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COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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PREFACE

This is a report of the research carried out in the laboratory from April 1986 to March 1988. Because of a number of important events in this period the annual report for 1986-87 could not be brought out at the stipulated time, hence this biennial report.

NCL has continued to concentrate its efforts on long-range projects of social and industrial significance without belittling the importance of the short-term projects or in any way weakening the links with industry. Basic research has also continued to receive its due share of attention.

In the continuous process of reviewing the research programme NCL narrowed down its sphere of attention to eight areas, from the former ten. That is not to say we have stopped work in two areas. It's only that *Plant Tissue Culture* has taken its rightful place under *Biotechnology*, and the areas of *Polymer Science and Engineering* and *Polymer Synthesis and Modifications* have been amalgamated into *Polymers*. This has gone a long way in ascertaining a more logical sharing of the precious resources of finance and scientific manpower.

In these, as well as in the other six areas of research, 'excellence' has been a key criterion as can be seen from the contents of this report. A brief summary would be quite in order here.

Research and development activities

Some more progress was made with ENCEILOX–1, the catalyst developed for the oxidation of ethylene to ethylene oxide. Pilot plant tests showed that its selectivity and productivity were comparable to those of the state-of-the-art commercial catalysts. A new coating technique for the preparation of the catalyst was developed. Facilities for the preparation of 5 litre batches of the catalyst were established.

Another catalyst, ENCIOX–1, was developed for selectively oxidising n–butenes to methyl ethyl ketone. The novelty of the process is that it uses a C_4 olefins mixture and enables the simultaneous separation of isobutene.

A homogeneous catalyst, ENCICARB–1, was developed for the carbonylation of methanol to acetic acid. The catalyst is identical in performance to the conventional Rh catalyst and is much cheaper besides. A 2 TPD semi-commercial plant is being set up in collaboration with GAAC and is expected to be commissioned by the end of 1989.

ENCICARB–2, a new catalyst developed for propionic acid synthesis, is 300 times cheaper than the old catalysts in the carbonylation process.

A monometallic catalyst for the production of aromatics from naphtha was developed on laboratory scale. The know-how has already been transferred to Associated Cement Companies Ltd.

A catalyst suitable for dewaxing different lubricating oil stocks, available at Madras Refineries Ltd., has been developed. It has been found suitable after trials with bright stock from Haldia Refinery.

Studies were also taken up to study the catalytic aspects of novel carbonyl derivatives of Group VIII and other late transition metals.

Work was carried out on a host of anticancer agents including 4-demethoxydaunomycin, Fredericamycin A, Mitoxantrone analogues, Hormothamnione, Duryne and others. The synthesis of other drugs and drug intermediates was also taken up in a big way.

NCL made a major contribution to the optimization of steps in Vitamin B_6 synthesis and the setting up of a pilot plant at the sponsor's site. Wtih the start of production of Vitamin B_6 in 1987, NCL made yet another important contribution in this area.

Extensive experimentation was carried out in the Vitamin E project. A chiral intermediate from L–cystine was prepared as an intermediate for biotin synthesis.

In the area of *Biotechnology* work continued rapidly in the UNDP project on fermentation of molasses and the sponsored project on high fructose corn syrup.

Progress was also made in the molecular cloning of xylanase from chainia and high activity xylanase of alkalophilic *Bacillus* and *Cephalosporium*. The single strand specific nuclease from *Aspergillus oryzae* was successfully immobilized.

In the area of plant tissue culture progress was made in many projects. Methods were developed for *Delphinium malabaricum* and *Vanilla walkeriae*. Reproducible methods were developed for the multiplication of mature *Eucalyptus tereticornis, Eucalyptus camaldulensis, Salvadora persica* and *Dendrocalamus strictus*.

In the last phase of the development effort on electronic grade silicon, work was done towards the development of a process for preparing trichlorosilane, purifying it and cracking it to get silicon.

A novel technique, designated as "Liquid Mix Technique" was developed for preparing important electroceramic materials like stabilized zirconia and zinc oxide based varistor materials.

Extensive support was provided to NCL's development effort in above areas by using analytical techinques like X-ray crystallography, ESCA, scanning

electron microscopy, mossbauer spectroscopy, thermal analysis, mass spectroscopy, spectrochemical analysis and property measurement. Additionally, original research was also carried out in these areas.

Development on a range of synthetic pyrethroids continued. A novel, innovative, non-MIC route was developed for the synthesis of carbaryl on laboratory scale. In the area of controlled release technology progress was made on controlled release formulations of Carbofuran and Quinalphos.

In entomological studies the emphasis was on the development of ecologically acceptable pest/vector management systems.

A project on development of polyphenylene sulphide, a high performance engineering plastic, was taken up jointly with Shri Ram Fibres (SRF). The process was demonstrated to SRF on a laboratory scale. The powder produced was successfully used in coating applications. NCL also helped SRF in setting up a pilot plant at their site.

Further studies were carried out on water absorbing polymers, sulphochlorinated polyethylene, and controlled release urea. Some headway has been made in the development of light weight durable polymers which can be used in Jaipur Foot; in the synthesis of polycarbonate (via a novel non-phosgene route); in developing low cost building materials and a new polymer support for penicillin acylase.

A number of polymers were developed for reducing drag in oil transport. Work was also taken up for making epoxidized natural rubber, polyphenylene oxide and polymer alloy resins for composites. An interesting project was taken up on metal replacement by polymeric materials in the engineering components of two-wheelers. Two components were developed, moulded in large quantities and tested by an end user. They were found to be functionally satisfactory.

Considerable progress is also reported on heat pumps, computer simulation of an industrial naphtha reformer and modelling and simulation of gas-liquid reactors.

Patents and publications

28 new patents were filed during the year. 164 Indian patents (49 sealed, 19 accepted and 96 filed) and 44 foreign patents were in force as on 31-3-88. 325 research papers were published. 28 staff members, research fellows and guest workers received post-graduate degrees (11 M. Sc. and 17 Ph. D.). 51 NCL scientists are recognised as research guides by different universities.

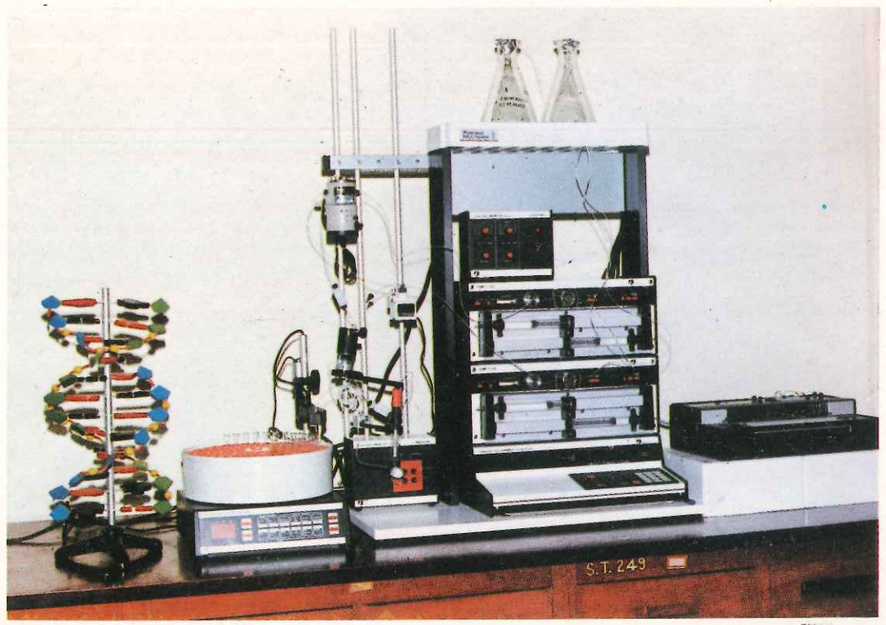
Research utilization

During 1986-88, 60 NCL processes were in production with a turnover of Rs. 147·04 crores. The foreign exchange saving on account of production during this period is estimated at about Rs. 58·81 crores.

April 1989
NCL, Pune

(L. K. Doraiswamy)
Director

ESR Spectrometer



Pharmacia FPLC system

Encilium pilot plant at NCL

Twin screw extruder

VIII

RESEARCH AND DEVELOPMENT PROJECTS

1. CATALYSIS

1·1 Vapour phase oxidation of ethylene to ethylene oxide (1-1-467 C)

NCL developed catalyst (ENCEILOX-1) for the oxidation of ethylene to ethylene oxide was tested in the pilot plant under commercial process conditions. The results showed that the selectivity and productivity of the catalyst for ethylene oxide were comparable to that of the commercial catalysts. Extensive data on the catalyst under different process conditions have been collected. A new coating technique for preparation of the catalyst was developed and facilities for the preparation of large (5 litres) catalyst batch were established. The studies on catalyst characterization by temperature programmed desorption of oxygen and $O_2 - H_2$ titrations, are in process. Further improvement on the catalyst to achieve higher activity and better selectivity is being attempted. A computer controlled high pressure internal recycle reactor (Berty reactor) for laboratory scale testing of ethylene oxidation catalysts and collection of process design data will be installed shortly.

1·2 Applications of homogeneous catalysis and C_1 Chemistry

1·2·1 Acetic anhydride via carbonylation of methanol (1-10-267)

NCL has developed a new type of catalyst (ENCICARB-5) for carbonylation of methyl acetate to acetic anhydride. This catalyst is the first of its kind and the laboratory scale development of a process is in progress in collaboration with Gujarat Alcohol and Allied Chemicals (GAAC), Ahmedabad.

1·2·2 Methyl ethyl ketone (1-23-267 Sp)

A catalyst (ENCIOX-1) for the selective oxidation of n-butenes to methyl ethyl ketone has been developed. A novel feature of this process is that it utilizes C_4 olefins mixture and simultaneous separation of isobutene is possible. A pilot plant for testing this process has been set up at NCL in collaboration with National Organic Chemical Industries Ltd. (NOCIL), Thane, and the development work is in progress.

1·2·3 Acetic acid via carbonylation of methanol (1-35-006 Sp)

A novel homogeneous catalyst has been developed for the carbonylation of methanol to acetic acid. This catalyst (ENCICARB-1) is much cheaper than the conventional Rh catalyst and its performance is identical to that of the latter. A semi commercial plant (2TPD) for acetic acid, based on NCL technology is being set up in collaboration with GAAC. The design of the semi commercial plant has been completed and the plant is expected to be commissioned in 1990.

1·2·4 Propionic acid/ethyl propionate via carbonylation of ethanol

A new catalyst (ENCICARB -2) which is 300 times cheaper than conventional catalysts, has been developed for propionic acid synthesis via carbonylation of ethanol. Laboratory scale work on this process has been completed and a commercial plant based on this technology is expected to be ready by 1990.

1·2·5 Reactions of CO and ($CO + H_2$) by homogeneous catalysis

Novel homogeneous catalysts for the following processes have also been developed :

ENCICARB-3 : Low pressure hydroformylation of allyl alcohol - a new route for 1, 4, butanediol.

ENCICARB-6 : Oxidative carbonylation of aromatic and aliphatic amines to carbamates

ENCICARB-7 : Carbonylation of nitrocompounds to isocyanates and carbamates

ENCICARB-8 : Carbonylation of ethylene to propionic acid.

The aim of this work is to develop new routes for bulk petrochemicals and speciality chemicals via C_1 chemistry.

1·3 Catalytic reactions over synthetic zeolites

1·3·1 Catalyst development for coal conversion processes for petroleum refining and petrochemical industries

(i) FCC catalysts (1-26-267 C)

A new project for the development of FCC catalysts funded by the Indian Oil Corporation (R&D), Faridabad was started.

Some catalyst formulations suitable for use in Indian conditions have been made on a laboratory scale. The activity and selectivity of some of the formulations were similar to those of the commercial catalysts.

(ii) Reforming catalyst (1-28-467 C)

A monometallic catalyst for the production of aromatics from naphtha was developed on a laboratory

scale. The know-how was transferred to Associated Cement Companies Ltd. (ACC) Thane, and the commercial samples were extensively evaluated at Indian Petrochemicals Corporation Ltd. (IPCL), Vadodara, in their bench reactors.

(iii) Hydrodewaxing catalyst (1-30-247 C)

Development of catalysts for the dewaxing of lube oils and diesel was taken up.

A catalyst suitable for dewaxing different lubricating oil stocks available at Madras Refineries Ltd. has been developed. This catalyst has also been evaluated for use with Bright Stock from Haldia Refinery and found suitable.

(iv) Styrene catalyst (1-31-467)

An iron-oxide based catalyst for dehydrogenation of ethylbenzene to styrene was developed on a laboratory scale.

Polychem Ltd., Bombay, have agreed to utilise the NCL catalyst in their styrene plant. Commercial batches of the catalyst made by United Catalysts India Ltd. (UCIL), Bombay, using NCL know-how were evaluated and found suitable.

(v) Ethylbenzene catalyst (1-32-467)

An Encilite-type catalyst for the alkylation of benzene with alcohol was developed.

Steps to commercialise this catalyst were taken and Hindustan Polymers, Vizag, agreed to test it in their commercial reactor. The know-how for manufacturing the catalyst was transferred to UCIL, Bombay.

(vi) Zeolite synthesis (1-36-024)

A UNDP sponsored programme for the synthesis of novel zeolites was initiated. This is a five-year programme on the synthesis of novel zeolites and their commercial application.

(vii) Isobutyl benzene (1-37-002 Sp)

A convenient process for the manufacture of isobutyl benzene in high purity was developed. The method consists of reacting toluene and propylene in an autoclave in the presence of an alkali metal catalyst. The yield and selectivity have been optimised.

1.4 Development of an improved catalyst for oxidation of toluene to benzaldehyde (1-25-467 Sp)

A promoted vanadium molybdenum catalyst showing about 70-75% selectivity for benzaldehyde at a toluene conversion of 10-15% in the vapour phase oxidation of toluene to benzaldehyde has been developed.

1.5 Organometallic chemistry and catalysis

1.5.1 Synthesis and structural characterisation of novel complexes, especially carbonyls

Studies on novel carbonyl derivatives of Group VIII and other late transition metals in their lower oxidation states have been carried out. Binuclear rhodium (I) carbonyl complexes of the type [Rh $(CO)_2$ azine] $_2$ were synthesised and studied. The substitution of carbonyl ligands with alkyl or aryl phosphite gave mono-and di-substituted derivatives. The reactivity of the metal- metal bond in the complex Rh_2 $(OCOCH_3)_4$ was studied using small bite ligands containing sulphur and nitrogen. The metal-metal bonded complexes are well known catalysts for hydrogenation, carbonylation and hydroformylation. Mononuclear ruthenium (II) complexes of 2-hydroxy pyridines were prepared and studied. Schiff base derivatives of S-benzyl dithiocarbazate with ruthenium (II) were synthesised and characterised.

1.6 Basic studies

(i) Mathematical modelling of chemically reacting systems relies on the applicability of macroscopic laws which in themselves are suspect under certain conditions such as when finite size systems or those operating far from equilibrium states are involved. A new mesoscopic approach to analyse such systems has been formulated and demonstrated by considering several situations such as bistability, limit cycles,chaotic and other exotic behaviour.

(ii) An arithmetic analytical approach to solution of mathematical equations of various types based on the nature of numbers as expounded in the now lost arithmetic techniques practised by Indian mathematicians during the period 800-1200 AD is proposed. The approach is simple and elegant, and can provide solutions in just a few steps. Several examples of interest such as the isothermal CSTR, Brusselator model, the Lotka-Volterra problem, analysis of chaotic systems, etc., have been solved to demonstrate the numerous advantages of using this methodology. This approach can open new vistas in mathematical analysis and has a wide scope for application to problems in basic and applied sciences.

(iii) Kinetics of hydroformylation of 1-hexene, allyl alcohol and vinyl acetate using a homogeneous (HRh) (CO) $(pph_3)_3$ catalyst was studied. The trends of rate dependence on H_2 and CO pressure, olefin concentration and catalyst concentration were found to be identical for all the three olefins studied. The reaction was found to be first order with respect to catalyst concentration and H_2 pressure, although

a certain critical catalyst concentration and H_2 pressure was observed below which the reaction rates were negligible. The rate of hydroformylation *v* CO pressure and olefin concentration passed through maxima indicating substrate inhibited kinetics at higher concentrations. Rate equations based on the rate data obtained over a wide range of conditions and in a temperature range of 30 to 80° have been proposed.

(iv) Kinetics of oxidation of ethylene to vinyl acetate was studied using a homogeneous Pd complex catalyst in acetic acid medium. The reaction was found to be first order with respect to catalyst and zero order with respect to benzoquinone. The rate *v* ethylene partial pressure relationship showed a non-linear dependence, while the rate *v* sodium acetate concentration relationship showed a maximum. A rate equation based on these observations has been proposed.

Kinetics of oxidation of n-butenes using the homogeneous $PdCl_2$ - $CuCl_2$ catalyst system was studied. The reaction was found to be first order with respect to n-butene, half order with respect to $PdCl_2$ and negative first order with respect to $CuCl_2$. A rate equation has been proposed.

(v) Kinetics of carbonylation of n-propanol, n-butanol and 1, 4 butanediol using homogeneous Rh complex catalyst has been studied. For n-propanol and n-butanol, the rates were found to vary with first, zero and zero order with respect to catalyst, alcohol and CO concentrations respectively. For the carbonylation of 1, 4 butanediol, the integral rate data in a batch reactor were used to evaluate the kinetic parameters. Rate equations have been developed for all the reactions studied.

(vi) Hydrogenation of phenyl acetylene and butenediol using Pd/C catalysts was studied with the aim of developing rate equations. These systems represent complex consecutive reactions and hence the importance of using integral batch reactor data in evaluating rate parameters was demonstrated. For both the systems, a complex kinetics with respect to phenyl acetylene and butenediol was observed in which substrate inhibition was significant. An approach to evaluate rate parameters for such complex multiphase catalytic reactions was experimentally demonstrated.

(vii) The influence of pretreatment of Pd/C catalysts on its activity and selectivity in hydrogenation of phenyl acetylene has been studied. Pretreatment of catalyst with H_2 resulted in an irreversible increase in hydrogenation activity but the selectivity of styrene decreased. When the catalyst was pretreated with phenyl acetylene, the hydrogenation activity was not influenced but the selectivity of styrene increased. This change was also irreversible.

(viii) Role of promoters, solvents and co-catalysts on the oxidative carbonylation of aniline was studied for Pd and Ru catalysts. The activity of these catalysts was strongly dependent on NaI (a promoter) concentration, O_2 pressure and aniline concentration. The reaction rate was inhibited at higher O_2 and NaI concentrations. The effect of pretreatment of Pd/C catalyst with O_2, CO and aniline has also been studied. Pretreatment of catalyst with O_2 resulted in a decrease in the initial activity, which after certain time returned to its original level. This indicated a reversible effect of catalyst pretreatment. Homogeneous Ru $(CO)_3$ I_3 type of complexes were studied and found to be highly active and selective for oxidative carbonylation of aniline to N, N'-diphenyl urea.

(ix) Mechanism of carbonylation of nitrocompounds using Pd $(Py)_2$ Cl_2 catalyst was studied. For the first time, experimental evidence was obtained to show that activation of CO is the first and essential step during carbonylation of nitrocompounds. IR spectroscopic characterization of catalytic intermediates was studied and a catalytic cycle proposed to describe the mechanism of overall reaction.

Catalytic intermediates during IR catalyzed carbonylation of alcohols were isolated and characterized by IR, NMR and other spectroscopic methods. Using certain type of ligands such as isoquinoline, it was possible to stabilize the intermediate IR complexes that are otherwise highly unstable. It has been shown that this stabilization does not affect the catalytic activity but on the other hand, improves the selectivity.

(x) Site energy distribution and catalytic properties of $AlPO_4$ - 5 (ALPO-5) were thoroughly investigated. Influence of thermal, hydrothermal and acid-base treatments on structural stability and surface and catalytic properties of ALPO-5 were also thoroughly investigated. ALPO-5 has a very good thermal stability up to 1150° but poor hydro-thermal and acid/base stability. High-pressure steam or water (at autogenous pressure)

treatment even at 200° lead to a complete collapse of its channel structure. ALPO-5 dissolves completely in 0.1 M HCl or NaOH solution. Studies on the sorption and thermodynamics of sorption of n-hexane, cyclohexane, benzene and pyridine on ALPO-5 at 200-400 ° indicated that the sorption of all the species is mobile; the sorption of n-hexane, at lower sorbate loading, in particular, and that of cyclohexane and benzene are "super mobile".

(xi) In the case of multicomponent sorption/diffusion of hydrocarbons (viz. n-hexane, toluene, p-xylene, n-propylbenzene and iso-propylbenzene) in H-ZSM-5, the sorption of a slow diffusing species in the zeolite is drastically reduced in the presence of a fast diffusing species. In multicomponent sorption, the sorption is kinetically controlled in the initial sorption period and, thereafter, it is controlled by the sorption equlibrium. In presence of p-xylene, the diffusion of n-propylbenzene is increased very significantly; in the case of single component sorption, the rate of sorption of p-xylene is greater than rate of sorption of n-propylbenzene, but in the multicomponent sorption rate of sorption of p-xylene is lower than rate of sorption of n-propylbenzene.

(xii) A novel GC technique for the rapid evaluation of shape selective behaviour of medium-pore zeolites, such as pentasil zeolites, has been developed and extensive studies have been carried out for determining the shape-selectivity of silicalite, ZSM-5, ZSM-8, ZSM-11, NaM and HM zeolites in the sorption of a large number of organic molecules with different critical sizes. Sorption selectivity of the pentasil zeolites is strongly influenced by the critical size, configuration and compressibility (or flexibility) of sorbate molecule; the influence of the latter two is, however, much stronger. It is also strongly influenced by the temperature and the zeolite parameters such as channel structure, nature of cation, degree of cation exchange, crystal size and also by the presence of poison molecules in the zeolite channel. A "shuttle cock-shuttle box" model has been proposed for explaining the shape-selectivity behaviour of the pentasil zeolites.

(xiii) Diffusion of liquid cumene in ZSM-5 and ZSM-8 zeolites has been investigated using a novel volumetric apparatus. The influence of type of cation, degree of cation exchange, dehydroxylation, poisoning and modification of channels by MgO, B_2O_3 and P_2O_5 on the diffusion has been studied.

(xiv) A new process - oxidative methane pyrolysis (OMP) - for the conversion of methane to ethylene in high yield and selectivity has been invented. Also, a series of catalysts, showing high stability or life and showing high methane conversion, and high selectivity and productivity with respect to ethylene, have been developed for the oxidative coupling of methane to C_2 single space hydrocarbons in presence of free oxygen.

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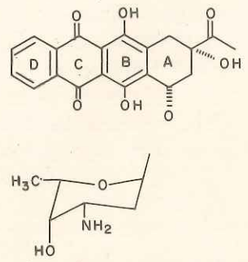
2. DRUGS AND DRUG INTERMEDIATES

2.1 Synthesis of anticancer agents

2.1.1 Synthesis of (-) -4-demethoxydaunomycin

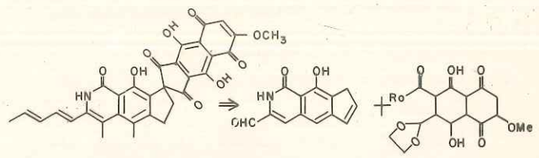
In the earlier reports, the synthesis of anthracyclinones such as daunomycinone, 4-demethoxydaunomycinone, 11-deoxydaunomycinone and 4-demethoxy-11-deoxydaunomycinone and the amino sugar, L-daunosamine starting from D-glucose, and D-glucosamine were reported. 4-Demethoxy-daunomycin, a synthetic analogue of daunomycin, is 8-10 times more effective than adriamycin and daunomycin, as an anticancer drug.

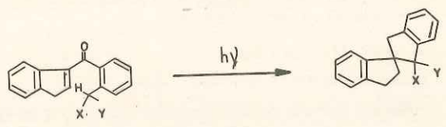


The total synthesis of (–) -4-demethoxydaunomycin has been achieved by the coupling reaction of (±)-4-demethoxydaunomycinone with N-trifluoro-acetyl-1-4-dia-*o-p*-nitrobenzoyl-L-daunosamine by α-glycosidation by chromatographic separation and fractional crystallization. The aglycone, 4-demethoxy-daunomycinone was synthesised by a new approach starting from quinizarin employing BCD and A ring condensation.

2.1.2 Fredericamycin A

Fredericamycin A is an anticancer antibiotic produced by the strain of *Streptomyces griseus.* The molecule contains a cyclopentanoisoquinolone moiety fused to a cyclopentanonaphthoquinone nucleus in a spiro fashion. The novel 1, 4-diketo spiro (4.4)-nonaneskeleton has attracted the attention of synthetic organic chemists throughout the world. Thus, a model spiro-compound has been synthesised by a novel photo-chemical route involving π, π* triplets as intermediates. The synthesis of the starting material for the photostep involves indenyl anion nucleophilicity, which is enhanced considerably by the use of phase transfer catalysts (PTC). The generality of PTC effect in enhancing the nucleophilicity of bulky and diffused nucleophiles has been shown. Attempts have been made for the synthesis of hetero-analogues of spiro-frame of fredericamycin A. An expeditious photocyclization route for rationally functionalized isoquinolone moiety is underway.

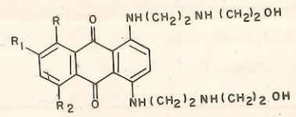




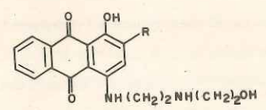
X,Y = a; H, H
b; H, OCH_3
c;

2.1.3 Mitoxantrone analogues

Mitoxantrone, a new synthetic anthraquinone derivative, has been shown to possess excellent antileukemic activity. A number of new synthetic analogues of mitoxantrone have been prepared. They are being screened for anticancer properties.



MITROXANTRONE R = R_2 = OH, R_1 = H
R = R_1 = R_2 = OH
R = R_1 = OH, R_2 = H
R = R_1 = R_2 = H

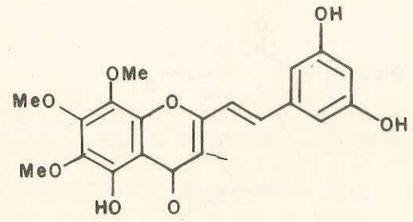


R = CH_3, C_2H_5, OCH_3, CH_2Ph

2.1.4 Hormothamnione

Hormothamnione, is the first naturally occurring styrylchromone, isolated recently from the marine cyanophyte *Hormothamnione enteromorphoides* in small quantities by employing painstaking reverse phase HPLC. It is an exceptionally potent cytotoxin to

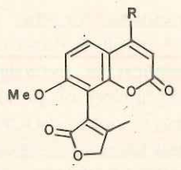
cancer cells *in vitro* and appears to be a selective inhibitor of RNA synthesis. Its synthesis was undertaken in order to make it available in good quantity. 2-Hydroxy-3, 4, 5, 6-tetramethoxy propiophenone prepared from phloroglucinol was converted into 2, 3-dimethyl- 5, 6, 7, 8-tetramethoxy chromone. Condensation of the chromone with 3, 5-dibenzyloxy-benzaldehyde followed by selective demethylation as well as debenzylation afforded hormothamnione in good yield.



Hormothamnione

2.1.5 Microminutin 4-methylmicrominutin

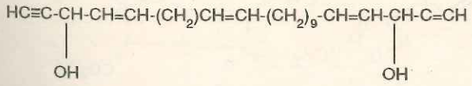
Microminutin isolated from the leaves of *Micromelum minutin* contains a γ- butenolide moiety at the C-8 of coumarin nucleus and exhibits cytotoxic activity. The methodology for the preparation of α-aryl-β-methyl- α, β-unsaturated - γ - lactones has been established and it has been successfully applied for the synthesis of microminutin and 4-methylmicrominutin.



R= H Microminutin
R= CH_3 4- methylmicrominutin

2.1.6 Duryne

Duryne is a cytotoxic polyacetylene derivative isolated recently from the marine sponge *Cribrochalina dura.* The synthesis of duryne has been initiated starting from 1, 10-dacanediol.



Duryne

2.1.7 Etoposide and tenoposide

The anticancer drug etoposide was synthesized with an overall yield of 16% from podophyllotoxin in seven chemical steps without involving chromatographic purifications. Tenoposide, the analogoues anticancer drug, was also made by the same methodology.

2.2 Synthesis of drugs and drug intermediates

2.2.1 Pyrazinamide

Study on a direct carbamoylation method on pyrazine was taken up for development of a two step process for pyrazinamide from piperazine. This study is in progress.

2.2.2 Diacerhein

The search for non-steroidal anti-inflammatory agents (NSAI) with minimum side effects is an ongoing process. Recently two firms in Italy introduced diacerhein (1, 8-diacetoxyanthraquinone-3-carboxylic acid), which works by a different mechanism from the one in which the drug intervenes in the arachidonic acid cascade to prostaglandins. A novel synthesis of diacerhein has been accomplished involving a remote controlled regioselective Diels-Alder and subsequent extrusion reaction of 5-hydroxy-1, 4-naphthoquinone with 1-methoxy-5-methylcyclohex-1, 4-diene.

2.2.3 Ambroxol

Ambroxol hydrochloride is used as an expectorant drug. A process for the manufacture of ambroxol has been successfully developed starting from anthralic acid and paracetamol. Anthranilic acid was converted into 2-amino-3, 5-dibromobenzaldehyde and paracetamol was reduced to *trans* 4-amino cyclohexanol. The dibromo-benzaldehyde was condensed with *trans* 4-aminocyclo-hexanol and reduced to give ambroxol which was then convcerted into its hydrochloride. This work has been carried out under sponsorship.

2.2.4 Carbamazepine

Carbamazepine is an analgesic and anticonvulsant drug. The process has been developed to prepare the key intermediate 10, 11-dihydro-5H-dibenz (b, f) azepin starting from *ortho* nitrotoluene. Further work is in progress. This work has been carried out under sponsorship.

2.2.5 Antitubercular and antileprotic compounds

In a collaborative programme with Sunderland Polytechnic, UK, various thiourea arylamino succinic acids and their monoamides were synthesised and screened for antitubercular as well as antimicrobial activity. In all 42 compounds in thiourea series and 45 compounds in aspartic acid series have been tested. A QSAR study has been undertaken.

2.2.6 Phenylglycine

A simple and economical process for D (-) - phenylglycine involving a quantitative method of resolution of dl (using second order asymmetric transformation resulting in a near total conversion of the dl to the required 1-phenylglycine) has been developed. A study of the reactions from the point of view of process development is in progress and pilot plant investigations are planned to be started by the end of 1988. This is part of the sponsored work aimed at developing a process for D (-)- phenylglycine Dane's Salt used in the manufacture of ampicillin.

2.2.7 4-Amino-3-nitro benzophenone and 2-amino-5-nitro-benzophenone

A new and convenient synthesis of 4-amino-3-nitro benzophenone and 2-amino-5-nitrobenzophenone was completed. These compounds are valuable intermediates for well known drugs such as mebendazole (anthelminthic) and nitrazepam (tranquiliser).

2.3 Vitamins

2.3.1 Vitamin B_6

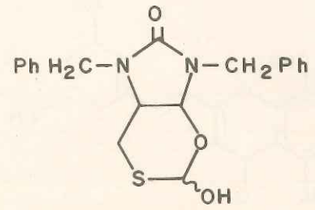
The optimization of steps in B_6 synthesis, rationalization of details of process for B_6 and work on the pilot plant at the sponsor's site concluded the development of Vitamin B_6 technology to a stage from which successful commissioning of the process at plant level could be achieved. The production of Vitamin B_6 based on NCL technology started in April 1987 at Lupin Laboratories , Ankleshwar.

2.3.2 Vitamin E

Various approaches to isophytol and its isomer 2, 6, 10, 14- tetramethylpentadec-2-ene (zamene) have been studied. (a) Using *p*-toluenesulphonylacetic ester has been used as the source for one carbon extension for the synthesis of the above two intermediates in the general strategy ($C_8 + C_1 + C_{10}$). Thus rhodinyl iodo (C_{10} unit) and 2-iodo 6-methylheptane (C_8 unit) were used for the alkylation of *p*-toluenesulphonylacetic ester. Decarboethoxylation and detoxylation gave norphytene. Similarly, using dihydrocitronellyl bromide and methylheptenyl iodide gave zamene, (b) Using aliphatic nitro compound as the carbonyl equivalent, 2, 6, 10, 14-tetramethyl pentadec-2-ene-7-one and 8-one were synthesised starting from methylheptenone, nitromethane and dihydrocitronellal ($C_8 + C_1 + C_{10}$) and dihydrocitronellyl bromide, sodium nitrite, formaldehyde and methylheptenyl chloride ($C_{10} + C_1 + C_4$), (c) Using cyanoacetic ester as one carbon equivalent, both norphytene and zamene were synthesised using methylheptene cyanoacetic ester and dihydrocitronellic acid ($C_8 + C_1 + C_{10}$), followed by decarboethoxylation and removal of cyano group to obtain zamene, (d) Phytone was synthesised using 1, 3-dioxalane-2-methyl-2-(3-chloropropyl) using methylheptenone ($C_8 + C_5 + C_5$).

2.3.3 d-Biotin

A chiral intermediate from L-cystine has been prepared as an intermediate for biotin preparation.



2.4 β-Lactam antibiotics

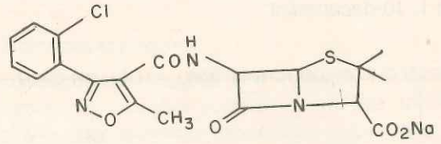
2.4.1 7 - Aminodeacetoxy cephalosporanic acid (7-ADCA)

β-Lactam anitibiotics (penicillins and cephalosporins)are the most important life saving drugs in use today. As they are less toxic and more effective they dominate the antibiotic therepy and 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 are directed to the development of a commercially viable process using penicillins.

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

2.4.2 Cloxacillin sodium

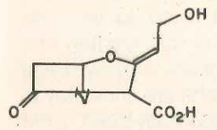
This orally active semi synthetic penicillin has been prepared on a laboratory scale by condensation of the isoxaole derivative with 6 - APA.



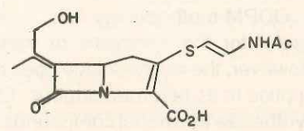
Cloxacillin sodium

2.4.3 Non-traditional β-lactam antibiotics

The ability of some strains of bacteria to produce β-lactamase, which deactivates the β-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 has been initiated on the total synthesis of these β-lactams by new methodologies.



CLAVULANIC ACID

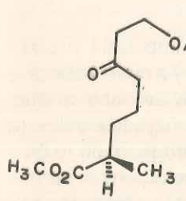


ASPARENOMYCINIC

2.5 Methodology in organic synthesis

2.5.1 Artemesinin

The key intermediate I from cyclopentenone for dl- and intermediate lactone II from 1-isolimonene for d-artemesinin have been prepared.



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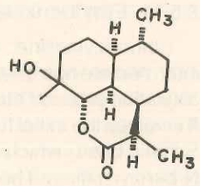
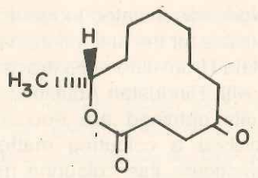


II

2.5.2 Macrolides

A short convergent synthesis of (±) patulolide A, a 12-membered macrolide with high antifungal activities, has been achieved in 10 steps starting from 1-bromo pentanol and 4-hydroxypent-1-yne.



(+) Patulolide A

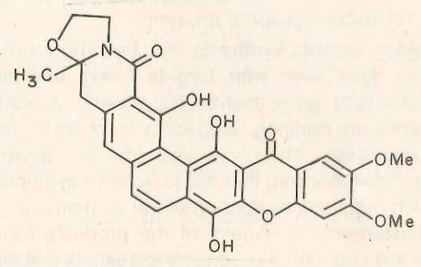
The total synthesis of (naturally occuring) (+) patulolide A from optically active propylene oxide is in progress and expected to be completed shortly.

2.5.3. Lipoic acid

In continuation of the work on asymmetric synthesis of R (+) -α- lipoic acid, alkylation and acylation of optically active sulfoxides derived from camphor and isopinacamphane, and propanedithiol were studied.

2.5.4 Cervinomycin

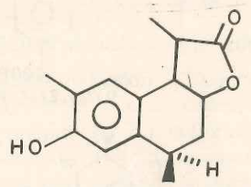
Cervinomycin is an antianaerobic and antimycoplasmol antibiotic produced by *Streptomyces cervinus*. The triacetyl cervinomycin is developing into a drug owing to its high solubility and low toxicity in addition to potent antianaerobic activity. Cervinomycin is a seven-ring xanthone derivative, including dihydroisoquinoline moiety, angularly fused to the xanthone nucleus. Synthesis of cervinomycin has been undertaken.



Cervinomycin

2.5.5 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



Heritol

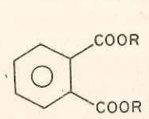
compatible with environment. Heritol has the potential of being a biodegradable natural pesticide owing to its occurrence in nature. Consequently, the total synthesis of this natural project has been undertaken starting from *o*-cresol.

2.5.6 Organometallic chemistry

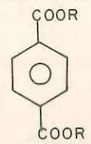
The structure and reactivity of tetraorganyl borates: Over the past five decades, organoborane intermediates have been widely employed as valuable intermediates in organic synthesis. This is primarily because the chemistry of these electrophilic and trivalent triorganylboranes is well established. However, it is interesting to note that very little is known of the chemistry of performed tetraorganylborate complexes. The knowledge is essential because of the difficulties associated with the preparation and isolation of these intermediates in pure form. The tretraorganylborate intermediates were prepared and isolated by the procedure reported in literature. The X-ray crystal structure determination and NMR studies for the evaluation of the environment around boron and magnesium in these complexes are in progress. To understand their nucleophilicity and other properties.

2.5.7 Synthesis of chiral stationary phases for gas chromatographic analysis

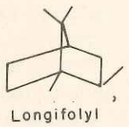
Today organic synthesis has become more challenging than ever with targets being exceptionally complex with many asymmetric centres. A number of reactions are routinely used today (such as asymmetric hydroboration, sharpless epoxidation, asymmetric Diels-Alder reaction) in order to achieve synthesis, and in such reactions evaluation of the enatiomeric excess or diastereomeric excess of the products formed is essential.Gas-chromotography is a simple and effective technique to achieve this. A number of chiral and non-chiral stationary phases have been prepared for the first time. Their utility is being thoroughly examined for enantiomer and diastereomer separations.



R = Me, Et, i-Pr
Menthyl



R = Me, Et, i-Pr, Cyclohexyl



Longifolyl

2.5.8 Stereocontrol in medium cyclic ring

Control and prediction of stereochemistry in medium cyclic rings is a complex and challenging task in organic synthesis today. Recently some work has been initiated on a conceptually new and novel approach to solve this problem via conformational protection and deprotection methodology. Thus, strain and functionalities have been used to freeze a 12-membered ring in a particular conformation. A novel aspect, viz. selectivity (e. g. facial stereoselectivity in Diels-Alder reaction), has been uncovered, which will be useful in the above studies. Currently, synthetic strategies for deprotection of conformation are under active investigation. Singlet oxygen induced transformation in protected 12-membered ring frame has also been studied.

2.5.9 Oxa-di-π-methane (ODPM) studies

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

2.5.10 Carbohydrates

A short synthesis of 2-deoxy sugars with activated leaving group at the anomeric position was achieved. L-oleandrose, the active sugar component of the antibioticivermectin was synthesized from D-glucose.

2.5.11 Ethylbenzylaniline

Ethbenzylaniline, an industrially important organic intermediate has been synthesized by a novel reductive alkylation process starting from easily available aniline. It involves the initial formation of N-benzylidineaniline (a Schiff's base) which undergoes hydrogenation to give N-benzylaniline. The addition of acetaldehyde at this stage followed by reductive dehydration and hydrogenation of the olefinic double bonds, yielded ethylbenzylaniline.

2.5.12 Colouring matter

Pterocarpus santalinus Linn (Red Sanders):

The paste derived from the wood of Red sanders has been reported in Ayurvedic literature to possess valuable anti-inflammatory properties. These trees are mainly grown in Andhra Pradesh and the paste is extensively used as folk medicine for controlling inflammation. Work was initiated to identify the active principles responsible for the anti-inflammatory activity. The material isolated from different extracts were tested in collaboration with Hindustan Antibiotics, Pune, and preliminary results obtained are encouraging. This wood also furnished a colouring matter and it is proposed to investigate this colouring matter for its possible use as a food colour.

2.6 Basic exploratory studies

2.6.1 2- Phenylisatiogens

The intermediates, phenylacetaldehyde enamines, were synthesized by three different routes and converted to 2-arylisatogens. The limitations of synthesis of 2-arylisatogens were studied. The isatogen have been dyed as polyesters.

2.6.2 Photochemical reactions

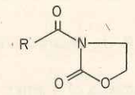
The synthetic potential of the photochemical method developed in this laboratory for the construction of bicyclo (3·20) heptene systems was explored. A formal synthesis of (±) $-\Delta^{9,12}$ – capnellene, a marine product known for its many biological activities, was achieved by the synthesis of a key intermediate, employing the above mentioned photochemical method.

The methodology is being extended to the synthesis of optically active Grandisol – an insect sex pheromone of *Anthronomus grandis,* a troublesome cotton pest and the synthesis of (±) – lineatin, an important aggregation pheromone.

2.6.3 Organic azides

In the quest for biologically active heterocycles, novel diazabicyclooctadiene and substituted benzofuroxans have been synthesised. The synthesis of the latter involves the cyclization of *o* - nitrophenylasides over phase-transfer catalysts.

Thermolysis of ethyl azidoformate, in acetic and propionic anhydrides as solvents, yielded the corresponding N–acyl–2–oxazolidinones in significant yields. The intramolecular cyclization was facilitated by the solvent. Thermolysis of *p*–toluenesulphonylazide and ethyl azideformate in heterocyclic bases yielded the corresponding N-iminopyridinium ylides. The detailed IR, PMR, and X–ray photoelectron spectral analyses of the ylides revealed a new electronic configuration.



R = CH_3, CH_2CH_3
N-acyl-2-Oxazolidinones

2.6.4 Synthetic dyes

A potential industrial outlet for *o*-cumidine as the intermediate for new monoazo and diazo solvent dyes has been found. The new solvent dyes prepared from *o*-cumidine had much better solubilities than the corresponding commercial dyes derived from *o*-toluidine. The performance of 4–*o*–cumylazo–*o*–cumidine as a fast base was comparable to that of fast Garnet GBC base. The reaction of 1–aminoenthraquinone and 1, 5–diaminoanthraquinone with α, β–unsaurated ketones in presence of anhydrous aluminium chloride led to the facilie formation of new substituted dihydroanthrapyridiniquinones in a one stage synthesis. The application of the new heterocycles as disperse dyes for polyster fibre was evaluated. Azo dyes, inaccessible by the diazolization and coupling route were synthesized by a novel reaction involving acetanilides and nitroarenes in the presence of a base under phase transfer catalytic conditions. The synthesis of speciality naphthols, which is in progress, will involve an in-depth study of the mechanistic aspects of carbonation reaction of *o*-hydroxycarbazole. Azo dyes have been prepared by diazotisation of substituted anilines and coupling with 1-morpholino and 1,8-dimorpholine naphthalene. Their use as disperse dyes on polyster fibre was evaluated.

2.6.5 Aminoacids and peptides

(a) Captopril (Antihypertensive drug)

A bench scale process (50 g) for captopril starting from L-proline and methacrylic acid has been developed. The process involves condensation diastereoisomer separation and few other steps like conversion of choloro compound to thio-compound as the final step. In all, eight different steps to get the final product were standardized. Recycling of unwanted isomer to economize the process is under study.

(b) Aspartame : (Sweetener)

A method of synthesis for the dipeptide ester Asp-Phe-OMe was developed. The separation of isomers formed by fractional crystalization was carried out and aspartame was synthesised in 75% yield.

An alternative method using an enzyme to couple the two different amino acid derivatives has been developed. Further work on the development of L-phenylalanine by asymmetric catalysis is in progress.

2.6.6 Oxidation of alchols to aldehydes and ketones

Vapour phase oxidation of some aliphatic and aromatic alcohols to the corresponding aldehydes/ ketones was undertaken. A number of such oxidations on silicon carbide (20-30) supported vanadium pentoxide (10% w/w) showed conversions in the range of 65-85%; benzyl alchol showed even better conversion, to the extent of 98-99%. The vanadium pentoxide catalyst prepared from ammonium metavandate had a satisfactory shelf life (10 months). Also, the catalyst could be used repeatedly after regeneration.

2.6.7 Studies in microanalysis

A modified Ingram-Belcher method is being developed for the microdetermination of carbon and hydrogen. This will be extend 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. Factors like, furnace temperature, carrier gas flow rates, combustion catalysts, etc. will be studied to get results comparable to those obtained with conventional methods.

2.7 Chloramphenicol (3-21-003)

Chloramphenicol is used mainly as a drug for the treatment of typhoid. A convenient route has been developed on laboratory scale for the preparation of chloramphenicol starting from styrene.

One of the key steps in the manufacture of chloramphenicol is the nitration of 2-formamido-3-phenyl-1,3- propanediol. However, this step is hazardous. In the process by a different route developed in NCL the nitration is carried out on a suitable derivative of 5-amino-6-phenyl-1, 3-dioxane. A critical study of the ortho, meta and para isomers formed during the nitration of 5-dichloroacetamido-6-phenyl-1, 3-dioxane under a variety of experimental conditions has been carried out using GLC and HPLC. The conditions for deblocking the dioxane ring after the nitration step have been optimised. 2-Methyl-2-phenylbutanedioic acid has been shown to be a very good reagent for the optical resolution of racemic amines and this has been used for the resolution of the following intermediates of chloramphenicol :

(a) 5–amino-6-phenyl–1, 3-dioxane, (b) 2–amino–3–phenyl–1, 3–propanediol and (c) 2–amino–3 (p–nitrophenyl)–1,3–propanediol. The merits of the reagent is that it has no hydrogen atom on the chiral centre adjacent to – CO_2H and hence does not racemize on heating with alkali. It can thus be recycled.

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3. BIOTECHNOLOGY

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

Investigations on the following were continued :

(i) Growth of a new flocculant strain of *Saccharomyces uvarum* in 10 litre fermentors (ii)continuous production of ethanol from molasses in a 300 litre reactor using ENCILIUM catalyst. Work has been in progress to develop a commercial process for the production of ethanol from cane molasses using a flocculant yeast strain (ENCILIUM process). Strain maintenance, selection for optimum fermentation and standardisation of the inoculum development procedures have been given particular attention.

3.2 High fructose corn syrup (4-8-167 Sp)

Investigations on the following were continued :

(i) Stability of glucose isomerase enzyme

(ii) Immobilization of glucose isomerase on alumina coated synthetic polymers

3.3 Microbial technology

3.3.1 Microbial xylanases

(a) Molecular cloning of xylanase from *Chainia*

Work on the xylanase secreting actinomycete *Chainia* includes DNA isolation, fractionation after digestion with restriction enzymes, isolation and purification of vector DNA and optimization of conditions for successful transformation. It is planned to construct the genomic library of *Chainia* in *E. coli*. Studies on protoplast isolation and regeneration of *Chainia* culture, transformation of the protoplasts broad-host-range *Streptomyces* vector have also been undertaken.

(b) High activity xylanase of alkalophilic *Bacillus* and *Cephalosporium*

Microbiological and fermentation studies are in progress to optimise xylanase secretion in an alkalophilic *Bacillus* strain isolated in the laboratory. High activity has been obtained in 48 hours in submerged culture and the preliminary characterisation of the enzyme has been in progress. A strain of *Cephalosporium*, capable of growing at alkaline pH and secreting xylanase has also been identified.

(c) Xylanase from alkalophilic and thermophilic *Bacillus*

Screeing of *Bacillus* culture capable of growing under alkaline pH and at or above 50° was undertaken and among the strains isolated one from the hot springs of Vajreshwari gave good xylanases activity. Investigations on this strain include optimization of the fermentation parameters, and characterisation of the enzyme. Standardisation of DNA isolation from this *Bacillus* and cloning of the xylanase gene into shuttle vector are also in progress.

3.3.2 Microbial nucleases

The single strand specific nuclease from *Aspergillus oryzae* (S–1 nuclease) is an important analytical enzyme used extensively in molecular biology research. The partially purified enzyme has been successfully immobilised on glutaraldehyde cross-linked gelatin alginate composite matrix and on Concanavalin A–Sepharose. Further purification of the enzyme using affinity techniques is in progress.

3.4 Basic and comparative biology

3.4.1 National Collection of Industrial Microorganisams (NCIM)

The NCIM is the biggest national centre for the maintenance and distribution of microbial strains important to biotechnology and industrial microbiology. Over 3000 microbial strains were maintained and additional strains including those applicable in recombiant DNA studies have been acquired. Research work related to strain development for ethanol production from molasses as well as industrial enzymes from novel microbial cultures has also been undertaken.

3.4.2 Germ plasm resource pools for biotechnology

The primary objective is to identify rare and little investigated microbial cultures, especially fungi and actinomycetes from indigenous resources and explore their biotechnological potential, mainly for industrial enzyme production. Under this scheme the emphasis has been on actinomycete genus *Chainia*, fungi associated with plant litter including the genus *Conidiobolus* and extremophiles, mainly thermophilic and / or alkalophilic bacteria, actinomycetes and fungi. Efforts have been focussed on identifying novel strains with ability to secrete xylanase enzymes ; a major project has been undertaken on this scheme. During the period under review, the strains werer identified for xylanolytic potential, including bacteria, *Streptomyces* and fungi which are also alkalophilic and /or thermophilic.

3.4.3 Basic biology and biochemistry of resource pool microorganisms

(a) Chitinase/Chitin synthetase complex in a dim orphic fungus *Benjaminiella poitrasii* and a hyperchitinase producer *Myrothecium verrucaria*

Studies on the dimorphic fungus *Benjaminiella poitrasii* including yeast phase mutants have been carried out with a view to elucidating the effect of various

parameters on the expressions of the morphological features, in relation to the synthesis of cell wall components and morphogenesis. Chitinase and chitobiase production by strains of *Myrothecium verrucaria* and *Trichodeima harzianum* in media containing crabshell chitin resulted in high yields. Characterisation of these enzymes has been in progress.

(b) D-xylose metabolism in *Candida shehatae*

The programme is related to studies on the elucidation of the biochemical pathway for the conversion of pentoses, especially D-xylose to ethanol, with active fermenting yeasts such as *Candida shehatae Pachysolen tannophilus* and *Pichia stipitis*. Microbiological aspects including maintenance, ethanol productivity and tolerance as well as standardisation of assay procedures for the oxidoreductive and phosphorylating enzyme of xylose metabolism are being standardised.

3.5 Plant molecular biology and plant genetic engineering

3.5.1 Genetic manipulation of rice and pigeonpea for improved protein quality using recombiant DNA technology

The immediate objective of this long term project is to clone and analyze specific seed storage protein genes in rice and pigeonpea. This basic information is essential before making further attempts to improve quality of storage proteins in these two plants.

In the protein work, rice albumin, prolamin and glutelin storage proteins were purified and shown to have molecular weights of 60 kD for albumin, 8.3 kD for prolamin and 22.8 and 28 kD for glutelin. The circular dichroism studies for rice albumin revealed an unusual secondary structure while prolamin showed a predominantly α–helical structure in 70% of ethanol. The partial N-terminal sequence of albumin and prolamin was as follows:

Rice albumin : Asn-Asp-His-Gly-Val-Thr-Gly

Rice prolamin : Asp-Pro-Trp-Gly-Cys-Tyr-Glu

Using antibodies against albumin, it was shown that the rate of synthesis of this protein was maximum between 18th to 20th day of post anthesis.

Pigeonpea globulins were isolated as salt soluble proteins and were further fractionated into legumin and vicilin. Legumin holoprotein showed a molecular weight of 375 kD with subunits of Mr 72 kD; 66 KD, 60 kD and 56 kD while vicilin holoprotein showed a molecular weight of 190 kD with two subunits of Mr 72 kD and 57 kD. The amino acid composition of albulin, legumin and vicilin showed the presence of large amounts of glutamic acid and aspartic acid while the levels of sulphur containing amino acids were low. Tryptic digests of legumin and vicilin showed partial similarity in their structure. Pigeonpea vicilin subunits were separated and partial N-terminal sequencing revealed the following sequence :

Vicilin 1 :

(72 kD) Gly–Ala–Arg–Val–Asp–Gln–Glu

Vicilin 2 :

(57 kD) Thr–Thr–Cys–Met–Glu–Ser–Gly

Circular dichroism studies showed that pigeonpea legumin and vicilin existed in a predominantly β–pleated sheet structure. Fluorescence studies showed pigeonpea vicilin to be unusually stable to both urea (8M) and guanidium – HCL (6M). For pigeonpea globulins the major antigenic determinant was found to reside on a polypeptide of Mr of 60 kD while 31 kD and 16 kD polypeptides antigenic to a lesser extent. Using redioimmunoassay (RIA), maximum globulin content was detected 28 days after flowering. RIA was also set up for screening a large number of varieties for quantitation of globulin content using a computer programme in Fortran language. Among the pigeonpea varieties screened, Gwalior-3 was found to contain the highest globulin content. A sensitive and rapid ELISA was adopted for quantitating proteins as low as 0.1 ng and the method could be used for quantitation of other proteins also.

In the work on nucleic acids, the inital objective was to construct a genomic and cDNA library in rice and pigeonpea. For the construction of the genomic library, procedures for the isolation of high molecular weight plant DNAs as well as partial digestion conditions to obtain 20 kb fragments were standardised. In the cDNA library work, total mRNA was isolated from the flowering tissue at a specific stage. As an offshoot of this work, rice long repeats in pBR 325 were cloned and a few clones were characterised in detail. Using one specific clone, a vast rearrangement of that clone was found during the change from embryonic stage to seedling stage. In addition to the cloning on rice, the *Mbol repeat family* was identified and characterised in five plants, viz. red gourd, snake gourd, cucumber, french bean and pigeonpea.

3.6 Plant tissue culture

3.6.1 Conversion of endangered plant species, seed biology and tissue culture (17-1-001 G)

Tissue culture methods have been developed for *Delphinium malabaricum* and *Vanilla walkeriae* and cultures initiated from *Pterocarpus santalinus*.

3.6.2 Technology transfer, biotechnological evaluation and clonal multiplication of *Eucalyptus, Bamboo and Salvadora* (17-3-001 G)

(a) Reproducible tissue culture methods were developed for multiplication of mature *Eucalyptus tereticornis* and *Eucalyptus camaldulensis, Salvadora persica* and *Dendrocalamus strictus* (seedlings).

Plant material was cultured from 35 elite trees of *E. tereticornis*, 40 of *E. camaldulensis* and 18 of *Salvadora perisica*, and cultures isolated from 7 trees of *E. tereticornis*, 8 of *E. camaldulensis* and 7 of *S. persica*.

The methodology for *D. strictus* (bamboo) from seedlings has also been developed.

(b) Tissue culture plantlets produced from the three species were sent to different forest corporations and user industries to evaluate their field performance.

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

Attempts are being made for induction of morphogenesis from high yielding coconut trees either through somatic embryogenesis/organogenesis *in vitro*.

3.6.4 Basic studies

Genetic modification of plants through protoplast technology.

Callus protoplasts of a drought resistant grain legume, the moth bean (*Vigna aconitifolia*) have been regenerated into shoots, and mesophyll protoplasts of cowpea (*Vigna ungiculata*) and pigeonpea (*Cajanus cajan*) into callus. Scanning electron microscopic analysis of organogenetic and non-organogenetic callus tissue of moth bean and the various stages of development of immature embryos in wheat through light and scanning electron microscopy were investigated. Plantlets regenerated from different explants of moth bean and through somatic embryogenesis in wheat have been transferred to the field.

3.6.5 Follow-up work

(a) **Sugarcane** – As part of an agreement between NCL, Deccan Sugar Institute (DSI) and Maharashtra State Farming Corporation (MSFC), 1000 tissue-culture-raised sugarcane plants were supplied to DIS for further multiplication. DSI has also set up a tissue culture laboratory where NCL's method for sugarcane C-740 and other varieties is being used in consultation with NCL.

Isolation of mutants/hybrids

(b) **Cotton** : Hybrids of cotton raised initially by embryo rescue are at the F2 generation. Cytological assessment of each plant has indicated that the plants are generally aneuploids.

(c). ***Annona squamosa*** (custard apple) : Twelve plants raised from anthers of custard apple are now at the flowering stage. Cytological analysis indicates that they are generally diploid.

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4. MATERIALS SCIENCE

4.1 Solar/semi conductor grade polycrystalline silicon (7-11-047)

The last phase of the laboratory scale process development work on electronic grade silicon was reached during 1986-88.

The process consists in (i) preparation of trichlorosilane (TCS), (ii) its purification and (iii) cracking of TCS to silicon.

4.1.1 TCS preparation

TCS preparation has been standardised for the production scale suitable to 1 TPA of silic on and the setup has been improved. It consists of a modified fluid-bed reactor with perforated baffles with a suitable design to augment heat transfer and mass transfer in the reactor leading to a decreased carry over.

4.1.2 Purification of TCS

Studies on the purification of TCS is by fractionation of TCS in three columns were carried out. The findings are :

(i) MS/SS are good materials for this system provided care is taken that the parts are not exposed to moisture, air, etc.,

(ii) SS coiled wire mesh rolls are good column packing materials to separate high and low boiling impurities like BCL_3 , PCL_3 from TCS,

(iii) a 100 mm dia column is capable of purifying TCS with a rate required for 1 TPA production of silicon,

(iv) a central feed continous distillation system with the reflux ratio of 5-10 is suitable to achieve the desired purity,

(v)silicon with 25-30 Ω cm resistivity can be routinely obtained by this purification.

4.1.3 Cracking of TCS to silicon

This is perhaps the most important part of the process because of the special factors such as the cracker design, operational procedure, the stringent conditions as regards the purity of the product, materials of construction, and the requirement that the system be leak-proof. In the last two years a major scale up in the process of cracking has been worked out, namely the production of silicon in a six-rod Siemens reactor. The 1-TPA electronic grade silicon pilot plant has been operated satisfactorily for a year. At present, the silicon obtained has impurities in 2-3 ppb range; the ultimate objective is to produce silicon with impurities in the concentration of 1 ppb or less.

4.2 High performance ceramics

Two high performance ceramic materials, namely, hard ferrites (Ba and Sr hexagonal ferrites) and fully/partially stabilized zirconia have been identified for further development. The reasons for the choice of these materials are, (i) modified chemical routes have to be employed during the synthesis and modification and in-house experience is readily available; (ii) tremendous demands for the final products, now met through imports although the basic raw materials are available in abundance, (iii) the end-product and its usage in the day-to-day consumer/commercial applications have been clearly identified.

4.2.1 Ba/Sr hexagonal ferrites

Hexagonal hard ferrites, namely, Ba/Sr ferrities, have attracted the attention of researchers because of their potential use as permanent magnets, microwave devices and most prominently as perpendicular magnetic recording media. These ferrites form nearly 50% of the annual product turnover of high performance ceramics and are not commercially produced in our country. Various preparation methods have been developed for the synthesis of these ferrites of which the commonly used is the conventional ceramic techniques. The technique, however, is not suitable for the preparation of high-performance materials since it requires high reaction temperatures (T≥1200°) and therefore needs milling to reduce the particle size from multidomain to singledomain to obtain high coercivity. The various othermethods include chemical coprecipitation, sol-gel, glass crystallization, thermal decompostion of organic precursors, etc. These methods offer an intimate mixing to achieve homogenous composition and high coercivity due to the small particles obtained by heat treatments at relatively low temperatures (Tα 750°). A chemical coprecipitation technique has been developed at NCL for the preparation of uniform submicron (~1μ m) size Ba/Sr ferrities. The major achievement of this method has been the high intrinsic coercivity value of the order of 6000 Oe on green Ba/Sr ferrite powders, is one of the highest reported on coprecipitated ferrites. Performance parameter on sintered isotropic Ba/Sr ferrite are listed in the following Tabel along with their values obtained during the last two years.

Performace parameter	Value obtained in NCL 1986-87	1987-88	Reported best values
Br (G)	2200--2400	2400--2800	2400--2800
Hc(Oe)	1500--1800	1800--2000	1800--2000
iHc (Oe)	2800--3000	2400--2800	2800--3400
$(BH)_{max}$ (MGOe)	0·9–1·1	1·1–1·4	1·4–1·7
D (gcm^{-3})	4·7–4·8	4·8–5·0	4·6–4·8
(emu/g)	54–56	56–60	56–60

These values are very close to the best reported values of parameters on isotropic Br/Sr ferrites. Further work to get the improved performance parameters further and on large scale batch runs (about 5 kg) for the preparation are in progress.

4.2.2 Stabilized zirconia

A novel technique designated as "Liquid Mix Technique" was developed and employed successfully for preparing important electro-ceramic materials such as stabilized zirconia (calcia, Yttria and Lanthanum doped types) and zinc oxide based varistor materials. These electro-ceramics have many industrial applications. The high ionic conductivity of fully stabilized zirconia is made use of in oxygen sensors, gas purification, fuel cells, etc. The stabilized zirconia powder (8% by weight Yttria doped) was prepared successfully and its physicochemical properties are measured. These properties are very much comparable with commercial (Zircar, USA) zirconia powders. Preliminary experiments have been performed to study thick films of these materials as potential oxygen sensors.

4.3 Amorphous silicon alloys for photovoltaic applications (G)

In the recent years emphasis has been on the synthesis and characterization of low band gap (Eg ≈ 1.5 eV) materials, (e.g. a–Sil–x Gex : H) and high band gap (Eg ≈ 1.8 eV) materials (e.g. a-Sil-x Cx : H) along with pure a-Sil-x Hx alloys (Eg ≈ 1.6 eV). The p-i-n junctions of these three materials when stacked in tandem with a low band gap material at the bottom are expected to generate solar cells with higher efficiency (≈ 25%) of solar energy conversion. However, the incorporation of Ge or C has been found to degrade the electronic as well as structural properties of the a-Si:H base alloy. The evaluation of the short range order (SRO) and its effects on the electronic properties of these amorphous tetrahedral semiconductor alloys using the Raman scattering (RS) techniques has been undertaken at NCL.

Various alloys, viz. $a–si_{1-x} H_x$ (x=0 to 0·25) have been synthesised using radio-frequency reactive sputtering (RFRS) and rf plasma assisted chemical vapour deposition (RF–PACVD) techniques. An RF--PA--CVD system has been designed and fabricated at NCL to enable deposition of a--Si:H films of area 150cm^2 of uniform thickness over 99% of area, at a rate of deposition greater than 2A°/sec. The conditions of depostion in both the techniques were optimized to furnish a--Si:H films with only Si-H species. The RF--PA-CVD films shows a Si-H stretching mode infrared radiation (IR) absorption at 2000^{-cm}, whereas for the RFRSD films the IR absorption is at 2080 cm^{-1}, both the types of films did not indicate IR absorption near 800-900 cm^{-1}. Raman scattering measurements indicate a higher degree of disorder in the RFRSD films than in RF-PA-CVD films. The disorder in RFRSD films has been attributed to vacancies of Si atoms near Si-H bonds which eventually caused Si-H vibrational mode to shift from 2000 cm^{-1} to 2080 cm^{-1}. The SRO in the RFRSD films has been found to vary in a complicated way with the interdependance of deposition parameters, such as rf power, Ar + H_2 pressure, substrate temperature.

Thin films of alloys $a–Si_{1-x} C_x$: H (x=0 to 0·2) have been deposited by RFRSD technique. IR absorption and Raman scattering measurements revealed Si-C heteropolar bond frequencies near 700--1000 cm^{-1} and a high degree of disorder with carbon incorporation. Conditions of preparation of $a–Si_{1-x} C_x$: H films have been optimized so as to minimise disorder.

Synthesis of $a–Si_{1-x} Ge_x$ alloys by novle techniques such as ion-beam-mixing and laser annealing has been undertaken in collaboration with the University of Poona. The films of a–Ge were deposited on a–Si or C–Si substrates and then bombarded with a Kr^+ –ion beam of energy 100 KeV and does of 10^{16} / cm^2. The appearance of Si–Ge heteropolar vibrational mode near 380–400 cm^{-1} has been attributed to the formation of $a–Si_{1-x} Ge_x$ alloys. The composition was estimated from the intensity and position of this mode. Similarly, RS measurements were carried out on ruby–laser–annealed a–Ge/a–Si layers. Laser pulse of energy in the range 0·5 to 1·5 J/cm were found to transform the bi–layers into a microcrystalline alloy of compostion $c–Si_{1-x} Ge_x$ (x-0·4 to 0·5). This indicates that much lower energy pulses are necessary to obtain amorphous films.

4.3.1 Surface and interface of GaAs

Passivation of GaAs remains a challenging problem for surface physicists/chemists. Considerable efforts have been devoted to passivate the GaAs surface in order to lower the surface barrier, reduce the surface density of states, and decrease surface recombination, as these characteristics limit the efficiency of certain minority carrier devices like bipolar transistors, lasers, LED's etc. Unfortunately, it has not been possible to overcome the intrinsic problem of the GaAs surface, in particular, the pinning of the Fermi level. NCL's effort is directed towards investigation of new passivating schemes.

4.3.2 Passivation of GaAs

New passivating schemes have been developed at NCL which are given below :

(a) By chemical and photochemical techniques

A new class of organic sulphides have been discovered that can impart excellent electronic properties to GaAs surfaces. The surface recombination velocity at the interfaces between organic sulphides and GaAs begins to approach that of the near ideal GaAs/GaAlAs interface.

(b) Polymer films by plasma polymerisation or plasma CVD (PCVD)

GaAs surface has been successfully passivated by the plasma polymerisation technique. This deposits good quality thin adhesive layers (few hundred A°) of polymers on GaAs substrate in a flowless and uniform manner. This is a completely pure and dry phase process.

Plasma polymeric films were examined as passivation films for the heat treatment of GaAs. These result suggest that PCVD–polymer can be used as a passivation film for the annealing of GaAs after ion–implantation.

(c) Langmuir–Blodgett films (LB)

MIS structures have also been fabricated using the Langmuir–Blodgett technique to passivate the etched GaAs surface. The high-frequency capacitance vs voltage measurements show an order of magnitude decrease in the interface trap density (10^{11} cm^{-2} eV^{-1}). Passivation with LB film is of interest because of their electronic and optical properties that can be used in GaAs–based devices.

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4.4 Structural chemistry

4.4.1 X-ray crystallography

Four small-molecular weight proteins (molecular weights ranging from 5000 to 10,000) have been identified. The new methods, developed at NCL, for the structure determination of small molecules, have been very successful and these will be used for these proteins.

The protein brookhaven, PIR protein sequence, the EMBL nucleic acid and cambridge crystallography databases set up on the HP 9000 computer will be used to detect the presence of specific tripeptides with definite conformational features.

4.4.2 Electron spectroscopy for chemical analysis (ESCA)

During the period of the report, 520 samples were analysed by ESCA using various techniques like XPS, UPS, AES, SAM, and depth profiling. These included 55 samples analysed for outside parties. In addition to analysing samples, the following basic work was also carried out. *In situ* investigation of the nature of chemical bonding was made by argon implantation on transition metal foils, and the surface was characterised by XPS and UPS techniques. Segregation and oxidation studies on Sn-Se, Fe-Zr and Cu-Zr systems were completed.

4.4.3 Scanning electron microscope (SEM) and X-ray fluorescence spectrometer

One thousand and thirty samples were analysed for the microstructure, grain and phase boundaries and grain size distribution by SEM. Elemental analysis by electron probe microanalysis was carried out on 88 samples during the period. Of these, 72 samples were from industries, universities and other research institutions.

The microstructure of ZnO-BaO binary ceramics, exhibiting non-linear voltage-current behaviour was investigated. The additive, BaO, which was found to be present in the intergranular phase, actually brought about an enhancement in the size of the ZnO grains. Catalysts $Fe_2O_3 + K_2CO_3$ and $Fe_2O_3 + K_2CO_3 + CeO_2 + MoO_3$ were extensively studied both in the fresh and used states. While SEM studies showed the formation of typical crystals and changes in the surface morphology after use, EPMA indicated changes in elemental concentration at different areas of the specimen under different reaction conditions.

4.4.4 X-ray diffraction studies

Structural elucidation studies were carried out on samples of key polycrystalline intermediates and end products received from various projects in catalysis, polymers, organometallic and coordination complexes, etc. Several new superconducting materials were also analysed. In all 4486 samples were analysed for crystallinity, particle size, presence of different phases etc. during this period. These services were also offered to other educational institutions and commercial organizations.

4.4.5 Mossbauer spectroscopy

Structural studies on 80 samples of different ferrites (Ba-ferrite, strontium ferrite, manganese-magnesium ferrites), iron oxide catalysts and iron complexes/ligands were carried out using mossbauer spectroscopy, these are key materials for various projects at NCL. Magnetic and mossbauer studies on barium ferrite-polymer composites were also carried out.

4.4.6 Magnetic properties measurements

Magnetic properties were evaluated for 120 samples of various soft and hard ferrites using B-H autoplotter and LCR bridge. Resonance, coercivity, saturation magnetization, BxH product were computed from the recorded B-H loops of ferrite samples. The samples of hard and soft ferrites received from RRL, Hyderabad, were also studied.

Magnetic susceptibility of various transition metal ion-complexes/ligands was measured by the Faraday method using 'Cahn balance' at room temperature and its variation with temperature in the temperature range of 77 to 300 K. Collaborative work (Dept. of Chemistry, Univ. of Poona) on transition metal ion-complexes and ligands was carried out. EPR spectra of catalysts (100 samples), superconducting materials (71 samples), polymer samples and IR-complexes (3 samples) were recorded to study their magnetic properties. Using EPR spectroscopy, F-centres and R-centres were detected for ZrO_2–La_2O_3 system. Presence of allowed and forbidden hyperfine and superfine lines was studied by EPR in a cubic CdO:Mn^{2+} system and analysed on the basis of Spin Hamiltonian formalism.

4.4.7 Thermal analysis

During the years under review, thermograms of 592 samples received from NCL scientists working on various projects and industrial R and D units were recorded. Thermal decomposition temperatures and phase changes during heating and cooling cycles were studied from thermal analysis data. The mechanism of high temperature oxidation of tin-selenide was studied.Thermoanalytical studies on zinc citrate, bismuth citrate and calcium citrate were carried out.

4.4.8 Mass spectrometry (MS)

During the period under review 2601 samples were analysed by MS and 192 by GC-MS technique. The following basic research work was also carried out. Substituent effect on the competing heterolytic cleavages and on the phosphours atom was investigated in a novel organophosphorus heterocyclic system. Application of orbital symmetry rules to ionic cycloreversion reactions was investigated. The mass spectral reactivity of the 8π electron antiaromatic azepines was correlated with its electrocyclic transformation products.

4.4.9 Spectrochemical studies

Hydrogen bonding and conformational behaviour of 2-haloethanols (XCH_2CH_2OH, X = F, Cl, Br, I), 3-halopropanols (XCH_2CH_2OH, X = F, Cl, Br, I), aminoethanol and propanols as well as diethanol and triethanolamines in dilute solution were established. The unusual hydrogen bonding in the ethanolamines were found to be responsible for their highly reactive nature. The intramolecularly hydrogen bonded seven membered ring species, reported to be present in addition to the intramolecularly hydrogen five membered species in the dipeptide analogues N-methlyl (glycine, 1-alanine, 1-leucine) N-methylamides, have been found to be absent in dilute chloroform (10^4M) solution.

4.4.10 Nicolet 60 SXB Fourier Transform Infrared spectro photometer

This equipment was installed in October 1986 to augment the infrastructural facilities in infrared spectroscopy. The instrument is capable of scanning in spectral region 25000–1Ocm^{-1}, using various beam splitters and detectors. There is a provision to record spectra in the reflectance mode in a controlled environment and temperature. Spectral accumlation facility to improve signal to noise ratio is available so that spectra of macrogram samples can be obtained.

During the period under review 2565 samples by IR spetrophotometer and 100 samples by UV-vis spectrophotometer were analysed.

4.5 Theoretical chemistry

Work on (i) quantum chemical calculations on structure and function of biologically active molecules, (ii) coupled cluster methods, and (iii) organic and high T_c superconductors was carried out. Theroretical investigations of the naturally occurring extensive (hyper) modifications of nucleic acid bases at the strategic locations of the anticodon loop in tRNAs has brought out the significance of the base substituent for probing the molecular environment in the vicinity of tRNA antiocodon. Coupled cluster methods have been used to study the static electronic properties like dipole moment, dipole polarization, etc. A multireference version of the coupled cluster method has been applied to calculate the ionization potentials and excitation energies of N_2, Co, H_2CO and some chemically interesting systems like ketone, diazomenthane and CH^+. An innovative model approach was developed to explain superconductivity in organic and oxide materials.

4.6 Properties measurement

Keeping in view the objectives of the properties measurement group as mentioned in the earlier report, the following physical thermodynamic properties were determined for nearly 550 samples received from different projects. Density and specific gravity, viscosity at different temperatures, refractive index at room temperature, surface tension at room temperature, vapour liquid equilibrium, solubility at various concentrations, pour point, pH, and electrical conductivity. Basic studies on the heat of mixing of the following binary systems were carried out to understand intermolecular interactions. Isopropanol + acetonitrile, ter. butanol + acetonitrile, n-hexane + acetonitrile, isopropanol + acetone, ter. butanol + acetone, isopropanol + dibutylether, and isobutanol + dibutylether.

Excess volume measurements on binary mixtures of ethylbenzene with chlorobenzene, nitrobenzene, aniline and benzylalcohol were undertaken with a view to understand the effect of different functional groups of polar aromatic compounds on the excess volume. Under the DST sponsored project on thermodynamic properties the measurements of vapour pressures and heats of mixing at various concentrations and temperatures of the following electrolytes in aqueous were undertaken. (i) LiCl, LiBr, LiI (ii) $SrCl_2$, $SrBR_2$ SrI_2 (iii) CsCl, CsBr, CsI (iv) $CaCl_2$, $CaBr_2$, $MgCl_2$. The above data were collected to improve the accuracy of the values and use the data in absorption heat pumps and to understand ionic interactions. On the water

evaporation control project sponsored by Department of Rural Development, Ministry of Agriculture, the work has been undertaken on the evaluation of polymer mixed monolayers which can withstand higher wind velocity. Some encouraging preliminary results have been obtainded for mixed monolayers of C_{18}–OC_2H_4OH + C_{22}–OC_2H_4OH films. Work on confirmatory experiments is in progress.

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5. AGROCHEMICALS

5.1 Synthetic pyrethroids (8-1-03S7)

5.1.1 Alphamethrin and (±) cis-DV acid

(±)*cis*-2,2-Dimethyl-3-(2,2-dichlorovinyl)cyclopropane carboxylic acid, commonly known as (±) *cis* DV acid, is a key intermediate in the synthesis of the highly potent photostable pyrethroid alphamethrin. A total synthetic route for (±) *cis*-DV acid via trichloro γ lactone, has been developed.

A laboratory scale process has been standardised for the conversion of (±) *cis* - DV acid into alphamethrin in high yields.

5.1.2 Intermediate for potent pyrethroid

A facile process has been developed for the kinetic resolution of (±) - 1,1,1-trichloro-2-hydroxy-4-methyl-3, pentene by the microbial hydrolysis of the corresponding acetate. The (-R) isomer so obtained in high chemical and optical yield is an intermediate for the highly potent pyrethroid NRDC 182.

5.1.3 Other pyrethroids

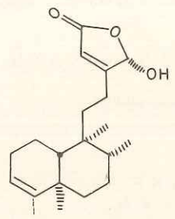
The synthesis of (RB)-cyano-3-phenoxy benzyl (±) *trans*-2- (2,2-dichlorovinyl) spiro (2,5) octane-1-carboxylate exhibiting good insecticidal activity has been carried out.

5.1.4 Secopyrethroids and related compounds

The acid moieties of several 1, 2-secopyrethroids have been synthesised, using Claisen orthoester condensation in the key step of the synthesis. Evaluation of insecticidal and larvicidal properties of some of the esters prepared from these is in progress. The synthesis of several 3-phenoxy benzyl ethers derived from 3, 3-dialkyl-aralkyl 2, 2-dihalo cyclopropane-1-alkanols has been carried out. Some of these ethers exhibited promising insecticidal activity.

5.2 Natural products of biochemical interest

One hundred and fifty plants were screened for various insect control activities. Antifeedant, juvenile hormone and growth-inhibitory activities were the prominent ones observed. Two new clerodane-type diterpenes* I and II showing antifeedant activity were isolated and identified. The structure of I was confirmed by X-ray crystallography. Plant extract were fractionated and monitored by bio-assay to isolate the active principles. Further work is underway.



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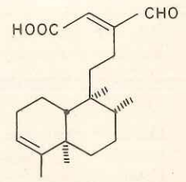

II

Continuing efforts to obtain very potent growth regulators for mosquito control have resulted in the synthesis of forty more compounds with broad spectrum activity against mosquitoes.

5.2.1 Neemrich-II (8-12-003S)

A new and simple process for obtaining Neemrich-II containing azadirachtin and other related active principles has been developed on a laboratory scale. Bioefficacy data at the laboratory level are encouraging. Further, scaling up and field trials are being planned. Simultaneously, shelf-life and toxicological data will be generated.

5.3 Synthesis of homobrassinolide

Synthesis of homobrassinolide, a potent plant growth promoter has been achieved in the laboratory scale. A collaborative project on homobrassinolide involving NCL and Godrej Soaps Pvt. Ltd., Bombay, has been started. Synthesis of homobrassinolide in multigram quantities and elaborate field trials have been undertaken.

5.4 'Non-MIC' route for carbamates

A novel, innovative non-MIC methodology involving an *in situ* acetyl azide-Curtius rearrangement has been developed for the synthesis of carbaryl on a laboratory scale. This methodology has been successfully extended to the preparation of eight other carbamates of commerce : carbofuran, propoxur, bendiocarb, dioxacarb, isoprocarb, promecarb, MTMC and xylylcarb.

5.5 Controlled release technology (8-5-3S56)

5.5.1 CR Carbofuran systems

A microencapsulated carbofuran in urea resin system with 50% a. i. content and particle size in the range of 10-100 microns, designated as ENCECAP-CF1 has been developed. *In vitro* release studies indicate that it is a porous system. Extensive field evaluation of this material as seed coat in sorghum (3 seasons) cotton, safflower and mustard (2 seasons each) has been carried out. A doubling of the protection period as compared to commercial furadan 50 SP was observed in these trials.

A granular CR formulation meant for soil broadcast containing 20% a. i. with particle size in the range 0.5-1.0 mm, designated as ENCECAP CF2 has been developed. This corresponds to furadan 3G and in actual application it is diluted with inert material so as to conform to 3% a. i. of the latter. It is prepared by dispersion of carbofuran in starch matrix crosslinked by urea resin at ambient temperatures under neutral or mildly acidic pH conditions. No effluents or by products are produced. There is wide scope for varying the release property, and is hence best suited for preparing tailor made formulations. Study of release kinetics shows that it is a porous monolith.

Field trials have attested to the beneficial performance of ENCECAP CF2. Trials under conditions of heavy flooding have not given very encouraging results. Evaluation of ENCECAP CF2 in the All India coordinated project on white grub in groundnut has shown CR formulation to be effective.

5.5.2 Controlled release quinalphos (18-6-03S SP)

The project to develop a CR quinalphos formulation was sponsored by Sandoz (India) Ltd. for use as a foliar spray. It is a contact insecticide of the organophosphate family, used widely on rice, cotton, vegetables etc. The objective was to formulate a CR foliar spray with increased effectiveness and reduced dermal toxicity.

A microcapsular formulation with capsule diameter in the 5-20 μ range was developed. Various reaction parameters were studied which had a bearing on microcapsule formation. The spray ability and storage stability of the formulations were checked in the laboratory. Five formulations, differing in degree of loading and copolymer compositions were sent to Sandoz for field trials. The formulations were tested against sucking pests, aphids and jassids in okra cultivation. Three of the CR formulations were effective giving a protection period of 20 days as against 7-10 days for the EC formulation.

Further trials are being conducted by Sandoz and their final report is awaited.

5.6 Pheromones

5.6.1 The total synthesis of (Z)-6-heneicosen-1-one and (Z)-1, 6-heneicosodien-11-one, the pheromones of Douglas-Fir Tussock moth, has been achieved by using three different synthetic routes. Tussock moth causes severe depoliation of fir trees insect in many parts of the world. These two pheromones are potent attractants. The three different syntheses were completed using a common synthon, -N,N-dimethylacetone hydrazone.

5.6.2 Queen bee substance

Queen bee substance, E-9-oxo-2-decenoic acid, functions both as a pheromone and a hormone. It is also an intermediate in the synthesis of some prosta glandins.

A new route has been developed for the three carbon homologation of aldehydes and used to synthesize queen bee substance starting from methyl cyclohexene. This route can also be satisfactorily employed for the preparaton of analogues of queen bee substance.

5.6.3 Three insect pheromones, (E)-3,7-dimethyl 1-2, 7-octadienyl propionate (E)-3, 7-dimethyl-2, octene-1, 8-diol and frontalin have been synthesized from a common intermediate. The control of the insects by these pheromones is of economic importance.

5.7 Basic work

Allylic compounds such as acetates and alcohols are of synthetic, mechanistic and biochemical importance. A novel method for the synthesis of acyclic Z-allylic acetates has been developed from cyclic homoallylic alcohols.

5.8 Entomology

The emphasis was on development of ecologically acceptable and compatable pest/vector management systems.

On the one hand, the work was on the identification and development of new chemicals, products and systems. On the other, the incorporation of known toxic and hazardous chemicals in safe and controlled systems was investigated. In the former endeavour, plants continued to be a source of new products. These were in the form of extractives, enriched particulate fractions, principle constituents or their combinations. Many of these were obtained by extraction, isolation or enrichment at the laboratory. Some were, however, already commercially available. Many terpenes and fatty acids falling in the latter category have been exhaustively evaluated for their behavioural and physiological properties against various insects. This has yielded considerable information and a few candidates with promising commercial potential. About 500 total extractives, fractions, products and combinations were put through the comprehensive NCL biological screen to determine their pest control activity.

Several categories of synthetic compounds consisting of pyrethroids, carbamates and insect growth regulators (IGRs) synthesised at NCL were also examined against a broad spectrum of insect pests. For some of these, the tests were extended beyond the conventional ones by examining their effects on behaviour as well. It was found that many IGRs exhibited both physiological and behavioural effects; sometimes, additionally developmental inhibition and/or on ability to impart acute or chronic toxicity to pests were also detected. The prospect of developing totally new pest management strategies has thus become bright. More than 250 new compounds were tested in this way.

Attempts were continued to obtain a potent mosquito repellent at a economically competitive price.

Further, optimisation of the entire controlled release delivery system for an aquatic larvicide was continued vigorously. It was found that the system was highly adaptable and attempts are being made to use it successfully for dengue vector control under domestic and peridomestic situations. In this, collaboration has been established with the National Institute of Virology and preliminary trials have already been undertaken. Similarly, the system has been adjudged as being effective in the control of the guinea worm vector, cyclops. This work is being vigorously pursued.

The basic research in this area has largely been the offshoot of the applied programmes outlined above or the one aimed at the development of new applied approaches. The role of ecophysiological and nutrition factors, as well as allelochemical cues, in determining host preference and suitability was studied; a wide range of extrinsic and intrinsic factors and allelochemics were examined. The effect of mixtures and combinations on the life cycle of different insects was investigated in considerable detail with the objective of gleaning viable leads. Studies on little known and understood behavioural effects of synthetic pest control chemicals were continued and interesting pointers positively additive forms effects obtained. Studies aimed at development of newer techniques, e. g. evaluation of volatile repellents, were continued with emphasis on mosquitoes as the target vectors. A new approach was initiated with the study of enzyme kinetics, with particular stress on the role and effects of esterase enzyme induction by extrinsic manipulation, including changes in diet and exposure to selected allelochemics. In the field of controlled release, studies were undertaken to establish mechanisms of toxicant transport and rates of release from different polymer configurations.

The study of effects of organometallic compounds on insects was extended to microorganisms, notably bacteria and fungi.

The NCL biological screen has been further enlarged and diversified to include four species of bacterial, and two of fungi and aquatic microfauna, especially Cyclops and Daphnia.

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6. TIME TARGETED PROJECTS

6.1 Ethylene to ethylene oxide

The integrated ethylene oxide pilot plant consisting of ethylene generation and ethylene oxidation units was commissioned and the testing of the catalyst manufactured as per the NCL process has been carried out in it. The performance of this catalyst was found to be comparable to that being currently used commercially in the country. Further improvements on the catalyst and its manufacture are being carried out. Facilities for evaluating the catalyst under the process conditions in an automated laboratory reactor assembly (Berty reactor) are being established. Discussions have been held with IPCL, Baroda, for taking follow up action to utilize the catalyst developed.

6.2 Molasses to ethanol

An immobilized whole cell system had been developed for the continuous fermentation of molasses to ethanol. The major problems faced in the scale up of this system was with regard to the strength and life of the catalyst. In order to overcome these difficulties a new strain of yeast capable of agglomerating during the growth stage was adapted for growth with molasses and used for its fermentation. A pilot plant reactor assembly of the capacity of 50 lit/day ethanol was installed and operated successfully for a period of 100 days. The new continuous process capable of producing 15% more ethanol is being offered to distilleries.

6.3 Ethylene from ethanol

A process has been developed for the dehydration of ethanol to ethylene using a zeolite catalyst. A pilot plant of 2-3 Kg/hr has been operated successfully and ethylene thus generated is being used in the pilot plant for ethylene oxide. The process is now being offered for commercial exploitation.

6.4 Monochloromethylacetoacetamide (MMACl)

MMACl is an intermediate in the manufacture of the pesticide monocrotophos. A continuous process has been developed based on the direct chlorination of monomethylacetoacetamide. The product obtained is comparable to the imported one. Further, the product was practically free of the dichloro compound. The process has been transferred to Colour Chem Ltd., Bombay, for commercialization. The design of the commercial plant is underway.

6.5 Piperazine

Piperazine is an important intermediate used in the preparation of drugs and the entire requirement is being met by imports. A continuous process for piperazine starting from ethylenediamine and ethylene dichloride has been developed and demonstrated to Diamines and Chemicals Limited, Baroda. A plant of 300 .TPA capacity has been designed and the equipment is being procured. The plant is proposed to be commissioned by the end of 1988.

6.6 Glyphosate

The process development work in laboratory scale (500g/batch) has been completed and is ready for release. Action is being taken to demonstrate the process in a 5 Kg /batch scale. The preliminary cost estimates show that the manufacture of glyphosate by this process would be commercially very profitable.

6.7 Alphamethrin

A laboratory scale process has been developed for the preparation of alphamethrin. The process is capable to yielding a higher selectivity with respect to the desired isomer, *cis*-alphamethrin. Preliminary process evalution indicated that it will not be feasible to manufacture by this process and sell it at a competitive price. Further laboratory scale work is therefore being carried out on improving the process.

6.8. Aminomethylpiperazine

Exploratroy work has been undertaken to identify a route for producing this product. Further work in a pilot plant is being planned.

6.9 2–6 Diethylaniline (2-6 DEA)

2–6 DEA is an intermediate required for the manufacture of butachlor. The entire requirement of the country is met through imports. Work on the development of a process using aniline and ethylene as raw materials has been started.Preliminary results indicate that an economical process can be developed. This work has been undertaken on behalf of Navin Chemical Enterprises, Bombay.

6.10 Morpholine

Work on the development of a vapour phase process for morpholine from diethylene glycol and ammonia has been initiated. A number of catalysts have been screened and a catalyst capable of giving 50% conversion with 80% selectivity has been chosen for further evaluation. Simultaneously other catalyst systems are also being investigated. This work has been undertaken on behalf of Navin Chemical Enterprises, Bombay.

6.11 Gasoline stabilizer

Several batches of N-phenyl-N'-butyl-*p*-phenylenediamine have been prepared on a small scale and samples for testing sent to the R&D centre of Indian Oil Corporation, Faridabad. These samples have been found to be satisfactory. Further investigations are being carried out to prepare the material by alternative routes so that an economically viable process can be developed.

12. 1-4 Butanediol

Exploratory work on the hydrogenation of butyne diol have shown promising results indicative of the possibility of developing a commercial process.

7. POLYMERS

7.1 Polyphenylene sulphide (PPS) (18-1-567 C)

The objective of the joint development project with Shri Ram Fibers (SRF), Madras, is to scale up the laboratory process for producing coating grade polyphenylene sulphide (an important engineering thermoplastic) and to develop the guidelines for processing the polymer. Another objective is to develop a laboratory scale process for moulding grade PPS powder through solid state polymerization. A process for synthesis of PPS has been demonstrated on a pilot scale reactor at SRF. The precipitation polymerization and separation process details have been optimized. The powder produced by NCL/SRF process has been successfully used in coating applications. The process details for further pilot plant trials have been defined.

The solid state polymerization process demonstrated on a bench scale is now being scaledup to produce adequate moulding grade powder for compounding with glass fibres.

Applications development trials for PPS coatings have been undertaken with the collaborator. Pilot plant trials will be carried out at SRF under optimum polymerization and separation conditions. The powder produced in the pilot plant will be used commercially for demonstrating coating applications of the polymer. The high molecular weight powder, produce at laboratory scale by solid state polymerization, will be compounded with glass fibres. The glass reinforced PPS will then be used for moulding trials to define processing guidelines and product areas.

7.2 Water absorbing polymers (18-2-006 Sp)

A semi-commercial plant with a capacity of 150 TPA has been commissioned by Indian Organic Chemicals Ltd. at Khopoli for producing the super-absorbent polymer, Jalshakti developed by NCL. Extensive field trials have been conducted for a variety of agricultural, horticultural and forestry applications in different climatic zones. For a number of crops, the use of Jalshkati has been found to be cost-effective in terms of increased yield. The improved second generation process technology, giving better yields in shorter reaction time, has been demonstrated at laboratory scale. Further trials are being carried out in the semi-commercial plant. The company has received a letter of intent from the Government for the production of 5000 TPA of Jalshakti.

7.3 Sulfochlorinated polyethylene (SCPE) (18-400-6)

A semi-commercial plant of 150 TPA capacity is planned to be set up at Shriram Rayons, Kota, for producing SCPE. A laboratory scale process for a superior grade SCPE (SCPE II) has been developed. Pilot plant trials will be taken up for producing both the grades of SCPE at Shriram Rayons, Kota.

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

The objective of this development project carried out in collaboration with Rashtriya Chemicals and Fertilisers, Bombay, is to develop urea-polymer controlled release formulations. Laboratory tests have been carried out with the formulations developed at NCL to quantify the rates of release of urea. The results are promising. Further field trials have been planned to test the efficacy of the controlled release technology.

7.5 Light weight durable polymers forJaipur Foot (18-8-006 G)

The objective of the project is to develop suitable polyurethane materials for different components of Jaipur Foot. The specific materials being developed at NCL include a rigid polyruethane foam to replace wood laminate in ankle block, a polyurethane elastomer to replace rubber as shell material and a polyurethane flexible foam to replace microcellular rubber in heel and forefoot inserts. The project is a tripartite collaboration between NCL (materials development), IIT, Bombay (design and testing), and SDM Hospital, Jaipur (end use testing). The project activities are supported by the Department of Science and Technology.

Polyurethane (PU) formulations including new polyols have been developed for rigid foam to replace wood laminate in ankle block. The foam ankle blocks are being cast for product testing and trials on patients. On the basis of preliminary tests, some formulations have been short-listed for flexible PU foam and PU cast elastomer. These materials are being characterised for their mechanical properties and processability. The casting process technology is being developed.

7.6 Synthesis of polycarbonates via nonphosgene route (18-9-056 C)

Bisphenol–4 was transesterified with diphenyl carbonate in the presence of a basic catalyst. Effect of stoichiometry was investigated. Polycarbonate with intrinsic viscosities upto 0.38 dl/g could be obtained. The polymer coloration could be avoided by addition of carefully selected additives. Under similar conditions, bisphenol-4 did not undergo transesterification with dimethyl carbonate when titanium tetraalkoxide was used as the catalyst.

7.7 Low cost alternative building materials and components (18-10-005)

Sealants and water proof compounds using readily available, inexpensive, indigenous polyols have been prepared at 1 kg/batch size and evaluated for various properties. The sealant has been tested for heatageing, volume shrinkage, tack free time, tensile strength, peel strength, application life and rheological properties at CBRI, Lucknow, and found to be satisfactory. Water proofing compounds have been tested for film properties such as scratch hardness, adhesion, flexibility bounding to concrete /brick, water permeability and found to have acceptable properties.

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

This is a joint development effort involving NCL and Hindustan Antibiotics Limited (HAL), Pune. The objective is to replace the derivatized cellulose matrix currently used with a water insoluble synthetic polymer matrix which can covalently bind penicillin acylase enzyme. The joint development is to be completed in two phases. In the first phase polymer matrices are being synthesized on a laboratory scale at NCL. The polymers are currently being screened at HAL for enzyme adsorption, activity retention and operational stability. A suitable matrix is to be identified by this exercise. This phase is expected to be successfully completed by December 88. In the second phase of the project, a production facility will be set up at HAL to generate the polymer matrices.

7.9 Polyacrylamides (18-12-056 Sp)

This is a project sponsored by Ficom Organics, Bombay for the development of suitable polymers for use as flocculants in applications such as sugarcane juice clarification, brine clarification, etc. Preliminary synthesis experiments have been carried out to produce suitable polymers, that have shown promising results in laboratory trials. Further work is planned on the standardization of the process and evaluation of the polymers in target applications.

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

The R & D activities in this frontier research area involve development of suitable polymers for drag reduction in transport of both crude oil and oil products through pipelines. The programme also involves development of computer software for the pipeline transport characteristics of the North Gujarat crude oil. The project activities are being carried out in collaboration with Indian Oil Corporation, Faridabad, Lubrizol, Thane and ONGC, Baroda. A number of new polymers have been developed at NCL. Preliminary trial in the 1/4" pipeline rig indicate that the performance of these polymers in terms of drag reduction is comparable or better than the commercially available imported polymers. In the laboratory pipeline trials adequate shear stability and drag reduction of the order of 65-80% have been demonstrated at low levels of loading. Extensive testing of the polymers in a 2" pipeline loop is in progress. User-friendly computer software have been developed both for the isothermal and non-isothermal flow of different types of oils and oil products through pipeline. It can also be used for the prediction of start-up behaviour of crude oil carrying pipelines.

7.11 Development of new specific reagent combinations for the beneficiation of

(i) alumina rich iron ores,

(ii) partially oxidized copper sulfide ores,

(iii) phosphate slimes

The aim of the investigation, carried out in collaboration with Tata Research Development and Design Centre (TRDDC), Pune, is to develop water soluble polymers with chelating type functional groups for winning valuable minerals from lean ores and slimes by selective flocculation technique. Polyacrylamide containing hydroxamate groups has shown excellent selectivity and 92% recovery in the selective flocculation of synthetic mixtures of iron oxide and kaolin. The method of estimating the functional group concentration has been established. However, higher concentrations of functional groups could not be introduced by this method. Acrylohydroxamic acid monomer has been synthesized by a modified method with higher conversions so that the desired concentration of the functional group could be achieved by polymerization/ copolymerizations. Sarcosine type (reportedly good collector for phosphate slimes) functionality, has been introduced by a novel method. Pyrene-labelled, partially hydrolysed polyacrylamides have been synthesized for fluorescence spectroscopic studies (to be carried out at University of Columbia, USA) to study polymer conformations in the adsorbed state.

7.12 Epoxidized natural rubber

Natural rubber, in spite of its desirable physical properties shows poor oil resistance and high gas permeability. Synthetic rubbers such as nitrile and butyl have been developed to offset these drawbacks. It has, however, been discovered recently that epoxidation of natural rubber under well defined conditions leads to a modified natural rubber with improved oil resistance and reduced oxygen permeability.

In view of this, an experimental programme was undertaken to epoxidize natural rubber latex using hydrogen peroxide and formic acid. The reaction conditions have been standardized for 50% epoxidation on a 100 g scale. The physical properties of vulcanizates have been evaluated and found to compare favourably with ENR-50 obtained from Malaysian Rubber Products Research Association.

7.13 Synthesis of polyphenylene oxide

Polyphenylene ethers (PPE) are a class of polymers which contain phenolic monomers attached via an ether linkage. Depending upon the monomer types used in the polymerization, a variety of homopolymers and copolymers can be produced. These polymers are fairly nonpolar, dimensionally stable and resistant to aqueous solutions, acids, bases, and salt solutions. Blending of PPE with polystyrene, polyolefins, nylons, and other miscible polymers yields true alloys that are reported to possess synergistic properties and greatly improved processability.

The preparation of homopolymer from 2,6-dimethyl phenol and of a PPE blend with high impact polystyrene (HIPS) has been standardized on a laboratory scale. A number of batches of PPE : HIPS were prepared and preliminary work was initiated for the incorporation of appropriate stabilizers, lubricants, pigments in these blends on the single screw extruder. Finally, the blends were obtained in a pellet form.

7.14 Polymer alloy resins for composites phase II-product development (G)

The objective is to make moulded products with PET/PMMA alloys and PPS/HDPE alloys. These two alloy systems have been demonstrated in the first phase of the project at NCL. The project is supported by the Department of Science and Technology.

Melt compounding of two alloy systems, namely PPS/HDPE and PET / PMMA, has been successfully completed. The melt compounding conditions for preparation of the alloys were defined on the basis of the basic rheology and thermal data generated on the component polymers. The thermal and viscoelastic characterization of the alloys has been completed. On the basis of the results, the property advantages anticipated due to alloying have been confirmed. For example, alloying of PPS with HDPE has shown to improve its impact resistance in addition to reducing its cost. Also, the alloying of PETP with PMMA has resulted in accelerated crystallization leading to shorter moulding cycles. The toughness and impact resistance of PETP are also improved. Injection moulding of PET/PMMA alloys has been successfully demonstrated.

Joint development efforts are being initiated with B. M. Thakkar and Co. for further development of the compounding process technology and moulded product development with two alloys.

7.15 Metal replacement by polymeric materials in engineering components of two wheelers (G)

Polymers and composites are increasingly replacing conventional materials such as metals and ceramics in engineering applications. In large volume applications of automotive parts the cost effectiveness of the material governed not merely by the material cost but also by the improved productivity and design flexibility offered by the material. The project involves a collaborative development effort with Bajaj Auto, Pune (end user), Kirloskar Kisan Equipment Ltd., Pune (processor) and B. M. Thakkar, Bombay (materials manufacturer) for FRTP compounds.

The project activity is supported by the Department of Science and Technology. Specific components were identified in consultation with the user industry. On the basis of performance requirements of these components, polymeric materials were selected to meet the performance and targets. The materials development and a thorough material characterization were carried out. On the basis of the rheology and thermal characteristics of the FRTP compounds, injection moulding dies were designed and fabricated and injection moulding conditions were optimized. Two prototype components have been moulded in large quantities for product testing by the user. The components have been found to be functionally satisfactory. Further field trials of the components on vehicles are in progress.

7.16 Basic studies

7.16.1 Superabsorbing polymers, which are capable of absorbing several hundered times their own weight of water or other liquid, are assuming importance in diverse fields. They show a range of unusual phenomena. A number of new experimental findings on deformation dependent superabsorption, memory effects, new volume transitions and surface instabilities in these materials have been made. Mechanistic interpretations based on thermodynamic considerations have been provided to explain these phenomena.

The work in the area of polymer crystallization/structure property relations seeks to illustrate the inter-relationship between the product properties, morphology and processing conditions of engineering thermoplastics including polymer blends/alloys. The specific polymers being investigated include

engineering plastics such as nylons, thermoplastic polyesters, polyphenylene sulphide, polyethylene terephthalate, polytetrafluoroethylene, etc. In thermoplasitc blends, the effect of the presence of the molten phase on nucleation and crystal growth has been investigated. It is known that solid particles act as heterogeneous nuclei and accclerate crystallization. However the use of a second fluid phase for modifying crystallization of polymers from melt is a new phenomenon. It has been demonstrated that the crystallization of PET, normally a sluggish ploymer to crystallize, is accelerated considerably because of the presence of molten PMMA. This improves the moldability of the engineering plastic.

The crystallizing ability of a polymer is greatly affected by its chemical structure since it involves packing of the individual polymer chains into an organized three-dimensional array. Besides the chemical nature, the physical conformation of a monomer unit can also drastically change the molecular packing. Thus incorporation of an allicyclic moiety that can exist in 'trans' or 'gauche' conformation affects the crystallization of polyesters. Through its effect on the trans-gauche equilibrium, the melt temperature in processing has been shown to affect the rate and degree of crystallization of copolyesters. This is a new phenomenon reported for the first time. It provides another tool for 'molecular engineering' to effect morphological changes for obtaining desired properties.

NCL has produced conducting polymers by an interesting technique. The conductivity of polyphenylene oxide (PPO) has been enhanced 10 to 12 times by doping it with non-toxic iron and copper salts. This has yielded a stable semiconductive (10^{-3} s/cm) polymer for which the conductivity has remained almost constant for over six months which is not achievable by existing methods.

7.16.2 Studies in modification of cellulose for utilization as a cheap biodegradable polymeric material for encapsulation of carbofuran were continued. Cellulose from different sources such as peanut shell, rice straw, wood and cotton pulp was xanthated and used as an encapsulant for carbofuran using the already established procedure. Besides, rich straw and peanut shells were also used as such without isolating the cellulose component for encapsulation.

The *in vitro* release rates of the encapsulated products under perfect sink conditions were studied in excess water and correlated with the crystallinity of the cellulose component used, measured by x-ray studies. In general, decrease in crystallinity led to increase in release rate. Thus release profiles of rice straw cellulose, wood pulp, cotton pulp, rice straw, peanut shell cellulose, starch and peanut shell powder were in the increasing order.

Further modification of cellulose (before xanthation) by graft copolymerization with vinyl monomers, both hydrophobic as well as hydrophilic, was studied; their release profiles were explained in terms of their crystallinity.

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8. PROCESS DESIGN

8.1 Regular packing development (19-1-006)

The aim of the project is to develop regular packings for use in distillation columns, in particular, those operating under reduced pressure. These packings have high mass transfer efficiency, low HETP and low pressure drop.

Two types of packings were tested in a pilot plant under various conditions of liquid / vapour loading, operating pressures, etc.

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

Installation of these packings in industrial columns is under way.

8.2 Heat pumps (19-2-006 C)

Heat pumps are unique heat recovery devices capable of recovering heat at lower temperatures and recycling the recovered heat at higher temperatures. Recognising the enormous potential for heat pumps in India, NCL has made pioneering efforts, through collaboration with the University of Salford, U. K. since 1980, to make Indian industries aware of the enormous potential of heat pumps. The primary objective of this project, funded by the British Overseas Development Administration, is to promote the use of heat pumps in Indian industries for energy conservation and recycling. The current status of the project is described below.

8.2.1 Experimental programme

A well instrumented water-to-water heat pump is being operated to collect design and performance data using single and non-azeotropic mixtures of chlorofluorocarbons as working fluids. It is also used to demonstrate the possibility of simultaneously producing chilled and hot water. A fully instrumented heat pump assisted dryer is being operated to collect design data and for demonstration. A mathematical model has been developed to simulate the performance of this dryer. A heat pump assisted distillation column with a computer control facility and a multi-purpose absorption heat pump unit are being installed. Predictive methods for the thermodynamic properties of absorption working pairs are being developed.

8.2.2 Industrial collaboration

Preliminary technoeconomic evaluations for various heat pump applications including simultaneous heating and cooling, drying, distillation and evaporation have been worked out for typical Indian cost parameters. Based on this some specific case studies such as heat pump assisted ethanol distillation, mechanical vapour recompression (MVR) assisted multiple effect evaporation, process heat recovery and waste heat utilization for absorption coolers heat pumps have been carried out for some potential users.

8.3 Process simulation, optimisation and synthesis

8.3.1 Computer simulation of IPCL's naphtha reformer

The performance of the catalytic naphtha reformers constituting the reforming section of IPCL's aromatics plant has been simulated on computer by using a suitable model of the deactivating reformation network. The performance of both the individual reformers and the reforming section including the hydrogen recycle loop, gas-liquid separator can be predicted by use of this model. In particular, it was found that important plant operating characteristics like aromatics yield, temperature drops across the reformers, effect of feed quality variation, cycle time can be predicted with reasonable accuracy. The model has been validated with running plant data supplied by IPCL.

8.3.2 Modelling and simulation of gas liquid reactors

The non-isothermal effects in gas absorption followed by exothermic reactions (biomolecular as well as consecutive competitive reactions) have been studied under conditions where depletion and/or generation of liquid phase species at the gas-liquid interface have been correctly accounted for. This has allowed a conceptually correct formulation of a possible interfacial temperature rise under some conditioning and hence the local reaction rates can be accounted for more correctly. This analysis is expected to have an important bearing on the gas-liquid reactor design and simulation.

8.4 Project design

Designs were prepared for several projects such as (i) production of n-methyl-monochloroacetoacetamide (ii) ethylene glycol from ethanol (iii) glucose from bagasse by enzymatic conversion and (iv) propionic acid. Members of this group also rendered help in collection of design data from the pilot plants of some of these projects.

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INFRASTRUCTURE ACTIVITIES

Division of Technical Services (DTS)

Planning, monitoring and research coordination, industrial liaison and technology transfer and documentation and market survey, publicity and public relations are major activities of the DTS. As such, the division in some way or other is closely associated with all the research divisions and renders help in drawing their research programmes.

Planning, monitoring and research coordination

As in the past research programmes for the years were prepared and placed before the Research Advisory Committee for ratification at meetings and also before Executive Committee (EC).

Four meetings of the EC were held during the period under reporting. Besides organisation of these meetings, DTS prepared final proposals for sponsorship, collaborative, grant-in-aid and consultancy projects and placed before the EC during these meetings.

Close to 1135 inquiries were received from private and government agencies, the parliament, NRDC, CSIR HQs, the sister laboratories and from AGCR/CSIR Audit groups.

Quarterly reports received from the area/project leaders were routinely scrutinized and important data was fed in the Centralized Project File Bank and information on progress of the various projects was sent to the Director pointing out any bottlenecks in the implementation of the project.

A comprehensive report on NCL in three parts was prepared for the CSIR Review Committee which visited NCL.

A beginning has been made towards computerization of the various activities of the DTS. In this context information projects, publications, research utilization data has been computerized and attempts are being made to computerize information contained in non-technical notes on the projects developed by the NCL.

Industrial liaison, technology transfer, etc.

NCL's links with industry have become increasingly stronger during the last few years. Convinced by the capacity of the NCL to develop small and big and even complex technologies and the consultancy services offered by the NCL, more and more entrepreneurs are approaching NCL for different kind of help. During the period under review 62 consultancy, 22 sponsored / grant-in-aid / collaborative agreements were executed.

As a part of NCL's assistance to industries who do not have in-house analytical/testing facilities 794 samples were analysed on behalf of 184 parties. The drawing office, reprography and photography rendered help to various divisions in the NCL. More than 754 tracings, 106,300 xerox copies, 1716 photographs, 1766 prints and 1269 slides were prepared. DTS received 396 applications for financial assistance for research schemes. These were scrutinized and sent to the CSIR with suitable comments. Quarterly and annual reports giving the research utilization data in respect of the laboratory, were sent to the CSIR.

Documentation, market data collection

The activities in this category are related to (I) surveying and indexing of literature on research management; (II) technoecnomic survey of important projects; (III) collection of market data on selected projects; (iv) collection of information on current market prices, licences applied for, licences granted etc. and storage of these on cards.

All the above data has been continuously up-dated and maintained in the Cardex System.

Publicity, public relations, extramural activities

Eight issues of the NCL Bulletin, the house journal of the NCL were brought out. One special issue containing the Director's letter to the Staff (April 1987) and a special issue - National Science Day Number were also brought out during the period under reporting. News about staff and important events was sent to the CSIR News regularly.

Information on NCL's activities was compiled and sent to the CSIR in the form of monthly summaries to the cabinet. Quarterly research utilization data in respect of NCL's activities was also sent regularly to the CSIR.

The DTS organised and successfully conducted the CSIR Junior Research Fellowship Examination held at Pune on 30-11-86 (600 candidates) and the CSIR-UGC JRF Examination - 1987 held at Pune on 27-3-1988. Around 600 and 350 candidates respectively appeared for this examination.

DTS also played a major role in organising and conduction of the section officers and assistant examination held on behalf of CSIR at the NCL from 22–24th August, 1987.

NCL participated in the following exhibitions / fairs during the reporting period.

(1) 'Trade and Industrial Fair 86', organised by the Ex-Service League, Pune (April-May, 1986).

(2) Glimpses of India Exhibition organised by the Maratha wada Mitramandal at Bombay (21-1-87 to 24-2-88).

(3) CSIR participated in the Scientific Exhibition organised by the Indian Science Congress on the occasion of its Platinum Jubilee at the Poona University Campus, between 7-20th January 1988. Sixteen CSIR laboratories including NCL participated in this exhibition. NCL through its DTS coordinated the CSIR participation in this exhibition.

CSIR Foundation Day was celebrated at the NCL on 26th September, 1987 in a big way. Several activities such as open day, essay competition and exhibitions were organised as a part of the Foundation Day programme. DTS played active role in organising all the activities connected with the Foundation Day.

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Documentation services

The NCL library is now carrying out three distinct activities. Along with providing regular documentation and library facilities it is the National Information Centre for Chemistry and Chemical Technology (NICHEM) and the NISSAT Access Centre for International Databases (NACID).

The library houses about 1,08,253 publications which include books, periodicals, patents, standards, technical reports, etc. In 1986-88 the library added to its stock 1280 books, 3666 bound periodicals, 1150 patents and standards, 175 photocopies, microfilms and translations, 14 technical reports and 36 thesis. 1243 periodicals were received in the library, of which 991 were on payment and 252 were gratis and on exchange. 15,788 outsiders used the library besides the laboratory staff. 31,709 publications were issued to staff and corporate members. Under interlibrary loan 385 publications were borrowed and 266 were issued.

2463 current journals were circulated among the Heads of Divisions for browsing. A monthly current awareness bulletin on Indian patents was compiled and circulated. Copies of C. A. selects produced by Chemical Abstracts Service, USA, on catalysis, fungicides. herbicides, insecticides, solar energy and zeolites were prepared and circulated among the concerned scientists.

Quarterly technical bulletins in the areas of polymer sciences, engineering and technology, and drugs and drug intermediates were compiled. These bulletins highlight new developments, breakthroughs, statistics of production, prices, exports-imports and Government policy.

Under reprographic services 1,93,205 copies were made in these two years, 1,27,907 for NCL scientists and 65,298 for outsiders, on payment. The NCL library is an Inspection Centre for Indian patents. 5693 patents were received in these two years. The library procures

copies of papers contributed by NCL scientists in both Indian and foreign journals. These reprints are properly documented and distributed to scientists and researchers from other orgnisations on request. During the period under review copies of 90 papers were procured and 1866 reprints were distributed.

The binding section of the library bound and repaired 4217 volumes of books and journals and completed 996 other binding and miscellaneous jobs.

Under the NICHEM project the major activity was computerization of library and information activities. A mint computer, WIPRO S-386 was acquired. The library also installed one PC/XT "Zenith Professional 86" and ported CDS/ISIS software package received from the Department of Scientific and Industrial Research under the NISSAT scheme. The process of creating book databases from January 1987 was started.

Contacts were established with DIALOG and STN, USA, and on-line searches were conducted on 25 topics.

The National Information System for Science and Technology intends to promote a National Document Supply System (NDSS) to provide copies of documents on request on the lines of the British Library Document Supply Centre. To ensure that NDSS is user responsive, an in-depth understanding of the market demand and supply of document interlending is required. NISSAT has initiated a market survey of document supply facilities in libraries. NCL, being a National Information Centre for Chemistry and Chemical Technology has been entrusted the job of taking this survey in and around Pune. 108 research institutions having well organised libraries were identified and surveyed.

Glass blowing

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

7495 jobs were completed in 1986-88 in addition to the fabrication of 12,677 ground glass joints and 871 high vacuum stop cocks. The sophisticated fabrications include silicon reactors, BET units, high vacuum units, cryostats for magnetic susceptibility units, heat exchangers, etc. The section has often and again lent a helping hand to local educational institutions when required.

In all jobs worth Rs. 5 lakhs were executed in the two years.

Publication

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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 shootings; (4) associating with project engineers in preparing feasibility reports and making turnkey offers on NCL technologies; (5) collaborating with industry for the development of complex and high-risk technologies of the laboratory on semicommercial 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 utilise 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, standardisaion, 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 up and design of the full scale commercial plant.

1.2 Supply of cultures

During the year under report 2486 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 department, private parties, etc.

1	Atomic absorption	22
2	ESCA	55
3	Mass spectrometry	198
4	GC/MS	24
5	IR/UV	221
6	Magnetic susceptibility / mesurement	18
7	Microanalysis	226
8	Netzsch thermal analysis	25
9	NMR	227
10	SEM /XRF	72
11	Analysis of special nature	15
12	VPC/GLC/HPLC	75
13	X-ray diffraction	200

The total receipts on account of analysis / testing carried out during the period amounted Rs. 2.2 lakhs.

1.4 Training

During the period, 22 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 AND 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 load.

(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 indegenously.

(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.

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

(i) The sponsor pays for or provides the staff required for the investigation. The expenditure borne by the sponsor is computed at 125% of the total salaries of the NCL scientists working on the scheme.

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

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

(iv) A fixed charge of Rs. 18,000/- 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.

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

(vi) A sum of Rs. 60/- per head per annum is payable by the sponsor on account of medical facilities provided for the staff.

(vii) 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.

(viii) 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.

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

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

(xi) 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 1986-87 &1987-88

1986-87

Process	Party
1. Choroquin phosphate	Standard Organics Ltd., Hyderabad
2. Development of a process for DCVC acid chloride-intermediate for cypermethrin	Hindustan Ciba Geigy Ltd., Bombay

3. Exploratory work in preparation of chlorchrysanthamate	National Organic Chemical Industries Ltd. (NOCIL), Bombay
4. Methylation of morphine to codeine	Govt. of India, Ministry of Finance, Dept. of Revenue, New Delhi
5. Polymeric materials based on CNS liquid	DST, New Delhi
6. Synthesis of various drugs and their intermediates such as atenolol, metoprolol etc.	Chemical Industries and Pharmaceuticals Laboratories Limited, Bombay

1987-88

Process	Party
1. Chlorination of acetoacetamide	Colour Chem. Ltd., Thane
2. Rosin derivatives and modified resins	Dujodwala Resins and Terpenes P. Ltd., Bombay

2.3 Sponsored projects continued during 1986-87 and 1987-88

1986-87

Process	Party
1. Conservation of plant species -seed biology/ tissue culture programme	Dept. of Environment (DOE), New Delhi
2. Development of controlled release pesticide formulation of (i) quinolphos and (ii) desulfoton	Sandoz (India) Ltd., Bombay
3. Development of improved catalyst for toluene oxidation to benzaldehyde	Indian Organic Chemicals Ltd. (IOCL), Bombay
4. Development of specific reagent for benefication of (i) alumina rich iron ore, (ii) phosphate shines, (iii) partially oxidised sulphide ores	DST, New Delhi (under Indo-US-STI programme)
5. High fructose corn syrup	IOCL, Bombay
6. Polymer alloy resin	DST, New Delhi
7. Polyphenelene sulphide	Shriram Fibre Ltd., Madras
8. Resin derivatives and modified resins	Dujadwala Resins and Terpenes Pvt. Ltd., Bombay
9. Studies on carbonylation reactions	Deccan Sugar Institute, Pune
10. Technology transfer, biotechnological evaluation of clonal multiplication of eucalyptus, bamboo and salvadora	National Bank for Agriculture and Rural Development (NABARD), Bombay
11. Water absorbing polymers	IPCL, Bombay

1987-88

Process	Party
1. Amorphous silicon alloys for photovoltaic applications	Dept. of Science and Technology (DST), New Delhi
2. Conversion of plant species-seed biology/ tissue culture programme	DOE, New Delhi
3. Developement of controlled release pesticide formulations of quinolphos and disulfoton	Sandoz (I) Ltd., Bombay
4. Development of high pressure liquid chromatograph	DST, New Delhi
5. Development of improved catalyst for toluene oxidation to benzaldehyde	IOCL, Bombay
6. Development of multifunctional additives for transport crude	ONGC, Dehra Dun (through IPT, Bombay)
7. Development of specific reagent for beneficiation of (1) alumina rich iron ore (2) phosphate shines and (3) partially oxidised sulphide ores	DST, New Delhi
8. Dispersive and non-dispersive infra-red analyser	DST, New Delhi
9. High fructose corn syrup	IOCL, Bombay
10. Measurement of thermodynamic properties	DST, New Delhi

11. Metal replacement by polymeric materials in engg. components of two wheelers	DST, New Delhi
12. Methyl ethyl ketone	NOCIL, Bombay
13. Polyphenelene sulphide	Shriram Fibre Ltd., Madras
14. Preparation of 2, 6 diethyl aniline	Navin Chemical Enterprises: , Ahmedabad
15. Preparation of morpholine from diethylene glycol and ammonia	Navin Chemical Enterprises, Ahmedabad
16. Studies on carbonylation reaction	Deccan Sugar Institute, Pune
17. Tech. transfer, bio-technological evaluation and clonal multiplication of eucalyptus,bamboo and salvadora	NABARD, Bombay
18. Water absorbing polymers	IOCL, Bombay

2.4 Sponsored projects newly undertaken during 1986-87 & 1987-88

1986-87

Process	Party
1. Amorphous silicon alloys for photovoltaic applications	DST, New Delhi
2. Development of high pressure liquid chromatograph	DST, New Delhi
3. Dispersive and non-dispersive infrared analyser	DST, New Delhi
4. Exploratory work on development of hydroprocessing/ hydrocracking/ hydrodewaxing of petroleum fractions including waxy distillates using NCL zeolite catalysts	United Catalyst India Limited, Bombay
5. Measurement of thermodynamic properties	DST, New Delhi
6. Metal replacement by polymeric materials in engineering components of two wheelers	DST, New Delhi
7. Methyl ethyl ketone	NOCIL, Bombay
8. Preparation of bromides	Dhrangadhra Chemical Works, Bombay
9. Preparation of 2-6 diethyl aniline	Navin Chemical Enterprises, Ahmedabad
10. Preparation of morpholine from diethylene glycol and ammonia	Navin Chemical Enterprises, Ahmedabad.

1987-88

Process	Party
1. Ambroxol	Jagsonpal Pharmaceuticals, New Delhi
2. Carbamazepine	Resonance Labs. Pvt. Ltd., Bombay
3. Development of catalyst and process for methanol to acetic acid	Gujarat Alcohol and Allied Chemicals Ltd., Ahmedabad
4. Development of controlled release coating formulations and packaging systems for fruits	Rallis India Ltd., Bombay
5. Development of novel shape selective zeolite catalysts	United Nations Development Programme (UNDP)
6. Development of polyacrylamide	Ficom Organics Ltd., Bombay
7. Development of selective flocculation technology for recovery of fine mineral particles	Dept. of Mines, Govt. of India (through TRDDC)
8 Isobutylbenzene	Filtra Materials Research Pvt. Ltd., Thane
9. Light weight durable polymers for Jaipur Foot	DST, New Delhi (through SDM Hospital, Jaipur)
10. Phenylglycine Dane salt	Ficom Organics Ltd., Bombay
11. Production of coconut by tissue culture	Dept. of Biotechnology (DBT), New Delhi
12. New polymer support for penicillin acylase enzyme	Hindustan Antibiotics Ltd., Pune

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 agreement between NCL and the collaborating firm. In certain cases the funding may be done in part or fully 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 colaborator 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 (that 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 semicommercial plant (if used for commercial production) and the commercial plant.

(x) Within 90 days of the successful commissioning of the semicommercial 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 knowhow to other parties. In case 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) Not with standing 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 in progress during 1986-87 & 1987-88

Process	Party
1. 7-ADCA	Hindustan Antibiotics Ltd. (HAL), Pune
2. Bioscience engineering	United Nations Development Programme (UNDP) project
3. Development of catalyst and process for monomethylamines from methanol and ammonia	Rashtriya Chemicals and Fertilizers Ltd., Bombay
4. Development of commercialisation of FCC catalyst	Indian Oil Corporation, Faridabad
5. Development of controlled release abate (temephos) or other suitable chemical for guinea worm control	Ministry of Agriculture, Department of Rural Development, New Delhi
6. Development of technology for conversion of ethanol to ethylene and its commercialisation	Davy Powergas (I) Ltd., Bombay
7. Ethylene to ethylene oxide	Engineers India Ltd., New Delhi
8. Evaluation of polymers for water evaporation control of high wind velocities	Ministry of Agriculture, Department of Rural Development, New Delhi
9. Exploratory work on development of hydroprocessing / hydrocracking / hydrodewaxing of petroleum fractions including waxy distillates using NCL zeolite catalyst	United Catalyst India Ltd., Bombay
10. Heat pumps	University of Salford, Salford, U. K.
11. Improved formulations of urea fertilizers	Rashtriya Chemicals and Fertilizers Ltd., Bombay
12. Joint development and commercialising of a catalyst and process for ethylbenzene	Hindustan Polymers, Visakhapattanam
13. New polymer support for penicillin acylase enzyme (PAE)	HAL, Pune
14. Regular packing development	Engineers India Ltd., New Delhi
15.Sul phochlorinated polyethylene	Delhi Cloth and General Mills Co. Ltd., New Delhi
16. Synthesis of polycarbonate via nonphosgenation route	Indian Petrochemical Corpn. Ltd., Vadodara

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 per 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/demonstrated during 1986-87 & 1987-88

Process	Licencee
1. Bromides	Dhrangadhra Chemical Works Ltd., Bombay
2. Chlorination of aceto-acetamide	Colour Chem. Ltd., Bombay
3. Chlorcrysanthamate	National Organic Chemical Industries Ltd., Bombay
4. DCVC acid chloride	Hindustan Ciba - Geigy Ltd., Bombay
5. Polymeric materials based on CNS liquid	Dept. of Science & Technology, 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 benefitted 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. Consultancy projects undertaken during the years 1986-88 are :

4.1 Consultancy in progress during 1986-87

Title	Consultee
1. General technical advice and assistance concerning the polyester fibre manufacturing plant	Indian Organic Chemicals Ltd. (IOCL), Bombay
2. General technical consultancy of advisory nature	Hindustan Organic Chemicals (HOC), Rasayani
3. Advice on polymerisation and spinning of polyester fibres with reference to process modification and improvement	Swadeshi Polytex Ltd., Gaziabad
4. Advisory consultancy on rosin derivatives and modified resins	Dujodwala Resins and Terpenes Pvt. Ltd., Bombay
5. 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
6. Advisory consultancy for development of catalysts	Standard Alkali, Bombay
7. Interpretation of data on physico-chemical characteristics of catalysts	Alchemie Research Centre, Bombay
8. Advisory consultancy on computer simulation for synthetic fibres	IOCL, Bombay
9. Advisory consultancy on computer modelling and simulation for IPCL plants	Indian Petrochemicals Corpn. Ltd. (IPCL), Vadodara
10. Advisory consultancy and establishment of tissue culture lab. for production of plantlets for E. Globuls leading to the development of viable plants for field trials	Tata Tea Ltd., Munner, Kerala
11. Advisory consultancy on R&D work on cardamom plant using plant tissue culture technique	A. V. Thomas & Co., Madras
12. Advisory consultancy on entomology	Alchemie Research Centre, Thane
13. Advisory consultancy for preparation of piperazine	Diamines and Chemicals Ltd., Kalol
14. Advisory consultancy on heat pump system for commercial application	Unidyne Energy Environmental Systems Pvt. Ltd., Bombay
15. Advisory consultancy on moulding of switch gear components of phenol resins	Larsen & Toubro Ltd., Bombay
16. Advisory consultancy on water absorbing polymer	IOCL, Bombay
17. Advisory consultancy on sodium and potassium ferrocyanide	Hindustan Development Corporation Ltd., New Delhi
18. Advisory consultancy on safestorage and handling of chemicals	Central Warehousing Corporation, New Delhi
19. Advisory consultancy on testing of catalysts reformer feed/ reformate analysis, TBP analysis, etc.	Bharat Petroleum Corporation Ltd., Bombay
20. Advisory consultancy on updating of single beam visible range spectrophotometer	The Scientific Instrument Co. (S. i. C. O)Ltd., Allahabad
21. Advisory consultancy on operation of reactor in respect of morpholine	Navin Chemical Enterprises, Ahmedabad
22. Advisory consultancy on trouble shooting problems and to provide technical advice on R & D work on process development of drugs and fine chemicals	Bakul Fine Chemicals Research Centre, Bombay
23. Advisory consultancy on suitability of rock for cast basalt production	Deccan Mechanical Chemical Industries Pvt. Ltd. (DEMECH), Pune
24. Advisory consultancy on monitoring of sulphur in the alcohol feed stocks	Vam Organic Chemicals Ltd., New Delhi
25. Advisory consultancy on the purification of guanidine nitrate	Explogel India, Pune
26. Advisory consultancy on 2, 6 diethylaniline	Navin Chemical Enterprises, Ahmedabad
27. Advisory consultancy on downstream petro-chemical and other industries based on product mix of Maharashtra and Gujarat Gas Crackers	Mukund Iron and Steel Works, Bombay (operated through CSIR)
28. Advisory consultancy on implementation of bromides	Dhrangadhra Chemical Works (DCW) Ltd., Bombay
29. Advisory consultancy on preliminary techno economic studies on potential for heat pumps	Sanjivani SSK Ltd., Kopargaon
30. Product design/ development of engineering plastic components in two wheelers	Bajaj Auto Ltd., Pune

1987-88

Title	Consultee
1. General technical advice and assistance concerning the polyester fibre manufacture plant	IOCL, Bombay
2. General technical consultancy of advisory nature	HOC, Rasayani
3. 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

4.	Advisory consultancy for the development of catalysts	Standard Alkali, Bombay
5.	Interpretation of data on physicochemical characteristics of catalysts	Alchemie Research Centre, Bombay
6.	Advisory consultancy on computer simulation for synthetic fibres.	IOCL, Bombay
7.	Advisory consultancy on computer modelling and simulation for IPCL plants	IPCL, Vadodara
8.	Advisory consultancy on entomology	Alchemie Research Centre, Thane
9.	Advisory consultancy on moulding of switch gear components of phenol resins.	Larsen and Toubro Ltd., Bombay
10.	Advisory consultancy on water absorbing polymer	IOCL, Bombay
11.	Advisory consultancy on sodium and potassium ferrocyanide	Hindustan Development Corpn. Ltd., New Delhi
12.	Advisory consultancy on testing of catalysts reformer feed/ reformate analysis, TBP analysis, etc.	Bharat Petroleum Corpn. Ltd., Bombay
13.	Advisory consultancy on updating of single beam visible range spectro-photometer	SICO Ltd., Allahabad
14.	Advisory consultancy on operation of reactor in respect of morpholine	Navin Chemical Enterprises, Ahmedabad
15.	Advisory consultancy on trouble shooting problems and to provide technical advice on R & D work on process development of drugs and fine chemicals	Bakul Fine Chemical Research Centre, Bombay
16.	Advisory consultancy on suitability of rock for cast basalt production	DEMECH P. Ltd., Pune
17.	Advisory consultancy on 2,6 diethylaniline	Navin Chemical Enterprises, Ahmedabad
18.	Advisory consultancy on downstream petrochemical and other industries based on product mix of Maharashtra and Gujarat Gas Crackers	Mukund Iron and Steel Works, Bombay (operated through CSIR)
19.	Advisory consultancy on implementation of bromides	DCW Ltd., Bombay
20.	Advisory consultancy on the establishment of plant tissue culture cell at Bashistha, Assam	Dept. of Forest, Govt. of Assam, Guwahati
21.	Advisory consultancy on formulation of adhesive for heavy duty staple pins	Esdee Paints P. Ltd., Bombay
22.	Advisory consultancy on use of heat pumps systems in paper mills	Padumjee Pulp and Paper Mills Ltd., Pune
23.	Advisory consultancy on basic design data, operation of pilot plant for methanol to acetic acid	Gujarat Alcohol and Allied Chemicals Ltd., Ahmedabad
24.	Advisory consultancy on piperazine and relevant matters	Diamines and Chemicals Ltd., Kalol (Gujarat)
25.	Advisory consultancy on continuous chlorination of acetoacetamide	Colour Chem Ltd., Bombay
26.	Advisory consultancy on phenolic resins	Bakelite Hylan Ltd., Bombay
27.	Advisory consultancy for analysis of technical grade pesticides viz. phosphamidon, temephos, monocrotophos	United Phosphorus Ltd., Bombay
28.	Advisory consultancy on pilot plant for methylamine	Rashtriya Chemicals and Fertilizers Ltd., Bombay
29.	Engineering consultancy on alkyl bromides	DCW Ltd.Bombay
30.	Advice on establishment of tissue culture facility and absorption of NCL– PTC technology	EID Parry (I) Ltd., Madras

31.	Advisory consultancy on analysis- FCCV catalyst	HIndustan Petroleum Corpn. Ltd., Bombay
32.	Advisory consultancy on agrochemicals, pharmaceuticals	Excel Industries Ltd., Bombay
33.	Advisory consultancy for interpretation of data and physico chemical analysis of catalysts	Hindustan Lever Ltd., Bombay
34.	Product design/ development of engineering plastic components in two wheelers	Bajaj Auto Ltd., Pune
35.	Characterisation and processing of PTFE	Hindustan Fluora Carbons Ltd., Hyderabad

5. LECTURES AND SEMINARS

5.1 Lectures delivered by the visiting scientists in the laboratory

	Scientist	Subject
1.	Dr. S. Y. Ambekar Mysore University, Mysore	A novel rearrangement during the Fisher Indole Synthesis
2.	Dr. R. Bambal, Ecole de Chimie, Mulhuse, France	Synthesis of cyclopropyl pyridine and derivatives
3.	Prof. S. Chander, Associate Professor of Mineral Processing, The Pennsylvania State University, Pennsylvania, USA	New instrumental methods for study of interfacial phenomena at electrodes
4.	Prof. S. Chandrasekaran, Department of Chemistry, Indian Institute of Technology, Kanpur	A hybrid Birch-Claisen methodology for arylation at allylic terminii : Synthesis of herbertene and laurinterol
5.	Dr. J. Chandrasekhar, Dept. of Organic Chemistry, Indian Institute of Science, Bangalore	Molecular and electronic structures of novel radical ions
6.	Prof. R. G. Cooks, Purdue University, USA	Mass spectrometry for natural products research : New methods and new instruments
7.	Dr. W. Dodd, Queensland Institute of Technology, Brisbane, Australia	Some aspects of the biology of *Eucalyptus*
8.	Prof. S. Fakerov, Director, Laboratory on Structure and Property of Polymers, University of Sofia, Bulgaria	Chemical healing : A new approach to chain mobility in linear polycondensates

	Scientist	Subject
9.	Prof. M. Hooper, Dept. of Pharmaceutical Chemistry, Sunderland Polytechnic, UK	(i) Drug design (ii) The search for novel anti-leprotic drugs (iii) Isatogens : Some X ray and NMR studies
10.	Dr. J. Hradil, Institute of Macromolecular Chemistry, Prague 16206 Czechoslovakia	Macroporus methacrylate copolymers
11.	Prof. B. Iddon, Dept. of Chemistry and Applied Chemistry, Salford University, UK	(i) New organolithium derivatives of azoles of synthetic importance (ii) Synthesis of heterocycles via reactive intermediates especially nitrenes (iii) Synthesis of compounds related to benzomorphans with potential analgesic activity (Iv) Bromoaromatic and heteroaromatic compounds introduction of bromine as a handle
12.	Dr. S. Iyer, Emory University, Atlanta, Georgia, USA	Transition metal complexes in organic synthesis
13.	Dr. H. J. Jacobson, Institute fur Genetik der Universitat, Bonn., FRG	Somatic embryogenesis in pulses
14.	Dr. K. Jahnisch, Academy of Science, GDR Central Institute of Organic Chemistry, Berlin	Synthesis and reaction behaviour of œ -haloacrylo-nitrile
15.	Dr. P. H. Ladwa, Postgraduate School for Biological Studies, Ahmednagar College, Ahmednagar	Stoichometric hydroboration oxidation of monocyclic terpenoids
16.	Mr. J. Letcher, VG Analytical Limited, England	Advance in mass spectrometry, instrumentation and applications
17.	Prof. E. N. Lightfoot, UNIDO Consultant, University of Wisconsin, USA	(i) The proper study of mankind is man even for engineers (ii) Biological modelling strategy (iii) Structural view of separation processes (Iv) Operating characteristics of process equipment (v) Recovery from dilute solutions - under the auspices of Technology Forum, Pune

	Scientist	Subject
18.	Dr, R. Litz Tropical Fruit Research Institute, Florida, USA	Somatic embryogenesis of tropical fruits
19.	Dr. J. Lokaj, Institute of Macromolecular Chemistry, Prague 16206, Czechoslovakia	Macroporus methacrylate copolymers
20.	Prof. M. Makosza, Director, Institute of Organic Chemistry, Polish Academy of Sciences, Warsaw, Poland	(i) Vicarious nucleophile substitution of hydrogen : A new method of nucleophilic alkylation of nitroarenes and heterocycles (ii) Vicarious reaction : Mechanism, orientation and application of heterocyclic chemistry (iii) Phase transfer catalysis
21.	Prof. M. S. Manhas Dept. of Chemistry, Stevens Institute of Technology, Hoboken, NJ 07030, USA	Synthesis of β-lactam antibiotics
22.	Dr. S. H. Mantle, Wye College, Kent, UK	(i) Recent progress in palm and yam tissue and cell culture (ii) Trends in somatic breeding techniques of crop plants
23.	Prof. B. M. Moudgil, Prof. and Director, Mineral Resources Research Centre, Univ. of Florida, Florida, USA	Solid-solid separation by selective flocculation
24.	Mr. J. Ozsef, Zatyko Institute for Fruit and Ornamental Plant Growing, Hungary	Work carried on ornamental plants at Institute for Fruit and Ornamental Plant Growing
25.	Dr. S. V. Pansare, Dept. of Chemistry, Univ. of Alberta, Edmonton, Alderta, Canada	Synthesis of β-fluoroamine acids
26.	Dr. S. Rajappa, Head of Research, May & Baker (I) Ltd., Bombay	Aspects of quinon-imide chemistry

Scientist	Subject
27. Dr. K. Ravichandran, Dept. of Chemistry, Univ. of Albama, Albama, USA	Studies in anthracyclines
28. Mr. J. J. Rybenzyski, Polish Academy of Sciences, Warsaw, Poland	Tissue culture activities at botanical garden
29. Dr. M. Scheller, Swiss Federal Institute of Technology, Zurich, Switzerland	Synthesis of photochemistry of polyfunctional acylsilanes - Part I
30. Dr. W. Surer, Product Manager, Perkin-Elmer AG, Switzerland	Recent applications (mainly to polymers) of thermal analysers
31. Dr. C. Thies, Biological Transport Laboratory, Washington University, St. Lousis, USA	(i) Microcapsule release behaviour (ii) Microcapsule formation : Solvent evaporation and interfacial polymerisation and capsules (iii) Gelation phenomena and microcapsules
32. Dr. Y. D. Vankar, Dept. of Chemistry, Indian Institute of Technology Kanpur	Development of some novel reagents and synthetic methods for organic synthesis
33. Dr. L. Wilder, Ciba-Geigy, Pharma Division, R&D, Basel, Switzerland	Organo--titanium compounds : Selective nucleophiles in organic synthesis

5.2 The following NCL scientists delivered lectures at various institutes, college courses, etc.

Scientist	Subject	Venue
1. Dr. John Barnabas	Molecular evolution	NCL, Pune
2. Dr. A. Bhattacharya	(i) Computerised evaluation of energy recovery systems	National symposium on application of computers in chemical engineering, Indira Gandhi Centre for Atomic Research, Kalpakkam
	(ii) Modelling and simulation at NCL	CSIR workshop on application of mathematics in major projects of CSIR, NGRI, Hyderabad
	(iii) Mathematical modelling at NCL	Workshop on mathematical modelling in CSIR, NAL, Bangalore
3. Dr. S. Gundiah	(i) Characterisation of polyelectrolytes in aqueous solutions	Tata Research Development and Design Centre, Pune
	(ii) Polyelectrolyte dimensions in solution	Columbia University, New York, USA
	(iii) Charge effects and effect of charge density on polyelectrolyte expansion in solution	University of Florida, USA
	(iv) Synthesis and characterisation of polyelectrolytes for mineral processing applications	Tata Research Development and Design Centre, Pune
4. Dr. P. K. Gupta	Genetic transformation system in Douglas-fir *(Pseudotsuga menziesii)*	Tata Energy Research Institute, New Delhi
5. Dr. (Mrs.) Vidya Gupta	(i) Plant genetic engineering : Achievements and perspectives	National symposium on environmental biotechnology, Post-Graduate Research Centre, Nanded
--	(ii) Plant genetic engineering-present status and future prospects	Seminar on molecular biophysics, Department of Chemistry, University of Poona, Pune
	(iii) Plant genome organisation	Training course on plant genetic engineering, cloning and analysis of a specific plant DNA fragment sponsored by DBT, NCL, Pune
6. Dr. (Mrs.) S. Hazra	Cloning of forest trees via *in vitro* techniques	Regional workshop on tissue culture of tropical crop plant, Dept. of Botany, University of Dhaka, Bangala Desh
7. Dr. V. K. Jayaraman	(i) Design of fixed bed catalytic reactors an overview	Research Centre, IPCL, Vadodara
	(ii) Application of numerical methods to reactor design	
8. Dr. C. P. Joshi	Isolation, culture and regeneration of legume protoplasts	National symposium on recent advances in plant tissue culture, Osmania University, Hyderabad

Scientist	Subject	Venue
9. Dr. S. S. Katti	(i) Monolayers (ii) Monomolecular film properties of n-long chain alcohols and alkoxy ethanols (iii) Soluble monolayers and their uses	Alchemie Research Centre, Thane Sangameshwar College, Solapur under the auspicious of modern and theoretical physics educational workshop
10. Mrs. S. V.. Kendurkar	Micropropagation of forest trees through tissue culture	National symposium on recent advances in plant cell tissue culture,
11. Dr. B. M. Khan	Chemical modification studies of *Achromobacter fischeri* nitrite reductase	Osmania University, Hyderabad Dept. of Biochemistry, Banaras Hindu University, Varanasi
12. Dr. S. T. Kshirsagar	(i) Raman scatering studies of amorphous hydrogenated silicon alloys	Seminar arranged by the DST, New Delhi for Indo-US S&T initiative programme in photovolatic materials, Dept. of Physics, University of Poona, Pune
	(ii) Raman studies of ion beam induced synthesis of $a–si_{1-x}$ Ge_x alloys	Seminar arranged by the DST, New Delhi for Indo-US STI programme on photovoltaic materials, Indian Association for the Cultivation of Science, Jadavpur, Calcutta
	(iii) Raman investigation of topological changes in doped amorphous hydrogenated silicon alloys	Seminar arranged by DST, New Delhi on the review meeting on Indo-US STI programme on photovoltaic materials, NCL, Pune
13. Dr. K. V.Krishnamurthy	(i) Tissue culture studies of a food legume: The moth bean *(Vigna aconitofolia)*	National symposium on recent advances in plant cell tissue culture, Osmania University, Hyderabad
	(ii) Plant actinomycete association	DAE symposium on biology and molecular biology of streptomycetes, Pune
	(iii) Recent advance in legume protoplast research with special reference to moth bean	12th Annual meeting of PTC Association (India), JNU, New Delhi
14. Dr. P. S. Kulkarni	(i) The technique of chemical ionization mass spectrometry	Ahmednagar College, Ahmednagar
	(ii) Application of mass spectrometry to stereochemical problems	-do-
	(iii) Basic principles of mass spectrometry	CDRI, Lucknow
	(iv) Fragmentation of heterocyclic and naturally occuring compounds	IIT, Madras
	(v) Fourier transformation mass spectrometry and its applications to chemical analysis	-do-
	(vi) Tandem mass spectrometry	CDRI, Lucknow

Scientist	Subject	Venue
15. Dr. S. N. Kulkarni	Quinazoline analogues of papaverine	Gulbarga University, Gulbarga
16. Dr. N. N. Maldar	(i) Polymer chemistry :Principles and practice inphenolformaldehyde, urea formaldehyde and melamine formaldehyde resins	Shivaji University, Solapur
	(ii) Polymer synthesis : Fundamentals and techniques in developments of heat resistant polyheterocycles	Shivaji University, Solapur
17. Dr. A. F. Mascarenhas	(i) Application of PTC-possibilities, advantages and limitations	College of Agricultural Banking, Pune
	(ii) Tissue culture of tree crops	Centre of Advanced Studies in Tropical Horticulture, Indian Institute of Horticultural Research, Bangalore
	(iii) Application of micropropagation in third world countries	International symposium on micropropagation, Malaysian Agricultural Research Development Institute, Kualalampur, Malaysia
	(iv) Test tube plants	Pocha Seeds, Pune
	(v) Use of tissue culture in plant quarantine for exchange of germplasm and plant material of forest trees	FAO, New Delhi
	(vi) Commercialisation of tissue culture	VII Street Memorial Lecture, 12th Plant Tissue Culture Conference, JNU, New Delhi
	(vii) Potentials of cell culture in plantation forestry programme	Symposium on genetic manipulation of woody plants, Michigan State University, USA
	(viii) Vegetative propagation of economic plants by tissue culture	Federation of Indian Chamber of Commerce meeting at NCL, Pune
	(ix) Biotechnological application of plant tissue culture to forest species in India	Tata Energy Research Institute, New Delhi
18. Mrs. M. R. Maval	Seed storage protein genes	Training on plant genetic engineering : Cloning and analysis of a specific plant DNA fragment, Sp. by DBT, NCL, Pune
19. Mr. Y. R. Mawal	Secondary structure of seed storage proteins	Training course on plant genetic engineering cloning and analysis of a specific plant DNA fragment, Sp. by DBT, NCL, Pune

Scientist	Subject	Venue
20. Dr. (Mrs.) R. S.Nadgauda	(i) Prospects and future of plant tissue culture in crop improvement	Manjrekar Memorial Lecture, Univ. of Poona, Pune
	(ii) Plant tissue culture	RRL, Trivandrum
21. Dr.G. T. Panse	(i) Strategies in peptide synthesis	Deccan Sugar Institute, Pune
	(ii) Commercial approach to peptide drugs	University of Poona, Pune
	(iii)Merriefield's synthesis on enzyme inhibitors	Mahabaleshwar Seminar, Mahabaleshwar
	(iv) Application of solid phase technology in chemical industry	HOC, Rasayani
	(v) Synthesis of biopolymers	Institute of Science, Bombay
	(vi) New approaches to synthesis of biomolecules	Nagpur University, Nagpur
	(vii) Conformation of synthetic studies in peptides	-do-
	(viii) New methods for production of peptide hormones and peptide drugs	Gharda Chemical Co. Pvt. Ltd., R & D Section, Bombay
	(ix) Recent advances in biosynthesis of antibiotics and their significance	Symposium on biology and molecular biology, Dept. of Atomic Energy and NCL
	(x) Synthetic vaccines	National Institute of Virology, Pune
22. Dr. N. R. Rajagopalan	Controlled release formulations	Sandoz Science Club, Sandoz India Ltd., Thane
23. Dr. P. K. Ranjekar	(i) Recombinant DNA technology for genetic conservation and exchange	FAO expert consultation on use of tissue culture in plant quarantine for exchange of planting materials, NBPGR, New Delhi
	(ii) Standardisation, calibration testing facilities in biology and chemistry at NCL	CSIR-Industry get together on measurement standards calibrations and quality assurance, NPL, New Delhi
	(iii) Viral enhances	DAE symposium on biology and molecular biology of streptomyces, NCL, Pune
	(iv) Strategies in gene identification and promoter analysis	Training course on plant genetic engineering cloning and analysis of a specific plant DNA fragment, Sp. by DBT, NCL Pune
	(v) (a) Strategies of gene cloning and gene identification in eukaryotes	National symposium on plant tissue culture, Osmania University, Hyderabad
	(b) Seed storage proteins and their genes	
	(vi) Homology and divergence of rice glutelin gene in comparision to 14 other storage proteins/genes	International Conference on research in plant sciences and its relevance to future, INSA, New Delhi

Scientist	Subject	Venue
24. Dr. A. S. Rao	(i) Six lectures on stereochemistry	University of Poona, Pune (under NCL Poona University collaborative programme)
	(ii) Oxiranes in organic synthesis, a synthesis of 9-deoxynanomycin A	75th Session of the Indian Science Congress, University of Poona, Pune
25. Dr. V. J. Rao	(i) Semiconductors and devices (two lectures)	Shivaji University, Kolhapur (under UGC special assistance pro-gramme)
	(ii) Semiconductors and devices	D.Y.Patil College of Engineering, Pimpri, Pune
	(iii) Why GaAs ?	Defence Metallurgical Research Laboratory, Hyderabad
	(iv) Photovoltaic materials	College of Engineering, Pune
26. Dr. M. S. Setty	(i) Thick film sensors	Training course on thick and thin film microelectronics, IISc, Bangalore
	(ii) Thick film hybrid microelectronics	Yeshwant Mahavidyalaya, Nanded
	(iii) Materials for components	
	(iv) Thick film sensors	
27. Dr. R. N. Sharma	(i) Safe alternatives in pest control	Indian National Trust for Arts and Cultural Heritage (INTACH), Delhi
	(ii) Controlled release	ITRC, Lucknow
	(iii) Developmental biology in applied research	ITRC, Lucknow
	(iv)Some non-conventional pest management approaches for minimising environmental pollution	University of Delhi, New Delhi
	(v) Some new frontiers in the concept and practice of insect management	Trivandrum Association for Advancement of Entomology, Trivandrum
28. Mr. R. S. Singh	Use of CDS / ISIS software in computerised information retrieval	Course on computer application in libraries and information science, University of Poona, Pune

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

1. One day seminar on Safety in Chemical Industry was organised at NCL under the auspices of the Indian Institute of Chemical Engineers (10th June 1986)
2. Indo British workshops on Heat Pumps and Energy Conservation were conducted during November 1986 and March 1988. More than 50 participants from about 40 industrial organisations attended each workshop. This has enhanced the awareness on the potential for heat pumps significantly in the country.
3. A three day symposium on The Biology and Molecular Biology of Streptomycetes was organised in the division of Biochemical Sciences in collaboration with the Board of Research in Nuclear Sciences, Dept. of Atomic Energy (February 4-6, 1987).
4. A symposium on Biology and Molecular Biology of Streptomycetes was organised by NCL in collaboration with Dept. of Atomic Energy. Several scientists from the biochemistry division participated, delivered lectures and presented papers (February 11-13, 1987).
5. A short term training course sponsored by the Dept. of Biotechnology, New Delhi, on Plant genetic engineering : Cloning and analysis of a specific plant DNA fragment was conducted. (September 10 - 30, 1987).
6. A workshop on Plant Tissue Culture for Micropropagation, Somaclonal Variation and Protoplast Technology for Plant Improvement, sponsored by Dept. of Biotechnology, New Delhi was held (February 1 - 14, 1988).

6. STAFF STRENGTH (as on 31-3-88)

(i) Scientific	
Director	1
Scientists in Director's grade	4
Scientist G	1
Dy. Director / Sci. F	8
Scientists E. II	19
Scientists E. I	64
Scientists C	152
Scientists B	124
Scientists A	8
SSAs	49
JSAs	7
Lab. Assistants Gr. VIII (SLAs)	8
	445
(ii) Technical	276
(iii) Non-technical	154
(iv) Group D technical	157
(v) Group D non-technical	57
	1089

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

(a) Research associates	2
(b) Senior research fellows	29
(c) Junior research fellows	46
(d) CSIR pool officers	4
(e) Guest workers	9
	90

7. STAFF NEWS

7.1 Awards/Honours

1. Dr. K. S. Balaraman and Dr. A. J. Varma have won the MRF Award constituted by the Indian Rubber Manufacturers' Research Association (IRMRA) for their outstanding technical paper entitled chorosulphonated polyethylene kinetics and microstructure.
2. Dr. L.K. Doraiswamy has been selected for the Om Prakash Bhasin Foundation Award for Science and Technology in the discipline of engineering for the year 1986.
3. Dr. L. K. Doraiswamy has been awarded the prestigious Olaf A. Hougen Professorship for 1987 at the Department of Chemical Engineering, University of Wisconsin, Madison, USA. Dr. Doraiswamy is the first Indian/Asian to receive this distinguished professorship.
4. Dr. M. V. Deshpande was co-opted on the Board of Studies in Microbiology by Shivaji University for three years from January 1988.
5. Dr. P. K. Gupta has been selected as an Associate by the Indian Academy of Sciences, Bangalore, for his significant contributions in the field of biological sciences. Under the scheme, the Academy selects young scientists below 35 years to associate them in its activities.
6. Dr. T. N. Guru Row has been selected for the young scientists award by the CSIR for his significant contributions in the field of chemical sciences.
7. Dr. B. M. Khan has been selected for the UNESCO / ROSTSCA young scientist award for the year 1987 in recognition of his outstanding contribution in the field of applied microbiology/ biotechnology.
8. Dr. B. D. Kulkarni has been selected as a fellow of the Indian Academy of Sciences, Bangalore, in recognition of his outstanding contributions in the field of chemical engineering.
9. Dr, R. A. Mashelkar has been awarded the prestigious FICCI award in the field of physical sciences including mathematics jointly with Dr. A. S. Divatia of BARC, Calcutta. This honour was given to Dr. Mashelker for his outstanding work on computer simulation of chemical/polymer plants for productivity improvement and technology absorption.
10. Dr. R. A. Mashelkar has been invited to be a member of the International Editorial Board of the prestigious Chemical Engineering Science published by Pergamon (UK) and rated for the past three decades as the topmost international journal publishing papers on fundamental research in chemical engineering.
11. Dr. R. A. Mashelkar has also been invited to be a member of the Editorial Board of Sadhana, Academy of Proceedings of Engineering Sciences, published by Indian Academy of Sciences (Three years from January 1987).
12. Dr. R. A. Mashelkar has been elected as Fellow of National Academy of Engineering from August 1987.
13. Dr. R. A. Mashelkar was invited to present a paper on polymers in the seminar on new technologies organised by Prof. M. G. K. Menon, Scientific Adviser to the Prime Minister. The seminar was presided over by the Prime Minister.
14. Dr. R. A. Mashelkar (along with Prof. M. M. Sharma of UDCT, Bombay) was invited to prepare a report on Indian Chemical Industry in the year 2000 AD : National Priorities by the Prime Minister's Scientific Advisory Committee (SAC). A presentation was made to the SAC and the final report has been submitted.
15. Dr. V. M. Nadkarni and Dr. S. Sivaram were jointly awarded the 1988 Professor M. Santappa Silver Jubilee Award by the Society of Polymer Science, India in recognition of their accomplishments and/ or innovations of unusual merit in the field of basic or applied polymer science by scientists below the age of 45.
16. Mr. B. M. Pathan, Artist was awarded the third prize for the poster captioned Protection made them bold - To be bold follow the old in the NSC Safety Competitions 1986-87 organised by the National Safety Council, Bombay.
17. Dr. P. Ratnasamy has been elected by the Indian National Science Academy as a Fellow. This honour is in recognition of his outstanding contributions in the area of catalysis.
18. Dr. K. Ravindranath has been selected for the Amar Dye-Chem Award, for Excellence in Research and Development for the year 1986 by the Indian Institute of Chemical Engineers, Calcutta. This award is annually given to a young chemical engineer below 35 years.

19. Dr. K. Ravindranath has been selected for the Young Scientists Award by the CSIR for his significant contributions in the field of engineering sciences.

20. Dr. M. S. Setty was elected again as a member of the Executive Committee of the ISHM-India for a second term (1988-90) during its 3rd Annual Conference. Dr. Setty was also elected editor of the ISHM-India journal.

21. Dr. S. Sivaram (jointly with Dr. V. K. Upadhyay of IPCL, Vadodara) has been awarded MRF Award for the best technical paper presented at the 14th rubber conference organised by the Indian Rubber Manufacturers' Research Association.

22. Dr.Saurav Pal has been awarded INSA Young Scientist Medal for 1987 by the Indian National Science Academy, New Delhi for his contributions to molecular electronic structure using many-body coupled cluster methods for closed and open shell systems and in particular, for first principle calculations of exciation energies and ionisation potentials of molecules.

23. Dr. G. R. Venkitakrishnan has been awarded the prestigious VASVIK award for the year 1986 for his contributions in the field of chemical sciences and technology. Dr. G. R. Venkitakrishnan shares this award with Prof. Rajinder Kumar of IISc., Bangalore.

7.2 Deputations/visits abroad

1. Dr. B. G. Hazra visited Japan on invitation by the Japan Society for the promotion of science fellowship at the University of Tokyo. (Ten Months from September 1985).

2. Dr. N. R. Ayyangar availed UNIDO study tour for visiting opium processing plants and R & D Centres at UK, Switzerland, Austria, France, Netherland, USA (May 1986).

3. Dr. Mala Rao was deputed at the University of Wisconsin, Madison, USA under the UNDP programme (One year from June 1986).

4. Mr. S. G. Patil was deputed to University of Georgia, USA for training on microbial fermentation under the UNDP programme (Six months from July 1986).

5. Dr. (Ms.) R. S. Nadgauda was deputed to participate in the workshop on micropropagation and mass propagation conducted jointly by CSC and Malaysian Agricultural Research and Development Institute at Kualalampur, Malaysia (July 14-24, 1986).

6. Dr. M. S. Setty visited USSR at the invitation of the USSR Academy of Science to deliver lectures on thick film technology (Two weeks from 28th July 1986).

7. Dr. S. G. Pataskar, Dr. G. S. Grover and Ms. S. D. Adyanthaya were deputed to UK to work at the Salford University under the joint agreement between NCL and the University of Salford on heat pumps and heat energy recycling (One year from August 1986).

8. Dr. S. Devotta was deputed to Salford University, UK to work on the NCL-Salford joint research programme on heat pumps and heat energy recycling (One month from 8th August 1986).

9. Mr. S. P. Gupte was deputed to University of Erlangen, West Germany to acquire expertise in advanced technology of three phase catalytic slurry reactors at the Institute fur Technische Chimie I (Three months from 15th August 1986).

10. Dr. (Ms.) Z. Muljiani visited France under CSIR-CNRS exchange programme (Two months and three weeks from 15th September 1986).

11. Dr. C. Gopinathan was deputed to USSR to study advanced techniques in catalysis at the Institute of Catalysis, Novosibirsk under the Indo-USSR cooperation in Science and Technology Programme (One month from18th November 1986).

12. Dr. S. T. Kshirsagar visited the Solar Energy Research Institute, Golden (Denver), Colorado, USA and the Dept. of Applied Sciences, Harvard University, Cambridge (Boston) Mass., USA under the Indo-US STI programme sponsored by DST, New Delhi (20th November to 10th December 1986).

13. Dr. S. Gundiah visited USA to acquaint himself with the most modern methods of synthesis and characterisation of polymers with specific functional groups used in mineral beneficiation under the DST-NSF programme (10th December 1986 to 3rd January 1987).

14. Dr. L. K. Doraiswamy was deputed to USA to participate in the international symposium on preventing chemical accidents (3-5 February 1987). He also visited National Cancer Institute and had discussions in the area of biochemistry (February 1987).

15. Dr. V. S. Patwardhan and Dr. S. Devotta were deputed to UK under NCL/Salford University link programme (Three weeks during March/April 1987).

16. Dr. K. V. Krishnamurthy visited West Germany under CSIR-DAAD scientists exchange programme (20th March to 20th May 1987).

17. Dr. C. I. Jose and Mr. S. D. Bakare were deputed to USA for training in the application and maintenance of the FT-IR instrument at Nicolet Instruments Co., Madison, USA (Two weeks from 6th April 1987).

18. Dr. V. M. Nadkarni was deputed as a member of the Science and Technology delegation of the Govt. of India to the Republic of Korea (April 1987).

19. Dr. P. K. Ranjekar was deputed to Hungary to undertake studies in the area of plant biotechnology (Two weeks from 10th May 1987).

20. Dr. A. Bhattacharya visited Federal Republic of Germany under CSIR-DAAD scientists exchange programme (May-June 1987).

21. Dr. R. A. Mashelkar was deputed to Salford University, UK to discuss the programme and progress on the joint collaboration with specific reference to the latest developments in the field of heat pumps and heat energy recycling (21 st May to 6th June 1987).

22. Dr. P. Ratnasamy was deputed to East Germany to deliver the plenary lecture at the 20 Jahrestreffen du Katalytiker der DDR ar Erfurt (May 26-29, 1987).

23. Mrs. R. C. Joshi was deputed to West Germany under the GAES (DAAD) programme (Sixteen months from 1st June 1987).

24. Dr. L. K. Doraiswamy visited Salford University, UK enroute to USA where he was on deputation to accept the prestigious Olaf A. Hougen Professorship for 1987 at the Dept. of Chemical Engineering, University of Wisconsin, Madison, USA (Six months from June 1987)

25. Dr. A. F. Mascarenhas was deputed to Singapore to participate in the symposium on Tissue culture of forest species at the National University of Singapore (June-15-18, 1987).

26. Dr. M. C. Srinivasan was deputed to Prague, Czechoslovakia to attend 2nd conference on taxonomy and automatic identification of bacteria (29th June to 3 rd September 1987).

27. Mr. C. Bhaskar was deputed to USA under the UNDP programme on bioscience and engineering for training in micro-encapsulation by coacervation at Washington University, St. Louis, MO, Dept. of Chemical Engineering (Nine months from August 1987).

28. Dr. M. C. Srinivasan was deputed under UNDP programme for study tour of Japan, USA and UK (September/October 1987).

29. Dr. A. A. Natu was deputed to West Germany under the CSIR-DAAD re-invitation programme (Three months from 15th September 1987).

30. Dr. S. G. Joshi, was deputed to Czechoslovakia under the CSIR-CSAV bilateral exchange programme to study polymer synthesis and characterisation for specific applications, polymerisation and polymer modification (Two months from 30th September 1987).

31. Dr. A. N. Kotasthane and Dr. (Ms.) A. J. Chandwadkar were deputed to the USSR to study the synthesis and characterisation of pentasil zeolites (Forty five days in October/November 1987).

32. Dr. G. R. Venkitakrishnan was deputed to UK, West Germany and Denmark to get acquainted with scale up methods and pilot plant facilities for biotechnology (October 5-26, 1987).

33. Ms. S. V. Awate was deputed to Sri Lanka to participate in the regional workshop on field-oriented analytical chemistry (November 10-13, 1987).

34. Dr. R. A. Mashelkar was deputed to USA under the UNDP assisted project-bioscience and engineering. (One month from 27th November 1987).

35. Dr. A. P. B. Sinha, was deputed to USA to attend the annual meeting of the Materials Research Society at Boston (30th November to 6th December 1987).

36. Dr. U. R. Kalkote left for Federal Republic of Germany to take up a Max Planck Fellowship (One year from 12th January 1988).

37. Dr. K. V. Krishnamurthy was deputed to West Germany under the CSIR-DAAD bilateral exchange programme (Two months from 20th March 1988).

38. Mr. K. G. Deshpande was deputed to the Federal Republic of Germany to take up training in operations, maintenance and applications of MSL-300 NMR spectrometer (March 7 - 18, 1988).

39. Dr. S. K. Date was deputed to the Federal Republic of Germany to take up training in the operation and maintenance of the Brucker SCR-200D electron spin resonance spectrometer (20th March to 13th April 1988).

40. Dr. S. T. Kshirsagar was deputed to the USA for attending the joint Indo-US review meeting on Amorphous silicon alloys for photovoltaic applications under the Indo-US Science and Technology Initiative Programme (25th March to 10th April 1988).

41. Dr. S. Krishnan was deputed to Trieste, Italy for attending symposium / workshop on Protein engineering (March 21-25, 1988).

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

Symposia/Conference/Workshop	Scientists
1. Cardamon days, RRL Trivandrum tissue culture studies on cardamom	Dr. (Mrs.) R. S. Nadgauda
2. International workshop on micropropagation and mass propagation organised by CSC and Mardi at Kualalumpur	Dr. (Mrs.) R. S. Nadgauda Dr. A. F. Mascarenhas
3. National symposium on recent advances in plant cell tissue culture of economically important plants, Hyderabad	Dr. K. V. Krishnamurthy Dr. C. P. Joshi Mr. D. A. Godbole Mrs. S. V. Kendurkar Mrs. E. M. Muralidharan
4. Opportunities of entrepreneurship for science and technology. persons in backward areas, Nanded	Dr. A. F. Mascarenhas Dr. S. S. Khuspe Dr. (Mrs.) S. Thengane Dr. (Mrs.) S. Hazra
5. Seminar on tissue culture of forest species at FRI, Malaysia	Dr. A. F. Mascarenhas
6. Symposia on genetic manipulation of woody plants at Michigan State University, USA.	Dr. A. F. Mascarenhas
7. PTC conference at JNU, Delhi	Dr. A. F. Mascarenhas Dr. K. V. Krishnamurthy
8. Workshop on application of biotechnology in forestry and horticulture, TERI, Delhi	Dr. P. K. Gupta Dr. A. F. Mascarenhas
9. DAE symposium on biology and molecular biology of streptomycetes, Poona	Dr. K. V. Krishnamurthy
10. Workshop on advanced ceramics, New Delhi	Dr. S. K. Date Dr. C. E. Deshpande
11. International conference on hyperfine interactions, Bangalore	Dr. S. K. Date
12. International conference on metallic and semiconducting glasses, Hederabad	Dr. S. K. Date Dr. C. E. Deshpande

13. International conference on valence fluctuations, Bangalore	Dr. S. K. Date
14. Characterization of materials for electronics, New Delhi	Dr. P. Singh Dr. (Miss) N. R. Pavaskar
15. Process induced material interactions in electronic devices, Pilani	Dr. P. Singh Dr. (Miss) N. R. Pavaskar
16. International workshop on advanced Raman spectroscopy, Kanpur	Dr. S. T. Kshirsagar
17. Seventh international conference on think films, New Delhi	Dr. V. J. Rao
18. International workshop on surfaces and interfaces of metals and semiconductors, Poona	Dr. V. J. Rao
19. National seminar on solar energy and rural development, Kolhapur	Dr. V. J. Rao
20. Asian pacific physics conference, Hong Kong	Dr. V. J. Rao
21. 5th Conference on semi-insulating III-V materials, Sweden	Dr. V. J. Rao
22. National seminar on GaAs and III-V compounds, Kharagpur	Dr. V. J. Rao
23. Workshop on advanced topics in surfactant, solutions, BARC, Bombay	Dr. S. Gundiah
24. Seminar on chemistry and application of new reagents for mineral beneficiation, TRDDC, Pune	Dr. S. Gundiah Mr. A. A. Gunari Dr. R. A. Kulkarni
25. Internation conference on rubber and rubber-like materials, NML, Jamshedpur	Dr. S. Gundiah
26. National workshop on plastics and polymers in buildings and building materials technologies and pollution abatement, New Delhi	Dr. S. Gundiah
27. 14th Internation symposium on controlled release of bioactive materials, Toronto	Mr. C. Bhaskar
28. Seminar on developments in UV-VIS NIR, AA spectroscopy and instrumentation, innovations in GC, HPLC instrumentation and analysis, data handling in chromatography, Pune	Dr. S. Gundiah Dr. R. A. Kulkarni
29. Indo--US seminar on special topics in mineral processing, TRDDC, Pune	Dr. S. Gundiah Mr. A. A. Gunari Dr. R. A. Kulkarni Dr. (Mrs.) M. G. Deo
30. Seminar on particle size analysis for industry and research , Bombay	Dr. R. A. Kulkarni

31.	VIIth All India symposium on developmental biology, ITRC,Lucknow	Dr. R. N. Sharma (Mrs.) V. S. Tare
32.	Second symposium on insects and environment, University of Delhi, Delhi	Dr. R. N. Sharma
33.	International symposium on integrated pest control progress and perspectives, Trivandrum	Dr. R. N. Sharma (Mrs.) V. S. Tare Mr. S. G. Deshpande Dr. R. Ramachandran
34.	Second symposium on vectors and vector borne diseases, Trivandrum	Dr. R. N. Sharma Mr. V. B. Tungikar Mr. P. H. Vartak
35.	Modern trends in the treatment of leprosy, Gulbarga	Dr. S. N. Kulkarni
36.	8th Indo-Soviet symposium on chemistry of natural products, RRL, Hyderabad	Dr. N. R. Ayyangar Dr. B. Pandey Dr. H. B. Borate Dr. (Mrs.) S. A. Patwardhan
37.	Seminar on HPLC conducted by Waters Associate and Sales, Bangalore	Dr. V. G. Naik
38.	Workshop on GC/MS by Hewlett Packard and Blue Star India, Bangalore	Dr. V. G. Naik
39.	6th International symposium on surfactants in solution, Hyatt Regency Hotel, New Delhi	Dr. S. S. Katti
40.	3rd National conference on surfactants , emulsions and biocolloids, Aligarh Muslim University, Aligarh	Dr. S. S. Katti
41.	DBT workshop on cloning and analysis of plant genes, Bose Institute, Calcutta	Dr. (Mrs.) Vidya Gupta
42.	Indo-German workshop on QSAR, CDRI, Lucknow	Dr. R. Tiwari
43.	Course on appreciation programme on computer and computer applications for non-computer personnel, Pune Management Association, Pune	Mr. V. G. Deodhar
44.	Course on introduction to EDP, CMC Limited, Bombay	Mr. M. B. Patil
45.	Third national symposium on composite material, Indian Society for Composite Materials, Trivandrum	Dr. S. T. Kshirsagar
46.	Workshop and training course on use of CDS/ISIS software packages, National Information System for Science and Technology, NIC, OGO Complex, New Delhi	Mr. N. B. Dahibhate
47.	Dissemination of information through scientific books and journals, IIT, Bombay	Mr. R. S. Singh

48.	4th National seminar on ferroelectrics and dielectrics, IIT, Kharagpur	Dr. P. Roy Chowdhury
49.	Symposium on thick film materials and HMCs, IISc, Bangalore	Dr. M. S. Setty
50.	2nd Indo-Soviet seminar on catalysis, RRL, Hyderabad	Dr. V. R. Choudhary Dr. S. D. Sansare
51.	34th Annual session of IIChE, Hyderabad	Mr. M. G. Sane
52.	The international congress on safety, health and environment, New Delhi	Dr. S. M. Abhyankar
53.	National workshop on low cost alternate building materials organised by CBRI, Roorkee, New Delhi	Dr. S. Gundiah Mr. S. R. Srinivasan
54.	8th National symposium on challenges in catalysis science and technology, Project Development India Limited, Sindri	Mr. K. J. Waghmare
55.	Gas-chromatography-Mass spectrometry detector conducted by Blue Star Limited, Bombay at Bangalore	Dr. P. S. Kulkarni
56.	4th National seminar on mass spectrometry, Bangalore	Dr. P. S. Kulkarni Mr. S. P, Mirajkar
57.	XVIIIth National seminar on crystallography, Department of Physics, Jammu University, Jammu	Dr. (Mrs.) V. G. Puranik
58.	National symposium on modern trends in inorganic chemistry, IIT, Madras	(i) Dr. (Mrs.) S. Gopinathan (ii) Dr. P. P. Bakare
59.	Third BHRAS international symposium on large scale applications of heat pumps, Oxford (U. K.)	Dr. V. S. Patwardhan Dr. S. Devotta
60.	One day workshop on mechanisms for accessing databases in USA, National Informatics Centre, New Delhi	Mr. M. B. Patil
61.	Three day lecture programme of advanced database management systems (ADBS) organised by National Informatics Centre (NIC), Western Region, Pune	Mr. V. G. Deodhar Mr. N. B. Dahibhate
62.	Chemical information workshop, Bangalore	Mr. R. S. Singh Mr. M. B. Patil
63.	UNESCO-DRTC regional seminar for Asia and the Pacific on handling and retrieval and chemical information, Bangalore	
64.	Workshop on new trends in library and information services organised by H. P. T. Arts & B. Y. K. Science College, Nasik	Mr. R. S. Singh
65.	A course on communication in library organisation, University of Poona, Pune	Mr. R. S. Singh

66.	XIIth IASLIC national seminar, Banaras Hindu University, Varanasi	Mr. R. S. Singh
67.	Patent information workshop : Access to innovations, Bombay	Mr. V. G. Deodhar
68.	Training course in personal computers; CEERI, Pilani	Mr. S. A. Tambe Mr. M. D. Bauskar, Dr. K. R. Srinivasan

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

	Scientist		Subject
1.	Dr. N. R. Ayyangar	(i)	A key-note speech on R and D in drug industry for self-reliance at the All India Seminar on National Drug Policy, New Delhi (April 1986)
		(ii)	Invited to chair the technical session during the VIII Indo-Soviet Symposium on Chemistry of Natural Products, RRL, Hyderabad (December 1986)
		(iii)	Invited lecture on sources and causes of pollution in chemical industries in National Seminar cum Workshop on Environmental Pollution held at Pune (December, 1986)
2.	Dr. R. V. Chaudhari		Prof. N. V. Subba Rao memorial lecture at Osmania University, Hyderabad (March 1988)
3.	Dr. L. K. Doraiswamy	(i)	Plenary lecture on catalytic reaction engineering-the changing panorama at the second Indo-Soviet seminar on Recent Advances in Catalysis and Catalytic Reaction Engineering, IISc, Bangalore (November 1986)
		(ii)	Olaf A. Hougen professorship lectures at University of Wisconsin, Madison, USA [a] On the identification of chemistry in chemical engineering [b] The ubiquitous gas-solid reaction analysis and reactor designs [c] On the merits of diminished activity, the concept of dilution in chemical engineering [d] An excursion into bygone era :Science and technology in ancient India
4.	Dr. A. F. Mascarenhas	(i)	Key-note lecture on plant cell culture and the essential oil industry, VIII Seminar on Fragnancy and Flavour Industry, Perfumes and Flavour Association of India.
		(ii)	Key-note address : Studies on tissue culture raised trees, Seminar on Tissue Culture of Forest Species, Forest Research Institute, Malasia and International Development Research Canada, Kualalampur

	Scientist		Subject
5.	Dr.R. A. Mashelkar	(i)	Plenary lecture on role of rheology in processing at research industry meet on plastics organised by IPCL, Baroda (January1987)
		(ii)	Invited lecture on some recent excitements in polymer science, Nainital University (May, 1987)
		(iii)	Invited lecture on emerging frontiers in polymer science and engineering at Bharat Petroleum (July 1987)
		(iv)	Invited lecture on polymers in industry : Needs, opportunities and challenges FICCI-CSIR national conference on Technology for Self-reliance and Growth, New Delhi (July 1987)
		(V)	K. G. Naik Gold Medal lecture on new frontiers in polymer science, Dept. of Chemistry, University of Baroda (August 1987)
		(vi)	Novel separations through super absorbing polymers at Dr. K. K. G. Menon felicitation symposium, Hindustan Lever Research Centre, Bombay
		(vii)	Invited lecture on new R & D trends in polymer science and engineering by the National Academy of Sciences at the symposium on New Materials, Tiruchirapally (October 1987).
6.	Dr. S. Nene	(i)	Invited lectures on membrane technology and applications at DBT sponsored symposium on Downstream Processing in Biotechnology A. C. College of Technology, Madras (January 1987)
		(ii)	Invited lecture on biochemical engineering aspects of actinomycete fermentations at DAE sponsored Workshop on Actinomycetes, Poona (February 1987)
7.	Mr. R. S. Singh		Invited as a faculty member in the workshop on Online Access to International Databases organised by Mahratta Chamber of Commerce and Industries, Pune jointly with Informatics (India) Pvt. Ltd., Bangalore and gave talk on 'Online searching of dialogue databases'.
8.	Mr. R. N. Sharma	(i)	Chaired the session on developmental biology in applied research, ITRC, Lucknow (December, 1986)
		(ii)	Chaired the session IV : Use of chemicals in integrated pest control-plant and animal products, Association for Advancement of Entomology, Trivandrum

7.5 Membership of Committees

The following staff members were nominated to serve on various committees, boards, etc. as indicated :

Scientist 1	Capacity 2	Name of the committee 3
1. Dr. N. R. Ayyangar	Member	Expert Group of Drugs for Safety in Chemicals and Petrochemical Industries
	Member	Expert Group on Chemicals for Safety Survey Committee Expert Group II-Private Sector Chemical Unit formed by Ministry of Industry, Govt. of India (1986)
2. 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 (1988-91)
	Member	Management Council of National Botanical Research Institute, Lucknow (1988-91)
	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 (1988-91)
	Member	Management Council of CSIR Centre for Biochemicals, New Delhi (1988-91)
	Member	Advisory Committee in Biological Sciences for S. S. Bhatnagar Prize for 1987
	Member	Biochemistry Research Committee of Council of Scientific and Industrial Research, New Delhi (1986-88)
	Member	Scientific Advisory Committee to National Institute of Virology, Pune (1988)
	Member	Sectional Committee on General Biology, Indian Academy of Sciences
	Member	Sectional Committee IX and Indian National Science Academy
	Member	Executive Committee and the Council of the Maharashtra Association for the Cultivation of Science (1986-89)
	Member	Editorial Board of the Indian Journal of Biochemistry and Biophysics (1986-88)
	Member	Editorial Board for Proceedings of Indian Academy of Sciences - Animal Sciences (1986-88)

Dr. J. Barnabas (Contd.)	Organiser and one of the coordinators	Mahabaleshwar Seminar on Modern Biology in collaboration with Tata Insittute of Fundamental Research, Bombay and Indian Institute of Science, Bangalore
	Member	Management Advisory Committee for Programmes related to Origin and Evolution of Life, Department of Science and Technology, New Delhi (1987)
	Member	Editorial Board for Proceedings of Indian National Science Academy (Biological Science) (1985-87)
3. Dr. S. K. Date	Member	Local Organising Committee, International Conference, Hyperfine Interaction, Bangalore (1986)
	Member	CSIR Committee on Standard Reference Materials (1988)
4 Dr. V. R. Choudhary	Member	Board of Studies in Chemical Technology, Faculty of Nagpur University, Nagpur
5. Dr. S. Devotta	Member	Editorial Board of the Journal of Heat Recovery Systems, Pergamon, UK
6. 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 (Chemial 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 of 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

6. Dr. L. K. Doraiswamy (Contd.)	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
7. 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
8. Dr. T. N. Guru Row	Member	Advisory Committee, National Information Centre for Crystallography (NICRYS)
9. Dr. S. H. Iqbal	Member	Advisory Committee for CSIR Exhibition to Advise on the Exhibition Policy and Organisation of Exhibition in India and Abroad
10. Dr. S. S. Katti	Member	Executive Committe of the Indian Society for Surface Science and Technology, Jadavpur University, Calcutta
11. Dr. K. V. Krishnamurthi	Founder Member	Plant Tissue Culture Association (India)
	Member	Indian Scientific Translators' Association (India).

11. Dr. K. V. Krishnamurthi (Contd.)	Member	INSDOC Panel of Translators
12. Dr. B. D. Kulkarni	Member	Research Advisory Committee of the IPCL R&D Programme
13. 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, UK.
14. 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 & Technology

14. Dr. R. A.. Mashelkar (Contd.)	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 and Technology
	Member	Awards Committee, Palit Award in Physical Chemistry and Polymer Science (1986-87)
	Member	Research Advisory Committee, IPCL Baroda (1986)
	President	Society for Polymer Science in India (1986-1989)
	Member	Council of Indian National Science Academy (1986-88)
	Member	Sectional Committee of Indian Academy of Sciences for Engineering Sciences Discipline (1986-88)
	Member	Committee to Select the Shanti Swarup Bhatnagar Prizes in Engineering Sciences (1984-86)
	Member	Academic Committee of National Defence Academy
15. Dr. V. M. Nadkarni	Member	Polymer Technology Selection Team for Maharashtra Gas Cracker Complex, Oil Industry Development Board, Ministry of Petroleum
	Member	ISI Committee on (i) Plastic Pipes Sub-Committee and (ii) Chemical Engineering Selection Committee
	Member	Metallurgical and Chemical Engineering Research Sub-Committee, Central Board of Railway Research, Ministry of Railways
	Member	Technical Advisor to Projects on High Performance Fibres and Resins for Composites, Department of Science and Technology, Govt. of India
	Member	Editorial Board, International Polymer Processing Journal (USA)
	Member	Project Co-ordination Committee, Technology Park, University of Poona, Pune

15. Dr. V. M. Nadkarni (Contd.)	Member	Committee of Technology for Modernisation of Railways, Ministry of Railways
	Member	DGTD Committee for Evaluation of PET X-ray Film Technology
	Member	DSIR Evaluation Committee for Technology Status Report on DMT/PSE
	Member	Editorial Advisory Board, Hanser - Verlag Publishers, Monograph Series on Progress in Polymer Processing
16. Dr. U. R. Nayak	Member	Sub-Committee of the Development Committee for Oleoresins, Gums and Essential Oils
	Member	Sub-Committee on Synthetic Perfumery Materials, ISI, New Delhi
17. Dr. P. K. Ranjekar	Member	DBT Task Force Committee for Plant Molecular Biology and Plant Biotechnology
	Member	International Advisory Board for the International Meeting of the Cell Biology
18. Dr. V. J. Rao	Member	National Advisory Committee of the International Conference on the Physics and Technology of Compensated Semi-conductor IIT, Madras
19. Dr. P. Ratnasamy	Member	Editorial Board of the Fuel Science and Technology (Journal brought out by CFRI, Dhanbad)
20. 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)
21. 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
22. Dr. A. P. B. Sinha	Member	Materials Research Committee, Dept. of Atomic Energy
23. Dr. R. N. Sharma	Member	Board of Studies in Science, Shivaji Univ., Kolhapur
	Member	M. Phil./ Ph. D. Admission Committee (Zoology), Univ. of Poona, Pune
	Member	Society for Malaria and other Communicable Diseases
24. Dr. M. C. Srinivasan	Nominated Member	World Federation Culture Collections Specialist Committee on Endangered Culture Collections

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

S. No.	Name	Degree	University	Subject	Guide
1	2	3	4	5	6
1.	Mr. N. Amarnath	Ph. D.	Poona	Studies in controlled release of aquatic herbicides	Dr. N. D. Ghatge
2.	Mr. K. C. Brahme	Ph. D.	Poona	Studies in organic compounds containing nitrogen	Dr. N. R. Ayyangar
3.	Ms. B. Chawla	M. Sc.	Poona	Protoplast studies of *Cajanus cajan* CV 149	Dr. K. V. Krishnamurthy
4.	Mr. N. B. Dahibhate	M. Lib. I.Sc.	Poona	Grey literature concept, scope and bibliographic organisation	*Prof. M. R. Riswadkar
5.	Ms. V. S. Dalavoy	Ph. D.	Poona	Studies in isoprenoids (newer facets in longifolene)	Dr. U. R. Nayak
6.	Mr. S. B. Deshpande	Ph. D.	Shivaji	Studies on structural, dielectric and piezoelectric properties of some modified ceramics Pb (Zr-Ti) O_3	Dr. P. Roychowdhury
7.	Mr. M. J. Eapen	Ph. D.	Poona	Solvent extraction of some transition metal chelates	Dr. V. Damodaran
8.	Mr. M. S. Gaikwad	Ph. D.	Poona	Stochastic modelling of non-isothermal continuous stirred tank reactors	Dr. B. D. Kulkarni
9.	Mr. D. S. Hebbalkar	Ph. D.	Shivaji	Physiological and behavioural effects of insectistatics on *Dysdercus koenigii*	Dr. R. N. Sharma
10	Mr. B. M. Khan	Ph. D.	Aligarh	Studies on nitrogen metabolizing enzymes from bacterial sources (nitrate and nitrite reductases from *Achromobacter fischeri)*	Dr. J. C. Sadana
11.	Ms. M. M. Kulkarni	Ph. D.	Poona	Chemistry and biological activity of natural products	Dr. B. A. Nagasampagi
12.	Ms. Resham Kulkarni	M. Sc.	Poona	Studies on somatic embryo-genesis of rice (*Oryza sativa*)	Dr. (Mrs.) S. Hazra
13.	Ms. M. D. Lagu	Ph. D.	Poona	Molecular analysis of plant genomes with special reference to three cucurbitaceae species	Dr. P. K. Ranjekar

14.	Mr. S. P. Mirajkar	M. Sc.	Poona	Mass spectrometry of some aromatic and anti-aromatic compounds	Dr. P. S. Kulkarni
15.	Mr. Sharad Ojha	M. Sc.	Poona	Production of a secondary metabolite (*Azadirachta indica* A. Juss) tissue culture	Dr. (Mrs.) R. S. Nadgauda
16.	Mr. K. R. Patil	MSc. (Chem Engg.)	Salford, U.K.	Experimental evaluation of acqueous salt system in an absorption of heat pumps	*Prof. F. A. Holland
17.	Mr. S. Pradhan	M. Sc.	Poona	Tissue culture studies with a drought resistant legume : The moth bean *Vigna aconitifolia* (Jacq.) Navechal	Dr. K. V. Krishnamurthy
18.	Mr. C. R. Rajan	Ph. D.	Poona	Polyphenylene sulphide	Dr. V. M. Nadkarni
19.	Mr. D. V. R. Raju	Ph. D.	Poona	Studies on thin films of a few semi-conducting materials	Dr. V. J. Rao
20.	Mr. Y. Ramanathan	M. Sc.	Poona	Standardisation of parameters in the isolation of protoplast from the leaf tissue of *Cajanus cajan* CV 149	Dr. K. V. Krishnamurthy
21.	Mr. S. A. Ranade	Ph. D.	Poona	Molecular studies in plant genomes with special reference to cowpea and pigeonpea	Dr. P. K. Ranjekar
22.	Mr. R. Thimma Reddy	Ph. D.	Poona	Synthetic transformations of longifolene/ longicyclene	Dr. U. R. Nayak
23.	Ms. V. Samuel	M. Sc.	Poona	Study of semiconducting Zn_3P_2 thin films	Dr. V. J. Rao
24.	Mr. M. G. Sane	Ph. D.	Poona	Studies on catalytic hydro-genation of *o*-nitrophenol to *o*-aminophenol in three phase slurry reactor	Dr. V. R. Choudhary
25.	Ms. B. A. Sayyed	Ph. D.	Poona	Synthesis and characterization of catalytically important iron oxide systems	Dr. S. K. Date
26.	Ms. S. P. Vaidya	Ph. D.	Poona	Studies in sesquiterpenes (newer perspectives of longifolene)	Dr. U. R. Nayak
27.	Mr. Vivek Verma	M. Sc.	Poona	Selection of variants of sugarcane, tolerant to NaCl by tissue culture technology	Dr. (Mrs.) S. Hazra
28.	Ms. Viswanath	M. Sc.	Poona	Somatic embryogenesis of bamboo	Dr. (Mrs.) R. S. Nadgauda

7.7 NCL scientists recognised by different universities as research guides

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

27.	Dr. Mascarenhas, A. F.	Poona
28.	Dr. Mashelkar, R. A.	Banaras, Bombay, Nagpur, Poona, Salford (UK)
29.	Dr. Nadkarni, V. M.	Poona, IIT, Delhi
30.	Dr. Nagasampagi, B. A.	Poona
31.	Dr. Nayak, U. R.	Poona, Shivaji
32.	Dr. Panse, G. T.	Poona, Shivaji
*33.	Dr. Pant, L. M.	Poona
34.	Dr. (Mrs.) Patwardhan S. A.	Poona, Shivaji
35.	Dr. Patwardhan, V. S.	Poona, Shivaji
36.	Dr. Ranjekar, P. K.	Poona, Shivaji
37.	Dr. (Mrs.) Rao, M.	Poona
38.	Dr. Rao, A. S.	Bombay, Shivaji, Poona
39.	Dr. Rao, V. J.	Poona
40.	Dr. Ravindranathan, T.	Bombay, Marathwada, Shivaji, Poona
41.	Dr. Setty, M. S.	Poona
42.	Dr. Sharma, R. N.	Poona, Shivaji
43.	Dr. Shankar, V.	Poona
*44.	Dr. Sinha, A. P. B.	Banaras, Bombay, Poona, Shivaji
45.	Dr. (Mrs.) Siva Raman, H.	Poona
46.	Dr. Sonawane, H. R.	Maratwada, Poona
47.	Dr. Srinivasan, M. C.	Poona, Shivaji
48.	Dr. Tewari, R.	Poona
49.	Dr. Umapathy, P.	Poona
50	Dr. Varma, A. J.	Poona
51.	Dr. Vernekar, S. P.	Poona, Shivaji

* Retired scientists

8. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

1. Shintre, S. N. , Dutta, A. and Mashelkar, R. A.
Transportation of crude oils through pipelines,
International seminar on frontier area, RRL, Jorhat, April, 1986.

2. Bhattacharya, A. and Ravetkar, D. D.,
A computer model for quick evaluation of energy recovery systems,
National symposium on application of computers in chemical engineering, Kalpakkam, 1986.

3. Singh, R. S.,
World information services : A global view,
Workshop on new trends in library and information services in collaboration wih Dept. of Library and Information Science, Univ. of Poona, HPT Arts and BYK Science College, Nasik, August, 1986.

4. Singh, R. S.,
Communication of scientific information seminar on dissemination of information through scientific books and journals,
IIT, Bombay, September 1986.

5. Patwardhan (Mrs.), S. A., Sharma, R. N., Gund (Mrs.), P., Phadnis, A. P.,
Synthesis and pest/vector control activity of geraniol based diethers,
VII Indo-Soviet symposium on chemistry of natural products, RRL, Hyderabad, December, 1986.

6. Roy Chowdhury P.,
Studies on microstructure and crystallographic parameters of Pb (Zr-Ti) O_3 ceramics modified with the oxides of Cr, Mn, Co and U,
4th National seminar of ferroelectrics and dielectrics, IIT, Kharagpur, December, 1986.

7. Setty, M. S., Naik, B. G. and Shinde, R. F.,
Study of bismuth ruthenate as conductive phase in thick resistive films,
Symposium on thick film materials and HMCs, IISc, Bangalore, December, 1986.

8. Panse, G. T.,
Synthetic and conformational studies in peptides: Effect of substitution of D(–) phenylglycine in place of glycine,
55th Annual convention of Society of Biological Chemists, Trivandrum, December, 1986.

9. Nanjundiah, B. S.,
Photo VCR in organic synthesis,
VIII Indo-Soviet symposium on chemistry of natural products, Hyderabad, December,1986.

10. Ravindranathan, T.,
Synthesis of biologically active heterocycles : D (+) biotin and α-lipoic acid,
VIII Indo Soviet symposium on chemistry on natural products, Hyderabad, December, 1986.

11. Deshpande, V. H.,
NCL's contribution to drug industry,
IDMA-CSIR seminar on role of R and D - newer concept in cost effective production of bulk drugs, RRL, Hyderabad, October, 1986.

12. Sane, M. G.,
Poisoning of palladium on charcoal in slurry phase hydrogenation of *o*-nitrophenol,
Indian Chemical Engineering Congress, Hyedrabad, December, 1986.

13. Panse, G. T.,
Recent advances in biosynthesis of cycloheximide derivatives and their significance,
Symposium on biology and molecular biology of streptomycetes, NCL, Pune, February, 1987.

14. Santra, M., Deshmukh, K. K., Waghmare, K. J., Sivasankar, S. and Ratnasamy, P.,
The influence of the hydrogenation and acidic functions on the activity and selectivity of hydrocracking catalysts,
8th National symposium on challanges in catalysis science and technology, Project and Development India Ltd., Sindri, February, 1987.

15. Srinivasan, S. R. and Gundiah, S.,
Sealants and coatings in building applications,
National workshop of low cost alternate building materials, New Delhi, March, 1987

16. Jain, R. K., Shirsalkar, M. M. and Gundiah, S.,
Plastics in building-present trends and future R and D needs,
National workshop on low cost alternate building materials, New Delhi, March,1987.

17. Mascarenhas, A. F.,
Useful forest tree species and bamboos,
Symposium on tissue culture and forest products, National University of Singapore, June, 1987.

18. Puranik, V. G., Tavale, S. S. and Guru Row, T. N.,
Electron density distribution in cage-like compounds : Directional preferences of electrophilic and nucleophilic attack,
XIVth International conference on crystallography, Perth, Australia, August, 1987.

19 Bhaskar, C.,
Controlled release abate larvicide and carbofuran pesticide field studies in India,
14th International symposium on controlled release of bioactive materials, Toronto, August, 1987.

20. Puranik, V. G., Tavale, S. S. and Guru Row, T. N.,
Structure of a polyester dye : 1-methoxy-2-phenyl-3H-napth- (2-1-8-mno) thioxanthene 3-one,
XVIIIth National seminar on crystallography, Dept. of Physics, Jammu University, October, 1987.

21. Puranik, V. G., Tavale, S. S. and Guru Row T. N.,
Absolute configuration of (4R)-4-benzyl-3-dichloroacetyl-1, 3-oxazolidine,
XVIIIth National seminar on crystallography, Dept. of Physics, Jammu University, October, 1987.

22. Puranik, V. G., Tavale, S. S., Guru Row, T. N. and Mehta, G.,
Structure of 2 novel polyguinanes from a caged hexacyclic [4.4.2]-propellane system,
XVIIIth National seminar on crystallography, Dept. of Physics, Jammu University, October, 1987.

23. Dhaneshwar, N. N., Tavale, S. S. and Guru Row, T. N.,
Structure of an oxidation product of echino cystic acid,
XVIIIth National seminar on crystallography, Dept. of Physics, Jammu University, October, 1987.

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Adsorption of NH_3O_n $AlPO_4O$–5 and SAPO-5 molecular sieves studied by TPD and isoteric measurements,
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Influence of stereo-chemical variation on chemical reactions, structure of spiro (camphene 2m-dithione) sulfoxide and its methylated product,
XIX th National seminar on crystallography, Gandhiji University, Chengancherry, Kerala, December, 1987.

27 Dhaneshwar, N. N., Tavale, S. S. and Guru Row, T. N.,
Structure of a commercial dye : Intrasil brilliant yellow 109 eF,
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The structure of 4N (dimethyl-maleoimido) phenyl methacrylate,
XIX th National seminar on crystallograpy Gandhiji Unversity, Chengancherry, Kerala, December, 1987.

29 Panse, G. T., Kamath, S. K., Jadhav, G. S. and Patil, S. D.,
Synthetic and spectral studies on optically active schiff bases and their thiazolidinones,
Convention of Chemists 1987, Shivaji University, Kolhapur.

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Monolayer studies of a nematogenic material at air-water interface,
3rd National conference on surfactants, emulsions and biocolloids, Dept. of Chemistry, A. M. U., Aligarh, December, 1987.

31. Panse, G. T. and Kamat, S. K.,
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35. Kulkarni, P. S. and Mirajkar, S. P.,
Mass spectral fragmentation of substituted 1,2-benzisoxazoles,
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36. Bakare, P. P., Shrotri, J. J. and Date, S. K.,
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Potential for heat pumps in chemical and process industries,
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9 PATENTS IN FORCE AS ON 31-3-1987

Indian patents sealed

1. 149249
An improved apparatus for the simultaneous determination of carbon, hydrogen and halogen or sulphur in organic matter, coke and coal, steel and like materials,
Malvankar, R. B., Ramdasi, S. S. and Pansare, V. S.

2. 151660
A novel process for recovery of D (+) camphor-sulphonic acid during the resolution of DL--phenylglycine,
Mitra, R. B., Joshi, B. N., Hinge, V. K. and Natekar (Miss), M. V.

3. 152306
Process for the preparation of 3-phenoxybenzyl IR-cis-2, 2-dimethyl-3 (2-cyanoprop-1-enyl) cyclopropane carboxylate,
Mitra, R. B., Kulkarni, G. H., Muljiani (Miss), Z. and Khanna, P. N.

4. 153336
A new process for the preparation of IR-cis-2, 2-dimethyl (2-oxopropyl) cyclopropane carboxylic acid, an important intermediate in the synthesis of insecticides of the synthetic pyrethroids group by oxidation of 3, 6, 6- trimethyl 4-formyl (3, 1, 0)-bicyclo-hex-3-ene using suitable oxidising agents,
Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D. and Bhawal, B. M.

5. 153415
A process for the isolation of a fraction from neem extract enriched with active principle exhibiting oviposition deterrent and anti-feedant activity against potato tuber moth.,
Nagasampagi, B. A., Sharma, R. N., Kulkarni (Miss), M. M., Bhosale, A. S. and Tungikar, V. B.

6. 153460
Process for the preparation of α- cyano-3-phenoxy-benzyl 1-R-cis-2, 2-dimethyl-3-(2-chloroprop-1-enyl) cyclopropane carboxylate, a new insecticide belonging to the synthetic pyrethroids group,
Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D.and Bhawal, B. M.

7. 153634
An improved chemical process for the manufacture of high alpha cellulose pulp from naturally occuring cellulosic materials, Bendale, D. S., Mahajan, M. B. and Karnik, R. S.

8. 153878
A new process for the preparation of 2, 2-dimethyl-3-(2-oxopropyl)-cyclopropane acetic acid, an important intermediate in the synthesis of chrysanthemic acid and synthetic pyrethroid insecticides,
Mitra, R. B., Hinge, V. K. and Khanra, A. S.

9. 154331
A process for the selective isolation of vinblastine sulphate from the leaves of *Vinca rosea* (*Catharanthus roseus* G. Don),
Rama Rao, A. V., Venkatswamy, G., Sathaye, K. M. and Yadagiri, P.

10. 154394
A new process for the preparation of 1R-cis-2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides,
Mitra, R. B., Joshi, G. D. and Khanra, A. S.

11. 154396
A new route for the preparation of 1R, cis-2–2, dimethyl-3-(2-oxopropyl) cyclopropanecarboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides,
Mitra, R. B. and Khanra, A. S.

12. 154460
A process for the preparation of new yellow to violet azo-N-substituted homophthalimide disperse dyes for synthetic fibres,
Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

13. 154665
An improved method for the preparation of 1R-cis-2, 2-dimethyl-3-(2-hydroxy-2-carboxypropyl) cyclopropane carboxylic acid from car-4-ene-3-o l,
Mitra, R. B., Kulkarni, G. H., Muljiani (Miss), Z., Naik, V. G. and Deshmukh, A. R. A.S.

14 154666
A method for the preparation of Y-lactone of 1R-cis-2,2-dimethyl-3-hydroxymethyl cyclopropane carboxylic acid from methyl 1R-cis-2, 2-dimethyl-3-(2-oxopropyl)–cyclopropane carboxylate,
Mitra, R. B. Kulkarni, G. H., Khanna, P. N. and Joshi, G. D.

15. 154667
A process for the manufacture of sodium hydrosulphate via ferrous hydrosulphite,
Gopinathan, C., Gopinathan (Mrs.), S., Unni. I. R., Awaskar, P. A., Pandit, S. K., Pardhy (Mrs.), S. A., Chatterjee, A. K. and Sonsale, A. Y.

16. 154669
Catalyst and process for the conversion of alcohol to hydrocarbons,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

17. 154702
Improved process for the conversion of toluene to xylenes,
Kulkarni (Miss), S. B., Ratnasamy, P., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Babu, G. P. and Chandavar, K. H.

18. 155205
A process for the preparation of catalyst,
Kulkarni (Miss), S. B., Ratnasamy, P., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Babu, G. P. and Chandavar, K. H.

19. 155892
Process for the catalytic conversion of alkylaromatic hydrocarbons into paraxylenes,
Ratnasamy, P., Kulkarni (Miss), S. B., Rao, B. S., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Kulkarni, S. J. and Hegde, S. G.

20. 155893
Process for the preparation of a catalytic composite materials,
Kulkarni (Miss), S. B., Ratnasamy, P., Shiralkar, V. P. Balakrishnan, I. and Kavedia, C. V.

21. 157061
Improved process for the disproportionation of toluene to benzene and xylene,
Ratnasamy, P., Kulkarni (Miss), S. B., Babu, G. P., Chandavar, K. H., Balakrishnan, I. and Shiralkar, V. P.

22. 157390 (703/DEL/81)
An improved process for the preparation of aromatic hydrcarbons from ethyl alcohol in a single step conversion,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

Indian patent applications accepted

1. 157487 (702/DEL/79)
A process for the reactive dyeing of cellulosic fibres by the application of 6-cyano-7–methyl-oxazolo (3, 2-a) pyrid-5 (4H)-one followed by treatment with diazonium salts,
Ayyangar, N. R., Rao, U. S. and Tilak ,B. D.

2. 157488 (703/DEL/81)
Improved process for the preparation of ethyl-α-(carbethoxy)-β(substituted anilino) acrylates,
Ayyangar N. R., Jinaraj V. K., Lahoti R. J. and Danial, T.

3. 157728 (804/DEL/81)
Process for the synthesis of new 3, 6- diaryl-3,-4-dihydro 1, 3, 2-oxazaphosphorin-2-oxides,
Tilak, B. D., Gogte, V. N. and Modak, A. S.

4. 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. J.

Indian patent applications filed

1. 732/DEL/80
Catalyst and process for the alkylation of benzene to ethylbenzene,
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu G. P. and Chandavar, K. H.

2. 44/DEL/82
An improved process for the catalytic alkylation of benzene to ethylbebzene,
Ratnasamy, P., Kulkarni (Miss) , S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

3. 78/DEL/82
An improved process for the preparation of substituted aromatic diamines,
Ghatge, N. D. and Maldar, N. N.

4. 96/DEL/82
A novel device for solar thermal conversion in which fluid is used as an absorbing medium,
Sathaye, S. D., Potdar, H. S., Soni, H. S. and Sinha, A. P. B.

5. 476/DEL/82
An Improved process for the preparation of N-alkyldisopropanolamine,
Nerlekar, P. G. and Moghe, P. P.

6. 670/DEL/82
An Improved process for the preparation of thermoplastic polyurethane polymers,
Ghatge, N. D. and Jadhav, J. Y.

7. 57/DEL/83
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reactions,
Siva Raman (Mrs.), H., Rao, B. S., Shankar, V., Pundle, A. V. and Siva Raman, C.

8. 115/DEL/83
A process for the preparation of composite catalyst material,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Shiralkar, V. P., Kotasthane, A. N., Rao, B. S. and Borade, R. B.

9. 275/DEL/83
Process for the preparation of crystalline catalyst composite material designated Encilite,
Ratnasamy, P., Boarde, R. B., Kulkarni (Miss), S. B. and Hegde, S. G.

10. 296/DEL/83
A process for the preparation of homogeneous metal chiral ligands catalysts using natural alkaloids,
Gogte ,V. N., Natu, A. A. and Ahuja (Miss), R. R.

11. 370/DEL/83
Process for the catalytic conversion of methanol to hydrocarbons mainly olefins,
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao B. S., Shiralkar, V. P., Hegde, S. G. and Borade, R. B.

12. 437/DEL/83
A Process for the conversion of alkanols to hydrocarbons,
Ratnasamy, P., Balakrishnan, I. and Rao, B. S.,

13. 539/DEL/83
A novel process for the preparation of isocyanate terminated (Telechelic) diene prepolymers by free radical polymerization technique,
Ghatge, N. D. Vernekar, S. P. and Vadgaonkar, P. P.

14. 585 / DEL / 83
An improved process for the preparation of 4-amino-3-nitrobenzophenone with or without alkyl substituents,
Ayyangar, N. R., Lohoti, R. J. and Thomas, D.

15. 628 / DEL/ 83
A process for the manufacture of benzene and xylenes admixtures from alkyl aromatic hydrocarbons,
Ratnasamy, P., Kulkarni (Miss), S. B., Meshram, N. R. and Hegde, S. G.

16. 115 / DEL / 84
A process for the preparation of 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid by reaction of hydrazine hydrate with 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid,
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde, D. D.

17. 116 / DEL / 84
A process for the preparation of substituted alkyl, cyclohexyl, cyclohexylkyl, aralkyl aryloxyalkyl esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid by transesterification,
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde, D. D.

18. 119 / DEL / 84
Preparations of substituted alkyl, cyclohexyl, cyclohexylalkyl aryl, aralkyl, esters of 2, 2-dimethyl-3-(2-oxoporopyl) cyclopropane acetic acid and 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid derived from (+) 3-carene as potential miticides by the reaction with thionyl chloride,
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A., and Shinde, D. D.

19. 506 / DEL / 84
A process for synthesis of 22, 23-dihydroxy-24S-ethyl-3 5 cyclo-5-cholestan-6-ones from phytosterols of sugarcane wax,
Mitra, R. B., Kapoor (Miss), V. M. and Hazra, B. G.

20. 507 / DEL / 84
An improved process for the preparaton of monoalkyl esters of azelaic acid,
Mitra, R. B., Joshi, R. S. and Lunkad, K. F.

21. 537 / DEL / 84
An improved process for the preparation of SY M N, N' disubstituted diarylurea compounds,
Ayyangar, N. R. and Choudhary, A. R.

22. 587 /DEL / 84
A novel process for the manufacture of 2, 4-dicholoro-5-pentadecylphenoxy acetic acid,
Amarnath, N., Ghatge, N. D. and Moghe, P. P.

23. 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.

24. 837 / DEL / 84
A process for separation of stigmasterol derived products from phytosterols of sugarcane wax,
Mitra, R. B., Kapoor (Miss), V. M. and Hazra, B. G.

25. 60 / DEL / 85
Process for the preparation of new catalyst composite material useful for conversion of alkanols to hydrocarbons,
Ratnasamy, P., Kulkarni (Miss), S. B., Kotasthane, A. N. and Shiralkar, V. P.

26. 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 (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

27. 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.

28. 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.

29. 267 / DEL / 85
A device for obtaining NMR spectra in undeuterated solvents on FT (fourier transform) instruments,
Deshpande, K. G.

30. 279 / DLE / 85
Process for conversion of methanol to olefins,
Ratnasamy, P., Balakrishnan, I., Rajiv Kumar and Hegde, S. G.

31. 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.

32. 632 / DEL / 85
A process for the preparation of novel lanthanum iron silicates designated as Encilite-2,
Ratnasamy, P., Kulkarni (Miss), S. B. Shiralkar, V. P., Kotasthane, A. N. and Chandwadkar (Mrs.), A. J.

33. 634 / DEL / 85
Improvements in or relating to the preparation of 3-acyloxy and 3-arolyloxy-isoxazole derivatives,
Mitra, R. B., Subba Rao, A., Ray, G. D., Toke, S. M. and Patil, S. G.

34. 735 / DEL / 85
A process for the preparation of methyl (+) –cis-3,3-dimethyl-2-formylcyclopropane-1-carboxylate,
Mitra, R. B., Muljiani (Miss), Z., Gadre (Mrs.), S., and Joshi (Mrs.), V.

35. 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. and Bhaldar, I. V.

36. 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. and Bhaldar, I. V.

37. 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. and Bhaldar, I. V.

38. 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.

39. 187 / DEL / 86
An improved process for the preparation of 2-bromol-1-phenylethanol,
Bhosale, S. S., Natekar (Miss), M. V., Joshi, P. L., Dixit, K. N., Vaidya, A. S. and Rao, A. S.

40. 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.

41. 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.

42. 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. and Pires, J. A.

43. 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.

44. *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.

45. *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.

46. *837 / DEL / 86
Process for the preparation of glucose isomerase,
Dhamankar (Miss), V. S., Gaikwad, S. M., Khire, J. M., Modak, S. P., Powar, V. K. and Vartak, H. G.

47. *935 / DEL / 86
Process for the preparation of crystalline phospho-alumino silicate catalysts,
Ratnasamy, P., Kulkarni (Miss), S. B., Kamble (Mrs.),K. R. and Hegde, S. G.

48. *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.

49. *1136 / DEL / 86
A process for the preparation of a catalyst composite useful for naphtha reforming,
Sivasankar, S., Ratnasamy, P., Budhkar, A. P., Padalkar, S. R. and Waghmare, K. J.

50. *1141 / DEL / 86
An improved process for the preparation of 2–(3–phenoxyaryl) alkanols,
Mitra, R. B. and Kapoor (Miss), V. M.

51. *117 / DEL / 87
Synthesis of α –(RS) – cyano–3–phenoxybenzyl (+) *cis* –2, 2–dimethyl–3–(2,2–dichlorovinyl) cyclopropane carboxylate, 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.

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* These applications were newly field during the year

Foreign patent applications sealed

1. UK patent application No. 7935813 (corresponds to the Indian patent application No. 761 / DEL / 78)
2. East German patent No. 232841 (application No. WBO 1J/2667853)*

Foreign patent applications filed

1. Netherland patent application No. 7907332 (corresponds to the Indian patent application No. 761/DEL.78)
   Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D., Khanra, A. S. and Bhawal, B. M.
2. Algerian patent application No. 7124*
3. Australian patent application No. 30020*
4. East German patent application No.01J/2860732/2 (Divisional to WBO 1J/266785)*
5. Egyptian patent application No. 763/84*
6. European patent No. 01601360 (appl. No. 84302893.7)* (designated countries : UK, France, West Germany, Belgium, Switzerland, Italy)
7. Indonesian patent application No. 10173*
8. Japanese patent application No. 44979/85*
9. Libyan patent application No. 2314*
10. Pakistan patent No. 129327 (appln. No. 251/84)*
11. USSR patent application No. 377, 3893.26*
12. USSR patent application No. 377,0903.04*
13. Thailand patent application No. 2565*
14. Australian patent application No. 51247/85**
15. European patent application No. 85308747.6** (designated countries : Belgium, West Germany, UK, France, Switzerland, Italy)
16. USSR patent application No. 4012815.04**
17. USA patent application No. 801682**
18. Japanese patent application No. 299733/85**
19. Canadian patent application No. 500350**
20. European patent application No. 869180.7***
21. US patent application No. 940517***

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* These patent applications correspond to Indian patent application Nos. 275/DEL/83 and 437/DEL/83

** These patent applications correspond to Indian patent application Nos. 60/DEL/85 and 279/DEL/85 were newly filed during the year

*** These patent applications correspond to Indian patent application No. 109/DEL/86

9. PATENTS IN FORCE AS ON 31-3-1988

Indian patents sealed

1. 149249
An improved apparatus for the simultaneous determination of carbon, hydrogen and halogen or sulphur in organic matter, coke and coal, steel and like materials,
Malvankar, R. B., Ramdasi, S. S. and Pansare, V. S.

2. 151660
A Novel process for recovery of D (+) camphorsulphonic acid during the resolution of DL–phenylglycine,
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A process for the selective isolation of vinblastine sulphate from the leaves of *Vinca rosea* (*Catharanthus roseus* G. Don),
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5. 154396
A new route for the preparation of IR, cis–2, 2–dimethyl–3–(2–oxopropyl) cyclopropanecarboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides,
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6. 154669
Catalyst and process for the conversion of alcohol to hydrocarbons,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

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Improved process for the conversion of toluene to xylenes,
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8. 155205
A process for the preparation of catalyst,
Kulkarni (Miss), S. B., Ratnasamy, P., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Babu, G. P. and Chandavar, K. H.

9. 155892
Process for the catalytic conversion of alkylaromatic hydrocarbons into paraxylenes,
Ratnasamy, P., Kulkarni (Miss), S. B., Rao, B. S., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Kulkarni, S. J. and Hegde, S. G.

10. 155893
Process for the preparation of a catalytic composite material,
Kulkarni (Miss), S. B., Ratnasamy, P., Shiralkar, V. P., Balakrishnan, I. and Kavedia, C. V.

11. 157061
Improved process for the disproportionation of toluene to benzene and xylene,
Ratnasamy, P., Kulkarni (Miss), S. B., Babu, G. P., Chandavar, K. H., Balakrishnan, I. and Shiralkar, V. P.

12. 157390
An improved process for the preparation of aromatic hydrocarbons from ethyl alcohol in a single step conversion,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

13. 157487 (702/DEL/79)
A process for the reactive dyeing of cellulosic fibres by the application of 6-cyano-7-methyl-oxazolo (3, 2-a) pyrid-5 (4H)-one followed by treatment with diazonium salts,
Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

14. 157488 (703/DEL/81)
Improved process for the preparation of ethyl -α– (carbethoxy)–β -(substituted anilino) acrylates,
Ayyangar, N. R., Jinaraj, V. K., Lahoti, R. J. and Danial, T.

15. 157728 (804/DEL/81)
Process for the synthesis of new 3, 6-diaryl-3, 4-dihydro 1, 3, 2-oxazaphosphorin-2-oxides,
Tilak, B. D., Gogte, V. N. and Modak, A. S.

16. 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. J.

17. 158254 (732/DEL/80)
Process for the preparation of a catalyst composite material,
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

18. 158255 (44/DEL/82)
An improved process for the catalytic alkylation of benzene to ethylbenzene,
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

19. 158329 (78/DEL/82)
An improved process for the preparation of substituted aromatic diamines,
Ghatge, N. D. and Maldar, N. N.

20. 158491 (476/DEL/82)
An improved process for the preparation of N-alkyldisopropanolamine,
Nerlekar, P. G. and Moghe, P. P.

21. 158574 (670/DEL/82)
An improved process for the preparation of thermoplastic polyurethane polymers,
Ghatge, N. D. and Jadhav, J. Y.

22. 159405 (57/DEL/83)
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reactions,
Siva Raman (Mrs.), H., Rao, B. S., Shankar, V., Pundle, A. V. and Siva Raman, C.

23. 159406 (58/DEL/83)
A catalytic process for the conversion of methanol to olefins rich hydrocarbons,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Shiralkar, V. P., Hegde, S. G. and Kotasthane, A. N.

24. 159409 (296/DEL/83)
A process for the preparation of homogeneous metal chiral ligands catalysts using natural alkaloids,
Gogte, V. N., Natu, A. A. and Ahuja (Miss), R. R.

25. 159164 (370/DEL/83)
Process for the catalytic conversion of methanol to hydrocarbons mainly olefins,
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S., Shiralkar, V. P., Hegde, S. G. and Borade, R. B.

26. 159420 (539/DEL/83)
A novel process for the preparation of isocyanate terminated (Telechelic) diene prepolymers by free radical polymerization technique,
Ghatge, N. D., Vernekar, S. P. and Vadgaonkar, P. P.

27. 161822 (585/DEL/83)
An improved process for the preparation of 4-amino-3-nitrobenzophenone with or without alkyl substituents,
Ayyangar, N. R., Lahoti, R. J. and Thomas, D.

Indian patent applications accepted

1. 159407 (115/DEL/83)
A process for the preparation of composite catalyst material,
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Shiralkar, V. P., Kotasthane, A. N., Rao, B. S. and Borade, R. B.

2. 159595 (628/DEL/83)
A process for the manufacture of benzene and xylenes admixtures from alkyl aromatic hydrocarbons,
Ratnasamy, P., Kulkarni (Miss), S. B., Meshram, N. R. and Hegde, S. G.

3. 159819 (507/DEL/84)
An improved process for the preparation of monoalkyl esters of azelaic acid,
Mitra, R. B., Joshi, R. S. and Lunkad, K. F.

4. 160038 (437/DEL/88)
A process for the convertion of alkanols and hydrocarbons,
Ratnasamy, P., Balakrishnan, I. and Rao, B. S.

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

6. 160212 (275/DEL/83)
Process for the preparation of a crystalline catalyst composite material designated as Encilite,
Ratnasamy, P., Borade, R. B., Kulkarni (Miss), S. B. and Hegde, S. G.

7. 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 (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

8. 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 Mashelker, R. A.

9. 160748 (837/DEL/84)
A process for separation of stigmasterol derived products from phytosterols of sugarcane wax,
Mitra, R. B., Kapoor (Miss), V. M. and
Hazra, B. G.

10. 160256 (60/DEL/85)
Process for the prepartion of new catalyst composite material useful for conversion of alkanols to hydrocarbons,
Ratnasamy, P., Kulkarni (Miss), S. B., Kotasthane, A. N. and Shiralkar, V. P.

11. 160829 (116/DEL/84)
A process for the preparation of substitued 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 (Miss), M. V., Arabale, A. A. and Shinde, D. D.

12. 160841 (115/DEL/84)
A process for the preparation of 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid by reaction of hydrazine hydrate with 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid,
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde, D. D.

13. 160974 (191/DEL/84)
Preparations of substituted alkyl, cyclohexyl, cyclohexylalkyl aryl, aralkyl, esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid and 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid derived from (+) 3-carene as potential miticides by the reaction with thionyl chloride,
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde, D. D.

14. 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 Shah, S. C.

15. 161612 (537/DEL/84)
An improved process for the preparation of SY M N, N' disubstituted diarylurea compounds,
Ayyangar, N. R. and Choudhary, A. R.

Indian patent applications filed

1. 506/DEL/84
A process for synthesis of 22, 23-dihydroxy-24S-ethyl-3-5-cyclo-5-cholestan-6-ones from phytosterols of sugarcane wax,
Mitra, R. B., Kapoor (Miss), V. M. and
Hazra, B. G.

2. 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.

3. 267/DEL/85
A device for obtaining NMR spectra in undeuterated solvents on FT (fourier transform) instruments,
Deshpande, K. G.

4. 279/DEL/85
Process for conversion of methanol to olefins,
Ratnasamy, P., Balakrishnan, I., Rajiv Kumar and Hegde, S. G,

5. 430/DEL/85
Novel dispensors for controlled release of aquatic larvicides,
Sharma, R. N., Vartak, H. G., Gund (Miss), P. D., Bhalder, I. V., Rao, J. V., Powar, V. K. and Mitra, R. B.

6. 632/DEL/85
A process for the preparation of novel lanthanum iron silicates designated as Encilite-2,
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Kotasthane, A. N. and Chandwadkar (Mrs.), A. J.

7. 634/DEL/85
Improvements in or relating to the preparation of 3-acyloxy and 3-arolyloxy-isoxazole derivatives,
Mitra, R. B., Subba Rao, A., Ray, G. D., Toke, S. M. and Patil, S. G.

8. 735/DEL/85
A process for the preparation of methyl (+) -cis-3,3-dimethyl-2-formylcyclopropane-1-carboxylate,
Mitra, R. B., Muljiani (Miss), Z., Gadre (Mrs.), S. and Joshi (Mrs.), V.

9. 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. and Bhaldar, I. V.

10. 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. and Bhaldar, I. V.

11. 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. and Bhaldar, I. V.

12. 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.

13. 187/DEL/86
An improved process for the preparation of 2-bromo-1-phenylethanol,
Bhosale, S. S., Natekar (Miss), M. V., Joshi, P. L., Dixit, K. N., Vaidya, A. S. and Rao, A. S.

14. 195/DEL/86
Improvements in or relating to the process for the preparation of lactone of 2, 2-dimethyl-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.

15. 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.

16. 281/DEL/86
Improved process for the production of trichlorosilane (TCS) from silicon tetrachloride,
Neurgaonkar, V. G.

17. 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.

18. 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., Deshpande (Mrs.), S. S., Pardhy (Mrs.), S. A. and Ratnasamy, P.

19. 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.

20. 837/DEL/86
Process for the preparation of glucose isomerase,
Dhamankar (Miss), V. S., Gaikwad, S. M. Khire, J. M., Modak, S. P., Powar, V. K. and Vartak, H. G.

21. 935/DEL/86
Process for the preparation of crystalline phospho-alumino silicate catalysts,
Ratnasamy, P., Kulkarni (Miss), S. B., Kamble, (Mrs.), K. R. and Hegde, S. G.

22. 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.

23. 1136/DEL/86
A process for the preparation of a catalyst composite useful for naphtha reforming,
Sivasankar, S., Ratnasamy, P., Budhkar, A. P., Padalkar, S. R. and Waghmare, K. J.

24. 1141/DEL/86
An improved process for the preparation of 2-(3-phenoxyaryl) alkanols,
Mitra, R. B. and Kapoor (Miss), V. M.

25. 117/DEL/87
Synthesis of α- (RS) - cyano-3-phenoxybenzyl (+) *cis*-2, 2-dimethyl-3-(2, 2-dichlorovinyl) cyclopropane carboxylate, 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.

26. *292/DEL/87
A process for the preparation of alpha-aryl propionic acids,
Sonawane, H. R., Kulkarni, D. G. and Ayyangar, N. R.

27. *316/DEL/87
Process for the preparation of a catalyst composite material,
Ratnasamy, P. and Sivasankar, S.

28. *325/DEL/87
Process for the preparation of a catalyst composite material,
Ratnasamy, P. and Sivasankar, S.

29. *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.

30. *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.

31. *784/DEL/87
An improved process for the preparation of a high silica zeolite catalyst composite material,
Rajiv Kumar.

32. *847/DEL/87
An improved catalyst useful for the preparation of carboxylic acids,
Kelkar, A. A., Jagannathan, R., Kolhe, D. S. and Chaudhari, R. V.

33. *848/DEL/87
An improved process for the preparation of carboxylic acids,
Kelkar, A. A., Jagannathan, R., Kolhe, D. S. and Chaudhari, R. V.

34. *881/DEL/87
A process for the preparation of controlled release agrochemical granules,
Bhaskar, C., Shukla, P. G., Rajagopalan, N. and Mitra, R. B.

35. *985/DEL/87
An improved process for the conversion of natural gas into middle distillates,
Ratnasamy, P. and Sivasankar, S.

36. *991/DEL/87
An improved process for the preparation of chloramphenicol 2, 2-dichloro- N [2-hydroxyl-1(hydroxymethyl) -2 (4-nitrophenyl)] ethyl acetamide,
Hazra, B. G., Pore, V. S., Maybhate, S. P. and Mitra, R. B.

37. *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.

38. *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.

39. *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.

40. *1152/DEL/87
Improvements in or relating to the preparation of 2, 4, 4-tetrachlorobutyronitrile,
Ayyangar, N. R., Moghe, P. P. and Naik, S. N.

41. *1159/DEL/87
An improved process for preparation of high temperature super conductors,
Mulla, I. S., Sinha, A. P. B. and Chandrachood, M. R.

42. *182/DEL/88
Process for the preparation of a novel crystalline aluminosilicate,
Kotasthane, A. N., Chandwadkar (Mrs.), A. J. and Ratnasamy, P.

43. *222/DEL/88
An improved reforming process,
Ratnasamy, P. and Sivasankar, S.

44. *261/DEL/88
An improved process for the preparation of 1, 1, 1-trichloro-4-methyl-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.

45. *263/DEL/88
Improved process for carbonylation of alcohols to carboxylic acid,
Kelkar, A. A. and Chaudhari, R. V.

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*These applications were newly filed during the year.

Foreign patent applications sealed

1. UK Patent Application No. 7935813 (corresponding to the Indian Patent Application No. 761/DEL/78).
2. East German Patent No. 232841 (Application No. WBO IJ/2667853).

Foreign patent applications filed

1. Netherland Patent Application No.7907332 (corresponding to the Indian Patent Application No. 761/DEL/78)
2. Algerian Patent Application No. 7124*
3. Australian Patent Application No. 30020/84*
4. East German Patent Application No. O1J/2860732/2 (Divisional to WBO IJ/266785)*
5. Egyptian Patent Application No. 763/84*
6. European Patent Application No. O1601360 (Appln. No. 84302893.7)* (designated countries : UK, France, West Germany, Belgium, Switzerland, Italy)
7. Indonesian Patent Application No. 10173*
8. Japanese Patent Application No. 44979/85*
9. Libyan Patent Application No. 2314*
10. Pakistan Patent No. 129327 (Appln. No. 251/84)*
11. USSR Application No. 4202710/26 (inventor's certificate)
12. USSR Patent Application No. 377,0903.04*
13. Thailand Patent Application No. 2565*
14. Australian Patent Application No. 51247/85*
15. European Patent Application No. 85308747.6** (designated countries : Belgium, West Germany, UK, France, Switzerland, Italy).
16. Japanese Patent Application No. 299733/85*
17. Canadian Patent Application No. 500350**
18. European Patent Application No. 86309180.7
19. US Patent Application No. 940517***

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* These patent applications correspond to Indian patent application Nos. 275/DEL/83 and 437/DEL/83

** These patent applications correspond to Indian patent application Nos. 60/DEL/85 and 279/DEL/85.

*** This patent application corresponds to Indian patent application No. 109/DEL/86

RESEARCH UTILIZATION

TABLE I : 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 1986-87	1987-88	Qty./value Rs. in lakhs Upto March 86	Capacity installed nature of release and remarks
1	2	3	4	5	6	7	8
1.	Acetanilide	Intermediate	Hindustan Organic Chemicals Ltd., PO: Rasayani 410 207 (through project engineers R. L. Dalal & Co., Bombay 400 018) (1969).	2922.00 T 935.04	3157.00 T 1111.25	32323.49 T 6206.00	2000.00 T Non-exclusive
2.	Acrylic acid/ acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., PO: Petrochemicals, Dist. Vadodara 391346 (1984)	N.A. N.A.	N.A. N.A.	5948.00 T 2150.31	10,000 T Sponsored
3.	Antipriming compositions	Antipriming in locomotives	Research Designs and Standards Organisation, M&C Wing, Lucknow 226 011 (1964)	4.00 T 0.50	3.5 T 0.44	180.58 T 17.93	26 T Non-exclusive
*4.	Butenediol	Pesticides, polymers	Hindustan Organic Chemicals Ltd., Rasayani (1986)	9.24 T 6.00	41.23 T 26.80	- -	150 T Collaborative work
5.	tert-Butyl catechol	Synthetic rubber	Percynic Chemicals, Bombay Silk Mills Bldg., Ind. Estate, Lalbaugh, Bombay 400 002 (1972)	N.A. N.A.	N.A. N.A.	102.00 T 115.79	50 T Non-exclusive
6.	Butyl titanate	Varnishes, enamels	(i) Synthochem, 33 A, Laxmibainagar Ind. Estate, Indore 452 006 (1973)	42.75 T 53.86	43.87 T 55.27	353.90 T 197.01	99 T Non-exclusive
			(ii) *Super Urecoat Industries Pvt. Ltd., F-11, Behind Nac Tiles, GIDC, Naroda 382 330 (1987)	- -	4.87 T 6.00	- -	Non-exclusive

1	2	3	4	5	6	7	8
7.	Calcium hypophosphite	Pharmaceuticals	Hypophosphite & Co. 79-F, Princess Street, Bombay 400 002 (1967)	6.00 T 6.00	6.00 T 6.00	200.00 T 155.30	24 T (including hypophosphites) Sponsored
8.	Can lining composition	Metal can industry	Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700 013 (1974)	- -	- -	6.34 T 2.10	500 Kg/day Non-exclusive
9.	Can sealing composition	Metal can industry	Arya Chemical Works, Calcutta (1962)	- -	- -	587.41 T 44.92	500 Kg/day Non-exclusive
10.	Catechol	Pharmaceuticals	Percynic Chemicals, Bombay (1972)	- -	- -	106.21 T 64.04	50 T Non-exclusive
11.	Cation exchange resin-styrene DVB base	Demineralization of liquids	Bharat Process & Mechanical Engineers Ltd., Dakhindari, Calcutta 700 048 (1969)	- -	- -	28662.18Cft 98.39	10000 Cft Non-exclusive
12.	Chlorobenzenes (MCB)	Industrial chemicals	Hindustan Organic Chemicals Ltd., PO : Rasayani (1976)	6989.00 T 954.00	7779.00 T 1061.83	48529.41 T 4885.38	7500 T Sponsored
13.	Citrate plasticizers tributyl/acetyl tributyl citrate	Plasticizers	Citroflex P. Ltd., Neville House, J. N. Herdia Marg, Bellard Estate, Bombay 400 038 (1985)	- -	2.60 T 1.15	664.00 T 116.00	1200 T Sponsored
14.	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
15.	Dihydroisojasmone and peach aldehyde	Perfumery chemicals	S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay 400 080 (1965)	1.07 T 5.86	0.57 T 3.15	61.62 T 21.07	2 T Non-exclusive

1	2	3	4	5	6	7	8
16.	Dimethoate	Pesticides	(i) Mico Farm Chemicals Ltd., Lotus Court, 165, Thambu, Chetty Street, Madras 600 001 (1979)	7.04 T 5.30	5.32 T 4.14	77.34 T 55.99	100 T Non-exclusive
			(ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979)	295.90 T 257.44	303.80 T 264.31	289.32 T 176.77	350 T Non-exclusive
			(iii) Khatau Junker Ltd., Plot No. 3000, GIDC Estate, P.B. No. 49, Ankleshwar 390 002 (1985)	150.00 T 101.00	- -	- -	300 T Non-exclusive
17.	Dimethylaniline (continuous process)	Industrial chemical	Navin Chemical Enterprises, Divn. of Mafatlal Industries Ltd., Devas 455 002 (1976)	520.00 T 229.00	722.00 T 289.00	3060.38 T 992.07	3000 T Sponsored
18.	Endosulfan	Pesticides	Bharat Pulverising Mills Pvt. Ltd., Shriniketan, 14 Queens Road, Bombay 400 020 (1980)	- -	- -	2300.00 T 2200.00	1200 T Non-exclusive
19.	Ethion	Pesticides	Shaw Wallace & Co. Ltd., Calcutta (1979)	87.32 T 77.71	102.95 T 91.63	153.06 T 113.01	150 T Non-exclusive
20.	Ethylenediamine	Bulk organic chemical	Diamines & Chemicals Ltd., The Bharat Vijay Mills Ltd. Premises, Kalol 382 712 (1982)	1508.00 T 964.00	1727.00 T 1146.00	1293.00 T 732.00	1800 T (ethylenediamine) and polyamines)
21.	Ethylene oxide condensates	Surface active agents	Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400016 (1965)	N.A. N.A.	N.A. N.A.	27404.14 T 7249.22	2500 T Non-exclusive
22.	Ferrites-Hard	Electronics	Dr. Shet Magnetics P. Ltd., 1069, V Block, 1st Floor, Rajaji Nagar, Bangalore 560 010 (1978)	-	N. A. 0.10	4.00 T 5.18	20 T Non-exclusive

1	2	3	4	5	6	7	8
23.	Ibuprofen	Drug	The Chemical Industrial & Pharmaceutical Laboratories Ltd., (CIPLA), 289, Bellasis Road, Bombay Central, Bombay 400 008 (1983)	20.76 T 202.16	0.70 T 5.92	Data not available	16 T (licensed) Sponsored
24.	Immoblized enzyme	Pharmaceutical	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018	-- --	-- --	2580.00 Kg N. A.	Captive consumption
25.	β-Ionone	Perfumery, intermediate for vitamin A	S. H. Kelkar & Co. Ltd., Bombay (1975)	0.29 T 1.54	0.29 T 1.58	2.86 T 12.29	4.4 T Non-exclusive
*26.	Jalshakti	Water absorbing polymer	Indian Organic Chemicals Ltd., Chemicals Division, Khopoli 410 203 (1986)	11.70 T 11.93	22.20 T 22.64	-- --	250 T Sponsored
27.	Maleic hydrazide	Agrochemical	Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur 458 001 (1978)	0.50 T 0.33	0.40 T 0.26	2.22 T 1.24	1 T Non-exclusive
28.	*p*- Menthane hydroperoxide	Synthetic rubber	Camphor & Allied Products Ltd., PO : Clutterbuckganj 243 502, Dist. Bareilly(1976)	5.58 T 3.35	9.16 T 5.50	231.00 T 133.64	60 T Exclusive
29.	Methyl chlorosilane	Intermediate	Hico Products Ltd., Bombay (1983)	N.A. N.A.	N.A. N.A.	1228.00 T 504.94	Collaborative Non-exclusive
30.	Monochloro acetic acid	Intermediate for weedicides, carboxymethyl cellulose, etc.	Hico Products Ltd., Bombay (1975)	N.A. N.A.	N.A. N.A.	3743.37 T 588.98	720 T Non-exclusive
31.	Monoethylaniline	Intermediate for explosive	The Atul Products Ltd., Atul 396 020, Dist. Valsad (1975)	45.80 T 17.86	118.30 T 46.14	865.21 T 306.40	150 T Non-exclusive

1	2	3	4	5	6	7	8
32.	1-Naphthyl acetic acid	Agrochemicals, plant growth regulator	Micro Chemicals (India), Mandsaur (1975)	1.00 T 0.10	0.90 T 0.09	5.10 T 5.01	1.50 T Sponsored
33.	Nicotine sulphate from tobacco and tobacco waste	Insecticides	Urvakunj Nicotine Industries, Petlad Cambay Road, Dharmaj 388 430, Dist. Kaira (1963)	-- --	-- --	1741.61 T 640.50	150 T Non-exclusive
34.	Nitrile rubber	Oil resistant rubber, formulations, adhesives	Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400 020 (1974)	653.00 T 151.90	801.00 T 270.26	6079.34 T 1001.01	2000 T
35.	*p*-Nitrophenol	Intermediate	Hundustan Organic ChemicalsLtd., PO: Rasayani (1978)	-- --	-- --	4.00 T 1.16	900 T Non-exclusive
36.	Nonylphenol	Surface active agent	Aniline Dyestuffs and Pharmaceuticals Pvt. Ltd., Mahalaxmi Chambers, 22 Bhulabhai Desai Road, Bombay 400 026 (1974)	-- --	-- --	178.73 T 25.31	1000 T Sponsored
37.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975)	14.73 T 451.75	18.08 T 476.13	54.89 T 281.76	20.61 T of various alkaloids (morphine codeine, narcotine, papavarine & thebaine)Exclulsive
38.	Perfumery products based on longifolene (capinone)	Prefumery	Caphor & Allied Products Ltd., Dist. Bareilly (1968)	19.50 T 56.26	12.67 T 36.55	205.87 T 298.65	50 T (for both capinone and meracene) Sponsored
39.	Perfumery products based on Δ3 carene (meracene)	Perfumery	--do--	7.41 T 8.78	4.65 T 5.97	129.18 T 71.70	--do--
40.	β-Phenethyl alcohol	Prefumery	Sunanda Aromatic Industries, Mysore-K.R.S. Road, Mettagalli P. O. Mysore 571 106 (1970)	-- --	-- --	1072.83 T 603.13	270 T Sponsored

1	2	3	4	5	6	7	8
41.	Phenthoate	Insecticides	Bharat Pulversing 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)	335.82 T 77.24	274.15 T 63.05	3459.71 T 626.02	600 T Non-exclusive
43.	Phthalates-octyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., 'D' Bldg., Shiv sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971)	2484.43 T 686.63	3208.64 T 1157.79	52273.09 T 8808.49	4050 T Non-exclusive
44.	Polyurethane coating	Coatings	Cipy Chemicals, 229, Rasta Peth, Pune 411 011 (1977)	-- --	-- --	14654.00 Ltrs. 6.09	30 T Non-exclusive
45.	Polyurethane printing rollers	Printing	Sree Saraswathy Press (1984) Ltd., 32, Acharya, P. C. Ray Rd., Calcutta 700 009 (1965)	-- --	-- --	662 Nos. 14.25	3000 Nos. Non-exclusive
46.	Quinapyramine sulphate/chloride	Veterinary drugs	Chintamani Fine Chemicals, S. No. 64/5 Bhide Baug, PO Vadagaon Budruk, Singhgad Road, Pune 411 041 (1982)	-- --	-- --	149.00 Kg 12.05	N. A. Non-exclusive
47.	D. C. Recording polarograph including potentiometric stripchart recorder for captive consumption	Polarographic analysis	Elico Pvt. Ltd., B-17, Sanathnagar Indl. Estate, Hyderabad 500 018 (1974)	27 Nos. 6.59	29 Nos. 7.54	195 + 3 Units 30.46	50 Units Non-exclusive
*48.	Rosin & turpentine oil derivatives	Rosin derivative	Dujodwala Resins & Terpentines Pvt. Ltd., 812/813 Tulsiani Chamber, Nariman Point, Bombay 400 021 (1986)	2466.00 T 573.00	3189.00 T 704.00	-- --	15000 T Sponsored

1	2	3	4	5	6	7	8
49.	Silica gel	Humidity control	Minco Products, 17, Thirwottyur High Road, Madras 600 081 (1963)	10.00 T 2.20	12.00 T 2.64	5000.20 T 25.32	12 T Sponsored
*50.	Sodium / Potassium ferrocyanides	Industrial chemicals	Hindustan Development Corporation Ltd., 'Kanchanjunga', 7th floor, 18, Barakhamba Road, New Delhi 110 001 (1986)	214.85 T 38.67	565.18 T 115.30	-- --	1250 T Non-exclusive
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)	3215.00 T 524.00	3492.00 T 493.18	14932.88 T 1286.90	2000 T Non-exclusive
			ii) The Anil Starch Products Ltd., P. B. No. 10009, Anil Rd., Ahmedabad 380 025 (1976)	1287.00 T 204.08	1711.00 T 213.91	5011.40 T 541.16	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 spectrophotometer / colorimeter	Biochemical research, spectroscopic analysis in visible range	Scientific Instruments Co. Ltd., B-1 Loni Rd., Industrial Area, Ghaziabad 201 007	33 Units 3.67	14 Units 1.70	261 Units 17.69	100 Units Non-exclusive
54.	Staple pin adhesive	Adhesive for staple pins	Esdee Paints, Near Power House, Kolshet Rd., Thane 400 607 (1979)	-- --	1071.00Lt. 0.78	9929.00 Lt 6.32	5000 Ltrs. Non-exclusive
55.	Terpineol	Perfumery	Dujodwala Industries Ltd., Tulsiani Chambers, 212, Nariman Point,	-- --	-- --	400.00 T 112.50	200 T Non-exclusive

1	2	3	4	5	6	7	8
*56.	Theophylline, aminophylline and caffeine	Pharmaceuticals	Pefco Foundry & Chemicals Ltd., Plot No. 10, Off Dr. Moses Rd., Worli, Bombay 400 018 (1986)	2.40 T 6.05	7.48 T 24.96	-- --	135 T Sponsored (pilot plant)
57.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate	Sudarshan Chemical Industries, 162, Wellesly Road, Sangam Bridge, Pune 411 001 (1977)	67.00 T 39.72	113.00 T 67.13	879.00 T 360.83	300 T Sponsored
58.	Vinblastin sulphate B. P./USP and Vincristine sulphate B. P. /USP	Pharmaceuticals	The Chemical & Pharmaceutical Laboratories Ltd., Bombay (1984)	874.40 gms. 55.31	2075.30 gms. 157.63	Data not available	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)	0.79 T 9.52	1.79 T 28.12	-- --	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

Note : The following processes had appeared in Table I of previous reports. As and when the production is reported on these items again they will be reported in Table I (i) Chloromethanes (ii) 4-Hydroxycoumarin and warfarin (iii) Phthalate–butyl octyl (iv) Radiosonde thermistors (v) Trichlorobenzene

VALUE OF PRODUCTION BASED ON NCL TECHNOLOGIES

Year	No. of items	Value of production (Rs. in lakhs)
1983-84	58	3685.16
1984-85	60	4703.84
1985-86	60	5251.80
1986-87	60	6728.39
1987-88	60	7975.74
		28344.93

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1986-88)

(Rs. in lakhs)

Type of industry	No. of processes in production	Value of production during 1986-87	Value of production during 1987-88
1. Public sector	9	2347.29	2676.45
2. Large scale private sector	24	2860.06	3397.95
3. Medium and small scale sector	27	1521.04	1901.34
	60	6728.39	7975.74

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.	Aniline	Organic intermediate	Hindustan Organic Chemicals Ltd., Rasayani (1973)	Non-exclusive	–
3.	Anisidine by liquid phase hydrogenation of nitroanisoles	Intermediate for dyestuffs	Amar Dye-Chem. Ltd., Rang Udyan, Sitladevi Temple Rd., Mahim, Bombay 400 016 (1974)	Sponsored	–
4.	Antioxidant TEDQ (2, 2, 4 trimethyl–6–ethoxy–1, 2–dihydroquinoline)	Rubber	–do– (1976)	Non-exclusive	–
5.	Atrazine	Herbicide	–do– (1978)	Non-exclusive	–
6.	Bromides	Photographic and allied chemicals	Dhrangadhra Chemical Works Ltd., 'Nirmal', 3rd floor, 241, Backbay Reclamation, Bombay 400 021 (1987)	Non-exclusive	Recently released
7.	1, 3–Butylene glycol	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpon. Ltd., Dist. Vadodara (1976)	Sponsored	–
*8.	Butyl titanate	Varnishes, enamels	Monopol Chemicals Pvt. Ltd., 901, Raheja Chambers, Nariman Point, Bombay 400 021 (1984-85)	Non-exclusive	Under implementation

1	2	3	4	5	6
9.	Camphene from pinene	Pharmaceuticals, perfumery	Dujodwala Resins and Terpenes Pvt. Ltd., Bombay (1978)	Sponsored	–
10.	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	–
11.	Chlorination of acetoacetamide	Industrial chemical	Colour Chem. Ltd., Ravindra Annexe, D. V. Road, 194, Churchgate Reclamation, Bombay 400 020 (1987)	Sponsored	Recently released
12.	Conversion of crotonaldehyde to maleic anhydride	Intermediate	Deccan Sugar Institute, Manjari, Pune 412 307 (1983-84)	Sponsored	Under implementation
13.	Carboxylation of ethanol to propionic acid	Intermediate	Deccan Sugar Institute, Pune (1983-84)	Sponsored	–
14.	Catalytic vapour phase oxidation of toluene to benzaldehyde	Intermediate for pharmaceuticals, perfumeries, etc.	Indian Organic Chemicals Ltd., Khopoli (1981)	Sponsored	–
15.	Chloroquin phosphate	Drug intermediate	I) Sudarshan Chemical Industries Ltd., Pune (1985)	Sponsored	–
			ii) Standard Organics Ltd., Saphire Bldg.,5-9-8812, Fateh Maidan, Hyderabad 500001 (1986-87)	Sponsored	Recently released
16.	Clonal multiplication of cardamom by tissue culture	Agriculture	i) A. V. Thomas & Co., 22, Marshells Rd., Egmore, Madras 600 008 (1984-85)	Non-exclusive	–

1	2	3	4	5	6
			ii) Cardamom Research Institute, Cardamom Board, Banerji Road, Cochin 682 018 (1984)	Non-exclusive	–
			iii) R. B. Thakur and Co. Pvt. Ltd., Clerk House, 8, Wade House Road, Bombay 400 039	Non-exclusive	--
17.	Chlorcrysanthamate	Pesticide intermediate	National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1986-87)	Sponsored	Recently released
18.	Dapson	Drug	CIPLA, Bombay (1984)	Sponsored	–
19.	Dextropropoxyphene hydrochloride	Drug	Centaur Laboratories, Kumar Engg. Compound, Kalina, Santacruze (East), Bombay 400 029 (1983-84)	Sponsored	–
20.	Diazepam	Anti-anxiety drug	Orion Chemicals, Mulchand Mansion, PrincessSt., Bombay 400 002 (1975)	Non-exclusive	–
21.	Dibutyl tin oxide	PVC stabilizers	Dura Chemical Corpn. Ltd., Wakefield House, 11, Sportt Rd., Ballard Estate, Bombay 400 038 (1977)	Non-exclusive	Under implementation
22.	DCVC acid chloride	Pesticide intermediate	Hindustan Ciba-Geigy Ltd., 14, Jamshedji Tata Road, P. B. 11015, Bombay 400 020 (1986-87)	Sponsored	Recently released
23.	Dichloropropionic acid (Dalapon)	Pesticides	i) Hico Products Ltd., Bombay (1975)	Non-exclusive	–
			ii) Jaydee Agrochemicals P. Ltd., Majwaji Ka Bagh, Moti Dugri Road, Jaipur 302 004 (1975)	Non-exclusive	–

1	2	3	4	5	6
*24.	Dimethoate	Pesticides	PNM Company, Thindal, Perundurai Main Road, Erode 638 009 (1978)	Non-exclusive	–
25.	Doxepin	Drugs	Pharmaceutical and Chemical Industries (PCI), 301, Arun Chambers, J. Dadajee Road, Tardeo, Bombay 400 034 (1985)	Sponsored	–
26.	Drag reducers for oil transportation	Petroleum industry	Oil Industry Development Board, 210, Ansari Bhavan, 16, Kasturba Gandhi Marg, New Delhi 110 001 (1985)	Non-exclusive	–
27.	DVO acid chloride	Intermediate	National Organic Chemical Industries Ltd., Bombay (1984-85)	Non-exclusive	–
*28.	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.
29.	Ethephon	Pesticides	i) Varson Chemicals Pvt. Ltd., 9th Mile, Hosur Rd., PO : Singasanda, Bangalore 560 068 (1978)	Non-exclusive	–
			ii) Sudarshan Chemical Industries Pvt. Ltd., Pune (1984-85)	Non-exclusive	–
			iii) Hycount Agro, Sherry Land, Quilon 691 005 (1984-85)	Non-exclusive	–
30.	Eucalyptus tereticornis by tissue culture	Forestry	A. V. Thomas and Co., Madras (1985)	Non-exclusive	Direct release (CSIR / NCL)
31.	Flematic skin oil	Veterinary drug	TTK Pharma P. Ltd., Old Trunk Road, Madras 600 043 (1984)	Non-exclusive	–

1	2	3	4	5	6
32.	Flexible magnets	Refrigeration gaskets, toys, educational kits	Dr. Shet Magnetics P. Ltd., Bangalore (1976)	Non-exclusive	–
33.	Hexachlorocyclo-pentadiene (HCCP)	Pesticides	Hindustan Organic Chemicals Ltd., Rasayani (1981)	Collaborative work	–
34.	IR spectrophoto-meter	Analysis	Dept. of Science and Technology, New Delhi (1985)	Sponsored	–
35.	Items having short shelf life	Sealants, adhesives	Hindustan Aeronautics Ltd. (Nasik Divn.), Ozar Townshop PO. Nasik 422 007 (1980)	Sponsored	–
36.	Ketoprofen	Drug	Pharmaceutical and Chemical Industries (PCI), Bombay (1985)	Sponsored	–
37.	1–Menthol from △3 carene	Perfumery	Bhavana Chemicals Ltd., Laxmi Insurance Bldg., Sir P. M.Rd., Bombay 400 001 (1978)	Sponsored	–
38.	Morpholine	Intermediate for rubber chemicals	i) Bombay Wire Ropes Ltd., Kavesar Village, Ghodbunder Road, Thane (1975)	Non-exclusive	–
			ii) Catalyst (India) P. Ltd., Embassy Centre, 10th floor, 207,Backbay Reclamation, Nariman point, Bombay 400 021 (1975)	Non-exclusive	–
39.	Multiplication of Napier grass by tissue culture	Agriculture	National Organic Chemical Industries Ltd., Bombay (1983-84)	Sponsored	–
40.	Multiplication of teak by tissue culture	Foresty	Forest Development Corpn. of Maharashtra Ltd., 6-A, Nawab Layout, Tilak Nagar, Nagpur (1981)	Sponsored	Under field trials

1	2	3	4	5	6
41.	Necelone (Amberone)	Perfumery	Comphor and Allied Products Ltd., 133, M. G. Road, Jehangir Bldg., Bombay 400 001 (1984-85)	Non-exclusive	Production likely to start by Dec. 1988
*42.	Nicotine sulphate	Insecticide	Kraun Fine Chemicals P. Ltd., 252/B, K. F. C. House, Sunlit Corner, Chikodi, (1983-84)	Non-exclusive	In trial production
43.	Nitrofen	Weedicide	Amar Dye-Chem. Ltd., Bombay (1978)	Non-exclusive	—
*44.	*p*-Nitrophenol	Intermediate	Catalyst (India) P. Ltd., Bombay (1975)	Non-exclusive	—
45.	Phenylglycyl chloride	Drug intermediate	Sudarshan Chemical Industries Ltd., Pune (1983-84)	Sponsored	—
46.	Polymeric materials based on CNS liquid	Low cost housing	Dept. of Science & Technology, New Delhi (1986-87)	Sponsored	Recently released
47.	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 400 020 (1981)	Non-exclusive	—
			(iii) Transpeck Industry Ltd., Kalali Road, Ataldra, Vadodara 390 012 (1983-84)	Non-exclusive	—
48.	Polysulphide sealant compound (Sp. by HAL, Nasik)	Sealants	(i) Rathi Rubber Products, Pune (1981)	Non-exclusive	—
49.	Polyurethane coating	Coating	Simple Coatings, Fahmeeda Manzil, Bhoipura, Bhopal (1984-85)	Non-exclusive	—

1	2	3	4	5	6
50.	Propylene oxide from propylene (extension to propylene glycol)	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Dist. Vadodara (1978)	Sponsored	—
51.	Silver paste for mica capacitor electrodes	Electronics	Laxmi Traders, Calcutta (1981)	Non-exclusive	—
52.	Simazine	Herbicide	Amar Dye-Chem. Ltd., Bombay (1978)	Non-exclusive	—
53.	Sodium sulphide	Various industries	Amar Dye-Chem Ltd., Bombay (1978)	Non-exclusive (technical aid)	–
54.	Substitute for side seam cement	Adhesive	Nand Industries, 324, Shaniwar Peth, Pune 411 030 (1978)	Sponsored	–
55.	Synthesis of basic drugs and intermediates	Drug intermediate	Dexo Laboratories P. Ltd., 6-3-348 Dwarakapuri Colony, Hyderabad 500 004 (1984-85)	Sponsored	–
*56.	Theophylline, aminophylline and caffeine	Pharmaceuticals	Neopharm Chemicals, 20/6 Mile Stone, Mathura Road, Faridabad 121 006 (1984-85)	Non-exclusive	–
57.	Thionyl chloride	Various industries	Dharamsi Morarji Chemicals Ltd., Prospect Chambers, 317/21, Dr. D. N. Road, Bombay 400 001 (1977)	Collaborative work	–
58.	Toluene disproportionation and transalkylation	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Vadodara (1985)	Sponsored	–
*59.	Vitamin B_6	Drugs	Themis Chemicals, Plot No. 69, GIDC, Vapi, (Dist. Valsad), Gujarat	Non-exclusice	–

* These processes have also been appeared in Table-I along with other licencees.

LIST OF 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 and polymerization 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 tetrachloride	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	–

A – Capital requirement less than Rs. 10 lakhs
B– Capital requirement between Rs. 10 lakhs & Rs. 20 lakhs
C– Capital requirement above Rs. 20 lakhs
These figures are tentative and purely indicative and are subject to revision from time to time

1	2	3	4	5	6
10.	Diazepam	Anti-anxiety drug	*p*-Nitrochlorobenzene, benzyl cyanide, dimethyl sulphate, iron powder and chloroacetylchloride	A	Released
11.	Dichloropropionic acid (Dalapon)	Weedicide	Propionic acid, chlorine and soda ash	C	Released
12.	Dimethoate	Pesticide	Phosphorous pentasulphide, methanol, monochloroacetic acid, methyl amine and caustic lye	C	Released , in production
13.	Endosulfan	Pesticide	Hexachlorocyclopentadiene, butenediol, thionyl chloride and epichlorohydrin	C	Released, process available on turn key basis through project engineers
14.	Ethylenediamine	Bulk organic chemical	Ethylene dichloride, ammonia and caustic soda	C	do
15.	Ethephon	Pesticide	Phosphorous trichloride, ethylene oxide, hydrochloric acid and sulphuric acid	A	Released
16.	Ethion	Pesticide	Phosphorus pentasulphide, ethyl alcohol, dibromomethane and caustic soda	C	Released , in production
17.	Eucalyptus by plant tissue culture	Forestry	–	–	–
18.	Ferrites-Hard	Electronics	Iron oxide, barium carbonate, additive and binder	B	Released, in production
19.	Gaskets from cork granules	Gaskets	Cork granules, nitrile rubber and rubber chemicals	A	Released
20.	Maleic hydrazide	Plant growth regulator	Maleic anhydride and hydrazine hydrate	A	Released, in production
21.	Methyl chlorosilanes	Basic material for silicon	Ferrosilicon and methyl chloride	C	Released ,in production

1	2	3	4	5	6
22.	Microfilters	Industrial filtration	Pulp, melamine and formaldehyde	A	Released
23.	Monochloroacetic acid	Intermediate for weedicides, carboxy-methylcellulose, etc.	Acetic acid, chlorine and catalyst	B	Released, in production
24.	Monochlorobenzene	Bulk organic chemicals	Benzene and chlorine	C	Released
25.	Necelone	Perfumery	Longifolene	A	Released
26.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	Tobacco/tobacco waste, lime, kerosene and sulphuric acid	A	Released, in production
27.	*p*-Nitrophenol	Intermediate for parathion and paracetamol	*p*-Nitrochlorobenzene, sodium hydroxide lye and hydrochloric acid	C	Released ,in production
28.	Phthalate-butyl octyl	Plasticizer in non-electrical application	Phthalic anhydride, butyl alcohol and 2-ethyl hexanol	C	Released , in production
29.	Phthalates-dibutyl/dioctyl	Plasticizers	Phthalic anhydride and butyl alcohol/ethyl hexanol	C	Released, in production
30.	Phthalates-dimethyl/ diethyl	Plasticizers	Phthalic anhydride and methyl/ethyl alcohol	C	-do-
31.	D. C. Recording polarograph	Polarographic analysis	Component parts and boxes	A	-do-
32.	Polysulphide liquid rubber	Adhesives, sealants, etc.	Ethylene chlorohydrin, *p*-formaldehyde, sodium sulphate,sulphur, sodium hydroxide and iron sulphide	A	--
33.	Polyurethane coating	Coating for leather, rubber wood, glass, etc.	Castor oil, toluene diisocyanate and solvents	A	Released, in production

1	2	3	4	5	6
34.	Quinapyramine sulphate and chloride	Veterinary drug	*p*-Aminoacetanilide, ethyl acetoacetate, ammonium acetate, dimethyl sulphate and guanidine carbonate	C	Released
35.	Radiosonde thermistors	Meteorology	Metallic oxides, platinum foil and components	A	Released, in production
36.	Rubber blowing agent	Rubber chemicals	Hexamine, sodium nitrite, hydrochloric acid and stabilizers	A	Released
37.	Silica gel (desiccant type)	Humidity control	Sodium silicate and sulphuric acid	A	Released, in production
38.	Silicon tetrachloride	Industrial chemical	Ferrosilicon, chlorine and hydrochloric acid	C	–
39.	Silver paste for mica capacitor electrodes	Electronic industry	Silver nitrate, acetone, caustic soda, glass and filler	A	Released
40.	Simazine	Herbicide	Cyanuric chloride and ethylamine	C	Released
41.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals and vitamin C synthesis	Dextrose monohydrate, hydrogen and catalyst	C	Released, in production
42.	Sorbitol (continuous process)	Pharmaceuticals	Dextrose monohydrate	C	Released
43.	Direct reading spectrophotometer/ colorimeter	Biochemical research and spectroscopic analysis in visible range	Components and boxes	B	Released, in production
44.	Sodium & potassium ferrocyanide	Pigments and textiles	Sodium cyanide/ ferrous sulphate	A	Released
45.	Staple pin adhesive	Adhesive for staple pins	Synthetic resin and solvent	A	Released
46.	Sugarcane by plant tissue culture	Agriculture	–	–	–

1	2	3	4	5	6
47.	Terpineol	Perfumery	Turpentine oil	B	Released (pilot plant available with NRDC)
48.	Theophylline, aminophylline and caffeine	Drugs (caffeine also used in beverages)	Dimethylurea, monochloroacetic acid, acetic anhydride	C	Released
49.	Thermistors	Temperature measurement and control electronic devices	Oxides of high purity components and binder	A	Released, in production
50.	Trichlorobenzene	Intermediate	Non-gamma BHC residue and caustic lye	B	Released, in production
51.	Turmeric by plant tissue culture	Agriculture	—	—	—
52.	Vinblastin sulphate & Vincristine sulphate	Drug	*Vinca rosea* leaves	C	Released
53.	Vitamin B_6	Drug	—	A	Released
54.	Xanthates-potassium ethyl and potassium amyl	Froth-floation	Ethyl/amyl alcohol, potassium hydroxide and carbon disulphate	A	Released

DATA ON NCL EXPENDITURE, RECEIPTS AND ACHIEVEMENTS

(1986-87 AND 1987-88)

	1986-87	1987-88
EXPENDITURE (Rs. in lakhs)		
1. Recurring	474.609	555.786
2. Capital	224.155	154.400
3. Pilot plant	0.479	—
	699.243	710.186
RECEIPTS (Rs. in lakhs)		
1. Receipts on account of sponsored projects	3.707	3.478
2. Analytical/testing charges	0.455	1.762
3. Institutional consultancy (CSIR share including know-how fee/job work)	5.580	10.021
4. Sale of laboratory products	0.692	0.457
5. Miscellaneous receipts	14.271	19.827
	24.705	35.545
ACHIEVEMENTS		
1. Total number of processes in production	60	60
2. Value of production based on NCL know-how (Rs. in lakhs)	6728.39	7975.74
3. Estimated saving in foreign exchange on account of above production (Rs. in lakhs)	2691.35	3190.30
4. Processes released and awaiting production		
(a) NCL processes	31	32
(b) Sponsored schemes	24	25
(c) Collaborative work	2	2
5. Total number of parties who have taken NCL processes	84	86
6. Total number of processes available for commercial exploitation	54	54
7. Number of processes released	7	2
8. Papers published	138	187
9. Papers presented/read at symposia, seminars, etc.	16	23
10. Doctorate and Master degrees received by NCL staff	28	(April 1986 to
11. No. of recognised guides for Doctorate and Masters degrees	51	March 1988)
12. Patents in force –		
(a) In India	77	87
(b) Abroad	23	21

CUMULATIVE DATA (1950-88)

EXPENDITURE (Rs. in lakhs)	
1. Recurring	4506.90
2. Capital **	1883.55
3. Pilot plant	97.42
	6487.87

RECEIPTS (Rs. in lakhs)	
1. Total money receipts	
(a)Total premia and royalties earned by NRDC through NCL processes	119.39
(b) Total receipts from sponsors	132.20
(c) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sale of laboratory products, Job work and other receipts	250.09
	501.68

ACHIEVEMENTS	
1. Total value of production based on NCL know how (Rs. in lakhs)	47,866.30
2. Total No. of papers published	4753
3. Total No. of papers presented / read at symposia, seminars	474
4. Total No. of degrees received	689

** 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 EXECUTIVE COMMITTEE
(1-10-84 to 31-12-87)

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4. Prof. G. S. R. Subba Rao, Chairman, Department of Organic Chemistry, Indian Institute of Science, Bangalore 560 012 — Member
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7. Dr. S. H. Iqbal, Scientist, National Chemical Laboratory, Pune 411 008 — Member Secretary
8. Administrative Officer, National Chemical Laboratory, Pune 411 008 — Member (Ex-Officio)
9. Sr. Finance & Accounts Officer, National Chemical Laboratory, Pune 411 008 — Member (Ex-Officio)

Permanent Invitees

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The Chariman, Coordination Council Chemical Sciences Group — Member (Ex-Officio)

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Technical Services Division of the NCL

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