobacco and tobacco waste	Insecticides	Urvakunj Nicotine Industries, Petlad Cambay Road, Dharmaj 388 430 Dist. Kaira (1963)	202.00 T 112.00	1741.61 T 640.50	150 T Non-exclusive
35.	Nitrile rubber	Oil resistant rubber, formulations, adhesives	Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, P.B.No.11486, Bombay 400 020 (1974)	Nil Nil	7533.34 T 1423.17	2000 T
36.	*p*-Nitrophenol	Intermediate	Hindustan Organic Chemicals Ltd., PO: Rasayani (1978)	– –	4.00 T 1.16	900 T Non-exclusive
37.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975)	15.99 T 428.05 (except cryptopine)	87.70 T 1209.64	20.61 T of various alkaloids (morphine codeine , narcotine, & thebaine)Exclusive
38.	Perfumery products based on longifolene (capinone)	Perfumery	Comphor & Allied Products Ltd., Dist. Bareilly (1968)	16.94 T 57.59	238.04 T 291.46	50 T (for both capinone and meracene) Sponsored
39.	Perfumery porducts based on Δ 3 carene (meracene)	Perfumery	-do-	6.81 T 9.87	141.24 T 83.45	-do-
40.	β-Phenethyl alcohol	Perfumery	Sunanda Industrial Chemicals Pvt.Ltd. (Associate company of Sunanda Aromatic Industries), Mysore-KRS Rd., Mettagalli P.O. Mysore 570 016 (1970)	– –	1072.83 T 603.13	Sponsored Production around 120 MT/Year restarting from Jan.90
41.	Phenthoate	Insecticides	Bharat Pulverising Mills Pvt. Ltd., Bombay (1975)	– –	27.10 T 17.55	600 T Sponsored
42.	Phthalates-diethyl and dimethyl	Plasticizers	The Mysore Acetate and Chemicals Co. Ltd., A-19, Acetate Town, Mandya 571 404 (1970)	283.88 T(DEP) 76.65 (DEP) 58.40 T(DMP) 16.35 (DMP)	4069.68 T 766.31	600 T Non-exclusive

1	2	3	4	5	6	7
43.	Phthalates-dicotyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., D' Bldg., Shiv Sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971)	2719.16 T(DOP) 1028.30 (DOP)	57966.16 T 10652.91	4050 T Non-exclusive
44.	Polyurethane coating	Coatings	Cipy Chemicals, J-62, 'S' Block, MIDC, Bhosari, Pune 411 026 (1977)	25.60 T 24.00	14654.00 Ltrs. 6.09	20 T Non-exclusive
45.	Polyurethane printing rollers	Printing	Sree Saraswathy Press (1984) Ltd., 32, Acharya, P.C. Ray Rd., Calcutta 700 009 (1965)	– –	662.00 Nos. 14.25	3000 Nos. Non-exclusive
46.	Quinapyramine sulphate/chloride	Veterinary drugs	Chintamani Fine Chemicals, S.No. 64/5, Bhide Baug, PO Vadgaon Budruk, Sinhgad Road, Pune 411 041 (1982)	– –	149.00 Kg 12.05	N.A. Non-exclusive
47.	D.C. Recording plarograph including potentiometric stripchart recorder for captive consumption	Polarographic analysis	Elico Pvt. Ltd., B-17, Sanathnagar Indl. Estate, Hyderabad 500 018 (1974)	15 Units 3.60	251 + 3 Units 44.59	50 Units Non-exclusive
48.	Rosin & turpentine oil derivatives	Perfumery	Dujodwala Resins & Terpenes Pvt.Ltd., 812/813, Tulsiani Chambers,. 212 Nariman Point, Bombay 400 021 (1986)	900.00 T 36.00	5655.00 T 1277.00	2400 T Sponsored
49.	Silica gel	Humidity control	Minco Products, 17, Thirwottyur High Road, Madras 600 081 (1963)	13.00 T 2.86	5022.20 T 30.16	12 T Sponsored
50.	Sodium / Potassium ferrocyanides	Industrial chemicals	Hindustan Development Corporation Ltd., 'Kanchenjunga', 7th floor, 18, Barakhamba Road, New Delhi 110 001 (1986)	197.18 T 53.24	1080.03 T 153.97	1250 T Non-exclusive

1	2	3	4	5	6	7
51.	70 % Sorbitol from dextrose monohydrate	Pharmaceuticals vitamin C synthesis	i) Maize Products, Divn. of Sayaji Mills Ltd., PO Kathawada Maize Products, Ahmedabad 382 430 (1976)	3351.00 T 394.95	21639.88 T 2304.08	2000 T Non-exclusive
			ii) The Anil Starch Products Ltd., P.B. No. 10009, Anil Rd., Ahmedabad 380 025 (1976)	2053.00 T 256.26	8009.40 T 959.15	2000 T Non-exclusive
52.	Sorbitol from glucose (continuous process)	Pharmaceutical	The Anil Starch Products Ltd., Ahmedabad (1985)	– –	1074.00 T 155.35	Sponsored
53.	Direct reading spectrophoto -meter/ colorimeter	Biochemical research, spectroscopic analysis in visible range	The Scientific Instruments Co.Ltd., B-1, Loni Rd.,Industrial Area, Ghaziabad 201 007	11 Units 1.10	308 Units 23.60	100 Units Non-exclusive
54.	Staple pin adhesive (Gum steek adhesive)	Adhesive for staple pins	Esdee Paints Pvt. Ltd., Near Power House, Kolshet Road, Thane 400 607 (1988)	– –	11000.00 Ltrs 7.10	5000 Ltrs Non-exclusive (Stopped production of staple pin adhesive. In place manuf.gum steek adhesive. Know how developed at NCL under consultancy)
55.	Terpineol	Perfumery	Dujodwala Industries Ltd., 814/815 Tulsiani Chambers, 212, Nariman Point, Bombay 400 021 (1976)	– –	400.00 T 112.50	200 T Non-exclusive
56.	Theophylline, aminophylline and caffeine	Pharmaceuticals	Pefco Industries Ltd., Chemical Divn., Kores Compound, 1st Pokhran Rd., Thane(W) 400 606 (1986)	43.04 T 110.27	9.88 T 31.01	135 T Sponsored (pilot plant)
57.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate Sangam Bridge,	Sudarshan Chemical Industries, 162, Welllesley Road, Sangam Bridge, Pune 411 001 (1977)	109.00 T 80.38	1059.00 T 467.68	300 T Sponsored

1	2	3	4	5	6	7
58.	Vinblastin sulphate B.P./USP and Vincristinesulphate B.P./USP	Pharmaceuticals	The Chemical & Pharmaceutical Laboratories Ltd. (CIPLA), Bombay (1984)	986.65 gms(VBS) 49.33 797.30 gms(VCS) 103.65	2949.70 gms 212.94 (from '86 onwards)	4000 gms.(VBS) 2000 gms.(VCS) Non-exclusive
59.	Vitamin B_6	Pharmaceuticals	Lupin Laboratories Ltd., 159, C.S.T. Road, Kalina, Santacruz (E), Bombay 400 098 (1986)	– –	2.58 T 37.64	50 T Non-exclusive
60.	Vitamin C	Pharmaceuticals	Hindustan Antibiotics Ltd., Pune (1975)	– –	5.83 T 7.82	125 T Non-exclusive

* During the period under review production has been newly reported on these items (3)

Note : The following processes had appeared in Table I of previous reports. As & when the production is reported on these items again, they will be reported in Table I: (i) Can lining composition (ii) Can sealing composition (iii) Nonyl phenol.

VALUE OF PRODUCTION BASED ON NCL TECHNOLOGIES

Year	No.of items	Value of production (Rs. in lakhs)
1984-85	60	4703.84
1985-86	60	5251.80
1986-87	60	6728.39
1987-88	60	7975.74
1988-89	60	9568.82

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1988-89)

	Type of industry	No.of processes in production	Value of production during 1988-89 (Rs. in lakhs)
1.	Public sector	10	4598.18
2.	Large scale private sector	23	4048.32
3.	Medium and small scale sector	27	922.32
		60	9568.82

TABLE II PROCESSES RELEASED AND AWAITING PRODUCTION

Sl. No.	Name of the Process	Field of utilization	Name of the party (Year of release)	Nature of release	Remarks
1	2	3	4	5	6
1.	Adhesive from renewable resources	Adhesive	Carborundum Universal Ltd., 28, Rajaji Road, Madras 600 001 (1985)	Sponsored	–
2.	Alkyl bromides	Photographic and allied chemicals	Dhrangadhra Chemical Works Ltd., 'Nirmal',3rd floor, Nariman Point, Bombay 400 021(1987)	Non-exclusive	Production likely to start by end of 1989
3.	Aniline	Organic intermediate	Hindustan Organic Chemicals Ltd., Rasayani (1973)	Non-exclusive	–
4.	1,3-Butylene glycol	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., Dist. Vadodara (1976)	Sponsored	–
* 5.	Butyl titanate	Varnishes, enamels	Monopol Chemicals Pvt. Ltd., 901, Raheja Chambers, Nariman Point, Bombay 400 021 (1984-85)	Non-exclusive	Pilot plant likely to be set up by January 1990
6.	Carboxin	Pesticides	i) Bharat Pulverising Mill P. Ltd., Bombay (1978)	Non-exclusive	Under implementation
			ii) Laxmi Traders, 2 India Exchange Place, Calcutta 700 001 (1980)	Non-exclusive	–
7.	Chlorination of acetoacetamide	Industrial chemical	Colour Chem Ltd., Ravindra Annexe, D.V.Road, 194, Churchgate Reclamation, Bombay 400 020 (1987)	Sponsored	Under implementation
8.	8-Chlorotheophylline	Drug intermediate	Trichem Laboratories, 11, Lalwani Industrial Estate, 2nd Floor, 14 G.D.Ambekar Marg, Wadala, Bombay 400 031 (1988)	Non-exclusive	Direct release

1	2	3	4	5	6
	9. Conversion of crotonaldehyde to maleic anhydride	Intermediate	Vasantdada Sugar Institute, Manjari, Pune 412 307 (1983-84)	Sponsored	–
	10. Carboxylation of ethanol to propionic acid	Intermediate	Vasantdada Sugar Institute, Pune (1983-84)	Sponsored	–
	11. Catalytic vapour phase oxidation of toulene to benzaldehyde	Intermediate for pharmaceuticals, perfumeries, etc.	Indian Organic Chemicals Ltd., Khopoli (1981)	Sponsored	–
	12. Chloroquin phosphate	Drug intermediate	i) Sudarshan Chemical Industries Ltd., Pune (1985)	Sponsored	–
			ii) Dr.Reddy's Laboratories Ltd., (earlier Standard Organics Ltd.), 7-1-27, Ameerpet, Hyderabad 500 016 (1986-87)	Sponsored	–
	13. Clonal multiplication of cardamom by tissue culture	Agriculture	i) A.V. Thomas & Co., 22, Marshells Rd., Egmore, Madras 600 008 (1984-85)	Non-exclusive	–
			ii) Cardamom Research Institute, Cardamom Board, Banerji Road, Cochin 682 018 (1984)	Non-exclusive	Nearly 100 plant-lets taken to field for evaluation
			iii) R.B. Thakur & Co. Pvt. Ltd., Clerk House, 8, Wade House Road, Bombay 400 039	Non-exclusive	–
	14. Chlorchrysanthamate	Pesticide intermediate	National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1986-87)	Sponsored	–
	15. Dapson	Drug	CIPLA, Bombay (1984)	Sponsored	–

1	2	3	4	5	6
16.	Dextropropoxyphene hydrochloride	Drug	Centaur Laboratories, Kumar Engg. Compound, Kalina, Santacruz (East), Bombay 400 029 (1983-84)	Sponsored	–
17.	Dibutyl tin oxide	PVC stabilizers	Dura Chemical Corpn. Ltd., Wakefield House, 11, Sprott Rd., Ballard Estate, Bombay 400 038 (1977)	Non-exclusive	Under implementation
18.	DCVC acid chloride	Pesticide intermediate	Hindustan Ciba Geigy Ltd., 14, Jamshedji Tata Rd, P.B.11015, Bombay 400 020 (1986-87)	Sponsored	–
19.	Dichloropropionic acid (Dalapon)	Pesticides	Hico Products Ltd., Bombay (1975)	Non-exclusive	–
*20.	Dimethoate	Pesticides	PNM Company, Thindal, Perundurai Main Road, Erode 638 009 (1978)	Non-exclusive	–
21.	Doxepin	Drugs	Pharmaceutical & Chemical Industries (PCI), 301, Arun Chambers, J. Dadajee Road, Tardeo, Bombay 400 034 (1985)	Sponsored	–
22.	Drag reducers for oil transportation	Petroleum industry	Oil Industry Development Board, 301 World Trade Center, 3rd Floor, Babar Road, New Delhi 110 001 (1985)	Non-exclusive	Grant given for Res.work only
23.	DVO acid chloride	Intermediate	National Organic Chemical Industries Ltd., Bombay (1984-85)	Non-exclusive	–
*24.	Endosulfan	Pesticides	Hindustan Insecticides Ltd., Hans Bhavan, Wing I, Bahadur Shah Zafar Marg, New Delhi 110 002 (1976)	Non-exclusive	Turn-key plant offered through project engrs; in trial prodn.

1	2	3	4	5	6
25.	Ethephon	Pesticides	i) Sudarshan Chemical Industries Pvt. Ltd., Pune (1984-85)	Non-exclusive	–
			ii) Hycount Agro, Sherry Land, Quilon 691 005 (1984-85)	Non-exclusive	–
26.	*Eucalyptus tereticornis* by tissue culture	Forestry	A.V. Thomas & Co., Madras (1985)	Non-exclusive	Direct release (CSIR/NCL)
27.	Hexachlorocyclo-pentadiene (HCCP)	Pesticides	Hindustan Organic Chemicals Ltd., Rasayani (1981)	Collaborative	–
28.	IR spectrophotometer	Analysis	Dept. of Science & Technology, New Mehrauli Road, New Delhi 110 016 (1985)	Sponsored	–
29.	Items having short shelf life	Sealants, adhesives	Hindustan Aeronautics Ltd., (Nasik Divn.), Ozar Township PO, Nasik 422 007 (1980)	Sponsored	–
30.	Ketoprofen	Drug	Pharmaceutical & Chemical Industries (PCI), Bombay (1985)	Sponsored	–
31.	1-Menthol from Δ 3 carene	Perfumery	Kosan Industries Ltd., (Formerly Bhavana Chemicals Ltd.), 64/65 Laxmi Insurance Bldg., Sir P.M. Road, Bombay 400 001 (1978)	Sponsored	–
32.	Multiplication of Napier grass by tissue culture	Agriculture	National Organic Chemical Industries Ltd., Bombay (1983-84)	Sponsored	–

1	2	3	4	5	6
33.	Multiplication of teak by tissue culture	Forestry	Forest Development Corpn. of Maharashtra Ltd., 6-a, Nawab Layout, Tilak Nagar, Nagpur 440 010 (1981)	Sponsored	Under field trials
34.	Necelone (Amberone)	Perfumery	Comphor & Allied Products Ltd., 133, M.G. Road, Jehangir Bldg., Bombay 400 001 (1984-85)	Non-exclusive	–
*35.	Nicotine sulphate	Insecticides	(i) Kraun Fine Chemicals Pvt. Ltd., 252/B, K.F.C. House, Sunlit Corner, Chikodi, Karnataka (1983-84)	Non-exclusive	In trial production
			(ii) Sunita Agro Industries Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Road Bombay 400 026 (1988)	Non-exclusive	Recently released
36.	Phenylglycyl chloride	Drug intermediate	Sudarshan Chemical Industries Ltd., Pune (1983-84)	Sponsored	–
37.	Polysulphide liquid rubber	Adhesives, sealants	i) Rathi Rubber Products, 27, Shankarshet Road, Pune 411 009 (1981)	Non-exclusive	–
			ii) Mundoz Corporation, 3, Moghe Bhuwan, Gokhale Rd., Bombay 400 028 (1981)	Non-exclusive	–
			iii) Transpeck Industry Ltd., Kalali Road, Ataldra, Vadodara 390 012 (1983-84)	Non-exclusive	–
38.	Polysulphide sealant compound (Sp. by HAL, Nasik)	Sealants	Rathi Rubber Products, Pune (1981)	Non-exclusive	–

1	2	3	4	5	6
39.	Polyurethane coating	Coating	Simple Coatings, Fahmeeda Manzil, Bhoipura, Bhopal (1984-85)	Non-exclusive	–
40.	Propylene oxide from propylene (extension to propylene glycol)	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Dist. Vadodara (1978)	Sponsored	–
41.	Polymeric materials based on CNS liquid	Low cost housing	Dept. of Science & Technology, New Delhi (1986-87)	Sponsored	–
42.	Silver paste for mica capacitor electrodes	Electronics	Laxmi Traders, Calcutta (1981)	Non-exclusive	–
43.	Sugarcane variety CO-740 by PTC technique	Agriculture	EID Parry (India) Ltd., Dare House, P.B.No.12, Madras (1988)	Non-exclusive	Direct release
44.	Synthesis of basic drugs and intermediates	Drug intermediate	Dexo Laboratories P. Ltd., 6-3-348 Dwarakapuri Colony, Hyderabad 500 004 (1984-85)	Sponsored	–
*45.	Theophylline, aminophylline and caffeine	Pharmaceuticals	(i) Neopharm Chemicals, 20/6 Mile Stone, Mathura Road, Faridabad 121 006 (1984-85)	Non-exclusive	–
			(ii) Thecaf India Ltd., '94, Arkadia, Nariman point, Bombay 400 021 (1988)	Non-exclusive	Recently released
46.	Toluene disproportionation and transalkylation	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Vadodara (1985)	Sponsored	–
*47.	Vitamin B_6	Drugs	(i) Themis Chemicals, Plot No.69, GIDC, Vapi (Dist. Valsad) (1983)	Non-exclusive	–

1	2	3	4	5	6
			(ii) Daurala Sugar Works, Kanchenjunga Building, 18, Barakhamba Road, New Delhi 110 001 (1989)	Non-exclusive	Recently released

* These processes have also been appeared in Table-I along with other licencee.

LIST OF THE PROCESSES AVAILABLE

Sl. No.	Name of the process/ product	Field of utilization	Major raw materials	Range of total capital requirement	Remarks
1	2	3	4	5	6
1	Acetanilide	Drug and dye intermediate	Aniline and acetic acid	C	Released, in production, turn-key plant available through project engineers
2	Atrazine	Herbicide	Cyanuric chloride, ethylamine and monoisopropylamine	C	Released
3	tert-Butyl catechol	Stabilizer andpoly-merization inhibitor for synthetic rubber	Catechol, tert-butyl alcohol and catalyst	A	Released, in production
4	Butyl titanate	Insulating varnish, special paints, catalyst	Butanol and titanium tetra-chloride	B	Released, in production
5	Can lining composition (based on nitrile rubber)	Lining cans for storing mineral oils, greases, food	Synthetic rubber latex, synthetic resins and rubber chemicals	A	Released, in production
6	Can sealing composition (based on natural rubber)	Metal can industry	Natural rubber latex and rubber chemicals	A	Released, in production
7	Carboxin	Pesticide	Acetoacetanilide, sulphuryl chloride,benzene and 2-mercaptoethanol	C	Released
8	Cardmom by plant tissue culture	Agriculture	–	–	–
9	2-Chloroethyl trimethyl ammonium chloride	Plant growth regulator	Trimethylamine and ethylene	A	–
10	8-Chlorotheophylline	Drug intermediate	Theophylline	A	Released
11	Diazepam	Anti-anxiety drug	p-Nitrochlorobenzene, benzyl cyanide, dimethylsulphate, iron powder and chloroacetylchloride	A	Released
12	Dichloropropionic acid (Dalapon)	Weedicide	Propionic acid, chlorine and soda ash	C	Released

1	2	3	4	5	6
13	Dimethoate	Pesticide	Phosphorous pentasulphide, methanol monochloroacetic acid, methylamine and caustic lye	C	Released, in production
14	Endosulfan	Pesticide	Hexachlorocyclopentadiene, butenediol, thionylchloride and epichlorohydrin	C	Released, process available on turn-key basis through project engineers
15	Ethylenediamine	Bulk organic chemical	Ethylene dichloride, ammonia and caustic soda	C	–do–
16	Ethephon	Pesticide	Phosphorous trichloride, ethylene oxide, hydrochloric acid and sulphuric acid	A	Released
17	Ethion	Pesticide	Phosphorous pentasulphide, ethyl alcohol, dibromomethene and caustic soda	C	Released, in production
18	Eucalyptus by plant tissue culture	Forestry	–	–	–
19	Ferrites-Hard	Electronics	Iron oxide, barium carbonate, additive and binder	B	Released, in production
20	Gaskets from cork granules	Gaskets	Cork granules, nitrile rubber and rubber chemicals	A	Released
21	Maleic hydrazide	Plant growth regulator	Maleic anhydride and hydrazine hydrate	A	Released, in production
22	Methyl chlorosilane	Basic material for silicon	Ferrosilicon and methyl chloride	C	Released, in production
23	Microfilters	Industrial filtration	Pulp, melamine and formaldehyde	A	Released
24	Monochloroacetic acid	Intermediate for weedicide, carboxymethyl cellulose, etc.	Acetic acid, chlorine and catalyst	B	Released, in production
25	Monochlorobenzene	Bulk organic chemicals	Benzene and chlorine	C	Released

1	2	3	4	5	6
26	Necelone	Perfumery	Longifolene	A	Released
27	Nicotine sulphate from tobacco and tobacco waste	Insecticide	Tobacco/tobacco waste, lime, kerosene and sulphuric acid	A	Released, in production
28	*p*-Nitrophenol	Intermediate for parathion and paracetamol	*p*-Nitrochlorobenzene, sodium hydroxide lye and hydrochloric acid	C	Released, in production
29	Phthalate-butyl octyl	Plasticizer in non-electrical application	Phthalic anhydride butyl alcohol and 2-ethyl hexanol	C	Released, in production
30	Phthalates-dibutyl/dioctyl	Plasticizers	Phthalic anhydride, butyl alcohol/ethyl hexanol	C	– do –
31	Phthalates-dimethyl/diethyl	Plasticizers_	Phthalic anhydride and mehtyl/ethyl alcohol	C	– do –
32	D.C. Recording polarograph	Polarographic analysis	Component parts and boxes	A	– do –
33	Polysulphide liquid rubber	Adhesives, sealants, etc.	Ethylene chlorohydrin, *p*-formaldehyde, sodium sulphate, sulphur, sodium hydroxide and iron sulphide	A	–
34	Polyurethane coating	Coating for leather, rubber, wood, glass, etc.	Castor oil, toluene diisocyanate and solvents	A	Released, in production
35	Quinapyramine sulphate and chloride	Veterinary drug	*p*-Aminoacetanilide, ethylacetoacetate, ammonium acetate, dimethyl sulphate and guanidine carbonate	C	Released, in production
36	Radiosonde thermistors	Meteorology	Metallic oxides, platinum foil and components	A	Released, in production
37	Rubber blowing agent	Rubber chemicals	Hexamine, sodium nitrite, hydrochloric acid and stabilizers	A	Released

1	2	3	4	5	6
38	Silica gel (desiccant type)	Humidity control	Sodium silicate and sulphuric acid	A	Released, in production
39	Silicon tetrachloride	Industrial chemical	Ferrosilicon, chlorine and hydrochloric acid	C	–
40	Silver paste for mica capacitor electrodes	Electronic industry	Silver nitrate, acetone, caustic soda, glass and filler	A	Released
41	Simazine	Herbicide	Cyanuric chloride and ethylamine	C	Released
42	70% Sorbitol from dextrose monohydrate	Pharmaceuticals and vitamin C synthesis	Dextrose monohydrate, hydrogen and catalyst	C	Released, in production
43	Sorbitol (continous process)	Pharmaceuticals	Dextrose monohydrate	C	Released
44	Direct reading spectrophotometer / colorimeter	Biochemical research and spectroscopic analysis in visible range	Components and boxes	B	Released, in production
45	Sodium and potassium ferrocyanide	Pigments and textiles	Sodium cyanide / ferrous sulphate	A	Released
46	Staple pin adhesive	Adhesive for staple pins	Synthetic resin and solvent	A	Released
47	Sugarcane by plant tissue culture	Agriculture	–	–	–
48	Terpineol	Perfumery	Turpentine oil	B	Released (pilot plant-is available with NRDC)
49	Theophylline, aminophylline and caffeine	Drugs(caffeine also used in beverages)	Dimethylurea, monochloroacetic acid and acetic anhydride	C	Released, in production
50	Thermistors	Temperature measurement and control electronic devices	Oxides of high purity components and binder	A	Released, in production

1	2	3	4	5	6
51	Trichlorobenzene	Intermediate	Non-gamma BHC, residue and caustic lye	B	Released, in production
52	Turmeric by plant tissue culture	Agriculture	–	–	–
53	Vinblastin sulphate & Vincristine sulphate	Drug	*Vinca rosea* leaves	C	Released, in production
54	Vitamin B_6	Drug	–	B	Released, in producton
55	Xanthates-potassium ethyl and potassium amyl	Froth-floation	Ethyl/amyl alcohol, potassium hydroxide · and carbon disulphate	A	Released

A - Capital requirement less than Rs 20 lakhs

B - Capital requirement between Rs 20 lakhs and 50 lakhs

C - Capital requirement above Rs 50 lakhs

-These figures are tentative and purely indicative and are subject to revision from time to time

CE – 10
org – 23
Ino – 5
Bio – 5
Phy – 6
Eo – 2
Poly – 4

DATA ON NCL EXPENDITURE, RECEIPTS AND ACHIEVEMENTS (1987-88 AND 1988-89)

EXPENDITURE (Rs. in lakhs)	1987-88	1988-89
1. Recurring	555.786	599.925
2. Capital	154.400	181.266
3. Pilot plant	–	–
	710.186	781.191
RECEIPTS (Rs. in lakhs)		
1. Receipts on account of fee for sponsored projects	3.478	9.571
2. Analytical/testing charges	1.762	0.968
3. Instituttional consultancy (CSIR share) including know-how fee / job work	10.021	17.660
4. Premia/Royalties		2.219
5. Sale of laboratory products	0.457	0.218
6. Other miscellaneous receipts	19.827	7.069
	35.545	7.705
ACHIEVEMENTS		
1. Total number of processes in production	60	60
2. Value of production based on NCL know-how (Rs. in lakhs)	7975.74	9568.82
3. Estimated savings in foreign exchange on account of above production (Rs. in lakhs)	3190.30	3827.53
4. Processes released and awaiting production		
a) NCL processes	32	23
b) Sponsored schemes	25	23
c) Collaborative work	02	01
5. Total number of parties who have taken NCL processes	86	87
6. Total number of processes available for commercial exploitation	54	55
7. Number of processes released	02	06
8. Papers published	187	186
9. Papers presented/read at symposia, seminars, etc	23	33
10. Doctorate and Masters degrees received by NCL staff	28 (86-88)	30
11. Number of recognised guides for Doctorate and Masters degrees	51	56
12. Patents in force –		
(a) In India	87	108
(b) Abroad	21	33

CUMULATIVE DATA (1950-89)

EXPENDITURE (Rs. in lakhs)	
1. Recurring	5106.83
2. Capital**	2064.82
3. Pilot plant	97.42
	7269.07

RECEIPTS (Rs. in lakhs)	
1.Total money receipts	
(a) Total premia and royalties earned by NRDC through NCL processes	121.61
(b)Total receipts from sponsors	141.77
(c) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sale of laboratory products, job work and other receipts	276.01
	539.31

ACHIEVEMENTS	
1. Total value of production based on NCL know-how (Rs. in lakhs)	57435.12
2. Total No. of papers published	4939
3. Total No. of papers presented/read at symposia, seminars	507
4.Total No. of degrees received	719

** This figure does not include capital expenditure on NCL buildings amount to Rs. 30.76 lakhs that was incurred by CSIR during 1949-50.

NCL MANAGEMENT COUNCIL
(1.4.88 to 31.3.91)

1.	Dr. R.A. Mashelkar, Director, NCL, Pune 411 008	Chairman	6.	Dr. (Mrs.) Bhanu Chanda, Scientist, NCL, Pune 411 008	Member
2.	Prof. John Barnabas, Scientist, NCL, Pune 411 008	Member	7.	Dr. D. Guptasarma, Scientist, National Geophysical Research Institute, Uppal Road, Hyderabad 500 007	Member
3.	Dr. G.R. Venkitakrishnan, Scientist, NCL, Pune 411 008	Member	8.	Administrative Officer, NCL, Pune 411 008	Member secretary (Ex-officio)
4.	Dr. S.H. Iqbal, Scientist, NCL, Pune 411 008	Member	9.	Sr. Finance & Accounts Officer NCL, Pune 411 008	Member (Ex-officio)
5.	Dr.T.N. Guru Row, Scientist, NCL, Pune 411 008 (till Jan. 89')	Member	10.	Director General, Scientific and Industrial Research, Rafi Marg, New Delhi 110 001 OR his nominee	Permanent invitee
5.	Dr. R.V. Choudhary, Scientist, NCL, Pune 411 008 (from Feb. 89')	Member			

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(1.4.88 to 31.3.89)

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   School of Chemistry,
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3. Prof. G. Padmanabhan, — Member
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   Design Centre,
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   Department of Textile Technology,
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7. Mr. Atmaram Saraogi, — Member
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   STP Ltd., 8, Camac Street,
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   (from Sept. 89)

8. Dr. S. Ganguly, — Member
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   Managing Director,
   The Associated Cement
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9. Director, — Member (Ex-officio)
   National Chemical Laboratory,
   Pune 411 008

10. Director General, — Permanent invitee
    Scientific and
    Industrial Research, Rafi Marg,
    New Delhi 110 001
    OR
    his nominee

11. Mr. S.N. Sharma, — CSIR Coordinator
    Scientist,
    Council of Scientific and
    Industrial Research, Rafi Marg,
    New Delhi 110 001

12. Dr. S.H. Iqbal, — Member - Secretary
    Scientist,
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NATIONAL CHEMICAL LABORATORY, PUNE - 411 008

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3.	Dr. G.R. Venkitakrishnan	Head Process Development Division	336243
4.	Dr. V.M. Nadkarni	Head Chemical Engineering Division	333941
5.	Dr. N.R. Ayyangar	Head Organic Chemistry(II) Division	337614
6.	Dr. S. Rajappa	Head Organic Chemistry(I) Division	335133
7.	Dr. P. Ratnasamy	Head Inorganic & Materials Chemistry Division	334761
8.	Dr. S. Sivaram	Head Polymer Chemistry Division	335234
9.	Prof. John Barnabas	Head Biochemical Sciences Division	338234
10.	Dr. S.H. Iqbal	Head Technical Services Division	337860
11.	Administrative Officer		337044
12.	Sr. Finance and Accounts Officer		336702
13.	Stores and Purchase Officer		339208
14.	Scientists and all other staff		336451 336452 336453
15.	NCL Guest House		330155
16.	NCL Hostel (1)		339753
17.	NCL Medical Centre		339454