Annual Report 1981-82

NATIONAL CHEMICAL LABORATORY, PUNE

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PREFACE

Introduction

This report highlights the research work carried out at the NCL from April 1981 to March 1982. Since the coming of age of in-house R and D in the Indian chemical industry the focus of work at NCL has shifted to such processes that not only use the valuable natural resources of the country but also have a significant impact on the social and economic fronts. Simultaneously the NCL has been strengthening its links with industry. More and more projects have been undertaken in collaboration with industry, projects that involve the gainful use of the expertise and facilities available at the NCL.

The laboratory continued to work on the three-tier structure of divisions, areas and projects, the only difference being that the number of areas were reduced from sixteen to fifteen. This has been in keeping with the dynamic philosophy of the laboratory which stresses the dropping of areas and projects that have ceased to be relevant and the taking up of those that promise early tangible benefits.

The projects themselves are in keeping with the reputation that the laboratory has earned for itself — that of combining basic with applied research and application of interdisciplinary expertise to ensure the development of novel, innovative processes.

Research and Development Activities

Preliminary trials of Neemrich and enriched extract of neem having oviposition deterrent activity against the potato tuber moth, have been very promising. Specific neem isolates were studied and were found to be highly toxic for aphids and tobacco leaf eating caterpillars.

Much progress was made on the tissue culture front. All tissue culture raised plants were evaluated. Procedures for the clonal multiplication of eucalyptus and banana trees were standardized. Field trials showed that the concentrations of oil, citronellol and citronellal in tissue culture raised eucalyptus plants was comparable to those in forest trees. The growth rate of teak plants in several locations proved to be 10% higher than those of the controls.

Processes for the preparation of the catalyst and isomerisation of C_8 aromatic feed from petroleum refineries were developed. The catalysts developed jointly with the Associated Cement Company showed stable activity over 200 hours and over three to four regeneration cycles. The processes are ready for commercial exploitation. The catalyst and process for the alkylation of benzene with ethylene rectified spirit were developed on pilot plant scale.

M/s Diamines and Chemicals Ltd (DACL) commenced commercial production of ethylenediamine and polyamines at Baroda. The NCL know-how was further developed jointly with DACL for this plant. Ethylenediamine and polyamines are being manufactured for the first time in India.

Another product that will be manufactured for the first time is citrate plasticizers. Processes for making tributyl and a cetyltributyl citrates were developed under the sponsorship of M/s Sturdia Chemicals Ltd.

The final design package, with all the data required for the detailed engineering of the plant, for making theophylline, aminophylline and caffeine was handed over to the sponsors, M/s PEFCO Foundry and Chemicals Ltd. A 150 TPA plant is expected to be commissioned soon.

A process for the preparation of N-tridecyldiisopropanolamine starting from tridecylamine and propylene oxide was developed on behalf of M/s BASF (India) Ltd. The product compares well with the imported material.

A catalyst for the vapour phase oxidation of toluene to benzaldehyde was developed on behalf of M/s Indian Organic Chemicals Ltd.

A process for making a hermetic sealing compound, which was sponsored by the Hindustan Aeronautics Ltd., was released to a private firm. Once the manufacture of these sealants starts there will be a considerable saving in foreign exchange and the country will become self-reliant in these vital compounds.

The vinblastine sulphate made by the NCL process, which has been optimised on a 40 kg batch scale, was

tested at the Hindustan Antibiotics Ltd., and was found to meet all the specifications laid down in BP 1980. The process has been released to M/s CIPLA and commercial production is expected to start in about a year.

A greatly improved process for making Vitamin B_6 was developed and given to IDPL which had bought the earlier not so economical process. Cheaper raw materials have been used in the modified process.

A UNDP supported programme, 'Bioscience and engineering' was started in September 1981. The programme has two parts to it — the utilization of cellulose for food/energy and controlled release pesticides. Another project in the international mould is to do with heat pumps. Taken up in collaboration with Salford University in U.K., the project aims at investigating various working fluids for better performance of the heat pump and coupling the pump to various systems.

Basic research did not lag far behind. Basic work of a high order was carried out in zeolite synthesis and charaterisation, co-ordination and organometallic compounds, preparative inorganic chemistry, polymer science and engineering, reactive telechelic dienes, catalysis and catalytic reaction engineering, the synthesis of new pyrethroids, 2-deoxy-ribose and deoxypodophyllotoxin analogue, and adriamycin.

Patents and Publications

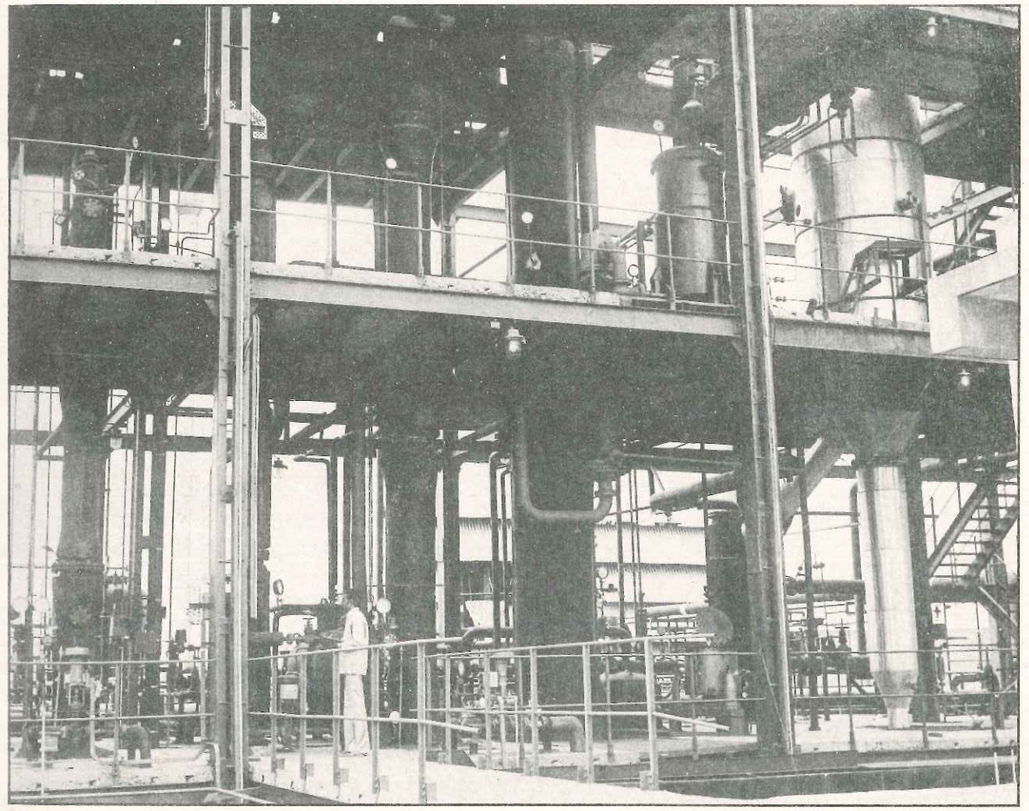
Twelve new patents were filed during the year, sixty-seven Indian patents (17 sealed, 5 accepted and 45 filed) and two foreign patents were in force as on 31st March 1982. One hundred and eighteen research papers were published during the year. Fifty staff members, research fellows and guest workers received post-graduate degrees that included 8 M.Sc., 1 Ph.D. (Tech) and 15 Ph.D. Fifty NCL scientists are recognised as research guides by different universities.

Research utilization

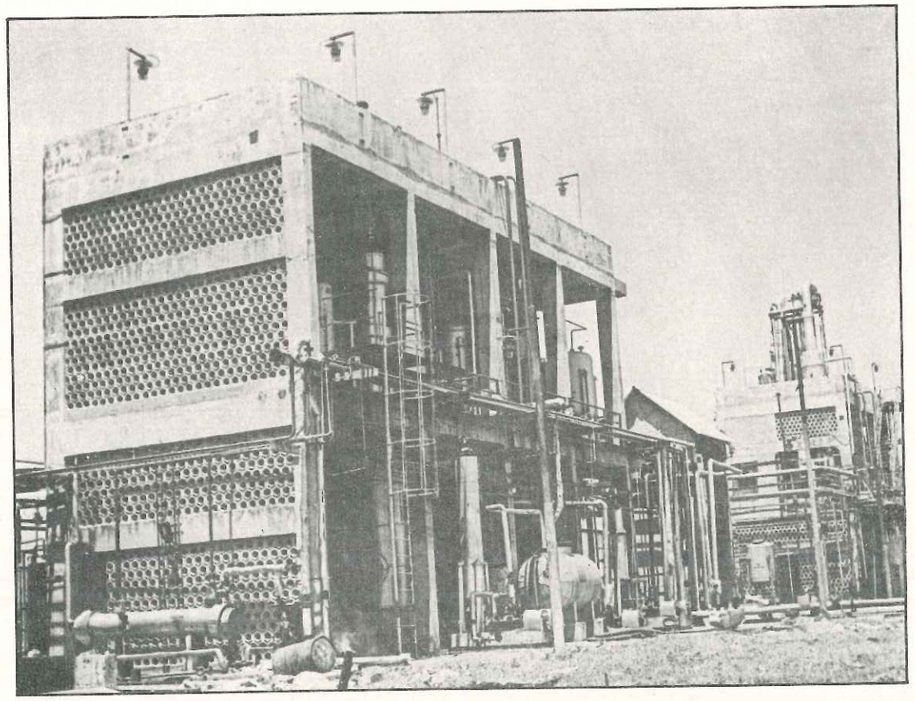
During 1981-82, sixty-two NCL processes were in production with a turnover of Rs.29.3 crores. The foreign exchange saving on account of production during this period is estimated at Rs.11.7 crores.

August, 1983
NCL, Pune

(L. K. Doraiswamy)
Director



Ethylenediamine plant of
Diamines and Chemicals Ltd., Baroda.
Capacity : 1200 tonnes per year.



Butenediol semi-commercial plant of
Hindustan Organic Chemicals Ltd., Rasayani
Capacity : 150 tonnes per year

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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 ethylene required for catalyst screening was prepared by vapour phase dehydration of ethanol on alumina. Oxidation of ethylene to ethylene oxide was carried out on silver catalysts.

Several silver catalysts (with promoters) on Norton and Harshaw supports were prepared, characterised for their chemical composition and mechanical strength (attrition or erosion) and tested for their activity and selectivity. Some of the catalysts gave promising results — 70-80% selectivity for ethylene oxide at 8-15% conversion of ethylene was achieved.

The entire scheme consisting of design, construction and operation with the requisite instrumentation, control and safety devices for the integrated pilot plant for vapour phase catalytic conversion of ethylene to ethylene oxide has been finalised after periodic discussions with Engineers India Ltd. The piping and instrumentation diagram, equipment layout, general alignment and fabrication drawings and instrument specification have been completed.

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

Propionic acid is a useful raw material for the manufacture of insecticides, and has several other important applications. Direct carbonylation is a novel route for propionic acid. A catalyst consisting of Rh complex (with iodine containing promoter) has been developed for the carbonylation of ethanol to propionic acid. The process conditions were standardized and a method for separation of the products and the catalyst has been standardized. Based on the experiments on catalyst recycle, it was concluded that the catalyst and the promoter can be recycled several times. Various methods of separation of catalyst and recycling were studied.

The kinetics of ethanol carbonylation using homogeneous Rh complex catalyst were studied. The effect of various operating parameters on the reaction rate was investigated and a rate equation was proposed. The active catalytic species was isolated and characterized by spectroscopic methods. The product distribution in a batch reactor was also studied at different conditions. Work on modelling batch and continuous reactors for propionic acid was started.

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

Carbonylation of nitrobenzene to phenyl isocyanate was studied using homogeneous palladium complexes (PdX_2 Cl_2 where X is pyridine or isoquinoline) as catalysts. The effect of different ligands, promoters and process variables on the activity of the catalyst was investigated. The role of promoters and solvents on activity and selectivity of the catalysts was studied and a mechanism of the reaction was proposed. Further, kinetics of the carbonylation reaction were studied using $Pd(Py)_2$ Cl_2 complex catalyst. The design data such as solubility and mass transfer coefficients (under carbonylation conditions) were determined.

Carbonylation of dinitrotoluene to toluene diisocyanate (TDI) using Pd and Rh complex catalysts was studied. The role of free pyridine and the nature of active catalytic species were studied by IR spectroscopy.

1.4 Metal complexes as homogeneous catalysts: (1-3-267-ii)

The kinetic study of the hydrogenation of allyl alcohol and allyl bromide using $RuCl_2(pph_3)_3$ catalyst was completed. It was found that the catalyst was deactivated rapidly during allyl alcohol hydrogenation, the deactivated catalytic species being characterized as $RuCl_2$ (CO) $(pph_3)_3$. A schematic mechanism for deactivation based on the abstraction of CO has been proposed. The kinetics and reaction mechanism of allyl bromide were studied in detail; the reaction was found to be of zero order with respect to allyl bromide and hydrogen while the order with respect to catalyst concentration was 0.85. An interesting observation on the rate determining step in this system was the dissociation of hydro-species,

viz., hydridochlorotris (tri-phenylphosphine) ruthenium (II), and not the oxidative addition of hydrogen. The activation energy of this reaction was found to be 11.13 kcal/mole. $RuCl_2$ $(pph_3)_3$ with and without promoters was also tried for the reduction of nitrobenzene but was found unsuitable. Tris (pyridine) rhodium (III) trichloride complex was prepared and used for this reaction along with $NaBH_4$. In order to investigate the role of $NaBH_4$ experiments were conducted at various concentration of $NaBH_4$, which showed that rate was highly dependent on the concentrations of $NaBH_4$.

Photocatalysts for decomposition of water (conversion of solar energy to chemical energy): Photodecomposition of water has attracted considerable attention in recent years. It has been found that certain transition metal complexes play an important role in this process as photocatalysts because of their strong absorption in the visible region and their capability to undergo oxidation reduction reactions.

When light is absorbed by these complexes, the excited $\bar{e}$ can be transferred to certain other suitable species, thus changing the oxidation state of the transition metal. These excited states are found to be potentially capable of reducing $H^+ \rightarrow \frac{1}{2} H_2$ if the redox potential of these systems is more negative than that of H^+/H_2 system.

Taking into consideration the demand for an efficient photocatalyst, work was undertaken to synthesize the Ruthenium (II) tris-bipyridyl complex $(Ru(bpy)_3)\ 2^+$.

This complex was prepared by refluxing $RuCl_3 . 3H_2O$ and bipyridyle in DMF and then precipitated from a solution of tetra-butylammonium chloride in acetone. The complex was purified by recrystallization from hot water. Elemental analysis showed:

	%C	%H	%N
Calculated	48.128	4.812	11.23
Observed	48.10	5.18	11.32

The visible spectrum of the complex showed absorption maximum at = 452 nm, which is in good agreement with the reported value.

In homogeneous systems the back $\bar{e}$ transfer reaction is also possible, which consumes all the acquired energy. To avoid this, the complex can be attached to a polymer support to form a heterogeneous system. Work is in progress to get a polymer of the required molecular weight and then to support the catalyst on a polymer backbone.

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

1.5.1 Synthesis and characterization of zeolites (Hisilite):

Kinetics of crystallization of high silica zeolites with different silica alumina ratios in the range 50 to 800 were extensively studied. The influence of the reaction temperature and the raw material concentration on the crystallization kinetics was evaluated. The samples were characterized by X-ray, SEM and sorption measurements. A series of catalyst samples using Hisilites of different SiO_2/Al_2O_3 molar ratios were prepared and tested for xylene isomerization, alkylation, disproportionation. The surface acidity of the catalyst samples was evaluated by the temperature programmed desorption of ammonia.

1.5.2 Catalytic reactions on Hisilite:

(a) Isomerization of C_8 Aromatics: The isomerization of *o*-xylene on high silica zeolite catalysts was extensively studied. Based on this data, suitable catalysts were manufactured by ACC, Thane under a joint agreement with NCL. The commercial batches were used for optimizing of the process parameters for isomerizing C_8 aromatic feed from a petroleum refinery (IPCL, Baroda). The life cycle and regenerability of several commercial (NCL-ACC) catalysts showed excellent stability over a period of 300 hrs. and good activity after regeneration for over 50 cycles.

(b) Ethyl benzene: Catalysts and process for the vapour phase alkylation of benzene with ethylene/rectified spirit have been developed on pilot plant scale. This process is an improvement on the existing practice of converting ethyl alcohol to ethylene and ethylene to ethyl benzene. The process parameters for the reaction were optimized and life cycle (> 700 hrs.) and regenerability of the (NCL-ACC) commercial catalyst were evaluated.

(c) Disproportionation of toluene to benzene and xylene: The activity of several catalysts prepared from hisilite of varying SiO_2/Al_2O_3 ratios and further modified by ion exchange as well as incipient impregnation were tested at atmospheric pressure as well as under high pressures at different temperatures and H_2/HC molar ratios. Life cycle studies indicated no deactivation of the catalysts for 100 hrs. on stream.

(d) Light olefins from methanol: Several modified hisilite catalysts were tested for the conversion of methanol to light olefins with 40% slectivity. The catalyst structure, as well as acidity, was found to strongly influence the product distribution.

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

A number of high silica zeolites (ZSM-5 type) with different Si/Al ratios were synthesised. Influence of Si/Al ratio, degree of cation exchange, deammoniation conditions of NH_4-ZSM-5 and hydrothermal treatments on the acid strength distribution of H-ZSM-5 zeolite were investigated by gas chromatographic techniques (with temperature programmed desorption and stepwise thermal desorption of pyridine) at catalytic conditions. Acidity of the zeolite was correlated with its catalytic properties. The zeolites (TPA-ZSM-5, NH_4—ZSM-5 and H-ZSM-5) were characterised by XRD, XPS, SEM and chemical analysis.

1.7 Vapour phase oxidation of crotonaldehyde to maleic anhydride: (1-9-467 Sp)

Vapour phase oxidation of crotonaldehyde to maleic anhydride offers an attractive route for the manufacture of maleic anhydride especially if crotonaldehyde is cheaply available as a by-product. Work was undertaken on the preparation, screening and testing of several catalysts. A catalyst containing V-Mo-P on alumina carrier has been developed. Approximately 60% conversion of crotonaldehyde with about 70-75% selectivity to maleic anhydride was reached. Pilot plant trials have been planned.

1.8 Basic studies

1.8.1 Effects of preparation conditions and presence of promoters (e.g. Ba) on thermal decomposition of silver carbonate (in the preparation of silver catalysts) were studied comprehensively.

1.8.2 Selective poisoning of stronger acid sites of H-ZSM-5 zeolite for the isomerization of xylenes and conversion of C_2—C_6 olefins and alcohols to aromatics was studied using a pulse-micro reactor. Pyridine, ammonia, and quinoline were used as poisons. The correlation between strength of acid sites and catalytic activity and selectivity was investigated.

1.8.3 A model for continuous slurry reactors has been developed for studying the kinetics of hydrogenation of glucose, which can help predict the slurry reactor performance for glucose hydrogenation. The model predictions using the kinetics obtained independently, were compared with experimental data.

1.8.4 A theoretical analysis of a three phase catalytic reaction for the case of homogeneous-heterogeneous reaction has been extended to consider general order kinetics. The results were compared with experimental data on hydration of propylene oxide to glycol. An experimental approach to evaluate the kinetics of homogeneous and heterogeneous reaction kinetics was used. This work is likely to be useful in designing the propylene glycol reactor.

1.8.5 Effectiveness factor analysis for the complex kinetics observed in hydrogenation of oils has been worked out. Due to the diffusivity of oil being lower than that of dissolved hydrogen, both the reactants exhibited significant concentration gradients within the catalyst. Analytical solution for simultaneous diffusion and reaction of oil species and hydrogen has been obtained and implications to oil hydrogenation reactor performance have been demonstrated.

The problem of a non-catalytic three phase reaction in which a sparingly soluble solid and gas dissolve and react within the liquid phase has been studied theoretically. Models to predict the conversion of the solid reactant have been developed which incorporate the change in regimes of the reactions. The application of the analysis to absorption of CO_2 in lime slurry has been demonstrated.

1.8.6 The multiplicity and instabilities in chemically reacting systems under isothermal conditions have been investigated theoretically. A new form of autocatalysis where the product of reaction affects the rate through rate constant variations has been proposed to explain the wide variety of phenomena noted in some experimental systems.

1.8.7 A new phenomenon of surface transformation among adsorbed species has been shown to be responsible for the occurrence of non-unique behaviour in some chemically reacting systems. This phenomenon which is especially important in oxidation reactions, has brought forth a new and more fundamental understanding of the cause for the occurrence of instabilities.

1.8.8 Due to the method of preparation, several industrial catalysts exhibit bimodal pore structure. A detailed mathematical analysis for this class of catalysts has been carried out for cases involving nonlinear rate forms, exothermic effects, volume change, etc. Simple attractive methods that relieve the burden of excessive numerical computations have been proposed.

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2. COORDINATION AND ORGANOMETALLIC COMPOUNDS

2.1 Organometallic compounds of group IV elements: (2-1-023)

Coordinated titanium and tin derivatives of hydrazones of salicylaldehyde and *o*-hydroxyacetophenone ($LH=N-NH_2$) and mixed azines [$(LH)=N-N=(L'H)$] formed from salicylaldehyde and benzoylacetone or *o*-hydroxyacetophenone having the formula ($L=N-NH_2$) MCl_3, $(L=N-NH_2)_2MCl_2$, $(L=N-N=L')MCl_2$ (M = Ti or Sn) have been prepared. In the isopropoxides derivative of titanium the alkoxy groups could be replaced by some bidentate ligands giving compounds of the formula ($L=N-N=L'$) Ti (salicylaldehyde)$_2$. Chlorititanium compounds formed hexacoordinated 1.1 addition products with nitrogen and phosphorus containing ligands such as 1,10-phenanthroline, 2,2'–bipyridyl, pyridine N-oxide, triphenyl– and trioctyl-phosphine oxides. Alkyl/aryl tin derivatives of these ligands also have been synthesized. Another type of ligand namely, derivatives of S-benzyl dithiocarbazates with *o*-hydroxy acetophenone, chloro- and bromo-salicylaldehydes gave penta and hexa-coordinated organoxytitanium and organotin compounds, for useful *o*-hydroxyacetophenone S-benzyl dithiocarbazate with $TiCl_4$ gave $(L)TiCl_3$, with $Ti(OPr)_4$, a di-propoxide, $(L)Ti(OPr)_2$ and with a bis-chelated titanium dipropoxide, $(L)Ti(L)_2$.

A series of compounds of the type $(L)VOCl_2$, where LH is a monobasic bidentate chelating ligand such as salicylaldehyde or a ß-diketone, have been synthesized. In these chloro-compounds, the chlorine atoms have been found replaceable with phenol, catechol and resorcinol. With oxo-vanadium trichloride, these phenols gave expected chlorine-free compounds. The chelated chloro-vanadium compounds can have a square pyramidal or trigonal bipyramidal geometry. The X-ray photoelectron spectra of the chlorine-free catechol derivative and acetylacetone oxo-vanadium dichloride indicate that the core electron binding energies fall in the lower valence state of vanadium atom.

2.2 Transition metal complexes particularly of group VIII metals: (2-4-236)

In continuation of the work on reduction of nitrobenzene to aniline reported earlier, attempts to isolate penta-coordinated cobal-oximes in the solid state as well as their adducts with axial ligands, were made with partial success.

In order to understand the nature of binding between the cobal-oxime type complexes and the substrates, a few dimagnetic cobalt (III) complexes having cobalt to carbon bonds, e.g., complexes of the ligands like methyl acrylate, acrylonitrile, styrene and chlorostyrene as axial ligands, were prepared and studied by IR, NMR and XPS.

Using tris (triphenylphosphine) dichlororuthenium (II) and tris (triphenylarsine) dichlororuthenium (II) as homogeneous catalysts, attempts were made to reduce maleic anhydride to tetrahydrofuran. It was, however, found that maleic anhydride was reduced to butyrolactone and THF formation could not be confirmed. The reaction took place in xylene at 400-450 p.s.i. and 200°. The ruthenium complex was found to be soluble in molten maleic anhydride, but no hydrogenation was observed to take place in the absence of the solvent, xylene.

In an attempt to develop a catalyst for the synthesis of ammonia under ambient conditions, the preparation of suitably supported catalysts was undertaken. Since the reaction was to be conducted in a fluidised bed at 400°, it was necessary that the catalyst have proper particle size in order to minimize losses due to carry over. Precipitated supports were washed free of halide ions and heated upto 450° and the dried powder were pelleted in a hydraulic press. The pellets were crushed and sieved to obtain samples in $-30+50$ mesh size. The catalyst samples were impregnated with ruthenium trichloride solution followed by heating at 400° in dry hydrogen. The samples contained 2.5-5.0 wt. % ruthenium metal. Only traces of ammonia could be detected when N_2 and H_2 were passed over such catalysts under ambient conditions.

The conventional processes for the manufacture of hydrazine, based on Raschig synthesis involving hypochlorite oxidation of ammonia, entail several drawbacks mainly due to the use of chlorine. A chlorine-free process being most desirable, investigations have been undertaken to develop an ammoxidation process which involves reaction of a ketone with ammonia and oxygen to give an azine and subsequent hydrolysis of the azine to give hydrazine and also back the ketone which can be recycled:

$$2\begin{matrix}R_1\\R_2\end{matrix}C=O + 2NH_3 + \tfrac{1}{2}O_2 \rightarrow \begin{matrix}R_1\\R_2\end{matrix}C=N-N=C\begin{matrix}R_1\\R_2\end{matrix} + H_2O$$

$$2H_2O$$

$$2\begin{matrix}R_1\\R_2\end{matrix}C=O + N_2H_4$$

Some preliminary experiments were carried out using benzophenone as the ketone and air as the oxidant. Azine formation in appreciable quantities has been observed at a temperature of 150-200° and ordinary pressure.

2.3 Basic studies

2.3.1 Synthesis and oxidative addition reactions of metal complexes: (0-28-002)

In continuation of the previous work, several platinum (II) complexes of the type $PtLX_2$, PtL_2X_2, PtLX' and Pt(IV) complexes PTLXY, where L = mono-or bidentate organic ligand containing nitrogen donor atoms, X = Cl or Br, X' = oxalate or malonate and Y = Br, have been synthesized. The starting materials, such as potassium tetrachloro-or bromoplatinate (II) potassium bis-oxalato or malonato-platinate (II) dihydrate, were isolated in the pure state and characterized by their elemental analysis and spectral data. X-ray photo-electron, U V difference and IR spectra of a number of Pt-complexes synthesized were recorded. Pt $4f_{7/2}$ binding energies showed that 1,8-naphthalenediamine ligand was a better donor of electron density to the metal than other ligands studied. The Cl $2p_{3/2}$ binding energies in the square planar Pt(II) complexes were observed in the range 198 ± 0.8 eV. The (Pt-Cl) stretching vibrations corresponding to two *cis*-Cl ligands were observed at ca. 335 and 320 cm^{-1} in the IR spectra. The extent of the interaction between malonato (8-amino-quinoline) platinum (II) with calf thymus DNA in buffer solutions was followed by U V difference spectral and melting techniques.

Several organic bidentate ligands containing S, N donor atoms, such as, 2-furaldehyde thiosemicarbazone, 2-furaldehyde-4-methyl or phenylthiosemicarbazone were synthesized. The infrared spectra of these ligands in solution or solid state were recorded in an attempt to locate the SH frequencies in these compounds.

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3. DRUGS AND DRUG INTERMEDIATES

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

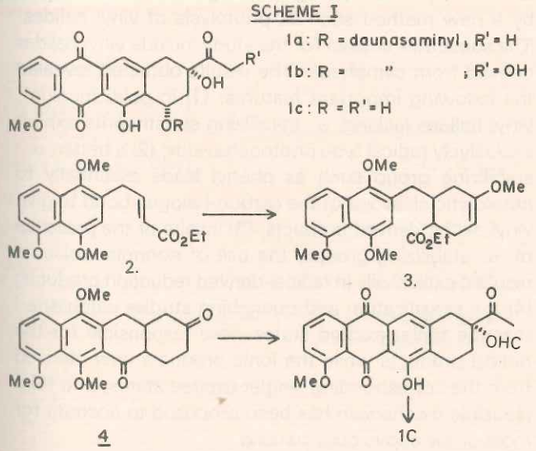
Process optimization studies on vinblastine sulphate isolated from the dried leaves of *Vinca rosea* were carried out on 40 kg per batch scale. The process has been released to a well known pharmaceutical company in Bombay for commercial exploitation. Steps are now being taken by this company to produce vinblastine sulphate B.P. vials (each vial containing 10 mg) at an early date. The conversion of vinblastine to vincristine is in progress.

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

Alternative methods for the synthesis of 4-methoxy-daunomycinone were developed starting from easily accessible intermediates. In addition, it was shown that new anthracycline antibiotics lacking a hydroxyl group at C-11 position [(11-deoxydaunomycin (1a) and 11-deoxyadriamycin (1b)] related to aclacinomycin A, showed a low incidence of cumulative dose dependent cardiotoxicity. Work has been initiated for the total synthesis of these molecules especially 11-deoxydaunomycinone (1c) and both Diels-Alder and non-Diels-Alder approach for its synthesis have been worked out.

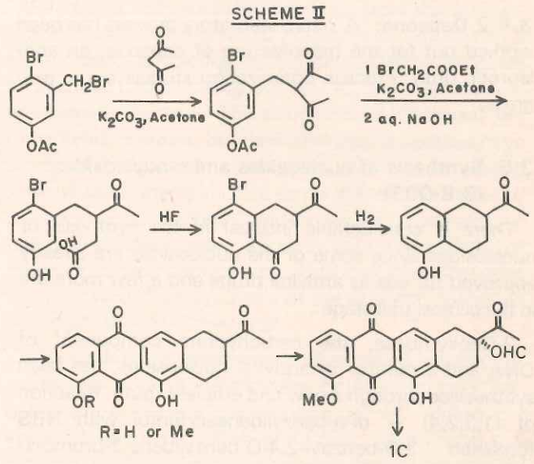
The main synthetic strategy in the Diels-Alder reaction is by selecting suitably substituted naphthalene synthon such as 2 with the desired diene to give the Diels-Alder adduct 3. It has been finally converted to the tetracycline dione 4 and latter has been transformed to 11-deoxydaunomycinone (2) as indicated in the scheme

SCHEME I



In a different approach, 11-deoxydaunomycinone has been synthesised by first constructing the AB ring, utilising inexpensive intermediates and reagents and condensing a D-ring unit to form the anthracyclinone skeleton which was finally transformed to 11-deoxydaunomycinone. The requisite AB synthon was made from *m*-cresol in 8 steps as shown in Scheme II. Work on the synthesis of optically active 11-deoxydaunomycinone is in progress.

SCHEME II



3.3 Isolation, identification, characterization and clinical testing of the ingredients of *Semecarpus anacardium* as an anticancer agent: (3-4-003-Sp)

The anticancer-active [(ILS (increase in life span) = 30%)] chloroform extract of freshly collected biba nuts was subjected to broad-cut column chromatography over weak silica gel. The benzene-eluted middle fraction (essentially a mixture of bhilawanols A and B, 70%) showed P388 anticancer activity; the first fraction eluted with light petroleum (unsaturated glyceride, 8%) and the last fraction eluted with ethyl acetate did not reveal any anticancer activity. In order to pinpoint the anticancer activity, the benzene fraction was further resolved ($AgNo_3$-silica gel chromatography of the acetylated mixture followed by hydrolysis) into its two constituents pure bhilawanol A (monoene) and pure bhilawanol B (diene). However, no significant anticancer activity was found for either bhilawanol A (ILS = 9%) or bhilawanol B (ILS = 27%).

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

3.4.1 Ibuprofen: It is an analgesic and an anti-inflammatory drug. Work was initiated under sponsorship by M/s. CIPLA, Bombay. All the laboratory work on this project has been completed. The company is at present carrying out pilot plant trials for its implementation. Steps are being taken by the sponsor to commence regular production.

3.4.2 Dapsone: A 2-step laboratory process has been worked out for the manufacture of dapsone, an anti-laprotic drug. Process optimization studies are in progress.

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

There is considerable interest in the synthesis of nucleosides since some of the nucleosides are already approved for use as antiviral drugs and a few more are in the clinical trial stage.

2-Deoxy-ribose, the carbohydrate component of DNA and a number of antiviral nucleosides, has been synthesised through a new and efficient route. Reaction of (1,3:2,4) — di-*o*-benzylideneerythritol with NBS furnished 3-O-benzoyl-2,4-O-benzylidene-1-bromo-1-deoxy-DL-erythritol. The bromo compound was reacted with sodium cyanide and the resulting cyano compound was reduced with Raney nickel-sodium hypophosphite in the presence of N,N'-diphenylethylenediamine to give 3-O-benzoyl-2, 4-O-benzylidene-1 deoxy-1-(1,3-diphenyl-2-imidazolidyl) erythritol in which all the functional groups were blocked. The blocking groups were removed by first treating with alkali and subsequently in acidic medium with careful control of pH to furnish 2-deoxy-ribose. A derivative of 2-deoxy-ribose wherein all the functional groups were suitably blocked has been prepared. A few new nucleosides have been prepared from theophylline.

The transformation of alkyl halides (R-X) to aldehydes $R\text{-}CH_2\text{-}CHO$ having two additional carbon atoms has been effected employing the following sequence of reactions. Methyl-3-oxo-4-phenylbutanoate was reacted with alkyl halides in the presence of NaH-benzene to furnish alkylated ß-keto esters which were hydrolysed to the corresponding benzyl ketones. Reduction of benzyl ketones with $NaBH_4$ and subsequent fragmentation of the homobenzylic alcohols gave the aldehydes.

3.6 Vitamin B_6: (3-10-03N7)

In the previous report, a different approach for the development of an economically viable process for Vitamin B_6 based on the Diels-Alder reaction was discussed. Various parameters at each stage were studied and the entire process was optimised on a suitable laboratory scale. Further steps are being taken to commercialise this process with the active participation of IDPL, Hyderabad, after carrying out some pilot plant experiments.

3.7 Doxepin hydrochloride: (3-11-003N-Sp)

The laboratory work has been completed on one kg scale.

3.8 Asymmetric synthesis of α-amino acids: (3-12-03N7)

Asymmetric synthesis of α-amino acid e.g. α-phenylglycine and other substituted α-amino acids related to L-DOPA, was carried out using dextro - and levo-chiral base viz. phenylethylamine. It was found that the asymmetric strecker synthesis gave the corresponding α-amino acids in moderate enantiomeric excess. The optical purities of the α-amino acids were determined by 'H NMR and optical rotations.

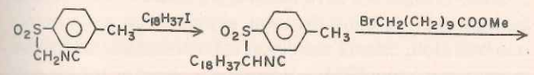
3.9 Photochemistry of vinyl halides: (3-14-003N)

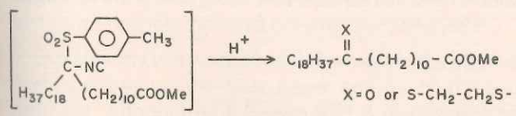
Vinyl cations are important organic reactive intermediates of recent origin. The work was initiated to check the possibility of generating these intermediates by a new method such as photolysis of vinyl halides. The substrates chosen for the study include vinyl halides derived from camphene. The results obtained revealed the following important features: (1) in polar medium, vinyl halides lacking α-stabilizing substituents exhibit exclusively radical type photobehaviour; (2) a better α-stabilizing group such as phenyl leads essentially to heterolytic cleavage of the carbon-halogen bond to give vinyl cation-derived products; (3) inspite of the presence of α-stabilizing groups, the use of nonpolar solvents resulted exclusively in radical-derived reduction products; (4) the sensitization and quenching studies established that the triplet excited states were responsible for the radical products while the ionic products were derived from the corresponding singlet excited states; and (5) a plausible mechanism has been proposed to account for most of the above observations.

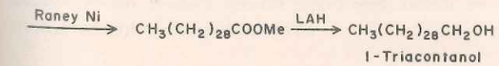
3.10 Synthesis of 1-triacontanol: (3-14-003N)

Recently Prof. Ries and his colleagues have demonstrated that the application of alfalfa increased the yields of tomatoes, cucumber, lettuce, rice and several other crops. They attributed this activity to 1-triacontanol, the principle constituent of the wax derived from alfalfa leaves. Since then several papers have appeared describing the synthesis of 1-triacontanol. Most of these synthetic methods are not suitable for large scale preparation of this product. As a fairly large quantity of 1-triacontanol is required for field trials to assess its importance as a plant growth regulator at reasonable cost, two different approaches for its synthesis have been worked out. In the first method (Tetrahedron *37*, 227-230, 1981) stearic acid was elaborated by two successive additions of 6-carbon units through enamine intermediates to give tricantonic acid which was further transformed to 1-triacontanol.

A simpler alternative method by which the product can be obtained in quantitative yields utilising inexpensive reagents and intermediates has been recently worked out. The synthetic approach is based on two successive alkylations of Tos MIC followed by acid hydrolysis and reduction of the resultant ester (see Scheme).







3.11 Dextropropoxyphene hydrochloride: (3-15-003N-Sp)

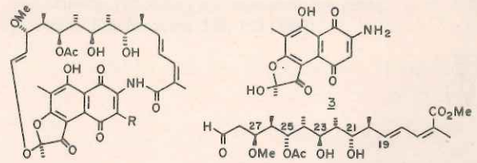
Dextropropoxyphene hydrochloride is an analgesic used for treating rheumatoid arthritis. At present the country's entire demand is met by imports. Laboratory work has been optimised and steps are being taken for scale up studies.

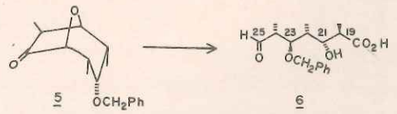
3.12 Basic studies

3.12.1 Synthesis of Macrolides: (0-8-003N)

Rifamycin: Rifamycin S(1) isolated from the fermentation medium of *Norcardia mediterrenei* belongs to a novel class of antibiotics, ansamycins, which constitutes an aliphatic bridge linking two non-adjacent positions of an aromatic nucleus. The structures of rifamycins are remarkably complex, but their biological properties have attracted the greatest attention of chemists as well as pharmacists. Rifampin (2), a semisynthetic derivative of rifamycin S is marketed widely for the treatment of tuberculosis and leprosy. Recently the total synthesis of rifamycin S was reported by Kishi and his colleagues from Harvard. Part synthesis of the aliphatic chain has been published by Corey *et al.*

The work on the synthesis of rifamycin S initiated recently has made good progress both at the naphthaquinone unit (3) and the aliphatic part (4). Unlike the approach adopted by Kishi and Corey, wherein the stereocontrol of the aliphatic chain has been achieved via acyclic intermediates, the present approach is by involving a cyclic intermediate (5) which has been made from furan. (5) will be transformed to (6) by Bayer-Villiger oxidation followed by alkaline hydrolysis. This fragment (6) will correspond to carbon atoms C-19 to C-25 of the rifamycin unit. The desired aromatic part (4) was made via tetralone (7) or 6,8 — dimethoxy-7-methyl-1-naphthol (8) as shown in Scheme 1.





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4. ENZYME ENGINEERING AND FERMENTATION TECHNOLOGY

4.1 Immobilized yeast cells system for fermentation of molasses to ethanol: (4-1-167-i & iii)

Several matrices for the immobilization of yeast cells were studied. A novel procedure for obtaining open-pore gel system was developed. Yeast cells immobilized in open-pore gelatin beds showed high productivity and no loss of activity after two months of continuous use in packed-bed reactors with sugarcane molasses as substrate.

In the flash ferm process, an apparatus for continuous flashing of the fermentation broth and recycle has been fabricated and some preliminary investigations were made. The possibility of combining this with the immobilized yeast cell reactor which gave very good ethanol productivity over a prolonged period was investigated. Studies on the long term stability and other parameters of the system have been undertaken and a pilot plant for the production of ethanol from molasses is being set up.

4.2 Enzyme and fermentation reaction engineering: (4-1-167-ii)

Theoretical investigations have been carried out on the effect of external film mass transfer on the apparent kinetic parameters in packed bed immobilized enzyme (IME) reactors. A generalized treatment has been developed which enables the prediction of the apparent kinetic parameters with simple approximations. The method would be useful even for nonlinear kinetic plots and can predict the intrinsic values of the IME kinetic parameters in packed bed reactors. A practical procedure has been evolved to examine the validity of the linearity approximation in the kinetic plots. The analysis has been extended to a completely inhibited enzyme reaction system.

Experiments were conducted to examine the effect of ß-glucosidase on the filter paper activity of the total cellulase. Although it is known that ß-glucosidase enhances long term saccharification, its effect on assay itself has not been examined. The experiments showed that filter paper activity was dependent on the ß-glucosidase which should be an important factor in the measurement of cellulose activity.

4.3 Basic studies

4.3.1 Protein structure: (0-1-001-iv)

Studies on structure-function relationships of citrate lyase complex from *Klebsiella aerogenes* were continued using *p*-azidobenzoyl-CoA as a photoaffinity reagent. The unusually large acyl carrier protein subunit of *Escherichia coli* citrate lyase complex was submitted to tryptic peptide mapping. Finger prints were suggestive of intrapeptide homologies.

4.3.2 Studies on separation methods: (0-33-001)

New gel electrophoretic methods were developed for the rapid isolation of proteins, nucleic acids and other biological materials.

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5. EQUIPMENT DESIGN AND DEVELOPMENT

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

The objective of this joint development project with Engineers India Ltd., New Delhi is to develop indigeneous capability in the design of special as well as conventional equipment used in chemical plants, with specific reference to vacuum distillation, where special packings with high height equivalent to theoretical plate and low pressure drop for effective mass transfer have to be developed.

Work on the commissioning of the 20 cm dia pilot plant rig was completed. An experimental programme to prepare a design package on regular packings was initiated. The experimental data on the column performance will be generated for nine systems using two special packings.

5.2 Heat pumps: (5-2-006)

The heat pump is a device to raise the temperature of waste heat streams for their effective reuse. The project has been started with a view to investigate the performance of heat pumps in order to use them in industry for energy recovery and recycle.

A unique collaborative arrangement has been evolved between NCL and Salford University, UK, for work in this area.

The first heat pump system received from Salford University was installed and operated to train the NCL scientists. Two of the staff members have been deputed for training in heat pumps at Salford.

6. FLUIDIZATION

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

An experimental assembly for a two dimensional fluid bed has been set up to examine the hydrodynamic behaviour.

The concept of catalyst dilution proposed earlier has been verified experimentally by using dehydration of alcohol over alumina as a model system. Experiments were conducted to 10 cm diameter fluid bed reactor and optimum dilution ratio for the system was experimentally obtained. The results indicated approximately two-fold increase in the selectivity of intermediate without significant drop in conversion.

Publications

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7. MATERIALS SCIENCE

7.1 Materials for solar energy utilization: (7-2-004)

7.1.1 Solar thermal materials: The development of selective molybdenum black by electrolytic technique and its characterization was completed during this period using a variety of techniques like X-ray and electron diffraction SEM, ESCA. The optical data (absorptance and reflectance) clearly showed that these films had required selectivity for medium temperature applications.

Selective liquid absorber device was characterized for efficiency at various temperatures from 80° to 100° using two covers. These results showed a little improvement over the results of the one cover system. In view of the possible applications of the selective liquid absorber device, heat exchange studies of absorbing liquid with water were planned. A simple heat exchanger for preliminary studies was designed. It was observed that a special distribution plate with smaller hole size must be used due to the high viscosity of the absorbing fluid. Some modifications to heat exchanger were made accordingly. Further studies are planned in view of the application of this device for alcohol distillation.

A patent application, for a solar conversion device, entitled, "A novel device for solar thermal conversion in which fluid is used as an absorbing medium," has been filed.

7.1.2 Amorphous silicon: A project on the preparation of pure and doped amorphous hydrogenated silicon (a-Si:H) films with low density of trapping states in the forbiden band gap and having high bulk and/or surface spectral response of photoconductivity was initiated. Such (a-Si:H) films are generally prepared by radio frequency (RF) gas. A stainless steel cross type reactor for capacitatively coupled RF deposition of (a-Si:H) from silane was designed and fabricated. In view of the extensive use of Laser Raman Spectrometer in the characterization of these films it was decided to develop this facility in the division. All necessary steps in procuring the LR spectrometer have been taken.

7.1.3 Chemical fixation of solar energy: A novel route for converting solar energy into electrical and/or chemical energy is via photoelectrochemical (PEC) cells. A project based on the PEC route has been thoroughly looked into for its possible applications. A literature survey for the last ten years (since its inception in 1970) has been completed. Some preliminary work on the cell fabrication has been done.

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

The work carried out during the previous year was consolidated, checked for reproducibility and communicated for publication after filling a few necessary gaps. An important gap that was so filled was the technique of burning Polyvinyl alcohol (PVA) used to press professional soft ferrites without the simultaneous oxidation of the Mn^{2+} in the ferrite and without the possibility of developing cracks after sintering. Detailed measurements of magnetic susceptibilities on the systems $Mn_{1-x}M_xO$ (M = Zn, Mg, Fe^{2+}) were carried out in collaboration with the solid state and structural chemistry unit of the Indian Institute of Science, Bangalore.

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

7.3.1 Palladium-Silver conducting paste: The paste formulations have been finalised. Reproducibility tests were carried out in relation to (a) compositional changes like particle size of Pd, Ag; Pd-Ag ratio; glass to Pd-Ag ratio; glass composition; organic binder ratio, etc. (b) printing parameters like mesh number, snap off distance squeegee pressure, speed, etc. and (c) firing conditions.

The following results were obtained:

Sheet resistivity	— 0.02-0.06 Ω/sq.
Adhesion strength	— 6-9 lbs.
Silver migration	— 10 sec. 60 min.
Solder leach resistance	— 4-5 dips
Solderability	— Good (62 Sn-36 Pb-2 Ag).

A compact dip soldering unit was fabricated. The flux and solder bath temperatures were independently and accurately controlled. In order to position a lead wire vertically on the sample, a small device was also fabricated. The unit has been giving satisfactory performance.

An Aremco, Accu-Coat 3100 (USA) screen printing machine was installed and operated successfully. Squeegee pressure and speed, length of stroke, X-Y and O adjustments for the sample position vacuum manifold for holding the sample, vertical motion of the upper platten facilitating sample loading/unloading, are some of the useful features of the unit.

A number of stencils required for printing different geometries for the evaluation of properties were fabricated. The photolithographic technique was used for the purpose.

7.3.2 RuO_2 resistor paste: Particle size of RuO_2 has significant effect on the performance of the thick film resistors. A fine particulate of RuO_2 powder was used for formulating resistor pastes. Several formulations were studied with very encouraging results. The Pd-Ag electrodes were used for the resistor evaluation.

7.4 Ultrapure silicon: (7-6-004-Sp)

Preparation of $SiHCl_3$ was studied thoroughly and the reaction conditions were optimised. The process was standardized for laboratory scale production of $SiHCl_3$ (1 kg. per day).

The purification of $SiHCl_3$ was studied using stainless steel and glass fractionation distillation units. To remove boron impurity, a chemical purification route was studied.

The hydrogen reduction of $SiHCl_3$ at high temperature (1050°) was studied using a tubular reactor. The purity of the silicon obtained was checked by resistivity measurement. A two rod reactor (SIEMENS REACTOR) for hydrogen reduction of trichlorosilane was fabricated. Experiments were done in this reactor to study the efficiency of the reaction. Further study for the optimization of the reaction parameters is in progress.

7.5 Basic studies

7.5.1 Ferroelectric ceramics: (0-27-004)

The effect of adding small amounts (0-030 wt%) of the oxides of chromium, manganese, cobalt and uranium on the piezoelectric properties of $Pb_{0.94}Sr_{0.06}(Ti_{0.47}Zr_{0.53})O_3$ ceramics has been studied. The Curie temperature of the unmodified sample was 355° and it showed a regular decrease (upto 340° for U_3O_8 doped compositions) with the increase of doping material. The spontaneous polarization for U_3O_8 and Cr_2O_3 doped compositions was appreciably high ($\sim$26 micro coul/cm^2). The ceramics modified with the oxides of chromium, manganese, cobalt and uranium exhibited high mechanical quality factor, Q_M and coercive field, E_c. The coercive field for the unmodified composition was 4.8 Kv/cm, which showed a regular increase (upto 9.5 Kv/cm) with increase in additives. Some of the Cr_2O_3 and U_3O_8 modified compositions showed Q_M greater than 1000. The room temperature dielectric constant, ε_T and dissipation factor, tan δ have also shown an increase (from 1100 to $\sim$1350 and from 0.5% to 1.3% respectively) with increase of additives in the compositions. The electromechanical coupling coefficient, K_p, for all the compositions lay between 0.40 and 0.50. Further, the transverse piezoelectric charge coefficient, d_{31}, and voltage coefficient, g_{31}, showed improvements in the case of U_3O_8 and Cr_2O_3 doped compositions.

For the application of ceramic materials in electric wave filters, the stability of the electrical and physical properties of the materials, especially of their K_P and N_P values over a wide range of temperature, is important. The N_P, K_P, d_{31} and g_{31} values of the compositions have been measured and it has been observed that N_p and K_p values change slightly for the modified compositions, whereas in the case of unmodified compositions, those values remain practically constant over the whole range of temperature (30-220°) studied. Some compositions of the modified ceramics showed promise for use in electric wave filters as these materials have high ε_T, K_P and Q_M. Greater K_P produced a filter with wider frequency spacing and greater Q_M resulted in low loss in the pass band and at the attenuation poles of the filter. The temperature stability of the materials with respect to N_P and K_P and their ageing properties were also good.

Viscoelastic properties of polymers: The zero shear viscosity, η° of polychloroprene samples of different molecular weights over a wide range of concentration in good and poor solvents have been studied. Butanone and cyclohexane have been used as θ-solvents and benzene at two different temperatures (25° and 45.5°) was used as good solvent. The zero shear specific viscosity η°_{sp} in θ-solvents at the higher concentration region was found to be higher compared to the values obtained in good solvents, whereas in the moderately concentrated region the values were just the opposite in θ-and good-solvents. The high values of specific viscosity in poor solvent at concentrated region has been attributed to high density of entanglement coupling where poly-polymer contacts were favourable. Contrary to the observations made by several authors that the cross-over concentration is independent of molecular weight, a close inter-dependence was found between them. The superposition of viscosity data (for each solvent) was carried out by vertically shifting the curve along $\log\eta^\circ$ axis at constant concentration. The shift factor was found to be exactly proportional to $M^{3.4}$ in the range of higher concentration (beyond the cross-over concentration point) and approximately to M in the range of lower concentration (below the cross-over concentration point). The double logarithmic plots of η° Vs. M at various selected concentrations in the higher concentration range (20-31%) for benzene and cyclohexane solutions at 45.5° showed that the emperical relation $\eta \propto M^{3.4}$ was obeyed by the present data. Further the data η° (c,M) were correlated by the method given by Dreval et al where the plot of $\log\eta^\circ_{sp}/c(\eta)$ versus $c(\eta)$ produced a single curve for polychloroprene samples of different molecular weights in two different θ-solvents (butanoene and cyclohexane) over the entire range of concentration. But in the case of good solvents, the similar plots yielded separate curves for each solvent. However, the normalization of the reduced concentration, $c(\eta)$ by Martin constant K_M reduced all experimental data of each polymer sample in different solvents (good and poor) over the whole range of concentration to the master curve.

Adiabatic, compressibility of macromolecules: The study of adiabatic compressibility of the sodium and hydrochloride salts of the two copolymers, acrylic acid-vinyl pyrrolidone (AA-VP) and N-dimethylaminoethyl methacrylate-vinyl pyrrolidone (DAM-VP), in aqueous solution has been carried out. The limiting values of apparent molal adiabatic compressibility, ϕK°_2 and volume, ϕV°_2 for the sodium salt of AA-VP copolymer and the hydrochloride salt of DAM-VP copolymer in aqueous solution are found to be $-61.5\times O^{-4}$ cc/bar/mole and 87.4 cc/mole, and -11.5×10^{-4} cc/bar/mole and 233.6 cc/mole respectively. The experimentally determined values are more or less in agreement with the calculated values. The maximum difference for ϕV°_2 between experimental and calculated values is $\sim$1 cc/mole. This indicates that no interaction has taken place between the acid and pyrrolidone, and base and pyrrolidone groups.

The characterization for the two copolymers, AA-VP and DAM-VP, was done by studying the IR and NMR spectra of these copolymers along with the corresponding homopolymers, PAA, PVP and PDAM. The weight average molecular weight of AA-VP and DAM-VP copolymers was estimated by the light scattering method as 7.68×10^4 and 2.12×10^5 respectively.

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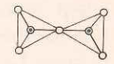


8. PEST CONTROL AGENTS

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

In continuation of the work on the synthesis of new insecticidal esters of the synthetic pyrethroids, the synthesis of three new insecticidal esters of 3-phenoxybenzyl alcohol has been achieved starting from the cheap, abundant and indigenously available (+) 3-carene. They are: (1) 3-phenoxybenzyl-IR-*cis,* 2,-2-dimethyl-3-(2-*p*-tolylprop-1-enyl) cyclopropane carboxylate, (2) 3-phenoxy-benzyl-IR-*cis*-2, 2-dimethyl-3-(2-*p*-anisyl, prop-1-enyl) cyclopropane carboxylate and (3) 3-phenoxybenzyl-IR-*cis*-2,2-dimethyl-3-(2-*p*-chlorophenylprop-1-enyl) cyclopropane carboxylate. These esters are being tested for their insecticidal and acaricidal activities.

Attempts are in progress, for the preparation of *t*-butyl-IR-*cis,* 2,2-dimethyl-3 (acetoxymethyl) cyclopropane carboxylate, an important intermediate for the synthesis of pyrethroids.

8.2 Development of pest control agents and other bioactive principles from renewable resources: (8-2-003S)

For the development of a commercially exploitable fraction from neem seed extract for oviposition deterrent (O.D.) activity against potato tuber moth, storage trials with Neemrich-I on stored potatoes were initiated at the experimental station of Central Potato Research Institute, Simla and at Rajgurunagar. Neem seeds were procured from Tamil Nadu, Uttar Pradesh and Maharashtra to study the variation, if any, in the activity of Neemrich-I isolated from them. Further work on the isolation and characterization of active fractions/compounds showing antifeedant, aphicidal and miticidal activities from the same fraction is on hand.

Fractionation of some plants showing insecticidal, repellent, O.D., juvenile hormonal, ovicidal and antigonadial activities were pursued vigorously. In two cases pure compounds that were isolated and characterized and showed insecticidal activity turned out to be toxic. Work has been initiated to prepare their analogues in order to study the structure-activity relationship. In two other cases, a number of pure compounds were isolated and characterized but none of them showed activity. In case of extracts showing good repellent activity, work on one was discontinued because of difficulty in isolation while in the other case more of essential oil was obtained and preliminary fractionations were carried out. During the detailed fractionation of plant extracts a number of new compounds were isolated and their structures determined in the area of sesquiterpenes, flavones, chromones and fatty acids.

A number of fresh plants were collected from the Konkan area. Extracts from 35 plants were screened and new leads have been obtained for antifeedant, anti-JH and insecticidal activities.

Hexalure was synthesized. Some work for the preparation of pheromones pertaining to tobacco leaf eating caterpillar and potato tuber moth was initiated.

8.3 Microencapsulation: (8-5-3S456)

8.3.1 Controlled release carbofuran formulation: Further studies in the encapsulation of carbofuran in starch xanthate and polyvinyl alcohol matrices were carried out. Conditions were standardized for preparing completely encapsulated carbofuran with a steady release rate in water lasting for 15 to 20 days.

8.3.2 Microencapsulation of fenitrothion: (i) Polyurea matrix:- Polyurea is formed by the reaction between diisocyanate and diamine. Experiments in microencapsulation of fenitrothion were carried out by the interfacial polycondensation of toluene diisocyanate and ethylenediamine or methyl phenylenediamine, the latter amine liberated *in situ* by the hydrolysis of toluene diisocyanate with water. Microcapsules in the range of 15 to 30 microns in diameter could be obtained. The yield of the polyurea in these reactions however was in the range of 60-65% only, especially for the reaction between TDI and EDA. A detailed investigation of the polycondensation reaction has been undertaken with a view to improve the yield. (ii) Polyamide matrix:- Work on encapsulation of fenitrothion in polyamide matrix by the interfacial polycondensation of sebacyl chloride and ethylenediamine and diethylene triamine was initiated. Because of the wasteful hydrolysis of sebacyl chloride by water, the reaction was carried out at low temperatures (0 to 5°). The yield of the polymer in this case also was in the range of 55-60%.

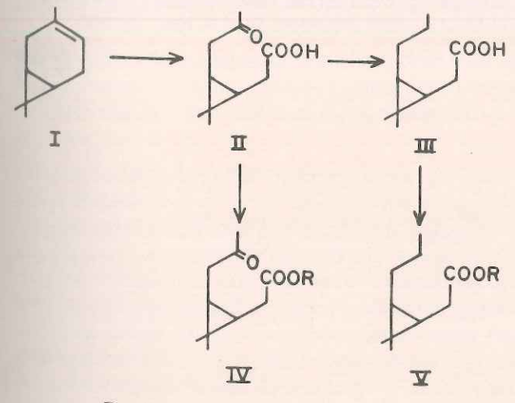
Detail studies of the polycondensation reaction were undertaken. The low yield was due to the wasteful hydrolysis of sebacyl chloride by (1) water and (2) the base used for fixing the HCl liberated. The hydrolysis due to water could be minimised by reducing the temperature of the reaction. The hydrolysis due to the presence of bases like sodium hydroxide and sodium carbonate was quite considerable. Use of tertiary amine (triethyl amine) instead of sodium hydroxide and sodium carbonate was investigated as HCl acceptor. These studies are in progress.

8.3.3 Development of mosquito larvicide in monolithic matrix: After successfully completing the development of controlled release aquatic herbicide, 2, 4 D-BEE, work on the development of mosquito larvicide in the monolithic matrix was initiated as part of the UNDP programme at NCL.

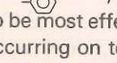
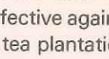
Abate, an organophosphorus compound, which is a widely used mosquito larvicide against Anopheles mosquitoes responsible for the spread of malaria, was selected and attempts were made to make use of natural rubber/latex as a carrier medium for use in stagnant water, the breeding place of the disease causing mosquitoes.

Methods for the incorporation of Abate into latex rubber from 1 to 10% have been standardised in 100 gm batches. From these master batches, standard sheets (vulcanised and unvulcanised) of 6″ × 4″ × 0.2″ were prepared by compounding with various additives and vulcanising at elevated temperature and pressure as desired. The sample sheets thus obtained are under study for release rate — bioassay and chemical/instrumental analysis. Based on these studies standardisation of the processing conditions for the release of the lethal dose of the toxicant will be undertaken.

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



R=alkyl, phenyl; substituted phenyl group

Twenty esters (IV and V) were prepared and tested for tuber mites, potato mites, red spider mites, pink mites and purple mites. Most of these esters were found to be promising for all these mites. Especially esters Va (R = ) as well as Vb (R = ) were found to be most effective against pink mites and purple mites occurring on tea plantation with 100% control at 0.05% concentration.

Formulated sample of Va has been sent to UPASI for testing on small field plots. An application for a patent to cover this work will shortly be filed.

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9. PLANT TISSUE CULTURE

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

Plant tissue culture methods are now being used increasingly in agriculture, horticulture, forestry and plant breeding. Research activities in this area during the year were directed mainly towards the clonal propagation of forest trees and agricultural crops and the evaluation of these clones in field trials.

9.1.1 Clonal propagation: Tissue culture conditions were established for the rapid multiplication of mature, fast growing *Eucalyptus terreticornis* trees which have been identified in forests in Tamil Nadu. Such elite trees have potentital applications in energy plantations. Methods for the clonal propagation of coconut, cashew, mango, tea,*Eucalyptus torreliana, E. camaldulensis, Dalbergia latifolia,* Sapium, bamboo and *Phaseolus acontifolius* will be taken up for study.

Field trials:

(a) Teak: Field trials of teak plants at different locations in Maharashtra showed that the clonally propagated elite plants were healthy with enhanced growth rate of about 15% as compared to normal seedlings (after 2 years). A further lot of 50 tissue culture teak plants was supplied to the Forest Corporation for preparing stumps and for testing their survival and growth rates.

(b) Banana and Cardamom: Thirty-five banana plants cv. Robusta and 10 cardamom plants raised by tissue culture were supplied to the Banana Research Station, Yawal and the India Cardamom Board, Kerala, respectively, for field trials.

(c) Sugarcane: About 2 acres were planted with setts from virus-free plants of sugarcane CV CO 740. This cane would be supplied in August 1982 to the State Farming Corporation of Maharashtra for yield trials at Sakharwadi on a 10 acre planting.

(d) Papaya: Sibmating of F4 generation hybrid papaya plants was carried out and seeds were sent to the Plant Virus Research Station, Pune for screening.

(e) *Eucalyptus citriodora:* The concentrations of oil and the two major components citronellal and citronellol in tissue culture plants were determined and found to be identical to the parent tree.

(f) Turmeric: The curcumin content of 60 percent of the third generation of mutants of turmeric plants was similar to the parent clones, i.e. between 6.5-7.5%.

9.1.2 Embryo culture: Attempts were made to standardise conditions for obtaining hybrids between the two species of cotton, *Gossypium hirsutum* and *G. arboreum* with a view to obtain plants with X genes for both wilt and blight resistance and for fibre quality.

9.2 Basic studies

9.2.1 Protoplasts: Protoplasts have been isolated from callus of Eucalyptus species and Matki *(Phaseolus acontifolicus).* Various media have been tried for regeneration to callus and plantlets. Cell clumps upto 200 could be obtained in case of Matki in a few media. Further experiments to obtain callus and plantlets from these cells are in progress.

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10. POLYMER SCIENCE AND ENGINEERING

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

10.1.1 MFI/Rheology correlation: A method for obtaining rheograms has been developed and applied to HDPE, LDPE, PP, PS, PVC, cellulosics, nylons, TP polyesters, acrylics, polysulfone, filled polymers and polyblends. The method developed by NCL allows one to generate a complete rheological information based on a single MFI measurement. This offers a major advantage to a polymer processor, who does not have a ready access to expensive rheogoniometers.

10.1.2 Development of composites based on reaction incorporated fillers: Various approaches for surface modification of cellulosic and mineral fillers were analysed and prioritized. Surface characterization of cellulose, oxidized cellulose, silica sand and talc was carried out. Chemical shifts were noted on ESCA and explained on the basis of the surface functional groups present. Oxidative modification of cellulose was taken up for enhancing bonding to the polymer matrix. In preliminary studies using test-tubes as molds, it was found that oxidized cellulose cured faster and that the resulting composite seemed to have good hardness and strength.

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

10.2.1 Simulation and modelling of polycondensation reactors: Computer modelling of the synthesis of polyethylene terephthalate in a batch and a continuous process was completed. The process improvements suggested as per the model predictions have been successfully implemented in the industry. Mathematical model development for the continuous polymerisation is in progress.

10.2.2 Copolymerisation reactors: Work on investigating the influence of micro-mixing on the composition and sequence length distribution of SAN copolymer in the batch vs. recycled loop reactors with a view to evolving innovative reactor configurations to produce copolymers with narrow and specific composition distribution was taken up. Computational experiments have shown the existence of multiple steady states in continuous SAN copolymerisation reactors. A unified policy for the design and operation of styrene and acrylic esters copolymerisation reactors has emerged.

10.2.3 Continuous interpolymer membrane process:

The technical feasibility of a process, involving *in situ* polymerisation of styrene in molten polyethylene followed by blown film extrusion, has been demonstrated. This process for making ion exchange membranes to be used for obtaining potable water (CSMCRI Project) is significantly faster and less energy intensive than the conventional batch process for membrane making. Further work on molecular structure determination and on exploring the potential of these membranes for other applications is in progress.

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

10.3.1 Polyphenylene sulphide: Polyphenylene sulfide is a new engineering plastic having unusual mechanical and chemical properties. At present this polymer is produced by only one company in the world. Laboratory experiments have been carried out to produce the polymer under much milder conditions than normally employed. The product has been tested and has been found to be comparable with the commercial product. Work has been carried out to optimise the process conditions for preparation of the polymer, to optimise the post treatment conditions, recovery of solvents etc. Work has also been undertaken on applications development of this polymer.

10.3.2 Oleopolymers: The project aims at the development of polymeric materials based on renewable resources (non-edible oils). Polycondensation reaction of castor oil with toluene diisocyanate (TDI) has been successfully tried. Reaction of castor oil with dimethyl terephthalate has also been carried out. The extent of reaction of hydroxyl groups of the oil was about 85%. Preliminary experiments have been conducted with castor oil, cellulose powder and TDI to test the technical feasibility of the concept of reaction incorporated fillers.

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11. POLYMER SYNTHESIS AND MODIFICATION

11.1 Polyurethane rubber for shoe soles: (11-2-005)

The development of polyurethane (PU) microcellular flexible elastomers was carried out using high molecular weight polyhydroxy compounds with toluene diisocyanate and 4,4′ diphenyl methane diisocyanate (MDI).

The elastomers made from TDI did not possess high shore A hardness, since aliphatic glycols were employed. The hardness was about 50-55°.

The polyfunctional (about three) high molecular weight polyols using castor oil/glycerol, TDI and polyethers of molecular weight 1000/2000 were prepared. These polyols had very high viscosity (16000 cps at 25-27°) and were difficult to process for elastomer preparation.

The low viscosity polyethers of functionality two or more were employed with MDI and aliphatic chain extenders like glycols for the preparation of the microcellular rubbers. The soles of size 18 × 10 cms × 10 mm (thickness) were cast moulded at 45-50° in 4-5 minutes, at low hydraulic pressures. The PU soles were observed to be satisfactory, possessed the desired physical properties and were comparable to the commercial grade of elastomer. The soles were moulded at various densities from 0.4 to 0.7 g/cc.

The physical properties of PU microcellular elastomer

Density of the sheet	0.6 – 0.7 g/cc
Tensile strength	650-700 psi.
Elongation at break	250-270%
Shore A hardness	65 – 70°
Tear strength	300-350 psi.
Abrasion resistance (Du Pont)	
Vol. loss-cc/hr.	3.4
De Mattia flex cracking at room temperature 27°	90,000 cycles.

A few samples of the polyethers made were evaluated for PU preparation.

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

This project was taken up in collaboration with CSMCRI, Bhavnagar. Different modified cellulose acetate polymeric membranes were prepared in NCL and evaluated at CSMCRI for desalination studies. NCL has also fabricated a small reverse osmosis unit. The polymeric membranes will be tested in this unit for different parameters in desalination process.

Preparation of polybenzimidazole (PBIL) type of polymers is in progress.

11.3 Metathetical polymerization of cyclo-olefins: (11-5-005)

Metathetical polymerization of Δ^3-carene, a naturally occurring bicyclic olefin, was carried out using WCl_6 — $AliBu_3$ and WCl_6 — $SnPr_4$ as catalyst. Low molecular weight polymers in yields less than 10% were obtained in most of the cases. The polymers gelled quickly in the absence of stabilizers and showed the presence of acyclic unsaturation thus demonstrating the occurrence of ring opening polymerization. Variations in catalyst — monomer ratio, catalyst — co-catalyst ratio, order of addition of reactants, temperature of polymerization, etc., did not result in either increased yields or increased molecular weights. When the solvent used for polymerization was changed from non-polar to polar solvent and *in situ* preparation of the catalyst, yields were slightly higher. However, using butoxy derivative of the transition metal compound resulted in low yields of crystalline polymers which were difficult to isolate.

11.4 Hydroxy terminated polybutadiene: (11-6-567-Sp)

Hydroxy terminated polybutadiene (HTPB) of molecular weight around 2500 was prepared using H_2O_2 as initiators. The batch was scaled upto 800 g. The samples were given to the sponsor of this work for testing.

Arrangements will be made to prepare HTPB by anionic polymerization.

11.5 Basic studies

11.5.1 Polymer characterization: (0-22-005)

The expansion coefficients obtained from light scattering measurements, carried out on a series of partially hydrolysed polyacrylamides, were 30-300% higher than the corresponding values obtained from viscosity measurements. Qualitatively, however, the variation of the expansion coefficients with molecular weight and charge density were similar. Electrostatic expansion coefficients were independent of molecular weights and total expansion coefficients confirmed to the predictions of Chien-Ishihara theory. The divergence in the values of the expansion coefficients obtained by the two methods

demonstrated the non-applicability of the conventional light scattering method for the determination of dimensions of polyelectrolytes.

The stability of poly (2,6-dimethyl-1-, 4-phenylene oxide) was probed in air and oxygen atmosphere and in the presence of bis-(1-phenyl-3 ∝ pyridyl triamine) Cu (II) by DTA and TGA. The kinetic parameters for the degradation of PDPO were determined.

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12. PROCESS DESIGN

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

A generalised computational procedure for simulating (and designing) continuous-contact absorbers for such important industrial systems as absorption of CO_2 and H_2S in amines, carbonates, etc., has been developed. In this connection, extensive modelling work in gas-liquid reactions (involving complex and general reaction schemes and many components) has been successfully undertaken.

Computer programmes for the design of distillation columns were developed and used successfully for the separation of propionic acid from a product stream.

A computer programme was developed for the simulation of a network of isothermal reactions in an integral reactor. The programme was applied to the complex scheme of xylene isomerisation.

12.2 Project designs: (12-2-067)

A process design package was prepared for the project on benzaldehyde (300 TPA). Revised process designs were prepared for NCL's process for the manufacture of theophylline, aminophylline and caffeine. A reactor for the commercial plant of chlorosilanes based on NCL's technology was also designed.

Follow-up work and certain additional designs were undertaken on the ethylenediamine project. The design cell also helped in the commissioning trials of the endosulfan plant.

13. PREPARATIVE INORGANIC CHEMISTRY

13.1 Sodium hydrosulphite: (13-2-002)

Sodium hydrosulphite is an important industrial chemical with a domestic production of 15000 T/Y valued at Rs.33 crores. About 75% of the total production of hydrosulphite is based on the use of zinc which has to be imported. Attempts were made to develop an alternative process for making hydrosulphite by using iron powder in place of zinc powder. The important steps of the process, i.e. formation of iron hydrosulphite by reacting iron powder and SO_2 in a slurry reactor designed and fabricated in the laboratory, the decomposition of iron hydrosulphite by sodium hydroxide/carbonate and the isolation of sodium hydrosulphite crystals by salting out were examined. However, in view of the increase in the price of iron powder of the required purity and mesh size and the reduction in the price of zinc metal in the Indian market, the iron based process does not appear to be attractive.

14. UTILIZATION OF CELLULOSE FOR FOOD/ENERGY

14.1 Protein food/energy from cellulosic materials: (14-1-167)

14.1.1 Cellulases: Hypercellulolytic mutants of *Penicillium funiculosum* and *Sclerotium rolfsii* were isolated from agar plates based on cellulose clearance tests. Mutants showing about 30% enhancement in activity in shake flasks will be studied for improved enzyme production. Fermentation parameters are being optimized with instrumentation controls and on two different media. Experiments conducted on a new UV mutant in the shake flasks demonstrated its superiority over the parent strain which was confirmed in the fermentor studies with automatic controls. Further, higher endoglucanase and possibly ß-glycosidase activities were observed.

Using the wild strain of *Penicillium funiculosum,* a number of experiments were conducted on instrumented fermentors with the aim of improving the cellulase activities and productivities. Some of the variables studied were the effect of substrate composition, temperature and pH policies, etc. Experiments were also conducted on the effect of inoculum, suitabilities of cheaper sources of nitrogen for fermentation, etc. Laboratory scale studies on saccharification were carried out with wet-milled, acid-treated bagasse.

Neurospora strains with cellulolytic activity and the capacity to convert pretreated cellulose to ethanol have been identified.

14.1.2 Microbial biomass protein: Rice straw pretreated by steaming in the presence of low concentrations of alkali was converted to protein-rich biomass product with *Penicillium janthinellum* F_3B. Semi-continuous fermentation was carried out in laboratory fermentors. Growth of *Candida utilis* on straw treated with steam under pressure was also investigated.

A few species of fungi and actinomycetes capable of decomposing lignocellulosic substrates were isolated and studies on the degradation of celluloses and lignin are in progress.

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16. TIME TARGETED PROJECTS

16.1 Catalytic vapour phase oxidation of toluene to benzaldehyde: (16-1-467-Sp)

The pilot plant was operated continuously and data for the design of an integrated pilot plant has been collected. The commercial feasibility of the process is now being examined after which a suitable size plant will be erected by the sponsor.

16.2 Hexachlorocyclopentadiene (HCCP): (16-2-007)

After the operation of the integrated pilot plant at NCL, it has been transferred to the site of HOC for further continuous operations. The activities related to a semi-commercial plant are expected to start in 1983.

16.3 Theophylline, aminophylline and caffeine: (16-3-3467-Sp)

The pilot plant work and process design work for this project have been concluded. M/s PEFCO Engg. and Foundry Chemicals, Bombay, are installing a plant of 135 TPA capacity at Roha. The plant is expected to be commissioned by February 1983.

16.4 o-Aminophenol: (1-4-067)

A process for the preparation of *o*-aminophenol confirming to the specifications required for the manufacture of pesticides has been optimised. The pilot plant work is envisaged only in collaboration with a party interested in exploiting the know-how.

16.5 Indothrin: (16-5-037)

Indothrin was prepared by modified process for conducting field trials. A techno-economic evaluation indicated that the product, if manufactured by this process, would not be competitive in price even though the product was comparable to other similar products from the point of view of efficacy. Therefore, work on this project has been suspended.

16.6 N-Tridecyldiisopropanolamine (TDDIPA): (16-6-037-Sp)

The project on TDDIPA sponsored by B.A.S.F. (India) which was started last year has been completed. A successful demonstration was given to the representatives of the party. A complete project report including the kinetic data based on the work done in NCL has been given to the party. The party is intending to implement the project as soon as propylene oxide from indigenous sources becomes available.

16.7 Aluminium chloride: (16-9-027)

The laboratory work on this project was concluded and it was decided that further work would be undertaken only in collaboration with an industrial organisation interested in exploiting the know-how.

16.8 Intermediates for chloroquin: (16-11-037)

Chloroquin is an important antimalarial drug. The main raw materials are 4,7-dichloroquinoline and novoldiamine. Their projected requirements (1982-83) are 550 and 350 tonne respectively. The former is also an intermediate for amodiaquin (1982-83 requirement: 200 tonnes).

The process condition for the preparation of 4,7-dichloroquinoline have been standardised. Further work for pilot plant study is in progress.

16.9 Citrate plasticizers: (16-14-067-Sp)

The process developed for TBC and ATBC is being used for a commercial plant of 1000 TPA capacity by M/s Citroflex India Ltd. The plant is scheduled to go into production in 1982.

16.10 Modified rosin and rosin derivatives: (16-15-007-Sp)

Work on the disproportionation of resin, using different catalysts and also evaluating the properties of the products obtained was finalised during the year.

Some work on the preparation of poly-rosin as well as maleinized rosin was initiated. The main objective is to prepare light coloured products having the requisite properties.

16.11 Small volume projects: (16-16-007)

16.11.1 Solvent extraction chemicals: (16-6-007-i)

In continuation of earlier work on solvent extraction chemicals (α -hydroxyoximes), some more samples corresponding to LIX-63 and LIX-65 have been prepared and sent to National Metallurgical Laboratory, Jamshedpur, for evaluation.

16.11.2 Sucrose esters: (16-16-007-ii)

Sucrose esters are very useful compounds for their surface active properties. These are being preferred over other surfactants because of the complete and easy degradability, good detergency and emulsification properties, non-dependence on petrochemicals, as well as non-toxic and non-pollutant nature.

Attempts have been made to make sucrose esters from easily available raw materials on laboratory scale. While further work is in progress, efforts are also being made to determine the surfactant properties of those compounds.

16.11.3 Crop protection chemicals:(16-16-007-iii)

This work was initiated for preparing some organophosphorus compounds which are effective herbicides not only for seasonal grasses but also for deep rooted perennial species as well as broad leaved weeds. Due to its non-selective, non-residual and post emergence herbicidal properties, N-(phosphonomethyl) glycine was selected initially. Attempts are being made to prepare this compound using only indigenously available raw materials.

16.11.4 Super phosphate type fertilizers from by-product bisulphate of acrylate industry: (16-16-007-iv)

Acrylate plants when set up in the country will produce 60 tonnes per day of ammonium bisulphate which will pose a serious problem of disposal as the material is corrosive. This by-product can be used to prepare superphosphate type fertilizers containing calcium and ammonium sulphate monocalcium and ammonium phosphate with small amounts of dicalcium phosphate.

The reaction of ammonium bisulphate with rock phosphate followed by curing was studied with various grades of rock phosphate, indigenous and imported as well as blends of both and fertiliser products containing 6% N and 10-12% P_2O_5 have been prepared.

16.11.5 Preparation of ferrocyanides from cyanide wastes: (16-16-007-v)

Cyanide bearing wastes arise from cyanide baths used in electroplating industries, heat treatment processes like carburising, nitriding and carbonitriding. HCN gas is a by-product in coke oven industries and sometimes in certain organic industries.

Cyanide bearing wastes are extraordinarily toxic and have to be treated and handled with great precautions. In the case of dilute effluents (1000 ppm) recovery of cyanide value is difficult and has to be destroyed by alkaline chlorination but in the case of concentrated wastes (1000 ppm) recovery of cyanide value as ferrocyanide is possible.

A process has been developed to convert the cyanide value into ferrocyanide by treating it with ferrous sulphate heptahydrate. The ferrocyanide formed thus is then separated by crystallizing out and purified. This process guarantees a quantitative neutralization of cyanide value and its conversion to very useful ferrocyanide salt, the requirement of which is met only by import (costing about 50 lakhs). A process manual has been prepared on utilisation of cyanide bearing waste starting with 1 kg of cyanide waste.

A consultancy was offered to TELCO, Pimpri, on their problem of utilisation of cyanide bearing waste.

HDC, Delhi, and GACL, Ahmedabad, have also shown keen interest in this work and negotiations are going on with them regarding the consultancy to be offered by NCL on utilisation of cyanide waste.

16.11.6 Pest control agents: (16-16-007-xi)

A fraction of neem seed oil has been found to be effective against potato tuber moth in the form of oviposition deterrent. The process for isolating this fraction (Neemrich-I) has been taken up for development and pilot plant trials. The process flow sheet involving a number of solvent extraction and distillation steps has been drawn up. The pilot plant equipment for each step has been assembled. The main solvent extraction unit for the Neem oil has been suitably modified to act as a semicontinuous extractor to handle 40 kg of Neem seed powder in one batch. In the meantime actual field trials for testing the effectiveness of Neemrich for protection against PTM are in progress at CPRS, Rajgurunagar. The cost of production of Neemrich on the basis of a 125 tonnes per year plant has been estimated to be Rs.30/- per kg.

16.12 Exploratory projects: (16-17-007)

16.12.1 Synthetic dyes: (16-17-007-iv)

The polycyclic systems based on 3-hydroxy-2-phenyl phenalen-1-one have been synthesised and evaluated as disperse dyes. Chromophoric systems from the reaction of homophthalic anhydride and arylacetic acid have been prepared. Complete spectral evidence in support of a polycyclic benzothioxanthene dye, CI-disperse red 303 was discussed in a communication sent to the Indian Journal of Chemistry.

Condensation of 2-N substituted, 1,3-isoquinolinedione with naphthostyryl and isatin in presence of phosphorus oxychloride led to the synthesis of a series of dyes. These dyes have been evaluated as disperse dyes. Azo and azoic coupling components have been prepared from cyanuric chloride derivatives. The fastness properties of these dyes were studied on polyester and polyamide fibres. Vilsmeir-Hack reaction was performed on N-substituted pyridones to get the corresponding formyl pyridones. Schiffs bases of the above pyridones have also been prepared.

Novel organic intermediates: Reduction of several substituted nitroarenes and partial reduction of several dinitro-arenes using hydrazine hydrate and Raney Ni has been achieved. The improved yields of sulfonyl 1-H azepines by the insertion of sulfonyl nitrenes in aromatic substrates has also been successfully accomplished. Novel synthesis of -chloroarylamine from nitroarenes was accomplished through the preparation of N-aryl benzohydroxamic acids and thionyl chlorides. Alkylation reactions on phenolics using appropriate olefins in presence of actionic resins are being studied.

16.12.2 Alumina by an acid recycle process: (16-17-007-v)

A process has been developed on the following lines:

(1). extraction of bauxite with hydrochloric acid containing a little sulphuric acid,

(2). precipitation of pure $AlCl_3.6H_2O$ from the acid extracts containing aluminium and iron in solution by saturation with HCl gas,

(3). decomposition of $AlCl_3.6H_2O$ at temp. 350-500° to yield $Al_2O_3.3H_2O$ and HCl,

(4). stripping off HCl gas from the residual acid liquor from step (2),

(5). removal of iron from the dilute HCl solution by anion exchange to produce the recycle acid of sufficient purity.

Yields of the order of 90-95% have been achieved for the extraction of alumina from bauxite and precipitation of pure $AlCl_3.6H_2O$. The decomposition of $AlCl_3.6H_2O$ was found to be practically quantitative.

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

16.13.1 Endosulfan: (16-18-007-i)

The plant installed by M/s Bharat Pulverising Mills Ltd., Bombay, has been working satisfactorily after initial problems at a capacity of 500 TPA. The commissioning activity of the second plant installed by M/s Hindustan Insecticides Ltd., Udyogamandal, is in progress. The plant installed by HIL has a capacity of 1600 TPA.

16.13.2 Butenediol: (16-18-007-ii)

Detailed analysis of the catalyst used for butenediol in the semi-commercial plant installed by M/s Hindustan Organic Chemicals Ltd., Rasayani, was carried out at NCL using ESCA, SEM and other surface characterisation instruments. The reasons for its non-performance have been found and a method to manufacture the catalyst has been devised. A batch of catalyst for the HOC plant was prepared and tested at NCL and HOC. As these have given satisfactory performance, the plant at HOC will be started with the catalyst prepared at NCL. Attempts are being made to get the catalyst prepared by a manufacturer.

As far as the second step is concerned where hydrogenation of butenediol is involved, a pretreatment method prior to hydrogenation was developed. The solution obtained from HOC unit was hydrogenated in a 75 lit. autoclave and the conversion, selectivity and overall yield expected were demonstrated. The bulk requirement of the catalyst was also prepared at NCL.

16.13.3 Chlorosilanes: (16-18-007-iii)

The basic design of a 1000 TPA commercial reactor was prepared by using the information generated in the semi-commercial reactor also designed by NCL and in operation at the Thane-Belapur site of M/s HICO Products Ltd., Bombay. This reactor has been so designed as to make possible a two-fold increase in capacity by adjusting certain process parameters and the time cycle. The reactor has been fabricated by a firm in Italy. The commercial plant for the production of 1000 TPA of mixed methylchlorosilanes along with a 1200 TPA methyl chloride plant is being erected at Kharsundi, Dt. Raigad, Maharashtra State. The detailed engineering is being carried out by Humphreys and Glasgow Consultants Pvt. Ltd., Bombay. The plant is expected to be commissioned during the last quarter of 1982. The

methylchlorosilanes technology jointly developed by NCL and HICO is also available to other parties through NRDC.

16.13.4 Ethylenediamine: (16-18-007-iv)

Diamines and Chemicals Ltd., Baroda, have installed a plant to manufacture 1200 TPA of ethylenediamine and polyamines. The plant was commissioned in January 1982. NCL was associated with commissioning and troubleshooting operations. The product has been well accepted by the consumers. The production will be raised to the design capacity as soon as the market demands the same.

16.13.5 Vitamin C

An improved process for the purification of crude Vitamin C from the enolization step was developed at the instance of HAL, Pimpri. In this process pure Vitamin C confirming to the required specifications was obtained in over 88% yield. A process packet for the purification of 50 kg of crude Vitamin C per batch was prepared and given to HAL for testing the process and implementing it.

OTHER BASIC AND EXPLORATORY PROJECTS

1. Molecular biology and genetic engineering: (0-1-001)

Methods were standardized for the preparation of various restriction endonucleases, plasmids and phage DNA. A preliminary characterization of the DNAs from three cellulolytic fungii has been completed.

1.1 DNA organization and regulation of gene expression in plants: DNAs of two legumes and three cereals have been studied in detail with respect to their properties and nucleotide sequence organization. Novel observations have been made with reference to the arrangement of repeated and single copy DNA sequences indicating that the gene regulation mechanisms in plants may be different from those proposed in animals.

Work is in progress on complete genome analysis of plants during differentiation using plant cells cultured *in vitro*.

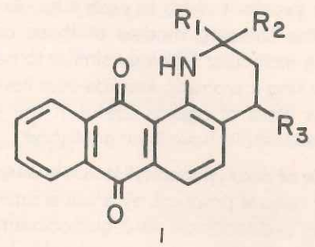
A computer programme has been standardized for five structure analysis of DNA by melting.

1.2 Theoretical studies on structure and function of biologically active molecules: Quantum chemical studies on the conformational structure of nucleic acid constituents and analogous molecules have been made using PCILO method. Studies on protonation and base modifications as well as the configurational alterations of systems related to nucleic acids are in progress.

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

2.1 A new synthesis of derivatives of tetrahydroanthrapyridine quinones: Although the Marschalk reaction has been known for a long time, ketones have not so far been found useful for the nuclear alkylation of amino-anthraquinones. Also, it is known that cinnamic aldehyde reacts very poorly with leucoaminoanthraquinones under alkaline conditions.

It has now been found that a set of α ß-unsaturated carbonyl compounds, including aldehydes and ketones, react with leucoaminoanthraquinones to give tetrahydroanthrapyridine derivatives (I & II). This is an interesting new result useful in the synthesis of angularly fused N-heterocyclic analogues of anthracyclines. It is not clear if these compounds are of any therapeutic value. The derivatives are highly coloured and their dyeing properties are worth investigating.



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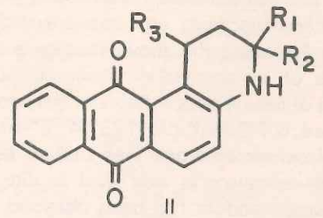

II

2.2 Organic chemistry of trivalent iodine: The reaction of a ketone with an aryl chloromethyl sulphone under basic conditions gives an α -sulphonyl aldehyde as the product. The reaction goes through an epoxy intermediate and involves a 1,2 rearrangement of the sulphonyl group. It is of considerably interest to see if this intermediate can be generated under milder conditions and transformed in an alternative way so that the sulphonyl group is removed from the α -position. In this context, attempts have been made to obtain phenyl benzenesulphonyl methyl iodonium acetate as a substitute for an aryl chloromethyl sulphone. Efforts have been made to get phenyliodoso acetate to react with phenyl chloromethyl sulphone, but these were not very successful mainly because of solubility problems.

A study of the reaction of iodosobenzene with alcohols showed that primary alcohols can be converted nearly quantitatively into aldehydes by treatment with the reagent in acetonitrile using phosphoric acid as catalyst. With a strong acid like H_2SO_4 as the catalyst, the oxida-

tion gave the carboxylic acid or ester. Secondary alcohols were converted into ketones more readily by the reagent. Acetonitrile functioned not only as a solvent but as a reagent with a facilitating mediatory role. The nature of the pathways involved has been clarified.

3. **Synthesis of ring c-aromatic steroid:** An elegant stereospecific total synthesis of an aromatic c-ring testosterone analogue has been completed. The approach to ring-c aromatic steroid is the shortest one with excellent yields at each step. An examination of the Drieding models of these compounds showed a molecular topology similar to natural steroids. The ring-c aromatic steroids thus have potential as a new class of agents useful in the antifertility field. These results have been published.

4. **Synthesis of deoxypodophyllotoxin analogue:** Synthesis of natural products by a novel inter and intra molecular cycloaddition *via-o*-quinodimethane generated *in situ* has attracted considerable interest due to the stereospecificity and regiospecificity of the reaction. Following the above strategy a successful synthesis of iso-deoxysikkimotoxin (6,7-dimethoxy analogue of deoxypodophyllotoxin) has been recently developed. 6,7-Dimethoxy-1-(3′,4′,5′-trimethoxyphenyl)-isochroman-3-one was utilised as a diene and n-phenylmalemide was used as dienophile. A stereospecific adduct has been obtained in almost quantitative yield. This adjuct was elaborated to iso-deoxysikkimotoxin by a simple route. This synthetic route is considered the shortest one and it proceeds with excellent yields for the synthesis of 1-aryltetralin lignan lactone.

   ß-Peltatin-A-methyl ether, an aryltetralin lignan lactone has insecticidal and antitumour activity. An isomer of this, i.e., (±)-Iso-ß-peltatin-A-methyl ether has been synthesised and the results have been published.

5. **New perfumery products from longifolene:** Structure determination of a brand new isomer of longifolene i.e., alloisolongifolene 1, has been finalised. The preparation of 1, has been standardised on a one kilogram scale. From the exploratory chemistry of alloisolongifolene unravelled during the past year, at least one compound — acetyl-alloisolongifolene-has emerged as a new aromatic chemical (rich woody ambergris fragrance) of distinct promise in the perfumery field. The Prins formaldehyde reaction on the hydrocarbon 1 has given oxygenated products which are theoretically novel and also likely to find use as special aromatic chemicals.

6. **Studies on *o*-hydroxyarylamides:** *o*-Hydroxyarylamides are systems through which proximity effects of hydroxyl group on the reactivity of the amide function may be profitably studied. The properties of such systems are of interest in the context of their possible significance for an understanding of the chemical behaviour of enzymes. These have been under study in this laboratory.

   The tautomerism of anions of *o*-hydroxyarylamides has been studied using C^{13} spectroscopy.

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

The laboratory has a collection of about 3000 non-pathogenic yeasts, bacteria and fungi. A hundred and fifty new cultures were added to the collection during the year. Yeast extract samples received from the Centre for Biochemicals, New Delhi, were tested for vitamins.

2. Centralized 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 2304 samples by infrared and 507 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. Two thousand and eighty three samples were analysed by classical and instrumental methods.

2.3 Microanalysis: (Infra-2(iii))

The group provides microanalytical service to NCL and outside scientists. During the period under review 2353 samples were analysed for the NCL research projects.

Besides, under basic studies, the group prepared α and ß monomers of some glycosides and IR spectra and 13_c NMR spectra of some of them were studied for correlation purposes.

Vapour phase oxidation of some alcohols was also studied on some oxidants such as CuO and V_2O_5 supported on SiC at 250°, 350° and 450°.

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. $60MH_2$ PNR spectra-6097; 90 MH_2 PHR FT spectra-593, C^{13} FT NMR spectra-200; selective deconplony (C^{13}-H′)-26; Homonuclear H′ deconplony-86; and variable temperature experiment-38.

A programme for simulation of NMR spectra was earlier adapted for use on the ICL 1904 S computer at the RCC, Poona. A plot programme is now being prepared and will shortly be available.

The spectra of the salts of a series of *o*-hydroxy and anhalides have been examined at various temperatures to obtain more information on the extent of tautomeric behaviour in these systems. Line widths and chemical shifts of the mobile protons have been found to show interesting variations. An evaluation of their significance will be possible when the study is complete.

The behaviour of some of these salts towards methoxymethyl chloride has been examined closely. With the salts of the more acidic aimdes there appears to be evidence of the formation of two products. Further work is in progress.

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

The group provides MS and GC/MS analytical services to the NCL and outside scientists. During the year under review 237 samples were analysed for NCL by GC/MS technique.

The following basic studies were also undertaken in the group.

The electron impact induced cycloreversion reactions of substituted 2-chloro-3, 6-diaryl-3, 4-dihydro-1,3,2-oxaza-phosphorin-2-oxides, a novel ring system, were studied. Retro Diels-Alder reactions by two different routes are major fragmentation modes. The Retro Diels-Alder reaction involving loss of PO_2Cl from the molecular ion, preceded by 1,3-allylic rearrangement is the major fragmentation mode in the metastable time scale. Further fragmentation of the (M-PO_2Cl) + heterodiene ion seems to occur from cyclic dihydroquinoline intermediates by substitution elimination reaction.

The chemical ionization mass spectra of 3,5,6-triamyl-4-hydroxy-Δ^1-cyclohexene and its acetate reveal that triphenyl cyclohexenyl and diphenyl cyclopentenyl benzyl cations equilibrate directly or through common intermediates. The results are supported by collisional activation and kinetic energy.

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Chapters in Books

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2.6 Electron diffraction: (Infra-2(vi))

The group provides routine electron diffration facilities to the scientists of the laboratory and also undertakes basic studies on crystal growth, semi-conducting, optical and dielectric properties of thin films of some binary and tertiary compounds.

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

The group provides ESCA facilities to the scientists of the laboratory and outside parties. Three hundred and sixty four samples were analysed by ESCA using various techniques such as XPS, UPS, AES and depth profiling etc., during the period under review. Besides maintaining the service facilities the following basic studies were undertaken in the group.

a) Work on zinc oxide varistors was completed.

b) Dilute Pb-Sn, Ag-Sn, Cd-Sn, Cu-Sn, In-Sn and Sb-Sn were prepared and studied by XPS technique to see the effect of coordination as well as electronegativity of the near neighbour on the core energy levels. The work has been further extended to study the surface segregation of Sn in these alloys.

c) UPS and AES studies on chalcogenides of Mn, Co, Fe, Sn, In, Cd, Sb, Pb and Hg were initiated.

Publications

1. Hegde, R.I., Sainkar, S.R., Badrinarayanan, S. and Sinha, A.P.B.,
A study of dilute tin alloys by X-ray photoelectron spectroscopy,
J. Electron Spectrosc. Relat. Phenon., **24,** 19 (1981).
2. Sainkar, S.R., Badrinarayanan, S., Date, S.K. and Sinha, A.P.B.,
X-ray photoelectron spectroscopic studies on ZnO-Sb_2O_3 varistors,
Appl. Phys. Letter, **39** (1), 65 (1981).
3. Dharmadhikari, V.S., Sainkar, S.R., Badrinarayanan, S. and Goswami, A.,
Characterisation of thin film of bismuth oxide by X-ray photoelectron spectroscopy,
J. Electronspectros. Relat. Phenom., **25,** 181 (1982).

2.8 Analytical group of process development: (Infra-2(viii))

Major functions of the analytical group are (a) to provide analytical support to the various projects of the laboratory, (b) standardization of new analytical methods required for process development, (c) preparation of analytical manuals for processes released to industry, (d) handling of troubleshooting in commercial plants, and (e) development of new analytical tools.

During the year under review this group handled more than 1000 samples from various projects and considerable attention was given to the following projects: (1) endosulfan, (2) ethylenediamine, (3) butenediol, (4) hexachlorocyclopentadiene, and (5) simazine. Many new techniques were developed for the analysis of various constituents including (a) trace analysis of HCCP in hetdiol, (b) estimation of palladium in catalysts using ion selective electrodes.

New developments: (a) A few ion-selective electrodes were developed during the year. They include solid state ion selective electrode for chloride, bromide, iodide, sulphide, silver and cyanide. Work is in progress to develop gas sensing probes for the monitoring of oxidisable gases like hydrogen, hydrocarbons, vinyl chloride, etc. (2) A new gold-plating composition was developed for plating gold on semiconductor devices. The composition is successfully being used commercially.

2.9 Analytical group of organic synthesis: (Infra-2(ix))

The group provides analytical service to the division of organic synthesis as well as other divisions by standard instrumental methods and endeavours to develop newer methods of analysis with special reference to synthetic pesticides as well as pesticides from natural sources, drugs, intermediates, etc. It is also working on the development of new liquid substrates for GLC columns and their applications for the separation and identification of intricate mixed products formed during organic reactions.

The group carried out analysis for the following NCL projects: Endosulfan — 150, Theophylline — 88, Organophosphorus pesticides (dimethoate, ethion, phosphamidon, phosalone) — 180, Vitavax — 30, Indothrin — 22, Abate (UNDP project of slow release pesticide) — 83.

Instrumental analysis carried out for the various research projects were — GLC-1537, IR-3321 and UV-23.

R & D in liquid substrates: To evaluate liquid crystal substrates as compared to commonly used phases, alkylation reactions of aromatics by organic esters in presence of $AlCl_3$ were carried out. The products formed at different stages were separated and identified on columns prepared from liquid crystals as well as SE-30, GF-1 and Carbowax. Similarly, other isomerisation reactions were carried out to study the clear advantage of liquid crystal phases. Twenty-six alkyl benzene isomers were prepared and studied on these phases.

Publications

1. Ghatge, B.B. and Kadam, A.N., Thermal decomposition of dimethoate, *Pesticides,* **XV (a),** 7 (1981).
2. Uppal, K.S. Panse, D.G.,Bapat, B.V. and Ghatge, B.B., Application of substituted aromatic polyesters as liquid substrates in GLC, *Ind. J. Tech.,* **19 (5),** 195 (1981).
3. Panse, D.G., Naikwadi, K.P., Bapat, B.V. and Ghatge, B.B., Applications of laterally mono and disubstituted liquid crystals as stationary phases in GLC, *Ind. J. Chem. Tech.,* **19,** 518 (1981).
4. Panse, D.G., Bapat, B.V. and Ghatge, B.B., Synthesis of laterally mono and disubstituted new liquid crystalline compounds, *Ind. J. Chem.,* **21B,** 66 (1982).

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

During the period under review the group undertook thermal analysis of 435 samples for various NCL projects. The information derived from these studies related to thermal decomposition, products and possible phase change occurring during the heating.

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

During the year, 169 samples from different projects in NCL were analysed by SEM for particle size and their distribution. In addition 47 samples were analysed by EPMA technique to determine surface elemental composition.

2.12 X-ray diffractometer: (Infra-2(xii))

Various groups in NCL widely used the XRD technique for characterising of different samples and calculating the crystal parameters. During the period under review XRD spectra for 931 samples for NCL projects were recorded.

2.13 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 other divisions of the laboratory in addition to the Process Development Division. The analytical services rendered during the year were: HPLC-225 and GLC-973 samples.

2.14 High pressure laboratory: (Infra-2 (xiv))

The group provides and maintains facilities for carrying out reactions at pressures and temperatures higher than atmospheric and compresses various gases in cylinders for all the divisions of the laboratory. It also undertakes work on the specific projects of the Process Development Division. Sometimes facilities are also provided to the outside parties for short durations. During this year 313 experiments were carried out for various research and development projects of the laboratory. In addition, this group prepared 650 kg of the catalyst needed for the butenediol project, to be tested in a pilot plant at HOC.

2.15 Mossbauer spectroscopy: (Infra-2(xv))

Mossbauer spectroscopic studies were carried out at different temperatures and atmospheres on the following systems:

(i) $Zn_xFe_{3-x}O_4$ (x varied from O to 1), (ii) Styrene catalysis — fresh and used, (iii) Iron co-ordinated nylon polymer, (iv) Al_2O_3: Fe_2O_3 10 atom % system and (v) Iron complexes of $\widehat{OO}$, $\widehat{On}$ and $\widehat{NN}$ donor vitamin K-derivatives.

The spectra were used to calculate the structural, electronic and magnetic properties of these systems. MOSFIT least square fitting programme was used to calculate Mossbauer parameters of $Zn_xFe_{3-x}O_4$ series, styrene catalysts, nylon polymer and vitamin-K derivative complexes.

2.16 Magnetic susceptibility: (Infra-2(xvii))

This is a general research facility for determining the magnetic susceptibility of magnetic materials. A magnetic susceptibility system comprising of Calm-1000 electrobalance, electromagnet, power supply, and controlling units was installed during the period under review. The system is capable of measuring the magnetic susceptibility of polycrystalline samples in the temperature range of 77°K to 1000°K.

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

The cell attended to 56 enquiries received from various small scale industries. NCL scientists visited a village near Khadakwasla, Pune at the request of the State Bank of India to see if NCL could be of assistance to the concerned agencies in the developmental activities of the village to make it an ideal village.

2.18 Crystallography: (Infra-2(xx))

A comparative study was made of the way in which various properties of an atom in a simple crystal are influenced by the point group symmetry of the atomic site. The properties described are: atomic valence charge distribution, anharmonicity of thermal vibrations, and the elastic distortion of the lattice by substitutional atoms.

The structure of the natural product 'Rubranol' was elucidated.

3. Measurement of thermodynamic properties: (Infra-3)

This group undertakes the measurement of various thermodynamic properties for different projects in NCL and also conducts basic research in this field. During this period, the measurement of heats of reaction and neutralization of the sodium salt of theophylline with dimethylsulphate and conc. H_2SO_4 was undertaken.

Isobaric vapour-liquid equilibrium of HCCP(1)-OCCP(2) system was obtained at 25 ± 2 mm pressure to understand whether this system behaves ideally or not. The results obtained reveal that this system behaves almost ideally.

Basic research on the thermodynamic properties of binary non-electrolyte mixtures is being continued. The heats of mixing of the following binary systems were carried out at 30° for various mole fractions.

1. Isobutylamine with chloroform.
2. Ethylenediamine with water.
3. Ethanolamine with water.

Heat of mixing ($\triangle H$) obtained at 0.5146 mole fraction is 2591 J/mole in case of (1). In case of (2) and (3) systems the experiments were carried out in the low concentration range ($x_1 = 0.003$ to 0.1). The $\triangle H$ values vary from −20 to −398 J/mole for system (2) and 10 to 12 KJ/mole for system (3).

These results are being analysed in the light of intermolecular interactions and current liquid mixture theories.

Computer programmes for Wilson and NRTL equations were developed. The NRTL equation was developed based on the method proposed by Nagahama. This equation correlates the VLE data in a better manner than the Wilson equation.

Construction of the vacuum system for VLE static method was completed. The vacuum obtained is of the order of 10^{-5} mm of Hg. Retention of the vacuum for longer periods is being tested.

3.1 Measurement of surface properties of soluble and insoluble monolayers: (Infra-3(i))

Measurement of surface active properties of different surface active agents derived from sugar esters which are being developed in NCL was undertaken. The main aim was to measure surface and interfacial tension, wetting (Drave's test and Herbig Number), foaming and foam stability, detergency and emulsification. Before the actual samples were undertaken for active property measurements, the apparatus was standardized and the reproducibility of measurements was ensured. During this year nearly 25 different surface active agents derived from sugar esters were scanned for the properties mentioned above. The results obtained indicated that some of the samples had better detergent properties as compared to standard compounds such as sodium lauryl sulphate, sodiumdodecyl benzene sulphate and Surf. The results are also being analysed for finding their suitability or otherwise for various other properties measured.

It has been observed that mixed monolayers exhibit better stability than the pure components. In continuation of the earlier work few more mixed monolayers will be undertaken for getting stable films so that they can withstand high wind velocities. During this period π-A isotherm and surface viscosity studies of monomolecular films of $C_{16}OC_3H_6OH$ + $C_{22}OC_3H_6OH$ have been undertaken in order to understand the nature and behaviour of these mixed films at different mole-fractions. The results obtained reveal that the mixed monolayer is miscible, homogeneous and more stable. These mixed films showed non-ideality at all mole fractions. 1:1 and 1:4 mole fractions ($C_{16}HC_{22}$) showed maximum deviation from the ideal. These have been depicted by plotting ΔG vs mole fraction, ΔA vs mole fraction, shear modulus vs mole fraction and compression modulus vs mole fraction curves. These mixed monolayers exhibit better evaporation retardation properties than the pure components as revealed from pan evaporimeter experiments. The study of mixed monolayers will be extended to polymers, especially polyvinyl stearate, which is expected to exhibit stable films with long chain alcohols and alkoxy ethanols. Work on these lines has been initiated.

Publications

1. Pradhan, S.D.,
   Chain length and isomeric effect of alcohol on the excess properties of amine-alcohol systems: excess free energy of mixing, enthalpy of mixing and volume change of mixing,
   Proc. Indian Acad. Sci., **90** *(4)*, 261 (1981).

4. Entomology: (Infra-4)

A comprehensive screen consisting of laboratory colonies of more than a dozen insect pests of agricultural and public health importance, as well as standardisation of procedures for evaluation of an equal number of biological activities, has been developed. Extracts of plants collected from all over the country as well as new synthetic compounds were put through this screen. Promising leads were followed up by close interaction of chemical work involving further fractionations and isolations of active principles, and entomological work aimed at development of application strategies. Products showing substantial potential in laboratory experiments were selected for small scale simulated field trials.

During the year under report, nearly 1000 separate bioassays were conducted to evaluate 35 new plant species and to further examine fractions/subfractions/active principles from plant extracts already identified as promising in the previous year.

Work on the detection and identification of newer activities in Neem and their development as viable pest control agents assumed a special importance in the current year. The enriched extract of neem showing oviposition deterrent activity against Potato Tuber Moth (PTM) was assigned the name Neemrich-I. A country hut storage trial on stored tuber was initiated with this product at Rajgurunagar, Pune in collaboration with Central Potato Research Institute of India, Simla. Results obtained indicate very good effect of Neemrich-I in preventing PTM damage of stored potatoes using traditional methods. Highly potent aphicidal and tobacco caterpillar antifeedant activities were also pinpointed in specific Neem isolates, the most promising of which has been named Neemrich-II. This work was undertaken at the instance of the Central Tobacco Research Institute of India, Rajahmundry. Neemrich-II is presently being prepared on pilot plant scale for field trials by CTRI.

In the project on controlled release formulations more than a dozen formulations of Abate made from natural rubber were evaluated against mosquito larvae.

Several new synthetic compounds developed at NCL were also evaluated for insecticidal, miticidal, behavioural and or developmental effects on various insects.

Apart from the leads already developed (Neemrich-I & II), several other very promising leads from both natural and synthetic sources have also been obtained. These include insecticidal, ovicidal, mosquito repellent and development distracting principles, which will facilitate development of new pest control agents.

Basic studies were undertaken on elucidation of mode of action of the oviposition deterrence principles found in various plants and on the mating behaviour and communication system, including pheromones, of selected insects.

Publications

1. Sharma, R.N. and Nadkar, R.,
   Inter-relationship between feeding and oviposition behaviour in some insects,
   XI Annu, Conf. Ethological Soc. of India, Calicut, J. Res., 47, (1982).

5. Instrumentation: (Infra-5)

This section caters to the maintenance needs of the laboratory for analytical equipment like IR, UV, X-ray spectrometers, NMR, rheometric equipment and process control instrumentation. During the year more than 1100 job requests were attended and installation of four GC, two IR, two HPLC, one FT. NMR and one X-ray ray diffractor was done.

As a part of the training programme for the staff, a few process control instrumentation projects were successfully completed. These are: (1) 8 station automatic seamner with 3½ digit digital readout, (2) start delta automatic starter for 3 motors, (3) ratio timers, and (4) level controllers and safety monitor system for reactors.

Under the grant-in-aid programme of DST the final assembly of the commercial medium resolution IR spectrometer is in progress. The prototype is scheduled to be completed by March 1983.

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

The DTS broadly looks after the public relations and research management activities of the NCL. These include (i) planning, monitoring and research coordination, (ii) industrial liaison and technology transfer, (iii) collection and documentation of market data, and (iv) publicity and extra mural work.

The NCL Research Programme for the years 1982-83 and 1983-84 was submitted to the Research Advisory Council and Executive Committee of the NCL after discussions at internal research programme meetings. A thorough study was made of material received in the Centralized Project File Bank (CPFB) and regular reports were made to the Director regarding the progress of projects and the difficulties that cropped up on occasion.

Area meetings were arranged for various research projects to assess the progress and bottlenecks in each of the areas. The NCL Annual Plan 1982-83 was prepared along with other background papers for presenting the NCL budget at CSIR headquarters. Projectwise accounts for all the areas and infra projects were systematically maintained.

The division handled 5328 enquiries from private parties, government departments, Lok Sabha, NRDC, CSIR headquarters, sister laboratories, polytechnology transfer centres, audit party, customs, excise, etc. The scientific staff of the DTS held discussions with various parties regarding NCL processes and proposals for sponsorship, collaboration and consultancy. The fruitful cases were processed through the Executive Committee, CSIR and NRDC as warranted.

Comments were sent on various applications for letter of intent/industrial licence/foreign collaboration/registration of R & D units with DST/financial assistance for research schemes. Analytical help was extended to 222 parties. Correspondence was carried on regarding the filing and renewal of Indian and foreign patents.

Routine screening of newspapers, classification of paper cuttings and documentation of information from periodicals and licence applications relevant to NCL's work and chemical industries was carried out. Assistance was rendered to NCL scientists needing commercial data on various chemicals/chemical products.

The NCL Annual Report for the year 1980-81 was printed. The NCL Bulletin meant for internal circulation was brought out at regular intervals.

Arrangements were made for taking visitors, some of them VIPs, round the laboratory. The DTS staff rendered valuable assistance in various activities like (i) bringing out the first NCL monograph on Plant Tissue Culture, (ii) preparing charts for the International Industrial Trade Fair in New Delhi, (iii) shooting of a film on Science in India for screening at the Festival of India in London, (iv) preparing a write-up on Plant tissue Culture for the Guinness Award, (v) drafting a script for a documentary on Plant Tissue Culture, (vi) preparing material for the committee constituted to look into the working of CSIR institutions.

An extensive literature survey covering the period 1907-79 was made regarding (i) toxicological data, and (ii) mode of action and utilization of simazine and atrazine.

Assistance was given to the Small Scale Chemical Industries Cell in the collection of information on expertise available in NCL, arranging a meeting of banking institutions, arranging study tours of industries and other institutions, preparing the form to be filled by prospective clients and preparing a brochure on the cells activities.

Photographic, draftsman and artists services were rendered for research and publicity. The photographic section completed 226 jobs making 2517 exposures, 2594 prints, and 1766 slides. Draftsman services prepared 450 tracings, illustrations and sketches, and made 724 ammonia prints.

7. Documentation services: (Infra-7)

The NCL library has an impressive collection of about 86,793 publications consisting of books, periodicals,

patents, standards, technical reports, etc. During the year 550 books, 1607 bound periodicals, 911 patents and standards, 80 photocopies, microfilms and translations, 45 technical reports and 10 theses were added to the library. The library received 600 periodicals out of which 475 were received on payment and the remaining 125 on gratis and exchange basis. Translations/photocopies of 103 papers published in various foreign languages were also procured by the library.

During the period under review 11,667 publications were issued to staff and corporate members. Under inter-library loan scheme, 83 publications were borrowed and 76 were issued to other libraries. Six hundred and five outside parties made use of NCL library facilities which are also available to industries, government departments, universities, colleges, research organisations, etc.

About 2,862 current periodicals were circulated amongst senior scientists for browsing purposes. Current monthly awareness services on agrochemicals and pesticides, Indian patents bulletin, chemical reactors, library bulletin and solar energy were brought out and circulated to the scientists in the particular fields. Current awareness services on biomass energy and nitrogen fixation were also started during the year.

During the year photocopies of 1,13,886 pages of scientific references were supplied to NCL scientists and 8,694 to outside parties.

The NCL library is an inspection centre for Indian patents. It received about 3,000 patents during the year.

8. Engineering services: (Infra-8)
Mechanical/Electrical/Refrigeration/Civil engineering

This group undertook fabrication and modification of equipment according to the requirements of projects in the Process Development and other divisions, besides, the regular maintenance of NCL's equipment, utility services and various NCL buildings. During the year 2076 and 1224 jobs were completed by the mechanical and electrical/refrigeration sections respectively.

Some of the major jobs carried out were as follows:

Mechanical

1. Erection of Pilot Plant for Regular Packing Development was completed. All the structurals and equipment that went into the project were fabricated. Complete piping work was carried out and tested by Workshop personnel.

2. The Liquid Nitrogen Plant supplied by M/s. Philips, Holland was installed and commissioned thus saving Rs.98000/- towards installation charges. The plant has been in operation for the last one year.

3. New laboratory facilities were created for the Organic (NP) Division by converting two halls on the second floor of the main building.

4. The old grinding room and a hall were also converted into laboratory rooms for the Organic (NP) Division.

5. A room was specially modified and air-conditioned to install the X-ray difractometer XRD — CAT — 4 in the special instruments laboratory.

6. The RGPP Pilot Plant was dismantled and shifted from Pilot Plant — I.

Electrical/Refrigeration

Electrification services were provided to various research laboratories and other buildings of the NCL, e.g. service building, workshop extension, entomology and rheology laboratory, polymer laboratory converted from old lecture room and photographic section, canteen extension and Administration/DTS block. Besides the above, an additional telephone line was provided to the dispensary and a new cold room of 5 T capacity was commissioned.

Civil

1. Resurfacing of laboratory roads.
2. Construction of shopping centre at NCL.
3. Development works (i) in the colony near D-II type (ii) in front of Co-operative stores, (iii) around the guest house and old hostel, (iv) around new shopping centre and (v) entomology laboratory.
4. Widening of road between NCL primary school and NCL east gate.
5. Extension to guest house.
6. Modification in basement, west wing of main building.
7. Construction of shed near wells No. 1 & 2
8. Laying and providing PVC pipe line from well No. 2 to NCL main garden.

9. Glass blowing: (Infra-10)

NCL has a well equipped modern glass blowing section that undertakes fabrication of many types of special glass apparatus such as chemical reactors, constant pressure gas burettes, silica reactors, BET units, high vacuum systems and heat exchangers. This section also looks after the repairs and maintenance of glass equipment. This section can undertake work upto 6" dia tubes and 50L flasks. During the period under review 4690 regular jobs were attended to and 7190 ground glass joints (including silica joints) and 250 high vacuum stopcocks were fabricated.

APPENDICES

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, trouble-shooting and establishment of in-house R & D units; (2) undertaking specified developmental work on sponsored basis; (3) rendering ad hoc assitance on industrial problems of standardization, optimization, analysis, material testing and troubleshooting; (4) associating with project engineers in preparing feasibility reports and making turn-key offers on NCL technologies; (5) collaborating with industry for the development of complex and high-risk technologies of the laboratory on semi-commercial scale; and (6) participating with industry in their negotiations for the import of technologies and in their assimilation. The norms and nature of such assistance are as follows:

1.1 Modes of technological assistance to industry by the NCL

1.1.1 Consultancy

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

1.1.2 Sponsored schemes

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

1.1.3 *Ad hoc* assistance

NCL can render assistance to industry on exploratory work, standardization, optimization, feasibility studies, analysis and testing, etc., on payment of *Ad hoc* fees depending upon the nature of the 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 needed for the establishment of a commercial plant, based on laboratory data either obtained at the 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 on pilot plant scale, 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 cell 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 liaison with the industry, (e) monitoring the assistance rendered, and (f) organizing 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 development of complex technologies with high investment risks. In such cases, based on the developmental work at the 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 602 cultures from the National Collection 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.

Spectrographic	21
Atomic absorption	40
Microanalysis	153
NMR	51
IR	50
Mass spectral analysis	81
GC/MS	10
VPC/GLC/HPLC	31
X-ray diffraction pattern	69
Spectrophotometric estimation/inorganic analysis of special nature	32
Surface area measurement	4
Mossbauer spectroscopy	7
ESCA	51
SEM/XRF	71
UV, Vis-spectra	17
Netzsch thermal analysis/ MOM Derivatograph	111

The total receipts on account of analyses/testing carried out during the year amounted to Rs.0.44 lakhs.

1.4 Training

During the year seven representatives of various industries and institutes were given training in HPLC techniques, plant tissue culture technique, microbiological technique and GC/MS technique.

1.5 Special equipment/instruments/testing facilities

An overall review of the special facilities available with the laboratory was taken in 1975-76. Thereafter only yearly additions of special equipment/instruments are being reported. The following is a list of the additions during 1981-82.

Name of the equipment	Description/Function
1. Automatic digital polarimeter (DIP-181) — Jasco Model 9102	For determination of optical rotation by automation
2. Catalyst Unit — Model B with gas recycling unit	For rapid testing of catalyst at high temperature and high pressure
3. Elmer Infrared spectrophotometer Model 683 Perkin	Infra red spectrum
4. High pressure liquid chromatograph — Model ALC/GPC 244	Qualitative and quantitative analyses of organic compounds
5. Programme board, printing punch — Type Sr 74/1/39010	Data punching, control, programme etc., on cards to feed the computer
6. Programme card verifier with key board — Type Sr 173/39209	For verification of the punch cards

□

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 the NCL scientists working on the scheme.

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

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

(iv) A fixed charge of Rs.11,000/- per scientist per annum is payable towards services, depreciation and incidentals. The charge is payable irrespective of whether the scientist is from the NCL or deputed by the sponsor.

(v) A minimum provision of Rs.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 addtion 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 the NCL/CSIR embodying various terms and conditions of the scheme.

2.2 Sponsored projects concluded during 1981-82

Process	Party
1. Catalytic vapour phase oxidation of toluene to benzaldehyde	Indian Organic Chemicals Ltd., Bombay
2. Multiplication of teak by tissue culture	Forest Development Corporation of Maharashtra Ltd., Nagpur
3. Neem as nitrification inhibitor	Rashtriya Chemicals and Fertilizers Ltd., (RCF), Bombay
4. Polycrystalline silicon-Ultrapure	Grindwell Norton Ltd., Bangalore
5. N-tridecyldiisopropanolamine	BASF (India) Ltd., Bombay
6. Theophylline, aminophylline and caffeine	PEFCO Foundry and Chemicals Ltd., Pune

2.3 Sponsored projects continued during 1981-82

Process	Party
*1. Absorbing black paints for IR detectors	Dept. of Science and Technology, New Delhi
2. Carbonylation of ethanol to propionic acid	Deccan Sugar Institute, Pune
3. Development of process know-how of the drugs, doxepin and ketoprofen	The Pharmaceutical Company of India, Bombay
4. Hydroxy terminated polybutadiene	Explosive Research and Development Laboratory (ERDL) Govt. of India (Ministry of Defence), Pune
*5. IR spectrophotometer	Dept. of Science and Technology, New Delhi

Process	Party
*6. Isolation, identification, characterisation and clinical testing of the ingredients of *Semecarpus anacardium*	Education and Youth Services Dept. S and T Cell, Govt. of Maharashtra, Bombay
*7. Isolation of active alkaloids from *Vinca rosea*	Education and Youth Services Dept. S and T Cell, Government of Maharashtra, Bombay
8. Rosin derivatives and modified resins	Dujodwala Resins and Terpenes Pvt. Ltd., Bombay
9. Synthesis of various drugs and their intermediates such as atenolol, metoprolol	CIPLA, Bombay
*10. Total synthesis of antitumour anthracyclinones adriamycine and its analogues	Education & Youth Services Dept., S & T Cell, Govt. of Maharashtra, Bombay

2.4 Sponsored projects newly undertaken during 1981-82

Process	Party
1. Dextropropoxyphene hydrochloride	Centaur Laboratories P. Ltd., Bombay
2. Maleic anhydride from crotonaldehyde	Deccan Sugar Institute, Pune
3. Neem as nitrification inhibitor	RCF, Bombay
*4. Physics and Chemistry of oxide surfaces	Indian National Science Academy, New Delhi

* Undertaken/supported under grant-in-aid programme

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 will 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 will however, be reviewed periodically in joint meetings with the collaborator taking into account the progress made and the bottlenecks that might crop up.

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

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

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

(vi) Normally the 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 the 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 firm is collaborating in the preparation of process package also, its inputs will be taken into account while deciding the total expenditure payable by it as under (iv).

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

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

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

(x) Within 90 days of the successful commissioning of the semi-commercial plant the collaborating firm will have to exercise its option for commercial exploitation of the process. If the firm does not exercise the option within the said 90 days or after exercising the option fails to establish commercial production within a specified period (2-3 years), the 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 paid to the NCL for the development of this 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 will however be reduced or in certain cases the process will be non-exclusive if it is funded by NRDC, DST or some other government agency. It will also be governed by the rules and regulations of such agencies.

(xii) After the completion of the period of exclusivity NCL will be free to offer the process know-how to other parties. In case the collaborating firm participates fully in the transfer of technology, it will equally share premia/royalties receivable 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 collaborating firm does not fully participate in the transfer of technology, it will be compensated to the extent of the expenses paid by it to the NCL for the development of the project.

(xiii) Notwithstanding clause (xi), in appropriate cases of national importance where the 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 a release will be shared by the collaborator in accordance with the provision of clause (xii).

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

(xv) NCL and the collaborating firm will periodically exchange 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 the NCL, as also to the NCL staff deputed to the firms' 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).

An agreement on stamp paper will be signed by NCL/CSIR and the collaborator embodying the terms and conditions agreed upon by the two parties.

2.5.1 Collaborative projects in progress during 1981-82

	Process	Collaborating firm
1.	Hexachlorocyclopentadiene	Hindustan Organic Chemicals Ltd., Rasayani
2.	Regular packing development	Engineers India Ltd., New Delhi
3.	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 1 covers chemicals of low volume production and which involve simple reactions/process steps. Here the work is carried out on a less than 5 kg per batch scale and the know-how comprises the process, the analytical methods and process control tests, the specifications of raw materials and products, and a list of major equipment with suggestions on sizes and materials of construction.

Level 2 includes the chemicals involving complex and engineering-intensive technologies. At this level, in addition to the level 1 work, pilot plant trials on a scale of 10-100 kg/batch or 2-20 kg/hr, are carried out and the chemical engineering design data, including scale-up studies, are collected. The know-how is offered in the form of a process package conforming to schedule 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 demonstrated during 1981-82

	Process	Licencee
1.	Dichloropropionic acid (Dalapon)	IDL Agro Chemicals Ltd., New Delhi
2.	N-Tridecyldiisopropanolamine	BASF (India) Ltd., Bombay
3.	Polysulphide liquid rubber	(i) Rathi Rubber Products, Pune (ii) Mundoz Corporation, Bombay
4.	Polysulphide sealing compound (sponsored by HAL, Nasik)	Rathi Rubber Products, Pune

3.3 Processes released during 1981-82

	Process	Licencee
1.	Polysulphide liquid rubber	(i) Rathi Rubber Products, Pune (ii) Mundoz Corporation, Bombay
2.	Polysulphide sealing compound (sponsored by HAL, Nasik)	Rathi Rubber Products, Pune

□

4. CONSULTANCY

Assistance of NCL experts in various branches of chemistry is made available to the chemical industry through consultancy services offered by the 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, the NCL scientists offer assistance in solving chemical problems, detailed engineering design, equipment procurement, process and product improvement, plant modifications, commissioning, technology absorption, etc.

Consultancy projects undertaken during the year are described below:

1. Abhi Chemical and Pharmaceutical Pvt. Ltd., Pune
   Under this consultancy the firm was given technical assistance in technology development, production and quality control of Acetazolamide, a drug useful in the treatment of glaucoma, and a carbonic anhydrase inhibitor and a diuretic. The firm has produced about 200 kg of the drug and supplied it to various formulation companies in the country during the last eighteen months.

2. Chemical Industrial and Pharmaceutical Laboratories Ltd. (CIPLA), Bombay
   Under this consultancy the firm was helped in planning and executing its R & D activities in the manufacture of life saving basic drugs.

3. Diamines and Chemicals Ltd., Kalol (N. Gujarat)
   Consultancy services were rendered to the company for the design, installation, commissioning and trouble shooting of the ethylenediamine and polyamines plant based on the NCL process. Comments were offered on the piping and instrument diagrams prepared by the firm's project engineers. NCL also prepared the basic designs for the distillation section.

4. Allied Colloids Pvt. Ltd., Bombay
   This consultancy was for (i) general technical advice and assistance in the day-to-day working of the plant for efficient operation, improvement, replacement etc., and (ii) advice on any problem relating to works referred to by the party.

5. 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.

6. 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.

7. Indian Organic Chemicals Ltd. (Fibres), Madras
   Consultancy was rendered on improvements in productivity of the existing polymerisation plant (brought out by rational mathematical modelling and simulation), in spinning, strategies for product diversification and R & D planning.

8. Swadeshi Polytex Ltd., Ghaziabad (U.P.)
   Consultancy services were rendered on process trouble shooting, optimization in polymerization, melt spinning and fibre line operations.

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

10. M/s. Apar Pvt. Ltd. Bombay
    Under this consultancy services were rendered in setting up their R & D laboratory.

□

5. PREMIA AND ROYALTIES RECEIVED BY NRDC THROUGH NCL PROCESSES DURING 1981-82

5.1 Premia

	Process	Firm	Premia received (Rs.)
1.	Dalapon	IDL Agro Chem Ltd., New Delhi	15,000
2.	Quinapyramine sulphate/chloride	Chintamani Fine Chemicals, Pune	25,000*

* Part payment

5.2 Royalties

	Process	Firm	Royalties received (Rs.)
1.	Can sealing composition based on nitrile rubber latex	Arya Chemical Works, Calcutta	820.22
2.	Dimethoate	Shaw Wallace & Co. Ltd., Calcutta	46,028.57
3.	Ethion	-do-	20,589.08
4.	Foundry core binder	Card-Chem Industries, Hyderabad	846.24
5.	Monoethylaniline	Atul Products Ltd., Atul	50,804.49
6.	Polyurethane printing rollers	Sree Saraswaty Press Ltd., Calcutta	7,871.00

□

6. LECTURES AND SEMINARS

6.1 The following visiting scientists delivered lectures in the laboratory:

	Scientist	Subject
1.	Mr. P. Diggory, Scientific Officer, C.E. Department, University of Salford, UK	(i) Heat pump equipment (ii) Design of a dryer for heat pump
2.	Dr. V. Pachaiyapan, Director (R & D), The Fertilizer Association of India, New Delhi	R & D in fertilizer industry with special reference to recent advances in ammonia production technology
3.	Prof. D. Vortmeyer, Institute B Fur Thermodynamik, Technische Universitat, Munchen, W. Germany	Experimental verification of mathematical models for fixed and moving bed exothermic chemical reactors
4.	Dr. Sushil Bhatia, Manager, Technical Development, Dennison Manufacturing Co., USA	Adhesives and coatings (2 lectures)

Scientist	Subject
5. Mr. M.N. Seetharaman, Head, Information Centre for Aeronautics, NAL, Bangalore	On-line information network
6. Prof. F. Lawson, Department of Chemical Engineering, Monash University, Clayton, Victoria, Australia	(i) Chemical Engineering and Research at Monash University (ii) Chance observations and process development
7. Dr. S.N. Hegde, Orchidologist, Forest Department, Arunachal Pradesh	Orchids of Arunachal Pradesh
8. Dr. (Miss) Veena Parnaik, Scientist, CCMB, Hyderabad	Studies on the template binding site of reverse transcriptase
9. Prof. S.K. Gupta, Department of Chemical Engineering, IIT, Kanpur	Kinetic modelling of polycondensation reactors
10. Dr. A.K. Rakshit, Department of Chemical Technology, University of Bombay, Bombay	Monolayer behaviour of fatty acids and their mixtures
11. Prof. Girish Chandra, Tata Institute of Fundamental Research, Bombay	Ultra-low temperatures, techniques and applications
12. Prof. J.R. Postgate, Director, Agricultural Research Council, Unit of Nitrogen Fixation, The University of Sussex, Brighton, UK	Recent developments in biological nitrogen fixation
13. Prof. G. Narsimhan, Department of Chemical Engineering, Indian Institute of Science, Bangalore	On certain optimal problems in gas-solid reactions
14. Prof. Gary Long, Department of Chemistry, University of Missouri-Rolla, Missouri, USA	(i) Mossbauer and magnetic properties of some mixed metal iron (II) oxides (ii) The magnetic properties of several one-dimensional magnetic materials

Scientist	Subject
15. Prof. A.B. Metzner, University of Delaware, USA	(i) Slip phenomena in polymeric solutions (ii) Non-isothermal rheology, with application to fibre spinning and film blowing of molten polymers (iii) Suggested changes in chemical engineering curricula (iv) Compressive flow between parallel discs
16. Dr. A.K. Rajavanshi, Director, Energy Division, Nimbkar Agricultural Research Institute, Phaltan	Future developments in alternative energy research
17. Dr. T.N. Guru Row, Department of Organic Chemistry, Indian Institute of Science, Bangalore	Recent advances in X-ray crystal structure analysis
18. Dr. G. Rajeswaran, State University of New York at Buffalo, New York	MIS Solar cells
19. Prof. D.R. Coughanowr, School of Chemical Engineering, University of New South Wales, Kensington, Australia	Control of temperature in an adiabatic fixed-bed tubular reactor
20. Prof. A.S. Mujumdar, Department of Chemical Engineering, McGill University, St. Montreal, Canada	(i) Flow and heat transfer in impinging jets (ii) Vibrated fluid beds
21. Dr. S.D. Yadav, Incharge R & D, Ajay Meta Chem, Pune	Role of polymers in foundries
22. Dr. G.A. Brinkman, National Institute of Nuclear and High Energy Physics, Amsterdam, Holland	Reactions of halogen and tritium atoms with aromatic compounds
23. Dr. P. Potier, Institute de Chimie des Substances Naturelles, CNRS, Gif-sur-Yvette, France	N-Oxide chemistry: Its application to the synthesis of natural products

Scientist	Subject
24. Dr. B.C. Das, Institute de Chimie des Substances Naturelles, CNRS, Gif-sur-Yvette, France	Applications of Mass spectrometry for solving structures of complex molecules
25. Dr. S. Krishnamurthy, Senior Research Scientist and Project Coordinator, Eastman Kodak Co., Rochester, USA	Remarkable Super-hydrides

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

Scientist	Subject	Venue
1. Dr. S.K. Date	Magnetism, surface chemistry and catalysis	Annual convention of chemists, Indian Institute of Technology, Madras
2. Dr. V.H. Deshpande	Studies dierected towards the total synthesis of anti-tumour anthracyclines	Kuman University, Nainital
3. Dr. S. Krishnappa	A keto-diol from the oil of *Cedrus deodara* Loud	Kuman University, Nainital
4. Dr. S.N. Kulkarni	Series of lectures on terpenoids	Department of Chemistry, Nagpur University, Nagpur
5. Dr. R.A. Mashelkar	(i) Convective diffusion in structured fields: A need for new analysis and design strategies	Department of chemical Engineering, Indian Institute of Science, Bangalore
	(ii) Modelling of polyethylene terephthalate reactors	
6. Dr. V.M. Nadkarni	(i) Polymer processing and its relationship to material properties	Seminar on Raw Materials Used in Plastic Industries, Pune Plastics Manufacturers Association, Pune
	(ii) NCL and the plastic processors (iii) Solving plastic processing problems	Seminar on problems and prospects of plastic industry in 80s
	(iv) R & D in polymers	Department of Chemistry, University of Poona, Pune
	(v) Management of research and development	Department of Management Studies, Thane College for Personnel from Chemical Industries, Thane

Scientist	Subject	Venue
7. Dr. A.V. Rama Rao	Organic Synthesis with a difference	School of Chemistry, University of Hyderabad, Hyderabad
8. Dr. A.S. Rao	Some applications of lead tetraacetate in organic synthesis	Sixth National Symposium on Organic Chemistry, Calcutta University, Calcutta
9. Dr. J.C. Sadana	Nitrosyl — an intermediate in the reduction of nitrate to ammonia	Symposium on Recent Advances in Nitrogen Fixation, 50th Annual Meeting of the Society of Biological Chemists of India, Baroda.
10. Dr. V.P. Shiralkar	Catalysis for fuel conversion processes	Ist National Workshop on Catalysis in Agriculture and Energy Conversion, Indian School of Mines, Dhanbad
11. Dr. A.P.B. Sinha	Lecture on photo-voltaic cell on solar energy	4th Indian Photobiology Symposium, Mahabaleshwar
12. Dr. H.R. Sonawane	Some aspects of the applied research in organic chemistry	1st Seminar on Chemistry, R.B. Narayanrao Borawake College, Shrirampur
13. Dr. A.J. Varma	(i) An overview of polymer chemistry	Seminar on Raw Materials Used in Plastic Industries Pune Plastic Manufacturers Association, Pune
	(ii) Homogeneous polymer catalysis complexes due to macroheterocyclic polymers	R & D Centre, Indian Petrochemicals Ltd., Baroda

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

1. A one day workshop on Ammoxidation Catalysis was organised at NCL on 15-4-81. About 80 people from various industries and research laboratories in Western India participated in the workshop. The workshop was beneficial to all those interested in the area of ammoxidation, since, for the first time, catalist manufacturers, users of the ammoxidation technology and researchers in the field, were brought together under one forum.
2. A workshop on liquid chromatography was arranged by Waters Associates, USA, jointly with Materials Research Instruments, Bombay, at NCL from 25 to 28th August 1981. About 40 participants, comprising 15 members from NCL and 25 from private firms, universities, defence research laboratories and CSIR laboratories from different parts of India benefitted from the workshop. The experts from Waters Associates and Materials Research Instruments demonstrated the working of the analytical as well as preparative HPLC units. □

7. STAFF STRENGTH* (as on 31-3-82)

1.	Scientific		
	(i)	Director	1
	(ii)	Dy. Director	1
	(iii)	Scientist F	7
	(iv)	Scientist EII	4
	(v)	Scientist EI	45
	(vi)	Scientist C	84
	(vii)	Scientist B	93
	(viii)	Scientist A	46
	(ix)	S.S.A.	82
	(x)	J.S.A. (Scientific Assistant Gd. VIII)	62
	(xi)	S.L.A. **(Gd. VII)	48
		Total	473
2.	Technical		253
3.	Administration		150
4.	Class IV technical		147
5.	Class IV non-technical		71
		Total (1-5)	1094
6.	Research Fellows, Pool Officers, Guest Workers and Graduate Trainees		
	(i)	JRFs, SRFs and PDFs	59
	(ii)	CSIR Pool Officers	3
	(iii)	Guest Workers	4
	(iv)	Graduate Trainees	13
	(v)	U.G.C. Teacher-Fellows	8
	(vi)	U.G.C. JRFs	2
		Total	89
7.	Scientific staff appointed for sponsored projects		31

* Denotes staff in position.

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

8. STAFF NEWS

8.1 Awards/Honours

1. Dr. A. Bhattacharya was awarded the Prof. N.R. Kuloor Memorial Medal and P.S. Narayana Medal for 1980-81 for research.
2. Dr. L.K. Doraiswamy was awarded the prestigious Dr. Homi J. Bhabha award for research in applied sciences for the year 1977 out of the endowment created by the Hari Om Ashram Trust.
3. Dr. L.K. Doraisway was awarded the prestigious 1980 VASVIK Industrial Research Award for outstanding research in the field of chemical sciences and technology instituted by the Vividhlaxi Audyogik Samshodhan Vikas Kendra, Bombay.
4. Dr. B.D. Kulkarni was awarded the prestigious Indian National Science Academy award for Scientist aged below 32 for his contributions to fluidization and multiplicities and instabilities in chemical reacting system.
5. Dr. V.S. Patwardhan was awarded the Amar Dye Chem award for excellence in Research and Development in Chemical Engineering.
6. Dr. V.S. Patwardhan was awarded the Mrs. Chinnamaul Memorial Prize for the best technical paper presented at the 33rd Annual Session of the Institute of Chemical Engineers, Delhi in 1980.
7. Mr. M.P. Sant was awarded the Sangram Medal by the Government of India in appreciation of services rendered as a Company Quarter Master Sergeant in the Home Guards and Civil Defence during the Indo-Pakistan war in 1971.

8.2 Deputations/Visits abroad

1. Dr. A.F. Mascarenhas was deputed to Singapore for participation in the International Symposium on Process of Plant Tissue Culture in Developing Countries and to visit some laboratories in Singapore (28th April to 3rd May 1981)
2. Dr. L.K. Doraiswamy, Visiting Professor, Salford University, Salford, and a recognized research guide of that University, reviewed the progress of work being done by the NCL staff members and gave a broad outline of work to be continued during his visit to Salford University. He gave a seminar at Salford University on Gas-Solid Reactions. He also visited the Chemical Engineering Departments of Imperial College of Science and Technology and University of Bradford (31st May to 15th June 1981)
3. Shri N.K. Yadav was deputed to West Germany for training in the operation of the High Speed Camera Model 16 HD 100-8000 (One week from 1st June 1981)
4. Shri S. Gopichand and Shri R.G. Kelkar were deputed to Burma under the ITEC programme for the erection and commissioning of the Terpineol plant. (Four weeks in June 1981)
5. Dr. R.N. Sharma was deputed to West Germany under the CSIR-DAAD exchange programme. He carried out a brief research project in collaboration with Prof. H. Rambold, Head, Division of Insect Biochemistry, Max Planck Institute of Biochemie, Munchen. He also visited various research institutions and universities in Munich, Stuttgart, Bonn, Koln, Hannover, Frankfurt and Berlin to famillarize himself with the technique and objectives being pursued there in the fields of agriculture, biochemistry, pesticides and entomology and also to aquaint his counterparts there, with the work being carried out at NCL. (Eight weeks from 12th September 1981)
6. Dr. A.V. Rama Rao visited Yugoslavia, Rumania and Bulgaria under the auspices of the Federation of Indian Chambers of Commerce and Industry. The FICCI arranged for the first time a chemical delegation to visit the above countries and Dr. Rama Rao was nominated by the CSIR to join the delegation as an organic chemistry expert to identify areas of interest for trade between India and the countries visited in the field of organic intermediates and finished goods, especially drugs, dyes, pesticides and other organic products. (14th to 26th September 1981)
7. Dr. L.K. Doraiswamy attended the second World Congress of Chemical Engineering at Montreal, Canada and presented a paper on Technologies for developing countries. He also visited some universities in USA. (4th to 20th October 1981)
8. Dr. V.S. Patwardhan was deputed to Salford University U.K. under the joint R & D programme between NCL and Dept. of Chemical Engineering, Salford University to hold discussions and inspect equipment in connection with the heat pump project. (Three months from October 1981)
9. Dr. R.A. Mashelkar went to Denmark to take up the post of Visiting Professor at the Institute for Kemiteknik, Denmark. (Six months from 25-1-82)
10. Dr. V.S. Patwardhan went to USA to take up the Visiting Scholar Research Associateship at Syracuse University. (One year from 21-2-82)
11. Dr. D.N. Sen visited the United States under the CSIR-NSF scientists exchange programme. He gave a seminar on Homogeneous Catalytic Reactions at the Department of Chemistry, University of Connecticut, and also gave a talk on industrial aspects of homogeneous catalysts at the Humphrey Chemical Company, North Haven. He also visited several other institutes like University of Notre Dame, Indiana; University of Illinois, Urbana-Champagne; University of California, San Diego; University of Delaware, Newark and also Union Carbide Company, Charleston. (18th March to 28th April 1982)

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

	Seminar/Symposium/Conference	Scientists
1.	Seminar on Avenues for R & D in Chemical Industry, Indian Institute of Chemical Engineers, Bombay	Dr. L.K. Doraiswamy Dr. R.A. Mashelkar Dr. V.M. Nadkarni
2.	Seminar on Latest Advances in Analytical Instrumentation, Tata Institute of Fundamental Research, Bombay	Dr. V.S. Pansare
3.	6th International Conference of Women Engineers and Scientists, Bombay	Dr. (Mrs.) Bhanu Chanda

Seminar/Symposium/Conference	Scientists
4. All India Convention on Water Pollution, Bombay	Dr. V. Damodaran Dr. B.B. Ghatge
5. Western Regional Conference on Information Needs of the 80's, S.N.D.T. Women's University, Bombay	Mrs. M.S. Naigaonkar
6. 50th Annual General Meeting of the Society of Biological Chemists, Baroda	Dr. P.K. Ranjekar Miss. S. Lakshmi Miss. M. Manohar Mr. B.G. Patil Mr. S.A. Ranade
7. Seminar on Organisation and dissemination of information, The Institute of Engineers, Pune	Mr. R. Nagrajan Mr. S.B. Katte
8. National seminar on patents system, Regional Research Laboratory, Hyderabad	Mrs. V.S. Dalvi
9. Regional Seminar on Industrial Waste Water treatment, The Institute of Engineers, Pune	Dr. P.P. Moghe
10. Workshop on Electron Spectroscopy, IIT, Bombay	Dr. A.P.B. Sinha Dr. S.R. Sainkar Dr. A.B. Mandale Mr. R.I. Hegde
11. Ist National workshop on catalysis in agriculture and energy conversion, Indian School of Mines, Dhanbad, Bihar	Mr. R.B. Borade Mr. G. Prakashbabu Dr. V.P. Shiralkar
12. International Conference on Application of Mossbauer effect, Jaipur	Dr. M.P. Gupta Dr. S.K. Date
13. 34th Annual session of the Indian Institute of Chemical Engineers, IIT, Madras	Dr. L.K. Doraiswamy Dr. V.R. Choudhary Dr. R.V. Chaudhari Dr. B.D. Kulkarni Dr. N.G. Karanth Dr. V.S. Patwardhan Mr. R. Jaganathan Mr. V.K. Jayaraman
14. All India Seminar on Mass-spectrometry, Bhabha Atomic Research Centre, Bombay	Dr. K.G. Das Dr. P.S. Kulkarni Mr. R.A. Swamy Mr. M. Malliah Mr. A.M. Reddy

Seminar/Symposium/Conference	Scientists
15. Seminar on Physics of Semiconductors, Bhabha Atomic Research Centre, Bombay	Dr. A.P.B. Sinha Dr. S.K. Date Dr. S.T. Kshirsagar Dr. S.D. Sathaye Mr. D.P. Amalnerkar Mr. C.D. George
16. Symposium on Applications of NMR in Chemistry & Biology, Indian Institute of Chemical Biology, Calcutta	Dr. P.M. Nair
17. Symposium on FT NMR Spectroscopy and its applications, Indian Institute of Science, Bangalore	Dr. P.M. Nair

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

Scientist	Subject
1. Dr. L.K. Doraiswamy	(i) Summing up address at the seminar on Avenues for R & D in Chemical Industry, held under the auspices of Indian Institute of Chemical Engineers (Bombay Regional Centre),Bombay (April 1981) (ii) Plenary lecture on Analysis of Gas-solid reactions-volume reaction Models and also acted as the Moderator for panel discussion on wealth and waste during the 34th Annual Session of the Indian Institute of Chemical Engineers at IIT, Madras (December 1981) (iii) Key-note address at the Plenary session of the 9th Public Relations World Congress organised by the Public Relations Society of India, Bombay. The theme of the talk was science and the common man. (January 1982)
3. Dr. R.A. Mashelkar	(i) Chaired the technical session on Polymer Science and Engineering during the seminar on Avenues for R & D in Chemical Industry held under the auspices of Indian Institute of Chemical Engineers (Bombay Regional Centre), Bombay (April 1981) (ii) Invited lecture on Polyethylene terephthalate reactor modelling at the 4th Research conference held at Hindustan Lever Ltd, Bombay (November 1981)
4. Dr. P.K. Ranjekar	Invited lecture on Molecular basis of interphase Nuclear organisation in plants at the International meeting on Human X-chromosomes and DNA condensation, IISc., Bangalore (December 1981)
5. Dr. A.P.B. Sinha	(i) Invited talk on Applications of photoelectron spectroscopy in the area of solid state materials — recent results obtained in NCL, at the workshop on Electron Spectroscopy, IIT, Bombay (December 1981) (ii) Invited talk on semiconductor electrolyte systems; techniques and applications at the Seminar on Physics of semiconductors, Bhabha Atomic Research Centre, Bombay (December 1981)
6. Dr. V. Jagannathan	Invited lecture on 'Tissue Culture' at the 4th Research conference held at Hindustan Lever Ltd, Bombay (November 1981)

8.5 Membership of Committees

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

	Scientist		Name of the Committee
1.	Dr. S.K. Date	Member	Organising committee of the International Conference on Application of Mossbauer effect
2.	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 Committee — Fertilizer Association of India
		Member	Award 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 (SERC)
		Member	Sub-group of Conversion and Utilization of Biomass- DST (Chairman, Sub-group of Steering Committee on Fuels from Biomass)
		Member	Research Advisory Council, — Regional Research Laboratory, Hyderabad
		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
		Chairman	CSIR-Advisory Committee on Engineering (JRF/SRF)
		Chairman	Technical Manpower Committee, Govt. of Maharashtra

	Scientist		Name of the Committee
2.	Dr. L.K. Doraiswamy (Contd.)	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 (1.1.82 to 31.12.82)
		Member	Development of Western Ghat Committee
3.	Dr. N.D. Ghatge	Member	Governing Council of Indian Rubber Manufacturers' Research Association, Bombay
		Member	Expert panel of Rubber Research Institute of India, Kottayam
4.	Dr. R.M. Joshi	Member	Advisory Board, Journal of Macromolecular Science-Chemistry, USA
5.	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
6.	Dr. R.A. Mashelkar	Editor	Advances in Transport Processes: Review Series published by Wiley Eastern/Wiley Halsted
		Editor	Chemical Engineering Communications published by Gordon and Breach (USA)
		Member	Editorial Board of Rheologica Acta, published by Springer Verlag (Germany)
		Member	Publications Committee-Indian Chemical Engineer
		Member	Reviewer's 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
7.	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
8.	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

Scientist		Name of the Committee
9. Dr. A.V. Rama Rao	Member	Board of Studies in Applied Chemistry, University of Cochin, Cochin
	Member/ Group Leader	Sub-Committee for Forest Product Research — Dept. of Science and Technology — Science Advisory Committee to the Cabinet (SACC)
10. Dr. S.C. Sethi	Member	Natural and Synthetic Perfumery Materials Sectional Committee, PCDC 18, ISI, New Delhi
11. Mr. M.S. Setty	Member	Screen Printing Association of India, Bombay
12. Dr. A.P.B. Sinha	Member	Materials Research Committee, Dept. of Atomic Energy,
13. Dr. C. Siva Raman	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

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

Sl. No.	Name	Degree	University	Subject of thesis	Guide
1	2	3	4	5	6
1.	Mr. K.B. Bastawade	M. Sc.	Poona	Studies on Cellulase	Dr. V. Jagannathan
2.	Mr. D.V. Gokhale	M. Sc.	Poona	Microbial enzymes: Studies on the effects of free and covalently bound polyethylene glycols	Dr. C. SivaRaman
3.	Mr. S.P. Gupte	M. Sc.	Poona	Absorption and reaction of acetylene with copper (I) compounds in liquid phase	Dr. R.V. Chaudhari
4.	Mrs. Vidya S. Gupta	Ph. D.	Poona	Structure and sequence organisation of DNA in Eukaryotes with special reference to three Graminacae plant species	Dr. P.K. Ranjekar
5.	Mr. R. Jaganathan	M. Sc.	Poona	Hydration of propylene oxide to propylene glycol using ion-exchange resin catalyst	Dr. R.V. Chaudhari
6.	Mrs. H.V. Kamath	Ph. D.	Poona	Synthesis of compounds of pharmacological interest	Dr. S.N. Kulkarni
7.	Mrs. S.S. Keskar	M. Sc.	Poona	Study of Cellulolytic enzymes	Dr. V. Jagannathan
8.	Mr. M.G. Kulkarni	Ph. D. (Tech.)	Bombay	Role of transport processes in free radical reactions	Dr. L.K. Doraiswamy
9.	Mr. R.A. Kulkarni	Ph. D.	Poona	Expansion coefficient of polyelectrolytes — The viscosity and light scattering study of partially hydrolysed polyacrylamides in solution	Dr. S. Gundiah
10.	Mr. S. J. Kulkarni	Ph. D.	Poona	The physico-chemical and catalytic properties of zeolites	Dr. (Miss) S.B. Kulkarni
11.	Mr. A.B. Landge	Ph. D.	Poona	Studies in polyisoprenoids and related compounds	Dr. C.R. Narayanan
12.	Mr. N.N. Maldar	Ph. D.	Poona	Studies in (i) vulcanization of rubber and (ii) synthesis of diamines and polyimides	Dr. N.D. Ghatge
13.	Mr. P.P. Moghe	Ph. D.	Poona	Studies in heterocyclic chemistry	Dr. B.D. Tilak
14.	Miss Sita P. Nilekani	Ph. D.	Poona	Studies on microbial enzymes: Citrate lyase from *Escherichia* coli	Dr. C. SivaRaman

1	2	3	4	5	6
15.	Mrs. U.S. Puntambekar	M. Sc.	Poona	Studies on cellulase	Dr. V. Jagannathan
16.	Mr. A.B. Sahasrabudhe	Ph. D.	Poona	Potential antitubercular compounds: Synthesis of 2-substituted isatogens and substituted benzisxazole	Dr. S.N. Kulkarni
17.	Mr. S.R. Sainkar	Ph. D.	Poona	Electron spectroscopic studies on metal oxide varistors	Dr. A.P.B. Sinha
18.	Mr. R.G. Sarawadkar	Ph. D.	Shivaji	Structure and activity of metal phosphate catalysts	Dr. (Miss) S.B. Kulkarni
19.	Mr. R.W. Shinde	M. Sc.	Poona	Studies in selective reduction of ilmenite by hydrogen	Dr. A.N. Gokarn
20.	Mr. V.P. Shiralkar	Ph. D.	Poona	Sorption and thermal properties of synthetic zeolites	Dr. (Miss) S.B. Kulkarni
21.	Mr. V.R. Shrihatti	Ph. D.	Poona	Studies on Ascorbic acid and its derivatives	Dr. P.M. Nair
22.	Mrs. V. Sivaramakrishnan	Ph. D.	Poona	A study of reactivity of ortho-hydroxyarylamides	Dr. P.M. Nair
23.	Mr. G. Sudhakar Reddy	Ph. D.	Poona	Studies in gaseous ion chemistry	Dr. K.G. Das
24.	Miss Rita Verma	M. Sc.	Poona	Analytical methods in organic chemistry	Dr. V.S. Pansare

8.7 NCL Scientists recognized by different universities as research guides

1.	Dr. Ayyangar, N.R.	Bombay, Poona
2.	Mr. 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. Doraiswamy, L.K.	Bombay, Calcutta, Jadavpur, Nagpur, Poona, Salford(UK)
7.	Dr. Ghatge, B.B.	Poona, Shivaji
8.	Dr. Ghatge, N.D.	Bombay, Poona, Shivaji
9.	Dr. Gogte, V.N.	Poona, Shivaji
10.	Dr. Gokarn, A.N.	Poona
11.	Dr. Gopinathan, C.	Marathwada, Poona
12.	Dr. Gundiah, S.	Poona
13.	Dr. Ingle, T.R.	Poona, Shivaji
14.	*Dr. Jagannathan, V.	Baroda, Bombay, Poona
15.	Dr. Jose, C.I.	Poona
16.	Dr. Joshi, R.M.	Bombay, Poona
17.	Dr. Karanth, N.G.	Nagpur, Poona, Shivaji
18.	Dr. Katti, S.S.	Bombay, Poona
19.	Dr. Krishnamurthy, K.V.	Shri Venkateswara
20.	Dr. Kulkarni, B.D.	Poona
21.	Dr. Kulkarni, G.H.	Nagpur, Poona
22.	Dr. Kulkarni (Miss), S.B.	Poona, Shivaji
23.	Dr. Kulkarni, S.N.	Bombay, Karnataka, Poona, Shivaji
24.	Dr. Mascarenhas, A.F.	Poona
25.	Dr. Mashelkar, R.A.	Banaras, Bombay, Nagpur, Poona, Salford (UK)

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

* Retired/Emeritus scientists

9. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

1. Ramachandran, P.A. and Bhattacharya, A.,
Modelling and simulation work at NCL get-together on simulation and optimization,
RRL Hyderabad, August 1981.
2. Ranade, S.A., Lagu (Mrs.), M.D., Gupta (Mrs.), V.S. and Rajnekar, P.K.,
Studies on plant histene,
50th Annual General Meeting of the Society of Biological Chemists, Baroda, November 1981.
3. Lakshmi (Miss), S. and Ranjekar, P.K.,
Characterization of repetitive DNA in three millet species,
50th Annual General Meeting of the Society of Biological Chemists, Baroda, November 1981.
4. Manohar (Miss), M. and Ranjekar, P.K.,
Genome analysis of three cucurbitaceae species,
50th Annual General Meeting of the Society of Biological Chemists, Baroda, November 1981.
5. Patil, B.G. and Ranjekar, P.K.,
Molecular characterization of the genome of *T. Viride,*
50th Annual General Meeting of the Society of Biological Chemists, Baroda, November 1981.
6. Gopinathan, C.,
Analysis of silicon intermediates by gas-chromatography,
Seminar on latest trends in chromatography, Instrument Society of America-India Section, Bombay, December 1981.
7. Prakashbabu, G. and Borade, R.B.,
1) Alkylation of benzene, 2) disproportionation of toluene and 3) isomerization of xylenes over ZSM-5 Zeolites,
Ist National Workshop on Catalysis in Agriculture and Energy Conversion, Indian School of Mines, Dhanbad — December 1981.
8. Kulkarni, B.D. and Patwardhan, V.S.,
Influence of convective flow on the effectiveness factor for Michaelis Menten Kinetics,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
9. Choudhary, V.R. and Chaudhary, S.K.,
Poisoning of Raney nickel catalyst for slurry phase hydrogenation of *p*-nitrotoluene,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
10. Kulkarni, B.D. and Jayaraman, V.K.,
Start-up and dynamic behaviour of CSTR for isothermal reactions involving two species and deactivation,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
11. Narayanan, R.A., Ramachandran, S., Varadarajan, A. and Satyanarayana, M.,
Solid state reaction of mixed compacts of succinic anhydride and paranitraniline,
34th Annual Session of Indian Institute of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
12. Ramachandran, S., Varadarajan, A., and Satyanarayana, M.,
Diffusion and reaction in solids,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
13. Jogdand, V.V., and Karanth, N.G.,
Sensitivity of the enzyme kinetic parameters estimation towards substrate concentration measurements,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
14. Ramachandran, S., Varadarajan, A., and Satyanarayana, M.,
New method of estimation of phase enthalpy differences of binary systems from vapour-liquid equilibrium data,
34th Annual Session of Indian Inst. of Chemical Engineers, Indian Institute of Technology, Madras, December 1981.
15. Date, S.K., Rane, A.T., Joag, P.S. and Nigawekar, A.S.,
Mossbauer study of the balance state of iron ions after Co^{57} decay in LaB_6.
International Conference on the Application of Mossbauer Effect, Jaipur, December 1981.
16. Krishnamurthy, V.A., Date, S.K., Sharma, B.K. and Tripathi, P.S.M.,
Mossbauer spectroscopic studies of structurally and chemically promoted Fischer-Tropsch iron catalysts, International Conference on the Application of Mossbauer Effect, Jaipur, December 1981.

17. Gupta, M.P., Sinha, A.P.B. and Date, S.K.,
119^m Sn Mossbauer study of Cu_2SnX_3 (X = S, Se and Te) compounds,
International Conference on the Application of Mossbauer Effect, Jaipur December 1981.

18. Padhye, S.B., Gupta, M.P. and Date, S.K.,
Mossbauer and magnetic properties of some iron complexes of $\hat{OO}$, $\hat{ON}$, $\hat{NN}$ donor vitamin K related compounds,
International conference on the application of Mossbauer effect,
Jaipur, December 1981.

19. Kumar, R., Vishwamittar, Chandra, K. and Date, S.K.,
Mossbauer and magnetic studies of $Fe_{0.968-x}Mn_xSi_{0.032}$ ternary systems,
International Conference on the Application of Mossbauer Effect, Jaipur, December 1981.

20. Kulkarni, S.N.,
O — aminophenyl/arylalkyl ketones and their derivatives, part IV : synthesis of substituted
O — nitrophenyl benzyl ketones and synthesis of 6, 7 — dimethoxy — 4 — benzylquinazolines
Annual Convention of Chemists, Indian Institute of Technology, Madras, December 1981.

21. Das, K.G., Kulkarni, P.S., Malliah, M. and Madhusudanan, K.P.,
Chemistry of gaseous anions,
National Symposium on Mass Spectrometry, BARC, Bombay, December 1981.

22. Das, K.G., Kulkarni, P.S. and Swamy, R.A.,
Chemical ionization induced substitution and reduction,
National Symposium on Mass Spectrometry, BARC, Bombay, December 1981.

23. Umapathy, P.,
Synthesis & reactions of Pt(II) and Pd(II) chelates,
All India Conference on Recent Trends in Co-ordination Chemistry,
Nawabshah Alamkhan Research Centre,
Hyderabad, February 1982. □

10. PATENTS IN FORCE

Indian patents sealed

1. 130551
A new process for separation of the dimethyl and monomethyl components from a mixture of dimethyl dichlorosilane and methyl trichlorosilane.
Gupta, J., Gopinathan, C., Gopinathan (Mrs.), S., Eapen, M.J. and Awasarkar, P.A.

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

3. 142789
Preparation of aminopolyols using CNSL and making polyurethane rigid foams.
Ghatge, N.D. and Gujar, K.B.

4. 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.

5. 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.

6. 144875
Improved continuous high pressure process for hydrogenation of glucose to produce sorbitol.
Brahme, P.H. and Verma, R.P.

7. 146029
A sulphate recycle process for the preparation of N-P fertilizers from Indian rock phosphate.
Padalkar, S.R., Dorai, C.S., Lobo, J. and Damodaran, V.

8. 146272
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.

9. 146327
Improvements in or relating to the preparation of *o*-isopropylphenols.
Divakar, K.J., Dhekne, V.V., Kulkarni (Mrs.), B.S. and Rao, A.S.

10. 147337
Improvements in or relating to the preparation of laevomenthol.
Divakar, K.J., Kulkarni, S.B. and Rao, A.S.

11. 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.

12. 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.

13. 147868
A process for the preparation of new yellow to red azo-N-substituted 6-substituted aminopyridone disperse dyes for polyester fibres.
Ayyangar, N.R., Deshpande, A.D. and Tilak, B.D.

14. 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.

15. 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.

16. 148462
A process for the preparation of new yellow to scarlet azo cationic dyes using para-aminophenacyltrimethylmmonium chloride as the diazo component for application to polyacrylonitrile fibres.
Ayyangar, N.R. and Khanna, I.K.

17. 148910 (4891/DEL/78)
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.

Indian patent applications accepted

1. 113703
Improvements in or relating to magnesium zinc ferrites.
Krishna Rao, V.V., Kanade (Miss), S.B. and Sinha, A.P.B.

2. 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.

3. 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.

4. 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.

5. 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.

Indian patent applications filed

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

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 347/DEL/79

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

8. 411/DEL/79

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

9. 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.

10. 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.

11. 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.

12. 797/DEL/79

A new process for the preparation of 1-R-*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.

13. 798/DEL/79

Process for the preparation of ∝ -cyano-3-phenoxybenzyl IR-**cis**-2, 2-dimethyl-3 (2-chloro-prop-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.

14. 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.

15. 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.

16. 942/DEL/79

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

17. 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.

18. 950/DEL/79

A process for the preparation of blue naphthostyril cationic dyes.
Ayyangar, N.R., Moghe, P.P. and Tilak, B.D.

19. 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.

20. 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.

21. 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.

22. 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., Venkataswamy, G., Sathaye, K.M. and Yadagiri, P.

23. 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.

24. 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.

25. 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.

26. 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.

27. 581/DEL/80

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

28. 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.

29. 663/DEL/80

A process for the isolation of active principles from the plant *Levendula gibsonii (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., Zadu (Miss), G.V., Nadkar, R.Y. and Nanda, B.

30. 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.

31. 732/DEL/80

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

32. 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.

33. 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.

34. 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.

35. 291/DEL/81*

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

36. 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., Balkrishnan, I. and Shiralkar, V.P.

37. 668/DEL/81*
A process for the preparation of polyamides.
Ghatge, N.D. and Mullick, U.P.

38. 702/DEL/81*
A process for the preparation of improved cellulose acetate.
Ghatge, N.D., Sabne, M.B. and Gujar, K.B.

39. 703/DEL/81*
Improved process for the preparation of ethyl-α (carbethoxyl-ß-(substituted anilino) acrylates.
Ayyangar, N.R., Jinaraj, V.K. Lahoti, R.J. and Danial, T.

40. 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., Balkrishnan, I., Rao, B.S., Chandwadkar (Mrs.), A.J. and Kotasthane, A.N.

41. 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.

42. 21/DEL/82*
Process for the preparation of improved composite catalyst material,
Kulkarni (Miss), S.B., Ratnasamy, P., Balkrishnan, I., Kulkarni, S.J. and Borade, R.B.

43. 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.

44. 78/DEL/82*
An improved process for the preparation of substituted aromatic diamines.
Ghatge, N.D. and Maldar, N.N.

45. 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.

Foreign patent applications filed

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.

2. Netherland Patent Application No. 79.07332
Werkwijze om 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.

* These patents were newly filed during the year. □

RESEARCH UTILIZATION

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

(T—Metric tons)

Sl. No.	Name of the process/product	Field of utilization	Name of the manufacturer (year of commencement of production)	Production		Capacity installed, Nature of release and remarks
				1981-82 Qty./value Rs. in lakhs	Upto March '81 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)	1853.00 T 332.45	16778.49 T 2192.82	2000 T Non-exclusive
2.	Acriflavine	Pharmaceuticals	Western India Fine Chemicals, 38, Agra Road, Mulund (West), Bombay 400 080 (1969)	— —	7.50 T 36.92	3 T Sponsored
3.	Antipriming compositions	Antipriming in locomotives	Research Designs and Standards Organization, M & C Wing, Lucknow 226 011 (1964)	2.04 T 0.26	156.54 T 14.87	26 T Non-exclusive
4.	*tert*-Butyl catechol	Synthetic rubber	Percynic Chemicals, Bombay Silk Mills Bldg., Industrial Estate, Lalbaug, Bombay 400 012 (1972)	4.85 T 6.24	57.34 T 61.18	50 T Non-exclusive
5.	Butyl titanate	Varnishes, enamels	Synthochem, 33A, Laxmibainagar Industrial Estate, Indore 452 006 (1973)	25.59 T 15.35	157.08 T 73.16	36 T Non-exclusive
6.	Calcium hypophosphite	Pharmaceuticals	Hypophosphite & Co., 79-F, Princess Street, Bombay 400 002 (1967)	8.00 T 6.00	172.25 T 129.30	24 T (including other hypophosphites) Sponsored

1	2	3	4	5	6	7
7.	Calcium silicate	Low density insulators	Newkem Products Corpn., Harganga Mahal, Khodadad Circle, Bombay 400 014 (1968)	207.74 T 14.35	4938.21 T 230.47	4200 T Sponsored
8.	Can lining composition	Metal can industry	Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700 013 (1974)	1.45 T 0.36	2.44 T 0.97	500 Kg/day Non-exclusive
9.	Can sealing composition	Metal can industry	—do— (1962)	68.7 T 6.63	444.96 T 30.44	500 Kg/day Non-exclusive
10.	Carbimazole	Pharmaceuticals	Nicholas Laboratories India Ltd., Sion-Trombay Road, Deonar, Bombay 400 088 (1970)	— —	391.59 Kg 32.42	250 Kg Sponsored
11.	Catechol	Pharmaceuticals	Percynic Chemicals, Bombay (1972)	6.60 T 4.29	51.57 T 29.85	50 T Non-exclusive
12.	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
13.	Cationic dyes for acrylic fibres	Dyes for synthetic fibres	Sahyadri Dyestuffs & Chemicals, 177 Parvati-Vithalwadi Road, Pune 411 030 (1976)	2.70 T 3.93	120.77 T 136.66	120 T Sponsored
14.	Chlorobenzenes	Industrial chemicals	Hindustan Organic Chemicals Ltd., P.O. Rasayani (1976)	4010.00 T 329.20	17153.41 T 1214.40	4500 T Sponsored
15.	Chloromethanes	Industrial chemicals	Standard Alkali, Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1974)	18.00 T 1.12	3552.12 T 156.90	3000 T —
16.	Clofibrate	Pharmaceuticals	Biological Evans Ltd., 18/1 & 3, Azamabad, Hyderabad 500 020 (1973)	— —	2.89 T 14.30	4 T Non-exclusive

1	2	3	4	5	6	7
17.	Diethyl-*m* aminophenol	Dye intermediate	Sahyadri Dyestuffs & Chemicals, Pune (1970)	28.30 T 32.36	581.73 T 624.69	150 T Sponsored
18.	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
19.	Dimethoate	Pesticides	(i) Mico Farm Chemicals Ltd., 'Lotus Court' 165, Thambu Chetty Street, Madras 600 001 (1979)	8.90 T 6.23	0.15 T 0.11	100 T Non-exclusive
			(ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979)	28.41 T 23.01	12.54 T 9.61	15 T (Pilot plant) Non-exclusive
20.	Dimethylaniline (Continuous process)	Industrial chemicals	Sahyadri Dyestuffs & Chemicals, Pune (1976)	342.30 T 78.33	2107.88 T 683.53	3000 T Sponsored
21.	Endosulfan	Pesticides	Bharat Pulverising Mills Pvt. Ltd., 'Shriniketan', 14 Queens Road, Bombay 400 020 (1980)	— —	24.16 T 20.54	600 T Non-exclusive
22.	Ethion	Pesticides	Shaw Wallace & Co. Ltd., Calcutta (1979)	17.34 T 14.05	15.72 T 12.19	15 T (Pilot plant) Non-exclusive
23. *	Ethylenediamine	Bulk organic chemicals	Diamines & Chemicals Ltd., The Bharat Vijay Mills Ltd. Premises, Kalol 382 721 (1982)	4.00 T N.A.	— —	2000 TPA of ethylenediamines and polyamines
24.	Ethylene oxide condensates	Surface active agents	Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400 016 (1965)	1913.00 T 554.77	11868.14 T 2181.95	2500 T Sponsored
25.	Ferrites-Hard	Electronics	(i) Semiconductors Ltd., Ahmednagar Road, Miles 4/5, Pune 411 014 (1968)	— —	20.07 T +1225 lakh Nos. 9.34	200 T Non-exclusive
			(ii) Dr. Shet Magnetics Pvt. Ltd., 1069, V Block, 1st floor, Rajajinagar, Bangalore 560 010 (1978)	4.00 T 1.00	N.A. 0.75	20 T Non-exclusive

1	2	3	4	5	6	7
26.	Foundry core binder (Sinol core binder)	Core binder in steel foundries for high dimensional accuracy	Card Chem Industries, B-12Co-op.Industrial Estate, Balanagar, Hyderabad 500 037 (1980)	— —	9919 Ltrs. 0.61	Not available Non-exclusive
27.	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
28.	ß-Ionone	Perfumery, intermediate for Vitamin-A	S.H. Kelkar & Co. Ltd., Bombay (1975)	95.00 Kg 0.35	0.824 T 3.34	4.4 T Non-exclusive
29.	Maleic hydrazide	Agrochemicals	Micro Chemicals (India), Scheme No.1, Road No.3, Nai Abadi, Mandsaur 458 001 (1978)	0.50 T 0.33	1.12 T 0.52	1 T Non-exclusive
30.	*p*-Menthane hydroperoxide	Synthetic rubber	Camphor & Allied Products Ltd., P.O. Clutterbuckganj 243 502 Dist. Bareilly (1976)	16.76 T 7.44	99.18 T 38.18	60 T Exclusive
31.	Monochloroacetic acid	Intermediate for weedicides, carboxymethyl cellulose, etc.	Hico Products Ltd., Bombay (1975)	465.00 T 60.45	1380.37 T 125.14	720 T Non-exclusive
32.	Monoethylaniline	Intermediate for explosives	The Atul Products Ltd., Atul 396 020, Dist. Valsad (1975)	79.50 T 42.57	438.83 T 128.50	100 T Non-exclusive
33.	1-Naphthyl acetic acid	Agrochemicals, plant growth regulator	Micro Chemicals (India), Mandsaur (1975)	1.00 T 1.00	3.10 T 3.10	1.5 T Sponsored
34.	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

1	2	3	4	5	6	7
35.	Nitrile rubber	Oil resistant rubber formulations, adhesives	Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400 020 (1974)	843.00 T 138.00	2305.00 T 439.99	2000 T
36.	*p*-Nitrophenol	Intermediate	Hindustan Organic Chemicals Ltd., P.O. Rasayani (1978)	— —	4.00 T 1.16	900 T Non-exclusive
37.	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	170.73 T 23.31	1000 T Sponsored
38.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975)	4.01 T 144.26	30.52 T 788.81	16.66 T of various alkaloids (morphine, codeine, narcotine, papavarine and thebaine) Exclusive
39.	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
40.	Perfumery products based on longifolene (Capinone)	Perfumery	Camphor & Allied Products Ltd., Dist. Bareilly (1968)	25.94 T 46.69	112.35 T 121.33	50 T (for both Capinone and Meracene) Sponsored
41.	Perfumery products based on Δ^3-carene (Meracene)	Perfumery	-do-	8.29 T 5.03	64.07 T 28.62	-do-
42.	ß-Phenethyl alcohol	Perfumery	Sunanda Aromatic Industries, Mysore-K.R.S. Road, Mettagalli P.O., Mysore 571 106 (1970)	— —	1072.83 T 603.13	270 T Sponsored

1	2	3	4	5	6	7
43.	Phenthoate	Insecticides	Bharat Pulverising Mills Pvt. Ltd., Bombay (1975)	— —	27.10 T 17.55	600 T Sponsored
44.	Phthalate-butyl octyl	Plasticizers	Herdillia Chemicals Ltd., Air India Bldg., Nariman Point, Bomaby 400 021 (1979)	65.40 T 12.60	75.00 T 14.33	5000 T (including other phthalates) Non-exclusive
45.	Phthalates-diethyl and dimethyl	Plasticizers	The Mysore Acetate and Chemicals Co. Ltd., A-19, Acetate Town, Mandya 571 404 (1970)	216.00 T 36.00	1594.87 T 216.79	600 T Non-exclusive
46.	Phthalates-dioctyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., 'D' Bldg. Shiv Sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971)	3970.00 T 780.00	27174.18 T 3656.55	5000 T Non-exclusive
47.	Polyurethane coating	Coatings	Cipy Chemicals, 229, Rasta Peth, Pune 411 011 (1977)	— —	6918.00 Ltrs. 2.18	30 T Non-exclusive
48.	Polyurethane printing rollers	Printing	Sree Saraswaty Press Ltd., 32, Acharya P.C. Ray Road, Calcutta 700 009 (1965)	— —	5448 Nos. 10.94	3000 Nos. Non-exclusive
49.	Radiosonde thermistors	Meteorology	The Bhagyanagar Laboratories, 11-1523/8, Golkonda Cross Road, Hyderabad (1974)	30000 Nos. 6.24	160000 Nos. 26.93	Non available Non-exclusive
50.	D.C. Recording polarograph including potentio-metric strip chart recorder for captive consumption	Polarographic analysis	(i) Elico Pvt. Ltd., Sanatnagar Ind. Estate, Hyderabad 500 018 (1974)	18 Units 3.24	165 Units +3 Nos. 24.94	50 Units Non-exclusive
			(ii) Chromatography & Instruments Co., 121/122, Makarpura Indl. Estate, Baroda 390 010 (1975)	12 Units 0.90	72 Units 12.35	100 Units Non-exclusive

1	2	3	4	5	6	7
51.	Rubberized cork sheets	Gaskets	Bharat Casements, Prop. Banco Aluminium Baroda Ltd., Baroda 390 001 (1966)	— —	110.76 lakh pieces +177.00 T 104.17	24 lakh pieces Non-exclusive
52.	Silica gel	Humidity control	Minco Products, 17, Thiruvottyur High Road, Madras 600 081 (1963)	11.00 T 1.38	482.50 T 14.92	18 T Sponsored
53.	Sorbide nitrate	Pharmaceuticals	Nicholas Laboratories India Ltd., Bombay (1969)	— —	2840.50 Kg 41.30	300 Kg Sponsored
54.	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)	1161.00 T 105.00	3764.20 T 337.27	2000 T Non-exclusive
			(ii) The Anil Starch Products Ltd., P.B. No. 10009, Anil Road, Ahmedabad 380 025 (1976)	532.00 T 61.82	1386.40 T 150.06	1000 T Non-exclusive
55.	Direct reading spectrophotometer/ colorimeter	Biochemical research, spectro-scopic analysis in visible range	Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Road, Allahabad 211 001 (1974)	20 Units 1.40	162 Units 10.50	100 Units Non-exclusive
56.	Staple pin adhesive	Adhesive for staple pins	Esdee Paints, Near Power House, Kolshet Road, Thane 400 607 (1979)	956 Kg 1.82	817.00 Ltrs 0.88	Not available Non-exclusive
57.	Terpineol	Perfumery	Dujodwala Industries, Tulsiani Chambers, 8th floor, 212, Nariman Point, Bombay 400 021 (1976)	— —	400.00 T 112.50	200 T Non-exclusive
58.	Thermistors	Electronics	Semiconductors Ltd., Pune (1963)	— —	92.44 lakh Nos. 75.62	20 lakh Nos. Non-exclusive

1	2	3	4	5	6	7
59.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate	Sudarshan Chemical Industries Ltd., 162, Wellesley Road, Sangam Bridge, Pune 411 001 (1977)	118.00 T 41.17	178.00 T 60.22	300 T Sponsored
60.	Vitamin C	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1975)	— —	5.83 T 7.28 (estimated)	125 T Non-exclusive
61.	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
62.	Warfarin	Rodenticide	Unichem Laboratories Ltd., Bombay (1974)	—	384.29	840 Kg Non-exclusive

* During the period under review, production has been newly reported on these items (1).

VALUE OF PRODUCTION BASED ON NCL KNOW-HOW

Year	No. of items manufactured	Value of production (Rs. in lakhs)
1977-78	71	1965.27
1978-79	68	2174.06
1979-80	65	2923.70
1980-81	61	3056.60
1981-82	62	2928.62
		1,3048.25

Cumulative value of production based on NCL know-how (excluding FCP production) during 1950-77 amounted to Rs.6184.48 lakhs.

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1981-82)

Type of industry	No. of processes in production	Value of production during 1981-82 (Rs. in lakhs)
1. Public sector	6	806.17
2. Large scale private sector	20	2010.40
3. Medium and small scale sector	36	112.05
	62	2928.62

□

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 (1974)	Sponsored	—
8.	Camphene from pinene	Pharmaceuticals, perfumery	Resin and Terpene Industries, 812/813, Tulsiani Chambers, 212, Nariman Point, Bombay 400 021 (1978)	Sponsored	—

1	2	3	4	5	6
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—	—
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 drugs	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)	—do—	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, 18-20 Kasturba Gandhi Marg, New Delhi 110 001	—do—	—

1	2	3	4	5	6
16.	*Dimethoate	Pesticides	PNM Company, Thindal, Perundurai Main Road, Eroda 638 009 (1978)	Non-exclusive	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. Under implementation
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)	—do—	—
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.	Items having short shelf life	Sealants, adhesives	Hindustan Aeronautics Ltd., (Nasik Division), Ozher Township P.O., Nasik 422 007 (1980)	Sponsored	—
23.	Matrix-bound penicillin acylase systems	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Pune (1974)	—do—	—
24.	l-Menthol from Δ^3-carene	Perfumery	Bhavana Chemicals Ltd., 64-65 and 53-57, Laxmi Insurance Bldg. Sir PM Road, Bombay 400 001 (1978)	—do—	Under implementation
25.	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—	—

1	2	3	4	5	6
26.	Multiplication of teak by tissue culture	Forestry	Forest Development Corpn. of Maharashtra Ltd., 6-A, Nawab Layout, Tilak Nagar, Nagpur (1981)	Sponsored	Recently released
27.	Nitrofen	Weedicide	Amar Dye-Chem Ltd., Bombay (1978)	Non-exclusive	—
28.	* *p*-Nitrophenol	Intermediate	Catalyst (India) P. Ltd., Bombay (1975)	—do—	—
29.	* Nicotine sulphate	Insecticides	Keen Agro Chemicals and Eng. P. Ltd., Tower House, M.G. Road, Ernakulam 682 011 (1978)	—do—	—
30.	Polycrystalline silicon-ultrapure	Electronics	Grindwell Norton Ltd., Devanhalli Road, Old Madras Road, Bangalore 560 049 (1982)	Sponsored	Recently released
31.	Polysulphide liquid 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—
32.	Polysulphide sealant compound (Sp. by HAL, Nasik)	Sealants	Rathi Rubber Products, Pune (1981)	—do—	—do—
33.	Propylene oxide from propylene (extension to propylene glycol)	Petrochemicals	Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1978)	Sponsored	—
34.	Quinapyramine sulphate/ chloride	Veterinary drug	Chintamani Fine Chemicals, S.No. 64/5, Bhide Baug, P.O. Vadgaon Budruk, Sinhagad Road, Pune 411 041 (1981)	Non-exclusive	Under implementation
35.	Simazine	Herbicide	Amar Dye-Chem Ltd., Bombay (1978)	—do—	—

1	2	3	4	5	6
36.	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—	—
37.	Sodium sulphide	Various industries	Amar Dye-Chem Ltd., Bombay (1976)	—do— (Technical aid)	—
38.	Sorbitol from glucose (continuous process)	Pharmaceuticals	The Anil Starch Products Ltd., Ahmedabad (1976)	Sponsored	—
39. *	Staple 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	—
40.	Substitute for side seam cement	Adhesive	Nand Industries, 324, Shaniwar Peth, Pune 411 030 (1978)	Sponsored	—
41.	Sulphur monochloride	Various industries	Phosphate Co. Ltd., 14, Netaji Subhash Road, Calcutta 700 001 (1976)	Non-exclusive (Technical aid)	—
42.	Theophylline, aminophylline and caffeine	Pharmaceuticals	Pefco Foundry & Chemicals Ltd., Plot No. 10, Off Dr. Moses Road, Worli, Bombay 400 018 (1978)	Non-exclusive	Production to start
43.	Thionyl chloride	Various industries	Dharamsi Morarji Chemical Co. Ltd., Prospect Chambers, 317/21, Dr. D.N. Road, Bombay 400 001 (1977)	Collaborative work	—
44.	N-Tridecyldiisopropanolamine	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 as they are being produced by other licensees.

The following processes which were included in Table II of Annual Report 1980-81 have now been dropped as the licensees have not shown any progress towards their implementation for a considerable period.

1. ß-Ionone
2. Phthalates — dibutyl and dioctyl

□

LIST OF PROCESSES AVAILABLE

Sl. No.	Name of the process/ product	Field of utilization	Major raw materials	Range of total capital requirement	Remarks
1	2	3	4	5	6
1.	Acetanilide	Drug and dye intermediate	Aniline and acetic acid	C	Released, in production, turn-key plant available through project engineers
2.	Aniline	Organic intermediate	Nitrobenzene, hydrogen and catalyst	C	Released
3.	Atrazine	Herbicide	Cyanuric chloride, ethylamine and monoisopropylamine	C	Released
4.	Benzoic acid from crude methyl benzoate	Pharmaceuticals	Crude methyl benzoate, sodium hydroxide and sulphuric acid	A	Released
5.	*tert*-Butyl catechol	Stabilizer and polymerization inhibitor for synthetic rubber	Catechol, *tert*-butyl alcohol and catalyst	A	Released, in production
6.	Butyl titanate	Insulating varnish, special paints, catalyst	Butanol and titanium tetrachloride	B	Released, in production
7.	Cadmium sulphide photoconductive cells	Instruments, photoelectric devices	Cadmium sulphate AR, indium, Wood's metal and components	A	Released
8.	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
9.	Can sealing composition (based on natural rubber)	Metal can industry	Natural rubber latex and rubber chemicals	A	-do-

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
10.	Carboxin	Pesticide	Acetoacetanilide, sulphuryl chloride, benzene and 2-mercaptoethanol	C	Released
11.	Catechol	Organic intermediate	Catechol rich cut of polyvalent phenol and solvents	A	Released, in production
12.	Chlorinated paraffin wax	Plasticizer and extender	Paraffin wax and chlorine	C	—
13.	2-Chloroethyltrimethyl ammonium chloride	Plant growth regulator	Trimethylamine and ethylene dichloride	A	—
14.	Chlorosilanes	Basic material for silicon	Ferrosilicon and methyl chloride	C	Released, collaborative work
15.	Clofibrate	Drug	*p*-Chlorophenol, acetone, chloroform, sodium hydroxide and ethanol	A	Released, in production
16.	Colchicine	Drug	Seeds of *Iphigenia stellata* and solvents	A	Released
17.	Controlled release herbicide formulation for the control of parthenium and other dicot weeds (Indian Patent No. 144674)	Herbicide	2, 4-D acid, thionyl chloride, pyridine, urea, saw dust and soap stone	C	—
18.	Diazepam	Anti-anxiety drug	*p*-Nitrochlorobenzene, benzyl cyanide, dimethyl sulphate, iron powder and chloroacetyl chloride	A	Released
19.	Dichloropropionic acid (Dalapon)	Weedicide	Propionic acid, chlorine and soda ash	C	-do-
20.	Dimethoate	Pesticide	Phosphorus pentasulphide, methanol, monochloroacetic acid, methyl amine and caustic lye	C	Released, in production
21.	Dimethylaniline (batch process)	Dyestuff and explosives intermediate	Aniline and methanol	C	Released

1	2	3	4	5	6
22.	N, N'-dimethyl biguanide HCl phenethyl biguanide HCl	Drugs	Dicyandiamide, dimethyl amine/ß-phenylethyl-amine and solvents	A	Released
23.	Dissolving grade pulp	Rayon, tyre cord	Suitable wood (e.g. bamboo, eucalyptus, etc.) and digesting agents	C	— Process available on turn-key basis through project engineers
24.	Endosulfan	Pesticide	Hexachlorocyclo-pentadiene, butene-diol, thionyl chloride and epichlorohydrin	C	Released, process available on turn-key basis through project engineers
25.	Ethylenediamine	Bulk organic chemical	Ethylene dichloride, ammonia and caustic soda	C	-do-
26.	Ethephon	Pesticide	Phosphorus trichloride, ethylene oxide, hydrochloric acid and sulphuric acid	A	Released
27.	Ethion	Pesticide	Phosphorus pentasulphide, ethyl alcohol, dibromomethane and caustic soda	C	Released, in production
28.	Ethylene dichloride from ethyl alcohol	Solvent and organic intermediate	Ethyl alcohol, chlorine and catalyst	C	—
29.	Ethylene from ethyl alcohol	Organic intermediate	Ethyl alcohol and catalyst	A	Released
30.	Ferrites-Hard	Electronics	Iron oxide, barium carbonate, additive and binder	B	Released, in production
31.	Gaskets from coir pith	Gaskets	Coir pith, nitrile rubber and rubber chemicals	A	Released
32.	Gaskets from cork granules	Gaskets	Cork granules, nitrile rubber and rubber chemicals	A	-do-
33.	ß-Ionone	Perfumery chemical, intermediate for Vitamin A	Lemon grass oil, caustic soda, acetone and sulphuric acid	C	Released, in production

1	2	3	4	5	6
34.	Maleic hydrazide	Plant growth regulator	Maleic anhydride and hydrazine hydrate	A	Released, in production
35.	Microfilters	Industrial filtration	Pulp, melamine and formaldehyde	A	Released
36.	Monochloroacetic acid	Intermediate for weedicides, carboxy-methylcellulose, etc.	Acetic acid, chlorine and catalyst	B	Released, in production
37.	Monochlorobenzene	Bulk organic chemical	Benzene and chlorine	C	Released
38.	Monoethylaniline	Intermediate for explosives	Aniline, ethyl alcohol and catalyst	B	Released, in production
39.	Morpholine	Intermediate for rubber chemicals, textile chemicals, optical brighteners, etc.	Diethanolamine, sulphuric acid and caustic soda	C	Released
40.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	Tobacco/tobacco waste, lime, kerosene and sulphuric acid	A	Released, in production
41.	Nitrofen	Weedicide	*p*-Nitrochlorobenzene, potassium hydroxide and 2, 4-dichlorophenol	B	Released
42.	*p*-Nitrophenol	Intermediate for parathion and paracetamol	*p*-Nitrochlorobenzene, sodium hydroxide lye and hydrochloric acid	C	Released, in production
43.	Optical whitening agent for synthetic fibres	Whitening agent for synthetic fibres	Acenaphthene, dichloroethane, chloro-sulphonic acid, methanol, acetic acid, methylamine, sodium hydroxide and sodium dichromate	A	Released
44.	Phenylacetic acid	Perfumery, Penicillin-G	Benzyl chloride, sodium cyanide and sodium hydroxide	B	Released
45.	Phthalate-butyl octyl	Plasticizer in non-electrical applications	Phthalic anhydride, butyl alcohol and 2-ethyl hexanol	C	Released, in production

1	2	3	4	5	6
46.	Phthalates-dibutyl/ dioctyl	Plasticizers	Phthalic anhydride and butyl alcohol/2-ethyl hexanol	C	Released, in production
47.	Phthalates-dimethyl/ diethyl	Plasticizers	Phthalic anhydride and methyl/ethyl alcohol	C	-do-
48.	D.C. Recording polarograph	Polarographic analysis	Component parts and boxes	A	-do-
49.	Polyol for making polyurethane rigid foam	Rigid foams	Cardanol, formaldehyde and a suitable amine	A	—
50.	Polysulphide liquid rubber	Adhesives, sealants, etc.	Ethylene chlorohydrin, *p*-formaldehyde, sodium sulphite, sulphur, sodium hydroxide and iron sulphide	A	—
51.	Polyurethane coating	Coating for leather, rubber, wood, glass, etc.	Castor oil, toluene diisocyanate and solvents	A	Released, in production
52.	Polyurethane printing rollers	Printing rollers	Castor oil, polyethylene glycol and toluene diisocyanate	A	-do-
53.	Quinapyramine sulphate and chloride	Veterinary drug	*p*-Aminoacetanilide, ethyl acetoacetate, ammonium acetate, dimethyl sulphate and guanidine carbonate	C	Released
54.	Radiosonde thermistors	Meteorology	Metallic oxides, platinum foil and components	A	Released, in production
55.	Rubber blowing agent	Rubber chemicals	Hexamine, sodium nitrite, hydrochloric acid and stabilizers	A	Released
56.	Rubber reclaiming agent	Rubber chemicals	Xylene and sulphur monochloride	A	Released
57.	Silica gel (desiccant type)	Humidity control	Sodium silicate and sulphuric acid	A	Released, in production

1	2	3	4	5	6
58.	Silicon tetrachloride	Industrial chemical	Ferrosilicon, chlorine and hydrochloric acid	C	—
59.	Silver paste for mica capacitor electrodes	Electronic industry	Silver nitrate, acetone, caustic soda, glass and filler	A	Released
60.	Simazine	Herbicide	Cyanuric chloride and ethylamine	C	Released
61.	Solid state strip chart recorder	Instrument	Chopper, input transformer, field effect transistors and other components	B	—
62.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals and Vitamin C synthesis	Dextrose monohydrate, hydrogen and catalyst	C	Released, in production
63.	Direct reading spectro-photometer/colorimeter	Biochemical research and spectroscopic analysis in visible range	Components and boxes	B	-do-
64.	Staple pin adhesive	Adhesive for staple pins	Synthetic resin and solvent	A	-do-
65.	Terpineol	Perfumery	∝ -Pinene	B	-do-
66.	Tetradifon	Acaricide	Trichlorobenzene, chlorosulphonic acid, monochlorobenzene and aluminium chloride	B	Released
67.	Theophylline, aminophylline and caffeine	Drugs (Caffeine also used in beverages)	Dimethylurea, mono-chloroacetic acid, acetic anhydride, sodium cyanide, dimethyl sulphate and ethylenediamine	C	Released
68.	Thermistors	Temperature measurement and control, electronic devices	Oxides of high purity, components and binder	A	Released, in production
69.	Thioglycolic acid	Cosmetics, catalyst for Bisphenol-A	Monochloroacetic acid, sodium hydroxide, sodium thiosulphate, zinc dust and solvents	A	Released

1	2	3	4	5	6
70.	Trichlorobenzene	Intermediate	Non-gamma BHC residue and caustic lye	B	Released, in production
71.	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 (1980-81 AND 1981-82)

	1980-81	1981-82
EXPENDITURE (Rs. in lakhs)		
1. Recurring	186.29	225.45
2. Capital	115.44	147.16
3. Pilot plant	—	—
	301.73	372.61
RECEIPTS (Rs. in lakhs)		
1. Receipts on account of sponsored projects	6.85	5.04
2. Analytical/testing charges	0.65	0.70
3. Institutional consultancy (CSIR share) including know-how fee/job work	0.56	2.32
4. Sale of laboratory products	0.11	0.14
5. Miscellaneous receipts	6.86	8.57
	15.19	16.77
ACHIEVEMENTS		
1. Total number of processes in production	61	62
2. Value of production based on NCL know-how (Rs. in lakhs)	3056.60	2928.62
3. Estimated saving in foreign exchange on account of above production (Rs. in lakhs)	1222.64	1171.45
4. Total number (cumulative) of processes released and awaiting production		
(a) NCL processes	19	24
(b) Sponsored schemes	10	17
(c) Collaborative work	3	3
5. Total number of parties who have taken NCL processes for exploitation	143	146
6. Total number of parties who have sponsored processes	87	90
7. Total number of processes available for commercial exploitation	72	71
8. Number of processes released during the year		
(a) NCL processes	4	2
(b) Sponsored processes completed/concluded	3	6
9. Papers published	134	118
10. Papers presented/read at symposia, seminars, etc.	33	23
11. Doctorate and Masters degrees received by NCL staff	23	24
12. No. of recognized guides for Doctorate and Masters degrees	51	50
13. Patents in force		
(a) In India	55	67
(b) Abroad	2	2
14. Premia and Royalties received by NRDC through NCL processes (Rs. in lakhs)		
(a) Premia	0.57	0.40
(b) Royalties	1.17	1.70
15. No. of processes assigned to NRDC	—	—

CUMULATIVE DATA (1950-82)

EXPENDITURE (Rs. in lakhs)	
1. Recurring	2127.00
2. Capital	830.14**
3. Pilot plant	74.47
	3031.61
RECEIPTS (Rs. in lakhs)	
1. Total money receipts	
a) Total premia earned by NRDC through NCL processes	45.49
b) Total royalties earned by NRDC through NCL processes	23.19
c) Total receipts from sponsors	98.01
d) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sales of laboratory products, job work and other receipts	129.79
	296.48

ACHIEVEMENTS	
1. Total value of production based on NCL know-how (Rs. in lakhs)	19233.14
2. Total No. of papers published	3597
3. Total No. of papers presented/ read at symposia, seminars	280
4. Total No. of degrees received	523

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

EXECUTIVE COMMITTEE
(as on 31-3-1982)

Director, National Chemical Laboratory, Pune 411 008.	Chairman
Prof. Goverdhan Mehta, Professor and Dean, School of Chemistry, University of Hyderabad, Hyderabad 500 001.	Member
Dr. H.E. Eduljee, Managing Director, Dai-Ichi Karkaria Pvt. Ltd., Liberty Building, Sir Vithaldas Thackersey Marg, Bombay 400 020.	Member
Prof. P.T. Narasimhan, Department of Chemistry, Indian Institute of Technology, Kanpur 208 016.	Member
Dr. R.B. Mitra, Scientist, National Chemical Laboratory, Pune 411 008.	Member
Dr. A.V. Rama Rao, Scientist, National Chemical Laboratory, Pune 411 008.	Member
Administrative Officer, National Chemical Laboratory, Pune 411 008.	Member
Sr. Finance & Accounts Officer, National Chemical Laboratory, Pune 411 008.	Member
Dr. C. SivaRaman, Scientist, National Chemical Laboratory, Pune 411 008.	Member- Secretary
Permanent Invitees:	
The Director-General Scientific & Industrial Research, Rafi Marg, New Delhi 110 001, or his nominee.	
The Chairman, Coordination Council, Chemical Sciences Group.	□

RESEARCH ADVISORY COUNCIL
(as on 31-3-1982)

Dr. S. Varadarajan, Chairman & Managing Director, Indian Petrochemicals Corpn. Ltd., P.O. Petrochemicals, Baroda 391 346.	Chairman
Dr. P.R. Mahadevan, Director, Foundation for Medical Research, 84-A, R.G. Thadani Marg, Worli, Bombay 400 018.	Member
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Prof. Goverdhan Mehta, Professor and Dean, School of Chemistry, University of Hyderabad, Hyderabad 500 001.	Member
Dr. J.L. Thakkar, Managing Director, Dharamsi Morarji Chemical Co. Ltd., Dadabhoy Naoroji Road, Bombay 400 001.	Member
Shri. D.M. Trivedi, Chief Executive, The National Rayon Corpn. Ltd., Everest House, Homi Modi Street, Bombay 400 023.	Member
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Shri K.V. Raghavan, Chairman & Managing Director, Engineers India Ltd., PTI Building, Sansad Marg, New Delhi 110 001.	Member
Prof. P.T. Narasimhan, Department of Chemistry, Indian Institute of Technology, Kanpur 208 016.	Member
The Director-General, Scientific & Industrial Research, CSIR, Rafi Marg, New Delhi 110 001, or his nominee	Member (Ex-officio)
The Director, National Chemical Laboratory, Pune 411 008.	-do-
Chairman, Coordination Council, Chemical Sciences Group.	-do-
Dr. C. SivaRaman, Scientist, National Chemical Laboratory, Pune 411 008.	Member- Secretary
	□

NATIONAL CHEMICAL LABORATORY, PUNE 411 008

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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. N.D. Ghatge	Head Polymer Chemistry Division	53234
7. Dr. G.R. Venkitakrishnan	Head Process Development Division	56243
8. Dr. C. SivaRaman	Head Biochemistry Division	58234
9. Dr. P. Ratnasamy	Head Inorganic Chemistry Division	54761
10. Dr. S.H. Iqbal	Head Technical Services Division	57338
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 July, 1983 □

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