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Director, National Chemical Laboratory,
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PREFACE

This report highlights the research work carried out at the NCL from April 1982 to March 1983. While in the sixties and early seventies short-term projects of immediate industrial relevance accounted for the major share of NCL's research efforts, in the late seventies these efforts were largely reoriented towards long-range projects of social and industrial significance. This, however, has not resulted in short-term projects being pushed to the rear or in weakening links between the laboratory and industry. On the contrary, these have become stronger as evident from the large number of sponsored and collaborative research projects being undertaken on behalf of user industries at the NCL.

Research at the NCL is made up of three well-defined components : short-range projects, long-range projects, and the basic research associated with the overall programme of the laboratory. During the year under review research at the NCL has been carried out in 13 areas. In each area NCL has been striving to maintain a high degree of excellence, using sophisticated tools and methods to achieve the R and D goals in keeping with the current international standards, and in doing so the established pattern of interdisciplinary approach has remained the corner stone of NCL's activities with equal emphasis on long-range and short-range projects.

Research and development activities

A 600 Kg. lot of butenediol catalyst was prepared at the NCL for Hindustan Organic Chemicals Limited, Rasayani, for their semi-commercial plant at Rasayani. The catalyst showed excellent activity. The process for the manufacture of this catalyst was demonstrated to United Catalyst India Ltd., Bombay.

During the year the entire technology for the manufacture of the drug, ketoprofen, one of the fast growing anti-inflammatory drugs was developed and demonstrated to the sponsors, viz. Pharmaceutical Company of India Ltd., Bombay. The firm is now taking steps to implement the technology at their chemical plant at Vapi.

Good work in the area of plant tissue culture continued to be done during the year. Thirty-two tonnes of virus-free sugar cane plants raised by tissue culture were supplied to the State Farming Corporation of Maharashtra for large-scale field trials. Two hundred plants were also supplied to Nimbkar Agricultural Research Institute, Phaltan, for field trials at their farms. Eleven virus-free banana plants of Robusta variety and fifteen cardamom plants raised by tissue culture were supplied to the Banana Research Station, Yawal, Jalgaon, Maharashtra and the Indian Cardamom Board, Kerala, respectively, for field trials.

Laboratory-scale investigations on the development of a suitable catalyst for the vapour phase oxidation of ethylene to ethylene oxide / ethylene glycol were continued. More than sixty silver based catalysts have been prepared and tested for their performance and a catalyst with the desirable characteristics has been obtained. A pilot plant is being set up under Engineers India Ltd. sponsorship to evaluate the catalyst under conditions as close as possible to those encountered in the industry.

Carbonylation of ethanol to propionic acid in the presence of an Rh complex catalyst was studied. The kinetics of the reaction has been established and a rate equation developed. A process for the manufacture of propionic acid has also been developed in which more than 95% selectivity for propionic acid can be achieved with near total conversion of ethanol. A pilot plant is proposed to be set up by the sponsors, Deccan Sugar Institute, Pune.

NCL has successfully developed High silica zeolites similar to those used by Mobil Oil Corporation, USA, for the disproportionation of toluene to benzene and xylenes. NCL is already in the process of signing an agreement with Indian Petrochemicals Corporation Limited, Baroda, for the development of the catalyst and process for the disproportionation of toluene.

The process for the manufacture of vinblastine sulphate was released to Chemical Industrial and Pharmaceuticals Pvt. Ltd. (CIPLA), Bombay. Trial experiments on its isolation from *Vinca rosea* leaves were carried out by the firm in their unit at Bangalore. The company is expected to introduce this drug in the market by early 1984. The conversion of vinblastine sulphate to vincristine sulphate was also accomplished and the process was passed on to CIPLA. Chintamani Fine Chemicals, Pune, commenced commercial production of quinapyramine sulphate/chloride (QSC) based on the technology developed

at the NCL. QSC is the drug of choice in the treatment of trypanosomiasis (commonly called 'SARA'), a dangerous and often fatal disease of domestic animals like cows, buffaloes, horses, camels, etc.

The 1600 TPA endosulfan plant installed by Hindustan Insecticides Ltd. at Udyogmandal based on the NCL technology was commissioned by NCL in collaboration with the company.

A laboratory-scale process for the preparation of necelone, a new speciality perfumery chemical, has been standardised and is now ready for commercialization. This aroma chemical has been evaluated and highly appreciated by perfumery firms both in India and in USA, and is now undergoing extensive consumer acceptance trials.

The collaborative programme of work between NCL and the University of Erlangen West Germany, in the area of complex reactions in three phase reactors was initiated during the year. The objective of the investigations is to examine the performance of slurry reactors which are commercially useful and which involve complex reactions.

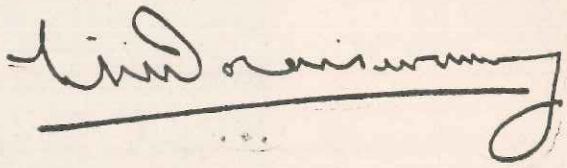
As mentioned earlier, basic work forms an integral component of NCL's research efforts. During the year, basic work of a high order was carried out in zeolite synthesis and characterisation, co-ordination and organometallic compounds, preparative organic chemistry, polymer science and engineering, catalysis and catalytic reaction engineering, synthesis of biologically active compounds, enzyme structure-function relationship, and synthesis of cyclopropane derivatives with miticidal activities.

Patents and publications

Nine new patents were filed during the year. Seventy-two Indian Patents (19 sealed, 4 accepted and 49 filed) and two foreign patents were in force as on 31-3-1983. One hundred and sixty-nine research papers were published during the year. Twenty-six staff members, research fellows and guest workers received post-graduate degrees that included 4 M. Sc., 1 M. Lib. Sc. and 21 Ph. D. Fifty-one NCL scientists are recognised as research guides by different universities.

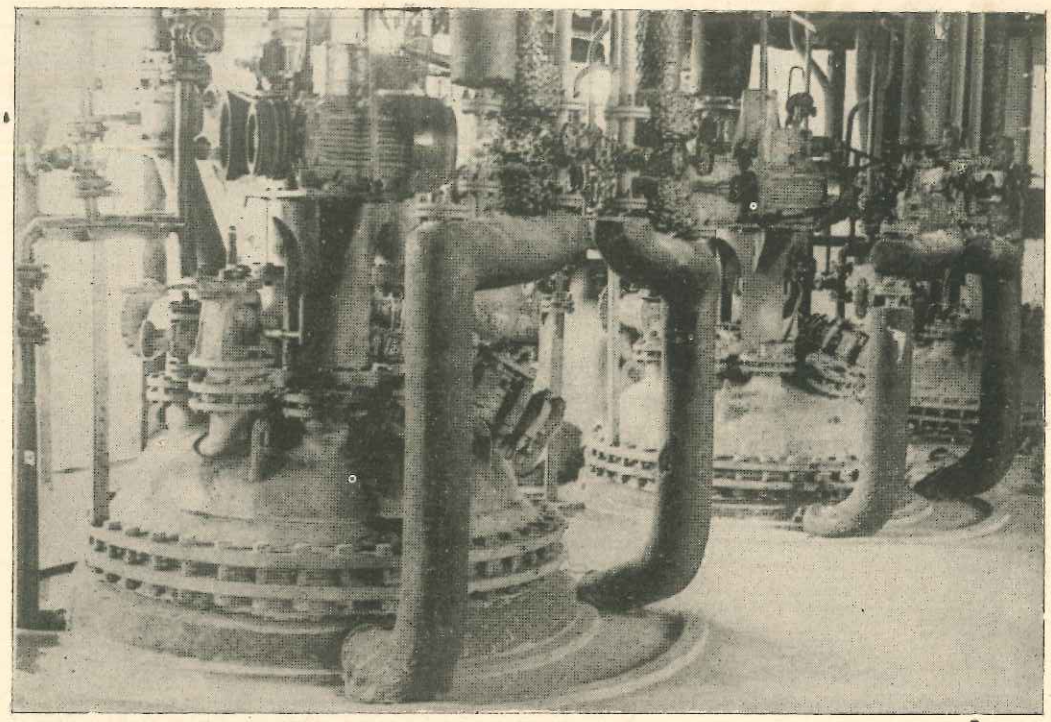
Research utilisation

During 1982-83, 58 NCL processes were in production with a turnover of about Rs. 30 crores. The foreign exchange saving on account of production during this period is estimated at about Rs. 12 crores.

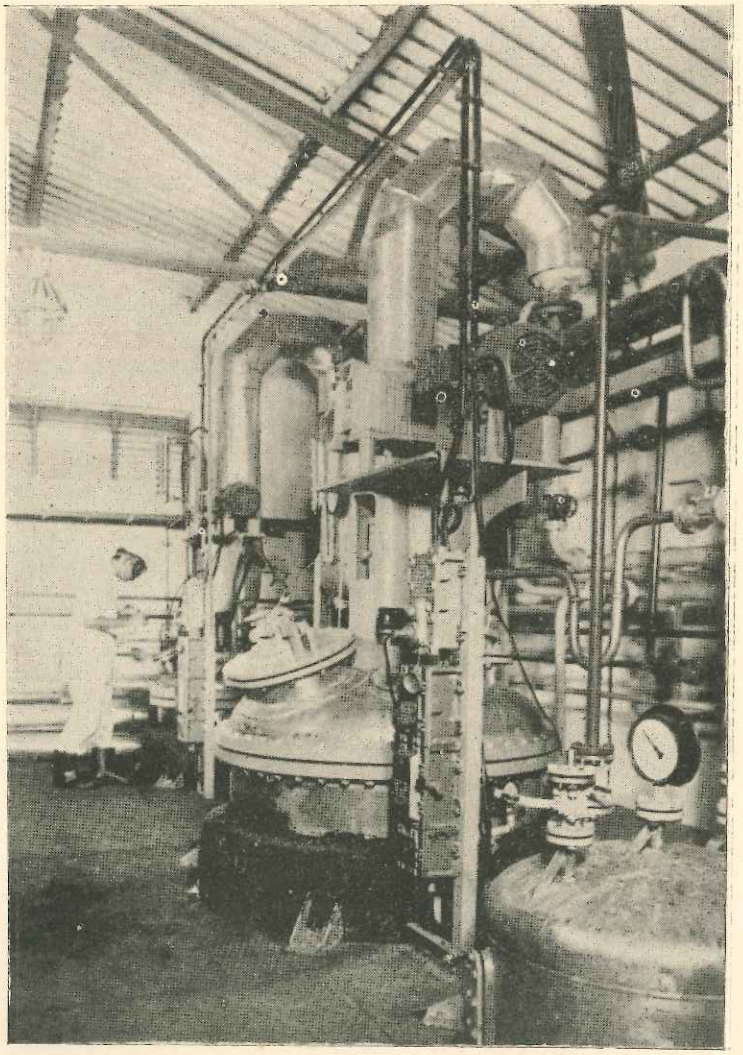


December, 1984
NCL, Pune

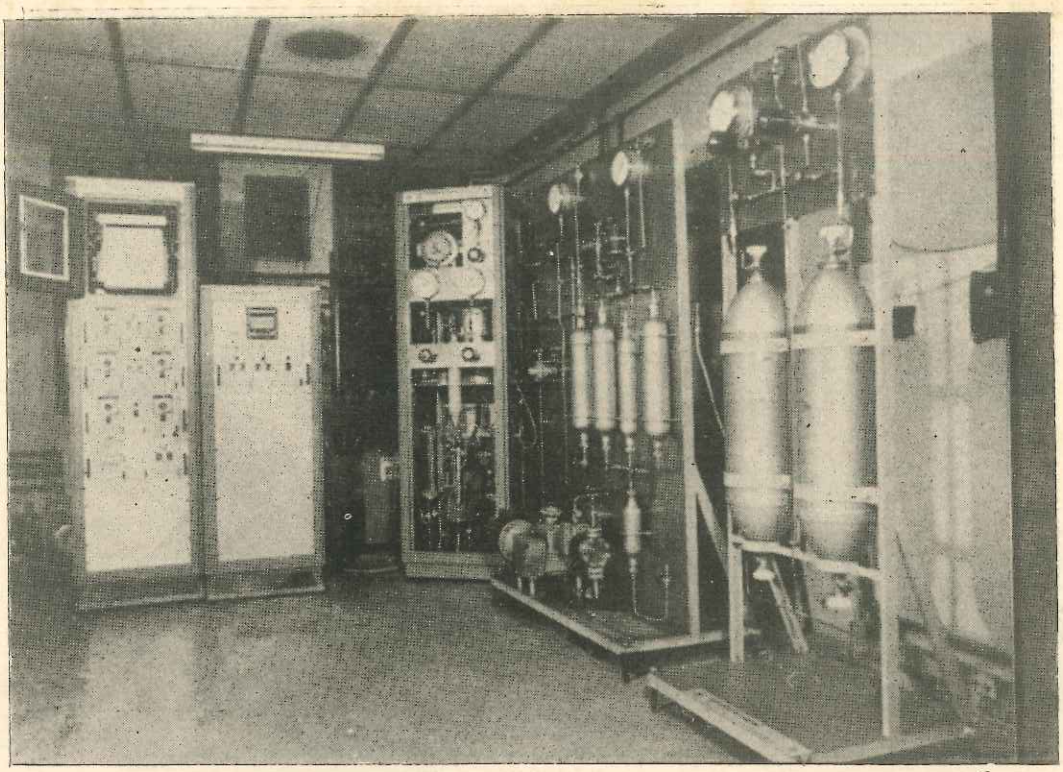
(L. K. Doraiswamy)
Director



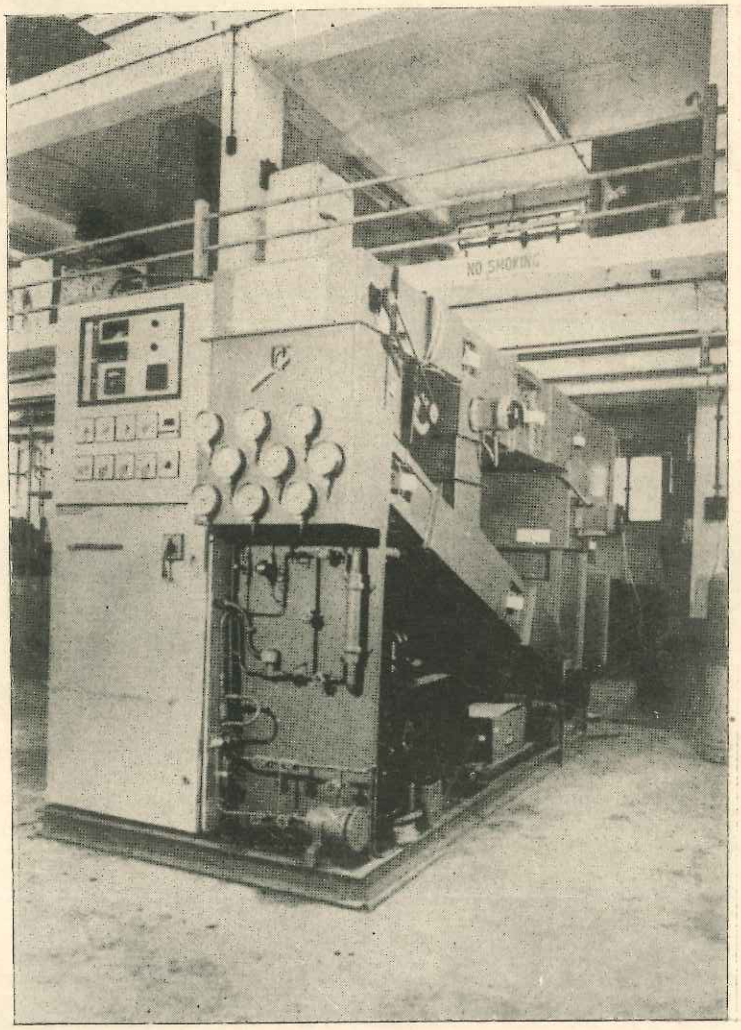
Theophylline, Aminophylline plant of Pefco Foundry and Chemicals Limited, Roha. Capacity : 135 TPA



Ibuprofen plant of CIPLA, Bombay. Capacity : 24 TPA



Catatest Unit for Evaluation of Zeolite Catalysts



Heat Pump project in collaboration with Salford University, U. K.

RESEARCH AND DEVELOPMENT PROJECTS

1. CATALYSIS AND CATALYTIC REACTION ENGINEERING

1.1 Vapour phase oxidation of ethylene to ethylene oxide/ethylene glycol : (1-1-467)

The laboratory scale investigations to develop a suitable catalyst were continued. More than sixty silver based catalysts have been prepared and tested for their performance in the oxidation of ethylene to ethylene oxide, and a range of catalysts with the desirable performance (75—80 percent selectivity for ethylene oxide at 9—12 percent conversion of ethylene) has been obtained. Additional work on new types of supports is in progress. A pilot plant is being set up to evaluate the catalyst under conditions as close as possible to those encountered in industry. The facility will be used to generate process information required for the design of large-size plants.

A simple low pressure mercury porosimeter was developed for measuring the pore size distribution (in the range of pore sizes 7-700 μm) on low surface area supports and the supported silver catalysts. The supports and the catalysts were characterised for their physico-chemical surface properties.

A gas chromatographic pulse technique for measuring the chemisorption of atomic and molecular oxygen on supported silver catalyst was also developed.

1.2 Carbonylation of ethanol to propionic acid : (1-2-067-Sp)

Carbonylation of ethanol to propionic acid in the presence of an Rh complex catalyst was studied. The kinetics of the reaction has been established and a rate equation developed. The active catalytic species has been isolated as a derivative with triphenylphosphine and characterised as Rh (CO) $(C_2H_5)I_2$.

A process for the manufacture of propionic acid has also been developed in which more than 95 percent selectivity for propionic acid can be achieved with near total conversion of ethanol. This is a unique process for manufacture of propionic acid in India, in view of the current emphasis on ethanol based chemicals. Work on optimization of process conditions, separation of the product, catalyst recycling and recovery has been completed. A pilot plant is proposed to be set up by the sponsors, Deccan Sugar Institute, Pune, at Manjri (Maharashtra).

1.3 Carbonylation of nitrocompounds to isocyanates : (1-3-267-i)

Carbonylation of nitrocompound is a single-step method for the manufacture of isocyanates, and has several advantages over the conventional phosgenation method. A detailed screening of the Pd complex catalysts for the carbonylation of nitrobenzene to phenyl isocyanate has been completed. It has been observed that Pd complexes with N-containing heterocyclic compounds as ligand catalysts [e. g. Pd $(Py)_2$ Cl_2, Pd $(isoquin)_2$ Cl_2] are the most suitable. The kinetics of carbonylation of nitrobenzene to phenyl isocyanate on Pd $(Py)_2$ d_2 catalyst also has been studied.

Carbonylation of 2, 4 dinitrotoluene to toluene diisocyanate on Pd and Rh complex catalysts has been studied. The isocyanate selectivity has been found to be dependent on Py/Pd ratio, and an optimum ratio exists for a given set of conditions. For the first time, the intermediates, mononitroisocyanate-*o*-nitro-*p*-isocyanates toluene and *p*-nitro-*o*-isocyanate toluene, have been identified and characterised. The work on characterisation of the Rh complex catalyst $[Rh(Py)_3Cl_3]$ has been completed and its structure determined by X-ray crystallography.

1.4 Polymer bound homogeneous catalysts: (1-4-256)

Preparation of different rhodium and palladium complexes and binding them to the polystyrene divinylbenzene beads was carried out. The chloromethylated beads obtained from Tulsi Fine Chemicals were phosgenated, and Wilkinson Complex was bound to them, and the bound complex tested for the hydrocarbonylation reaction of allyl alcohol. Palladium bound complexes were tried in the car-

bonylation reaction to convert nitrobenzene to urethane and were tested for hydrogenation of B_3D, B_2D, etc. Preparation of pyridine bound polymer to which the palladium complex will be bound is in progress. Analysis of the complexes by IR has been carried out.

1.5 Catalytic reactions over synthetic high silica zeolites: (1-6-046)

The zeolite catalysts developed at NCL are similar to those used by Mobil Oil Corporation, USA, in their process for disproportionation of toluene to benzenes and xylenes. More than 80% of the petrochemical plants in the world use the Mobil process which converts the less valuable and abundant toluene into more valuable benzenes and xylenes using ZSM-5 catalysts. NCL is already in the process of signing an agreement with IPCL, Baroda, for the development of the catalyst and the process for the disproportionation of toluene.

Negotiation for testing and evaluation on bench and pilot plant scales for possible collaboration for joint development and commercialization of zeolite catalyst are in progress with reputed international companies as well as Indian firms.

1.6 Adsorption and diffusion in high silica zeolites: (1-7-046)

A new gas chromatographic adsorption/desorption method for measuring the adsorption isotherms on narrow pore zeolites has been developed, and adsorption of benzene on H-ZSM-5 zeolite has been measured under reaction conditions. A new gas chromatographic technique based on dynamic desorption has been developed for measuring the kinetics of desorption of hydrocarbons and/or measuring the two component diffusion in H-ZSM-5 under reaction conditions.

A simple apparatus for measuring rates of penetration/sorption of liquid hydrocarbons in the empty channels of narrow pore type zeolites has also been developed and extensive studies on the single component diffusion of a number of liquid hydrocarbons, alcohols and organic bases in H-ZSM-5 zeolite at different temperatures have been carried out. Effect of Si/Al ratio, degree of cation exchange, various pretreatment parameters and poisoning of stronger acid sites by pyridine on the diffusion have also been investigated.

1.7 Butenediol : (16-8-007)

The performance of the catalyst samples received from ACC, Thane, and UCIL, Bombay, was tested in the reactor. A new method to test the catalyst using ESCA and scanning electron microscopy has been developed. With this technique a number of catalyst samples can be tested for their suitability, thus avoiding the regular tests which are time consuming.

A 600 kg lot of butenediol catalyst was prepared at NCL for HOC for their semicommercial plant at Rasayani. The catalyst showed excellent activity.

A demonstration of the preparation of the above catalysts was made to UCIL, Bombay.

1.8 Structural and catalytic properties of transition metals and its oxides :(1-11-247)

1.8.1 Ethyl benzene to styrene : Over the past thirty years catalytic dehydrogenation processes have risen to a position of major importance. Styrene is being manufactured commercially by catalytic dehydrogenation of ethyl benzene. Considerable research has gone into the improvement of the activity and the selectivity of catalysts for the conversion of ethyl benzene to styrene. An increase of 1 or 2% in the selectivity can result in a substantial saving of starting material while increase in conversion can considerably reduce the capital expenditure.

Keeping the above in mind, three new non-zeolitic, non-supported, potassia-promoted-chromia-stabilized iron oxide catalysts were prepared by the wet mixing of ferric oxide (prepared from anhydrous ferric chloride) potassium chromate and potassium carbonate. Selectivity and conversion on the catalyst were found to be 92.75% and 45.99% respectively. Catalyst pellets sintered at a higher temperature gave poor conversion and selectivity. Addition of cerium oxide and molybdenum oxide has been reported to have a beneficial effect on the activity and selectivity of steam-active alkalized iron oxide catalyst. A new catalyst containing cerium was prepared and tested for several days. It gave a conversion of more than 64% and a selectivity of more than 95%. Although the conversion and selectivity are quite good, the crushing strength of the catalyst pellets is poor. Work is in progress to improve the crushing strength.

1.8.2 4-Ethyl toluene to 4-methyl styrene : Manufacture of vinyl toluene is analogous to that of styrene in which toluene is substituted for benzene.

Since the end of the Second World War, toluene has been easily available because of greatly reduced demand for military purposes. Styrene has enjoyed a special position among vinyl aromatic monomers because of the absence of isomers. Additional steps are normally required to make substituted styrene derivatives, and separation and purification of isomers are usually difficult.

A few experiments were carried out to convert 4-ethyl toluene to 4-methyl styrene using an industrial catalyst. A conversion of 16% and a selectivity 98% were obtained. A new catalyst was also prepared and tested. A maximum conversion of 50.8% and a selectivity 85.5% were obtained with this catalyst.

1.9 Studies on complex reactions in three phase reactors : (1-12-006)

The collaborative programme of work between NCL and the University of Erlangen, West Germany is centred on certain aspects of complex reactions in three phase reactors. A model system for the complex consecutive reaction, viz. hydrogenation of phenylacetylene first to styrene and then to ethyl benzene was chosen for the current study. The effect of various parameters such as catalyst loading, hydrogen pressure, substrate concentration and agitation speed on the concentration profile and the initial rates in a batch reactor was studied. For the analysis of the complex consecutive reactions in a slurry reactor, a general computer programme using a single point and a nine point collocation method was developed considering the simultaneous diffusion and reaction of all the species within a particle.

1.10 Catalytic applications of metal complexes, with particular emphasis on conversion of CO to chemicals : (1-13-267)

1.10.1 Metal clusters anchored to inorganic supports: Of the many emerging facets of transition metal chemistry, none is more facinating than that of polynuclear metal clusters, those that contain two or more metal atoms bonded to one another as well as to other nonmetallic elements. The use of such clusters as catalysts for important organic reactions, particularly for coal based C_1 chemistry, is being explored. However, recent reports show that most of the clusters break down during the course of reaction and that more efficient catalysts can be made by anchoring the clusters to inorganic matrices. With this end in view $Rh_6(CO)_{16}$ and $Ru_3(CO)_{12}$ have been anchored in this laboratory to a number of inorganic matrices, viz., aerogel-200, zeolite (SL-153), gamma-alumina, magnesium oxide, titanium dioxide and zirconium dioxide.

Varying degrees of success have been reported in the attempts to incorporate metal complexes in polymers containing chelating groups of various sizes and donor sets. The rhodium and ruthenium complexes, viz. $Rh_6(CO)_9(P)_3(O)_4$ and $Ru_3(CO)_{10}(P)_2$ (where P=silanated phosphine), were prepared and their IR spectra studied. ESCA studies gave binding energies of 309 ev ($3d_{5/2}$) and 314.4 ev ($3d_{3/2}$) for Rh, indicating the zerovalent state of Rh.

The results of work of this group on ferrocenyl aroyl hydrazones and their copper and tin complexes were recently reported in Inorganica Chim. Acta. Attempts are now being made to prepare a heterometallic complex of the type $Fe_2M(C_{38}H_{34}N_4O_4)xH_2O$ [where M=Ni (II), Co (II), Mn (II), Fe (II), Ru (II), Fe (III)]. The aroyl hydrazone used in the present study is salicyloyl hydrazone. Further work on the preparation of ferrocenyl heterometallic complexes will be carried out. Some of these metal complexes may find use as precursors in the preparation of heterometallic catalysts.

Mixed metal carbonyl clusters of the type $RuFe(CO)_{12}$, $RuFe_2(CO)_{12}$, $H_2Ru_2Fe(CO)_{13}$ have been isolated and their IR studies carried out. ESCA of these compounds could not be recorded due to to their instability.

Further investigations on the synthesis of bimetallic clusters and supporting them and transition metal complexes on various supports, as well as on the use of these catalysts along with ZSM-5 zeolites for FT synthesis will be carried out with a view to developing FT catalysts that are more selective than the conventional ones.

1.10.2 The upgrading of coal liquids : Studies on the determination of high-pressure reaction networks and kinetics of catalytic hydroconversion of aromatic hydrocarbons and sulphur and nitrogen containing compounds in liquids derived from coal are under way. The ultimate objective of these studies is to upgrade coal derived liquids (CDL) and render them useful as a source for conventional fuel or as chemical feed stock. A number of experiments were carried out in the CATATEST unit in the hydrogenation of mixtures of aromatic compounds containing

toluene or xylene, naphthalene and/or quinoline using two different alumina-supported cobalt-moly catalysts and one nickel-moly catalyst. Similar experiments are also being carried out with CDL obtained from the Central Fuel Research Institute. Different parameters, viz. temperature, hydrogen gas pressure, hydrogen gas flow rate and LHSV have been studied with respect to hydrodenitrogenation (HDN), isomerization and cracking.

1.11 Basic studies

1.11.1 Hydroformylation of allyl alcohol is a new route for the manufacture of 1, 4 butanediol. Work on catalyst screening and product distribution has been completed and a selectivity of 70% has been achieved for n-hydroxybutaraldehyde. Further the kinetics of the hydroformylation reaction has been studied using HRh (CO) $(PPh_3)_3$ complex catalyst. In a certain range of CO pressure the rate is significantly affected by slight changes in pressure. This parametric sensitivity is a new observation and is being investigated further.

1.11.2 Synthesis of complex catalysts of Rh, Ir, Pt and Ru containing phosphine and CO [viz. Rh(CO) Cl $(PPh_3)_2$, Ir(CO) Cl $(PPh_3)_2$, Ru $(CO)_2$ $(PPh_3)_2$ $(Cl)_2$, Pt-PPh_3] was undertaken. Screening of the above catalysts for their activity and selectivity in the hydroformylation of allyl alcohol, vinyl acetate and allyl acetate, and subsequent product characterisation were undertaken.

1.11.3 A mathematical model that incorporates the transformation on the surface of a catalyst has been developed to show that such a transformation can cause a change in the stability of the catalyst. The model, especially applicable to oxidation reactions, indicates unstable operation even for reactions following the Eley-Rideal mechanism. No other model reported in the literature so far can predict this phenomenon.

1.11.4 Dynamics of coupled CSTR operating under different stability conditions has been investigated theoretically. The simple model proposed serves to provide guidelines for analysing more complex fixed-bed reactors.

1.11.5 A new set of transformations that converts the original two-point boundary value problems into equivalent initial value problems has been proposed and demonstrated for complex reactions in bidispersed catalyst pellets. The transformations considerably facilitate the computation of catalyst effectiveness.

1.11.6 Methods of weighted residuals, the Galerkin method in particular, have been used to obtain solutions to some practically important problems in bidispersed catalysts. The specific situations analysed include catalyst deactivation, nonisothermicity and variation of transport parameters with the internal field. The conventional numerical techniques are inapplicable in such cases and the present method yields simple solutions without excessive computations.

1.11.7 Mathematical models of chemically reacting systems that take into account the fluctuations in the microscopic environment have been developed. The role of fluctuations in reacting systems near the bifurcation point has been investigated.

1.11.8 The quantitative characterisation of catalytic activity is of tremendous importance in the tailor-making of industrial catalysts. The extent to which the catalytic activity of an industrial catalyst is mirrored in its adsorption properties is the main interest of these studies.

The first step in quantifying catalytic activity is the determination of the site energy distribution (using the random patch model) and the many studies in this direction have yielded some useful information. It will be possible with this to predict and control selectivity and the region of operating pressures needed to achieve a desired selectivity. These studies can also be useful in dealing with situations where interactions exist between adsorbed molecules, or the adsorbed phases are mobile, or two different types of active sites are present (bifunctional catalysts). The latter is, of course, essential in analysing catalysts employed in reforming and platforming.

In oxidation reactions where the hydrocarbon is weakly chemisorbed, one can demonstrate the effect of nonideal collisions between gas and adsorbed phases on the rates. The consequences of this effect in determining the dynamics of the fixed bed reactor are currently being studied.

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2. COORDINATION AND ORGANOMETALLIC COMPOUNDS

2.1 Synthesis of new carbonyl compounds of rhodium and ruthenium : (2-4-023)

Chelated carbonyl complexes of the type $Ru(CO)_2(L)_2$ (bipy or phenan), $Ru(CO)_2Cl_2.2LPPh_2$, $Ru(PPh_3)_2(CO)_2$. LH, $Ru(CO)_2Cl_2[LS]_2$, $Rh(CO)(PPh_3)_2$ (L) and $RhCl[PPh(L)_2]_2(CO)$ where LH is a bidentate chelating ligand such as β-diketones, α-hydroxyaldehydes and ketones, 8-hydroxyquinoline, etc., have been synthesized. Their properties, including spectral characteristics, have been determined.

Studies using syngas : The reaction of carbon monoxide and hydrogen over rhodium or ruthenium catalyts was studied in a special reactor at atmospheric pressure. A mixture of hydrocarbons or oxygenated compounds was obtained, the mixture composition depending on the catalyst support employed. The results have been encouraging. It has been observed that the activity of carbon monoxide adsorbed on active charcoal can reduce the time taken for the addition of carbon monoxide to rhodium and ruthenium compounds.

2.2. Basic Studies

2.2.1 Basic studies in structural inorganic chemistry : (0-38-24)

In continuation of the previous work several platinum complexes of the type, $Pt(II)L_2$, $Pt(II)L_2M_2$, PtLX' and Pt (IV) LXY (where L = mono- or bidentate organic ligand containing nitrogen donor atoms; X = Cl or Br, X' = malonate or oxalate; Y = Br) have been synthesized and characterised from their elemental analysis, IR and X-ray photo electron spectral data. The Pt $4f_{7/2}$ binding energies indicate that 1, 8 -naphthalenediamine ligand is a better donor of electron density to the metal than the other ligands studied. The Cl $2p_{3/2}$ binding energies in the square planar Pt(II) complexes are observed in the range 198.8±0.8 eV. The ν(Pt-Cl) vibrations corresponding to two Cl ligands in *cis*-arrangement in the IR spectra of the platinum complexes have been located at about 335 and 320 cm^{-1}.

X-ray photoelectron spectra of several solid organotin (IV) and tin (II) chelates with substituted-8 quinolinols have been recorded. An Sn $3d_{5/2}$ binding energy range of 2.96 eV has been found. Qualitative analysis of the results has shown that there seems to be no apparent correlation between Sn 3d binding energies and the coordination number or the oxidation state of tin in these compounds. There is, however, a general correlation between ESCA binding energies and Mossbauer isomer shifts.

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3. DRUGS AND DRUG INTERMEDIATES

3.1 Vinca alkaloids : (3-1-003N-Sp)

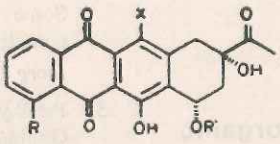
The process for the manufacture of vinblastine sulphate was released to CIPLA, Bombay. Trial experiments for its isolation from *Vinca rosea* leaves were carried out by them at their pharmaceutical unit in Bangalore. Further, they have also worked out a method of sealing vinblastine sulphate in vials. The vials have been clinically tested. The Company is expected to introduce these vials in the market by early 1984.

The conversion of vinblastine sulphate to vincristine sulphate was also accomplished and the process was passed on to CIPLA.

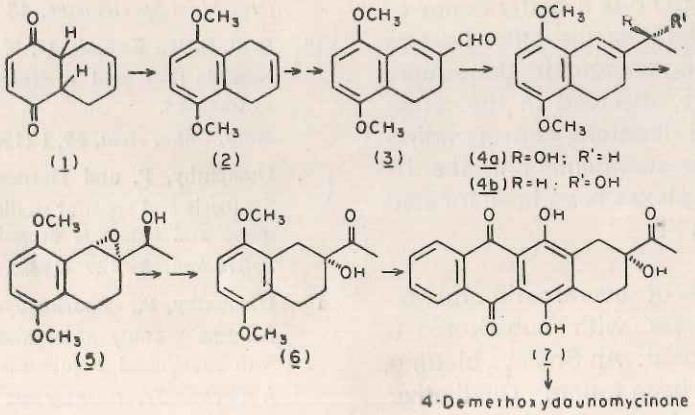
3.2 Anti-tumor anthracyclines : (3-2-013N-Sp)

In the earlier reports, various methods of synthesizing 4-demethoxy-daunomycinone were reported. In addition a number of alternative approaches have been worked out for the total synthesis of 4-demethoxy-daunomycinone as well as L-daunasamine, the desired amino sugar.

Although numerous syntheses of anthracyclinones have been achieved, a new approach to the assemblage of the tetracyclic system of AB+CD coupling by making use of the key intermediate 2-acetyl-2-hydroxy-5, 8-dimethoxy-1, 2, 3, 4-tetrahydronaphthalene (**6**) has proved most practical. Consequently several methods have been developed for the synthesis of **6** and this was resolved to obtain optically pure (−)-**6**. A practical and convenient method has now been developed for preparing R-(−)-**6** via Sharpless asymmetric epoxidation (kinetic resolution method) by making use of racemic allylic alcohol (4), prepared from benzoquinone as indicated. The undesired antipode (4**b**) is then epimerized and recycled. This new approach is exceptionally simple and easy to operate for the synthesis of a variety of aglycones in optically active form.



	R	R'	X
Daunomycin	OMe	daunosaminyl	OH
4-Demethoxydaunomycin	H	daunosaminyl	OH
11-Deoxydaunomycin	OMe	daunosaminyl	H
Daunomycinone	OMe	H	OH
4-Demethoxydaunomycinone	H	H	OH
11-Deoxydaunomycinone	OMe	H	H



A flexible and regiospecific synthesis of (±) — daunomycinone and (±) 11-deoxydaunomycinone has been completed starting from a common synthon which was obtained in a seven-step synthesis from *m*-cresol. This approach has been reported for the first time and is more flexibile for the preparation of a variety of anti-tumor anthracyclinones.

3.3 Various receptor drugs and their intermediates : (3-7-003N-Sp)

3.3.1 Anti-inflammatory agents : Earlier, work was initiated on ibuprofen under the sponsorship of CIPLA, Bombay, to find a feasible process for its commercial production. More than half a dozen synthetic routes have been worked out and the best method, which is also the most economical, has been passed on to the sponsor. Pilot plant trials have been carried out at their Vikhroli unit and regular production is expected to commence from December 1983.

Laboratory work has been undertaken for the synthesis of naproxen. The emphasis is on finding alternative and economically viable routes for this important analgesic and anti-inflammatory drug.

3.3.2 Dapsone : Earlier, a two-step methodology for the manufacture of dapsone was worked out and passed on to the sponsor. However, in view of some delay in procuring pressure reactors, etc., an alternative approach has also been worked out. This is now being optimized.

3.3.3 Beta-blockers : New synthetic approaches to some of the recently introduced β-blockers have been made. Methodology for the synthesis of atenolol and labatolol have been optimized on laboratory scale.

3.4 Synthesis of nucleosides and c-nucleosides: (3-8-003 S)

A convenient route has been developed for the preparation of uracil, 6-methyluracil and a few substituted uracils. The transformation of uridine to 2' deoxyuridine, an intermediate for the synthesis of some antiviral drugs, has been investigated.

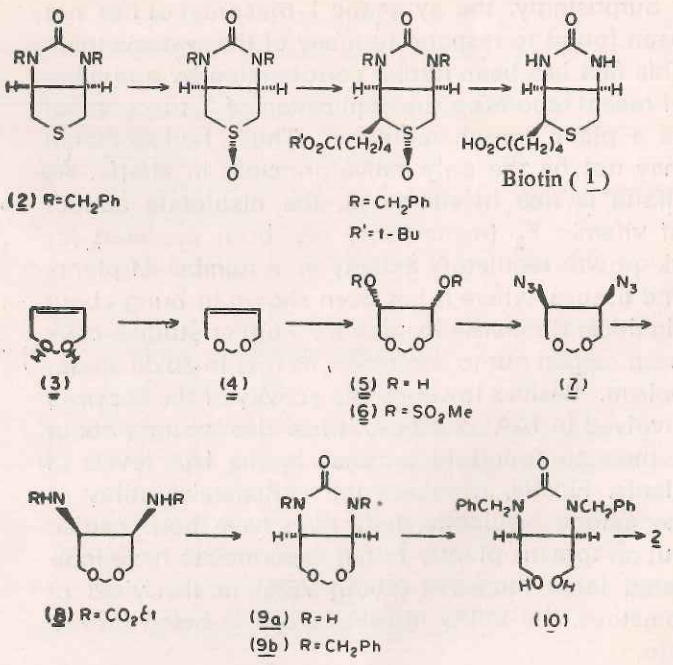
3.5 Synthesis of ketoprofen : (3-11-003N-Sp)

Ketoprofen is one of the fast growing anti-inflammatory drugs. The entire technology for the manufacture of this drug from *m*-toluic acid has been developed and demonstrated to the representative of the sponsor, the Pharmaceutical Company of India Ltd., Bombay. The firm is now taking steps for implementing this technology at their chemical unit at Vapi.

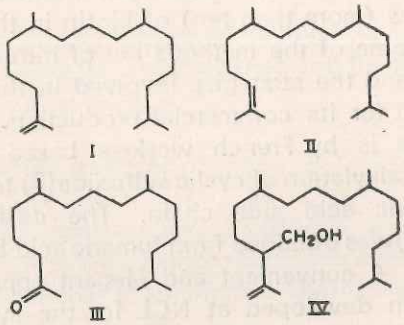
3.6 Synthesis of biologically active compounds: (3-12-03N7)

3.6.1 Biotin : (3-12-03N7-i) With the recent recognition of the importance of biotin (1) in food and nutrition, the interest of many synthetic organic chemists in this member of vitamin B complex has been revived. This has resulted in numerous elegant syntheses (more than ten) of biotin in the past few years. Some of the methods are of industrial significance and the strategies involved in them can be exploited for its commercial production. One such synthesis is by French workers based on stereo selective alkylation of cyclic sulfoxide (3) to introduce the valeric acid side chain. The desired cyclic sulfide (2) was obtained from fumaric acid by classical methods. A convenient and elegant approach has now been developed at NCL for the synthesis of (2) starting from *cis*-but-2-ene-l, 4-diol (see Scheme 2). The highlight of this new approach is an efficient one-step conversion of the diurethane (8) to the imidazolidone (9a) or its dibenzyl ether (9a) at will. The method is of general utility in the conversion of vicinal diamines to imidazolidone.

Scheme 2.



3.6.2 Vitamin E : (3-12-03N7-ii) Norphytene (1) and its isomer (2) have been synthesized using citronellal enamine, meldrum acid and TosMIC (Tosymethylisocyanide). In this synthesis norphytene is converted to phytone by oxidation or ozonolysis, while its isomer is converted to phytone (3) by Prins reaction to (4) followed by ozonolysis, Jones oxidation and heating. Phytone is an intermediate for isophytol. Norphytene, when subjected to Prins reaction gives four products of which phytol is one. Identification of the other products is in progress.



3.6.3 Vitamin B_6: (3-12-03N7-iii) The laboratory process for the manufacture of Vitamin B_6 has been released to Lupin Laboratories Pvt. Ltd., Bombay, through NRDC for commercial exploitation.

3.7 Plant growth regulators : (3-14-003N)

Surprisingly, the synthetic 1-triacontanol has not been found to respond to many of the systems tried. This fact has been further corroborated by a number of recent reports on the application of 1-triacontanol as a plant growth regulator. Thus, 1-triacontanol may not be the only active principle in alfalfa. As alfalfa is rich in vitamin K, the bisulphite adduct of vitamin K_3 (menadione) has been assessed for its growth regulatory activity in a number of plants and tissues, where it has been shown to bring about significant increase in growth. Further studies have been carried out to determine its role in auxin metabolism. Besides lowering the activity of the enzymes involved in IAA oxidation, it has also brought about a three to four fold increase in the IAA levels of plants. Finally, to assess the commercial utility of menadione bisulphite, field trials have been carried out on tomato plants. Initial experiments have indicated large increases (about 75%) in the yield of tomatoes. Its utility in other crops is being looked into.

3.8 Calcium channel blockers–Verapamil : (3-15-003N-Sp)

Lately, increased attention is being focussed on calcium channel blockers, besides various beta blockers. They act by inhibiting the contraction of smooth muscle in the valves of coronary arteries and causing them to expand. This increases the blood supply to the heart. In this class of drugs, verapamil has a good market in this country and, at present, formulations are prepared from the imported basic drug. Under the sponsorship of Centaur, Bombay,an elegant and economically viable approach has been initiated for the synthesis of this important calcium channel blocker and good progress has already been made.

3.9 Synthesis of basic drugs and intermediates : (3-16-003N-Sp)

Pyrazinamide is one of the important anti-T.B. drugs and most of it is being imported or made from imported pyrazine-carboxylic acid. One of the time-honoured methods of its manufacture is from quinoxaline obtained by condensation of *o*-phenalenediamine with glyoxal. The major drawback of this approach is the need to use large quantities of potassium permanganate for oxidation which makes the process uneconomical. An alternative approach which has been described in the patent literature is starting from 2-3-diaminepropionic acid and converting it to pyrazine carboxylic acid by condensation with glyoxal followed by air oxidation. A similar approach has been worked out starting from acrylic acid going through 2,3-diaminoacrylic acid *via* dichloroacrylic acid. This was further converted to pyrazinecarboacrylic acid and finally to pyrazine amide. However, the main drawback is in the conversion of dichloropropionic acid to diaminopropionic acid which has met with some unexpected problems during the process optimization.

Another alternative approach starting from succinic acid and leading to pyrazine dicarboxylic acid has been worked out at NCL for the first time. A communication on this synthesis is being sent and other alternative approaches are being explored.

3.10 Phenylglycylchloride hydrochloride : (3-17-003N-Sp)

D(–)-phenylglycylchloride hydrochloride, an important intermediate for the manufacture of ampicillin, is at present wholly imported. Under the

sponsorship of Sudarshan Chemical Industries Ltd., Pune, a laboratory process for the manufacture of this important intermediate has been worked out starting from phenylacetic acid. All the steps have been well optimized and some of the steps are already being demonstrated to the sponsor. Steps are also being taken to work out other alternative methods for making DL-phenylglycine.

3.11 Basic studies

3.11.1 Use of photochemical reactions in organic syntheses : The use of a photochemical transformation as a key step in a multi-step synthesis has acquired a great significance in recent times. A study has been recently initiated on the photochemistry of some organic molecules incorporating vinylcyclopropanes and it has been demonstrated that bicyclo (4.1.0) heptenes (1) selectively undergo rearrangement (VCR) to bicyclo (3.2.0) heptenes (2) under only photolytic conditions. By contrast thermolysis of (1) is known to yield products arising from sigmatropic rearrangements. The application of the photo-induced VCR reaction in the synthesis of insect sex pheromones and some other natural products is being explored.

3.11.2 *O*-Aminophenyl/aryl alkyl ketones and their derivatives : A true quinazoline analogue of papaverine — an alkaloid of natural origin used as an antispasmodic drug has been synthesized for the first time at NCL. This has been achieved through basic research which has resulted in the development of a new route to substituted 2-phenyl isatogens, an entirely new method of preparing substituted *o*-nitrophenylbenzyl ketones (which are unknown) and finally a new route to 4-benzylquinazolines.

3.11.3 New methodology : Recently, two isomers of epibicyclosesquiphellandrene have been synthesized with respect to isopropyl group and the stereochemistry of isopropyl group of natural compounds has been revised.

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4. BIOTECHNOLOGY

4.1 Immobilized yeast cells system for fermentation of cane molasses to ethanol UNDP — Bioscience and Engineering : (4.1-167—i & iii)

Isolates of ethanol- and substrate-tolerant strains of yeasts have been obtained from cane juice/molasses. One of these, designated *Saccharomyces* Y-10, when immobilized in open pore gelatin beads and used in packed bed reactors, gave high productivities of ethanol (about 80 g/1.h at 8% w/v concentration) and conversion (to ethanol) efficiencies of 95 to 100% in continuous operation over periods of about two months.

The engineering aspects of the operation of the immobilized yeast cell column fermenters are being examined in detail. The effect of internal and external diffusion and reactor geometry and configuration have been studied. Experiments conducted on minimising the cost of pretreatment of the feed stream have yielded promising results. The equipment for the preparation of the immobilized cell beads for a 10 L per day ethanol plant has been fabricated and initial trials have been satisfactory. The immobilized yeast cell reactor system has been scaled up to a small pilot plant with a capacity initially of 10 L of 95% ethanol per day which will be increased to 50—100 L per day.

The biomethanation of distillery stillage is being developed using mixed cultures obtained from animal excreta. A continuous conversion process is being developed for the production of methane and reduction of biological oxygen demand in the waste.

4.1.1 Ethanol production from molasses : (4-1-167-i & iii)

The yeast immobilization system based on open pore gelatin matrix for fermentation of molasses developed earlier has been subjected to a number of engineering investigations with a view to generating information required for scale-up. The influence of internal and external mass transfer resistance on reactor productivity, and the effect of the reactor geometry and configuration on the performance of the reactor were investigated. Since molasses pretreatment is reported to be an important cost centre in any continuous alcohol fermentation process, a simple and inexpensive pretreatment procedure was devised and tested successfully. Since the biocatalyst life is critical, for the overall economy, the possibility of extending the reactor life by several cycles of reactor operation, regeneration, etc., has been investigated. A standard test procedure has been evolved to monitor the quality of the immobilized cell produced.

Apparatus for growing yeast cells and immobilining them for a continuous pilot plant reactor of the capacity of 10 L of ethanol per day has been fabricated and erected. The pilot plant trials have been started. Based on the information collected on this scale, and if this immobilized system is found practicable, a larger plant of 100 L per day capacity will be erected. If the assessment is negative other immobilization schemes will be attempted.

4.1.2 Enzyme and fermentations reaction engineering : (4-1-167—ii)

Experiments have been initiated for the production of glycerol from glucose by fermentation. Various osmophilic and nonosmophilic yeast cultures were tested for their ability to produce glycerol. Of these, two osmophilic cultures were selected for further studies. Effect of sodium chloride addition from 0-20 percent has been investigated and found to increase glycerol production, but it also increased the fermentation time. Effect of inoculum size was also investigated. Centrifugation and recycling of cells give better yields of glycerol.

Two osmophilic cultures have been selected after screening several yeast strains for their ability to ferment glucose to glycerol containing a high concentration of salt media. Supplementation of the medium with sodium chloride (20% concentration) has resulted in increased glycerol production by these isolates, but at slower rates of fermentation.

The influence of internal and external mass transfer resistances on reaction rates and hence productivities in immobilized yeast cell reactors for ethanol production has been investigated. This system is a solid liquid-gas catalytic system in which gas is evolved during the reaction. The removal of the gas from the reactor is a critical factor affecting productivity and the modelling of this effect has been initiated.

4.2 Biotechnology of cellulose utilisation : (4-4-167)

4.2.1 Cellulases : Selection of hypersecreting mutants and their nutrient optimization for increasing enzyme activity and productivity constituted a major part of these studies. Effects of surfactants as well as commercial organic nitrogen sources like cotton-seed meal and "Scotaferm" were used to advantage in some of these fermentations. The nutritional requirements of *Penicillium funiculosum* UV-49 mutant have been studied in shake flasks. A remarkable feature of the mutant is its ability to utilise inorganic nitrogen sources like urea for both growth and enzyme production, in contrast to the parent strain and *T. reesei*. The long term saccharification ability as well as utilisation efficiency of the mutant enzyme were evaluated and found to be better than those reported in the literature. Studies on a non-sclerotical mutant of *Sclerotium rolfsii* were continued for evaluating its enzyme productivity. In an attempt to increase cellulase production in instrumented fermenters, fed batch experiments were conducted which gave improved cellulase activity. This technique will also give scope for using a relatively high substrate concentration. Further investigations are in progress. The levels of glucose and total reducing sugars in the broth during fermentation are also monitored as these can throw light on the complex phenomenon of growth and enzyme production.

Experiments have been conducted on a suitable pretreatment method for lignocellulosics for enzyme production as well as saccharification. Rice straw treated with water at moderate temperatures and pressures and subjected to amine delignification has been found to be an effective substrate. This method is being standardised.

4.2.2 Microbial biomass product : Basic parameters such as mass doubling time under semi-continuous fermentation were standardised in a continuous fermenter with both *P. janthinellum* and *P. funiculosum* using soluble carbohydrate substrates.

4.3 Genetic engineering and molecular biology : (4-5-001)

4.3.1 DNA organization and gene regulation : Fine melting analysis of DNA from eleven plant species and two cellulolytic fungi was carried out using a computer programme.

DNA sequence organization has been studied partially in three millets and three curcubit plant species. The data support the earlier findings on the diversity of genomic organization in plants.

Genomic DNA from pearl millet was cloned in Bam HI site of pBR 322 and clones that harboured sequences homologous to non-poly $(A)^+$ RNA were isolated by employing Grunstein-Hogness procedure. Work is in progress towards the characterisation of these cloned DNA fragments by hybridisation with various specific DNA probes.

Hybrids between *Cellulomonas* sp. and *Bacillus subtilis* were generated through protoplast fusion in presence of polyethyleneglycol. Hybrids selected for their cellulose utilising ability and complementation to auxotrophic markers in *Bacillus subtilis* were also tested for their spore forming property. Hybrids were further characterised both for their cellulase production and for genomic homologies with parent strains by colony and dot hybridisation methods. Unlike parent strains, one of the hybrids exhibited presence of β-galactosidase and CM case activities. Detailed molecular analysis of these hybrids is in progress.

4.4 Basic studies

4.4.1 Enzyme structure function : (4-1-167-iv)

The presence of an essential arginine residue at the active sites of each of the enzyme subunits of citrate lyase complexes from *Klebsiella aerogenes* and *Streptococcus faecalis* has been shown from the kinetics of inactivation by the arginine specific reagents, phenylglyoxal and 2, 3-butanedione. The binding of acetyl-CoA, one of the substrates of the acyl transferase subunit of the complex has, been shown to result in conformational change in the enzymatic subunit which greatly enhances the reactivity of its essential arginine residue.

The unusually large acyl-carrier protein subunit of *Escherichia coli* citrate lyase has been shown to have its 4 co-enzyme like prosthetic groups attached to domains with identical amino acid sequences.

4.4.2 Separation methods : An inexpensive acrylate polymer with the capacity to absorb 200 times its volume of water was developed. The polymer obtained in the form of rods can be conveniently used as disposable sticks for the concentration of macromolecules.

Several proteinase inhibitors isolated from horse gram are being characterised.

4.4.3 Theoretical studies on structure and function of biologically active molecules : A programme package for correlation analysis is being developed to study relationships between various physico-chemical properties, structural indices and observed potency of bioactive compounds. Such an analysis could be specially useful in anticipating novel compounds with the desired characteristics and their design.

Applications of structural analysis to larger biomolecular systems are also being examined.

4.4.4 Industrial Enzymes :

(a) Alkaline protease : An isolate of a saprophytic strain of *Conidiobolus* has been found to produce, in submerged culture, high levels of extracellular alkaline proteinase equivalent to 4.4 g crystalline trypsin in 1 L.

(b) **Glucose isomerase :** An isolate of a strain of a sclerotium forming actinomycete of the genus *Chainia* was found to secrete levels as high as 4000 units of glucose isomerase activity per litre in submerged growth in a xylane containing medium.

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5. EQUIPMENT DESIGN AND DEVELOPMENT

5.1 Regular packing development : (5-1-006)

This is a collaborative project with Engineers India Limited, New Delhi. The objective of the project is to develop indigenous capability in the design of special packings to be used in vacuum distillation columns. These packings have low HETP (Height Equivalent to a Theoretical Plate) values and cause less pressure drop in comparison with the conventional random packings. These packings, therefore, are very efficient mass transfer devices.

The erection of the pilot distillation plant has been completed and initial trials with model systems have been started. The work on characterisation of the packings and measurement of physical properties of test fluids has been completed.

5.2 Heat pumps : (5-2-006)

There is a growing awareness that heat pumps can be utilised in industry for energy recovery and recycle. A major collaborative arrangement has been evolved between NCL and Salford University, UK for work in this important area. The programme provides for exchange of scientists, training and also collaborative research.

The heat pump assisted dryer unit has been received and installed. Stability of working fluids is a critical problem. A sophisticated facility for testing the stability has also been received and installed. A major thrust of the work during this year has been on the interaction with Indian industry to indentify specific applications of heat pumps in improving the economy of energy utilisation in their plants.

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6. FLUIDIZATION

6.1 Design and modelling of fluid-bed reactors: (6-2-006)

Cracking of chlorosilanes to silicon is an industrially important reaction system presently investigated in this laboratory at an interdisciplinary level. The reaction carried out in a slugging reactor shows considerable advantages of this reactor over conventional reactors with respect to both the extent of conversion and selectivity. A mathematical model to describe the behaviour of reaction in a slugging bed reactor has been formulated. The reaction typically follows a consecutive path with a solid phase intermediate. The governing non-linear equations have been numerically solved to obtain the behavioural features of the system.

The inherent randomness present in the operation of a fluid-bed makes it necessary to model these systems as stochastic processes. A preliminary stochastic model for predicting the fluid-bed performance has been completed. More detailed studies are in progress.

A two-dimensional fluid-bed reactor assembly has been used to study the hydrodynamic features of the bed for a class of catalysts such as the one used in ammoxidation reaction. A high speed movie camera has been used to photograph the events in the bed and studies pertaining to deciphering some of the fundamental properties such as bubble formation, movement, coalescence and break-up are in progress.

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7. MATERIALS SCIENCE

7.1 Solar thermal conversion : (7-2-004-i)

A parabolic concentrator frame design and its performance for solar thermal conversion have been reported earlier. Some modifications in the frame design were carried out to increase its working efficiency and ease of installation. A suitable design for absorber box and its fabrication have been completed.

The actual characterisation of this system (concentrator and absorber) was done by experiments in which isotherm 500 oil was heated to 80-90°. These results show that by using solar energy via this system one can save fuel worth 3600 kcal per day (7 hours).

Ten such units have been fabricated and work on their use for definite applications is in progress.

The experiments for optimizing the conditions of absorber coil showed that 'series type' of absorber is better than both parallel and hybrid type (parallel+series) absorber coil.

It has been observed that lamp black gives better performance as compared to black paint that is commercially available.

7.2 Silicon : (7-2-004-ii)

This project is aimed at solving the following problems in the preparation of silicon from trichlorosilane.

1. During the conversion of $SiHCl_3$ to Si, in addition to the desired reaction (i), several side reactions such as (ii), (iii) and (iv), take place leading to the formation of unwanted $SiCl_4$.

   (i) $SiHCl_3 + H_2 \longrightarrow Si + 3HCl$

   (ii) $4SiHCl_3 \longrightarrow 3SiCl_4 + Si + 2H_2$

   (iii) $2SiHCl_3 \longrightarrow SiCl_4 + Si + 2HCl$

   (iv) $Si + 4HCl \longrightarrow SiCl_4 + 2H_2$

   As a result, the efficiency of the desired reaction (i) is only 33%. Hence a method has to be found to suppress the formation of $SiCl_4$ or to convert $SiCl_4$ back to $SiHCl_3$.

2. The process uses a large excess of hydrogen (20:1). This is a major cost centre and hydrogen must be recycled to bring down the cost. In fact all the by-products such as HCl, unconverted $SiHCl_3$ and H_2 need to be recycled.

3. The conventional process is highly energy intensive (~300-400 KWH/KgSi) as the deposition is carried out on silicon rods heated electrically in a transparent quartz tube from which there is a large loss due to radiation.

The following results have been achieved:

(i) Work has been carried out (a) to suppress the formation of $SiCl_4$ and (b) to convert $SiCl_4$ to $SiHCl_3$. By a proper control of the composition of the feed mixture and the cracking temperature, the formation of any additional $SiCl_4$ has been minimised. Furthermore, the conversion of additional $SiCl_4$ to $SiHCl_3$ has been achieved. The conversion efficiency is 35% per pass. With these two improvements, a major cost factor, namely unwanted formation of $SiCl_4$, has been largely dealt with.

(ii) A process innovation has been made in the recycling process whereby all by-products are recycled with minimum number of steps in the process. This appears to be a significant step towards reduction in the cost. Thus in this process, except for about 5-10% make up, no chemical is used. The input is only crude silicon (metallurgical grade) and the output is high purity silicon. The additional input is of course energy.

(iii) The high cost of energy expended in the process can also be reduced by carrying out the deposition on a fluidized bed of silicon particles. Most of the problems associated with this process have been overcome and the conditions have been established under which the deposition on the wall, if any, is continuously rubbed off by the fluidizing particles. The parameters for a continuous operation of the fluid bed have been optimized. Runs lasting 20 hours have already been taken. This process holds promise at least for solar applications. All the performance data have been first collected on separate laboratory units and after optimization of the relevant parameters, the units have been connected and run as an integrated unit. Optimization experiments have also been carried out after integration and the necessary data required for the design of the pilot plant have been collected.

These improvements, which have been successfully tried out on a laboratory scale, relate to major cost centres in the existing process and therefore hold promise for improving the overall economics of the process. However, in order that the potentiality of these innovations is fully tested out and the total process made worthy of commercial exploitation, the work is now required to be scaled up. One can then get meaningful data on the performance of this cyclic process and also obtain the necessary design data for the final plant (say 100 TPA). A one ton per annum pilot plant has therefore been designed. In this pilot plant there is a provision for a six-rod cracking unit as well as a bank of fluid-bed cracking units. Since the rest of the process is common to both types of crackers, it is planned to keep provisions for both the options in the same pilot plant. To start with, the pilot plant will be set up with only the rod-cracking unit. As soon as all the data required for the fluid-bed unit have been collected on the laboratory unit, the designing and construction of the fluid-bed cracking unit of the pilot plant will be taken up.

7.3 High permeability ferrites : (7-3-004)

The work on high permeability manganous-zinc ferrites was completed. Some basic work relevant to the project work has been published. The basic work deals with the synthesis of the solid solutions MnO. ZnO, MnO. Feo, MnO. MgO and the study of their magnetic, electrical and optical properties. Further, a series of compounds with the general formulae $Mn_xFe_{3-x}O_4$ and $Zn_xFe_{3-x}O_4$ with predetermined compositions have been prepared making use of the stabilized MnO and FeO respectively. Mossbauer spectroscopy and other magnetic techniques have been used to study these compounds. The use of stabilized MnO has been further extended to the preparation of commercially important square loop manganous-magnesium ferrites. These have been successfully prepared and found to show a rectangularity ratio $\geqslant$ 0.96.

Further work on the preparation and study of $MnCr_2O_4$, $MnTiO_3$ and Mn_2TiO_4 by this novel technique, using stabilized MnO, is in progress.

7.4 Thick film materials : (7-5-004)

7.4.1 Pd-Ag conducting paste : After studying the effect of several parameters on the paste formulations and conductor print properties, reproducibility tests were carried out. The specifications (for sheet resistivity, adhesion strength, silver migration, solder leach resistance, viscosity, etc.) have been drafted. A sample of the paste has been sent to CEERI, Pilani, for independent evaluation.

7.4.2 Gold conducting paste : Gold powder of different particle size and shape was prepared by using different reducing agents. Several formulations of the paste were prepared. Screen printing parameters have been optimized. The conductivity (6-9 mΩ/Sq.) and adhesion (6-8 lbs) characteristics are comparable with the imported sample.

7.4.3 Silver epoxy : It is a single component curing type silver conducting paste. A specific type for chip bonding of LSI circuits was required by Semiconductor Complex Limited (SCL), Chandigarh. The important properties like electrical conductivity, thermal conductivity and adhesion strength are good. The formulation was approved by SCL and large scale chip bonding production trials using this paste are in progress.

7.4.4 RuO_2 based resistor paste : It is essential that the conducting phase is stable at the resistor firing temperatures and in the presence of glass compositions. (RuO_2 is reported to be non-stoichiometric.). One of the methods is to prepare a ruthenate like $Bi_2Ru_2O_7$. It has high δ value and positive TCR. The solid state reaction between RuO_2 and Bi_2O_3 has been very closely studied. Varying preparation conditions have been reported in literature. Optimum conditions were worked out based on X-ray analysis. Pure $Bi_2Ru_2O_7$ was prepared.

7.4.5 CdO thick films : This is a low cost material which is a substitute for imported RuO_2 thick film resistor. A novel method of depositing thick films of CdO has been worked out. One can induct dopants and get a homogeneous system to control δ s and TCR. The basic studies on CdO thick films like X-ray analysis, electrical conductivity, ESCA, thermoemf, Hall effect, etc., are in progress.

7.4.6 Copper paste : Kirloskar Brothers Ltd., (Hermetic Compressors Division) Karad, referred the problem of developing copper paste for copper hydrogen brazing of discharge muffler steel parts in their hermetic compressors to NCL. The brazed parts are being imported presently. A few copper

paste formulations which are thixotropic in nature have been developed. Brazing test results are awaited.

7.5 Basic Studies

7.5.1 Studies on UV stable polymers for solar applications : (0–40–004)

A substantial cost reduction in solar thermal devices can be achieved if polymer materials are used in place of the expensive glass parts of these devices.

Two such polymer materials ('Tedlar' of Du Pont and FEK-244 of 3 M Company) which are in use abroad were characterised here. A few copolymer compositions of methyl methacrylate and methyl vinyl ketone were synthesized for studying the UV degradation of polymers. A suitable UV light source (2500 W) and a tensile strength tester are being procured to facilitate this study.

The rheological properties of another polymer (polybutadiene) were studied in different solvents (good and θ solvent) over a wide range of concentrations. The molecular weights of the samples are being determined by the light scattering method. Polybutadiene was chosen because it is a *cis* compound and its chain is more flexible than that of polychloroprene (probably a *trans* compound) which was studied earlier. The results are being interpreted with the help of the molecular theory of viscoelasticity for entangled polymer liquids developed by Doi and Edwards employing the reptating model of de Gennes.

In the development of PZT compositions suitable for use in ceramic electric wave filters, some mixed compositions were prepared by doping Pb (Ti-Zr)O_3 ceramics with the oxides of chromium and manganese as well as chromium and uranium, mixed in pairs. The relevant dielectric and piezoelectric properties of these compositions were studied over a wide range of temperatures ($-60°$ to $180°$). The ageing characteristics were also studied. Some of these modified compositions showed promise for use in ceramic electric wave filters because of their high dielectric constant (1100-1300), high mechanical quality factor (~ 1000) and good ageing and temperature stability at the resonance frequency.

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8. PEST CONTROL AGENTS

8.1 Synthetic pyrethroids : (8-1-03S7)

In continuation of the work on the synthesis of active photostable pyrethroids from the indigenously available, cheap and abundant (+)-3-carene, the synthesis of two pyrethroids, possessing the desired IR *trans*-configuration has been carried out. They are (1) 3-phenoxybenzyl (+) IR-*trans* 2, 2-dimethyl-3-(2-E-styryl) cyclopropanecarboxylate and (2) 3-phenoxy benzyl (+) IR-*trans* 2, 2-dimethyl-3-(2-phenyl-2-chlorovinyl) cyclopropanecarboxylate (as a mixture of E & Z isomers). The above esters are reported to possess ectoparasiticidal activity.

The synthesis of methyl IR-*trans*, 2, 2-dimethyl-3-(2-oxopropyl) cyclopropanecarboxylate has been carried out starting from (+)-3-carene. Attempts to convert the latter into IR-*trans*-Indothrin are in progress.

The synthesis of 3-phenoxybenzyl IR-*cis*, 2, 2-dimethyl-3- (hydroxymethyl / formyl / acetoxymethyl) cyclopropanecarboxylates has been achieved from the γ—lactone of IR-*cis*, 2,2-dimethyl-3-hydroxymethyl cyclopropanecarboxylic acid obtainable from (+) -3-carene. The 3-acetoxy ester is reported to possess insecticidal activity.

A new route for the preparation of car-4-ene-3-ol, from carene-3- epoxide has been developed. The alcohol is a valuable intermediate for the preparation of IR-*cis*-2, 2-dimethyl-3-(2-oxopropyl) cyclopropanecarboxylic acid, from which highly potent pyrethroids like IR-*cis*-indothrin and other related esters have been synthesized.

Epoxidation of the δ – lactone of IR-*cis* 2, 2-dimethyl-3-(2-hydroxy prop-1-enyl) cyclopropane carboxylic acid, followed by acid catalysed rearrangement of the epoxide, gave the γ-lactone of IR-*cis*, 2, 2-dimethyl-3-(1-hydroxy-2-oxopropyl) cyclopropane carboxylic acid. Attempts to convert the latter into methyl IR *cis*, 2, 2-dimethyl-3-formyl cyclopropane carboxylate are in progress. Different approaches to convert methyl IR-*cis*-2, 2-dimethyl-3-(2-oxopropyl) cyclopropanecarboxylate into the IR *cis*-caronaldehyde ester are also being explored.

Four 3-phenoxybenzyl esters bearing close structural resemblance to 'cut up 'chrysanthemates have been synthesized. The acid moieties of these esters have been synthesized from (+) citronellal. The esters exhibit larvicidal activity.

8.2 Development of pest control agents and other bioactive principles. (8-2-003S)

Storage trials on Neemrich-I, from neem seed extract, conducted at the experimental station of Central Potato Research Institute at Rajgurunagar gave encouraging results for the oviposition deterrent activity against potato tuber moth. A process was developed for isolation of Neemrich-II which showed antifeedant activity against *Spodoptera litura* (tobacco caterpillar). Preliminary field trials on this product have been carried out at Central Tobacco Research Institute at Rajahmundry. Neemrich-I has been sent to RRL, Hyderabad, for generating toxicity data. Two active rich fractions and two pure compounds showing aphicidal activity and one pure compound showing miticidal activity have been isolated from neem extract. Further separation and identification of the active principles are under way. Extracts from 24 samples of neem seeds obtained from six states are being evaluated to see the variation in activity, if any, due to geographical factors.

Screening of plant extracts and their fractionation, wherever indicated, were continued. Thus, extracts of 49 plants were screened. Follow-up work by way of detailed and systematic chromatographic separation for isolation and characterisation of pure compounds was carried out on a number of plant extracts showing various activities : growth disruption (1), insecticidal (2), J. H. (1), antifeedant (1), repellent (1), ovicidal and larvicidal (2 each). During the course of these fractionations a number of pure compounds were isolated, some of which have been fully characterised. In one case the activity (insecticidal) has been correlated to the pure compounds.

Forty plants were collected from Kasa and Trymbak forest areas.

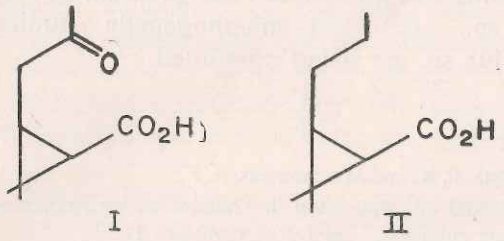
A number of substituted cinnamic acids, some with cyclopropane ring, were synthesized to study structure activity relationship for growth inhibition. A number of substituted ∝, ∝–dimethyl benzyl alcohols were synthesized for the elucidation of the structure of a naturally occurring monoterpene. Some intermediates for the synthesis of pheromones pertaining to potato tuber moth and tobacco leaf eating caterpillar were prepared. A novel synthesis of 2, 6-dimethyl-1, 6-heptadien-3-yl acetate, which is known to mimic the activity of comstock mealybug pheromone, has been carried out. Comstock mealybug is one of the pests that cause damage to apples, pears and other agricultural crops.

4-*n*-Butyl-1, 2-methylenedioxybenzene, a constituent of the essential oil derived from the shrub *Ottonia valii* is reported to have pyrethrum synergist activity. It has been synthesized by reaction of 5-bromo-1, 3-benzodioxole with *n-butyllithium*.

8.3 A new group of cyclopropane derivatives with miticidal activity : (8-6-003S)

In continuation of previous work, sixteen cyclopropanoid esters were evaluated against pink mites and purple mites at United Planters' Association of South India. One of the esters was found to be as effective as kelthane, which is a standard miticide. Further testing is in progress.

New routes have been developed for the preparation of the acids I and II from 3-carene.



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8.4 Synthetic studies in agrochemicals : (8-8-03S7)

Homobrassinolide (22*S*, 23*S* and 22*R*, 23*R*-isomeric mixture) was synthesized in eight steps starting from stigmasterol. At a concentration of 0.1 to 1.0 ppm, it gave a positive reaction in the rice (Tinan-3) to laminar inclination bicassay test conducted by the Plant Tissue Culture Group of the Biochemistry Division.

Both the isomers (22*S*, 23*S* and 22*R*, 23*R*) of homocastasterone and homobrassinolide were synthesized in pure form. 22, 23-deoxyanalogues of homocastasterone and homobrassinolide were also synthesized starting from β-sitosterol. Work has also been carried out with phytosterol from sugarcane press-mud, an indigenous source rich in stigmasterol and sitosterol. A method has been developed for completely separating stigmasterol derived products from the phytosterol mixture. The stigmasterol content in the phytosterol mixture was found to be much higher than what was reported earlier.

With a view to developing new compounds in the isoxazole series having potential fungicidal activity several isoxazole derivatives have been synthesized. To start with, the known isoxazole derivative hymexazole (Tachigaren, Sankyo Co., Japan), and its 4-chloro and 4-bromo derivatives have been synthesized and tested for activity against the fungal species that were already reported. A new compound, 3-benzoxy-4-chloro-5-methylisoxazole, was synthesized and found to inhibit the growth of some fungi to the extent of 100% with or without the presence of salts like Fe^{+++} or Al^{+++} at 250 μg/ml, indicating that it may be more active than hymexazole.

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9. PLANT TISSUE CULTURE

9.1 Plant tissue culture for agriculture and forestry : (9-1-001)

The research activities during the year were directed mainly towards the induction of haploids from pollen isolation of virus-free plants, clonal propagation, growth of immature hybrid embryos, protoplast fusion and somatic hybridisation. The progress of this work is being evaluated by conducting field trials.

9.1.1. Haploid and Triploids : Haploid plants have been successfully obtained via anther culture of the heterozygous fruit tree, *Annona squamosa* L. (custard apple).

The endosperm of the tissue of this fruit tree cultured *in vitro* has yielded a triploid callus. Efforts are in progress to initiate differentiation in the callus cultures.

9.1.2 Clonal multiplication : A method developed for the multiplication of the fast growing elite *Eucalyptus terreticornis* is being used for the production of sufficient number of plants for field trials. Work on the methods for the clonal propagation of *E. torreliana* and *E. camaldulensis*, rubber, *Dalbergia latifolia*, bamboo, salvadora, coconut, cashew and tea is in progress.

9.1.3 Field trials

(a) Sugarcane : 32 tons of virus free sugarcane plants raised by tissue culture were supplied to the State Farming Corpn. of Maharashtra for large scale field trials.

Two hundred virus free sugarcane plants raised by tissue culture were supplied to Nimbkar Agricultural Research Institute, Phaltan, for field trials.

(b) Banana and Cardamom : Eleven virus free banana plants of Robusta variety and fifteen cardamom plants raised by tissue culture were supplied to the Banana Research Station, Yawal, Jalgaon, and the Indian Cardamom Board, Kerala, respectively, for field trials.

(c) Wheat : The wheat strain (NI-917) evolved at NCL by tissue culture was sent to Regional Wheat Rust Research Station, Mahabaleshwar, to have the rust reaction tested.

(d) Embryo culture : Studies are in progress to grow the immature hybrid embryos obtained by hybridisation between two cotton species (*G. hirsutum* × *G. arboreum*) to maturity.

9.1.4 Differentiation : Histological studies are being carried out with sugarcane calli of two varieties Co-740 and Co-7219 at different stages during their transformation. Methods were standardised for the extraction and *in vitro* assay of the enzymes involved in nitrogen metabolism in differentiating and non-differentiating sugarcane calli.

9.1.5 Protoplast : Studies on isolation and regeneration of protoplasts of a leguminous plant (Phaseolus sp.) and some trees (Sapium sp., Eucalyptus sp., etc.) and morphogenetic studies in Phaseolus sp. are being continued.

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10. POLYMER SCIENCE AND ENGINEERING

10.1 Rheology and processing of industrial polymers : (10-2-046)

The rheology of a highly loaded ferrite filled system has been studied with a view to identifying the matrix to develop flexible magnets. Certain thermoplastic elastomers were found to be suitable. A detailed study of its rheological properties, with and without different types of coupling agents, has been made to explore the possibility of increasing the loading, improving the dispersion and making the processing easier. An extrusion process with a proper die design is being presently developed in order to obtain flexible magnets.

Computer simulation of the melt spinning of polyethylene terephthalate has been developed and used successfully in industry for improvement of productivity and product quality. An extension to the multiple filament case is being attempted.

10.2 Polymerization reactors: Analysis, design and development : (10-3-567)

Kinetic mechanisms of SAN copolymerization at low and high conversion have been separately studied. The critical parameters which control the microstructure of the copolymer at azeotropic and nonazeotropic compositions of the monomers have been identified. The phenomena of thermal and concentration multiplicities in copolymerization reactors have been modelled. New analysis and design strategies for copolymeriaztion reactors have been worked out.

10.3 Development of novel polymeric materials : (10-5-356)

10.3.1 Polyphenylene sulphide : Polyphenylene sulphide is a new engineering plastic with unusual mechanical and chemical properties. As a speciality polymer, it has tremendous promise in applications where a combination of mechanical and thermal properties is required.

The laboratory development work on coating grade polyphenylene sulphide has been completed. Procedures related to polymer separation from the reaction product recovery and post treatment for developing molding grade polyphenylene sulphide have also been standardised.

It is proposed to undertake pilot plant work and application development work in collaboration with a suitable outside agency.

10.3.2 Oleopolymers based on castor oil : (10-5-567) The technical feasibility of producing a whole range of polymeric materials ranging from flexible elastomers to rigid materials using specific systems which include castor oil networks with dimethyl terephthalate, toluene di-isocyanate and maleic anhydride adducts has been demonstrated. Interaction with industry is being initiated.

Epoxies filled with oxidised cellulose and treated clay have been shown to have fast curing properties. The oxidation of the cellulose was carried out with periodate and chromic acid, while the clay was treated with long chain amines. The effect of oxidation of cellulose on curing kinetics has been studied through gel-time experiments.

Industrial interactions for the process optimization and products development of SAN copolymers are being initiated.

Computer modelling of the synthesis of PET by both batch and continuous processes has been completed. The process improvements as per the model have been successfully implemented in the industry. The mathematical modelling approach has also been extended to predict the approach-to-equilibrium molecular weight distribution in PET melts, a problem of considerable industrial significance.

10.4 Adhesives from renewable resources : (10-6-006-Sp)

This is a project sponsored by Carborundum Universial Ltd., Madras, for the development of phenolic novolac resins for use as binders in abrasive grinding wheels.

Semi-solid to solid resins have been prepared by the condensation of CNSL with paraform and further reaction with iscocyanates to yield products with reactivity better than the conventional phenolics. Efforts are under way to develop formulations that can meet the targeted product requirements, viz. melting point (70°-90°), flow length, (around 30 mm), and size reducibility (to about 200 mesh).

10.5 Drag reducers for oil transport : (10-7-567)

This project has been sponsored by the Oil India Development Board, New Delhi. The objective is to

identify the polymers that can give drag reduction in oil transport. A selected set of monomers required for the synthesis of such systems has been polymerized under controlled conditions with a view to synthesizing high molecular weight polymers. The experimental study involves testing of various polymers for shear stability and drag reduction efficacy.

10.6 Other novel polymeric materials

Experiments have been performed with asphalt and a chemical modifier to enhance its properties with a view to improving the high temperature flow characteristics and crack resistance of asphalt for possible application in water resistant coatings. Encouraging results in increasing the modulus of elasticity of asphalt have led to industrial interaction, such as with RDSO. Lucknow.

The curing characteristics of cellulose and modified cellulose fillers in an epoxy matrix were studied. The modified celluloses cured much faster and at lower temperatures than ordinary cellulose. Surface modified mineral fillers have been prepared for use in thermoplastic matrix.

Experiments were designed for obtaining surface conducting PTFE and FEP. The effect of ethereal and dipolar aprotic solvents on the reactivity of sodium naphthalenide have been studied and the useful solvent systems identified.

10.7 Basic studies

10.7.1 The effort on providing unified frameworks for analysis of transport processes in polymeric media has been continued. An altered free volume state model has been proposed to correlate transport properties of polymers. The model can satisfactorily correlate diffusive transport in polymer solutions and gels as well as in solid polymers. The role of carrier action in dyeing was explained on the basis of the AFVS models, which confirms the plasticization theory of carrier action.

10.7.2 Validity of an instability mechanism in stress induced migration phenomena was examined. Specifically, pressure-drop-flow rate relationship in channel flow of very dilute polymer solutions was examined. Comparison between theory and experiment showed such a mechanism to be unlikely even though it is useful for estimating the maximum extent of the migration effect.

10.7.3 A rigorous analysis of the limiting case of fully developed flow of polymer solutions through fine capillaries under the conditions of macromolecular migration was completed. Apart from the theory serving as an upper bound of the migration process, a major conclusion was the independence of the asymptotic flow curves from capillary size. This general observation suggests that size dependence of flow curve may not always serve as a positive indication of effective slip.

10.7.4 The role of stress-induced macromolecular migration in longitudinal dispersion involving macromolecular solutions was examined. The phenomenon was shown to lead to a likely interpretation of several anomalous observations (hitherto unexplained) which have been reported in the literature.

10.7.5 The kinetics of the industrially important system of free radical bulk copolymerization of styrene and acrylonitrile (SAN) was studied both at low and high conversions to have a greater insight into the polymer structure and the influence of gel effect on reactor behaviour. The kinetics of the copolymerization system has been successfully used to investigate theoretically the multiplicity and instabilities of the isothermal and nonisothermal continuous copolymerization reactors.

10.7.6 A mathematical model has been developed to compute the molecular weight distribution (MWD) in the polyethylene terephthalate (PET) manufacturing process and in the blending of molten PET chips. The model is useful for calculating the time required to reach equilibrium MWD, which is critical for getting uniform product quality.

10.7.7 A number of thermoplastic elastomers (S. I. S., Hytrel, polyurethane elastomer) were loaded with very high levels of barium ferrite fillers (of the order of 50-60% by volume) and a systematic study of their rheological characteristics was carried out. Use of surface modifiers such as titanates and silanes was found to ease processing. Titanates were more efficient in reducing the viscosity levels of such highly filled systems. However, it was found that the surface modifiers had an adverse effect on the mechanical properties.

10.7.8 The effect of chemical surface treatment conditions on the electrical surface conductivity of fluorinated polymer films was studied comprehensively. Ideal conditions for the reaction were established to improve surface conductivity by a factor of 10^{10}.

10.7.9 It is known that the properties of filled polymer systems depend greatly on the extent of polymer-filler interaction. A detailed study was carried out to establish that significant interactions occur when cellulose and dialdehyde cellulose are used as fillers in an epoxy matrix, giving a useful composite.

10.7.10 X-ray photoelectron spectroscopic investigation of surface coated inorganic fillers in powder form was used to study the extent of surface coating of silica, clay and wollastonite with a long chain alkylamine. The results indicate that this is a useful method for studying such surface coated materials in powder form. Generally, only the surface coverage of smooth films had been studied by this method.

10.7.11 A project has been initiated for generating basic structure-property data relevant to developing high modulus fibres and engineering plastics from polymeric structures that are melt anisotropic liquid crystals.

The structures are essentially composed of *para* or *meta* linked aromatic moieties interposed by ether, ester, ether-ester, ether-amide and ester-amide linkages.

As the first step, model compounds of varying well defined structures are being synthesized. The influence of molecular geometric parameters such as kink and substituents on thermal properties and type (nematic or smectic) are being investigated. Polymers will be synthesized from the model compounds for thermal, mechanical and rheological characterisation to establish quantitative structure-property relationships.

10.7.12 Studies have been carried out on the crystalline structure and morphology of various polymers and polymeric blends in order to investigate the effect of various solid state processing parameters on crystallinity, phase structure and morphology.

The effect of chemical composition on crystalline parameters such as lattice structure and dimension are also being investigated in different types of polymers such as polyether-ketones, thermoplastic polyesters, etc.

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11. POLYMER SYNTHESIS AND MODIFICATIONS

11.1 Polymeric membranes for desalination : (11-3-056)

Polymeric membranes prepared from modified cellulose acetate were evaluated in NCL fabricated reverse osmosis (R. O.) unit made of stainless steel and capable of withstanding high pressure, for desalination studies.

Studies with solutions of different concentration of salt (NaCl) sucrose and glucose were carried out using this R. O. unit and modified cellulose acetate membranes.

Preparation of polyimidazole type of polymers is in progress.

11.2 Aromatic polymers-Polyamides for the desalination and effluent treatment : (11-3-056-Sp (i))

In continuation of the earlier work, the synthesis of Nomaxpolymer with film forming viscosity ($\eta \sim$ 0.9 dl/g) from 1, 3 phenylenediamine and isophthaloyl chloride by solution polymerization, has been successfully standardised by carrying out a series of experiments. Further, attempts were made to prepare substituted derivatives of 1, 3 phenylenediamine, e.g., 4-bromo-6-methyl and 4-methoxy-6-methyl-1, 3-phenylenediamine and their polyamide with isophthaloyl chloride to give a better film forming polymer. Samples of these polyamides were submitted to BARC, Bombay, for further evaluation.

Preparation of 1, 3-diaminobenzidine and isophthaloyl chloride required for the synthesis of polybenzimidazole (PBI) polymer was standardised on a laboratory scale.

11.3 Hydroxy terminated polybutadiene (HTPB) : (11-6-567-Sp)

Hdyroxy terminated polybutadiene can be prepared by free radical or anionic polymerization methods. During 1981-82 HTPB of molecular weight ~2000 was prepared using H_2O_2 as initiator on 250 g scale. During 1982-83 the polymerization was scaled up to 800 g per batch and four samples of polymer were given to Explosive Research and Development Laboratory, Pune, for testing. The polymer prepared in five batches was sent to ERDL for testing on a larger scale.

Low molecular weight HTPB was prepared and its effect on high molecular weight HTPB was studied.

At the instance of ERDL, a vacuum line was set up to prepare the polymer by the anionic polymerization technique. Using high vacuum anionic technique, HTPB was prepared on a 10 g scale in glass ampoule. To reduce the 1, 2 addition so that the 1, 4 addition can occur preferentially different techniques were tried and attempts were made to prepare a dilithium initiator soluble in a nonpolar solvent.

11.4 Polymer characterisation : (0-22-005)

Kinetics of coordination polymerization of styrene initiated by butoxy titanium trichloride and aluminium alkyls was investigated using a vacuum dilatometer. Trialkyls yielded steady state polymerization over a considerable period whereas use of diethyl aluminium chloride resulted in continuously declining rates of polymerization. The effect of monomer and catalyst concentration, catalyst to cocatalyst ratio, temperature and the catalyst ageing time as well as the effect of an electron donor on the course of polymerization was investigated in detail. For the steady state of polymerization, first-order rate law with reference to catalyst and monomer was observed. From the oxidation states of the catalyst a trivalent state for the transition metal was inferred for the reactive species. The declining rates of polymerization due to the deactivation of the catalyst followed, apparently, the second-order rate law.

Solution polymerization of methacrylic acid was carried out at 60° in dioxan, water and dioxan-water mixtures using potassium persulphate as the initiator. The polymer obtained in 75:25 water : dioxan mixture (molecular weight 3×10^5 to 5×10^5) was separated into eight fractions by the fractional precipitation technique using methanol as the solvent and ether as the nonsolvent. Light scattering, viscosity and osmotic pressure measurements were carried out for the fractions, and critical miscibility temperatures were determined in dimethyl formamide and dioxan mixtures (isorefractive solvents). It was found that a dimethyl formamide and dioxan mixture in the ratio 5:7 behaves as an ideal solvent at about 27° (theta temperature). Light scattering measurements at various degrees of ionization and concentration of added salt are being carried out on fractionated polymethacrylic acid samples.

A Waters high temperature Gel Permeation Chromatograph model ALC/GPC-150C was commissioned. The effect of instrumental band spreading on the polydispensity was estimated using standard polystyrene samples. For these narrow molecular weight distribution samples the corrections were found to be less than 10%.

11.5 Polymer modification — Studies in modification of cellulose, starch and PVA and their cross linking : (0-32-004)

The work in this field is concentrated on the development of a general process for encapsulating pesticides, weedicides, herbicides, etc., using starch and its derivatives for the purpose.

With a view to developing additional wall material from other sources, work on modification of cellulose and its cross linking was undertaken, and not much work has been reported on the use of cellulose based derivatives for encapsulation.

Since xanthates are being used widely for encapsulation, modification of cellulose through xanthation was initiated and conditions for xanthation to the required degree of substitution were standardised. The resultant products were used for encapsulation of various pesticides. In this case too methods had to be standardised using various additives to achieve the earlier results.

Release rates of these encapsulated products were determined spectroscopically and confirmed by physical methods.

Release rates have been observed to be faster than required. Efforts are being made to slow them down to the desired level.

Modification of cellulosic materials through other methods, such as urea adducts, thiourethanes, etc., is under study.

11.6 Metathetical polymerization of cycloolefins : (0-37-005)

Metathetical polymerization of $\triangle^3$-carene was carried out using WCl_6 and $SnPr_4$ as catalysts. *In situ* preparation of the catalyst and use of chlorobenzene as solvent resulted in higher polymer yields. But the conversions and the molecular weights of the resultant polymer were still low. Use of butoxy derivatives of WCl_6 resulted in low yields of crystalline polymer with a high melting point. More interestingly, a rubbery product was obtained by increasing the quantity of the reactants, yields being correspondingly low. Depositing the catalyst components on inert supports like molecular sieves and silica gel, and carrying out the polymerization by the addition of the monomer did not improve the yields or the molecular weights.

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12. PROCESS DESIGN

12.1 Process modelling and simulation : (12-1-067)

The monochlorobenzene plant at HOC, Rasayani, was simulated in order to develop a mathematical model. The model was used to make concrete predictions of plant productivity. A mathematical model of chlorobenzene reactor has also been developed.

For evaluating the potential of a plant producing benzaldehyde by toluene air oxidation, a model was developed so as to study the effect of changes in conversion and selectivity. The results were used to work out the optimum plant size.

Active work was undertaken for developing general purpose multicomponent distillation programmes and adopting them in complex situations involving azeotropic and extractive distillations. The programmes have been used in the simulation of the chlorobenzene plant and also for simulating the separation of ethylene diamine from higher amines.

Many VLE and LLE routines have been developed, which are likely to be useful for future designs.

12.2 Project design : (12-2-067)

Project designs were prepared for a number of NCL projects. These include silicon pilot plant, a pilot plant for producing polyphenylene sulfide, a continuous fermentation unit based on immobilized whole cells, etc. The design cell also helped in the commissioning of the plants based on NCL technology.

13. TIME TARGETED PROJECTS

13.1 Ethylene to ethylene oxide : (1-1-467)

A catalyst for the conversion of ethylene to ethylene oxide has been developed and tested in a laboratory reactor. The selectivity obtained at the laboratory reactor is comparable to that offered by international companies. An integrated pilot plant incorporating a single tube reactor is under erection. It is proposed to get the catalyst made by a well-known catalyst manufacturing company, test it in the pilot plant, and collect data required for the design of the commercial plant.

13.2 Industrial application of synthetic zeolites : (1-6-467)

A catalyst for the preparation of ethyl benzene from ethanol and benzene was developed in a laboratory reactor. Detailed investigations in a pilot plant reactor were carried out using the above catalyst and process data were generated to enable the design of a commercial plant to be carried out. The process was then demonstrated to the representatives of Polychem Ltd., Bombay, who have been showing keen interest in the industrial exploitation of this process on a joint development basis. The possibilities of using this catalyst in their commercial reactor directly are being exploited.

13.3 Solar grade polysilicon : (7-9-2467)

NCL has developed a laboratory scale process for the preparation of solar grade polysilicon. It is proposed to install an integrated pilot plant to produce one tonne silicon per annum in collaboration with MERADO at Pune. The Department of Science and Technology, New Delhi, has sponsored this project at NCL. The process, in principle, consists in reducing trichlorosilane or tetrachlorosilane or their mixtures at high temperature in the presence of hydrogen. A special feature of the work being carried out at NCL is the development of a fluid bed reactor to convert trichlorosilane to silicon continuously. This process will offer distinct advantages over conventional processes, the Siemen's process in particular, with regard to cost of production. Exploratory experiments have yielded promising results.

13.4 Ethylene from ethanol : (16-20-467)

Most of the ethylene is being made in the country from petroleum sources and only a small part from alcohol. With the increase in the cost of petroleum, the price of ethylene made from alcohol would be cheaper. Further, there are some locations where ethylene is required in small quantities, and transportation from a large plant to these places and its storage could pose a problem. The objective of this project is to develop know-how and engineering indigenously for small-sized ethylene plants based on the dehydration of ethyl alcohol. NCL has considerable experience in the development of catalysts and catalytic reactors using fluidized beds. It is therefore proposed to install an integrated pilot plant for ethylene, having a capacity of about 5 kg per hour, and generate the necessary data.

Design of a pilot plant has been carried out. An integrated pilot plant reactorassembly will be fabricated and operated at NCL. The indigenously available catalyst and new catalysts developed in the laboratory will be tested for their performance. The purification schemes will be finalized. Data will be collected for the design of a commercial unit and the basic engineering design package will be prepared.

13.5 Ethanol production from molasses : (16-21-167)

Ethanol is being conventionally produced by the fermentation of molasses using yeast. The yeast cells, immobilized in the laboratories, when used for the fermentation of sugarcane molasses, had shown high productivity and no loss of activity during continuous use over two months in packed bed reactors. Subsequently, standardisation of the yeast cell growth and immobilization to obtain sufficient quantity of biocatalyst for a pilot plant reactor with a capacity of 20 litres per day of ethanol was taken up. Fabrication and erection of the pilot plant reactor have been undertaken. Experiments are planned to be carried out on this reactor assembly which will help to identify the critical parameters and give data necessary for the design of an integrated pilot plant at NCL with a capacity of 100 litres per day.

13.6 Vitamin B_6 : (16-23-03N7)

A new process for the preparation of vitamin B_6 has been worked out on laboratory scale. A pilot plant to produce 2 kg per batch of vitamin B_6 has been erected. The pilot plant will be used to collect engineering data required for the design of a commercial plant. The process has been released to Lupin Laboratories Ltd., Bombay.

13.7 Small volume projects

13.7.1 Modified rosin and resin derivatives : (16-15-007-Sp) Developmental work on evolving an industrially feasible process for maleinized rosin and its esters was pursued. Attempts were also made to obtain these esters with improved softening points, viscosities and selective solubilities.

13.7.2 Sucrose esters : (16-16-007) Sucrose esters are the non-ionic type surface active agents of choice due to their complete and easy biodegradability, good detergency and emulsification properties. These surfactants could be very beneficial for our country as they are derived fully from renewable resources and not from petrochemicals. In addition they are non-toxic and do not cause pollution.

Several attempts were made to prepare a number of sucrose esters by alternative processes. The emphasis has been mostly on utilising the non-edible oils. The surface active properties, viz. detergency, surface tension, emulsification, wetting time and lime soap dispersion, etc., of these compunds are being checked simultaneously.

13.7.3 Solvent extraction chemicals : (16-16-007-i) In continuation of the earlier work, more samples of 2-hydroxyoximes corresponding to LIX-63 and LIX-65 were prepared and sent to National Metallurgical Laboratory, Jamshedpur, for evaluation.

13.7.4 N, N-Diethyl diphenylurea : (16-16-007-ii) N, N-Diethyl diphenylurea is a very effective stabilizer for explosives and is well known as centrallite or carbimate. A novel process for its preparation has been worked out on 1 kg scale.

13.7.5 Crop protection chemicals : (16-16-007-iii) Several experiments were carried out to prepare N-(phosphonomethyl) glycine-a non-selective and non-residual post emergence herbicide—which is very effective against grasses, deep rooted perennial species and also broad leaved weeds. The emphasis has been on the use of indigenously available raw materials with a view to developing an economically viable process

13.7.6 Nitric phosphate fertilizer : (16-17-007-vi) The objective is to prepare water soluble fertilizers from Indian rock phosphate using the nitric acid process. This process is better suited to Indian rocks than the sulphuric acid process which is dependent on imported sulphur. The method in which the nitric acid treatment is followed by filtration, precipitation and conversion of Ca HPO_4 to ammonium phosphate was examined.

13.7.7 Clonidine hydrochloride : (16-16-007-vii) Clonidine hydrochloride is an effective drug for the treatment of hypertension. The process conditions for its preparation have been standardised.

13.8 Follow-up work : (16-18-007)

The processes leading to the production of the herbicides simazine, atrazine and dalapon were demonstrated successfully to Sudarshan Chemical Industries, Pune.

13.8.1 Ethephon : A number of experiments were carried out to check the viability, reproducibility and the other factors connected with the process for ethephon, a plant growth regulator particularly useful for application on rubber plants.

13.8.2 Thiourea : Maharashtra Fine Chemicals, Pune, have approached NCL for know-how on the conversion of their by-product ammonium sulphide to thiourea. The earlier NCL process used H_2S and calcium cyanamide. Some experiments were carried out to determine the conditions for the conversion of ammonium sulphide and calcium cyanamide to thiourea. Negotiations with the party are in progress for the transfer of the technology.

13.8.3 Endosulfan : The plant installed at HIL, Udyogamandal, was successfully commissioned by NCL in collaboration with the company.

13.8.4 Butenediol : Negotiations for the commercial manufacture of the catalyst required by HOC, Rasayani, for butenediol have been successfully completed and the manufacturing procedure has been demonstrated to the company. Trial production of the catalyst has been started. Several samples of butenediol solutions received from the party were tested for their suitability for hydrogenation. A 20 kg lot of hydrogenation catalyst was prepared.

13.8.5 Acrylic esters : NCL scientists were associated with the commissioning and trouble-shooting of the acrylic esters plant established by Indian Petrochemicals Corporation Ltd., Vadodara.

13.8.6 Sodium potassium ferrocyanides : Hindustan Development Corpn. Ltd., New Delhi have approached NCL for the know-how for the preparation of sodium ferrocyanide from pure sodium cyanide.

NCL had already completed the work on the preparation of sodium ferrocyanide from cyanide waste (NaCN, 40%+Na_2CO_3, 60%). In order to be able to transfer the technology to HDC, experiments are being carried out to convert pure sodium cyanide to sodium ferrocyanide on a 500 g per batch (sodium cyanide) scale. Various parameters for the reaction as well the analytical procedures are being standardised.

13.8.7 Hydrogenation of esters obtainable from non-edible/edible-acid oils : Fatty alcohols derivatives are used in textile auxiliary chemicals, lubricating oil additives, surfactants, cosmetics, plasticizers, pharmaceuticals and in water evaporation control. The process involves hydrogenolysis of oils / esters / acids under high pressure and at a moderately high temperature using a copper chromite catalyst.

Aegis Chemical Industries Ltd., Bombay, have sponsored a scheme to investigate the following : (i) the performance of imported copper chromite catalysts, (ii) the suitability of cheaper raw materials, and (iii) production of unsaturated alcohols. Significant amount of experimental work has been carried out.

OTHER BASIC AND EXPLORATORY PROJECTS

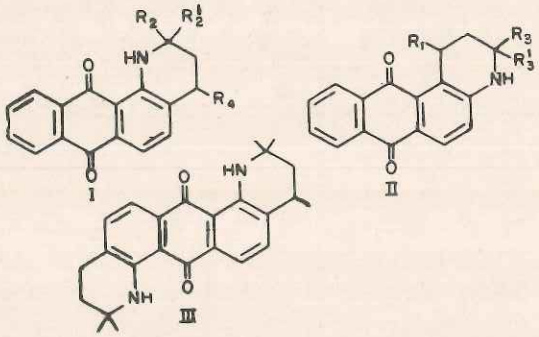
1. Asymmetric synthesis (optical induction)—Chloramphenicol : (0-7-003 S III)

Preliminary experiments on epoxidation of cinnamyl alcohol and acetate have been tried out with *t*-butylhydroperoxide and benzoyl peroxide. The epoxides were isolated and characterised. Low and ambient temperature epoxide opening using ammonia gas under various catalytic and non-catalytic conditions was attempted. A new method to determine enantiomeric excess (e. e.) in new amino alcohols, whose rotation is unknown, has been developed. This will be useful in determining e. e. in the chloramphenicol series.

New phase transfer catalysts based on quinine and quinidine were prepared and their use in optical induction reactions is under investigation.

2. Studies in chemical reactivity : (0-11-003)

(a) A new synthesis of some anthrapyridines (I, II, and III) has been obtained in a study of the applications of the Marchalk reaction. These are angularly annellated hetero-analogues of anthracyclines. It is not clear if these have any therapeutic value. The method and the derivatives are new.



(b) Some substituted stilbene 2-carboxylic acids have been prepared and the temperature dependence of their acid strengths studied in an effort to see if these could be put to practical use in desalination. A system with suitable properties would be regenerable with solar energy.

(c) Against the background of the isolation of several relatively stable iodonium ylides in the laboratory, an attempt was made to see if sulphonylmethyl iodonium salts could be prepared and converted into the corresponding ylides. Suitable reaction conditions for the same have not yet been found.

3. New perfumery products from longifolene : (0-31-003S)

An excellent new speciality perfumery chemical (trivial name : necelone; chemical name: acetyl alloisolongifolene) with a rich, woody, amber fragrance has been developed from the new isomer (alloisolongifolene) of the commercially available longifolene. This aroma chemical has been evaluated and highly appreciated by perfumery firms both in India and in USA and is now undergoing extensive consumer acceptance trials. A laboratory scale process for necelone on 1 kg batch scale has been standardised and is now ready for commercialization.

The product resulting from the hypoiodite reaction on the alcohol derived from alloisolongifolene 1 by hydroboration, has been found to be interesting (camphoraceous, woody) and useful in perfumery formulations. One of the products (an unusual unsaturated pyran) derived from the formaldehyde addition to 1 has been found to have a woody odour.

4. Synthesis of gamma lactones related to nanaomycin D

: There is considerable interest in the synthesis of the antibiotic, nanaomycin D. B5-(2-Benzoyloxy-methyl-4-methoxyphenyl) 2(5H)-Furanone, an analogue of nanaomycin D, has been synthesized employing an organoselenium reagent to introduce unsaturation in the lactone ring.

Publications

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Phagodeterrency of various fractions of neem oil against *Schistoceca gregaria* Frosk,
Ind J. Entom., **42** (3), 469 (1980).

*2. Purohit, P. C. and Sonawane, H. R.,
Photochemistry and haloketones I. Reactions of some ∝—alocyclohexanones,
Tetrahedron, **37**, 873 (1981).

3. Powar, (Mrs.) P. P., Naikwadi, K. P., Likhite, S. M., Bapat, B. V. and Ghatge, B. B.,
Liquid crystals III—Application of laterally substituted liquid crystals for the separation of alkyl benzenes as compared with conventional phases in gas chromatography,
J. Chromatography, **245** (1), 57 (1982).

4. Talekar, D. G. and Rao, A. S.,
Transformation of alkylhalides to aldehydes having two additional carbon atoms,
Ind. J. Chem., **21B**, 408 (1982).

5. Kadam, A. N. and Ghatge, B. B.,
Hydrolysis studies on Imidan,
Ind. J. Chem., **21B** (5), 460 (1982).

6. Shankaran, K. and Rao, A. S.,
Synthesis of 2, 6-dimethyl-1-1-6-heptadien-3-01 a probable biogenetic precursor of the pheromone, 2, 6-dimethyl-1-5-heptadien-3-01-acetate,
Ind. J. Chem., **21B**, 542 (1982).

7. Shankaran, K., Talekar, D. G. and Rao, A. S.,
Transformation of alkyl halides to aldehydes having two additional carbon atoms,
Ind. J. Chem., **21B**, 542 (1982).

8. Talekar, D. G., Sanghvi, Y. S. and Rao, A. S.,
Transformation of gamma-lactone and delta-lactone to gamma acetoxybenzyl and delta-acetoxybenzyl ketones,
Ind. J. Chem., **21B**, 710 (1982).

9. Ayyangar N. R., Joshi, S. Y. and Lugade A. G.,
Polycyclic compounds : Part I-Structural polycyclic features of C. I. Disperse Red-303.,
Ind. J. Chem., **21B**, 842 (1982).

10. Khanapure, S. P., Bhawal, B. M. and Hazra, B. G.,
A convenient synthesis of 7-methoxyisochroman-3-one, 3-one,
Ind. J. Chem., **21B**, 889 (1982).

11. Sanghvi, Y. S., Dabral, (Miss) V. and Rao, A. S.,
A convenient synthesis of 4-normal-butyl-1, 2-methylene-dioxybenzene,
Ind. J. Chem., **21B**, 893 (1982).

12. Khanapure, S. P., Hazra, B. G. and Das, K. G.,
A novel dimerization of an aromatic C-ring steroid,
Ind. J. Chem., **21B**, 957 (1982).

13. Ayyangar, N. R., Lahoti, R. J. and Daniel, T.,
A convenient synthesis of ethyl carbethoxy arylamino acrylates and related compounds,
Org. Prep. Proc. Int., **14**, 327 (1982).

14. Ayyangar, N. R., Kalkote, U. R. and Nikrad. P. V.,
Novel orthohalogenation reaction. Synthesis of orthochloroacylamines from nitroarenes,
Tetrahedron Lett., **23**, 1099 (1982).

15. Ayyangar, N. R., Lahoti, R. J. and Otiv, S. R.,
Disperse dyes derived by the condensation of homophthalimides and 2-pyridones with naphthostyrils and isatin,
Dyes and Pigments, **3** (4), 317 (1982).

16. Ayyangar, N. R. and Lugade, A. G.,
Metanitrochlorobenzene and metachloroaniline,
Colourage, *XXIX* (26), 3 (1982).

17. Ayyangar, N. R.,
New horizons of dyestuff industry in India,
Wheels (Gujarathi translation), 5 (1982).

18. Sethi, S. C., Natu, A. D. and Wadia, M. S.,
Autoxidation of arylcycloalkenes : A method for the preparation of epoxides,
Heterocycles, **18**, 221 (1982).

19. Joshi, C. P. and Ranjekar, P. K.,
Visualization and distribution of heterochromatin in interphase nuclei of several plant species as revealed by a new Giemsa banding technique,
Cytologia, **47**, 471 (1982).

20. Ayyangar, N. R., Kalkote, U. R., Lugade, A. G., Nikrad, P. V. and Sharma, V. K.,
Partial reduction of dinitroarenes to nitroanilines with hydrazine hydrate,
Bull. Soc. Chem. Japan, **56** (10), 3159 (1983).

21. Ayyangar N. R., Kalkote, U. R. and Nikrad, P. V.,
Novel Reactions Part I : Facile synthesis of substituted orthochloroanilines,
Ind. J. Chem., **22B**, 873 (1983).

22. Ayyangar, N. R. and Srinivasan, K. V.,
Correlation of pK_{BH}^{+} of acetanilides with liquid chromatographic behaviour,
J. Chromatography, **267**, 399 (1983).

* These papers were not reported in earlier Annual reports.

INFRASTRUCTURE ACTIVITIES

1. National collection of industrial microorganisms (NCIM) : (Infra-1)

The laboratory has a collection of about 3200 non-pathogenic yeasts, bacteria and fungi. Routine subculturing tests on their biochemical performance and long term preservation were continued. These cultures are made available to industrial, educational and research establishments. During the year under review 611 cultures were supplied to industrial research institutes, including CSIR laboratories.

Publications

1. Vartak, H. G., Modak, S. R., Bodhe, A. M. and Ghadge G. D.,
   A procedure for easy removal of acrylamide gel rods from the casting glass tubes,
   Analytical Biochem., **128**, 468 (1983).
2. Srinivasan, M. C., Vartak, H. G., Powar, V. K. and Sutar, I. I.,
   High activity alkali stable proteinase from a fungal source,
   Biotech. Lett., **5**, 285 (1983).

2. Centralised chemical analysis and instrumental services : (Infra-2)

2.1 Spectrochemical analysis : (Infra-2(i))

This group provides infrared spectral analysis to the scientists of the laboratory and outside parties. Besides, it also undertakes some basic studies on specific compounds. During the year, 2045 samples by infrared and 680 samples by ultraviolet visible were analysed for the laboratory.

2.2 Physico-chemical analysis : (Infra-2(ii))

The group carries out routine chemical and instrumental (spectrometric, spectrographic, atomic absorption, flame photometry, etc.) analysis of inorganic chemicals for NCL scientists and outside parties. It also undertakes development of new methods and improvement of the existing methods of chemical analysis.

A fluorescence accessory has been added to the SP-8-100 spectrophotometer and a new dropping mercury electrode assembly from PAR has been added to the polarographic unit. A mercury distillation unit has been purchased for the purification of mercury. 2488 samples were analysed by classical and instrumental methods.

2.3 Microanalysis : (Infra-2(iii))

This group provides microanalytical service to NCL and outside scientists. 3039 samples were analysed for NCL research projects during the year under review.

The following basic studies were also undertaken by the group.

(a) A method was developed for simultaneous spectrophotometric microdetermination of sulphur and phosphorus in organic compounds and a paper was communicated to Microchemical Journal, USA.

(b) Study of the spectral characteristics and chromatographic behaviour of some fully acetylated glycosides was carried out. Far IR and IR spectroscopy work of these compounds is concluded and a note is being prepared for publication.

Mass spectra of these compounds were studied at 70 ev and 20 ev. C. I. (CH_4) spectra were also obtained and after obtaining C. I. (NH_3) spectra, the fragmentation patterns will be studied and the possibility of suggesting a new fragmentation scheme will be explored.

GLC and HPLC data have also been obtained under various conditions and a note based on the observations made will be communicated shortly.

(c) Studies on relative activities of some combustion catalysts were continued. Particle size by SEM, DTA, TGA, oxidation states by ESCA etc., were determined for twenty oxidation catalysts, as well as their relative efficiencies, using phenanthrene, acetanilide, stearyl alcohol, cholesterol and 8-hydroxyquinoline. Rates of combustion of phenanthrene using some of them were studied at 300°. Rate constants were determined and equations were found out by the method of least squares.

(d) Vapour phase oxidation of some fatty alcohols on V_2O_5 supported on SiC was studied at 250°, 300° and 350°. In addition to the corresponding aldehydes some unknown products were formed. They are being identified.

2.4 Nuclear magnetic resonance (NMR) spectrometry : (Infra-2 (iv))

The group provides NMR spectroscopic help to the scientists, and also develops and applies NMR spectroscopy to chemical and biochemical problems. During the year the following services were rendered : 60 MHZ proton spectra-4873; 80 MHZ proton spectra-157: 90 MHZ proton spectra-780; ^{13}C spectra (20 and 22, 63 MHZ)-59 and 31_P spectra-8.

A large number of relaxation rate measurements were carried out, and procedures were worked out for the evaluation exchange rates in some amidic systems by the method of saturation transfer.

Extensive measurements of NH and OH relaxation times in hydrogen bonded amidic and phenolic compounds have been carried out and their exchange properties studied by the method of saturation transfer. In tautomerism involving these functions, evaluation of the tautomeric equilibrium is difficult by most of the conventional techniques. The study indicates that relaxation data will be helpful for this purpose. Deuterium isotope effects in ^{13}C spectra are also being measured and these will also be helpful in characterising the equilibria mentioned.

Some aromatic aldehydes and ozazones required for some NMR studies have been prepared and will be used respectively for rotational barrier measurements and studies in mutarotation.

2.5 Mass spectrometry (MS) : (Infra-2 (v))

The group provides MS and GC-MS facilities to the scientists of the laboratory and outside parties. During the period under review 1480 samples were analysed by MS for various NCL projects and 47 by GC-MS technique.

The following basic studies were carried out in the group—

The chemistry of gaseous ions : The reactivity of the open shell and closed shell isomeric bifunctional nitroarene ions, formed under electron ionization and chemical ionization conditions, was compared. Differences in the reactivity of isomeric pairs of open shell nitroarenes were found to be enhanced in the closed shell nitroarenes under chemical ionization conditions.

The mass spectral fragmentation of biologically active 1, 3, 2-oxaza phosphorinanes substituted at various positions has been investigated. Novel single and double hydrogen transfer reactions were observed.

2.6 Electron spectroscopy for chemical analysis (ESCA) : (Infra-2(vii))

ESCA facilities to the scientists of the laboratory and outside parties are provided by the group. During the period under review 596 samples were analysed by ESCA using various techniques such as XPS, UPS, AES, etc. In addition to maintaining the service facilities the following basic studies were also undertaken by the group :

(a) Nature of chemical bonding segregation and chemisorption in chalcogenides.

(b) Segregation studies in dilute tin alloys.

Publications

1. Dharmadhikari, V. S., Sainkar, S. R., Badrinarayanan, S. and Goswami, A.,
   Characterization of thin film of bismuth oxide by X-ray Photoelectron Spectroscopy,
   J. Electron. Spectroscopy, **25**, 181 (1982).

2. Amalnerkar, D. P., Badrinarayanan, S., Date, S. K. and Sinha, A.P.B.,
   X-ray Photoelectron Spectroscopy studies of oxygen chemisorption on thick film photoconducting cadmium sulphide,
   Appl. Phys. Lett., **41** (3), 270 (1982).

3. Dixit, A. V., Bhoraskar, (Mrs.) S. V. and Badrinarayanan, S.,
   Application of PZT ceramics in electron multiplies,
   International Symposium on Ceramics 29-30 Nov. (1982).

4. Hegde, R. I.,
   Core level binding energy shift in dilute tin alloys,
   Surface and Surface Analysis, **4**, 204 (1982).

5. Umapathy, P., Badrinarayanan, S. and Sinha, A. P. B.,
   An ESCA study of organo tin (iv) and tin (ii) chelates with substituted 8-Quinolinols,
   J. Electron. Spectroscopy, **28**, 261 (1983).

2.7 Analytical group of the process development division : (Infra-2(viii))

Major activities of this group are,(a) to give analytical support to various projects, (b) development of analytical procedures required for the on-going projects, (c) preparation of analytical manuals for the processes developedi n the division, and (d) basic research in the field of analytical chemistry.

During the year under review the group handled more than 1000 samples from various projects.

The group was active in the development of non-selective electrodes. Electrodes selective to the

following ions were developed : potassium, fluoride and nitrate. Detailed evaluations of the electrodes are being carried out. Attempts are being made to develop electrodes for other ions as well as enzyme electrodes for alcohols and glucose.

2.8 Analytical group of organic chemistry I : (Infra–2 (ix))

Analytical service was rendered to the division of Organic Chemistry I and other divisions of the laboratory, by standard instrumental methods. Attempts were made to develop new methods of analysis with special reference to agrochemicals and pharmaceuticals. Work on the development of new techniques for better applications of gas liquid chromatography and high performance liquid chromatography in separation and identification of intricate mixed products formed during reactions in organic chemistry was also carried out.

The group carried out the following analyses for NCL projects : Organophosphorus pesticides : 102, carboxin : 25, and endosulfan : 305.

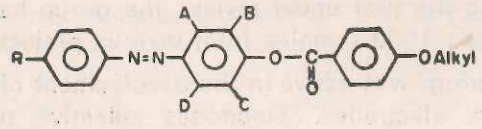
Instrumental analyses carried out for research and development projects were GLC : 1990, IR : 3070, HPLC : 83 and UV : 230.

Special analytical service has been provided to the UNDP project on slow release pesticides. After standardisation of procedures by classical and instrumental methods, 235 samples were analysed.

Suitable column technology to make glass columns of correct and specific application was developed from indigenously available materials and successfully put into daily practice for general as well as semi-preparative applications.

High performance liquid chromatographic analysis has been extended for a variety of compounds. A special Zwitterion technique has been perfected for separation of highly polar acidic as well as basic compounds.

Synthetic work on laterally substituted new liquid crystalline compounds has been further extended with substitution on both the sides of the middle ring.



(where A, B, C, D are laterally substituted groups, such as $-CH_3$, —Cl, NO_2, etc., and R is Alkyl or O-Alkyl).

The compounds show a wide range of transition temperatures and were found quite suitable for use as GLC substrates in the separation of high boiling isomeric mixtures of a variety of organic compounds.

The super cooling nature of some of these substrates on solid support was found very convenient for extending the use of these phases more efficiently, even at ambient temperatures.

2.9 Netzsch thermal analyser : (Infra-2 (x))

During the year under review thermograms of 264 samples received from NCL scientists working on different projects were recorded. Thermal decomposition products and phase changes during the heating were studied from these data.

2.10 Scanning electron microscope (SEM) and X-ray fluorescence spectrometer (XRF) : (Infra–2 (xi))

Four hundred and twenty-five samples received from NCL scientists were studied by scanning electron microscopy for particle size and their distribution.

2.11 X-ray diffractometer (XRD) : (Infra-2 (xii))

During the review period XRD was widely used by NCL scientists, and scientific and educational institutions. XRD spectra of 1021 NCL samples were recorded.

2.12 GLC and HPLC analysis : (Infra-2 (xiii))

The group provides facilities in gas liquid chromatographic (GLC) and high performance liquid chromatographic (HPLC) analyses to all the divisions of the laboratory. The analytical services rendered during the year were : HPLC-486 and GLC-644 samples.

Publications

1. Ganguli, P. and Date, S. K.,
Comments on spin-crossover phenomenon in ferric dithiocarbamates and other materials,
National Academy of Science Letters, 5, 55 (1982).

2.16 Cell for assistance to small scale chemical industry : (Infra-2(xix)

The cell started functioning in the laboratory in June 1982. The objective of this cell was to assist the small scale chemical industries through scientific/technical expertise of NCL on the basis of institutional consultancy. The cell has been receiving a number of enquiries which could be classified as : (a) those relating to trouble shooting, (b) those from parties who have identified their projects and need assistance from the cell, (c) those parties asking for suggestions for starting new chemical industries. The cell has so far solved the problems of about 12 parties. Presently, the cell has undertaken one consultancy; five more are in the pipeline.

Many enquiries need some experimental work to be carried out at NCL. It is proposed to undertake, experimental/developmental work in such cases.

2.17 Crystallography : (Infra-2(xx))

The ENRAF-NONIUS CAD4 four circle single crystal automatic diffractometer assisted by a PDP 11/23 Computer was installed in June 1982. Since then, about 30 crystal structures have been solved by this group. These structures, mainly small to medium sized molecules, come from a variety of branches, viz., organic, organometallic, bioinorganic, inorganic, biological molecules and drugs. All the necessary programme packages have been developed or adopted in the existing ICL 1904-S facility at Regional Computer Centre, Pune. The low temperature facility has been set on the CAD4 diffractometer and plans are under way to start studies on charge density distributions. All the necessary programmes are planned to be run on the CYBER facility at TIFR, Bombay. Communications based on the results obtained by the study of all the structures are under preparation.

The programme packages have been developed such that they are fully automatic and the user need not be an expert in crystallographic methods to use the system successfully.

3. Properties measurement : (Infra-3)

The main aim of this group is threefold.

(i) To measure various physical, thermodynamic and surface properties of various compounds obtained from different projects of NCL.

(ii) Try to build up a property data bank as well as that of some common compounds with relevant needs of NCL.

(iii) To undertake basic research in thermodynamic and surface chemistry of monolayers so as to keep the background of the subject up to date and improve upon the existing facilities either by changing the methods of measurement or by replacing them with those based on more sophisticated instrumentation.

During the year several physical and thermodynamic properties of 100 samples from different projects of NCL were measured. These properties are: (a) viscosity at different temperatures, (b) density, (c) refractive index at room temperature, (d) specific heat at different temperatures, (e) heats of dissolution.

Surface active properties, viz., detergency and surface tension, of nearly 50 esters have been measured and Dray's test for foaming carried out to find out their suitability as surfactants.

Nearly 20 samples of controlled release pesticides were analysed by spectroscopy to find out the per cent release as a function of time.

GLC analysis of nearly 400 samples was carried out during the year.

VLE (dynamic method) of two samples was carried out. Basic research was concentrated on two topics.

(i) Heats of mixing of the following binary systems were carried out to understand intermolecular interactions and possible complex formation.

(a) butanediol + water

(b) n-butylamine + n-butanol + t-butanol

(c) sec. butylamine + sec. butylalcohol with n-hexane, 1 :1 complex.

(ii) monomolecular film properties of mixed monolayers of polyvinyl stearate systems were studied.

The above binary systems have been found to be miscible and compatible, and non-ideal in their behaviour. They also exhibit better stability towards evaporation retardation.

Computer programmes for several equations, viz., Wilson, Barker, NRTIL, etc., were developed during the year.

A static method for determining VLE was developed and set up. A preliminary list containing data on 15 properties of 50 compounds has been prepared.

Publications

1. Kulkarni, V. S. and Katti, S. S.,
Surface viscosity and pressure area isotherms of mixed monolayers of hexadeconol with docosanol and hexadecoxyethanol with docosanoxy ethanol at 25°C.
J. Colloid. Interface Sci., **89** (1), 40 (1982).

4. Entomology : (Infra-4)

The complex biological screen consisting of several insect, pest and vector colonies, and bioevaluation systems covering insecticidal, acaricidal, behavioural, hormonal, reproductive and developmental aspects was further enhanced by incorporating newer insect colonies as well as bioassays. Among the new organisms taken up for laboratory colonisation were plant parasitic nematodes and a few additional species of stored products pests. Laboratory colonies of the important vectors namely, *Anopheles steophensi* and *Culex fatigans* were developed in addition to the earlier existing colony of *Aedes aegypti*.

The screening of indigenous plant species was continued using the above enlarged screen. Simultaneously, promising leads taken up for follow-up action were pursued in close collaboration with the organic chemistry groups concerned.

Two behavioural, one general insecticidal, two mosquito larvicidal, one developmental and several hormonal and acaricidal leads deserve particular mention. Some of these are being followed up with the objective of identifying the active principles involved.

The active principles responsible for oviposition deterrence activity were again sought actively. After considerable work, one of the major chemical ingredients contributing to oviposition deterrence against potato tuber moth has been identified.

Field trials were undertaken with Neemrich-II at the farmers' fields in Rajahmundry in collaboration with the Central Tobacco Research Institute of India. These first trials carried out in tobacco nurseries were quite successful in terms of protection afforded to the leaves of the young plant. However, actual field practice needs a completely aqueous formulation, work on which is vigorously going on.

Laboratory and field procedures for bioevaluating controlled release formulations of pesticides were streamlined and a complete protocol for the abate larvicide formulations was evolved. More than a dozen new latex-abate formulations were assessed in the newly devised system. Of all the latex based formulations analysed so far, only one merited further follow-up in the field system. After six weeks of satisfactory release in field trenches, the dispenser ceased to be effective. Some algal and/or silt deposition was determined to be the cause of the stoppage of toxicant release. Work on newer formulations incorporating larvicides as well as using newer polymeric matrices is continuing.

A commercially available standard controlled release dispenser of abate was used to generate data regarding release rate, concentration build-up, application strategies, etc., which would serve as models for evaluation of the NCL products. These studies were also used to enunciate properties, characteristics, design geometry, abate incorporation, application doses and strategies as well as desirable toxicant release rates and concentrations suitable for Indian conditions.

Preliminary work was also initiated on the development of a system for elucidating chemical principles responsible for host selection by insect pests. The tobacco leaf eating caterpillar, now emerging as a major national pest, was selected as the insect system and its several host plants were examined to obtain data on orientational, feeding, reproductive and developmental performance of the test insect on them. Initial chemical work entailing extraction of two less preferred food plants and examining them for bioactive principles has also been initiated in association with a group of the organic chemistry division.

Biochemical studies on variations in protein contents of selective test insects in response to different dietary and chemical environments were undertaken. Standard protein patterns for three species of mosquito vectors were also examined. Respiratory Quctient for the cotton stainer in conditicns of different chemical and environmental stress was determined.

More than a dozen seed oils from Indian forest plants were screened for their pest control potential using a restricted number of pest species.

Publications

1. *Sharma, R. N., Bhosale, A. S., Joshi, V. N., Hebbalkar, D.S., Tungikar, V. B., Gupta, A. S. and Patwardhan, S. A., *Lavendula gibsonii*, a plant with manifold insectistatic potential, *Phytoparasitica*, **9**, 101 (1981).

2. Sharma, R. N., Development and utilization of plant products for insect control : A comprehensive approach *in 'cultivation and utilization of medicinal plants'*. (Ed: Atal C. R.) *A Govt. of India Publication*, 657 (1982).

3. Sharma, R. N., The use of insect material in developmental biology practicals, *Proc. of Conf. on Teaching and Research in Dev. Biol. in Afro-Asian Countries*, Univ. of Poona, 19 (1982).

4. Hebbalkar, D. S. and Sharma, R. N., An experimental analysis of mating behaviour in *Dysdercus koenigi.*, *Indian J. Exptl. Biol.*, **20**, 399 (1982).

* This paper was not reported in earlier annual reports.

5. Instrumentation : (Infra-5)

The instrumentation section looked after the maintenance of sophisticated analytical equipment of the laboratory, and also advised scientists on the procurement of new instruments and spares for preventive maintenance.

The section is now being equipped with ultra sophisticated incircuit emulators and troubleshooters for system checks and fault analysis, and the staff has also been trained at home and abrcad.

Under the DST sponsored programme, medium resolution grating IR spectrophotometer was developed and designed for assembly at Central Electronics Ltd., Ghaziabad.

6. Division of technical services (DTS) : (Infra-6)

The work carried out in DTS during the year can be divided into four categories—(1) planning, monitoring and research co-ordination, (2) industrial liaison, technolcgy transfer, etc., (3) documentation, market data collection, and (4) publicity, public relations, extramural activities, and work of a special nature.

Planning, monitoring and research co-ordination

The most important activity in this category was the preparation of the research programme for 1982-84, containing all the details of the proposals submitted by the scientists for the 4th Research Advisory Council (RAC) and the 60th Executive Committee (EC) meetings. The agenda for the 6th RAC meeting covering the research programme for 1983-84, and 1984-85 was also prepared. A detailed document on the annual plan for 1983-84, project budget RE 1982-83, BE 1983-84 and sixth plan projections was prepared and sent to the DGSIR.

Fifteen sponsorship, collaborative, grant-in-aid and consultancy proposals were prepared and sent to outside parties. The prcposals for the finalized new schemes and for the renewal of some existing schemes were placed before the EC at its 60th and 61st meetings for approval.

Area meetings were arranged for various research projects to assess the progress and bottlenecks in each of the areas.

A comprehensive report on the current research programme, status of the projects and the plan of work inthe next two or three years and the expenditure involved was prepared and sent to the DGTD. A detailed note on Indo-Hungarian collaboration in science and technology was prepared and sent to the CSIR for consideration. A special document entitled, Multi-Agency and Thrust Area Project Proposals of NCL was prepared and sent to the CSIR.

To meet the requirements of the Central Insecticides Board (CIB) regarding registration of pesticide products, a detailed compilation of bioefficacy, toxicity and chemical analysis data on the processes developed and released by NCL was carried out. Data on dimethoate, ethion, simazine, atrazine, dalapon and endosulfan were included in this compilation. As a result of the concerted and co-ordinated efforts made by the DTS, dimethoate and ethion have now been registered with the CIB. Toxicity data was compiled on carboxin on behalf of Sudarshan Chemical Industries Ltd., Pune, and on simazine, atrazine and nitrofen for Amar Dye-Chem. Ltd., Bombay.

Enquiries numbering 6470 from private parties, government departments, the parliament, NRDC, CSIR, sister laboratories, PTCs, AGCR/CSIR audit groups, customs, excise, etc., were handled during

the year. The material received for the Centralised Project File Bank (CPFB) was scrutinised and regular reports sent to the Director on the progress of the work in the various projects and the difficulties encountered.

The research programme meetings, and the meetings of the various committees set up by the Director to help him in the management of the laboratory were organised and attended by members of the DTS staff.

Industrial liaison, technology transfer, etc.

Discussions were held with parties and entrepreneurs (about 250) who approached NCL with requests for possible exploitation of know-how, for consultancy or for collaboration. Four consultancy agreements, with Amar Dye-Chem, Bombay, DRDE, Gwalior, Petrofils and Peico Electronics and Electricals, were executed. Three sponsorship agreements on hydrogenation of esters from non-edible/edible/acid oils, with Aegis Chemicals, Jalgaon, on adhesives from renewable resources with Carborundum Universal, Madras, and on synthesis of basic drugs and intermediates with Dexo Laboratories, Hyderabad, were executed.

As part of NCL's assistance to industries in the region, analysis of 482 samples for 278 parties were arranged. Drawing office, xerography and photography facilities were made available to all the other divisions of the laboratory. Five hundred and thirty-six tracings and 1695 ammonia prints were made during the year.

A committee was formed to decide the objectives and the working of the Small Scale Industries Cell of NCL, and assistance was rendered to this Committee to enable it to hold its meeting and submit its recommendations. Two consultancy agreements were finalized on behalf of the Cell, one with Lanz Laboratory, Bombay, and the other with Poona Pharmachem Ltd., Pune.

Assistance was given in working out the details of NCL's interaction with outside agencies such as Engineers India Ltd., New Delhi, on Ethylene Oxide Project, and University of Erlangen, West Germany, on the work to be carried out with Prof. H. Hofmann.

Documentation, market data collection

As part of the routine work, regular survey and indexing of literature on research management was carried out. Techno-economic survey of important projects, and market data collection on selected products were carried out. Information on current market prices, licences applied for and licences granted, etc., was compiled on cards, and these were updated regularly.

Replies to the questions raised in the parliament were sent as and when required. Data on the employment pattern of Ph.D. degree holders who received their degrees during 1976-81 was compiled and sent to the DST.

Publicity, public relations, extramural activities, special tasks, etc.

Information required for inclusion in the NCL Annual Report 1981-82 was compiled. Details such as degrees awarded, staff news, etc., were furnished for CSIR NEWS. Six issues of the house journal, *NCL Bulletin*, were brought out.

Articles on the NCL technologies for chlorosilanes, aminophylline and theophylline, ethylenediamine and ethion were specially prepared at the request of THE CHEMICAL TIMES for publication.

More than 2500 visitors were taken around the laboratory, as also many VIPs.

The one day NCL-ICMA get-together on 8 October 1982, attended by over 250 participants, was organised. Later in the day, the participants were taken around the laboratory and given a glimpse of the work going on in it.

Another important event was the round-table discussions on 'Innovative Research and Patentability Thereof', held on 15 December 1982. It was organised by the CSIR Patent Unit with the assistance of the DTS.

The high mark of the events of the year was the Sixth National Symposium on Recent Advances in Catalysis and Catalytic Reaction Engineering held in February 1983. Delegates from about 14 countries, besides numerous delegates from within India, took part in it. Its organisation from its inception to the end was with the full association of the DTS. A special 20 page handout was prepared for the occasion.

Full guidance was rendered to an MBA student of the University of Poona to prepare a detailed project report on pesticides in partial fulfilment of the course requirement.

7. Documentation services : (Infra-7)

The NCL library houses about 91,486 publications consisting of books, periodicals, patents, standards, technical reports, etc. During the year 1070 books, 2590 bound periodicals, 861 patents, 73 photocopies, microfilms and translations, 15 technical reports and 84 theses were added to the library. The library received 600 periodicals out of which 475 were on payment and remaining 125 on gratis and exchange basis.

During the year 12,416 publications were issued to staff and corporate members. Under inter-library loan scheme, 82 publications were borrowed and 75 were issued to other libraries. In addition to NCL staff, the library facilities were extended to persons from industries, government departments, universities, colleges and other organizations. Five -hundred and ninety-one outsiders made use of the NCL library facilties.

About 2427 current periodicals were circulated amongst senior scientists for browsing purposes. Current awareness services on Indian patents bulletin, chemical reactors, library bulletin, solar energy, biomass energy and nitrogen fixation were compiled and circulated among the scientists. During the year photocopies of 2,08,427 pages of scientific reference were supplied to NCL scientists and 18,683 pages to outside parties.

The NCL library brings out a technical bulletin for internal circulation in three areas (i) polymer science and engineering, and technology (ii) drugs and drug intermediates, and (iii) biomass. One bulletin is compiled every month by rotation. The bulletin highlights new developments/breakthroughs, statistical information on production/pricing, export, import and government policies, etc. The information included in these bulletins is culled from the literature available in the NCL library.

Publications

1. Singh, R. S.,
Information resources, services and information need in chemistry and chemical technology in India—A survey, *Annals of Library Science and Documentation*, **28** (1), 42 (1982).

8. Engineering services : (Infra-8)

Mechanical / Electrical / Refrigeration / Civil Engineering :

This section looks after the installation and maintenance of the laboratory units and utility services. It also undertakes fabrication and modification of equipment as per the requirements of the R & D work. During the year, 2186 and 1119 jobs were completed by the mechanical and electrical/refrigeration sections, respectively, of which the following deserve special mention :

Mechanical

1. Major work on the erection of a pilot plant for ethylene oxide has beencompleted. A lotof equipment was also designed and fabricated in the engineering services for this project. This includes a generator to produce ethylene gas, cyclone type air heater, liquid seal, etc. This work involves X-ray quality S. S. welding of pipes which are to be subjected to pressures up to 25 atmospheres. This is the first time that such welded joints have been made by the NCL engineering services on such a large scale, by the TIG welding process.

2. A pilot plant for vitamin B_6 project was erected. To erect this pilot plant a three storeyed steel structure was designed and raised in two days. Many modifications were carried out in the various equipment going into the plant. All the service and process lines were laid and the whole job was completed within the stipulated time.

3. Construction of a shed to house the welding, fabrication and carpentry units has been taken up.

4. Modifications as suggested by EIL engineers and scientist have been carried out in the regular packing pilot plant project. Further work is in progress.

5. Laying of water lines and installation of pump set and other accessories to supply water from the well to all the toilet tanks of the main building was completed. This will result in the saving of a good amount of tank water.

6. Design, fabrication and installation of a portable crane of 500 kg. capacity to serve the 75 litre autoclave in the high pressure laboratory.

7. An extruder for the silicon project, a one litre capacity S. S. reactor for the xylene project and a pressure osmosis cell for the polymer chemistry group were designed and fabricated.

8. A room was specially modified and airconditioned to install another NMR spectrometer. Renewal of a section of the laboratory in the biochemistry division was also carried out.

9. Pumps and other accessories in the pump house of the second well were installed.

10. Modification of S. S. filter for the endosulfan project was cerried out.

11. A fountain was designed and installed in front of the newly built guest house.

Electrical/Refrigeration

Electrification services were provided to various research laboratories and other buildings of the NCL, such as entomology extension, pilot plant II laboratory, 72 staff quarters and shopping centre. Gate light fixtures at colony entrances and approach road to the new guest house were constructed. Connections to two pumps of 10 HP each near the second well were made.

Two 50 KVA diesel engine generator sets for emergency power supply to critical points in chemical engineering laboratory, sophisticated instruments laboratory and biochemistry division were installed and commissioned.

Twenty-three window model air-conditioning units were installed in various divisions of the laboratory.

Civil

Besides the regular maintenance of the laboratory and the colony this section supervised the construction of the new building for polymer science and engineering and plant tissue culture, and staff quarters.

9. Glass blowing : (Infra-10)

NCL has a well equipped glass blowing section that undertakes designing and fabrication of special glass apparatus, such as constant pressure gas burettes, silica and borosilicate glass reactors, BET units, high vacuum systems, etc. This section mainly looks after the repairs, modifications and maintenance of glass equipment and apparatus.

During the year over 4000 regular jobs were attended to and over 70,000 ground glass joints and 300 stopcocks (including high vacuum stopcocks) were fabricated and used for these jobs.

During the year under review, Hindustan Insecticides Ltd., Udyogmandal, Cochin, was assisted in the erection of a new 4' dia glass pipe line for different process/production steps of endosulfan. This was done to eliminate corrosion as well as to avoid the formation of undesired side products.

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 product development, troubleshooting 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 troubleshooting ; (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 semi-commercial scale ; and (6) participating in the industry's negotiations for the import of technologies and in their assimilation. The norms and nature of such assistance are as follows :

1.1 Modes of technological assistance to industry by the NCL

1.1.1 Consultancy

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

1.1.2 Sponsored schemes

Industry can 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, standardisation, optimization, feasibility studies, analysis and testing, etc., on payment of *ad hoc* fees depending upon the nature of the problem. 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 in-plant 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 / semi-commercial plant is set up at the collaborating industry's site. Data obtained on this plant is used in the scale-up and design of the full scale commercial plant.

1.2 Supply of cultures

During the year under report 611 cultures from the National Collction of Industrial Microorganisms were supplied to various institutions.

1.3 Analytical services

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

1.	Atomic absorption	31
2.	ESCA	148
3.	Flame photometry	24
4.	GC/MS	5
5.	IR	52
6.	Magnetic susceptibility	64
7.	Mass spectral analysis	13
8.	Microanalysis	94
9.	Netzsch thermal analysis	64
10.	NMR	20
11.	SEM/XRF	124
12.	Spectrographic	19
13.	Spectrophotometric estimation / inorganic analysis of special nature	30
14.	UV, Vis-spectra	30
15.	VPC/GLC/HPLC	28
16.	X-ray diffraction	184

The total receipts on account of analyses / testing carried out during the year amounted to Rs. 1.165 lakhs.

1.4 Training

During the year 13 representatives of various industries and institutes were given training in chemistry of natural products, operation of different analytical instruments, protoplast technique, plant tissue culture technique, microbiological technique, study of crystal structure analysis of antibiotic compounds by X-ray methods, 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 considerations 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 has not already been established indigenously.

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

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 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 expense. The firm will be free to take back the non-consumable items on completion of the investigation.

(iv) A fixed charge of Rs. 11000/-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. 1200/-per year is made for contingencies, sundry expenses and daily wage labour. The charge will vary according to the nature and scale of work.

(vi) A sum 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 duration of the scheme is less than or more than a year, the charge payable is pro rata.

(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, the sponsor executes an agreement on a five rupee stamp paper with NCL/CSIR embodying various terms and conditions of the scheme.

2.2 Sponsored projects concluded during 1982-83

Process	Party
1. Hydrogenation of esters obtainable from non-edible / edible / acid oils	Aegis Chemical Industries Ltd., Jalgaon
2. Isolation, identification, characterisation and chemical testing of the ingredient of *Semecarpus anacardium* as an anticancer agent	Education and Youth Services Dept., S and T Cell, Govt. of Maharashtra, Bombay
3. Synthesis of various drugs and their intermediates-Ibuprofen	Chemical Industrial and Pharmaceutical Laboratory Ltd. (CIPLA), Bombay

2.3 Sponsored projects continued during 1982-83

Process	Party
1. Absorbing black paints for IR detectors	Dept. of Science and Technology, New Delhi
2. Aromatic polymers, polyamide, etc.	Dept. of Atomic Energy, Bombay
3. Carbonylation of ethanol to propionic acid	Deccan Sugar Institute, Pune
4. Conversion of crotonaldehyde to maleic anhydride	Deccan Sugar Institute, Pune
5. Dextropropoxyphene hydrochloride	Centaur Laboratories Pvt. Ltd., Bombay
6. Hydroxy terminated polybutadiene	Explosives Research and Development Laboratory (ERDL) Govt. of India (Ministry of Defence), Pune
7. IR spectrophotometer	Dept. of Science and Technology, New Delhi
8. Isolation of active alkaloids (vincristine and vinblastine) from *Vinca rosea*	Education and Youth Services Dept., S and T Cell, Govt. of Maharashtra, Bombay
9. Multiplication of Napier grass by tissue culture	National Organic Chemical Industries Ltd., Bombay
10. Physics and Chemistry of oxide surfaces	Indian National Science Academy, New Delhi
11. Rosin derivatives and modified resins	Dujodwala Resins and Terpenes Pvt. Ltd., Bombay
12. Synthesis of basic drugs and intermediates	Dexo Laboratories Pvt. Ltd., Hyderabad
13. Synthesis of various drugs and their intermediates such as atenolol, metoprolol, etc	Chemical Industrial and Pharmaceutical Laboratories Ltd., (CIPLA), Bombay
14. Total synthesis of antitumour anthracyclinones-adriamycine and its analogues	Education and Youth Services Dept., S and T Cell, Govt. of Maharashtra, Bombay

2.4 Sponsored projects newly undertaken during 1982-83

Process	Party
1. Adhesives from renewable resources	Carborundum Universal Ltd., Madras
2. Chloroquin phosphate	Sudarshan Chemical Industries Ltd., Pune and Standard Organic Ltd., Hyderabad
3. Drag reducers for oil transport	Oil Industry Development Board, New Delhi
4. Enzyme reagents	Dept. of Science and Technology, New Delhi
5. Multiplicity and stability in chemically reacting systems	Indian National Science Academy, New Delhi
6. Phenylglycyl chloride hydrochloride and *p*-hydroxyphenyl glycine	Sudarshan Chemical Industries Ltd., Pune
7. Polymer alloy resins	Dept. of Science and Technology, New Delhi
8. Solar grade polysilicon	Dept. of Science and Technology, New Delhi
9. Studies in fluidization with reference to acrylonitrile reactor	Indian Petrochemicals Corpn. Ltd., Baroda
10. Synthesis of doxepin and ketoprofen	Pharmaceutical Company of India (PCI), Bombay

2.5 Collaborative work

Wherever 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 collaborator will pay for such deputation according

to the CSIR norms and will bear all expenses of the scientists on travel, boarding, lodging and local transport.

(viii) The collaborating firm will have to make its own arrangements for the fabrication, setting up and commissioning of the full scale commercial plant (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 semi-commercial 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 no exercise its option within the said 90 days or after opting for it fails to establish commercial production within a specified period (2-3 years), NCL will be free to release the technology to other parties. In such an eventuality the collaborator will be compensated to the extent of the amount he has paid to NCL for the development of the project.

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

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

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

(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 1982-83

Process	Collaborating firm
1. Complex reactions in three phase slurry reactor	University of Erlangen, West Germany
2. Heat pumps	Salford University, UK
3. Regular packing development	Engineers India Ltd., New Delhi
4. Toluene disproportionation	IPCL, Baroda
5. Vapour phase oxidation of ethylene to ethylene oxide and glycol	Engineers India Ltd., New Delhi

3. TECHNOLOGY TRANSFER

3.1 Levels of transfer

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

Level I 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 I 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 IA of the American Institute of Chemical Engineers Code.

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

3.2 Processes released during 1982-83

Process	Licencee
Dimethoate	Khatau Junkar Ltd., Bombay

4. CONSULTANCY

Assistance of NCL experts in various branches of chemistry is made available to the chemical industry through consultancy services offered by NCL. Both public and private sector firms have 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.

Consultancy projects undertaken during the year are described below :

1. Hindustan Antibiotics Ltd., Pune.

   Under this consultancy NCL offered advisory assistance in the transfer of the immobilized enzyme technology for 6-APA from laboratory through pilot plant, to the industrial scale and gave a process package for improved recovery of vitamin C in the existing plant.

2. Hindustan Organic Chemicals Ltd., Rasayani

   Consultancy was rendered on improvements in productivity of the existing plants manufacturing organic chemicals, R & D planning and advice on diversification.

3. Indian Organic Chemicals Ltd. (Fibres), Madras

Consultancy was rendered on improvements in productivity of the existing polymerization plant (brought out by rational mathematical modelling and simulation), in spinning, strategies for product diversification and R & D planning.

4. Swadeshi Polytex Ltd., Ghaziabad (U. P.)

Consultancy services were rendered on process troubleshooting, optimization in polymerization, melt spinning and fibre line operations.

5. Hico Products Ltd., Bombay

Under this consultancy services were offered on the design of a chlorosilanes reactor of 1000 TPA capacity based on the process jointly developed by NCL and Hico.

6. Defence Research & Development Establishment, Gwalior

This consultancy covered development of catalyst for pilot plant operations to produce pyridine aldehyde and characterisation of the catalyst using sophisticated instruments, etc.

7. Peico Electronics and Electricals Ltd., Pune

Under this consultancy service technical advice and assistance relating to interpretation/evaluation of the results of testing carried out on the sophisticated instruments at NCL were offered.

5. PREMIA AND ROYALTIES RECEIVED BY NRDC THROUGH NCL PROCESSES DURING 1982-83

5.1 Premia

	Process	Firm	Premium Received (Rs.)
1.	Stable pin adhesive	Esdee Paints Pvt. Ltd., Thane	6,000.00

5.2 Royalties

	Process	Firm	Royalty Received (Rs.)
1.	Can sealing composition based on nitrile rubber	Arya Chemical Works, Calcutta	1,355.84
2.	Dimethoate	Shaw Wallace and Co. Ltd., Calcutta	82,446.00
3.	Ethion	—do—	21,182.00
4.	Monoethylaniline	Atul Products Ltd., Atul	3,409.00
5.	Polyurethane printing rollers	Sree Saraswaty Press Ltd., Calcutta	8,172.00

6. LECTURES AND SEMINARS

6.1 The following visiting scientists delivered lectures in the laboratory

	Scientist	Subject
1.	Dr. Alexander Novak, Director, Infrared, Raman and Raman Spectroscopy Laboratory, CNRS, Thiais, France	Spectroscopic study of hydrogen band
2.	Prof. Arvind Varma, Department of Chemical Engineering, University of Notre Dame, USA	(i) Ethylene oxidation on supported platinum catalyst in a fixed-bed reactor : Experiments and model (ii) Parametric sensitivity and runaway in tubal reactors (iii) Steady state and transient reaction kinetics on three-way catalysts for automotive exhausts
3.	Prof. H. L. Bhatnagar, Head, Chemistry Department, Kurukshetra University, Haryana	Phase transitions — some theoretical considerations
4.	Prof. K. L. Chopra, Indian Institute of Technology, New Delhi	Future electronic materials

Scientist	Subject
5. Dr. Dora Hayes, (UN Consultant), Chief, Lifestock Insect Laboratory, Beltsville, MD, USA	Controlled release systems against arthropod pests of livestock
6. Prof. G. Emig, University of Erlangen, Nurenberg, West Germany	Catalytic air oxidation of propylene to acrolein modelling based on data from an industrial fixed-bed reactor
7. Dr. S. R. Gadre, Department of Chemistry, University of Poona, Pune	How do electrons move in molecules
8. Mr. George Caux, Beckman Instruments, USA	Plasma emission spectroscopy
9. Dr. A. C. Ghosh, General Manager, Ranbaxy Laboratories Ltd., Okhla, New Delhi	Story of *Penicillium ilandicum* from mycotoxins to antitumour antibiotics
10. Prof. J. B. Goodenough, Inorganic Chemistry Laboratory, University of Oxford, UK	Photochemistry–present status
11. Dr. Helenka Shayn, Product Specialist, Pharmacia Fine Chemicals, Sweden	Lecture-cum-demonstration on purification and characterization of bio-molecules
12. Prof. H. Hofmann, University of Erlangen, Nurenberg, West Germany	Dependence of the kinetics of low temperature water-gas shift reaction on the catalyst oxygen activity as investigated by wave front analysis
13, Prof. (Mrs.) Indra K. Verma, Department of Chemistry, IIT, New Delhi	Polyimides
14. Dr. D. S. Joag, Department of Physics, University of Poona, Pune	Some applications of field electron emission and ion microscopy
15. Dr. L. Kohout, Czechoslavak Academy of Science, Institute of Orgar.ic Chemistry and Biochemistry, Flemingo, Prague, Czechoslovakia	Steroids with modified skeleton

Scientists	Subject
16. Dr. A. Luccio, Brookhaven National Laboratory (NSLS), New York, USA	Experiments with national synchrotron light source
17. Prof. E. W. J. Mitchell, Clarendon Laboratory, Oxford, UK	Neutron scattering in condensed matter research
18. Prof. R. Mutharasan, Department of Chemical Engineering, Drexel University, USA	(i) Hexosan hydrolysis in concentrated slurries (ii) Ethanol fermentation in yeast mobilized tubular fermentor
19. Prof. K. C. Nicolaou, Department of Chemistry, University of Pennsylvania, USA	(i) The endiandric acid story (ii) Total synthesis of macrolide antibiotics
20. Mr. J. A. Norohna, Engineering Division Eastman Kodak Company, USA	Reactor stability and control related to unstability and runaway conditions
21. Dr. S. B. Ogale, Department of Physics, University of Poona, Pune	Tailoring of solid surfaces; Modern techniques
22. Prof. S. S. Parmar, Department of Physiology, University of North Dakota, School of Medicine Grand Forks, North Dakota, USA	Neurohumoral mediation in drugs affecting central nervous system
23. Dr. T. S. Raghunathan, Indian Institute of Technology, Bombay	The hydrolysis of vegetable oils — Kinetic and equilibrium aspects
24. Prof. D. Ramakrishna, Department of Chemical Engineering, Purdue University, West Lafayette, Indiana, USA	(i) On symmetric interactions between reaction and multi-component diffusion (ii) Analysis of axial dispersion models without Danckwerts boundary conditions
25. Dr. V. V. Ramana Rao, Institute of Petrochemistry, Engler Bunte Institute, University of Karlsruhe, Karlsruhe, West Germany	Unusual reactions of substituted arylacetylenes with dry HCl gas

Scientist	Subject
26. Prof. C. N. R. Rao, Chairman, Solid State Materials and Structural Unit, Indian Institute of Science, Bangalore	Materials and microscope
27. Prof. Richard Glass, Department of Chemistry, The University of Arizona, Tucson, Arizona, USA	New synthetic methods aimed at the total synthesis of pyrrolizidine alkaloids and a synthesis of an important Corey prostaglandin intermediates
28. Dr. T. H. Ryan, ETD Research, England	Photoacoustic spectroscopy
29. Dr. Subhas Risbud, University of Illinois, USA	Synthesis of non-oxide glasses
30. Dr. H. P. Schelling, Head of Research, Agrochemical Division, Sandoz Ltd., Switzerland	Natural products
31. Dr. J. G. Shah, University of Bristol, UK	Growth and morphology compound semiconductors
32. Dr. B. N. Shintre, State University of New York — Buffalo, USA	Hydrodynamic modelling of motionless mixing
33. Dr. A Srinivasan, Department of Medical Chemistry, College of Pharmacy, University of Utah. Salt Lake City, Utah, USA	Pyridopyrimidine derivatives as antitumor agents
34. Prof. S. Y. Yano, Department of Synthetic Chemistry, Gifu University, Gifu, Japan	In commensurate phase transition of cholesteryl, 2, 2, 3, 3 tetrafluopropionate

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

Scientist	Subject	Venue
1. Dr. S. Badrinarayanan	Photoelectron spectroscopy–Auger electron spectroscopy and its applications	Workshop on characterisation and evaluation of heterogeneous catalysts, RRL, Hyderabad
2. Dr. D. N. Deobagkar	Two lectures on techniques in DNA sequencing	Zoology Department, Poona University, Pune
3. Dr. S. S. Katti	Studies on monomolecular film properties of long chain organic compounds	Chemistry Department, Poona University, Pune
4. Dr. R. A. Mashelkar	A unified free volume approach to transport phenomena in polymeric media	IUPAC Symposium, Athens
5. Dr. P. M. Nair	Application of NMR spectroscopy to drugs	Workshop on applications of NMR to drugs and pharmaceuticals, HAL, Pimpri
6. Dr. A. V. Rama Rao	(i) Synthesis with a difference	Indian Institute of Science, Bangalore.
	(ii) NCL and Indian Drug Industry — an over view	Get-together CSIR & Drug Industry at CDRI, Lucknow
	(iii) Newer concepts in chemistry and technology of some synthetic drugs	HPT Arts and BYK Science College, Nasik
	(iv) Studies directed towards the total synthesis of antitumour anthracycline antibiotics	Indian Association for Cancer Research, Bombay
	(v) Development of potential synthetic drugs	International seminar on medicinal plants, phytochemicals, pharmaceuticals and cosmetics, Export Promotion Council, New Delhi
7. Dr. P. K. Ranjekar	Four lectures on DNA structure and sequence organisation	Zoology Department, Poona University, Pune
8. Dr. V. J. Rao	Three lectures on polycrystalline silicon solar cells	Department of Physics, Shivaji University, Kolhapur
9. Dr. V. Shankar	Four lectures on isolation, purification and immobilization of enzymes	Zoology Department, Poona University, Pune
10. Dr. C. SivaRaman	(i) Carriers for immobilized enzymes (ii) Immobilized whole cells spectrum	Workshop on recent advances in enzyme engineering and technology, Biochemical Engineering Research Centre, IIT New Delhi

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

1. A one-day NCL-ICMA get-together was held at the NCL on 8th October 1982. Organised jointly by and the Indian Chemical Manufacturers' Association, Bombay, the get-together was attended by more than 200 participants including executives and R&D and production managers. The occasion provided an opportunity for both sides to appreciate each other's problems. The men from industry availed themselves of the opportunity to get to know NCL's R&D programmes and facilities available to tackle industrial problems and the efforts made by the NCL to help small-scale chemical manufacturers.

2. A one-day round table discussion on, "Innovative research and patentability thereof", organised by the CSIR Patent Unit was held in the NCL on 15 December 1982. Over 25 senior scientists from NCL actively participated in the discussions.

3. The Sixth National Symposium on, "Recen advances in catalysis and catalytic reaction engineering," was held at the NCL on 5-7 February 1983. The symposium was jointly organised by the NCL and Catalysis Society, of India, Madras, with the view of having exchange of ideas on recent developments in the field. It was attended by about 200 Indian and Foreign delegates including some of the eminent scientists in the field.

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7. STAFF STRENGTH (as on 31-3-83)

1. **Scientific**		
(i)	Director	1
(ii)	Scientist in D's Grade	2
(iii)	Dy. Director	1
(iv)	Scientist 'F'	5
(v)	Scientist E-II	3
(vi)	Scientist E-I	42
(vii)	Scientist 'C'	89
(viii)	Scientist 'B'	95
(ix)	Scientist 'A'	44
(x)	S. S. A.	88
(xi)	Scientific Assistant	66
(xii)	S. L. A. **Grade VIII	48
	Total	484
2. Technical		93
3. Administrative		165
4. Class IV (Technical) (Including Trade-Apprentices)		153
5. Class IV (Non-Technical)		82
	Total (1-5)	1177
6. Research Fellows, Pool Officers, Guest Workers and Graduate Trainees		
(i)	JRFs, SRFs, and PDFs	57
(ii)	CSIR Pool Officers	6
(iii)	Guest Workers	8
(iv)	Graduate Trainees	11
(v)	U. G. C. Teacher-Fellows	3
	Total	85
7. Scientific staff appointed for sponsored projects		30

*Denotes staff in position.

**Senior Laboratory Assistants (S. L. As) are included in the scientific category since a majority of them have post-graduate qualifications and are engaged in scientific work.

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8. STAFF NEWS

8.1 Awards /Honours

1. Dr. N. R. Ayyangar was awarded The Amar Dye-Chem. Limited Award for his outstanding R and D work and contributions to the dyestuff and other chemical industries, by The Indian Merchants' Chamber Diamond Jubilee Endowment Trust.

2. Dr. K. G. Das, Regional Research Laboratory, Hyderabad (formely of NCL), N. Sadasivan. H. S. Jagtap, M. Y. Gupta and S. P. Mirajkar were awarded a certificate of merit by the NRDC for the development of a controlled release herbicide.

3. Dr. S. K. Date was elected fellow of the Maharashtra Academy of Sciences, Pune, for his valuable contributions to the area of solid state materials.

4. Dr. L. K. Doraiswamy was awarded an honorary degree of 'Doctor of science' by the University of Salford, UK, for his outstanding contributions in the field of chemical engineering in a convocation held at Salford on 9th July 1982.

5. Dr. L. K. Doraiswamy was awarded the S. H. Zaheer Medal for 1983 for his outstanding contributions to the field of engineering and technology, by the Indian National Science Academy, New Delhi.

6. Dr. (Mrs.) Vidya Gupta was selected for the Sri. A. Krishnamurthy Award by the Society of Biological Chemists of India for the year 1981-82 for the best full length paper published in an Indian Scientific journal in 1981-82.

7. Dr. B. D. Kulkarni was awarded the Amar Dye-Chem Award by the Indian Institute of Chemical Engineers for excellence in research and development in chemical engineering for the year 1982.

8. Dr. R. A. Mashelkar was awarded the prestigious Herdillia Award for excellence in basic research in chemical engineering for the year 1982.

8.2 Deputations / Visits abroad

1. Dr. R. A. Mashelkar was invited to be a Visiting Professor in Chemical Engineering at the Institute for Kemiteknik, Denmark. This is one of the foremost chemical engineering schools in Europe with strong programmes in the areas of rheology and non-Newtonian fluid mechanics phase equilibria, mathematical methods in chemical engineering, catalysis and reaction engineering. During his stay, he gave a series of advanced seminars on 'Heat and Mass Transport Phenomena in Macromolecular Media.' Apart from this, Dr. Mashelkar took part in conducting a course on process and plant design for the senior chemical engineering students. Dr. Mashelkar was invited to present special seminars concerning the problems of chemical industry development in India. He was also invited to advise in the setting up of a new polymer research centre at the University of Copenhagen. (Six months from January 1982)

2. Dr. C. SivaRaman and Dr. N. G. Karanth visited several research laboratories and a few fermenter manufacturing companies in Japan, U. S. A., Canada and Europe under a sponsored study tour in connection with a UNDP project on Bioscience and Engineering. The objectives of the tour were to observe the latest developments in applications of biotechnology particularly related to the problem of bioconversion of cellulose to food, energy and chemicals, to identify centres for training NCL scientists in the field of biotechnology to identify technical consultants from various biotechnical centres for acting as advisors to the UNDP programme at NCL, and also to evaluate the capability of some possible equipment suppliers. (Seven weeks from 22nd April 1982)

3. Dr. K. S. Balaraman was deputed to Czechoslovakia under the bilateral exchange programme between CSIR and the Czechoslovak Academy of Sciences. He spent about 10 weeks in the, Institute of Macromolecular Chemistry, Prague and about 2 weeks in the Institute of Process Fundamentals, Suchlol, Prague, and had discussions with various experts in the field of polymer characterisation. During his stay he also visited other academic institutions and Polymer industries in and around Prague. (9th August to 2nd November 1982)

4. Mr. M. B. Sabne was deputed to Czechoslovakia, under the bilateral exchange programme between CSIR and the Czechoslovak Academy of sciences. He worked in the Institute of Macro-

molecular Chemistry, Prague, with Dr. F. Hrabak in the field of synthesis and characterization of polymers. During his stay Mr. Sabne also visited academic institutions and polymer industries in and around Prague. (9th August to 2nd November 1982)

5. Dr. A. S. Gupta was deputed to Czechoslovakia under the bilateral CSIR-Czechoslovak Academy of Sciences Exchange Programme. He visited Institute of Organic Chemistry and Institute of Entomology at Prague and Institute of Chemistry at Bratislara to familiarise himself with the work being carried out as also the techniques used in the area of natural products, pheromones and juvenile hormone including synthesis and field applications. (Six weeks during April, May 1982)

8.3 Participation of NCL scientists in symposia, seminars, etc.

Seminars / Symposium / Conference	Scientists
1. Seminar on management and uses of micrographic reprographic and office equipment Visvesvaraya Industrial and Technological Museum, Bangalore	Mr. V. G. Deodhar
2. 1st regional symposium on bio-organic chemistry, Indian Institute of Science, Bangalore	Dr. C. Siva Raman
3. 35th annual session of the Indian Institute of Chemical Engineers, Waltair	Dr. V. R. Choudhary Mr. M. G. Sane
4. National symposium on recent advances in catalysis and catalytic reaction engineering, National Chemical Laboratory, Pune	Dr. V. R. Choudhary Mr. V. S. Nayak
5. 10th national seminar on information services in libraries and information centres in India, Indian Institute of Technology, Kanpur	Mr. R. S. Singh
6. All India seminar on research methods in library and information science, University of Poona, Pune	Mr. R. S. Singh Mr. M. B. Patil and other technical staff of the library
7. Seminar on co-operation in information management, National Metallurgical Laboratory, Jamshedpur	Mr. R. S. Singh
8. National symposium on the chemistry of natural products, Bose Institute, Calcutta	Dr. A. V. Rama Rao Dr. S. N. Kulkarni
9. A short course on fundamentals of microprocessors, Institution of Engineers (India), Pune	Mr. S. D. Bakare
10. Workshop course on gene cloning and allied techniques, (organiser and instructor), Bhabha Atomic Research Centre, Bombay	Dr. D. N. Deobagkar
11. Meeting of the RAC sub-committee inorganic projects of RRL, Bhubaneswar	Dr. V. Damodaran

Seminars / Symposium / Conference	Scientists
12. Special symposium on molecular bio-physics and bio-crystallography	Dr. R. Tewari
13. Symposium of modern biology on recent trends in plant biochemistry, Mahabaleshwar	Dr. D. N. Deobagkar
14. Conference on teaching and research in development biology in Afro-Asian countries, University of Poona, Pune	Dr. D. N. Deobagkar
15. Guha Research Conference, Madgao, Goa	Dr. D. N. Deobagkar
16. Symposium on BASF intermediates for the pharma synthesis, organised by BASF Alkhengeseilschaft, West Germany, at Bombay	Dr. A. V. Rama Rao
17. International seminar on medicinal plants, phytochemicals pharmaceutical and cosmetics, organised by Export Promotion Council of India, New Delhi.	Dr. A. V. Rama Rao
18. 1st national symposium on bio-organic chemistry, Indian Institute of Science, Bangalore	Dr. T. N. Guru Row
19. Annual meeting of the AMRS, Indian Institute of Science Bangalore	Dr. P. M. Nair
20. Workshop on 'plant molecular biology in crop improvement, Bhabha Atomic Research Centre, Bombay	Dr. (Mrs.) Vidya Gupta
21. Workshop course on gene cloning and allied techniques, Bhabha Atomic Research Centre, Bombay	Mr. B. G. Patil
22. International symposium on water hyacinth, PRL, Hyderabad	Mr. D. Raghunath Mr. N. Amarnath

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

	Scientist		Subject
1.	Dr. D. N. Deobagkar	(i)	Invited talk on gene structure and organisation during the one-day national symposium at the Indian Institute of Science, Bangalore (July 1982)
		(ii)	Invited lecture on transfer of cellulose coding DNA from cellulomonas species to *Bacellus subtilis* at Indian Institute of Science, Bangalore (July 1982)
2.	Dr. L. K. Doraiswamy		Key-note address on data needs of the chemical industry at the symposium on applied thermodynamics for process design at the IIT, Bombay (January 1983)
3.	Dr. A. V. Rama Rao	(i)	Plenary talk on new approaches to the total synthesis of biologically active natural products at the 34th Session of Indian Pharmaceutical Congress Association, Varanasi (December 1982)
		(ii)	An invited lecture on Synthesis of natural products with biological activity at the seminar on natural products chemistry at the Bose Institute, Calcutta (February 1983)
4.	Dr. P. K. Ranjekar	(i)	Invited lecture on molecular organization of chromosomes, proceedings of Molecular Biology for Crop Improvement Workshop at Bhabha Atomic Research Centre, Bombay (December 1982)
		(ii)	Invited lecture on DNA sequence organisation in Eukaryotes, proceedings of Molecular Biology for Crop Improvement, Workshop at Bhabha Atomic Research Centre, Bombay (December 1982)
		(iii)	Invited lecture on plant nuclear genomes : evolutionary considerations, international meeting on 'Cosmic and Chemical Evolution' at Mahabaleshwar (January 1983)
		(iv)	Plenary talk on plant nuclear genomes : structure and function at the annual conference of Society of Cell Biology, New Delhi (December 1982)
5.	Dr. V. J. Rao		An invited lecture on grain boundary effects and passivation of the grain boundaries in silicon MIS solar cells, at the 2nd national conference on physics of semi-conductors at University of Delhi (December 1982)
6.	Dr. P. Roy-Chowdhury		Chaired one of the technical sessions of the second national conference on ferroelectrics and dielectrics, at Ravishankar University, Raipur (November 1982)

8.5 Membership of Committees

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

Scientist	Capacity	Committee
1, Dr. S. M. Abhyankar	Member	Board of Studies in Chemical Engineering Small Scale Industries Services Institute, Bombay
2. Dr. N. R. Ayyangar	Alternate Member	ISI-Chemical Division Council
	Member	Working group on capacity utilisation of alcohol, 'Ministry of Chemicals and Fertilizers, Govt. of India
3. Dr. L. K. Doraiswamy	Member	Sub-group on R & D in Petrochemicals appointed by the Planning Commission
	Member	Steering Committee on Fuels from Biomass—DST
	Member	Hindustan Lever Research Foundation, Bombay (Industrial Chemicals Panel)
	Member	ISI-Chemical Division Council
	Member	R & D Advisory Commitee-Fertilizer Association of India
	Member	Awad Committee — K. G. Naik Gold Medal, M. S. University of Baroda
	Member	International Reviewer, Panel of Applied Mechanics Reviews (S. E. Res. Inst., Texas, USA)
	Member	National Organizing Committee (INSA) of the 7th International Fermentation Symposium (1984)
	Member	Editorial Advisory Board of Advances in Transport Phenomena (Wiley Group)
	Member	CSIR—Chemical Engineering Research Committee
	Member	DST—Science Engineering Research Council
	Member	Sub-group on Conversion and Utilisation of Biomass—DST Chairman Sub-group of Steering Committee on Fuels from Biomass — DST
	Member	Awards Committee—I. I. Ch. E 1980
	Member	R & D group, Hindustan Antibiotics Ltd., Pimpri, Pune
	Member	CSIR Polytechnology Transfer Centre (Bombay) — Advisory Council
	Member	Technical Advisory Committee for Chemical Industry—Kerala State Industrial Development Corpn. Ltd.
	Member	Development Council for Inorganic Chemical Industries, Ministry of Industry, Govt. of India
	Member	Scientific Advisory Board — Nimbkar Agricultural Research Institute, Phaltan
	Member	Scientific Advisory Committee, Dept. of Petroleum, Ministry of Petroleum, Chemicals, and Fertilizers, Govt. of India
	Part-time Director	Indian Petrochemicals Corpn, Ltd., Baroda
	Part-time Director	Hindustan Organic Chemicals Ltd., Rasayani

Scientist	Capacity	Committee
3. Dr. L. K. Doraiswamy (Contd.)	Chairman	CSIR-Advisory Committee on Engineering (JRF/SRF)
	Chairman	Technical Manpower Committee, Govt. of Maharashtra
	Member	Council of Indian National Science Academy, New Delhi (1983 to 1985)
	Member	Governing Council and Academic Council, IAT, Pune
	Member	ICMA Awards Selection Committee (1983)
	Member	University of Poona Senate
	Member	Academic Committees of National Defence Academy, Pune and Army Cadet College, Dehra Dun
	Chairman	CSIR Review Committee to review the functioning of Field/ Regional Centres of National Laboratories / Institutes and Polytechnology Transfer Centres, etc.
	Member	CSIR Standing Committee for Emeritus Scientists
	Member	Development of Western Ghat Committee
4. Dr. N. D. Ghatge	Member	Governing Council of Indian Rubber Manufactures' Research Association, Bombay
	Member	Expert panel of Rubber Research Institute of India, Kottayam
5. Dr. T. N. Guru Row	Member	National Information Centre for Crystallography (NICRYS)
6. Dr. N. G. Karanth	Member	Editorial Board of the new International Journal of Bioprocess Technology, to be published quarterly by Marcel Dekker Inc. of New York and Basel
7. Dr. R. A. Mashelkar	Editor	Advances in Transport Processes : Review Series, published by Wiley Eastern/Wiley Halsted
	Editor	Chemical Engineering Communicatcns, published by Gordon and Breach (USA)
	Member	Editorial Board of Rheologica Acta, published by Springer Verlag (Germany)
	Member	Publications Committee-Indian Chemical Engineer
	Member	Reviewers' Board-Applied Mechanics Reviews, S. E. Res. Inst., Texas (USA)
	Member	Executive Committee-Indian Institute of Chemical Engineers (Poona Local Centre)
	Associate Member	International Committee on Rheology
	Member	Editorial Board of Indian Journal of Technology (1983-85)
8. Dr. R. B. Mitra	Member	Development Council for Organic Chemicals constituted by the Ministry of Petroleum and Chemicals, New Delhi
	Member	Central Insecticides Board, Faridabad
	Member	Research Advisory Council, RRL, Jorhat

Scientist	Capacity	Committee
9. Dr. V. M. Nadkarni	Member	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
10. Dr. U. R. Nayak	Member	Sub-Committee of the Development Committee for Oleoresins, gums and essential oils.
11. Dr. A. V. Rama Rao	Member	Board of Studies in Applied Chemistry, University of Cochin, Kerala
12, Dr. S. C. Sethi	Member/ Group Leader	Sub-committee for Forest Product Research — Dept. of Science and Technology — Science Advisory Committee to the Cabinet (SACC)
	Member	Natural and Synthetic Perfumery Materials Sectional Committee, PCDC 18, ISI, New Delhi
13. Mr. M. S. Setty	Member	Screen Printing Association of India, Bombay
14, Dr. A. P. B. Sinha	Member	Materials Research Committee, Dept, of Atomic Energy.
15. Dr. C. SivaRaman	Member	Guha Research Conference, Chorwad (Gujarat)
	Member	Indian Academy of Sciences, Bangalore
	Member	Indian National Committee for the International Union of Biochemistry (IUB), INSA, New Delhi.
16. Dr. R. Tewari	Member	Regional Computer Centre Users Committee, NCL nominee

8.6 Degrees received by NCL Staff members and research fellows/guest workers

Sr. No.	Name	Degree	University	Subject	Guide
1	2	3	4	5	6
1.	Miss R. R. Ahuja	Ph. D.	Poona	Optical induction	Dr. V. N. Gogte
2.	Mrs. D. M. Barve	M. Sc.	Poona	Study on plant tissue culture	Dr. V. Jagannathan
3.	Mr. S. B. Bendre	M. Sc.	Poona	Studies in gas chromatography	Dr. B. B. Ghatge
4.	Mr. U. G. Bhat	Ph. D.	Poona	Chemical investigations of sesquiterpenoids	Dr. B. A. Nagasampagi
5.	Mr. S. K. Choudhari	Ph. D.	Poona	Studies on Raney nickel catalyst	Dr. V. R. Choudhary
6.	Mr. C. E. Deshpande	Ph. D.	Poona	Unstable oxides MnO and FeO; their stabilization and use in some ferrites	Dr. M. N. S. Murthy
7.	Mr. M. V. Deshpande	Ph. D.	Poona	Studies on cellulases and hemi-cellulases	Dr. J. C. Sadana
8.	Mr. C. P. Joshi	Ph. D.	Poona	Cytological and molecular biological studies in plant genomes	Dr. P. K. Ranjekar
9.	Mr. A. N. Kadam	Ph. D.	Poona	Development and applications of chromatographic technique in the studies of pesticides	Dr. B. B. Ghatge
10	Mr. M. S. Kirtiwar	Ph. D.	Poona	Studies on adiabatic compressibility of polyelectrolytes in solution : Effect of solvent	Dr. P. Roy-Chowdhury
11.	Mr. A. H. Lachke	Ph. D.	Poona	Isolation, purification and characterisation of cellulolytic enzymes from *Sclerotium rolfsii*	Dr. J. C. Sadana
12.	Mr. T. P. Mohandas	Ph. D.	Poona	Oxidative transformation with organic trivalent iodine compounds	Dr. P. M. Nair
13.	Mr. U. P. Mulik	Ph. D.	Shivaji	Studies in synthesis of (i) Diamines, diisocyanates and polyimides therefrom (ii) Novel polyamide polymers	Dr. N. D. Ghatge
14.	Mr. K. P. Naikwadi	Ph. D.	Shivaji	Liquid crystals, their synthesis and application as stationary phases in gas chromatography	Dr. B. B. Ghatge
15.	Mr. P. V. Nikrad	Ph. D.	Poona	Novel organic intermediates and reactions	Dr. N. R. Ayyangar

1	2	3	4	5	6
16.	Mr. S. K. Pandit	Ph. D.	Poona	Synthetic studies in organo-titanium (IV) and organotin (IV) chemistry and sulphur dioxide insertion reactions in related compounds	Dr. C. Gopinathan
17.	Mrs. S. A. Pardhy	Ph. D.	Poona	Studies in organoxy-titanium and organotin derivatives of substituted hydrazines	Dr. C. Gopinathan
18.	Mr. M. B. Patil	M. Lib. Sc.	Poona	Patterns of literature use by the scientists at the National Chemical Laboratory	Mr. M. R. Riswadkar*
19.	Mr. Y. S. Sanghvi	Ph. D.	Poona	Synthesis of terpenoids and epoxides	Dr. A. S. Rao
20.	Mr. S. D. Sansare	Ph. D.	Bombay	Studies on the poisoning of copper chromite catalyst by thiophene	Dr. L. K. Doraiswamy
21.	Mr. D. D. Sawaikar	M. Sc.	Poona	Studies in isoprenoids and related compounds	Dr. C. R. Narayanan (ex-Scientist)
22.	Mr. J. C. Sehra	Ph. D.	Poona	Kinetics of coordination polymerisation of styrene with butoxy titanium trichloride and and aluminium alkyls	Dr. S. Gundiah
23.	Mr. R. T. Shah	Ph. D.	Banaras	Development of a laboratory catalytic reactor based on rotating disc flow	Dr. L. K. Doraiswamy
24.	Mr. K. Shankaran	Ph. D.	Poona	Synthesis of terpenoids and some applications of Diels-Alder and fragmentation reactions	Dr. A. S. Rao
25.	Mr. R. F. Shinde	M. Sc.	Poona	Structural and electrical properties of thick films of V_2O_5 doped RuO_2	Dr. A. P. B. Sinha
26.	Mr. J. S. Sohani	Ph. D.	Poona	Studies in sesquiterpenoids lactones	Dr. B. A. Nagasampagi

*Guide not from NCL

8.7 NCL Scientists recognised by different universities as research guides

1.	Dr. Ayyangar, N. R.	Bombay, Poona
2.	Dr. Brahme, P. H.	Poona
3.	Dr. Chaudhari, R. V.	Poona, Shivaji
4.	Dr. Choudhary, V. R.	Poona, Shivaji
5.	Dr. Damodaran, V.	Poona, Shri Venkateswara
6.	Dr. Date, S. K.	Poona
7.	Dr. Deobagkar, D. N.	Poona
8.	Dr. Doraiswamy, L. K.	Banaras, Bombay, Calcutta, Jadavpur, Nagpur, Poona, Salford (UK)
9.	Dr. Ghatge, B. B.	Poona, Shivaji
10.	*Dr. Ghatge, N. D.	Bombay, Poona, Shivaji
11.	Dr. Gogte, V. N.	Poona, Shivaji
12.	Dr. Gokarn, A. N.	Poona
13.	Dr. Gopinathan, C.	Marathwada, Poona
14.	Dr. Gundiah, S.	Poona
15.	Dr. Harish Narain	Shivaji
16.	Dr. Ingle, T. R.	Poona, Shivaji
17.	*Dr. Jagannathan, V.	Baroda, Bombay, Poona
18.	Dr. Jose, C. I.	Poona
19.	Dr. Karanth, N. G.	Nagpur, Poona, Shivaji
20.	Dr. Katti, S. S.	Bombay, Poona
21.	Dr. Krishnamurthy, K. V,	Shri Venkateswara
22.	Dr. Kulkarni, B. D.	Poona
23.	Dr. Kulkarni, G. H.	Nagpur, Poona
24.	Dr. Kulkarni, S. N.	Bombay, Karnataka, Poona, Shivaji
25.	Dr Mascarenhas, A. F.	Poona
26.	Dr. Mashelkar, R. A.	Banaras, Bombay, Nagpur, Poona, Salford (UK)
27.	Dr. Mitra, R. B,	Bombay, Poona

28.	Dr. Nagasampagi, B. A.	Poona
29.	Dr. Nair, P. M.	Andhra, Poona, Shivaji
30.	Dr. Nayak, U. R.	Poona, Shivaji
31.	Dr. Pansare, V. S.	Poona
32.	Dr. Panse, G. T.	Shivaji
33.	Dr. Pant, L. M.	Poona
34.	Dr. Patwardhan, V. S.	Shivaji
35.	Dr. Rama Rao, A. V.	Bombay, Poona, Shivaji
36.	Dr. Ranjekar, P. K.	Poona, Shivaji
37.	Dr. Rao, A. S.	Bombay, Poona, Shivaji
38.	Dr. Ravindranathan, T.	Bombay, Marathwada, Shivaji
39.	Dr. Roy-Chowdhury, P.	Marathwada, Poona, Shivaji
40.	*Dr. Sadana, J. C.	Aligarh, Poona
41.	*Dr. Sen, D. N.	Bombay, Poona, Shivaji
42.	Dr. Sethi, S. C.	Poona
43.	Dr. Sharma, R. N.	Poona, Shivaji
44.	Dr. Sinha, A. P. B.	Banaras, Bombay, Poona, Shivaji
45.	*Dr. SivaRaman, C.	Poona
46.	Dr. Sonawane, H. R.	Poona
47.	Dr. Srinivasan, M. C.	Shivaji
48.	Dr. Tewari, R.	Poona
49.	Dr. Umapathy, P.	Poona
50.	Dr. Vartak, H. G.	Poona, Shivaji
51.	Dr. Vernekar, S. P.	Shivaji

*Retired/Emeritus scientists

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9. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

1. Balakrishnan, I., Hegde, S. G., Rao B. S., Kulkarni S. B. and Ratnasamy, P.,
   Acidity and catalytic activity of Mo-ZSM-5 catalysts in the conversion of methanol to hydrocarbons,
   4th International Conference on Molybdenum, Colorado, USA, August 1982.

2. Roy-Chowdhury, P. and Deshpande, S. B.,
   Piezoelectric properties of lead titanate — lead zirconate ceramic modified with oxides of chromium, manganese, cobalt and uranium,
   2nd National Conference on Ferroelectrics and Dielectrics, Ravishankar University, Raipur, November 1982.

3. Murthy, M. N. S., Deshpande, C. E. and Bakare, P. P.,
   Electronic ceramics with unstable valency states of transition metal ions,
   International symposium on Ceramics, *BEL* Bangalore, November 1982.

4. Sahasrabudhe, N. A., Rele, M.V., Sainani, M. N., Balakrishnan, H. and Ranjekar, P. K.,
   Analysis of the DNA of a cellulolytic filamentous fungus *Penicillium funiculosum*,
   Proceedings of the 51st Meeting of Society of Biological Chemists (India), Chandigarh, November 1982.

5. Patil, B. G. and Ranjekar, P. K.,
   A rapid and simple method of isolation of DNA from the filamentous fungus *Trichoderma viride*,
   Proceedings of the 51st Meeting of Society of Biological Chemists (India), Chandigarh, November 1982.

6. Joshi, C. P., Patankar, S. M. and Ranjekar, P. K.,
   Cytomolecular determinants of interphase nuclease structure in plants,
   Proceedings of the 51st Annual Meeting of Society of Biological Chemists (India), Chandigarh, November 1982.

7. Bhave, M., Lagu, M. and Ranjekar, P. K.
   Characterisation of sequence complexity and DNA sequence organisation in five cucurbitaceae genomes,
   Proceedings of the 51st Annual Meeting of Society of Biological Chemists (India), Chandigarh, November 1982.

8. Deobagkar, D. N., Muralidharan, K. and Chandra, H. S.,
   Heterochromatin and Methylation of DNA in mealybugs,
   Conference on Teaching and Research in Development Biology in Afro-Asian Countries, University of Poona, Pune, November 1982.

9. Ghatge, B. B. and Bapat, B. V.
   Synthesis of laterally substituted liquid crystalline compounds and their properties as GLC substrates,
   9th International Conference of Liquid Crystals, Bangalore, December 1982.

10. Singh, R. S. and Dalvi, (Mrs.) V. S.,
    Patent information service at NCL,
    10th National Seminar on Information Services in Libraries and Information Centres in India, Indian Institute of Technology, Kanpur, December 1982.

11. Choudhary, V. R. and Chaudhary, S. K.,
    Hydrogenation of *p*-nitrotoluene on Raney nickel in stirred three phase slurry reactor,
    35th Annual Session of the Indian Institute of Chemical Engineers, Waltair, January 1983.

12. Choudhary, V. R. and Sane, M. G.,
    Slurry phase hydrogenation of *o*-nitrophenol on Raney nickel aged at different conditions,
    35th Annual Session of the Indian Institute of Chemical Engineers, Waltair, January 1983.

13. Karanth, N. G.,
    Some aspects of continuous production of fermentative ethanol,
    VIII International Symposium of Yeasts, Bombay, January 1983.

14. Iqbal, S. H., and Saraf, C. U.,
    NCL and small scale chemical industries,
    Seminar on chemicals and chemical intermediates industry in small scale sector, SISI, New Delhi, January 1983.

15. Singh R. S., and Patil, M. B.,
    Bibliometric study of papers contributed by NCL scientists,
    All India seminar on research method in library and information science, University of Poona, Pune, January 1983.

16. Dake, S. B. and Chaudhari, R. V.,
Carbonylation of organic halides using Pd-complex catalyst : a novel route for carboxylic acids and esters,
6th National symposium on recent advances in catalysis and catalytic reaction engineering NCL, Pune, February 1983.

17. Deshpande, R. M. and Chaudhari, R. V.,
Hydroformylation of unsaturated alcohols/esters : A new route for glycols,
6th National symposium on recent advances in catalysis and catalytic reaction engineering, NCL, Pune, February 1983.

18. Nayak, V. S. and Choudhary, V. R.,
Selective poisoning of stronger acid sites on H-ZSM-5 with pyridine for hydrocarbon conversion in a pulse micro-reactor,
6th National symposium on recent advances in catalysis and catalytic reaction engineering, NCL, Pune, February 1983.

19. Singh, R. S. and Patil, M. B.,
Modern information handling methods in chemistry in India,
Seminar on co-operation in information management, National Metallurgical Laboratory, Jamshedpur, February 1983.

20. Kulkarni, S. N.,
Synthesis of zamene,
Seminar on natural products chemistry, Bose Institute, Calcutta, February 1983.

21. Mitra, R. B., Hazra, B. G. and Kapur, V. M.,
Synthesis and plant growth promoting activity of analogues of brassinolide and castasterone, National symposium on natural product chemistry, Bose Institute, Calcutta, February 1983.

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10. PATENTS IN FORCE

Indian patents sealed

1. 141245
Improvements in or relating to the preparation of 1, 3, 3-trimethyl-2-methylene indoline.
Ayyanagar, N. R., Pandit, S. K. and Tilak, B. D.

2. 142789
Preparation of aminopolyols using CNSL and making polyurethane rigid foams.
Ghatge, N. D. and Gujar, K. B.

3. 144636
A process for the preparation of new yellow naphthoquinoquinazoline dione disperse dyes for polyester fibres
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

4. 144674
Process for the preparation of a new slow-release herbicide to control *Parthenium hysterophorus* Linn.
Thayumanavan, B., Jagtap, H. S., Tarkunde, A. B., Das, K. G. and Tilak, B. D.

5. 144875
Improved continuous high pressure process for hydrogenation of glucose to produce sorbitol.
Brahme, P. H. and Verma R. P.

6. 147337
Improvements in or relating to the prepartion of laevomenthol.
Divakar, K. J., Kulkarni, S. B. and Rao, A. S.

7. 147527
A process for the preparation of new yellow to violet azo-N-substituted pyridone disperse dyes for synthetic fibres.
Ayyangar, N. R., Deshpande, A. D. and Tilak, B. D.

8. 147825
Process for the preparation of new yellow pyrimidanthronyl triazine disperse dyes for polyester fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

9. 147868
A process for the preparation of new yellow to red azo-N-substituted 6-substituted amino-pyridone disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, A. D. and Tilak, B. D.

10. 147994
A process for the preparation of new yellow isothiazolanthronyl triazine disperse dyes for polyester fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

11. 148159
A process for the preparation of new yellow benzanthronyl triazine disperse dyes for synthetic fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

12. 148462
A process for the preparation of new yellow to scarlet azo cationic dyes using para-aminophenacyltrimethylammonium chloride as the diazo component for application to polyacrylonitrile fibres.
Ayyangar, N. R. and Khanna, I. K.

13. 148910
A process for the preparation of yellow to violet azo disperse dyes from 2-hydroxy-3-naphthoic acid-alkylamides and their 6-sulphoalkylamido derivatives for the application to polyester cotton blends.
Ayyangar, N. R., Bapat, B. V. and Tilak, B. D.

14. 147817 (15/DEL/78)
A process for the preparation of new red triazinyl-azonaphthol disperse dyes for polyester fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

15. 148119 (265/DEL/78)
A process for the preparation of new yellow naphthoquino-quinazoline dione disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

16. 148132 (266/DEL/78)
A process for the preparation of new yellow naphthoquino-quinazoline dione disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

17. 149249 (165/DEL/78)
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.

18. 150006 (343/DEL/80)
A process for the preparation of new red triazinylazonaphthol disperse dyes for polyester fibres (Divisional application to patent application No. 15/DEL/78).
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

19. 150166 (752/DEL/78)
A process for the preparation of new violet naphthostyril disperse dyes for polyester fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

Indian patent applications accepted

1. 150165 (750/DEL/78)
A process for the preparation of new violet naphthostyril cationic dyes for application to polyacrylonitrile fibres.
Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

2. 150391 (761/DEL/78)
Synthesis of 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., Khanra, A. S., Choudhari, P. N. and Bhawal, B. M.

3. 150470 (958/DEL/78)
A new process for the preparation of *cis*-caronic acid from 4-∝-acetyl-car-2-ene.
Mitra, R. B., Kulkarni, G., H. Gore, K. G., Khanna, P. N., Joshi, G. D. and Khanra, A. S.

4. 150474 (793 / DEL / 78)
Improvements in or relating to the preparation and sintering of manganous zinc ferrous ferrite,
Murthy, M. N. S., Deshpande, C. E., Bakare, P. P. and Shrotri, (Mrs.) J. J.

Indian patent applications filed

1. 318/DEL/78
A process for the prepartation of new yellow to violet azo-N-substituted homophthalimide disperse dyes for synthetic fibres.
Ayyangar , N. R., Rao, U. S. and Tilak, B. D.

2. 347 / DEL / 79
A novel process for recovery of D (+) camphorsulphonic acid during the resolution of DL-phenyl-glycine.
Mitra, R. B., Joshi, B. N., Hinge, V. K. and Natekar, (Miss) M. V.

3. 411 / DEL / 79
Process for the preparation of 3-phenoxybenzyl 1R-*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. 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.

5. 703 / DEL / 79
A process for the preparation of new yellow to blue azopyride-2-one pendant cationic dyes for acrylic fibres.
Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

6. 704 /DEL/79
A process for the preparation of new yellow to red azoarylimidazopyridone disperse dyes for synthetic fibres.
Ayyangar, N. R., Rao, U. S. and Tilak B. D.

7. 797/DEL/79
A new process for the preparation of 1R-*cis* 2, 2-dimethyl-3-(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.

8. 798/DEL/79
Process for the preparation of ∝-cyano-3-phenoxybenzyl 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,

9. 869/DEL/79
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.

10. 922 /DEL /79
A process for the preparation of new yellow to violet azo disperse dyes derived from morpholinonaphthalenes for application to synthetic fibres.
Ayyangar, N. R., Moghe, P. P. and Tilak B. D.

11. 942/DEL/79
Process for the preparation of a novel controlled release mosquito larvicide.
Das, K. G., Mirajkar, S. P. and Tungikar, V. B.

12. 949/DEL/79
A process for the preparation of new blue azo disperse dyes from 3-chloro 1, 2, 3, 4-tetrahydro-7, 8-benzoquinoline and the isomeric 2-(chloromethyl) - benz- (g) -indoline for the application of synthetic fibres.
Ayyangar, N. R., Moghe, P. P. and Tilak, B. D.

13. 950/DEL/79
A process for the preparation of blue napthostyril cationic dyes.
Ayyangar, N. R., Moghe, P. P. and Tilak B. D.

14. 91/DEL/80
An improved chemical process for the manufacture of high alpha cellulose pulp from naturally occurring cellulosic materials.
Bendale, D. S., Mahajan, M. B. and Karnik, R. S.

15. 208/DEL/80
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.

16. 378/DEL/80
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.

17. 425/DEL/80
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-ol.
Mitra, R. B., Kulkarni, G. H., Muljiani, (Miss) Z., Naik, V. G. and Deshmukh, A. R. A. S.

18. 426/DEL/80
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.

19. 444/DEL/80
A process for the manufacture of sodium hydrosulphate via ferrous hydrosulphite.
Gopinathan, C., Gopinathan, (Mrs.) S., Unny, I. R., Awasarkar, P. A., Pandit, S. K., Pardhy, (Mrs.) S. A., Chatterjee, A. K. and Sonsale, A. Y.

20. 453/DEL/80
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.

21. 512/DEL/80
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.

22. 581/DEL/80
Catalyst and process for the conversion of alcohol to hydrocarbons.
Kulkarni (Miss), S. B., Ratnasamy, P., Balkrishnan I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

23. 599/DEL/80
A process for the preparation of new yellow naphthoquinoquinazolinedione disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

24. 663 / DEL / 80
A process for the isolation of active principles from the plant *Lavendula gibsoni* (*L. perottetii* Benth; family Lamiaceae) exhibiting antigonadial, antifeedant, oviposition deterrent, repellent and ovicidal activities against insect pests.
Gupta, A. S., Sharma, R. N., Patwardhan, (Mrs.) S. A., Bhosale, A. S., Zaqu, (Miss) G. V., Nadkar, R. Y. and Nanda, B.

25. 669/DEL/80
Catalyst and process for the selective conversion of ethylene into aromatic hydrocarbons containing 6 to 8 carbon atoms.
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

26. 732/DEL/80
Catalyst and process for the alkylation of benzene to ethylbenzene.
Ratnasamy, A., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Ghandavar, K. H.

27. 843/DEL/80
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.

28. 900/DEL/80
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.

29. 290/DEL/81
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.

30. 291 / DEL / 81
Process for the preparation of a catalytic composite material,
Kulkarni (Miss), S. B., Ratnasamy, P., Shiralkar, V. P., Balakrishnan, I. and Kavedia, C. V.

31. 630/DEL/81
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.

32. 668/DEL/81
A process for the preparation of polyamides.
Ghatge, N. D. and Mullick, U. P.

33. 702/DEL/81
A process for the preparation of improved cellulose acetate.
Ghatge, N. D., Sabne, M. B. and Gujar, K. B.

34. 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.

35. 707/DEL/81
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.

36. 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.

37. 21/DEL/82
Process for the preparation of improved composite catalyst material.
Kulkarni, (Miss) S. B., Ratnasamy P., Balakrishnan, I., Kulkarni, S. J. and Borade, R. B.

38. 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.

39. 78/DEL/82
An improved process for the preparation of substituted aromatic diamines.
Ghatge, N. D. and Maldar, N. N.

40. 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.

41. 476/DEL/82*
An improved process for the preparation of N-Akyldiisopropanolamines.
Nerlekar, P. G. and Moghe, P. P.

42. 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.

43. 668 / DEL/82*
A process for the synthesis of (+)4-demethoxy-7- deoxydaunomycinone - A key intermediate for the manufacture of 4-demethoxydaunomycin, an antitumor compound.
Rama Rao, A. V., Chanda, B. and Borate, H. B.

44. 670 / DEL / 82*
An improved process for the preparation of thermoplastic polyurethane polymers.
Ghatge, N. D. and Jadhav, J. Y.

45. 57 /DEL/83*
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reactions.
SivaRaman, H., Rao, B. S., Shankar, V., Pundle, A. V., and SivaRaman, C.

46. 58 / DEL / 83*
A catalytic process for the conversion of methanol to olefins.
Kulkarni, (Miss) S. B., Ratnasamy, P. Balakrishnan, I., Rao, B. S., Shiralkar, V. P., Hegde, S. G. and Kotasthane, A. N.

47. 60 /DEL/83*
An improved process for the production of pyridoxine hydrochloride (vitamin B_6).
Rama Rao, A. V., Joshi, C. G., Rao, M. N, and Sathe, V. M.

48. 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.

49. 140 /DEL /83*
A process for the preparation of car-4-ene-3-01, an intermediate for use in the synthesis of pyrethroid insecticides.
Mitra, R. B., Muljiani, (Miss) Z. and Deshmukh, A. R. A. S.

Foreign patent application sealed

1. U. K. Patent Application No. 7935813
New pyrethroid (corresponds to the Indian Patent Application No. 761 / DEL /78-Synthesis of 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., Khanra, A. S. and Bhawal B. M.

Foreign patent application filed

1. Netherland Patent Application No. 79.07332
Werkwijze on insecticiden uit de pyrethoide-groep te bereiden (corresponds to the Indian Patent Application No. 761 /DEL/78- Synthesis of 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., Khanra, A. S. and Bhawal, B. M.

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* These patents were newly filed during the year.

RESEARCH UTILISATION

TABLE I : PRODUCTS MANUFACTURED ON THE BASIS OF NCL KNOW-HOW

(T — Metric tons)

Sl No.	Name of the process/product	Field of utilisation	Name of the manufacturer (year of commencement of production)	Production		Capacity installed. Nature of release and remarks
				1982-83 Qty./value Rs. in lakhs	Up to March'82 Qty./value Rs. in lakhs	
1	2	3	4	5	6	7
1.	Acetanilide	Intermediate	Hindustan Organic Chemicals Ltd. P. O. Rasayani 410 207 (through project engineers R. L. Dalal & Co. Bombay 400 018) (1969)	2337.00 T 450.97	18631.49 T 2525.27	2000 T Non-exclusive
2.	Antipriming compositions	Antipriming in locomotives	Research Designs and Standards Organization M&C Wing, Lucknow 226 011 (1964)	2.00 T 0.24	158.58 T 15.13	26 T Non-exclusive
3.	*tert*-Butyl catechol	Synthetic rubber	Percynic Chemicals, Bombay Silk Mills Bldg., Industrial Estate, Lalbaug, Bombay 400 012 (1972)	5.63 T 7.05	62.19 T 67.42	50 T Non-exclusive
4.	Butyl titanate	Varnishes, enamels	Synthochem, 33 A, Laxmibainagar Industrial Estate, Indore 452 006 (1973)	28.77 T 17.26	182.67 T 88.51	36 T Non-Exclusive
5.	Calcium hypophosphite	Pharmaceuticals	Hypophosphite & Co., 79-F, Princess Street, Bombay 400 002 (1967)	10.00 T 9.00	180.25 T 135.30	24 T (including other hypophosphites) Sponsored
6.	Calcium silicate	Low density insulators	Newkem Products Corpn., Harganga Mahal, Khodabad Circle, Bombay 400 014 (1968)	— —	5145.95 T 244.82	4200 T Sponsored

1	2	3	4	5	6	7
7.	Can lining composition	Metal can industry	Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700 013 (1974)	2.45 T 0.77	3.89 T 1.33	500 Kg/day Non-exclusive
8.	Can sealing composition	Metal can industry	—do— (1962)	73.75 T 7.85	513.66 T 37.07	500 Kg/day Non-exclusive
9.	Carbimazole	Pharmaceuticals	Nicholas Laboratories India Ltd., Sion-Trombay Road, Deonar, Bombay 400 088 (1970)	— —	391.59 Kg 32.42	250 Kg Sponsored
10.	Catechol	Pharmaceuticals	Percynic Chemicals Bombay (1972)	5.98 T 4.68	58.17 T 34.14	50 T Non-exclusive
11.	Cation exchange resin-styrene DVB base	Demineralization of liquids	Bharat Process & Mechanical Engineers Ltd., Dakhindari, Calcutta 700 048 (1968-69)	— —	28662.18 Cft 98.39	10,000 Cft Non-exclusive
12.	Cationic dyes For acrylic fibres	Dyes for synthetic fibres	Sahyadri Dyestuffs & Chemicals, 177 Parvati-Vithalwadi Road, Pune 411 030 (1976)	— —	123.47 T 140.59	120 T Sponsored
13.	Chlorobenzenes	Industrial chemicals	Hindustan Organic Chemicals Ltd., P. O. Rasayani (1976)	3797.00 T 345.72	21163.41 T 1543.60	4500 T Sponsored
14.	Chloromethanes	Industrial chemicals	Standard Alkali Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1974)	450.00 T 13.42	3570.12 T 158.02	3000 T —
15.	Diethyl-*m*-aminophenol	Dye intermediate	Sahyadri Dyestuffs & Chemicals, Pune (1970)	— —	610.03 T 657.05	150 T Sponsored
16.	Dihydroisojasmone and peach aldehyde	Perfumery chemicals	S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay 400 080 (1965)	— —	61.62 T 21.07	2 T Non-exclusive

1	2	3	4	5	6	7
17.	Dimethoate	Pesticides	(i) Mico Farm Chemicals Ltd., 'Lotus Court' 165, Thambu Chetty Street, Madras 600 001 (1979)	19.59 T 13.13	9.05 T 6.34	100 T Non-exclusive
			(ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979)	— —	40.95 T 32.62	15 T (Pilot plant) Non-exclusive
18.	Dimethylaniline (Continuous process)	Industrial chemicals	Sahyadri Dyestuffs & Chemicals, Pune (1976)	— —	2450.18 T 761.86	3000 T Sponsored
19.	Endosulfan	Pesticides	Bharat Pulverising Mills Pvt. Ltd., 'Shriniketan' 14 Queens Road, Bombay 400 020 (1980)	— —	24.16 T 20.54	600 T Non-exclusive
20.	Ethion	Pesticides	Shaw Wallace & Co. Ltd., Calcutta (1979)	— —	33.06 T 26.24	15 T (Pilot plant) Non-exclusive
21.	Ethylenediamine	Bulk organic chemicals	Diamines & Chemicals Ltd., The Bharat Vijay Mills Ltd., Premises, Kalol 382 721 (1982)	74.00 T 31.00	4.00 T N. A.	2000 T of ethylenediamine and polyamines
22.	Ethylene oxide condensates	Surface active agents	Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400 016 (1965)	2105.00 T 642.03	13781.14 T 2736.72	2500 T Sponsored
23.	Ferrites-Hard	Electronics	Dr. Shet Magnetics Pvt. Ltd., 1069, V Block, 1st floor, Rajajinagar, Bangalore 560 010 (1978)	N. A. 0.56	4.00 T 1.75	20 T Non-exclusive
24.	Foundry core binder (Sinol core binder)	Core binder in steel foundries for high dimensional accuracy	Card Chem. Industries, B-12, Co-op. Industrial Estate, Balanagar, Hyderabad 500 037 (1980)	— —	9919 Ltrs 0.61	Not available Non-exclusive

1	2	3	4	5	6	7
25.	4-Hydroxycoumarin	Pharmaceuticals	Unichem Laboratories Ltd., 'Unichem Bhavan', S. V. Road, Bombay 400 060 (1974)	— —	273.69 Kg. 1.06 (including warfarin)	540 Kg Non-exclusive
26.	β-ionone	Prefumery, intermediate for vitamin A	S. H. Kelkar & Co. Ltd., Bombay (1975)	0.31 T 1.13	0.919 T 3.69	4.4 T Non-exclusive
27.	Maleic hydrazide	Agrochemicals	Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur 458 001 (1978)	0.60 T 0.39	1.62 T 0.85	1 T Non-exclusive
28.	*p*-Menthane hydroperoxide	Synthetic rubber	Camphor & Allied Products Ltd. P. O. Clutterbuckganj 243 502 Dist. Bareilly (1976)	13.40 T 6.51	115.94 T 45.64	60 T Exclusive
29.	Monochloroacetic acid	Intermediate for weedicides, carboxymethyl cellulose, etc.	Hico Products Ltd. Bombay (1975)	380.00 T 55.10	1845.37 T 185.59	720 T Non-exclusive
30.	Monoethylaniline	Intermediate for explosives	The Atul Products Ltd., Atul 396 020, Dist. Valsad (1975)	79.50 T 31.03	518.33 T 171.07	100 T Non-exclusive
31.	1-Naphthylacetic acid	Agrochemicals, Plant growth regulator	Micro Chemicals (India), Mandsaur (1975)	1.00 T 1.00	4.10 T 4.10	1.5 T Sponsored
32.	Nicotine sulphate from tobacco and tobacco waste	Insecticides	Urvakunj Nicotine Industries, Petlad-Cambay Road, Dharmaj 388 430, Dist. Kaira (1963)	— —	953.99 T 212.78	150 T Non-exclusive
33.	Nitrile rubber	Oil resistant rubber formulations, adhesives	Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400 020 (1974)	577.00 T 83.00	3148.00 T 577.99	2000 T

1	2	3	4	5	6	7
34.	*p*-Nitrophenol	Intermediate	Hindustan Organic Chemicals Ltd., P. O. Rasayani (1978)	— —	4.00 T 1.16	900 T Non-exclusive
35.	Nonyl phenol	Surface active agent	Aniline Dyestuffs and Pharmaceuticals Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Road, Bombay 400 026 (1974)	4.00 T 1.00	174.73 T 24.31	1000 T Sponsored
36.	Opium alkaloids	Pharmaceuticals	Govt. of Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975)	5.84 T 229.07	34.53 T 933.07	16.66 T of various alkaloids (morphine, codeine, narcotine, papavarine and thebaine) Exclusive
37.	Oxalic acid from bark of Ain tree	Industrial chemicals	The Vidarbha Organic Chemical Industries Ltd., Sajan Singh Bldg., Mount Road Extn., Nagpur 440 001 (1976)	— —	320.78 T 23.43	1500 T Sponsored
38.	Perfumery products based on longifolene (capinone)	Perfumery	Camphor & Allied Products Ltd., Dist. Bareilly (1968)	13.00 T 23.39	138.29 T 168.02	50 T (for both capinone and meracene) Sponsored
39.	Perfumery products based on Δ^3-carene (meracene)	Perfumery	—do—	20.90 T 11.83	72.36 T 33.65	—do—
40.	β-Phenethyl alcohol	Perfumery	Sunanda Aromatic Industries, Mysore-K. R. S. Road, Mettagalli P. O., Myscre 571 106 (1970)	— —	1072.83 T 603.13	270 T Sponsored
41.	Phenthoate	Insecticides	Bharat Pulverising Mills Pvt. Ltd., Bombay (1975)	— —	27.10 T 17.55	600 T Sponsored

1	2	3	4	5	6	7
42.	Phthalate-butyl octyl	Plasticizers	Herdillia Chemicals Ltd., Air India Bldg., Nariman Point, Bombay 400 021 (1979)	161.03 T 29.80	140.40 T 26.93	5000 T (including other phthalates) Non-exclusive
43.	Phthalates-diethyl and dimethyl	Plasticizers	The Mysore Acetate and Chemicals Co. Ltd., A-19, Acetate Town, Mandya 571 404 (1970)	326.00 T 55.00	1810.87 T 252.79	600 T Non-exclusive
44.	Phthalates-dioctyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., 'D' Bldg., Shiv Sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971)	4115.00 T 800.00	31144.18 T 4436.55	5000 T Non-exclusive
45.	Polyurethane coating	Coatings	Cipy Chemicals, 229, Rasta Peth, Pune 411 011 (1977)	744.00 Ltrs 0.34	6918.00 Ltrs 2.18	30 T Non-exclusive
46.	Polyurethane Printing rollers	Printing	Sree Saraswaty Press Ltd., 32, Acharya P. C. Ray Road, Calcutta 700 009 (1965)	1177 Nos. 3.31	5448 Nos. 10.94	3000 Nos. Non-exclusive
47.	*Quinapyramine sulphate/chloride	Veterinary drugs	Chintamani Fine Chemicals, S. No. 64/5, Bhide Baug, P. O. Vadgaon Budruk, Sinhagad Road, Pune 411 041 (1982)	9.00 Kg. 0.85	— —	N. A. Non-exclusive
48.	Radiosonde thermistors	Meteorology	The Bhagyanagar Laboratories, 11-1523/8, Golkonda Cross Road, Hyderabad (1974)	25,000 Nos. 5.62	1,90,000 Nos. 33.17	N. A. Non-exclusive
49.	D. C. Recording polarograph including potentiometric strip chart recorder for captive consumption	Polarographic analysis	(i) Elico Pvt. Ltd., Sanatnagar Ind. Estate, Hyderabad 500 018 (1974)	12 Units 2.28	183 Units +3 Nos. 28.18	50 Units Non-exclusive
			(ii) Chromatography & Instruments Co., 121/122, Makarpura Ind. Estate, Baroda, 390 010 (1974)	— —	84 Unit 13.45	100 Units Non-exclusive

1	2	3	4	5	6	7
50.	Silica gel	Humidity control	Minco Products, 17, Thiruvottyur High Road, Madras 600 081 (1963)	12.00 T 1.45	4925.50 T 16.30	18 T Sponsored
51.	70 % Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	(i) Maize Products, Divn. of Sayaji Mills Ltd., P. O. Kathawada-Maize Products, Ahmedabad 382 430 (1976)	884.00 T 88.40	4925.20 T 442.27	2000 T Non-exclusive
			(ii) The Anil Starch Products Ltd., P. B. No. 10009, Anil Road, Ahmedabad 380 025 (1976)	457.00 T 49.98	1918.40 T 211.88	1000 T Non-exclusive
52.	Direct reading spectrophotometer/ colorimeter	Biochemical research, spectroscopic analysis in visible range	Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Road, Allahabad 211 001 (1974)	— —	182 Units 11.90	100 Units Non-exclusive
53.	Staple pin adhesive	Adhesive for staple pins	Esdee Paints, Near Power House, Kolshet Rd., Thane 400 607 (1979)	1180.00 Ltrs 0.57	1773.00 Ltrs 2.70	N. A. Non-exclusive
54.	Terpineol	Perfumery	Dujodwala Industries, Tulsiani Chambers, 8th floor, 212, Nariman Point, Bombay 400 021 (1976)	— —	400.00 T 112.50	200 T Non-exclusive
55.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate	Sudarshan Chemical Industries Ltd., 162, Wellesley Road, Sangam Bridge, Pune 411 001 (1977)	114.00 T 43.02	296.00 T 101.39	300 T Sponsored
56.	Vitamin C	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1975)	— —	5.83 T 7.28 (estimated)	125 T Non-exclusive

1	2	3	4	5	6	7
57.	Trichlorobenzene	Intermediate	Mycol International Agencies, 'Lotus Court', 165, Thambu Chetty St., Madras 600 001 (1978)	— —	2.30 T 0.16	100 Kg / batch Non-exclusive
58.	Warfarin	Rodenticide	Unichem Laboratories Ltd., Bombay (1974)	— —	384.29 Kg —	840 Kg Non-exclusive

* During the period under review, production has been newly reported on this item.

VALUE OF PRODUCTION BASED ON NCL TECHNOLOGIES

Year	No. of items manufactured	Valu of production (Rs. in lakhs)
1978–79	68	2174.06
1979–80	65	2923.70
1980–81	61	3056.60
1981–82	62	2928.62
1982–83	58	3019.11
		14102.09

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1982–83)

Type of industry	No. of processes in production	Value of production during 1982–83 (Rs. in lakhs)
1. Public sector	6	1026.00
2. Large scale private sector	20	1871.51
3. Medium and small scale sector	32	121.60
	58	3019.11

TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

Sl. No.	Name of the process	Field of utilisation	Name of the party (Year of release)	Nature of release	Remarks
1	2	3	4	5	6
1.	Acrylic acid/acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., P. O. Petrochemicals, Dist. Baroda 391 346 (1975)	Sponsored	Under implementation
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 Road, Mahim, Bombay 400 016 (1974)	Sponsored	—
4.	Antioxidant TEDQ (2, 2, 4-trimethyl-6-ethoxy-1, 2-dihydroquinoline)	Rubber anti-oxidant	—do— (1976)	Non-exclusive	—
5.	Atrazine	Herbicide	—do— (1978)	—do—	—
6.	Butenediol	Pesticides, polymers	Hindustan Organic Chemicals Ltd., Rasayani	Collaborative work	—
7.	1, 3-Butylene glycol	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1976)	Sponsored	—
8.	Camphene from pinene	Pharmaceuticals, perfumery	Resin and Terpene Industries 812/813, Tulsiani Chambers, 212, Nariman Point, Bombay 400 021 (1978)	Sponsored	—
9.	Carboxin	Pesticides	(i) Sudarshan Chemical Industries Ltd., Pune (1978)	Non-exclusive	Under implementation
			(ii) Bharat Pulverising Mills P. Ltd., Bombay (1978)	—do—	—do—
			(iii) Laxmi Traders, 2, India Exchange Place, Calcutta 700 001 (1980)	—do—	—

1	2	3	4	5	6
10.	Catalytic vapour phase oxidation of toluene to benzaldehyde	Intermediates for pharmaceuticals, perfumeries, etc.	Indian Organic Chemicals Ltd., Khopoli 410 203 Dist. Raigad (1981)	Sponsored	Recently released
11.	Citrate plasticizers-tributyl/acetyl tributyl citrate	Plasticizers	Sturdia Chemicals Ltd., Neville House, J. N. Hardia Marg, Ballard Estate, Bombay 400 038 (1980)	Sponsored	—
12.	Clofibrate	Pharmaceuticals	S. D.'s Lab-Chem. Industry, Samuel Street, PB No. 3232, Bombay 400 003 (1975)	Non-exclusive	—
13.	Diazepam	Anti-anxiety drug	Orion Chemicals, 8, Mulchand Mansion, Princess Street Bombay, 400 002 (1975)	—do—	—
14.	Dibutyl tin oxide	PVC stabilizers	Dura Chemical Corpn. P. Ltd., Wakefield House, 11, Sprott Road, Ballard Estate, Bombay 400 038 (1977)	Non-exclusive	Under implementation
15.	Dichloropropionic acid (Dalapon)	Pesticides	(i) Hico Products Ltd., Bombay (1975)	—do—	—
			(ii) Jaydee Agrochemicals P. Ltd., Majwaji Ka Bagh, Moti Dugri Road, Jaipur 302 004 (1975)	—do—	—
			(iii) IDL Agrochemicals Ltd. 11th floor, Hindustan Times House, 18-30 Kasturba Gandhi Marg, New Delhi 110 001	—do—	—
16.	*Dimethoate	Pesticides	PNM Company, Thindal, Perundurai Main Road, Erode 638 009 (1978)	—do—	In trial production
17.	*Endosulfan	Pesticides	Hindustan Insecticides Ltd., Hans Bhavan, Wing I, Bahadur Shah Zafar Marg, New Delhi 110 002 (1976)	—do—	Turn-key plant offered through project engineers, In trial production

1	2	3	4	5	6
18.	Ethephon	Pesticides	Varson Chemicals P. Ltd., 9th Mile, Hosur Road, P. O. Singasanda, Bangalore 560 068 (1978)	—do—	—
19.	Flexible magnets	Refrigeration gaskets, toys, educational kits	Dr. Shet Magnetics P. Ltd., Bangalore (1976)	Non-exclusive	—
20.	Fumed silica	Bulk inorganic chemicals	Century Rayon, PB No. 22, Murbad Road, Shahad 421 103 Thane (1976)	Sponsored	—
21.	Hexachlorocyclopentadiene (HCCP)	Pesticides	Hindustan Organic Chemicals, Ltd., Rasayani (1981)	Collaborative work	—
22,	Ibuprofen	Drug	The Chemical Industrial & Pharmaceutical Laboratories Ltd., 289, Bellasis Road, Bombay 400 008 (1982)	Sponsored (Govt. of Maharashtra)	In trial production
23.	Items having short shelf life	Sealants, adhesives	Hindustan Aeronautics Ltd., (Nasik Division), Ozer Township P. O. Nasik 422 007 (1980)	Sponsored	—
24.	Matrix-bound penicillin acylase systems	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Pune (1974)	—do—	—
25.	Methylchlorosilanes	Intermediate	Hico Products Ltd., Bombay	Collaborative work	In trial production
26.	1-Menthol from $\triangle^3$-carene	Perfumery	Bhavana Chemicals Ltd., 64-65 and 53-57, Laxmi Insurance Bldg., Sir PM Road, Bombay 400 001 (1978)	Sponsored	Under implementation

1	2	3	4	5	6
27.	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)	—do—	—
28.	Multiplication of teak by tissue culture	Forestry	Forest Development Corpn. of Maharashtra Ltd., 6-A, Nawab Layout, Tilak Nagar, Nagpur (1981)	Sponsored	—
29.	Nitrofen	Weedicide	Amar Dye-Chem Ltd., Bombay (1978)	Non-exclusive	—
30.	*p-Nitrophenol	Intermediate	Catalyst (India) P. Ltd., Bombay (1975)	—do—	—
31.	*Nicotine sulphate	Insecticides	Keen Agro Chemicals and Engg. P. Ltd., Tower House, M. G. Road, Ernakulam 682 011 (1978)	Non-exclusive	—
32.	Polycrystalline silicon-ultrapure	Electronics	Grindwell Norton Ltd., Devenhalli Road, Old Madras Road, Bangalore 560 049 (1982)	Sponsored	Recently released
33.	Polysulphide iiquid rubber	Adhesives, sealants	(i) Rathi Rubber Products, 27, Shankarshet Road, Pune 411 009 (1981)	Non-exclusive	—do—
			(ii) Mundoz Corpn., 3, Moghe Bhuwan, Gokhale Road, Dadar, Bombay 400 028 (1981)	—do—	—do—
34.	Polysulphide sealant compound (Sp. by HAL, Nasik)	Sealants	Rathi Rubber Products, Pune (1981)	—do—	—do—
35.	Propylene oxide from.. propylene (extension to propylene gycol)	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1978)	Sponsored	—

1	2	3	4	5	6
36.	Simazine	Herbicide	Amar Dye-Chem Ltd., Bombay (1978)	Non-exclusive	—
37.	Silver paste for mica capacitor electrodes	Electronics	(i) Jyoti Refinery, 216, Lakad Ganj, Nagpur (1978)	Non-exclusive	In trial production
			(ii) Ramans (India) 9882/6, Ambala City (1978)	—do—	—
			(iii) Luxmi Traders, Calcutta (1981)	—do—	—
38.	Sodium sulphide	Various industries	Amar Dye-Chem. Ltd., Bombay (1976)	—do— (Technical aid)	—
39.	Sorbitol from glucose (continuous process)	Pharmaceuticas	The Anil Starch Products Ltd., Ahmedabad (1976)	Sponsored	—
50.	*Stape pin adhesive	Adhesive for staple pins	Duro Metochem. P. Ltd. Nirlon House, 254-B, Dr. Annie Besant Road, Worli, Bombay 400 025 (1976)	Non-exclusive	—
41.	Substitute for side seam cement	Adhesive	Nand Industries, 324, Shaniwar Peth, Pune 411 030 (1978)	Sponsored	—
42.	Sulphur monochloride	Various industries	Phosphate Co. Ltd., 14, Netaji Subhash Road, Calcutta 700 001 (1976)	Non-exclusive (Technical aid)	—
43.	Theophyllihe, aminophylline and caffeine	Pharmaceuticals	Pefco Foundry & Chemicals Ltd., Plot No. 10, Off Dr. Moses Road, Worli, Bombay 400 018 (1978)	Non-exclusive	In trial production
44.	Thionyl chloride	Various industries	Dharamsi Morarji Chemical Co. Ltd., Prospect Chambers, 317/21, Dr. D. N. Road, Bombay 400 001 (1977)	Collaborative work	—
45.	N-Tridecyldiisopro-panolamine	Intermediate	BASF (India) Ltd., Sudam Kalu Ahire Marg. PB No. 19108, Bombay 400 025 (1981)	Sponsored	Recently released

*These processes have also appeared in Table I along with other licensees.

LIST OF PROCESSES AVAILABLE

Sl. No.	Name of the process/ product	Field of utilisation	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.	Aniline	Organic intermediate	Nitrobenzene, hydrogen and catalyst	C	Released
3.	Atrazine	Herbicide	Cyanuric chloride, ethylamine and monoisopropylamine	C	Released
4.	*tert*-Butyl catechol	Stabilizer and poly merization inhibitor for synthetic rubber	Catechol, *tert*-butyl alcohol and catalyst	A	Released, in production
5.	Butyl titanate	Insulating varnish, special paints, catalyst	Butanol and titanium tetrachloride	B	Released, in production
6.	Can lining composition (based on nitrile rubber latex)	Lining cans for storing mineral oils, greases, food	Synthetic rubber latex, synthetic resins and rubber chemicals	A	Released, in production
7.	Can sealing composition (based on natural rubber)	Metal can industry	Natural rubber latex and rubber chemicals	A	Released , in production
8.	Carboxin	Pesticide	Acetoacetanilide, sulphuryl chloride, benzene and 2-mercaptoethanol	C	Released
9.	2-Chloroethyltrimethyl ammonium chloride	Plant growth regulator	Trimethylamine and ethylene	A	—
10.	Diazepam	Anti-anxiety drug	p-Nitrochlorobenzene, benzyl cyanide, dimethyl sulphate, iron powder and and chloroacetyl chloride	A	Released
11.	Dichloropropionic acid (Dalapon)	Weedicide	Propionic acid, chlorine and soda ash	C	Released

A — Capital requirement less than Rs. 10 lakhs
B — Capital requirement between Rs. 10 lakhs and 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
12.	Dimethoate	Pesticide	Phosphorous pentasulphide, methanol, monochloroacetic acid, methyl amine and caustic lye	C	Released, in production
13.	Dimethylaniline (batch process)	Dyestuff and explosives intermediate	Aniline and methanol	C	Released
14.	N, N'-dimethyl biguanide HCl and phenethyl biguanide HCl	Drugs	Dicyandiamide, dimethyl amine/β-phenylethylamine and solvents	A	Released
15.	Endosulfan	Pesticide	Hexachlorocyclopentadiene, butenediol, thionyl chloride and epichlorohydrin	C	Released, process available on turn-key basis through project engineers
16.	Ethylenediamine	Bulk organic chemical	Ethylene dichloride, ammonia and caustic soda	C	—do—
17	Ethephon	Pesticide	Phosphorus trichloride, ethylene oxide, hydrochloric acid and sulphuric acid	A	Released
18.	Ethion	Pesticide	Phosphorus pentasulphide, ethyl alcohol, dibromo-methane and caustic soda	C	Released, in production
19.	Ethylene from ethyl alcohol	Organic intermediate	Ethyl alcohol and catalyst	A	Released
20.	Ethylene dichloride from ethyl alcohol	Solvent and organic intermediate	Ethyl alcohol, chlorine and catalyst	C	—
21.	Ferrites-Hard	Electronics	Iron oxide, barium carbonate, additive and binder	B	Released, in production
22.	Gaskets from coir pith	Gaskets	Coir pith, nitrile rubber and rubber chemicals	A	Released
23.	Gaskets from cork granules	Gaskets	Cork granules, nitrile rubber and rubber chemicals	A	Released
24.	β-Ionone	Perfumery chemicals, intermediate for vitamin A	Lemon grass oil, caustic soda, acetone and sulphuric aid	C	Released, in production
25.	Maleic hydrazide	Plant growth regulator	Maleic anhydride and hydrazine hydrate	A	Released, in production
26.	Methylchlorosilanes	Basic material for silicon	Ferrosilicon and methyl chloride	C	Released, in production
27.	Microfilters	Industrial filtration	Pulp, melamine and formal-dehyde	A	Released

1	2	3	4	5	6
28.	Monochloroacetic acid	Intermediate for weedicides, carboxy-methylcellulose, etc.	Acetic acid, chlorine and catalyst	B	Released, in production
29.	Monochlorobenzene	Bulk organic chemicals	Benzene and chlorine	C	Released
30.	Monoethylaniline	Intermediate for explosives	Aniline, ethyl alcohol and catalyst	B	Released, in production
31.	Morpholine	Intermediate for rubber chemicals, textile chemicals, optical brighteners, etc.	Diethanolamine, sulphuric acid and caustic soda	C	Released
32.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	Tobacco/tobacco waste, lime, kerosene and sulphuric acid	A	Released, in production
33.	*p*-Nitrophenol	Intermediate for parathion and paracetamol	*p*-Nitrochlorobenzene, sodium hydroxide lye and hydrochloric acid	C	Released, in production
34.	Phthalate-butyl octyl	Plasticizer in non-electrical applications	Phthalic anhydride, butyl alcohol and 2-ethyl hexanol	C	Released, in production
35.	Phthalates-dibutyl/ dioctyl	Plasticizers	Phthalic anhydride and butyl alcohol/2-ethyl hexanol	C	Released, in production
36.	Phthalates-dimethyl diethyl	Plasticizers	Phthalic anhydride and methyl/ethyl alcohol	C	—do—
37.	D. C. Recording polarograph	Polarographic analysis	Component parts and boxes	A	—do—
38.	Polyol for making polyurethane rigid foam	Rigid foams	Cardanol, formaldehyde and a suitable amine	A	—
39.	Polysulphide liquid rubber	Adhesives, sealants, etc.	Ethylene chlorohydrin, *p*-formaldehyde, sodium sulphate, sulphur, sodium hydroxide and iron sulphide	A	—
40.	Polyurethane coating	Coating for leather, rubber, wood, glass, etc.	Castor oil, toluene diisocyanate and solvents	A	Released, in production
41.	Polyurethane printing rollers	Printing rollers	Castor oil, polyethylene glycol and toluene diisocyanate	A	—do—
42.	Quinapyramine sulphate and chloride	Veterinary drug	*p*-Aminoacetanilide, ethyl acetoacetate, ammonium acetate, dimethyl sulphate and guanidine carbonate	C	Released

1	2	3	4	5	6
43.	Radiosonde thermistors	Meteorology	Metallic oxides, platinum foil and components	A	Released, in production
44.	Rubber blowing agent	Rubber chemicals	Hexamine, sodium nitrite, hydrochloric acid and stabilizers	A	Released
45.	Rubber reclaiming agent	Rubber chemicals	Xylene and sulphur monochloride	A	Released
46.	Silica gel (desiccant type)	Humidity control	Sodium silicate and sulphuric acid	A	Released, in production
47.	Silicon tetrachloride	Industrial chemical	Ferrosilicon, chlorine and hydrochloric acid	C	—
48.	Silver paste for mica capacitor electrodes	Electronic industry	Silver nitrate, acetone, caustic soda, glass and filler	A	Released
49.	Simazine	Herbicide	Cyanuric chloride and ethylamine	C	Released
50.	70 % Sorbitol from dextrose monohydrate	Pharmaceuticals and Vitamin C synthesis	Dextrose monohydrate, hydrogen and catalyst	C	Released, in production
51.	Direct reading spectro-photometer/colorimeter	Biochemical research and spectroscopic analysis in visible range	Components and boxes	B	—do—
52.	Staple pin adhesive	Adhesive for staple pins	Synthetic resin and solvent	A	—do—
53.	Terpineol	Perfumery	Turpentine oil	B	—do— (pilot plant available with NRDC)
54.	Theophylline, amino-phylline and caffeine	Drugs (caffeine also used in beverages)	Dimethylurea, monochloro-acetic acid, acetic anhydride	C	Released
55.	Thermistors	Temperature measurement and control elctronic devices	Oxides of high purity components and binder	A	Released, in production
36.	Trichlorobenzene	Intermediate	Non-gamma BHC residue and caustic lye	B	Released, in production
57.	Vitamin B_6	Drug	—	A	Released
58.	Xanthates — potassium ethyl and potassium amyl	Froth-flotation	Ethyl/amyl alcohol, potassium hydroxide and carbon disulphide	A	Released

DATA ON NCL EXPENDITURE, RECEIPTS AND ACHIEVEMENTS (1981-82 AND 1982-83)

	1981-82	1982-83
EXPENDITURE (Rs. in lakhs)		
1. Recurring	225.45	271.99
2. Capital	147.16	159.00
3. Pilot plant	—	—
	372.61	430.99
RECEIPTS (Rs. in lakhs)		
1. Receipts on account of sponsored projects	5.04	7.19
2. Analytical / testing charges	0.70	1.16
3. Institutional consultancy (CSIR share) including know-how fee/job work	2.32	2.80
4. Sale of laboratory products	0.14	0.15
5. Miscellaneous receipts	8.57	8.30
	16.77	19.60
ACHIEVEMENTS		
1. Total number of processes in production	62	58
2. Value of production based on NCL know-how (Rs. in lakhs)	2928.62	3019.11
3. Estimated saving in foreign exchange on account of above production (Rs. in lakhs)	1171.45	1207.64
4. Total number (cumulative) of processes released and awaiting production		
(a) NCL processes	24	23
(b) Sponsored schemes	17	19
(c) Collaborative work	3	4
5. Total number of parties who have taken NCL processes for exploitation	146	147
6. Total number of parties who have sponsored processes	90	93
7. Total number of processes available for commercial exploitation	71	57
8. Number of processes released during the year		
(a) NCL processes	2	1
(b) Sponsored processes completed / concluded	6	3
9. Papers published	118	168
10. Papers presented / read at symposia, seminars, etc.	23	21
11. Doctorate and Masters degrees received by NCL staff	24	26
12. No. of recognised guides for Doctorate and Masters degrees	50	51
13. Patents in force	67	72
(a) In India	2	2
(b) Abroad		
14. Premia and Royalties received by NRDC through NCL processes (Rs. in lakhs)		
(a) Premia	0.40	0.60
(b) Royalties	1.70	1.17

CUMULATIVE DATA (1950-83)

EXPENDITURE (Rs. in lakhs)	
1. Recurring	2398.99
2. Capital	989.14**
3. Pilot plant	74.47
	3462.60
RECEIPTS (Rs. in lakhs)	
1. Total money receipts	
a) Total premia earned by NRDC through NCL processes	51.09
b) Total royalties earned by NRDC through NCL processes	24.36
c) Total receipts from sponsors	105.20
d) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sales of laboratory products, job work and other receipts	138.09
	318.74

ACHIEVEMENTS	
1. Total value of production based on NCL know-how (Rs. in lakhs)	22252.25
2. Total No. of papers published	3765
3. Total No. of papers presented/ read at symposis, seminars	301
4. Total No. of degrees received	549

** This figure does not include capital expenditure on NCL buildings amounting to Rs 30.76 lakhs that was incurred by CSIR during 1949-50.

NCL EXECUTIVE COMMITTEE

(1-7-82 — 30-6-1984)

Director, National Chemical Laboratory, Pune 411 008.	Chairman
Shri H. Krishnamurthy, Chairman and Managing Director, Hindustan Organic Chemicals Ltd., Rasayani 410 207.	Member
Prof. Goverdhan Mehta, Dean, School of Chemistry, University of Hyderabad, Central University P. O., Hyderabad 500 134.	Member
Prof. E. C. Subbarao, Director, Tata Research Development and Design Centre, 1, Mangaldas Road, Pune 411 001.	Member
Dr. A. P. B. Sinha, Scientist, National Chemical Laboratory, Pune 411 008.	Member
Dr. R. A. Mashelkar, Scientist, National Chemical Laboratory, Pune 411 008.	Member
Administrative Officer, National Chemical Laboratory, Pune 411 008.	Member (Ex-officio)
Sr. Finance and Accounts Officer, National Chemical Laboratory, Pune 411 008.	Member (Ex-officio)
Dr. S. H. Iqbal, Scientist, National Chemical Laboratory, Pune 411 008.	Member Secretary
Prof. C. N. R. Rao, Chairman, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore 560 012.	Invitee
Permanent Invitees	
The Director General, Scientific & Industrial Research, Rafi Marg, New Delhi 110 001. (or his nominee).	Member (Ex-officio)
The Chairman, Co-ordination Council, Chemical Sciences Group.	Member (Ex-officio)

NCL RESEARCH ADVISORY COUNCIL

(1-7-1982 to 30-6-1984)

Prof. C. N. R. Rao, Chairman , Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore —560 012.	Chairman
Dr. K. Aghoramurthy, Adviser (Chemicals and Petrochemicals) Ministry of Petroleum, Chemicals and Fertlizers, (Dept. of Chemicals and Fertilizers), New Delhi 110 001.	Member
Prof. Goverdhan Mehta, Dean, School of Chemistry, University of Hyderabad, Central University P. O., Hyderabad 500 134.	Member
Shri.. H. Krishnamurthy, Chairman and Managing Director, Hindustan Organic Chemicals Ltd., Rasayani 410 207.	Member
Dr. G. R. Kulkarni Planning Manager, National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021.	Member
Prof. R. C. Mehrotra, Professor Emeritus, Chemistry Department, University of Rajasthan, Jaipur 302 004.	Member
Prof. H. Y. Mohan Ram, Professor of Botany, Dept. of Botany, University of Delhi, Delhi 110 007.	Member
Prof. M. Santappa, Vice-Chancellor, Madras University, Madras 600 005.	Member
Prof. E. C. Subbarao, Director, Tata Research Development and Design Centre, 1, Mangaldas Road, Pune 411 001.	Member
The Director-General, Scientific and Industrial Research, CSIR, Rafi Marg, New Delhi 110 001, or his nominee.	Member (Ex-officio)
The Director, National Chemical Laboratory, Pune 411 008.	Member (Ex-officio)
The Chairman, Co-ordination Council, Chemical Sciences Group.	Member (Ex-officio)
Dr. S. H. Iqbal, Scientist, National Chemical Laboratory, Pune 411 008.	Member Secretary

NATIONAL CHEMICAL LABORATORY, PUNE–411 008

TELEX : 0145-266

TELEGRAM : CHEMISTRY

		Telephone*
1. Dr. L. K. Doraiswamy	Director	56151
2. Dr. R. B. Mitra	Head Organic Chemistry (I) Division	55153
3. Dr. A. P. B. Sinha	Head Physical Chemistry Division	54353
4. Dr. R. A. Mashelkar	Head Chemical Engineering Division	51716
5. Dr. A. V. Rama Rao	Head Organic Chemistry (II) Division	57614
6. Dr. G. R. Venkitakrishnan	Head Process Development Division	56243
7. Dr. P. Ratnasamy	Head Inorganic Chemistry Division	54761
8. Dr. S. H. Iqbal	Acting Head Polymer Chemistry Division	53234
9. Dr. M. C. Srinivasan	Acting Head Biochemistry Division	58234
10. Dr. S. H. Iqbal	Head Technical Services Division	57860
Administrative Officer		57044
Sr. Finance and Accounts Officer		56702
Stores and Purchase Officer		59208
Scientists and all other staff		56451 56452 56453
NCL Guest House/Hostel (1)		56155
NCL Medical Centre		59454

*As in December 1984.

editor • Dr. S. H. Iqbal

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