NCL

# Annual Report

## 1980-81


NATIONAL CHEMICAL LABORATORY, PUNE

# NATIONAL CHEMICAL LABORATORY PUNE 1980-1981

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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## PREFACE

### Introduction

The research work carried out at the NCL during 1980-81 is highlighted in the following pages. The Indian chemical industry has now built up sufficient in-house R & D for undertaking development of processes of immediate relevance to itself. The major part of the NCL's research work was therefore devoted in the period under review to development of processes, specially the long range ones, that utilize the valuable natural resources of the country and have significant social and economic impact where immediate profits may not necessarily be the major criterion of selection. At the same time, the NCL has also been collaborating with the industry in developing specialized processes where the industry could gainfully utilize the expertise and the facilities available at the NCL in terms of specialized equipment and sophisticated instruments.

As in the previous year, the NCL research programme continued to operate according to a three-tier structure comprising 8 divisions, 16 research areas and various projects in each area. Since work on one of the earlier areas-surface chemistry (water evaporation control) - was concluded, it was replaced by a new area, preparative inorganic chemistry, which is aimed at developing commercially important inorganic processes.

The projects that have been reported in this annual report reflect a new trend in NCL's research activity - combination of basic and applied research with maximum interdisciplinary approach to evolve novel and innovative technologies.

### Research and Development Activities

NCL is collaborating with a number of private and public sector industries for the development of novel and efficient catalysts for important chemical processes. For instance, NCL, in collaboration with Associated Cement Co. Ltd. ( ACC ), Bombay, developed a new zeolite catalyst for the selective isomerization of xylenes. Its performance has been found satisfactory in pilot plant studies. A similar catalyst has been developed for the alkylation of benzene to ethyl benzene which is subsequently converted to styrene, one of the most important industrial monomers at present. This catalyst was also developed in collaboration with ACC and is soon expected to be used in an industrial plant.

A new economically feasible route for the total synthesis of vitamin $B_6$ has been worked out and is being optimized for commercialization. Isolation of the cytotoxic drug, vinblastine, in the form of its sulphate, was optimized on 40 kg per batch scale yielding approximately 1g of vinblastine sulphate for 6-8 kg of dried leaves of *Vinca rosea.*

A novel method for the synthesis of the key intermediate for the anti-tumour drug 4-demethoxy-daunomycin was developed starting from 2-methyl-hydroquinone.

During investigations on the applications of solar energy, an efficient solar selective molybdenum black film was prepared which made it easier to prepare surfaces for large area solar collectors. A two-rod quartz bell jar reactor for deposition of hyper-pure silicon on thin silicon rods was designed and fabricated. Subsequently a larger stainless steel reactor was designed and fabricated where deposition can be simultaneously carried out on six thin rods.

Methods were developed for the clonal multiplication of pomegranate and cardamom. Two hundred teak plants were supplied to the Forest

Development Corporation of Maharashtra for field trials. A process was developed for the isolation of virus free banana plants by shoot tip culture.

A laboratory scale process was developed for polyphenylene sulphide, a new engineering plastic with remarkable mechanical, thermal and chemical properties. Work on polymeric membranes for desalination is in progress in collaboration with the Central Salt and Marine Chemicals Research Institute, Bhavnagar.

Bharat Pulverising Mills Ltd., Bombay commissioned a 400 TPA endosulfan plant based on NCL technology. Endosulfan is a widely used broad spectrum pesticide. Hico Products Ltd. successfully set up and operated a semi-commercial plant for methyl chlorosilanes, based on a high level technology developed at the NCL. At the instance of NRDC, a 10 kg/batch pilot plant for terpineol based on turpentine oil was designed, fabricated, set up and commissioned at the NCL in collaboration with MERADO, Pune. It was subsequently transferred to the Central Research Organisation, Rangoon, Burma, under the Indian Technical Economic Cooperation Programme with Burma. This is the first instance of export of an NCL technology.

NCL processes for the herbicide dalapon, the veterinary drug quinapyramine sulphate/chloride and silver paste for mica capacitor electrodes were released for commercial exploitation.

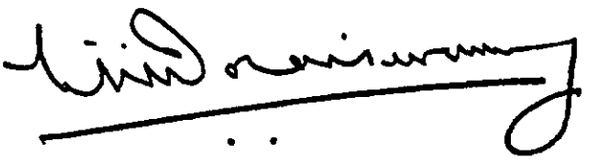
Basic research of a high order was carried out by the NCL scientists in the fields of solid state chemistry, synthetic pyrethroids, development of pest control agents and other bioactive principles from renewable sources, coordination chemistry, molecular biology, catalysis and catalytic reaction engineering and polymer science and engineering.

## Patents and Publications

Thirteen new Indian patents were filed during the year. Fifty-five Indian patents (9 sealed, 10 accepted and 36 filed) and two foreign patents were in force as on 31st March 1981. One hundred and thirty-four research papers were published during the year, and 23 staff members, research fellows and guest workers received post-graduate degrees that included 5 M. Sc., 1 M. Sc. (Tech.) and 17 Ph. D. Fifty-one NCL scientists are recognized as research guides by different universities.

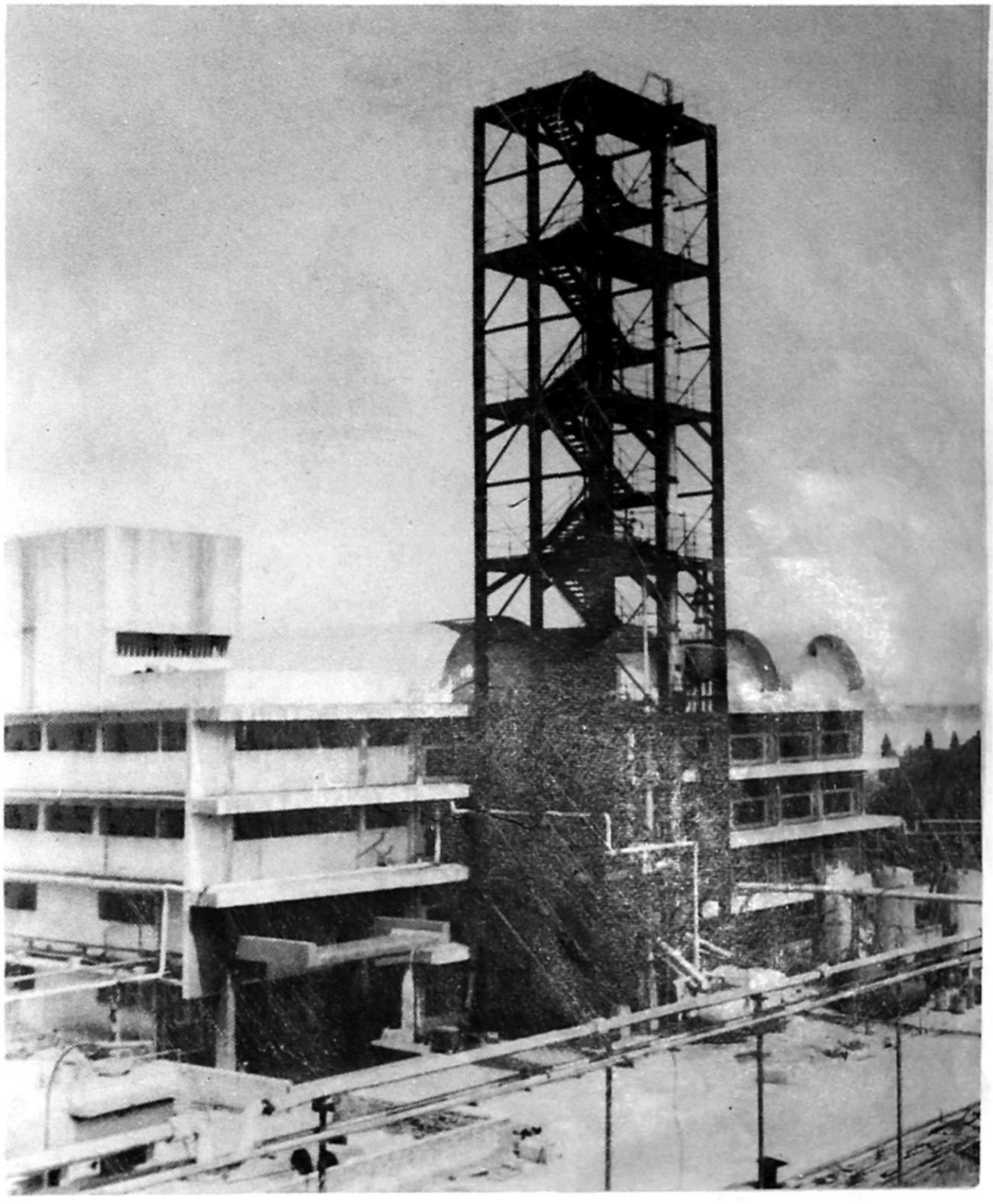
## Research Utilization

During 1980-81, sixty-one NCL processes were in production with a turnover of Rs. 30.5 crores. The corresponding figures for the previous year were sixty five processes and Rs. 29.2 crores turnover. The foreign exchange saving on account of production in 1980-81 is estimated at Rs. 12.2 crores.



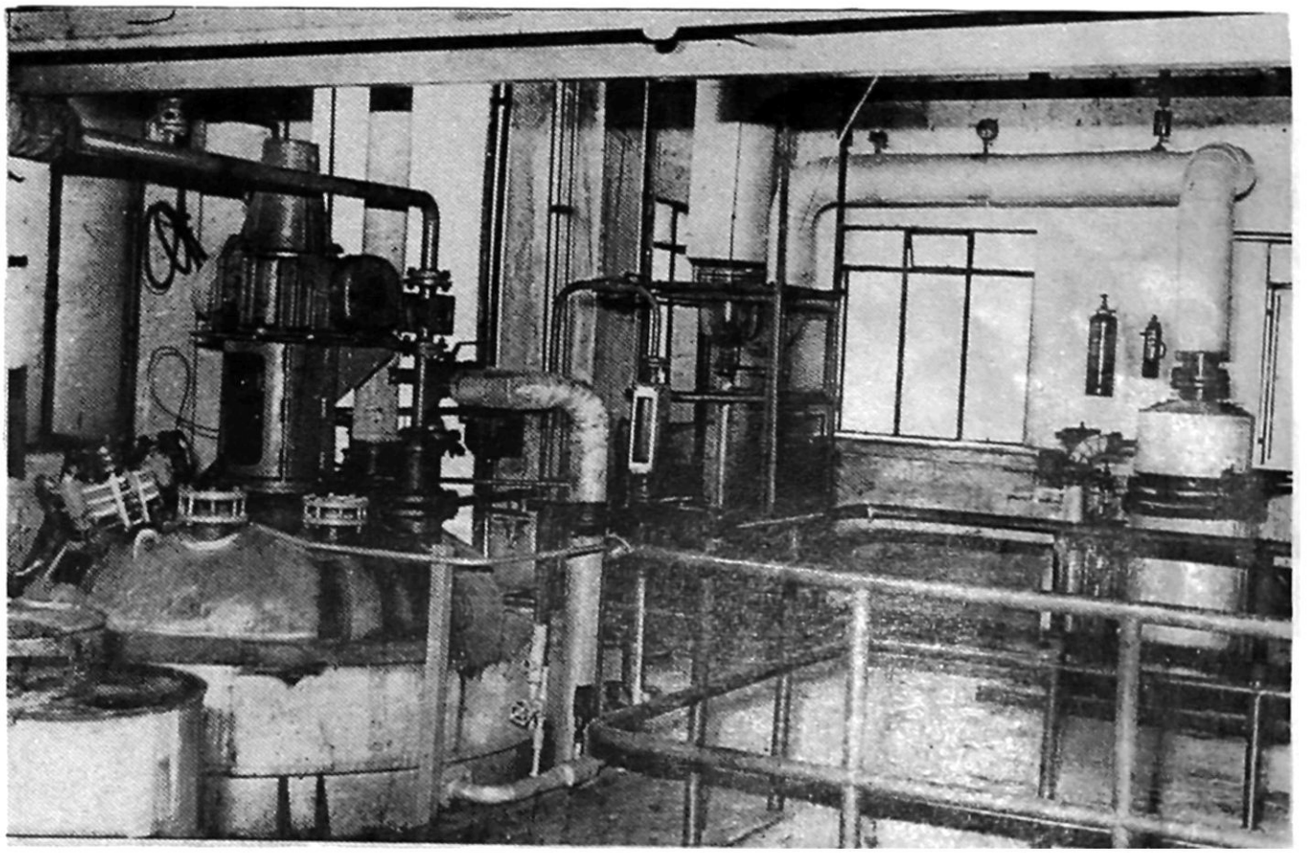
August, 1982
NCL, Pune

**(L. K. Doraiswamy)**
Director



Chlorosilanes semi-commercial plant of
Hico Products Ltd., Bombay

**Export of NCL technology**



Endosulfan plant of
Bharat Pulverising Mills Ltd., Bombay
Capacity : 600 Tonnes per year

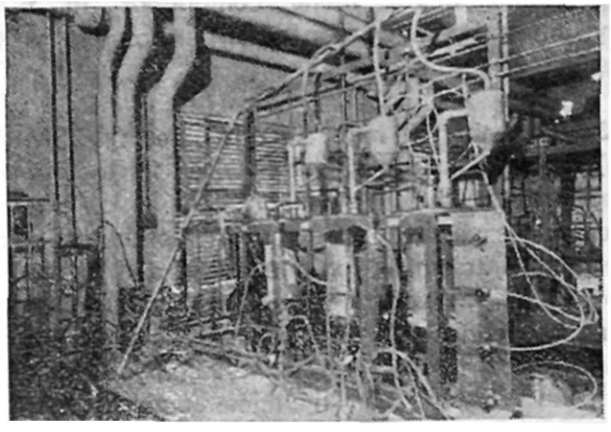
**Instrument acquired during the year**

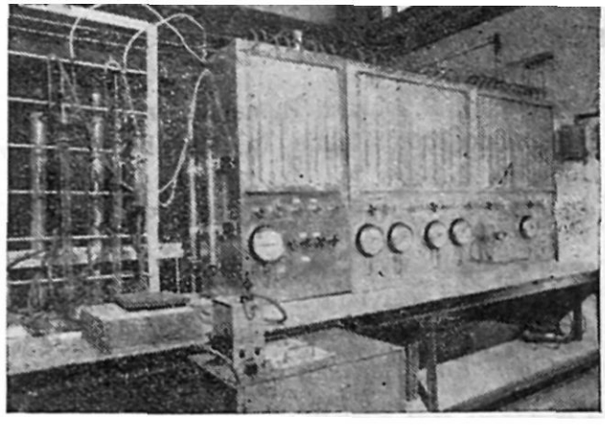
Brabender plasticorder with film blowing machine

# 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)





Ethylene oxide lab. scale reactor and the controls

This project has been undertaken jointly with Engineers India Ltd., New Delhi. Work done during the year under report includes (a) setting up of a unit for the preparation of ethylene by dehydration of ethanol over alumina catalyst (capacity of about 0.5 kg ethylene per hour); (b) establishment of a catalyst testing assembly consisting of four reactors with a common control panel; (c) development of a technique for coating the active catalyst mass firmly on low surface area support; and (d) preparation of a number of supported silver catalysts under different conditions.

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

Catalyst development for carbonylation of ethanol to propionic acid was continued. Several catalysts and promoters were tested for this reaction in a high pressure stirred reactor. Rh complex catalyst with a specific combination of solvents was found to be the best catalyst. With this catalyst, conversion greater than 99% and selectivity of 90-95 % were achieved. Work on recycle and recovery of the catalyst is in progress.

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

*The programme on catalyst development* for carbonylation of nitrobenzene and dinitrotoluene (DNT) was continued. For carbonylation of nitrobenzene, screening of catalysts and promoters and the role of solvents, ligands, etc., were studied. The effect of process parameters (temperature, pressure, reactants, concentration, etc.) on activity and selectivity of Pd complex catalysts was investigated. Screening of catalysts and product distribution studies on carbonylation of DNT were completed. Based on these studies, a catalyst giving complete conversion of DNT and about 50-60 % selectivity for toluene diisocyanate was developed. Further work on catalyst development, kinetics and recycle of catalysts is in progress.

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

A kinetic model based on the reaction mechanism for homogeneous hydrogenation of cyclohexene to cyclohexane using dichlorobis (triphenylphosphine) ruthenium (II) was developed.

Homogeneous hydrogenation of allyl alcohol to propyl alcohol and allyl bromide to propyl bromide using dichlorotris (triphenylphosphine) ruthenium (II) was also carried out and some kinetic parameters such as effect of catalyst, olefin, hydrogen concentration and temperature on the rate of hydrogenation were studied.

### 1.5 Polymer-bound homogeneous catalysts : (1-4-256)

A method for anchoring homogeneous catalysts to polymeric supports was standardized and a polymer bound Rh complex catalyst for carbonylation of alcohols (ethanol) was developed. This catalyst gives activity comparable to that of the homogeneous counterpart. However, during the course of reaction, part of the complex leached out. Further work to modify the functional groups so as to suit the requirement of ethanol carbonylation is being undertaken.

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

The high silica zeolites belonging to the ZSM family are selective in hydrocarbon conversion reactions. The process parameters for the manufacture of high silica zeolites prepared by using indigenous raw materials were optimized and several batches of catalysts were tested by X-ray and sorption measurements. The synthesized catalysts were tested for the selective isomerization to *o*- and *p*-xylene using isomer feed at atmospheric pressure as well as at high pressure on a pilot plant scale. The process parameters were optimized and the catalyst life cycle as well as the regenerability of the catalysts were evaluated. The effects of incorporation of transition metal ions and of hydrogen to hydrocarbon ratio were studied.

Catalysts and process for ethyl benzene by vapour phase alkylation of benzene with rectified spirit/ethylene were developed. The influence of temperature and other process parameters on the selectivity to ethyl benzene were evaluated. A detailed kinetic analysis is in progress.

Work on the development of catalysts and processes for olefins from methanol, toluene disproportionation, transalkylation and other reactions is in progress.

### 1.7 Basic studies

**1.7.1** Promoting action of water on the slurry phase hydrogenation of *p*-nitrotoluene on Raney nickel catalyst was found to result in a two-to-three-fold enhancement in the reaction rate at optimum water concentration. The kinetics of the hydrogenation reaction was also studied in a three phase slurry reactor.

**1.7.2** Poisoning of Raney nickel catalyst by sulphur, halogen and heavy metal compounds in the slurry phase hydrogenation of *p*-nitrotoluene was investigated.

**1.7.3** A number of high silica zeolites (H-ZSM-5 type) were prepared and characterized for their acid strength distribution. Effects of Si/Al ratio, extent of cation exchange, pretreatment condition and hydrothermal treatment on the acidic and catalytic properties of the zeolite were investigated. Correlations between acidity and catalytic activity of the zeolite for a number of hydrocarbon conversion reactions were studied using a microreactor combined with a gas chromatograph.

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*Chem. Eng. Sci.*, **36**, 945 (1981).

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Effectiveness factors in bidispersed catalyst : The general *n*th order case,
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Kinetics of a non-catalytic slurry reaction: A reaction of acetylene with cuprous oxide suspended in water,
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1. Chaudhari, R. V. and Ramachandran, P. A.,
Designing of three phase catalytic reactors,
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McGraw Hill Publications have awarded a certificate of recognition for this paper to both the authors.

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## 2. COORDINATION AND ORGANOMETALLIC COMPOUNDS

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

New chelated titanium and tin compounds of S-benzyl-$\beta$ - N - 2 - hydroxyphenyldithiocarbazate, its 5-chloro and 5-bromo derivatives and *o*-hydroxy-acetophenone-S-benzyldithiocarbazate were prepared. Organotin and chlorotitanium derivatives of the hydrazones of salicylaldehyde and *o*-hydroxy-acetophenone and their adducts with nitrogen bases were also synthesized. New saligenin (*o*-hydroxy benzyl alcohol) complexes of titanium and tin were also prepared.

Hydroxy compounds such as phenolphthalein, $\alpha$-naphtholphthalein 1, 1-diphenyl ethanol and mono-, di- and tri-chloroacetic acids were found to give stable chelated titanium compounds.

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

Since rare transition metals like ruthenium, rhodium and palladium were not available, work during this period was mainly centred on less costly transition metals like cobalt and titanium.

Pentacoordinated cobalt dimethylglyoxime complexes (cobaloxime) with piperidine, morpholine and pyridine as the axial ligands were prepared *in situ* and used as homogeneous catalysts for the reduction of nitrobenzene to aniline. A number of experiments were carried out to optimize the reaction conditions like catalyst to substrate ratio, temperature, solvents and stirring rates. The cobaloxime complex with piperidine as its axial ligand (in benzene) was found to convert nitrobenzene to aniline selectively and almost quantitatively under ambient conditions. The rate of hydrogenation was 1.1 mole $H_2$/mole/minute. The major cost for the production of aniline by this method comes from the dimethylglyoxime.

IR and ESCA studies on the catalyst isolated before and after the reaction showed no change in the oxidation state or structure of the complex. However, the formation of an unstable Co(I) species during the reaction could not be ruled out, since the cobaloxime species are highly sensitive to air and moisture. A tentative reaction mechanism involving cobaloxime-nitrobenzene radical ion, its reaction with molecular hydrogen forming hydrido complex and finally the hydrogen transfer to the substrate was proposed.

Alumina supported cyclopentadienyl titanium dichloride was prepared by the reaction of cyclopentadienyl titanium trichloride with surface hydroxyl groups of activated alumina. This supported titanium complex was reduced by excess of n-butyl lithium in hexane and the resulting catalyst was found to be active for the hydrogenation of hexene-1.

Several aryl substituted titanosiloxanes of the type $Ph_3SiO\text{-}TiCpCl_2$ and $Ph_2SiO_2$ $(TiCpCl_2)_2$ were also prepared and characterized to test their catalytic activity and suitability for the reduction of olefin substrates.

### 2.3 Basic studies

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

In continuation of previous work, the extent of interaction between *cis*-dichlorobis (theophylline) platinum (II) with calf thymus DNA in buffer solutions was studied by UV difference spectral and melting techniques. The UV difference spectrum for the DNA solution mixed with *cis*-$Pt(theoph)_2Cl_2$ did not change indicating no reaction with DNA bases. However, the spectrum of the aquated Pt-complex mixed with DNA exhibited large hyperchromism with a wave length shift of the peak absorption from 259 to 282-290 nm. This can be attributed to the change in the electron distribution of the base moieties induced by binding with platinum and due to the loss of base stacking. Melting profiles for the DNA samples treated with Pt-complex showed decrease in the melting temperature. Binding of the quinine residues of the DNA involving probably $(N_7)$ — 0(6) positions to the metal is implied in these studies.

Several Pt(II) and Pd(II) complexes, for instance, dichloro ( 3, 5, 6-tribromo-1, 10-phenanthroline ) platinum ( II ), *cis*-dichlorobis ( theophylline ) platinum (II), bis (8-quinolinolato)-platinum (II) and palladium (II), were synthesized and characterized.

Oxidative addition reactions of Pt(II) and Pd(II) complexes with 8-quinolinol or 8-aminoquinoline were carried out. Bromination of the compounds,

in chloroform medium, for instance, yielded the corresponding Pt(IV) or Pd(IV) complexes. These were characterized by their elemental analysis and spectral data. Chlorination reactions carried out with bis (8-quinolinolato) - platinum (II) or palladium (II) resulted in the isolation of new compounds, dichlorobis ( 5, 7-dichloro-8-quinolinolato ) Pt(IV) or Pd(IV). $\nu$ (Pt-Cl) frequencies could be located in the IR spectra of these compounds at Ca. 330 $cm^{-1}$. The position of the bands suggested that the oxidative addition of the halogen (Cl) had taken place in the *trans* position in these complexes.

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## 3. DRUGS AND DRUG INTERMEDIATES

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

During the year under report, the isolation of vinblastine in the form of its sulphate from the leaves of *Vinca rosea* was optimized on a 40kg per batch scale yielding approximately 1g of vinblastine sulphate for over 6-8 kg of dried leaves. The content of vinblastine sulphate varied depending upon the source of the leaves. Optimization at various stages of operation, viz., extraction, crystallization, purification and recovery of solvents was also carried out. The vinblastine sulphate was further purified to meet the specifications laid down in B. P. 1980.

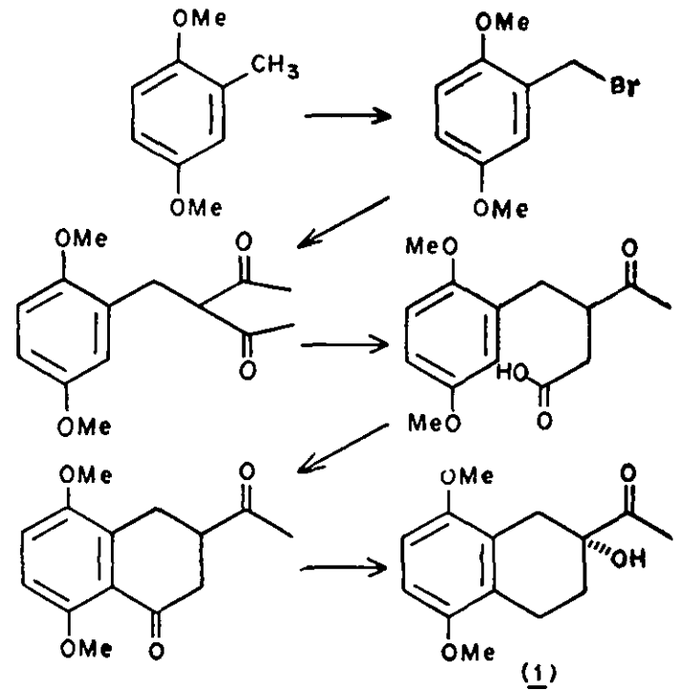
Vinblastine sulphate B. P. thus obtained was given to Hindustan Antibiotics Ltd. (HAL), Pimpri, Pune, for vial making. A trial batch of 600 vials, each containing 10 mg of vinblastine sulphate B. P. was prepared and tested by the Quality Control Department of HAL and found to meet all the specifications. Attempts are now being made to release the process to industry for commercial exploitation.

Several experiments were carried out for the conversion of vinblastine sulphate to vincristine sulphate with more than 60% conversion efficiency. Further purification of vincristine sulphate is being carried out.

### 3.2 Synthesis of anti-tumour anthracyclinones: (3-2-013-Sp)

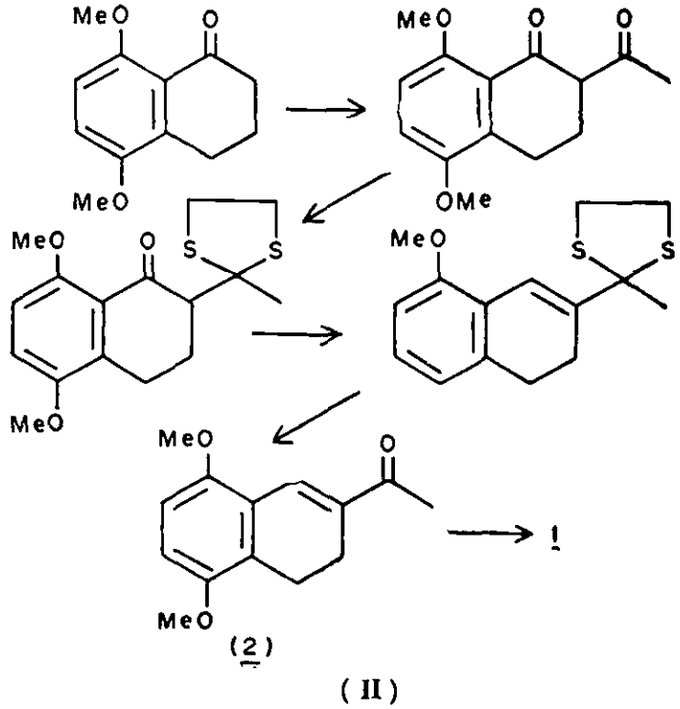
In continuation of the programme of work on the synthesis of (±) 2-acetyl-2-hydroxy-5, 8-dimethoxy-tetraline (1), which was elaborated to (±) 4-demethoxydaunomycinone, a novel and convenient alternative method for the synthesis of the key intermediate (1) was developed for large scale preparation starting from 2-methyl-hydroquinone (I). A patent has been filed on this approach.

Synthesis of 2-acetyl-5, 8-dimethoxy-3, 4-dihydro-naphthalene (2) was successfully achieved through a much shorter route and in better yields (II). Thus 2-acetyl-5, 8-dimethoxytetralone selectively protected with 1 equiv. of ethanedithiol and the resultant keto product reduced by $NaBH_4$ followed by acid work up and subsequent deketalization gave (2) in good yield. (2) can be smoothly converted to optically active

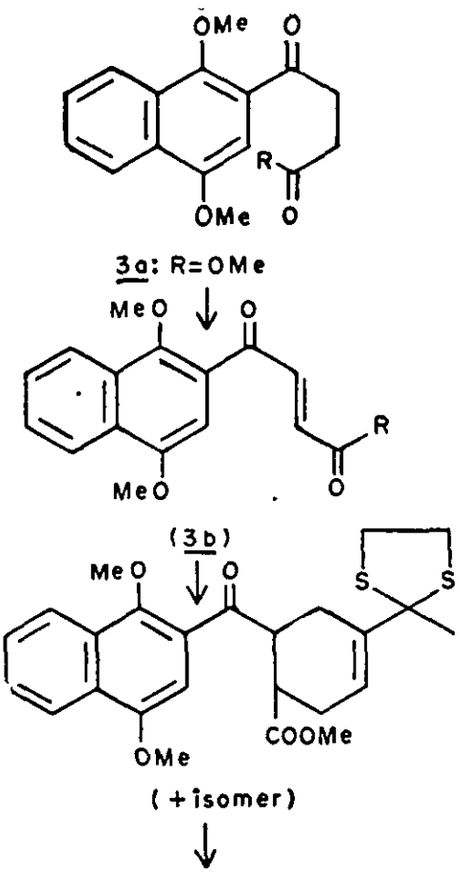



( I )

(R) (—)—(1). Further synthetic routes from (R) (—)—(1) to optically active anthracyclinones were also established.



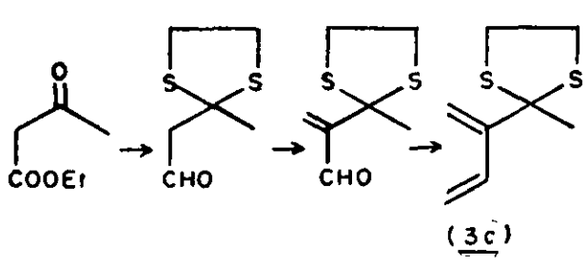

( II )




4-Demethoxydaunomycinone

(III)

Another convenient Diels-Alder approach for the synthesis of 4-demethoxydaunomycinone was completed starting from 1, 4-dimethoxynaphthalene (III). Condensation of 1, 4-dimethoxynaphthalene with succinic anhydride and esterification of the resultant keto-acid gave (3a). Bromination and dehydrobromination of (3) gave the desired dienophile (3b) which was subjected to D. A. reaction with the diene (3c). The diene (3c) was made starting from ethylacetoacetate as shown in (IV).




(IV)

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

A comparative study of the chloroform extracts of biba aged nuts versus fresh nuts revealed that the anticancer activity of the nuts deteriorates considerably with time. Several extracts/derivatives of biba were prepared and sent to the Cancer Research Institute and Haffkine Institute, Bombay, for anticancer and toxicity tests. Of these, two compounds monoene bhilawanol diacetate and diene bhilawanol diacetate showed border line activity against P 388 leukemia.

### 3.4 Antitumour agents — synthesis of nucleosides : (3-8-003)

There is considerable interest in the synthesis of nucleosides since some of the nucleosides are used as antiviral drugs.

Starting from theophylline a few nucleosides were prepared and one of them was sent to the National Institute of Virology, Pune, for testing its antiviral activity.

α-Ketoacids are useful intermediates for the synthesis of the C-nucleoside, showdomycin. The transformation of aldehydes to α-ketoacids by a new route was carried out earlier. A novel route for the synthesis of aliphatic as well as aromatic aldehydes, based on the fragmentation of homobenzylic alcohols on heating with lead tetraacetate, was developed. This route was found to be useful for transforming aliphatic as well as aromatic acids to the corresponding aldehydes. Methyl 3-keto-4-phenylbutanoate, an important intermediate for the synthesis of homobenzylic alcohols was prepared by a new route starting from the readily available methyl 4-ketophenylbutanoate.

### 3.5 Vitamin $B_6$ : (3-10-037)

The work on vitamin $B_6$ was initiated quite sometime back and a 12-step synthesis was first worked out based on the well known Harris-Folker method. Subsequently, a Diels-Alder approach utilizing 4-methyl-5-ethoxyoxazole and 4, 7-dihydro-1, 3-dioxapin was developed. Although the latter method initially appeared to be promising for commercial utilization, scale-up and other technoeconomic constraints led to suspension of further work on the process. However, on a recent comprehensive assess-

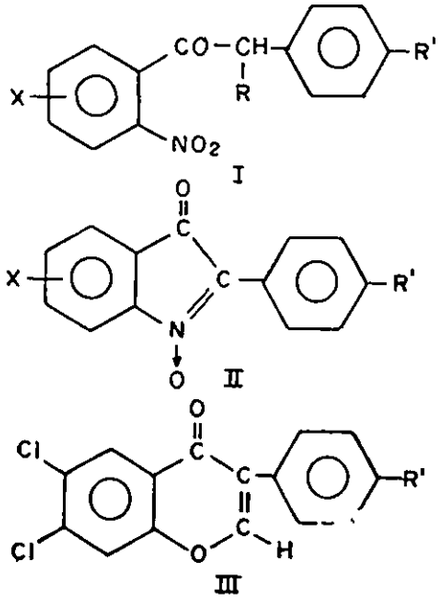
ment of the earlier work, it was felt that the development of an economically viable process for vitamin $B_6$ depended mainly on the synthesis of a suitable diene as well as a proper dienophile. Several substituted oxazoles were considered and finally a suitable oxazole was made and condensed with 4, 7-dihydro-1, 3-dioxapin to give pyridoxine hydrochloride through simple operations. Various parameters at every stage were studied and the entire process was optimized on laboratory scale.

All the intermediates required for the synthesis are indigenously available except 2-butene-1, 4-diol which is at present imported. It is understood that even this intermediate will be made by HOC in the near future. Attempts are being made to carry out pilot plant experiments before the project is released for commercial exploitation.

### 3.6 Basic studies

#### 3.6.1 *o*-Aminophenyl/arylalkyl ketones and their derivatives : (0-7-003)

As indicated in the previous report, the penultimate $\beta$-ketoaldehydes (I, R=CHO) showed better antitubercular activity than the corresponding isatogens (II). During the year $\beta$-ketoaldehydes reported earlier were screened and isatogens having 5, 6-dichloro and 5-chloro substituents were prepared. Chlorine substituted isatogens (II) did not show good activity, while the penultimate compounds showed good activity.




The best activities of ( I, R=CHO) were 1.56 $\mu$g/ml (I, R = CHO, X = 5, 6-dichloro and R' = *p*-Me), 3.12 $\mu$g/ml (I, R = CHO, X = 5, 6-dichloro and R' = H or OMe) and (I, R = CHO, X=H, R'=$CH_3$, Cl, $OC_4H_9$, $OC_5H_{11}$). This enhanced activity could be attributed to the metal complexing property of these $\beta$-ketoaldehydes. In the dichloro series during isatogen formation by the base catalyzed deformylation of $\beta$-ketoaldehydes (I,R=CHO) almost 50% of the product contained isoflavanone structures (III) formed by the displacement of the *o*-nitro group.

Basic studies indicated compounds of the type I (where R=H) could be prepared by acid catalyzed deformylation of $\beta$-ketoaldehydes (I, R=CHO). Moderate yields were obtained of ± (R=H) where (1) X=R'=H, (2) X=H, R'=Me, (3) X=H and R'=3, 4-dimethoxy. Further work on cyclization of these to 4-benzylquinazolines along with nitration studies of deoxybenzoins having one ring activated is in progress.

#### 3.6.2 Photochemistry of organic compounds :

The photochemistry of the carbon-halogen bond is of current interest and a number of new developments which are important from the theoretical as well as synthesis points of view had taken place in the last decade. Though the ground state reactions of $\alpha$-haloketones had been extensively studied, their photochemistry remained unexplored. During the year the photochemistry of some $\alpha$-halocyclohexanones in cyclohexane was investigated and it was found to involve competing radical and ionic photoreactions. The principal photoprocess observed was the homolytic $\beta$-cleavage of carbon-halogen bond to give radical products along with some ionic products. Photo Favorskii type ring contraction was found to be completely absent. Sensitization and quenching studies showed that radical cleavage occurred from $n—\pi^*$ triplet states whereas ionic cleavage could be a singlet derived reaction, thus providing for the first time an experimental support in favour of Wagner-model.

### Publications

1. Rama Rao, A. V., Deshpande, V. H. and Laxma Reddy, M.,
A simple synthesis of (±) 4-demethoxydaunomycinone,
*Tetrahedron Letters*, **21**, 2661 (1980).

2. Kale, K. V. and Kulkarni, S. N.,
Formation of 2-phenylimino-3-(8-ethoxy-5-quinolyl)-4-thiazolidinone in the reaction between an unsymmetrical thiourea containing quinoline nucleus and ethyl bromoacetate,
*Ind. J. Chem.*, **19B**, 152 (1980).

3. Phadtare, S. K., Kamat, S. K. and Panse, G. T.,
Synthesis of pyrazoline, quinazolone and quinolone derivatives,
*Ind. J. Chem.*, **19B**, 212 (1980).

4. Sinha (Mrs.), B. and Pansare, V. S.,
Anhydrous cupric sulphate-catalyzed synthesis of glycosides,
*Ind. J. Chem.*, **19**, 825 (1980).

5. Sahasrabudhe, A. B., Kamath (Mrs.), H. V., Bapat, B. V. and Kulkarni, S. N.,
Antitubercular agents Part III : Synthesis of substituted 2-aryl isatogens,
*Ind. J. Chem.*, **19B**, 230 (1980).

6. Rama Rao, A. V., Venkatswamy, G. and Yemul, S. S.,
Novel polyisoprenylated benzophenones from *G. xanthochymus*,
*Ind. J. Chem.*, **19B**, 627 (1980).

7. Rama Rao, A. V., Bhide, K. S. and Mujumdar, R. B.,
Phenolics from the bark of *Chloroxylon swietenia* DC Part-II,
*Ind. J. Chem.*, **19B**, 1046 (1980).

8. Rama Rao, A. V., Bhide, K. S. and Mujumdar, R. B.,
Mahanimbinol,
*Chem. and Ind.* (*London*), 697 (1980).

9. Shankaran, K. and Rao, A. S.,
A convenient route for the preparation of aromatic aldehydes,
*Synth. Commun.*, **10**, 573 (1980).

10. Purohit, P. C. and Sonawane, H. R.,
Photochemistry of $\alpha$-haloketones I,
*Tetrahedron*, **37**, 873 (1981).

11. Rama Rao, A. V. and Vaidyanathan, A.,
The 1H NMR spectrum of benzanthrone,
*Spectrochimica Acta*, **37A**, 145 (1981).

12. Rama Rao, A. V., Deshmukh M. N. and Sivadasan (Mrs)., L.,
A simple procedure for the preparation of methyl esters,
*Chem. and Ind.* (*London*), 164 (1981).

13. Rama Rao, A. V., Deshmukh, M. N. and Kamalam (Miss), M.,
A convenient synthesis of 1-triacontanol,
*Tetrahedron*, **37**, 227 (1981).

14. Arur, P. V. and Kulkarni, S. N.,
Antitubercular agents Part IV : Synthesis of new thiourea derivatives containing diphenylsulphide 2-carboxylic acid and thiaxanthene-9-one moieties,
*Ind. J. Chem.*, **20B**, 50 (1981).

15. Ghatge, B.B., Kulkarni, S. N. and Kadam, A. N.,
Preparation of $\beta$-aryl-γ-aroylbutyric acids : Attempted synthesis of hydantoin analogues,
*J. Ind. Chem. Soc.*, **58**, 90 (1981).

16. Bhat, K. S. and Rao, A. S.,
Preparation of rearrangement of *cis*-methyl 3, 4-epoxy-4-(4'-methylphenyl) butanoate,
*Ind. J. Chem.*, **20B**, 355 (1981).

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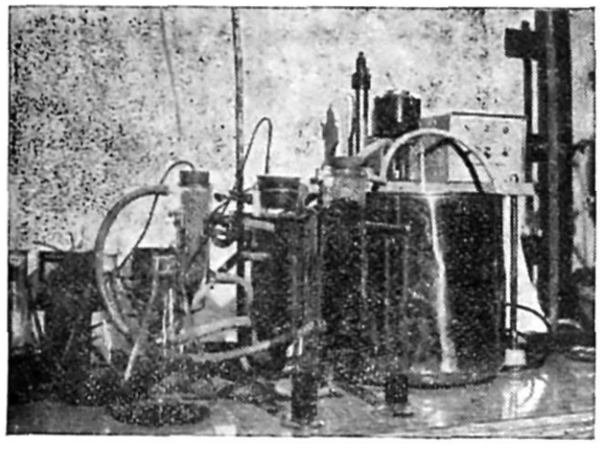
## 4. ENZYME ENGINEERING AND FERMENTATION TECHNOLOGY

### 4.1 Immobilized enzyme and microbial whole cells : (4-1-167-i)

**4.1.1 6-APA/Ampicillin production :** Conditions for rapid hydrolysis of benzyl penicillin with immobilized penicillin acylase and improved recovery of 6-APA were established in collaboration with Hindustan Antibiotics Ltd., Pimpri, Pune. The effect of chemical modifications on the enzymatic activity of penicillin acylase purified from *Kluyvora citrophila* was studied.

**4.1.2 Immobilized whole cells :** Immobilization of whole cells with urethane prepolymers was taken up for study. Yeast cells immobilized as films on nylon or stainless steel screens were reused repeatedly for ethanol production. Glucose at 16% was found to ferment almost quantitatively. The fermentation of molasses to acetone-butanol by free as well as immobilized cells of *Clostridia* strains is being studied.



Lab. set-up of immobilized yeast cells for fermentation

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

Study of the kinetic parameters determination through time course of enzyme reactions is an important field of research in enzyme kinetics. Theoretical investigations showed that care has to be exercised when using modified double reciprocal plots and under certain circumstances, integrated kinetic expressions must be used. Studies were carried out on the effect of external film mass transfer on the apparent kinetic parameters in packed bed immobilized enzyme reactors and a generalized theoretical treatment was developed which would enable predictions of true kinetic parameters from experiments influenced by external mass trasfer.

### 4.3 Vacuum fermentation of molasses to ethanol : (4-1-167-iii)

Preliminary laboratory investigations were carried out on a modification of the vacu-ferm process involving application of vacuum only to the liquid containing ethanol and subsequent flashing. This procedure has distinct advantages, viz., the elimination of compression of carbon dioxide evolved during fermentation and the possibility of obtaining higher yields of ethanol. Pilot plant experiments on using the flash-ferm process are being planned.

### 4.4 Basic studies

**4.4.1 Basic studies on enzyme structure and function :** Studies on structure-function relationships in *Klebsiella aerogenes* citrate lyase complex were continued. *p*-Azidobenzoyl-CoA was used as a photoaffinity label and the reagent was shown to bind specifically to the active site of the lyase subunit. The reagent had no effect on the acyl transferase activity both in the complex as well as in the isolated subunit. $^{14}$C-labelled reagent was used for titration of the lyase active sites by covalent binding after photolysis. These experiments have established for the first time that the citrate lyase complex has 6-lyase active sites, all amenable to acyl-CoA mediated cleavage of citrate.

The enzyme complex of *Escherichia coli* was shown to have a unique quaternary structure with a single large ACP subunit in association with 6-acyl transferase and 6-acyl lyase subunits.

### Publications

1. Karanth, N. G. and Srivastava, A. K.,
Use of modified double-reciprocal plot for enzyme kinetic parameters — A pitfall,
*Biochemical et Biophysika Acta*, **615**, 279 (1980).

2. Karanth, N. G. and Manchanda, A. C.,
Useful sparger arrangement for fermentations involving heavy mycelial suspensions,
*Biotech. Bioeng.*, **22**, 1985 (1980).

3. Sadana, A., Kulkarni, B. D. and Ramachandran, P. A.,
Criteria for multiplicity in complex bio-chemical reactions,
*Chem. Eng. Commun.*, **7**, 389 (1980).

4. Sadana, A.,
A deactivation model for immobilized and soluble enzymes,
*Biotech. Letters*, **2(6)**, 279 (1980).

5. Karanth, N. G.,
Some observations on the similarity of batch and plug flow systems as applied to enzyme reactors,
*Biotech. Bioeng*, **23**, 225 (1981).

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## 5. EQUIPMENT DESIGN AND DEVELOPMENT

### 5.1 Regular packing development : (15-1-006)

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

Work on the erection of a pilot plant distillation rig with a 20 cm diameter column with accessories like reflux drum condensers and heat exchangers was taken up.

### 5.2 Basic studies

#### 5.2.1 Mass transfer : (0-25-006)

Investigations on gas-liquid reactions in packed columns and packed trickle bed columns were continued to facilitate the preparation of rational models for design purposes.

### Publications

1. Patwardhan, V. S.,
Gas liquid reactions in packed trickle beds : Regimes of reaction in the static hold up,
*Canad. J. Chem. Eng.*, **58**, 454 (1980).

2. Patwardhan, V. S.,
Enhancement factor in gas liquid reactions in presence of significant gas side mass transfer resistance,
*Chem. Eng. Sci.*, **36**, 222 (1981).

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## 6. FLUIDIZATION

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

A research scheme on 'Design and modelling of fluid-bed reactors' was undertaken with the objective of investigations on a relatively unexplored but very important aspect of providing a theoretical base for modelling the industrial reactors.

The results accomplished include the analysis of fluid-bed reactors for a variety of complex reactions which, in combination with each other or with appropriate simplifications, would provide the basic methodology for handling a variety of common types of complex reactions encountered in industries. The associated problem of reactor optimization with respect to selectivity for a complex reaction network was satisfactorily solved by invoking dilution of the reactor and temperature profiling using staged bed reactors. The complications arising out of high exothermicity, such as multiplicity, instability, etc., were appropriately modelled and criteria were evolved to avoid such regions. The work in this area has led to the development of a simple, yet rigorous, model for describing the fluid-bed.

**Publications**


1. Irani, R. K., Kulkarni, B. D. and Doraiswamy, L. K.,
   Analysis of fluid-bed reactors for reactions involving a change in volume,
   *Ind. Eng. Chem. Fundam.*, **19**, 424 (1980).
2. Kulkarni, B. D. and Patwardhan, V. S.,
   Selectivity in complex reactions in fluidized-bed reactors : The effect of temperature,
   *Chem. Eng. J.*, **21**, 195 (1980).
3. Irani, R. K., Jayaraman, V. K., Kulkarni, B. D. and Doraiswamy, L. K.,
   Optimal production of intermediate for zero-first and first-first order reaction sequences in a fluidized-bed reactor,
   *Chem. Eng. Sci.*, **36**, 29 (1981).


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## 7. MATERIALS SCIENCE

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

**7.1.1 Solar thermal materials :** A solar selective molybdenum black film with a high solar absorptance coupled with a low emittance in the thermal IR region was prepared through an electrolyte technique, which made the preparation of large area collector surface easy. These films were non-crystalline as found by X-ray analysis. The surface morphology was examined with a Scanning Electron Microscope. Elemental analysis of these films was done by the energy dispersive X-ray analysis. The X-ray photo-electron spectroscopic data were also collected. These analyses revealed that the film was basically an amorphous $MoO_3$ containing traces of copper The reflectance measurement showed a cut-off at 3·5 microns. The total adsorptance ( $\alpha$ ) over the solar spectrum region and the emittance ( $\epsilon$ ) were calculated from the experimental data as follows :

| Temp°K | $\alpha$ | $\epsilon$ | $\alpha/\epsilon$ |
|---|---|---|---|
| 300 | 0.85 | 0.11 | 7.7 |
| 373 | 0.85 | 0.32 | 2.6 |

### 7.2 Thick film materials : (7-5-004)

Palladium powder was prepared in large quantities following the procedure optimized and reported earlier. A few glass compositions, specially required for Pd-Ag conducting paste were formulated, melted, fritted and milled to 1-$\mu$ particle size. The first paste formulated using one of the above glasses was screen printed on alumina substrates. The prints were fired at 800, 850 and 900°. The initial results with reference to conductivity, adherence and solderability were very encouraging. Special stencils were made to print 1 mm × 228 mm labrynth structures, 2 mm squares, 5 mm × 10 mm rectangles for conductivity, bondability and solderability tests. The line resolution for 1 mm lines (0.5 to 1 mm interspace) was good. The $\rho_s$ varied from 0.04 to 0.09 $\Omega$/ sq. The palladium-silver ratio was changed from 10 : 90 to 50 : 50 in order to examine its effect on the electrical conductivity. The paste formulations were printed on $Al_2O_3$ substrates using 250 and 300 mesh number

stencils. The peak firing temperature varied from 600 to 900°. $\rho_s$ decreased with the increase in firing temperature and decrease in mesh number for every formulation. Also, the $\rho_s$ increased with the increase in palladium content.

An adhesion test unit was fabricated to measure the bonding/soldering strength of the print. A load upto 5 kg could be applied.

**7.2.1 Thick films of CdS :** In the context of the programme of work on thick films of CdS reported earlier, it was felt that chemisorped oxygen might be influencing the overall photoelectronic behaviour of the CdS films. The conductivity measurements were therefore carried out during oxygen chemisorption-desorption cycles. X-ray diffractograms taken on various doped CdS films were studied. The results showed the presence of mixed phases of cubic and hexagonal for the undoped films and hexagonal phase for the doped films.

Cadmium sulphide powder, rich in cubic phase, was prepared in order to study the phase transformation from cubic to hexagonal in it. Both XRD and thermal analysis techniques were used for the purpose. The results are being studied.

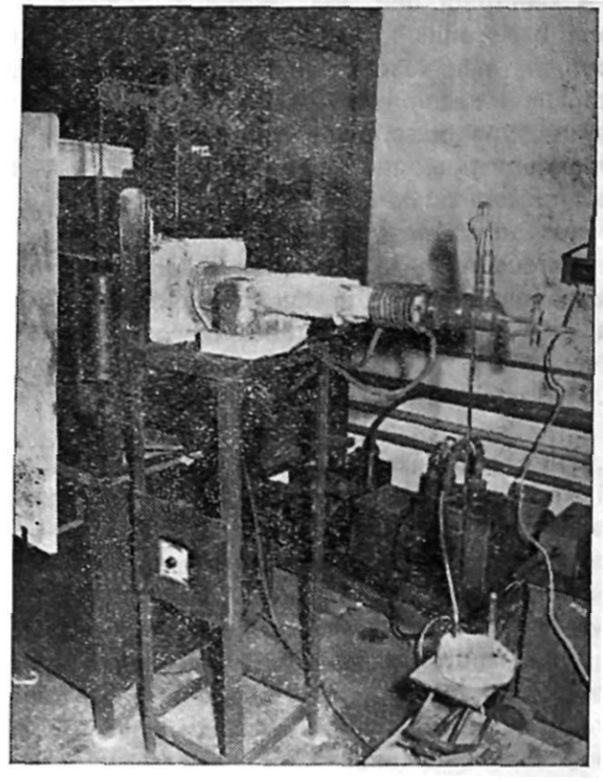
### 7.3 Ultrapure silicon : (7-6-004-Sp)

A two-rod reactor for deposition of hyperpure polysilicon on thin silicon rod was designed and fabricated. The reactor was made of a high purity quartz bell jar with arrangements to heat the rod by a high current power supply. Several runs were carried out to find out the deposition yield as function of the rod temperature, composition of the feed mixture, the rate of gas inlet, etc. The current, voltage and power requirements as the deposition progressed and the diameter increased were also experimentally determined. The effluent gases were condensed in liquid nitrogen and analysed by VPC. A full set of data was collected after varying all the process parameters.

After completing the studies on the quartz bell jar reactor, a larger stainless steel reactor was designed and fabricated. In this reactor deposition can be carried out on six thin rods simultaneously. It is designed to grow silicon rods of 50 cm length and 7.5 cm diameter.

The purity of silicon deposited in the above mentioned quartz bell jar was checked on a mass spectrometer at the Solid State Physics Laboratory, New Delhi. No boron could be detected at detection limit of 30 ppb.

### 7.4 High permeability ferrites : (7-3-004)



High permeability ferrites sintering unit

A very simple method of sintering high-permeability ferrites without any controlled atmosphere was worked out. The results were found to be highly satisfactory and reproducible. A process for making these ferrites on a laboratory scale (about 75g per batch of sintering) was standardized for commerical exploitation.

### 7.5 Rutilization of titanium dioxide : (7-7-004)

A thorough literature survey of the manufacturing procedures and techniques for rutile grade titanium dioxide-including its property, measurement and formulation-was carried out.

The hydrolysis route was chosen as an alternative to the burning of titanium tetrachloride vapours in hydrogen gas. The hydrolysis route was envisaged to study some of the parameters for the rutilization of titanium dioxide, i. e., to study the parameters that effect the preparation of titanium dioxide in its rutile crystalline modification in preference to the anatase or amorphous grade.

A semi-pilot unit was assembled comprising the three basic units : a vertical air jacketed silica tube form the main reactor tube, a preheater for heating titanium tetrachloride vapour to about 1000°, and a rosette type brass burner to premix titanium tetrachloride vapour and hydrogen gas and then burn the reactant mixture in the main reactor tube in excess dry air. A preheater was set up for anhydrous $AlCl_3$ to admit controlled doses of the vapour and to study the effect of doping concentration of $AlCl_3$ vapours in the rutilization of $TiO_2$ *in situ.*

### 7.6 Basic studies

**7.6.1** Ferrous oxide was stabilized with just a trace of $Fe_2O_3$ and employed successfully in the preparation of ferrous zinc ferrites. These ferrites are relatively novel and have been prepared only recently by very few other workers employing, however, very elaborate methods. It was also found that FeO and MnO could both be stabilized by solid solution in each other. In fact these two oxides were found to dissolve in each other giving a whole range of solid solutions from pure MnO to pure FeO. The solution was found to be ideal following Vegard's law as shown by a linear variation in the cubic lattice parameter with concentration.

The system MnO : ZnO rich in ZnO was also prepared and studied by X-ray powder diffraction and thermogravimetry. MnO dissolves in ZnO up to 15 mole % forming an ideal solution. MnO so dissolved resists oxidation in air up to 750°.

### 7.6.2 Ferro-electric ceramics, viscoelastic properties of polymers and adiabatic compressibility of macromolecules : (0-27-004)

Ferro-electric ceramics : Pb (Ti-Zr)$O_3$ ceramics were modified by the additions of small amounts of $Cr_2O_3$, $Co_2O_3$ and $U_3O_8$ and piezo electric properties of these modified ceramics compositions were studied. It was observed that the quantity of doping material has very little effect on the Curie temperature for $Cr_2O_3$ and $Co_2O_3$ doped compounds.

Adiabatic compressibility of macromolecules : The adiabatic compressibility of some polymers, viz., poly (acrylic acid) and poly (vinyl pyrrolidine) was studied in three different solvents and reported earlier. A similar study of copolymers prepared in combination with the same ionic and non-ionic polymers was carried out.

Viscoelastic properties of the polymers : The creep behaviour of butyl rubber solution in decalin from 0 to 100% concentration at various temperatures was studied. Measurement of viscosity at 30° to 110° by proper combination of capillary viscometer, Brookfield LVT viscometer and Weissenberg rheogoniometer was carried out.

### Publications


1. Amalnerkar, D. P., Setty, M. S., Pavaskar (Miss), N. R. and Sinha, A. P. B.,
   Studies on thick films of photoconducting CdS,
   *Bull. Mater. Sci.*, **2**(4), 251 (1980).

2. Krishna Murthy, G. S. R., Kapadia (Miss), V. V., Rao, V. J. and Sinha, A. P. B.,
   Theoretical performance of Back-illuminated thin film MIS Schottky Barrier solar cells,
   *Phys. Stat. Sol.*, **57**(a), 691 (1980).

3. Kale (Miss), M., Pavaskar (Miss), N. R. and Sinha, A. P. B.,
   Field effect studies on vanadium phosphate glasses,
   *Phys. Stat. Sol.*, **62**(a), 83 (1981).

4. Potdar, H. S., Pavaskar, (Miss), N. R., Mitra (Mrs.), A. and Sinha, A. P. B.,
   Solar selective copper-black layers by an anodic oxidation process,
   *Solar Energy Materials*, **4**, 291 (1981).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## 8. PEST CONTROL AGENTS

### 8.1 Synthetic pyrethroids : (8-1-037)

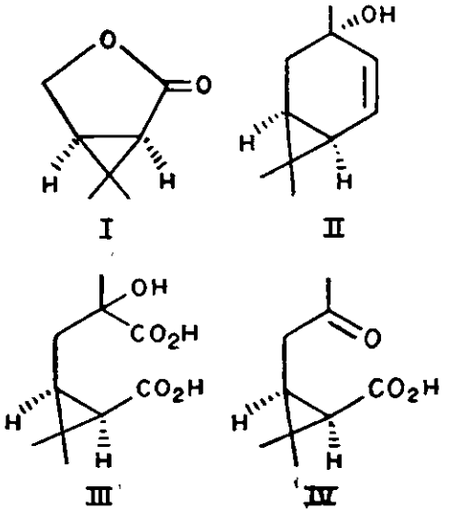
In continuation of the work on synthesis of photostable pyrethroids from indigenously available cheap and abundant (+) 3-carene, 3-phenoxybenzyl *dl-cis*-2,2-dimethyl-3-(2-chloro-2-phenyl prop-1-enyl) cyclopropane carboxylate was successfully synthesized. The above ester was found to show insecticidal activity.

The synthesis of two more methyl esters of cyclopropane carboxylic acids, viz., (1) methyl 1R *cis* 2, 2-dimethyl-3-(2-*p*-tolyl prop-1-enyl) cylcopropane carboxylate and (2) methyl 1R *cis*, 2, 2-dimethyl-3-(2-*p*-anisylprop-1-enyl) cyclopropane carboxylate was carried out from (+) 3-carene. Preparation of 3-phenoxybenzylesters from the above mentioned acids is in progress.

Methyl 1R *cis*, 2, 2-dimethyl-3-(2-phenyl prop-1-enyl) cyclopropane carboxylate and methyl (+) *cis*-chrysanthemate were synthesized by a new approach from (+) 3-carene.

Novel approaches for the preparation of methyl 1R *cis*, 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylate, an important intermediate in the synthesis of pyrethroid group of insecticides like Indothrin and other related insecticides from (+) 3-carene were also tried.

The synthesis of the γ–lactone of 1R *cis*-2, 2-dimethyl-3-hydroxymethyl cyclopropane carboxylic acid (I) was achieved starting from the above keto acid. The lactone is an important intermediate for the synthesis of methyl 1R *cis*, caronaldehyde ester from which 1R *cis* pyrethroids such as decamethrin can be prepared.




An improved procedure for the synthesis of Indothrin was developed and adopted for making larger quantities. This involved the oxidation of the known alcohol (II) to the hydroxy dicarboxylic acid (III) and its further oxidative decarboxylation to the crucial keto acid intermediate (IV) for Indothrin.

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

Considerable effort was made for the development of a commercially exploitable fraction from neem seed extract for oviposition deterrent activity against potato tuber moth. Simulated godown trials for protection of potatoes were carried out under different storage conditions. Considerable amount of the requisite fraction was prepared for actual field and storage trials at Rajgurunagar. The process involving extraction and fractionation of neem seeds was internally demonstrated to facilitate scale-up studies for development of eventual commercial process. While one other fraction was found to exhibit antifeedant activity, another inactive fraction was found to be suitable for soap making.

The screening results of a large number of other plant extracts showed that 45 of them exhibited some activity or the other giving a total of about 100 leads. Considerable follow-up work by way of separation into enriched fraction and/or pure compounds, was carried on ten selected plants where the level of activities was most promising. Three of these showed insecticidal, two repellent, two oviposition deterrent, two juvenile hormonal and one each ovicidal and antigonadial activities. During these fractionations a number of pure compounds such as flavones, chromones, sterols and unsaturated long chain acids were isolated, some of which were also fully characterized. A few of them were found to be new.

About 50 new plants were collected and extracts from some of them will be screened.

In the field of pheromonal compounds, the synthesis of Z7-12 Ac, Z9-14 Form, Z9-14 Ac and Z11-16 Ac was completed and the compounds were sent to IARI, New Delhi, for evaluation. Synthesis of Z7-16 Ac (Hexalure) is under progress.

### 8.3 Microencapsulation : (8-5-3456)

#### 8.3.1 Microencapsulation of carbofuran :

Experimental conditions for the complete encapsulation of carbofuran by cross-linked polyvinyl alcohol were standardized on a bench scale with a maximum carbofuran content of 70% in the product. Work was initiated on using crosslinked starch xanthate as the alternate cheaper polymer matrix for encapsulation of carbofuran. Conditions could be standardized for this system also with a maximum carbofuran content of 70%. Two different crosslinking agents, viz., nitrous acid and hydrogen peroxide were employed for this system and complete encapsulation could be obtained with both.

Study of the release rate of the different encapsulated products based on polyvinyl alcohol and starch xanthate in pure water, was undertaken using UV absorption at 275 nm for measuring the concentration of the pesticide released. The rate of release was observed to be very much reduced by encapsulation. Whereas it took from 6 to 7 days for 70% of the pesticide to be released from the encapsulated product, it usually takes less than 4 hours for the non-encapsulated pesticide.

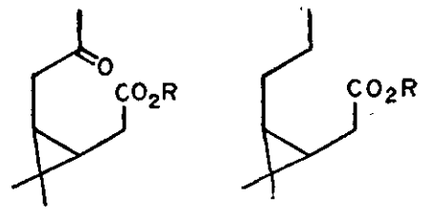
#### 8.3.2 Controlled release aquatic herbicide :

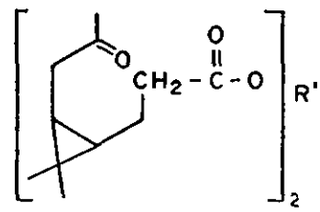
After the instrumental analysis of samples containing 10, 30 and 50 percent herbicide, it was confirmed that the release rate of 2, 4-D BEE from the natural rubber matrix was independent of the concentrates of the herbicide present in the formulation. However, the quantity of BEE present in the matrix determined the longevity of the release of BEE into the medium.

Based on the studies of the release rate, longevity of the release and the processibility conditions, 4 kg of the matrix containing 30% of 2, 4-D BEE was prepared for use in the laboratory experimental tanks of 450 litres capacity.

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

In continuation of previous work four more compounds were prepared for evaluating miticidal activity :




$R = -CH_2-C_6H_4OC_6H_5(m)$;
$-(CH_2)_{10}OH$

$R' = -(CH_2)_{10}-$

According to bioassay reports from United Planters Association of South India one of the aromatic derivatives was found to show pronounced activity against purple mites and pink mites comparable to Kelthane. This compound was prepared in larger quantities and given for field trials.

Further work on screening of more compounds is in progress.

### Publications


1.* Mane, B. M., Gore, K. G. and Kulkarni, G. H., Epoxidation of dehydration products of carane 3-$\beta$-hydroxy-4 $\alpha$-acetate, *Ind. J. Chem.*, **18B**, 395 (1979).

2.* Pai, P. P., Joshi, G. D., Gore, K. G. and Kulkarni, G. H., Epoxidation of 4-substituted car-2-ene derivatives, *Ind. J. Chem.*, **18B**, 549 (1979).

3.* Pai, P. P., Mane, B.M., Joshi, R. S. and Kulkarni, G. H., Allylic oxidation of (+) car-3-ene, *Curr. Sci.*, **48**, 155 (1979).

4. Bhat, N. G., Pai, P. P. and Kulkarni, G. H., Some minor products of Prins reaction of (+) car-3-ene,
*Ind. J. Chem.*, **19B**, 316 (1980).

5. Patwardhan (Mrs.), S. A. and Gupta, A. S., Unimolecular gas phase decomposition of some 4-oxafarnesane derivatives,
*Ind. J. Chem.*, **19B**, 398 (1980).

6. Mane, B. M., Gore, K. G. and Kulkarni, G. H., Stereospecific conversion of (+) car-3-ene into (+) dihydrochrysanthemo lactone and methyl (+) *cis* chrysanthemate,
*Ind. J. Chem.*, **19B**, 605 (1980).

7. Mane B. M., Pai, P. P. Kulkarni, G. H. and Mitra, R. B.,
Synthesis of methyl 1R *cis* 2, 2-dimethyl-3-(2-phenyl prop-1-enyl) cyclopropane carboxylate,
*Ind. J. Chem.*, **19B**, 710 (1980).

8. Mane, B. M., Gore, K. G. and Kulkarni, G. H., Stereospecific conversion of (+) car-3-ene into methyl 1S (+) *cis* and methyl 1R (—) *trans* 2, 2-dimethyl-3-(2, 2-diphenylvinyl) cyclopropane carboxylates,
*Ind. J. Chem.*, **19B**, 711 (1980).

9. Bhat, N. G., Pai, P. P. and Kulkarni, G. H., Some interesting oxidation products of 3, 7, 7, trimethyl, 4-hydroxymethyl (4, 1, 0) -bicyclo-hept-2-ene,
*Chem. and Ind.*, 94 (1981).

10. Bhat, N. G., Mane, B. M., Kulkarni, G. H. and Mitra, R. B.,
Synthesis of methyl 1R (+) *cis* chrysanthemate and methyl 1S (+) *cis*-2,2-dimethyl-3-(2-phenyl prop-1-enyl) cyclopropane carboxylate from (+) car-3-ene,
*Ind. J. Chem.*, **20**, 204 (1981).

11. Sharma, R. N., Joshi (Miss), V. N., Zadu (Miss), G., Bhosle, A.S., Gupta, A.S., Patwardhan (Mrs.), S. A. and Nanda, B.,
Oviposition deterrence activities of some lamiaceae plants against insect pests,
*Z. Naturforsch*, **36C**, 122 (1981).

* These papers were not reported in the earlier annual reports.

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## 9. PLANT TISSUE CULTURE

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

#### 9.1.1 Virus free plants

**Banana :** A process was developed for the isolation of virus-free banana plants by shoot tip culture. The problem was undertaken to obtain from the banana variety Robusta plants free from bunchy top virus, a disease now prevalent extensively in Maharashtra. This work is being carried out in collaboration with the Banana Research Station, Yawal.

#### 9.1.2 Isolation of mutants

(a) **Turmeric :** Two mutants with rhizome curcumin contents twice as high as controls were isolated by regeneration of callus cultures treated with colchicine. The mutants will be screened in the field to determine the yield and stability of this character.

(b) **Wheat :** Fifth generation trials were carried out on wheat plants raised initially by tissue culture. Results indicate a gradual stability of the yield and grain quality in this generation. Ten selections were made for bulk trials during the next year.

#### 9.1.3 Embryo culture

(a) **Papaya :** Plants of fourth generation showed a high degree of tolerance to the virus. Field trials are in progress at the College of Agriculture, Pune.

#### 9.1.4 Clonal multiplication

(a) **Teak and eucalyptus :** Two hundred plants were supplied to the Forest Development Corporation of Maharashtra (FDCM), Nagpur, for field trials. Observation data supplied by the FDCM showed that the plant growth was good.

In eucalyptus trials conducted with plants raised from 20 years old trees, early flowering after two years was observed.

(b) **Pomegranate and Cardamom :** A method was developed for obtaining high rates of multiplication from two varieties of pomegranate (Muscat and Ganesh), which are normally propagated by air

layering at a slow rate. A method was also standardized for two good varieties of cardamom (Malabar and Vazhukhai), supplied by the Cardamom Board, Kerala.

### 9.2 Basic studies

**9.2.1 Protoplasts** : Conditions were standardized for the isolation of protoplasts in large numbers for *Eucalyptus, Phaseolus aconitifolius* and *Phaseolus aurous*. Conditions for callus regeneration are being studied. Differentiation of shoot apices and cotyledous was also obtained from *P. aconitifol* seedlings.

**9.2.2 Cloning** : Preliminary data on the fraction isolated from the plant extract, which enhances cloning of apple cells at low plating density, indicated its complex nature. Work on these factors is being continued.

### Publications

1. Mascarenhas, A. F., Barve (Mrs.), D. M. and Jagannathan, V.,
Plant tissue culture and the rose industry,
*The Indian Rose Annual,* 136 (1980).

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## 10. POLYMER SCIENCE AND ENGINEERING

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

The following special projects were initiated during the year :

**10.1.1 MFI/rheology correlation** : The rheological data required for the design of processing equipment are normally obtained on expensive sophisticated instruments, whereas an industrial processor usually has access only to the melt flow index determined by inexpensive MFI apparatus. MFI is a single point measurement and does not provide data on the flow characteristics over the temperature and shear rate. Investigations on a wide variety of industrial polymers were undertaken to establish this relationship.

**10.1.2 Recycling of plastics** : Quantitative guidelines can be provided to the processors for the level of recycle waste that can be mixed with the virgin polymer without adversely affecting the properties. This can be done by first studying the extent of polymer degradation through properties of mixed virgin/waste samples as a function of composition. Work on this concept was initiated.

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

**10.2.1 Simulation and modelling of polycondensation reactors** : The estimated production of PET fibre in the country is likely to reach 100 thousand TPA in the next few years. There is scanty information on the modelling of polyethylene terephthalate reactors which is very crucial in providing valuable insights into the methods of improvement of productivity and product quality. The present programme of modelling was continued and work on modelling of semi-batch and continuous transesterification, esterification, pre-polymerization and polycondensation reactors was completed. A simple engineering model for the last process of melt polycondensation was effectively tested with industrial data.

**10.2.2 Recycle loop reactor development for copolymerization** : The objective of this research was to develop new configuration to produce polymers with narrow composition sequence length

distribution. Kinetic experiments were undertaken in a batch reactor with a view to provide inputs to the design of a recycle loop reactor. Computations were undertaken which indicated the existence of multiple steady state in a continuous styrene acrylonitrile copolymerization reactor.

**10.2.3 Continuous interpolymer membrane film process :** In order to develop a continuous process for the preparation of interpolymer membrane (HDPE, styrene and DVB) which will be subsequently utilized in electrodialysis, the continuous process concept proposed by NCL was tested on a laboratory scale screw extruder. The technical feasibility of this concept was successfully demonstrated. The interpolymer samples made by *in situ* polymerization of styrene in molten HDPE in the Brabender batch mixer gave films with uniform properties. Optimization of process and operational variables is being undertaken.

### 10.3 Polyphenylene sulphide : (10-4-567)

Polyphenylene sulphide is a new engineering plastic with remarkable mechanical, chemical and thermal properties. A laboratory scale process using a new co-solvent system was successfully completed. Work related to optimization of process parameters, recovery of solvents and application development with specific reference to coating was also undertaken.

### Publications


1 Mashelkar, R. A.,
Chemical engineering problems of rheologically complex fluids,
*Rheology I Plenum, NY, Eds. Astarita, G., Marrucci, G. and Nicolais, L.,* 219 (1980).

2. Mashelkar, R. A. and Marrucci, G.,
Anomalous transport phenomena in rapid external flows of viscoelastic fluids,
*Rheol. Acta,* **19,** 426 (1980).

3. Navin Chand,
Studies in surface anisotropy of PET fibres by ESCA,
*Proc. International Conference on Structure Property Relations of Rubber,* IIT, Kharagpur (1980).

4. Navin Chand,
XPS study of drawn PET fibres,
*Popular Platics,* **3,** 6 (1981).


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## 11. POLYMER SYNTHESIS AND MODIFICATION

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

The preparation of microcellular flexible polyurethane elastomer on laboratory scale was carried out. Various types of high molecular weight polyhydric compounds such as polyethers and polyesters were employed with isocyanate resin for the preparation of the polyurethane rubber.

Adequate expertise was gained in the preparation of micro-cellular rubber. Standardization of the conditions for the preparation of urethane elastomer, involving various parameters was studied. Several mouldings of the soles and sheets were made and the physical properties of the rubber such as shore 'A' hardness, density, tensile strength, tear strength and abrasion properties were evaluated.

Further developmental work on polyurethane rubber is in progress.

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

This project was taken up in collaboration with the Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar. Modified cellulose acetate polymers prepared at the NCL were tested at the CSMCRI for membrane preparation and desalination studies on small scale. The results were found encouraging. Large scale preparation of modified cellulose acetate polymers will be taken up for further evaluation at CSMCRI.

Polybenzimidozole type of polymers were also under study.

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

Ring opening polymerization of cyclo-olefins using typical olefin metathesis-catalysts is relatively new. Several cyclo-olefins which resisted ring opening polymerization by conventional polymerization techniques have been polymerized during 1970s, by using metathesis-catalysts. These catalysts essentially consist of a transition metal compound along with a base metal alkyl. The preferred transition metals

are heavy metals like tungsten, molybdenum and rhenium. Polymers of nonborrene, cyclo-octene and cyclo-pentene are reported to have reached the commercial stage. Polymers obtained from ring opening polymerization of cyclo-olefins offer many interesting aspects, especially structure-property relationships.

Preliminary experiments were carried out using $\Delta^3$-carene, a naturally occurring bicyclic-olefin as the monomer, and $WCl_6$-$AliBu_3$ catalyst system. Ring opening polymerizations were obtained with about 25% conversions. However, the molecular weights were low.

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

In connection with the development of know-how on the production of lower molecular weight hydroxy terminated polybutadiene, preparatory work on the study of polymers that are suitable as binders in propellants was taken up using different initiator systems.

### 11.5 Basic studies

#### 11.5.1 Polymer characterization : (0-22-005)

One more sample of polyacrylamide was synthesized and hydrolyzed to different extents. Viscosity and light scattering measurements were carried out on the hydrolyzed samples. The viscosity, osmotic pressure and light scattering data for six series of hydrolyzed polyacrylamides with differing levels of hydrolysis but constant backbone length were evaluated in the light of modern theories on macroion expansion coefficient. The number-average and weight-average molecular weights for each series showed that the main chain degradation was prevented under the conditions of hydrolysis employed. The electrostatic expansion coefficient obtained with polyacrylamide as the reference molecule showed that none of the existing theories on macroion expansion coefficient was satisfactory. However, treating the total expansion as due to electrostatic interactions alone, the data were in qualitative agreement with the theory of Chien-Ishihara [J. Polym. Sci. Poly. Phys. Ed. 14, 1015 (1976)]. As electrostatic expansions are generally treated as long-range interference effect, in view of the observed effect of charges on the short-range interference effect the Chien-Ishihara theory is in agreement only at low charge densities.

#### 11.5.2 Thermochemistry and thermodynamics of monomers and polymers : (0-24-005)

A large amount of thermochemical, spectroscopic and structural data on over 400 nitrogen compounds was searched, evaluated, selected and correlated on the basis of bond-additivity principle of computing the total chemical binding energy, thermochemical bond energy and other thermodynamic properties. The work has been successfully accomplished with confidence limit of $\pm 3$ kcal/mole in predicting the energy of a molecule or a polymer repeat unit containing nitrogen, as also for a vast array of nitrogen aromatic heterocyclics and azoles. Over 90 transferable bond energy terms of typical bonds were identified.

### Publications


1. Gunari, A. A. and Gundiah, S.,
   Kinetics of alkaline hydrolysis of polyacrylamide in solution by viscometric technique,
   *Makromol. Chem.*, **182**, 1 (1981).

2. Raghunath, D.,
   Flowed—in gasket,
   *Popular Plastics and Rubber*, **XXVI** (5), 5 (1981).


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## 12. PROCESS DESIGN

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

A complete computer programme for simulation of multicomponent distillation was developed. The programme is also capable of handling complex situations such as azeotropic and extractive distillation. The programme was used to design the recovery systems for ethylenediamine plant to be set up at Baroda by Diamines and Chemicals.

Methods were developed for the design of semi-batch and continuous three phase reactors. A key feature of this work is that the programmes can handle non-linear kinetics without running into excessive computational difficulties.

### 12.2 Project designs : (12-2-067)

Process design packages for (i) titanium tetrachloride (ii) ethylene dichloride, (iii) terpineol (revised), (iv) ethylenediamine and final process report including detailed process design of product-recovery system were completed.

Feasibility reports for ethylene oxide and ethylene dichloride starting from alcohol were prepared. Follow-up work on acrylates, endosulfan and methylchlorosilanes was undertaken. Work on commissioning of endosulfan was done and a 400 TPA plant was successfully installed at Bharat Pulverising Mills, Bombay. The pilot plant erected at NCL for terpineol was commissioned and the performance of this plant was found to meet the design specifications.

#### Publications


1. Ramachandran, P. A. and Chaudhari, R. V., Predicting performance of three phase catalytic reactors,
   *Chem. Eng.*, **87**, 75 (1980).


#### Review articles


1. Chaudhari, R. V. and Ramachandran, P. A., Three phase slurry reactors,
   *AIChE. J.*, **26**, 177 (1980).


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## 13. PREPARATIVE INORGANIC CHEMISTRY

### 13.1 Sodium hydrosulphite : (13-2-002)

It was observed that iron powder of suitable purity and mesh size could be used as a substitute for zinc in the formation of hydrosulphite from sulphur dioxide. The laboratory studies showed that the conversion of sulphur dioxide and iron to hydrosulphite was about 70%. Calculations at this stage show that if iron powder of 95% purity is available for Rs. 4/- per kg, there will be a saving of Rs. 5/- per kg, on raw material cost of sodium hydrosulphite.

#### Publications


1. Damodaran, V., Lobo, J., Gopichand, S., Dorai, C. S., Padalkar, S. R. and Ramachandran, P. A., A novel recycle route to N-P fertilizers,
   *Fertilizer News*, **25** (5), 3 (1980).


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## 14. UTILIZATION OF CELLULOSE FOR FOOD / ENERGY

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

**14.1.1 Cellulase :** Studies were continued for optimization of cellulase production in fermenters with instrumentation control. Cultures of *Penicillium funiculosum* as well as *Penicillium janthinellum* were studied in order to maximize enzyme yields and productivity. *P. janthinellum* showed poor extracellular activity when the medium was continuously maintained at pH 5.0 while bringing down the pH to 3·0 — 4·5 after a period of growth at pH 5·0 gave rapid externalization of the cellulase activity. Further studies are in progress with the two cultures to evaluate the effect of pH profiling on enzyme production and activity.

Mutation studies to isolate hyperproducers of the two strains were also continued. Variants found impaired in sporulation were isolated from *P. janthinellum* and their enzyme production would be evaluated in comparison with parent strain. Work is in progress to select catabolite-repression resistant mutants of the two *Penicillium* cultures.

**14.1.2 Single cell protein :** In laboratory fermenters, rice straw subjected to simple pretreatment procedures was fermented in 72 hours to yield biomass product containing 20-22% protein. The use of cheaper grades of salts as nutrients was studied and the yields obtained were comparable to those with laboratory grade reagents. Studies are in progress to optimize the fermentation cycle and to adapt to a semi-continuous process for biomass product formation.

Mutant strains of *Pleurotus flabellatus* were tested for their ability to effect more rapid fermentation of alkali pretreated rice straw. Some of the promising strains showed 30-34% crude protein in the biomass product after 10-14 days of fermentation.

### 14.2 Basic studies

Purification studies on the cellulase complex of *Fusarium lini* were carried out. Two exoglucanases and five endoglucanases were isolated in pure form using electrophoresis and flat bed isoelectric focussing.

Two endoglucanases were purified to homogeneity from culture filtrates of *Sclerotium rolfsii.* The endo enzyme also hydrolyzed xylan in addition to cellulose which seems to be an intrinsic property of the enzyme protein.

### Publications

1. Sadana, J. C., Shewale, J. G. and Deshpande, M. V.,

   High cellobiase and xylanase production by *S. rolfsii* UV-8 mutant in submerged culture, *Appl. and Environ. Microbiol.,* **39**(4), 935 (1980).

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## 15. UTILIZATION OF PLANT AND FOREST RESOURCES

### 15.1 Supplementing the rapidly depleting petrochemical feedstocks from *Euphorbia* latex : (15-5-356)

As part of a national programme on new and renewable energy resources, the present project envisages identification of unutilized energy plants in the country's wild vegetation and their possible exploitation for the production of fuels. In contrast to carbohydrates, hydrocarbons and hydrocarbon-like plant materials offer the possibility of relatively simple and energy-efficient processing to liquid fuels/ chemicals. Many latex-bearing wild plants are reported to store high levels of hydrocarbons, e.g. the *Euphorbia* (Gopher) species can reduce carbon dioxide down to hydrocarbons with higher hydrogen-to-carbon ratios and lower heteroatom contents.

Exploratory studies were made to determine whether direct catalytic upgrading of the hydrocarbon-like plant constituents could be carried out. The latex of *Euphorbia nerufolia* was suitably processed to yield a colourless resin Chemical investigation of this material revealed it to be a rich source of $C_{-30}$ and $C_{-31}$ pentacyclic compounds (cycloartanol, cycloartenol and 24-methylene cycloartanol) besides euphol. This plant material (in n-heptane) could be upgraded to liquid premium fuel by relatively simple catalytic processing over shape-selective ZSM-zeolite catalyst : at 480° the yield of BTX aromatics averaged about 88%.

### Publications


1.* Dalavoy (Mrs.), V. S., Deodhar (Mrs.), V. B. and Nayak, U. R.,
Trans, *trans*-2, 10-dodecadienedioic acid (10-dehydrotraumatic acid) from 10-undecenoic acid,
*Ind. J. Chem.*, **17B**, 507 (1979).

2.* Deshpande, R. P., Suryawanshi, S. N. and Nayak, U. R.,
An efficient preparation of $\alpha$-longiforic acid — a *cis* 1, 4-dicarboxylic acid from longifolene,
*Ind. J. Chem.*, **17B**, 617 (1979).

3.* Deodhar (Mrs.), V. B., Dalavoy (Mrs.),V. S. and Nayak, U. R ,
10, 12, 12, 12-Tetrachlorododecanoic isobutyl-amide from 10-undecenoic acid : A novel *n*-decane with two toxophoric groups at terminal positions,
*Ind. J. Chem.*, **17B**, 618 (1979).

4. Deshpande, R. P., Prakasa Rao, A. S. C. and Nayak, U. R.,
Lead tetraacetate oxidative decarboxylation of the halfesters of $\alpha$-and $\beta$-longiforic acids,
*Ind. J. Chem.*, **19B**, 443 (1980).

5. Lamture, J. B., Suryawanshi, S. N. and Nayak, U. R.,
Hydrogen bromide reaction on $\omega$-methyl and $\omega$, $\omega$–dimethyl longifolene : Synthesis of 15-methyl and 15, 15-dimethyl longicyclene,
*Ind. J. Chem.*, **19B**, 576 (1980).

6. Lamture, J. B. and Nayak, U. R.,
Anomalous Hassner reaction on longifolane : Formation of $\omega$-iodo longifolene,
*Ind. J. Chem.*, **19B**, 1001 (1980).

7. Yadav, J. S., Soman, R., Sobti, R. R., Nayak, U. R. and Sukh Dev,
Mechanism of rearrangement of longifolene to isolongifolene : Part II
*Tetrahedron*, **36**, 2105 (1980).


* These papers were not reported in the earlier annual reports.

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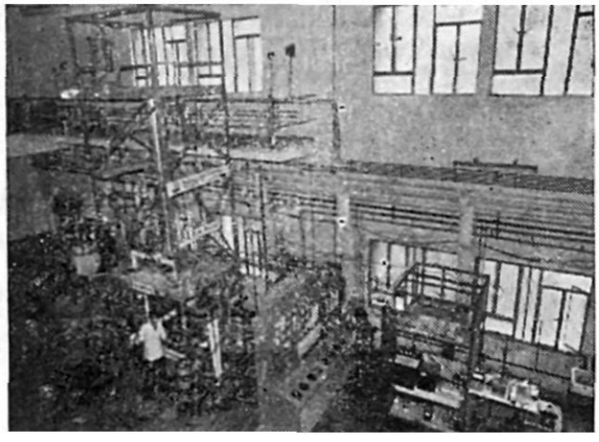
## 16. TIME TARGETED PROJECTS

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



Benzaldehyde pilot plant

A pilot plant incorporating a single tube reactor recovery and recycle system was installed and tested. The data for the design of an integrated plant will now be collected. Attempts to have the catalyst manufactured and tested in the pilot plant are being made.

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

The integrated pilot plant with recycles was run for continuous periods of time. Additional data for the design of the proposed plant at the site of HOC, Rasayani were collected. The conversion, yield and quality of the product were obtained as per expectation. The final acceptability of the product to make endosulfan was also confirmed. HOC is expected to take a decision soon on setting up a semi-commercial plant for HCCP.

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

A process design package prepared on the basis of the pilot plant work at NCL was handed over to the sponsor. A few pilot plant runs were carried out to acquaint the staff of the sponsor and the consultants with the process. Methods for treating the combined effluent to meet the requirements of the pollution control board were developed. Additional tests were carried out to determine the suitability of the materials of construction for the plant. Process conditions for caffeine and aminophylline were standardized on bench scale.

### 16.4 *o*-Aminophenol (OAP) : (1-4-067)

The hydrogenation of OAP in various solvents was carried out. The process conditions to obtain the product of the desired specifications suitable for the manufacture of phosalone were obtained. Pilot plant experiments will be taken up to collect design data.

### 16.5 Indothrin : (16-5-037)

During the preliminary developmental work it was found necessary to make considerable modifications in the process particularly from the point of view of manufacturing the product at commercially attractive prices. A sample of Indothrin prepared in the laboratory was sent for field tests. The results indicated that the product was comparable to similar synthetic pyrethroids being marketed. It is proposed to install a pilot plant to produce sufficient quantities of the product for large scale field trials and also to collect sufficient data for the design of a commercial plant.

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

Tridemorph is a systemic fungicide marketed by BASF under the trade name 'Callixin'. TDDIPA is the intermediate required for the manufacture of Tridemorph. BASF (India) sponsored a scheme for developing a process for the manufacture of TDDIPA. It is prepared by reacting n-tridecylamine and propylene oxide in the presence of a catalyst in a pressure reactor.

Laboratory scale experiments were completed and the product of required specifications was obtained. Further experiments are being continued to collect data for designing a commercial plant.

### 16.7 Aluminium chloride : (16-9-027)

After having established process conditions for the preparation of $\gamma$-alumina by dehydration or aluminium chloride, studies on its chlorination in

fluidized bed in the presence of carbon monoxide were conducted. The effect of various parameters such as temperature and ratio of carbon monoxide to fluorine were studied and further work is in progress.

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

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

An industrially attractive and viable process for the preparation of 4, 7-dichloroquinoline from *m*-chloroaniline has been worked out (500 g scale). Further work is in progress.

Preliminary work on the preparation of novaldiamine, involving five major steps, was carried out on laboratory scale.

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

The project was sponsored by Sturdia Chemicals, Bombay. The process development work was completed on bench scale for making tributyl citrate and acetyl tributyl citrate. Pilot plant experiments (30 kg of product per batch) were completed to collect additional process data. The two processes were successfully demonstrated to the sponsors, Sturdia Chemicals, and their project engineers, Industrial Consultants Bureau, Bombay. The products obtained by these processes exhibited an excellent heat stability, an important desired property of a plasticizer. The finished products compared very favourably with the imported samples of tributyl and acetyl tributyl citrate in respect of product specifications.

### 16·10 Modified rosin and rosin derivatives : (16-15-007-Sp)

Attempts were made to esterify rosin with polyhydric alcohols in order to conserve energy and chemicals as well as to obtain a product with low acid value and better keeping properties.

Disproportionated rosin is extensively used in the manufacture of synthetic rubber. Work was organized to prepare completely disproportionated rosin using different catalysts and evaluate the products obtained.

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

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

In continuation of earlier work, solvent extraction chemicals, which are organic $\alpha$-hydroxyoximes, were prepared on 1 kg. scale. Three such samples corresponding to Lix63, Lix65N and Lix64N were sent to National Metallurgical Laboratory(NML), Jamshedpur, for evaluation.

#### 16.11.2 Glyphosine : (16-16-007-iii)

N, N-bis-( phosphonomethyl ) glycine is a plant growth regulator which hastens the ripening of sugarcanes and prevents decomposition of sucrose during the summer months thereby resulting in enhanced recoveries of sugar from canes. A suitable process was developed on laboratory scale for the preparation of this plant growth regulator.

#### 16.11.3 Sulphochlorinated polyethylene elastomer (SCPE)-Hypalon : (16-16-007-vi)

As part of a process development programme for higher grades of SCPE comparable to Hypalon 40 and 45 which possess higher tensile strength than Hypalon 20, several experimental runs with higher molecular weight grades of LDPE and HDPE were taken using water-suspension techniques. In the absence of special high pressure corrosion resistant equipment, further work on this project was suspended.

### 16.12 Follow-up work : (16-18-007)

#### 16.12.1 Endosulfan : (16-18-007-i)

A plant of 400 TPA capacity installed at the site of Bharat Pulverising Mills Ltd., Bombay, was commissioned. NCL staff was associated with the commissioning and troubleshooting activities in this plant.

#### 16.12.2 Butene diol : (16-18-007-ii)

HOC had installed a semi-commerical plant of 150 TPA capacity for the manufacture of butene diol. The mechanical testing of this plant and a trial production were carried out. There were some difficulties in obtaining a product of the required

quality, which were traced to non-performance of the catalyst. Additional work was carried out at NCL to overcome the difficulties. It is expected that with the newly prepared catalyst the plant will give a product of the desired quality.

### 16.12.3 Chlorosilanes : (16-18-007-iii)

The NCL designed a reactor of 100 TPA capacity and an integrated semi-commercial plant was installed and commissioned at the Thane-Belapur site of Hico Products Ltd., Bombay, the collaborator of this project, during the second half of 1980. HICO also installed a matching plant for methyl chloride based on a process developed by them. Both these units have been in operation since October 1980. This plant has enough in-built flexibility to produce up to 180 TPA of methyl chlorosilanes. So far about 50 runs have been conducted on this unit during which it has been possible to consistently achieve over 75% selectivity to dimethyldichlorosilane—the most important among the chlorosilanes. The finished chlorosilanes conforming to international specifications were obtained by fractional distillation.

HICO is now making progress towards setting up a 1000-1200 TPA chlorosilanes plant along with a 1200 TPA methyl chloride plant. These plants are being erected at Kharsundi of Raigad District, Maharashtra State. While the basic design of the commerical reactor was prepared by NCL / HICO, the detailed engineering of the plants will be carried out by Humphreys and Glasgow Consultants Pvt. Ltd., Bombay. The plant is expected to be commissioned towards the end of 1982.

NCL-HICO are now in a position to offer this technology through NRDC to any party desirous of establishing a methyl chlorosilanes plant.

### 16.12.4 Ethylenediamine : (16-18-007-iv)

Diamines and Chemicals Ltd., Kalol, are installing a 1000 TPA plant for the manufacture of ethylenediamine and polyamines. NCL was associated with the party in design conferences and advice with regard to design of various equipment and procedures for start-up and analysis, process control and quality control. The plant is expected to be commissioned by the end of the year.

### 16.12.5 Terpineol : (16-18-007-v)

An integrated pilot plant for terpineol was constructed and operated at NCL and exported to Burma under the ITEC programme. The plant was installed and operated in Burma and training was given to the staff of Central Research Organisation, Rangoon. The plant gave a product of the desired quality at the designed capacity.

### 16.12.6 Phthalates (DOP and DBP) : (16-18-007-viii)

The NCL process for DOP and DBP was demonstrated to the representatives of Mysore Petrochemicals Ltd. (MPCL), Bangalore, and their consultants Tata Consulting Engineers, Bombay. MPCL is intending to install a plant of 2500 TPA capacity for DOP and DBP.

### 16.12.7 Propylene oxide : (16-18-007-x)

Detailed experimental investigations on the corrosion aspect of the chlorohydrination tower initiated at the instance of Engineers India Ltd., New Delhi, were concluded. The results and conclusions were submitted to the inspecting teams of both the organizations.

### Publications

1. Bhat, N. A.,
Oxychlorination of benzene,
*Chemical Engineering World,* **XV** (9), 65 (1980).

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## OTHER BASIC AND EXPLORATORY PROJECTS

### 1. Nucleic acids : (0-1-001-iii)

**1.1 Genetic engineering** :(a) Gene transfer : Knowledge about the organization of DNA sequences is essential before undertaking gene transfer experiments. During the year the genomes of a few cellulase producing fungi and nitrogen fixing bacteria were studied.

(b) Gene transfer in plants : The DNAs of four leguminous plant species and three cereals were analysed. Work was also undertaken to isolate specific genes and to identify their specific function.

A novel technique of chromosome banding in plants was developed.

Methods of isolation of plant nuclei, chromatin and mRNA are being standardized.

**1.2 Basic and exploratory studies on structure and function biologically active molecules:** A theoretical programme was initiated to predict molecular structure and related physicochemical properties vital for biochemical potency. Quantum chemical PCILO and molecular mechanics PPF methods were adapted and optimized for use in ICL 1904S computer available to NCL users. PCILO method was applied to study some conformational aspects in the synthesis of anthracyclic ring in daunomycin and adriamycin systems.

Monte-Carlo simulation method was developed to generate on the computer alternative three dimensional structure possible for polymer molecules and estimate their statistically averaged properties from a knowledge of conformational energy variation in much smaller yet representative constituent segments. Application of this method to explain the observed end to end dimensions (sizes) showed that a minimal fragment about the size of dinucleotide triphosphate was sufficient to represent the extent of conformational flexibility-rigidity in single stranded nucleic acids.

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

**2.1 Organic chemistry of trivalent iodine** : The reactivity of iodosobenzene and its possible use for the oxidation of alcohols were studied. This reagent, which is milder and more selective than iodobenzene dichloride, was found to be more convenient to use in some respects. A variety o alcohols were successfully oxidized in acetonitrile by this reagent in the presence of catalytic amounts of acids like phosphoric acid. Acetonitrile was shown to have a definite positive role in the reaction. The reaction is comparable to the Moffat oxidation where DMSO is the oxidizing agent and the role of acetonitrile is probably similar to that of dicyclohexylcarbodiimide in the Moffat case.

**2.2 Reactivity of ascorbic acid derivatives** : 2, 3-di-*O*- methylascorbic acid was known to isomerize in the presence of base to an *iso*-dimethyl derivative. The stereochemistry of the latter was established. Opening of the γ-lactone ring has been regarded as the first step in the sequence of reactions involved. It was found on investigation that the only reaction that took place on treatment of 2, 3-di-*O*-methyl-6-*O*-tritylascorbic acid with base was an epimerization at $C_4$. The precise significance of this result is under further examination; but it is consistent with the main conclusions of recent work on the role of the 6-hydroxyl group in the determination of the reactivity of the γ-lactone ring of the ascorbic acid skeleton.

### 3. Synthetic dyes : (0-15-003)

New blue azo disperse dyes from 3-chloro-1, 2, 3, 4-tetrahydro-7-benzoquinoline and the isomeric 2-(chloromethyl)-benz-(g) indoline were prepared and evaluated as dyes for polyester fibres. They showed good fastness properties.

The reaction of naphthalic anhydride with arylacetic acids resulted in the formation of 3-hydroxy-2-arylphenalen-1-ones. Complete spectral evidence in support of their structures has been discussed in a communication sent to Indian Journal of Chemistry. The compounds (yellow to orange) have been evaluated as disperse dyes.

It was found that nitroarenes can be reduced efficiently with hydrazine hydrate in presence of catalysts in suitable solvents. The yields and purities of the products are excellent.

The work on sulphonylazepines, which have biologically interesting properties, was continued. Processes have been devised for their improved yield. Stable 1H-azepines have been synthesized. Novel disperse dyes derived by the condensation

of homophthalimides and 2-pyridones with naphthostyril and isatin, were synthesized and evaluated.

In continuation of the work on N-substituted pyridones, the reactions of 7-methyloxazolo- (3, 2a) pyrid-5 (4H)-one with aliphatic and aromatic amines and other nucleophiles were studied.

## 4. Crystallography : (0-17-004)

The acetone extract of the plant *Vicoa indica* shows good ovicidal activity against mosquitoes. The structure analysis of a new highly oxygenated germacranolide ($C_{22}H_{32}O_9$) isolated from this extract, was undertaken in order to confirm the structure obtained by NMR and chemical methods. The X-ray work confirmed the molecular structure and clarified the stereochemistry of the molecule. The structure analysis, which proved to be rather difficult because of the non-availability of good crystals, was solved by direct methods using the programme MULTAN (1977).

The crystal structure of a synthetic compound named 2 - (2-hydroxy-5-methylphenyl) - propenyl-acetate was solved by direct methods and refined by full matrix least squares method. This compound was found to be similar to some naturally occurring vinyl esters. The precisely refined structure showed expected molecular dimensions.

## 5. Water evaporation control : (0-26-046)

As monomolecular films spread from emulsions cannot withstand wind velocities greater than 15 km/hr multiemulsions of the type W/O/W were prepared using various polymers as additives. Addition of HTPB to the emulsion gave some encouraging results. During the year similar types of emulsions were prepared but with different surfactants, viz., span-20 and tween-80 and using HTPB, polyethylene oxide and polyacrylic acid polymers as additives. Here again it was found that HTPB containing emulsion gave better results, i. e., 10-15 % higher than without polymer additive at 30 km/hr.

In order to understand this finding in detail, work was initiated on the study of mixed monolayers of different mixtures having wide chain length difference and with polymers as well.

Systematic work on the mixed monolayers of $C_{16}$ -OH + $C_{22}$–OH and $C_{16}$–$OH_4$–$C_2OH$ + $C_{22}$–$OC_2H_4OH$ was undertaken by measuring surface viscosity and surface pressure at 25° at five different mole fractions. The results obtained revealed that these mixed monolayers were miscible and homogeneous. The extent of non-ideality was further clarified by plots of area-mole fraction $\triangle G$ vs mole fraction, shear modulus Gs vs mole fraction and compression modulus vs mole fraction curves. It was observed that the non-ideal behaviour was mainly due to chain-chain interaction, i. e., van der Waal's interaction. This effect was more predominant if the chain length of the two components was wide apart.

Work on monomolecular film properties, viz. $\pi$-A $\mu$-$\pi$ and $\triangle V$-$\pi$ isotherms was initiated on the mixed monolayers of PVA + alkoxy ethanols to understand the intermolecular interaction and stability of mixed films over a large change in surface elasticity. These results will be helpful in understanding the stability of films obtained in large scale experiments.

## 6. Synthesis and reactions of epoxides : (0-29-003)

Studies on vanadyl acetylacetone-*t*-butyl hydroperoxide epoxidation of 2-benzylidene cyclohexanols having equatorial hydroxyl revealed that the epoxidation was non-stereo-selective. Along with *cis*-epoxyalcohols significant amounts of *trans*-epoxyalcohols were also formed.

*cis*-Methyl 3, 4 - epoxy - 4 - ( 4' - methylphenyl ) - butanoate was prepared. The acid and the base catalyzed rearrangements of this epoxyester were investigated.

2-Methyl-2-( 2-hydroxy-4' -hydroxymethyl-phenyl) oxirane diisobutyrate and 2-hydroxymethyl-2- (2'-hydroxy-4'-hydroxymethyl-phenyl) oxirane triisobutyrate, which are natural oxiranes, were synthesized.

## 7. Autoxidation :

A systematic study was undertaken on the autoxidation of arylcycloalkenes using cobalt naphthenate as catalyst. The effect of the ring size on the progress and products of the reaction was carefully observed. The major product obtained was the corresponding epoxide in each case, in contrast with the alicyclic compounds wherein the corresponding allylic alcohols and ketones were obtained as the major products.

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2. Seshadri (Miss), M. and Ranjekar, P. K., Unusual DNA sequence organization in two *Phaseolus* species, *Biochem. Biophys. Acts*, **610**, 211 (1980).

3. Deshpande (Miss), V. and Ranjekar, P. K., Repetitive DNA in three *Gramineae* species with low DNA content, *Hoppe-Seyler's Zeitschrift fur Physiologie Chemie*, **361**, 1223 (1980).

4. Joshi, C. P. and Ranjekar, P. K., Technique for heterochromatin visualization and chromosome banding in plants, *The Nucleus*, **23**(3), 169 (1980).

5. Rele (Mrs.), M. V., Vartak, H. G. and Jagannathan, V., Proteinase inhibitors from *Vigna unguiculata* subsp. *cylindrica*. Occurrence of thiol proteinase inhibitors in plants and purification from *Vigna unguiculata* subsp. *cylindrica*, *Arch. Biochem. Biophys.*, **204**, 117 (1980).

6. Vartak, H. G., Bodhe, A. M., Paranjpe, S. V. and Jagannathan, V., Proteinase inhibitors from *Vigna unguiculata* subsp. *cylindrica*. Inhibitors of subtilisin and trypsin, *Arch. Biochem. Biophys.*, **204**, 129 (1980).

7 Vartak, H. G., Rele (Mrs.), M. V. and Jagannathan, V., Proteinase inhibitors from *Vigna unguiculata* subsp. *cylindrica*. Properties and kinetics of inhibitors of papain, subtilisin and trypsin, *Arch. Biochem. Biophys.*, **204**, 134 (1980).

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9. Dhekne, V. V. and Rao, A. S., Thermal rearrangement of 2-methyl-2-(2'-acetoxy-5' -methylphenyl) oxirane, *Ind. J. Chem.*, **19B**, 852 (1980).

10. Sanghvi, Y. S. and Rao, A. S., Synthesis of two naturally occurring isobutyrates related to thymol, *Ind. J. Chem.*, **19B**, 952 (1980).

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13. Gogte, V. N., Kelkar, S. V. and Tilak, B. D., Synthesis of heterocyclic compounds Part XXIII : Synthesis of 1, 5-, 1,6-and 1, 8-naphthyridines, *Ind. J. Chem.*, **19B**, 1011 (1980).

14. Devdhar, R. S., Gogte, V. N. and Tilak, B. D., Synthesis of heterocyclic compounds Part XXIV : Synthesis of 2, 4-disubstituted thianaphthalenium perchlorates thiachromans, *Ind. J. Chem.*, **19B** 1014 (1980).

15. Ahuja (Miss), R. R., Natu, A. A. and Gogte, V. N., Optical induction IV : Optical induction by using homogeneous catalysts, *Tetrahedron Letters*, 4743 (1980).

16. Pol (Mrs.), A. V., Naik, V. G. and Sonawane, H. R., Oxidation of $\Delta^3$-carene and $\alpha$-pinene with thallium (III) nitrate, *Ind. J. Chem.*, **19B**, 603 (1980).

17. Pol (Mrs.), A. V., Naik, V. G. and Sonawane, H. R., Oxidation of 1-*p*-menthene and limonene with thallium (III) nitrate, *Ind. J. Chem.*, **19B**, 604 (1980).

18. Narayanan, C. R. and Naik, D. G.,
Simple methods to identify proton (s) on a carbon holding an amino group,
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19. Ayyangar, N. R., Rao, U. S. and Tilak, B. D.,
6-Cyano-2, 3-dihydro-7-methyloxazolo 3, 2-a pyrid-5 (4H)-one as a novel reactive coupling component for production of azo dyes on cotton,
*Chem. and Ind. (London)*, **29** (1981).

20. Ayyangar, N. R., Lugade, A. G., Sane, M. G. and Srinivasan, K. V.,
The separation of 2-amino-3H-phenoxazin-3-one from *ortho*-aminophenol,
*J. Chromatography*, **209**, 113 (1981).

21. Ayyangar, N. R., Purohit, A. K. and Tilak, B. D.,
Stable 1H-azepines,
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Pressure induced sulphonyl-1H-azepine synthesis by sulphonylnitrene insertion in benzene,
*J. Chem. Soc. Chem. Commun.* (London), 790 (1981).

23. Ayyangar, N. R., Lugade, A. G., Nikrad, P. V. and Sharma, V. K.,
Catalytic reduction of nitroarenes with hydrazine hydrate in suitable solvents,
*Synthesis*, 640 (1981).

24. Narayanan, C. R. and Naik, D. G.,
A new triterpenoid and steroid from Indian Kurchi bark,
*Ind. J. Chem.*, **20B**, 62 (1981).

**Books/chapters in books**

1. Advances in Transport Processes — Vol. I,
Edited by A. S. Mujumdar and R. A. Mashelkar,
Publishers : Wiley Eastern/Wiley Holsted 1980.

2. Pesticide Analysis,
Edited by K. G. Das,
Publishers : Marcel Dekker, USA.

3. Thermal convection in non-Newtonian fluids,
A. V. Shenoy and R. A. Mashelkar,
Advances in Heat Transfer
Hartnett, J. and Irvine, T F, Eds, Acad. Press NY, P. 143,

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1. Sinha, A. P. B.,
Electronic materials,
*Electronics Information and Planning*, **8**, 391 (1981).

2. Setty, M. S.,
Thick film materials,
*Electronics Information and Planning*, **8** (6) 436 (1981).

3. Sethi, S. C.,
Falling jet evaporator gives concentrated *p*-menthane hydroperoxide,
*Science Today*, **2**, 49 (1981).

4. Ayyangar, N. R. and Lugade, A. G.,
Phenol — A key intermediate for chemical products,
*Indian Chem. Manufacturer*, **19** (6), 5 (1981).

■ ■ ■

## INFRASTRUCTURE ACTIVITIES

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

The collection has about 2600 cultures of bacteria, yeast and fungi. Organisms are routinely subcultured and tested for biochemical performance. Five hundred and sixteen cultures were supplied to industrial and research institutions during the year.

The NCIM specializes in the maintenance of rhizobia and nitrifying bacteria. Nearly 90 nitrifiers and 120 rhizobial cultures are routinely subcultured and maintained.

A yeast culture has been adapted to grow at 40° and fermentation studies on this culture for the production of alcohol are in progress.

### 2. Centralized chemical analysis and instrumental service : (Infra-2)

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

This group provides infrared spectral analysis to the scientists of the laboratory and outside parties. It also undertakes some basic studies on specific compounds. During the year, 1808 samples by infrared and 738 samples by ultraviolet visible were analysed for the laborartoy.

Infrared and proton magnetic resonance studies on the hydrogen bonding in malonic acid analogues cycloalkane 1:1 dicarboxylic acid monopotassium salts showed that while a nearly symmetrical hydrogen bond is present in the cyclopropane derivative, an unsymmetrical hydrogen bond exists in the cyclobutane and cyclopentane derivative. These findings can be explained by the difference in the angle between the two carboxylic groups found in the parent acids from X-ray crystallographic data. The angle of 118° in the cyclopropane derivative would facilitate the formation of a planar symmetrical six membered ring as against the non-planar ring obtained when the angle is close to tetrahedral (109°) as found in the cyclobutane derivative.

**Publications**


1 Raghunath, D., Jose, C. I., Amarnath, N. and Ghatge, N. D.,
Elastomer - a slow release substrate,
*Popular Plastics and Rubber*, **25**, 37 (1980).


#### 2.2 Physicochemical analysis : (Infra-2(ii))

The group carries out routine chemical and instrumental analysis of inorganic chemicals for NCL scientists and outside parties. One thousand three hundred and fifty nine NCL samples were analysed by instrumental (spectrographic, atomic absorption, flame photometry, polarographic, spectrophotometric, etc.) and classical methods.

Besides analytical work, methods were established for the routine determination of rhodium. A method was also developed for vanadium using solvent extraction of the thiocyanate complex followed by aspiration into the flame of the atomic absorption spectrophotometer.

Work on the solvent extraction of metals using conventional chelating agents along with a high molecular weight amine is being continued.

#### 2.3 Microanalysis : (Infra-2(iii))

This group meets the laboratory's needs in microanalysis and renders possible assistance to outside institutes. During the year, 2682 samples were analysed for the NCL research projects.

**Publications**


1 Malvankar, R. B., Ramdasi, S. S. and Pansare, V. S.,
Simultaneous microdetermination of carbon, hydrogen and halogen or sulphur in organic compounds,
*Ind. J. Chem.*, **19**, 722 (1980).


#### 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 assistance was rendered. Spectra scanned : T-60 spectrometer-5983; WH 90 FT NMR spectrometry-845; $C^{13}$ FT NMR spectra-314; decoupling experiments-240 and variable temperature spectra-48.

The stereochemistry of isodimethyl ascorbic acid at $C_2$ was obtained from a comparative study of related bicyclic derivatives.

The LAOCOON-3 programme for computer simulation of NMR spectra has been adapted for use on the ICL-1904S system at the Regional Computer Centre, Pune. The PMR spectra of a number of substituted phthalic anhydrides were analysed with this programme and it has been established that the rule of additivity of chemical shifts holds reasonably well for this system. NMR spectra of some salicylamide salts have been studied as a function of temperature and useful indications have been obtained about the temperature dependence of the tautomeric equilibrium of the anions.

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

The group provides MS and GC/MS analytical services, develops new MS and GC/MS analytical techniques specially for the trace analysis of drugs, pesticides and intermediates and updates MS analytical facilities.

During the period unde review the samples analysed for NCL were 1050 by MS and 146 by GC/MS.

The following basic studies were undertaken in the group:

**2.5.1 Gaseous ion chemistry :** As *a* continuation of the previous work on the rearrangements of carbenium ions in the gas phase, work was initiated on ion-molecule reactions in the gas phase. The ammonia positive ion chemical ionization and hydroxy negative ion chemical ionization techniques have been adopted. Preliminary studies have shown interesting nucleophilic substitution reactions which have no analogy in solution chemistry. Interesting reductions were also observed. Work is in progress to confirm these preliminary observations.

**2.5.2 Retro mass spectral approach to synthesis of natural products : To** explore the scope of using isochromanone as a synthon in the infra-molecular Diels-Alder approach to the synthesis of estradiol, triptolide and X-ceasalpin, most of the required intermediates have been successfully synthesized by elegant routes.

### Publications


1. Jalees Afzal, Viramani, M., Hazra, B. G. and Das K. G.,
   A novel thermal knoevenagel condensation via a thermal Michael reaction,
   *Synthetic Communication,* **10,** 843 (1980).
2. Khanapure, S. P., Hazra, B. G. and Das, K. G., An improved stereospecific total synthesis of an aromatic c-ring testosterone analogue, *J. Chem. Soc. Perkin I,* 1360 (1981).
3. Mallaiah, M., Hazra, B. G. and Das, K. G., Synthesis of (±)-iso-β-peltatin-a methyl ether, *Ind. J. Chem.,* **20** (B), 434 (1981).


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

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

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

The group provides ESCA facilities to the scientists of the laboratory and outside parties. During the period under review 400 NCL samples were analysed by ESCA using various techniques such as XPS, UPS and AES. In addition to maintaining the service facilities, the following basic studies were undertaken in the group.

Devices : (a) Work on zinc oxide varistors was completed. ZnO when mixed with other oxides such as $Bi_2O_3$, $Sb_2O_3$, CoO, $MnO_2$ and $Cr_2O_3$ exhibit a non-ohmic behaviour in their current voltage characteristics. These varistors were analysed by XPS technique to explain the origin of the non-ohmic behaviour.

(b) Thin film $Bi_2O_3$ is used as optical semi-reflectors and in TV cameras. The dielectric properties of as-evaporated films are very much different from those subjected to post oxidative treatment. These thin films were characterized by analysing their surface composition by XPS techniques.

(c) Metals and alloys : Dilute Pb-Sn, Ag-Sn, Cd-Sn, Cu-Sn and In-Sn alloys were prepared and studied by XPS technique to see the effect coordination on the core electron levels.

### Publications


1. Sainkar, S. R., Badrinarayanan, S., Date, S. K. and Sinha, A P. B.,
   X-ray pho oelectron spectroscopic studies on $ZnO-Bi_2O_3$ varistors,
   *Surface and Interface Analysis,* **3,** 142 (1981).

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

The group gave analytical support to various process development projects and evolved new analytical procedures for some of them. About 1300 samples were analysed for various NCL projects.

The group also assisted in the commissioning of the analytical laboratory of Hindustan Insecticides Ltd., Alwaye, Kerala, and trained their staff members in various analytical methods connected with the endosulfan plant.

A new method for the rapid estimation of HCCP in various streams as well as in the effluents was developed. Analytical work for caprolactam recovery was also carried out.

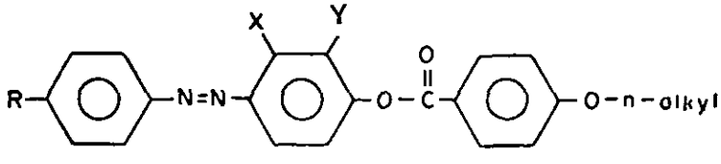
## 2.9 Analytical group of organic synthesis : (Infra-2(ix))

The group provides analytical services to the division of organic synthesis and other divisions by standard instrumental methods and endeavours to develop new methods of analysis with special reference to pesticides, drugs, etc. It is also working on the development of new liquid substrates for GLC columns and their application for the separation and identification of intricate mixed products formed during various reactions in organic chemistry.

The group carried out the following analyses for NCL projects : theophylline, aminophylline and caffeine-110; organophosphorus pesticides (temophos, fenthion, dimethoate, ethion) and carboxin-52. Instrumental analyses carried out for various R & D projects including Indothrin, pest control compounds, etc., were GLC-1023; IR137-3051 ; IR599B-358 and UV-59.

Analytical data collection for registration of NCL developed pesticides was in progress. Simultaneously, methods for EC formulation of these products were being developed.

Synthetic work on laterally substituted new liquid crystalline compounds was further extended. So far 30 liquid crystals have been prepared having mono and disubstitutions on middle ring of the general formula :




where X and Y are laterally substituted groups.

Some of them proved good substrates for isomers separation. For direct application of these phases, Friedel-Craft alkylation reaction was carried out on benzene, toluene and ethyl benzene using organic esters as alkylating agents. Products formed under various conditions were completely identified by GLC using these substrates.

Incidentally synthesis of meta-dialkyl benzenes from its isomers in more than 95% purity could be obtained using organic esters as alkylating agents.

Initial work on bonded phases was started. Liquid crystalline substances will be chemically bonded on solid support to be used in GC as well as HPLC columns.

### Publications


1. Uppal, K. S., Panse, D. G., Bapat, B. V. and Ghatge, B. B.,
   Effect of chain length of alkyl phthalates used as stationary liquid phases in gas chromatography,
   *Ind. J. Tech.*, **18** (6), 243 (1980).

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   Synthesis of aromatic polyesters and their application as liquid substrates in GC,
   *Ind. J. Tech.*, **18** (6), 246 (1980).

3. Naikwadi, K. P., Panse, D. G., Bapat, B. V. and Ghatge, B. B.,
   Liquid crystals I : Synthesis and application as stationary phases in gas liquid chromatography,
   *J. Chromatog.*, **195**, 309 (1980).

4. Naikwadi, K. P., Panse, D. G., Bapat, B. V. and Ghatge, B. B.,
   Liquid crystals II : Applications of liquid crystals as stationary phases in gas liquid chromatography,
   *J. Chromatog.*, **206**, 361 (1981).

5. Naikwadi, K. P., Bapat, B. V. and Ghatge, B. B.,
   Synthesis of laterally and substituted new liquid crystalline compounds : 4-alkoxy-2-methyl-4-(4'-alkoxy benzoyloxy) azobenzene,
   *Ind. J. Chem.*, **20** (B), 165 (1981).

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

The group undertook thermal analysis for various NCL projects. The information derived from these studies related to thermal decomposition, phase transformation, thermal degradation, etc. One hundred and forty-eight samples were analysed for NCL research projects.

Samples having different $Fe_2O_3$ and $BaCO_3$ compositions were prepared. The thermal analysis of these samples is in progress.

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

During the year 300 samples were studied by SEM. In addition, 70 samples were analysed by EPMA technique to determine the surface elemental composition.

### 2.12 X-ray diffraction (XRD) : (Infra-2(xii))

Analytical facilities are extended by this group to different research projects of the NCL. During the year XRD techniques were widely used by various groups in NCL for characterization of different samples and calculating the crystal parameters. XRD spectra of 714 samples were recorded for NCL projects.

### 2.13 GLC and HPLC analysis : (Infra -2(xiii))

The group has facilities for gas liquid chromatographic (GLC) and high performance liquid chromatographic (HPLC) analyses. The facility is utilized by the various divisions of the laboratory in addition to the process development division. A preparative HPLC unit and a dual channel UV detector and data system for the existing HPLC unit will be shortly procured. Proposals to acquire a new GLC unit and a TLC/FID unit are under active consideration.

During the year 1330 samples by GLC and 277 samples by HPLC were analysed.

### 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. The group also provides facilities for compressing various gases in gas cylinders.

During the year, 274 experiments were carried out for various research and development projects of the laboratory.

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

Some of the iron and tin based compounds such as hydrated iron oxides, mixed spinels and tin chalcogenides as $Cu_2SnS_3$ $Cu_3SnTe_3$ $Cu_2SnSe_3$ and many organo tin compounds were studied by the mossbauer spectroscopic technique to understand their structural, electronic and magnetic properties.

### Publications


1. Badrinarayanan, S., Gupta, M. P., Date S. K. and Sinha, A. P. B., Mossbauer spectroscopic analysis of the spinel $CuO_{0.5}$ $Mn_{0.5}$ $Fe_2O_4$, *Ind. J. Chem.*, **19**(A), 894 (1980).

2. Bakare, P. P., Gupta, M. P. and Sinha, A. P. B., Mossbauer spectroscopic studies on oxide and hydrated oxides of iron, *Ind. J. Pure and Appl. Phys.*, **18**, 473 (1980).

3 Seeta Bharti, Gupta, M. P., Date, S. K. and Sinha, A. P. B., Cation distribution of $MnFe_2O_4$ : A mossbauer study, *Ind. J. Pure and Appl. Phys.*, **18** (10), 747 (1980).


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

The aim of this project is to undertake the measurement of thermodynamic properties required for various process development projects of NCL and also to conduct some basic research in this field.

During the year, heats of reaction and neutralization of the following systems were completed (i) heats of reaction of dimethylsulphate with sodium theophylline, (ii) heats of reaction of denatured spirit with turpentine oil, (iii) heats of neutralization of rosin with 0.0974N NaOH. VLE data for the system butanediol-water and butenediol-water were collected for the butene diol project.

Basic studies on the excess thermodynamic properties viz. excess free energy, enthalpy and entropy of isomeric butanols with n-heptane at 55° was completed. The excess properties were found to be positive due to hydrogen bond breaking. The data on the excess free energy and enthalpy of mixing could well be represented by Redlich Kister equation. An attempt to calculate excess enthalpy from temperature dependence of excess free energy for iso-and sec- butanol system was made. The results obtained were discussed in the light of the idealized model.

Using modified twin type calorimeter, determination of heats of mixing of secondary and tertiary butylamine-chloroform binary systems covering an entire concentration range was carried out at 40°. The heats of mixing observed at 0.5 mol fraction was 2300 J/mole in the case of ter-butylamine-chloroform system. These data were fitted to 3, 4, 5 constant equations using the least square method. Computer calculations showed that the standard deviation was of the order of 21.5 J/mole with four constant equation.

Heats of mixing of ethylenediamine with water below 0-0.1 mol fraction of diamine were determined at 30°. Partial molar enthalpy of mixing of diamine in water was found to be 29.0 KJ/mole.

Computer programming using Banker's method for vapour composition calculations was completed.

Work on the construction of static VLE apparatus was initiated.

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Excess free energy of binary mixtures of isomeric butanols with n-heptane,
*Ind. J. Chem.,* **19,** 795 (1980).

2. Damle, H. G. and Katti, S. S..
Electrical conductivity of molten salt systems: Binary mixtures of silver iodide with cadmium and strontium iodides,
*Ind. J. Chem.,* **19,** 897 (1980).

3. Pradhan, S. D. and Pathak, G.,
A simple calorimeter for the heats of mixing study of associated liquids : Enthalpy of hydrogen bonded ethanol butylamine complex,
*Proc. Ind. Acad. Sci.,* **89,** 341 (1980).

4. Pradhan, S. D. and Pathak, G.,
Enthalpy of hydrogen bonded alcohol-butylamine complexes by simpler calorimetric method,
*Proc. Ind. Acad. Sci.,* **89,** 349 (1980).

5. Anilkumar, Pathak, G. and Katti, S. S.,
Excess thermodynamic properties of isomeric butanols with n-heptane at 55°,
*Proc. Ind. Acad. Sci.,* **89,** 455 (1980).

6. Damle, H. G. and Katti, S. S.,
Ion complexes in molten mixtures of AgI and $SrI_2$ : Electromotive force differential thermal analysis and X-ray diffraction measurements,
*Ind. J. Chem.,* **19 A,** 987 (1980).

7. Anilkumar and Katti, S. S.,
Isothermal vapour liquid equilibrium of isomeric butanols with n-heptane,
*Ind. J. Tech.,* **18,** 60 (1980).


### 4. Entomology : (Infra-4)

The group interacts closely with concerned divisions for execution of projects and exploratory work requiring chemical and biological studies. During the year under review nearly 1000 bioassays were done. Due to greater in-flow of fractions/sub-fractions/active principles from plant extracts already identified as promising in the previous year, only 25 new plant species were screened. More than 300 such fractions were examined in the current year and intensive follow-up action/development work continued, especially with the oviposition deterrence activity found in neem. A new species of compositae was identified as a potentially rich source of new insecticidal principles.

In connection with the project on controlled release formulations, laboratory trials were conducted to reassess procedures already developed for evaluation of larvicidal formulations. Exploratory work on the development of bioassay for examining efficacy of controlled release adulticide formulations was taken up.

Basic studies in entomology were undertaken on elucidation of mode of action of the oviposition deterrence principles found in various plants and on the mating behaviour and pheromone system of red cotton bug.

## Publications

1. Sharma, R. N., Bhosle, A. S., Joshi (Miss), V. N., Hebbalkar D. S., Tungikar, V. B., Gupta, A. S. and Patwardhan (Mrs ), S., A., *Lavendula gibsonii* : A plant with manifold insectistatic potential, *Phytoparasitica,* **9** (2), 101 (1981).

## 5. Instrumentation : (Infra-5)

The responsibility of this section is to look after the maintenance of various sophisticated research and analytical instruments in the laboratory. Nearly 1800 maintenance/repair jobs on the instruments were completed during the year. This group also attended to the installations of HPLCs, GLC, IR spectrometers, catalyst testing units, etc.

Work on IR spectrometer was taken up as a grant-in-aid programme of DST.

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

The responsibility of the DTS is to look after the following major activities : (i) planning, monitoring and research coordination, (ii) industrial liaison and technology transfer, (iii) documentation and collection of market data and (iv) publicity and extra mural work.

NCL research programme document for the years 1981-82 and 1982-83 was prepared and finalized after discussions at internal research programme meetings for various divisions and then submitted to Research Advisory Council and Executive Committee of the NCL. Research programme lists were prepared indicating the projects, their code numbers and project / area leaders. Notes on NCL's energy and other research programmes were prepared for the Chemical Coordination Council meeting. A system on Centralized Project File Bank (CPFB) was evolved and started whereby important correspondence, quarterly and other reports and documments for each project are stored separately under respective code numbers. Area meetings for various research projects were arranged for assessing the progress and bottlenecks in each area. A 200 page annual plan 1981-82 document and background papers for the NCL budget discussions at the CSIR headquarters were prepared. Projectwise accounts for various areas and infra projects were maintained.

During the year, 3320 technical enquiries from private parties, manufacturing firms, CSIR, NRDC, Polytechnology Transfer Centres, audit party, government departments, sister laboratories, etc., were attended to. DTS scientists held discussions with various parties regarding the possibility of transfer of NCL technologies and of undertaking sponsorship/ collaborative/consultancy work. Draft proposals for such work and secrecy agreements for certain projects were prepared and submitted to the Executive Committee and CSIR for approval. Agreements for the approved proposals were executed with the concerned parties. A handout on sponsored work at the NCL was prepared for prospective sponsors. DTS maintained close liaison with Central Insecticides Board, Faridabad, testing organizations and NCL licensees for generation of toxicity and bio-efficacy data needed for registration of pesticides. Comments were sent on various applications for letter of intent/industrial licence/foreign collaboration and for registration of R & D units with DST and on various research schemes seeking financial assistance from the CSIR. The system of undertaking analysis at the NCL for outside parties was given closer attention with a view to achieve better efficacy and speed. Work on filing, renewal and other correspondence on Indian and foreign patents was carried out.

Routine screening of newspapers, classification of paper cuttings and documentation of information from periodicals and licence applications relevant to NCL 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 1979-80 was printed. The NCL brochure was brought out and copies were sent to various CSIR laboratories and important personalities connected with research and development. The brochure was very much appreciated by the recipients for its high quality, novel presentation and informative contents.

Arrangements were made for taking visitors and VIPs round the laboratory. DTS staff participated in the organization of various programmes under the Indo-Soviet symposium. Photographic, draftsman and artists services were rendered for research and publicity. The photographic section completed

242 jobs and made 2261 exposures, 2320 prints and 1257 slides. Draftsman services prepared 300 illustrations/tracings.

## 7. Documentation services : (Infra-7)

The NCL library houses about 83,590 publications comprising books, periodicals, patents, standards, technical reports. etc. During the period under review, 473 books, 1994 periodicals (bound), 945 patents/standards, 35 technical reports and 19 theses were added. The library received 600 periodicals out of which 125 were received gratis and on exchange basis. Translation/photocopies of 103 papers published in various foreign languages were also procured.

During the year, 12,641 publications were issued to staff and corporate members, under the inter-library loan scheme. Library facilities were also extended to persons from industries, government departments, universities, colleges, research organizations, etc. Seven hundred and thirty-three outsiders made use of the NCL library. Ninety-four publications were borrowed and 181 publications were loaned to other libraries.

About 245 current periodicals were circulated amongst senior scientists. Current awareness services on agrochemicals and pesticides, Indian patents bulletin, library bulletin, solar energy and a bimonthly service on chemical reactors were compiled and circulated among the scientists.

One automatic plain paper copier Ricoh DT 850 was procured and installed in the library. During the year 1,26,183 pages of scientific references were supplied to the scientists and 5831 pages to outside parties.

The NCL library is an inspection centre for Indian patents. It received 2038 patents during 1980-81.

A survey report was prepared for the project of survey of users and resources of information in chemistry and chemical technology with the financial assistance of Department of Science and Technology under National Information System for Science and Technology (NISSAT).

## 8. Engineering services : (Infra-8)

### Mechanical/Electrical/Refrigeration/Civil engineering

Apart from the regular maintenance of NCL's equipment, utility services and various NCL buildings, this group also undertook fabrication and modification of equipment according to the requirements of projects in the process development and other divisions. The number of jobs completed during the year by the mechanical and electrical/refrigeration section were 1780 and 1025 respectively. Some of the important jobs completed were as follows :

### Mechanical

1. Dismantled and shifted the grinding machines from the old grinding room and reinstalled the same in the new building with all necessary service facilities.
2. Shifted and laid the main water lines over the terrace of the newly built office blocks in the main building.
3. Constructed one special sterile room for biochemistry division.
4. Old chemical hall was converted into laboratory rooms for process development division and provided all necessary service facilities.
5. The motor garage was converted into a laboratory room with all services for the entomology section.
6. Interconnected the corporation water line to garden water mains.
7. Fabricated special type of stainless steel sprayer for the solar energy project.

### Electrical / Refrigeration

Provided electrification services to various research laboratories and other buildings of the NCL, e.g., inorganic division extension, administration block, pilot plant II, solar energy, process development hall, etc. One hundred and sixty tube lights for colony streets and ninety-six 15 A power points were installed in G and F type quarters. Separate meters were provided for each room in the new hostel.

**Civil**

1. Supervised the extension work of the main building on the second floor and the polymer science and engineering building work in progress.
2. Made modifications in (i) PP building (ii) part of PD laboratory for rheological laboratory and (iii) service unit building.

## 9. Glass blowing : (Infra-10)

Fabrication, repairs and maintenance of glass equipment is an every day requirement of a chemical laboratory. A well equipped section has been working to meet these requirements. During the period under review, 4000 regular jobs were attended to. Five thousand five hundred and sixteen taper joints and 240 vacuum stop cocks were fabricated and utilized for the jobs.

■ ■ ■

# 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) offering consultancy on product development, troubleshooting and establishment of in-house R & D units; (2) undertaking specified developmental work on sponsored basis; (3) rendering *ad hoc* assistance on industrial problems of 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 (for details see p. 47).

#### 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 (p. 42).

#### 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 either on 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, it was decided that the following approaches may be adopted for providing assistance to the small scale sector.

(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.

With the above objective in view a cell to render assistance to small scale chemical industries started functioning during the year.

### 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 516 cultures from the National Collection of Industrial Microorganisms (NCIM) 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.

| | |
|---|---|
| Microanalysis | 137 |
| NMR | 33 |
| IR | 10 |
| Mass spectral analysis | 99 |
| GC/MS | 4 |
| VPC/GLC/HPLC | 8 |
| Thermogravimetric analysis (DTA, TGA, TG, etc.) | 53 |
| X-ray diffraction pattern | 70 |
| Spectrophotometric estimation/ inorganic analysis of special nature | 63 |
| Surface area measurement | 7 |
| Mossbauer spectroscopy | 3 |
| ESCA | 11 |
| SEM | 50 |

The total receipts on account of analyses/ testing carried out during the year amounted to Rs. 0.65 lakhs.

## 1.4 Training

During the year, seven representatives of industry and institutes were given training in plant tissue culture technique, microbiological technique, high vacuum technique and surface area measurement by BET method.

## 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 1980-81.

| | Name of the equipment | Description / Function |
|---|---|---|
| 1. | Analytical ultracentrifuge with UV scanner-Beckman Model L8-80 | Useful for precise measurement of molecular properties |
| 2. | Analytical ultracentrifuge-Beckman Model L8-80 | Useful for separation and characterization of macro-molecules |
| 3. | Freeze dryer-Model EFO3R | Useful for concentrating biologically active samples |
| 4. | Gas chromatograph—Model 58408 Hewlett Packard | Computerised GC to analyse gas and liquid samples with facilities like temperature programming, automatic injection, calibration for quantitative work, etc. |
| 5. | Gas chromatograph— Model 57348 | Quantitative and accurate analysis with automatic data reporting integrator |
| 6. | Gas chromatograph— Model GG-6 AMPF | To analyse biochemicals produced in biological reactions |
| 7. | Gas chromatograph— Perkin Elmer Sigma 3 | To analyse gas and liquid samples, equipped with TCD and FID with facility for temperature programming and fitted with a calculating integrator |
| 8. | Micromeritics Accusorb Model 2100 E | To measure the surface area of solid samples by low temperature adsorption of nitrogen employing the BET method |
| 9. | Perkin Elmer infrared spectrophotometer —Model 599 B | To analyse gas and liquid samples accurately with temperature programming facility |
| 10. | Pressure reaction apparatus | Agitated reactors made of stainless steel and Hastelloy material with facilities for automatic temperature, stirrer and speed control |
| 11. | Refrigerated high speed centrifuge | To carry out centrifugal separation of biological materials |
| 12. | Sonic oscillators | High intensity oscillator system used for carrying out operations like cell disruption and tissue homogenization |
| 13. | Spectrofluorometer — Amino SPF-125 | Useful for fluoroscence studies on enzymes, nucleic acids and other biochemicals |
| 14. | Thermal analyser lab. system | To measure dimensional changes in a sample as a function of temperature |
| 15. | Viscometer | To measure accurate viscosity of fluids at different temperatures |
| 16. | Zeiss fluoroscence microscope | Useful in the field of plant tissue culture and microbiology |
| 17. | X-ray unit | For clinical use in the NCL dispensary |

## 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 is not already established indigenously.

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

*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 expen*diture 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 additon 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 prorata.

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

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

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

## 2.2 Sponsored projects concluded during 1980-81

| Process | Party |
|---|---|
| 1. Citrate plasticizers : (i) tributyl citrate (ii) acetyl tributyl citrate | Sturdia Chemicals Ltd. Bombay |
| 2. Items having short shelf life | Hindustan Aeronautics Ltd., Nasik |
| 3. Studies in fluidization | Indian Petrochemicals Corpn. Ltd., Baroda |

## 2.3 Sponsored projects continued during 1980-81

| Process | Party |
|---|---|
| 1. Benzaldehyde by catalytic oxidation of toluene | Indian Organic Chemicals Ltd., Bombay |
| *2. Isolation of active alkaloids from *Vinca rosea* | Education & Youth Services Dept., S & T Cell, Govt. of Maharashtra, Bombay. |
| 3. Multiplication of teak by tissue culture | Forest Development Corpn. of Maharashtra Ltd., Nagpur |
| 4. Polycrystalline silicon-ultrapure | Grindwell Norton Ltd., Bombay |
| 5. N-Tridecyldiisopropanolamine | BASF (India) Ltd., Bombay |
| 6. New methods of synthesis of receptor drugs | CIPLA. Bombay |
| 7. Rosin derivatives and modified resins | Dujodwala Resins and Terpenes Pvt. Ltd., Bombay |
| *8. Total synthesis of antitumour anthracyclinones: Adriamycine and its analogues | Education & Employment Dept., S & T Cell, Govt. of Maharashtra Bombay |
| 9. Theophylline, aminophylline and caffeine | Dr. R. Maheshwari, Bombay |
| *10. Isolation, identification, characterization and clinical testing of ingredients of *Semecarpus anacardium* | Education & Youth Services Dept., S & T Cell, Govt. of Maharashtra Bombay and DST, New Delhi |
| 11. Propionic acid. | Deccan Sugar Institute, Pune |

## 2.4 Sponsored projects newly undertaken during 1980-81

| Process | Party |
|---|---|
| *1. Absorbing black paints for IR detectors | Dept. of Science & Technology, New Delhi |
| 2. Citrate plasticizers : (i) tributyl citrate (ii) acetyl tributyl citrate | Sturdia Chemicals Ltd., Bombay |
| 3. Development of a process for the manufacture of hydroxy terminated polybutadiene (HTPB) | The Explosives Research & Development Laboratory. Govt. of India (Ministry of Defence), Pune |
| *4. Development of IR spectrophotometer | Dept. of Science and Technology, New Delhi |
| 5. Doxepin and Ketoprofen | CIPLA, Bombay |

* Undertaken/supported under grant-in-aid programme

## 2.5 Collaborative work

As mentioned earlier the laboratory is collaborating with the industry on some important projects that are engineering-intensive and which involve development of complex technologies with high investment risk.

*General terms and conditions for collaborative work* :

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 their 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-commerical 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 wil 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 (that will be based on the design data collected on 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 an appropriate time.

(ix) The collaborating firm will be charged certain royalty on 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 he has 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/ royalty 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 1980-81

| Process | Collaborating firm |
|---|---|
| 1. Butene diol | Hindustan Organic Chemicals Ltd., Rasayani |
| 2. Ethylene oxide/glycol | Engineers India Ltd., New Delhi |
| 3. Hexachlorocyclopentadiene | Hindustan Organic Chemicals Ltd., Rasayani |
| 4. Methylchlorosilanes | Hico Products Ltd., Bombay |
| 5. Regular packing development | 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 different 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 1980-81

| Process | Licensee |
|---|---|
| 1. Carboxin (technical) | Luxmi Traders, Calcutta and their consultants R. L. Dalal and Co., Bombay |
| 2. Integrated hexachlorocyclopentadiene (HCCP) pilot plant | Hindustan Organic Chemicals Ltd., Rasayani |
| 3. Phthalates—dibutyl/dioctyl | Mysore Petro Chemicals Ltd., Bangalore |
| 4. Quinapyramine sulphate and chloride (QSC) | Chintamani Fine Chemicals, Pune |
| 5. Silver paste for mica capacitor electrodes | Luxmi Traders, Calcutta |

### 3.3 Processes released during 1980-81

| Process | Licensee |
|---|---|
| 1. Dichloropropionic acid (Dalapon) | Banda Vasudeo Rao, Hyderabad |
| 2. Integrated pilot plant for the manufacture of terpineol from turpentine oil | Central Research Organisation, Rangoon (Burma) |
| 3. Quinapyramine sulphate and chloride (QSC) | Chintamani Fine Chemicals, Pune |
| 4. Silver paste for mica capacitor electrodes | Luxmi Traders, Calcutta |

## 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 industries. 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 stated below :

(1) Abhi Chemical and Pharmaceutical Pvt. Ltd., Pune

Under this consultancy, technical advice and assistance relating to examining literature and providing general technical advice regarding technical documents for the manufacture of the drug Acetazolamide, referred to by the company, was rendered.

(2) Century Enka Ltd., Pune

Advice was given on a possible process for upgrading the recovered caprolactam to a polymer grade caprolactam. A similar advice was also given for the caprolactam recovered from the depolymerization of nylon.

(3) 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 some basic drugs.

(4) Dalal Consultants & Engineers Pvt. Ltd., Bombay

NCL offered advice on the commissioning and start-up of the endosulfan plant installed at the site of Hindustan Insecticides Ltd., Udyogamandal, Kerala. The training programme and the start-up schedule were prepared jointly. NCL was associated in the precommissioning trials of the commercial plant.

(5) Diamines and Chemicals Ltd., Kalol (N. Gujarat)

Consultancy services were rendered to the company for the design, installation and commissioning 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.

(6) Dujodwala Resins and Terpenes Pvt. Ltd., Bombay

This consultancy was for (i) general technical advice and assistance in 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.

(7) Hamdard (Wakf) Laboratories (India), Delhi

General technical consultancy was provided for the party's proposed 100 kg herbal extraction and concentration plant.

(8) Hindustan Antibiotics Ltd., Pune

This advisory consultancy included improvement of recoveries of 6 APA in the plant, process optimization in the penicillin plant, improvement in Vit. C recovery and collaboration on other useful drugs and intermediates.

(9) Hindustan Organic Chemicals Ltd., Rasayani

Under this consultancy NCL offered advice on various problems related to the production of different chemicals in their plants. NCL suggested projects for consideration in the proposed expansion/diversification programmes. NCL also advised on the installation of the integrated pilot plants for butene diol and hexachlorocyclopentadiene projects on which development is being carried out jointly.

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

Consultancy services were rendered to the firm on (i) simulation of polycondensation reactor system to improve productivity and product quality, (ii) improvements in polymer processing with special reference to

spinning, (iii) removing various bottlenecks in production, and (iv) ideas on future lines of expansion.

(11) Shyam Chemicals Pvt. Ltd., Bombay

Consultancy was rendered to the party relating to (i) advice for improving the quality of copper chloride manufactured by the party, (ii) examination of any troubleshooting problems in manufacturing copper chloride referred to by the party and advice on the same.

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

Consultancy services were rendered to the firm on (i) improvement in productivity, (ii) improvement of product quality, (iii) removing various bottlenecks in production and (iv) ideas on future lines of expansion.

(13) Tata Engineering and Locomotive Co. (TELCO), Pimpri, Pune

Under this consultancy NCL worked out a detailed procedure based on chlorination in alkaline medium for the complete detoxification of the cyanide wastes

## 5. PREMIA AND ROYALTIES RECEIVED BY NRDC THROUGH NCL PROCESSES DURING 1980-81

### 5.1 Premia

| | Process | Firm | Premia received (Rs.) |
|---|---|---|---|
| 1. | Carboxin | Bharat Pulverising Mills P. Ltd., Bombay | 12,000* |
| 2. | Quinapyramine sulphate/chloride | Chintamani Fine Chemicals, Pune | 25,000* |
| 3. | Silver paste for mica capacitor electrodes | Luxmi Traders, Calcutta | 20,000 |

* Part payment

### 5.2 Royalties

| | Process | Firm | Royalties received (Rs.) |
|---|---|---|---|
| 1. | Can sealing composition based on nitrile rubber latex | Arya Chemical Works, Calcutta | 663·81 |
| 2. | Dimethoate | Shaw Wallace & Co. Ltd., Calcutta | 8,657·91 |
| 3. | Ethion | —do— | 6,581·88 |
| 4. | Foundry core binder | Card-Chem Industries, Hyderabad | 1,279·00 |
| 5. | Monoethylaniline | Atul Products Ltd., Atul | 83,798·36 |
| 6. | Polyurethane coatings | Cipy Chemicals, Pune | 2,052·35 |
| 7. | Polyurethane printing rollers | Sree Saraswaty Press Ltd., Calcutta | 8,840·04 |
| 8. | D. C. recording polarograph | Chromatography and Instruments Co, Baroda | 1,950·00 |
| 9. | Direct reading spectrophotometer/ colorimeter | Scientific Instruments Co. Ltd., Allahabad | 3,168·00 |

## 6. LECTURES AND SEMINARS

### 6.1 The following visiting scientists delivered lectures in the laboratory :

| Scientist | Subject |
|---|---|
| 1. Dr. D. Dadyburjor, Department of Chemical Engineering, Rensselear Polytechnic Institute, Troy, New York, USA | Sintering and regeneration of supported metal catalysts |
| 2. Dr. D. N. Deobagkar, Molecular Biology and Cell Biology Laboratory, Indian Institute of Science, Bangalore | Molecular regulation of gene expression in Drosophila |
| 3. Dr. (Miss) Bharati Dhruva, Department of Microbiology and Immunology, University of Illinois, USA | Integration *in vivo* into Simian virus 40 DNA of a sequence that resembles a certain family of genomic interspersed repeated sequences |
| 4. Prof. G. F. Froment, Director, Laboratorium voor Petrochemische Techniek, Gent, Belgium | Catalyst deactivation by coke formation |
| 5. Dr. M. Higgins, Biochemistry Department, Guy's Hospital Medical School, London, UK | Intracellular cholesterol control of synthesis and esterification |
| 6. Dr. Mazhar Husain, Department of Biochemistry and Biophysics, Molecular Biology Division, University of California, San Francisco, USA | Oxidative defluoronation by monooxygenases |
| 7. Dr. H. L. Jones, Unilever Research, UK | Clonal propagation of oil palm |
| 8. Dr. J. B. Joshi, Lecturer, Chemical Engineering, Bombay University Department of Chemical Technology, Bombay | Design of multiphase contactors |
| 9. Dr. K. M. Kale, Du Pont Experimental Station, Delaware, USA | Characterization of miceller and premiceller association and polymer surfactant interaction by surfactant specific electrodes |

| | Scientist | Subject |
|---|---|---|
| 10. | Dr. K. Kalyanam,<br>Indian Petrochemicals Corpn. Ltd.,<br>Baroda | C-13 NMR of synthetic polymers |
| 11. | Dr. M. J. Modak<br>Associate Member & Associate Professor,<br>School of Medical Sciences,<br>Sloan Kettering Institute and Cornell<br>University, USA. | Structure-function relationships in reverse transcriptase |
| 12. | Dr. R. Mutharasan,<br>Associate Professor of Chemical Engineering,<br>Drexel University,<br>Philadelphia, Pennsylvania,<br>USA | Ethenol fermentation in a cell immobilized column fermentor |
| 13. | Prof. J. R. A. Pearson,<br>Department of Chemical Engineering,<br>Imperial College of Science and Technology,<br>London, UK | (i) Fibre spinning : Modelling the steady state process<br>(ii) Fibre spinning : Instability and draw resonance<br>(iii) The mechanics of roller coating on to stretched webs<br>(iv) Twin screw extrusion of elastomers |
| 14. | Dr. V. Prakash,<br>Scientist,<br>Central Food Technological Research<br>Institute, Mysore | Interaction of proteins with solvent components in 8M urea |
| 15. | Prof. D. Ramakrishna,<br>School of Chemical Engineering,<br>Purdue University,<br>West Lafayette, Indiana,<br>USA. | (i) The prospects of population balances<br>(ii) Application of population balances to liquid-liquid systems<br>(iii) Statistical foundation of population balances<br>(iv) Linear operator methods in chemical engineering |
| 16. | Dr. R. Sanadi,<br>Boston Biomedical Research Institute,<br>USA | (i) Oxidative phosphorylation Part I : Role of coupling factors<br>(ii) Part II : Role of coupling factor B |
| 17. | Prof. Dr.-ing-Alfons Vogelpohl,<br>Technische Universitat,<br>Clausthal, W. Germany | (i) Hydrodynamics of three phase fluidized bed contactors<br>(ii) Backmixing in pulsed sieve extracted column |
| 18. | Prof. D. T. Wasan,<br>Department of Chemical Engineering,<br>Illinois Institute of Technology,<br>Chicago, USA | Foams, emulsions and surface rheology — theory and applications |
| 19. | Mr. W. Willemer.<br>Technical Leader,<br>Schleicher and Schull,<br>Dassel, W. Germany | Desalination by membrane separation technique |

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

| Scientist | Subject | Venue |
|---|---|---|
| 1. Dr. S. Badrinarayanan | Review of ESCA studies at the NCL | ESCA Workshop, Indian Institute of Technology, Delhi |
| 2. Mr. A. D. Deshpande | A series of four lectures on polymerization under the course Introduction to chemical engineering | Department of Chemistry, University of Poona, Pune |
| 3. Dr. (Miss) S. B. Kulkarni | Shape selective catalysis on synthetic zeolites | Under the joint auspices of the Chemical Society, Poona University and the Royal Chemical Society, London, University of Poona, Pune |
| 4. Dr. S. N. Kulkarni | Stereochemistry of natural cadinenes | Under the auspices of Dalton Society of the Chemistry Department, University of Karnatak, Dharwar |
| 5. Dr. V. M. Nadkarni | Recent advances in processing of polymeric composites, NPC | Symposium on Recent Advances in Composite Technologies, Madras |
| 6. Dr. U. R. Nayak | Lead tetraacetate mediated synthesis of some novel longifolene-derived oxygen heterocycles | Indian Institute of Science, Bangalore |
| 7. Dr. G. T. Panse | The use of polymeric supports/reagents in organic synthesis | Department of Chemistry, University of Poona, Pune |
| 8. Dr. P. A. Ramachandran | (i) Analysis of role of mass transfer in complex three-phase reaction systems<br>(ii) Modelling of semi-batch and continuous three-phase reactors<br>(iii) Hydrodynamics and mass transfer aspects of various types of three-phase reactors | Chemical Engineering Department, Indian Institute of Science, Bangalore |
| 9. Dr. P. K. Ranjekar | (i) Genome organization in Eukaryotes- a series of four lectures | Zoology Department, University of Poona, Pune |
| | (ii) (a) Satellite and repetitive DNA in Eukaryotes<br>(b) DNA sequence organization in Eukaryotes | Department of Biochemistry, Indian Institute of Science, Bangalore |

| Scientist | Subject | Venue |
|---|---|---|
| 10. Dr. Paul Ratnasamy | (i) Alkylation, isomerization and *transalkylation of aromatics over* Hysil | R & D Centre. Indian Petro-*chemicals Corpn. Ltd., Baroda* |
| | (ii) Catalysis in the post-petroleum era | Loyola College, Madras |
| 11. Mr. S. R. Sainkar | Electron spectroscopy for chemical analysis | University of Poona, Pune |
| 12. Dr. C. SivaRaman | (i) Analytical ultracentrifugation theory and principles | University of Poona, Pune |
| | (ii) Analytical ultracentrifugation practice | |
| | (iii) Protein folding | |
| | (iv) Quaternary structure of proteins | |
| 13. Dr. A. J. Varma | (i) Interactions of ions and ion-pairs by crown ethers and their polymers | Department of Chemistry, University of Poona, Pune |
| | (ii) A series of four lectures on polymer chemistry | |

### 6.3 Seminars / Workshops / Special training courses, etc. organized by/at NCL

(1) The 6th Indo-Soviet Symposium on the Chemistry of Natural Products was held at the NCL from 28th January to 1st February 1981. About 70 delegates including 13 from the USSR participated in the symposium. Nine plenary lectures and 36 invited lectures were delivered. Twenty-four papers were presented at the symposium.

The following invited lectures were delivered by NCL scientists :

(i) Dr. A. V. Rama Rao—Studies directed towards total synthesis of adriamycine and its analogues

(ii) Dr. U. R. Nayak—Logifolene : A dream molecule of the organic chemist

The following papers were presented by NCL scientists :

(i) Narayanan, C. R. and Sawaikar, D. D., Novel epoxide reactions of pentacyclic tri-terpenes.

(ii) Sanghvi, Y. S. and Rao, A. S., Synthesis of naturally occurring isobutyrates and oxygenated oxiranes related to thymol.

(iii) Purohit, P. C., Naik, V. G. and Sonawane, H. R., Photochemistry of (+)-4- ∝-acetyl-2 carene.

(iv) Patwardhan (Mrs.), S. A. and Gupta, A. S., Flavones in labiateae.

(v) Bhat, U. G. and Nagasampagi, B. A., New sesquiterpenoids from *Nanothamnus sericeous*.

(2) An All India Seminar on Polymers as Engineering Materials was held at the NCL on 28 March 1981 under the auspices of Indian Institute of Chemical Engineers (Poona Regional Centre).

Dr. L. K. Doraiswamy delivered the key-note address on Polymers as Engineering Materials. Dr. V. M Nadkarni gave a talk on Materials Engineering of Polymers in the first technical session.

Dr. N. D. Ghatge and Dr. Nadkarni attended the panel discussion on industry-academia interaction in the polymer field on behalf of NCL.

## 7. STAFF STRENGTH* (as on 31-3-81)

| | | | |
|---|---|---|---|
| 1. | Scientific | | |
| | (i) | Director | 1 |
| | (ii) | Dy. Director | 1 |
| | (iii) | Scientist F | 4 |
| | (iv) | Scientist EII | 6 |
| | (v) | Scientist EI | 37 |
| | (vi) | Scientist C | 75 |
| | (vii) | Scientist B | 68 |
| | (viii) | Scientist A | 56 |
| | (ix) | S. S. A. | 91 |
| | (x) | J. S. A. (Scientific Assistant Gd. VIII) | 35 |
| | (xi) | S. L. A.** (Gd. VII) | 89 |
| | | Total | 463 |
| 2. | Technical | | 253 |
| 3. | Administration | | 153 |
| 4. | Class IV technical | | 147 |
| 5. | Class IV non-technical | | 79 |
| | | Total (1-5) | 1095 |
| 6. | Research Fellows, Pool Officers, Guest Workers and Graduate Trainees | | |
| | (i) | JRFs, SRFs and PDFs | 66 |
| | (ii) | CSIR Pool Officers | 4 |
| | (iii) | Guest Workers | 4 |
| | (iv) | Graduate Trainees | 6 |
| | (v) | U. G. C. Teacher-Fellows | 8 |
| | (vi) | U. G. C. JRFs | 2 |
| | | Total | 90 |
| 7. | Scientific staff appointed for sponsored projects | | 31 |

* Denotes staff in position.

** Senior Laboratory Assistants (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. L. K. Doraiswamy, Director, has been appointed Visiting Professor in the Department of Chemical Engineering, University of Salford, UK; was invited by the University Grants Commission to be a national lecturer for the year 1980-81; and is the recipient of the Prof. N. R. Kuloor Memorial Lecturership for the year 1980.

2. Dr. R. B. Mitra, Deputy Director, was awarded the Dr. K. G. Naik Gold Medal by the M. S. University, Baroda, for the year 1979.

3. Dr. N. G. Karanth was awarded the Amar Dye-Chem Award for Excellence in Research and Development in Chemical Engineering for the year 1980 by the Indian Institute of Chemical Engineers.

4. Dr. Paul Ratnasamy was elected Secretary of the Catalysis Society of India for two years at the 5th National Catalysis Symposium held at Regional Research Laboratory, Hyderabad, in December, 1980.

5. Dr. S. C. Sethi was awarded the NRDC Independence Day Award for the development of a process for *p*-Menthane hydroperoxide.

6. Dr. N. R. Ayyangar was elected Fellow of the Maharashtra Academy of Sciences.

7. Mr. P. P. Moghe has been appointed as an honorary consultant to the Disease Investigation Section, Maharashtra State, Pune, and the Industrial Chemical Laboratory, Pune, for rendering assistance on pollution problems and disposal of industrial wastes respectively.

8. Mr. C. H. Patil was awarded the third prize in the Fifth Industrial Safety Poster Competition-1980, organized by the Council of Industrial Safety (Maharashtra State Branch of the National Safety Council) Bombay.

## 8.2 Deputations/Visits abroad

1. Dr. L. K. Doraiswamy visited USA to attend the International Bioenergy Conference held at Atlanta. He also visited various laboratories in USA (20th April to 10th May 1980).

2. Dr. V. R. Choudhary was deputed to W. Germany to carry out research in the field of heterogeneous catalysis (on Zeolite catalysts) at the Enyler-Bunte-Institute (division of gas, coal and petroleum) of the University of Karlsruhe, and to attend the 15th International Seminar on Research and Education in Physical Chemistry and Chemical Engineering held at the same university. He visited a number of industrial complexes in W. Germany, viz., Bayer, Hoechst, Dynamite Nobel, Braun Coal, etc. and also attended the 5th International Conference of Zeolites held at Naples (Italy) in June 1980 (1st May 1979 to 15th July 1980).

3. Dr. L. K. Doraiswamy participated in the 3rd Engineering Foundation Conference on Fluidization held at Henniker, New Hampshire, USA, and presented a paper on Criteria for Temperature Multiplicity in Fluidized Bed Reactors. He also visited a few centres of chemical engineering research in USA (2nd August to 8th August 1980).

4. Dr. A. S. Rao was deputed to Cairo, Egypt, under the Indo-ARE agreement for scientific and technical co-operation, to ascertain and discuss the development of technology on organophosphorus compounds (pesticides) and other natural products (29th September to 14th October 1980).

5. Dr. S. M. Abhyankar was deputed to France under the CSIR-CNRS exchange programme for 1980-81, to get himself acquainted with the latest techniques used in the field of catalytic reactions and gas-solid reactions (1st October to 6th November 1980).

6. Dr. (Miss) S. B. Kulkarni was deputed to USA under CSIR-NSF exchange of scientists programme. She visited chemical engineering, surface science and catalysis laboratories at universities in Wisconsin, Utah, Stanford, California, Texas and Worcester. She also visited Zeopower Company which is engaged in the application of zeolites for solar refrigerators at Massachusetts (30th October to 6th December 1980).

7. Dr. R. V. Chaudhari was deputed to W. Germany under the CSIR-DAAD exchange of scientists programme. He worked in the field of homogeneous catalysis and reaction engineering at the Technische Chemie Institute of the University of Erlangen and visited several other laboratories in W. Germany. Dr. Chaudhari also visited the Department of Chemical Engineering, University of Edinburgh, Scotland,and Technische Chemie Laboratory of Eidgenossische Technische Hochschule, Zurich, to give invited lectures (1st December 1980 to 15th February 1981).

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

| Seminar/Symposium/Conference | Scientists |
|---|---|
| 1. Workshop on Financial Management in R & D, CSIR, New Delhi | Mrs. S. S. Adke<br>Mr. M. A. Baig |
| 2. Scanning Electron Microscopy, University of Poona, Pune | Dr. S. Badrinarayanan<br>Mr. S. R. Sainkar<br>Mr. R. I. Hegde<br>Dr. (Mrs.) A. Mitra<br>Mr. C. D. George<br>Dr. Prabhat Singh |
| 3. ESCA Workshop, IIT, Delhi | Dr. S. Badrinarayanan<br>Mr. S. R. Sainkar |
| 4. Lecture series on Recent Advances in Inorganic Acids Industry, Bombay, under the auspices of Indian Chemical Manufacturers' Association | Dr. V. Damodaran |
| 5. International Symposium on Trace Analysis and Technological Development, BARC, Bombay | Dr. V. Damodaran |
| 6. 21st Annual Conference of the Association of Microbiologists of India, Bombay | Mr. M. V. Deshpande |
| 7. 33rd Annual Session of the Indian Institute of Chemical Engineering, IIT. Delhi | Dr. L. K. Doraiswamy<br>Dr. R. A. Mashelkar<br>Dr. V. S. Patwardhan<br>Dr. N. G. Karanth<br>Mr. D. D. Ravetkar |
| 8. Safety aspects in the Research Applications of Ionizing Radiations, BARC, Bombay | Mr. P. K. Gupta |
| 9. 7th Course on Administrative Management in R & D, Hyderabad | Mr. P. K. Maheshwari<br>Mr. B. M. Gowaikar |
| 10. National Seminar on Turmeric and Ginger, Calicut | Dr. A. F. Mascarenhas |
| 11. International Conference on Structure Property Relations of Rubber, IIT, Kharagpur | Dr Navin Chand<br>Mr. N. N. Maldar |
| 12. 9th National Seminar of IASLIC (Indian Association of Special Libraries and Information Centres), Nagpur | Mr. M. B. Patil |

| Seminar/Symposium/Conference | Scientist |
|---|---|
| 13. 5th National Symposium on Catalysis, Hyderabad | Dr. Paul Ratnasamy<br>Dr. V. R. Choudhary<br>Dr. S. J. Kulkarni<br>Dr. V. P. Shiralkar<br>Mr. A. N. Kotasthane |
| 14. National Seminar on Accoustics and Ultrasonics, Allahabad | Dr P. Roy-Chowdhury |
| 15 Conference on Ferroelectrics, IIT, Delhi | Dr P. Roy-Chowdhury |
| 16. Surface and Interface Properties in Materials Science, Roorkee | Mr. S. R. Sainkar<br>Mr. R. I. Hegde |
| 17. Symposium on Electron Microscopy, Vallabh Vidyanagar | Mr. S. R. Sainkar<br>Mr. C. D. George |
| 18. Seminar on The Chemistry of Natural Products, Vikram University, Ujjain | Dr. S. C. Sethi<br>Mr. A. D. Natu |
| 19. Seminar on A Perspective of the Perfumes and Flavours Industry in India, New Delhi | Dr. S. C. Sethi |
| 20. Courses on PL/1 Programming conducted by DST under NISSAT scheme, New Delhi | Mr. R. S. Singh |
| 21. Electronic devices—Development and Future Trends, Institute of Engineers, Pune | Dr. A. P. B. Sinha<br>Mr. M. S. Setty<br>Dr. (Miss) N. R. Pavaskar<br>Mr. D. P. Amalnerkar |
| 22. Workshop on Electronic Components and Materials Technology Development, New Delhi | Dr. A. P. B. Sinha<br>Dr. M. N. S. Murthy<br>Mr M S. Setty |
| 23. 2nd International Conference of FAOB/SBC (I) Golden Jubilee Session, IISc., Bangalore | Dr. C. SivaRaman<br>Mr. A. H. Lachke<br>Mr. C. P. Joshi<br>Mrs. V. Gupta<br>Miss Laxmi SivaRaman |
| 24. International Conference on Theoretical Biochemistry and Biophysics, Goa | Dr. R. Tewari |
| 25. 6th All India Plant Tissue Culture Conference, University of Poona, Pune | The entire tissue culture group of the Biochemistry Division. |

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

| | Scientist | Subject |
|---|---|---|
| 1. | Dr. L. K. Doraiswamy | (i) Inaugurated the Institute of Science (Bombay) Diamond Jubilee Symposium on Solvent Extraction (September 1980)<br>(ii) Delivered the K. H. Kabbur Memorial Lecture (1978) at the BUDCT, Bombay on Design of Fluid Bed Reactors for Complex Reactions (September 1980)<br>(iii) Chaired the Panel discussion on Industrial Sickness : Causes and Remedies organized by the Indian Institute of Chemical Engineers (Pune Regional Centre) in collaboration with the Bank of Maharashtra, Mahratta Chamber of Commerce and Industries, and Maharashtra State Financial Corporation (September 1980)<br>(iv) Delivered the N. R Kuloor Memorial Lecture (1980) on (a) Some Aspects of Fluidized Bed Modelling, (b) Catalyst Deactivation, (c) A Case Study in Process Design at IISc, Bangalore (January 1981)<br>(v) Key-note lecture on Chemical Engineering Research in India at 61st Annual Convention of Institution of Engineers, Hyderabad (February 1981)<br>(vi) Inaugurated the seminar on Catalysis Design : Some Guidelines at BUDCT, Bombay (February 1981) |
| 2. | Dr. V. N. Gogte | An invited lecture on the Manufacture of Drug Intermediates : Scope, Opportunities and Hurdles at the meeting jointly organized by IDMA, DG-Trade Development and SSIS Centre, Bombay |
| 3. | Dr. V. Jagannathan | Key-note lecture at the 6th All India Plant Tissue Culture Conference on History of Plant Tissue Culture and its Potential Use in Agriculture at Pune (February 1981) |
| 4. | Dr. N. G. Karanth | Co-Chairman, Session on Biochemical Engineering at the 33rd Annual Session of Indian Institute of Chemical Engineers, IIT, Delhi (December 1980) |
| 5. | Dr. R. A. Mashelkar | Chairman, Session on Fluid Mechanics at the 33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi (December 1980) |
| 6. | Dr. C. R. Narayanan | An invited lecture on Reactions of Some Steroid Epoxides at the Annual Convention of Chemists, IIT, Bombay (December 1980) |
| 7. | Dr. V. S. Patwardhan | Co-Chairman, Session on Separation Techniques at the 33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi (December 1980) |
| 8. | Dr. A. V. Rama Rao | Key-note address on Pointers and Pathways in Drug Synthesis at the 18th Annual Celebrations of IDMA, Bombay (December 1980) |
| 9. | Dr. A. P. B. Sinha | (i) Chaired Session III on Optoelectronic Devices and Transducers of the Symposium on Electronic Devices-Development and Future Trends organized by the Institution of Electronic and Telecommunication Engineers, Poona Centre at the Institute of Engineers, Pune (September 1980)<br>(ii) Key-note address on Materials at Workshop on Electronic Components and Materials Technology Development, Vigyan Bhavan, New Delhi (December 1980) |
| 10. | Dr. C. SivaRaman | (i) Inaugural talk of the Society of Biological Chemists of India, Poona Branch on Studies on Bacterial Citrate Lyase at the University of Poona, Pune (November 1980)<br>(ii) An invited lecture on Structure—Function Relationships in Bacterial Citrate Lyase at 2nd International Conference of FAOB/SBC (I) Golden Jubilee Session at IISc, Bangalore (December 1980) |

## 8.5 Membership of Committees

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

| Scientist | | Name of the Committee |
|---|---|---|
| 1. Dr. K. G. Das | Member | American Society for Mass spectrometry |
| | Member | Indian Society for Mass spectrometry |
| | Alternate Member | ISI Chemical Division Council |
| | Member | Natural and Synthetic Perfumery Materials Sectional Committee PCDC 18, ISI |
| | Member | Controlled Release Society. USA |
| | Regional Editor | Mass Spectrometry Reviews, USA |
| 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 | CSIR—Core Committee Awards JRF/SRF |
| | 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 | Editorial Advisory Board of the ICMA-(Chemical Industry News) and ICMA Awards Committee |

| Scientist | | Name of the Committee |
|---|---|---|
| 2. Dr. L. K. Doraiswamy (Contd.) | 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 & 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 |
| 3. Dr. N. D. Ghatge | Member | Governing Council of Indian Rubber Manufacturers' Research Association, Bombay |
| | Member | Periodical Evaluation of the Activities of Rubber Research Institute of India, Kottayam |
| 4. Dr. V. Jagannathan | Member | Biochemical and Microbiology Research Committee, CSIR, New Delhi |
| | Member | Hindustan Lever Research Foundation—Scientific Panel on Agriculture, Animal Husbandry and Industrial Chemicals, Bombay |
| | Member | Editorial Board, Indian Journal of Biochemistry and Biophysics, New Delhi |
| | Member | Maharashtra Academy of Sciences |
| 5. Dr. R. A. Mashelkar | Member | Editorial Board of Chemical Engineering Communications published by Gordon Breach (USA) |
| | Member | Publications Committee—Indian Chemical Engineer |
| | Member | Reviewers' Board—Applied Mechanics Reviews (S. E. Res. Inst., Texas, USA) |
| | Member Secretary | Executive Committee—Indian Institute of Chemical Engineers (Poona Local Centre) |
| | Member | Experts Committee in Chemical Engineering, Govt. of Maharashtra |
| | Associate Editor | Review series published by Wiley Eastern/John Wiley |
| | Member | CSIR Research Fellowships and Post—doctoral Fellowships in Engineering Sciences Committee |
| | Member | CSIR Expert Committee in Materials Sciences and Chemical Engineering |
| | Member | Expert Committee on Selection of Nuffield Foundation Fellows |

| Scientist | | Name of the Committee |
|---|---|---|
| 6. 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 |
| | Member | Biological Sciences Committee, Palampur (HP) constituted by CSIR |
| | Member | Small Industries Service Institute, Bombay |
| 7. Dr. S. C. Sethi | Member | Natural and Synthetic Perfumery Materials Sectional Committee, PCDC 18, ISI, New Delhi |
| 8. Dr. A. P. B. Sinha | Member | Chemical Research Committee, CSIR, New Delhi |
| | Member | Material Research Committee, Dept. of Atomic Energy, Govt. of India |
| | Member | Sub-committee on High Temperature Materials, International Union of Pure and Applied Chemistry |
| 9. Dr. C. SivaRaman | Member | Guha Research Conference, Chorwad (Gujarat) |
| | Member | Indian Academy of Sciences, Bangalore |
| | Member | Indian National Committee for the International Union of Biochemistry (IUB), INSA, New Delhi |

## 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. Anilkumar | Ph. D. | Poona | Thermodynamics of binary non-electrolytic mixtures | Dr. S. S. Katti |
| 2. | Mrs. N. V. Bhaferao | M. Sc. | Poona | New stationary phases for gas-liquid chromatography, analytical technique | Dr. B. B. Ghatge |
| 3. | Mr. C. Bhaskar | M. Sc. | Poona | Kinetic studies of ethyl methacrylate polymerization | Dr. N. D. Ghatge |
| 4. | Mrs. Sunanda Bhole | Ph. D. | Poona | Optical induction | Dr. V. N. Gogte |
| 5. | Mr. G. M. Chaphekar | M.Tech. | IIT, Bombay | Chlorination of ferrosilicon | Prof. G. Mandal* |
| 6. | Mrs. V. S. Dalavoy | M. Sc. | Poona | Studies on 10-undecenoic acid : A versatile synthon from castor oil | Dr. U. R. Nayak |
| 7. | Mr. H. G. Damle | Ph. D. | Poona | Studies in molten salt binary mixtures | Dr. S. S. Katti |
| 8. | Mr. M. N. Deshmukh | Ph. D. | Poona | Chemical investigation of some Indian medicinal plants and synthesis of some biologically active compounds | Dr. A. V. Rama Rao |
| 9. | Mr. R. P. Deshpande | Ph. D. | Poona | Studies in sesquiterpenes (Novel reactions of longifolene) | Dr. U. R. Nayak |
| 10. | Mr. V. V. Dhekne | Ph. D. | Bombay | Synthesis and transformation of oxygenated alkyl and alkenyl aromatic compounds | Dr. A. S. Rao |
| 11. | Mr. C. D. George | M. Sc. | Poona | Structures and semiconducting properties of some thin films | Dr. A. Goswami |
| 12. | Mr. P. N. Khanna | Ph. D. | Bombay | Useful synthons of biologically active compounds | Dr R. B. Mitra |
| 13. | Mr. P. B. Kokil | Ph. D. | Shivaji | Studies on the chemistry of trivalent iodine and the oxygenation of aromatic compounds | Dr. P. M. Nair |
| 14. | Mr. B. M. Mane | Ph. D. | Poona | Isolation and transformation of naturally occurring terpenes | Dr. G. H. Kulkarni |
| 15. | Miss Uma Mehra | Ph. D. | Poona | Structure and organization of Eukaryotic genomes with special reference to those of bovine, buffalo, goat and sheep | Dr. P. K. Ranjekar |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 16. | Mr. Navin Chand | Ph.D. (Text.) | IIT, New Delhi | Investigations on the structure of polymers and fibres through dielectric relaxations | Dr. A. K. Gupta* |
| 17. | Mr. G. G. Pai | Ph. D. | Poona | Synthetic studies in steroidal intermediates | Dr. B. D. Tilak |
| 18. | Mr. P. P. Pai | Ph. D. | Poona | Investigation of natural terpenoids and their transformation products | Dr. G. H. Kulkarni |
| 19. | Mr. P. R. Pednekar | Ph. D. | Bombay | Terpenoids | Dr. K. K. Chakravarti |
| 20. | Mr. J. G. Shewale | Ph. D. | Poona | Studies on cellulases | Dr. J. C. Sadana |
| 21. | Mrs. H. SivaRaman | Ph. D. | Bombay | Microbial enzymes | Drs. M. R. Raghavendra Rao*/C. SivaRaman |
| 22. | Miss Malathi Seshadri | Ph. D. | Poona | Study of nucleic acids:DNA comparison of *Phaseolus* plant species | Dr. P. K. Ranjekar |
| 23. | Mr. S. M. Toke | M. Sc. | Poona | Nucleophilic reactions of 1, 3-dimethyl-6-thiouracil | Dr. R. B. Mitra |

* Guides not from NCL

## 8.7 NCL Scientists recognized by different universities as research guides

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

| | | |
|---|---|---|
| 26. | Dr. Mashelkar, R. A. | Banaras, Bombay, Nagpur, Poona, Salford (UK) |
| 27. | Dr. Mitra, R. B. | Bombay, Poona |
| 28. | Dr. Murthy, M. N. S. | Poona |
| 29. | Dr. Nair, P. M. | Andhra, Poona, Shivaji |
| 30. | Dr. Nagasampagi, B. A. | Poona |
| 31. | Dr. Nanavati, D. D. | Bombay, Poona |
| 32. | Dr. Nayak, U. R. | Poona, Shivaji |
| 33. | Dr. Pansare, V. S. | Poona |
| 34. | Dr. Panse, G. T. | Shivaji |
| 35. | Dr. Pant, L. M. | Poona |
| 36. | Dr. Patwardhan, V. S. | Shivaji |
| 37. | Dr. Rama Rao, A. V. | Bombay, Poona, Shivaji |
| 38. | Dr. Ranjekar, P. K. | Poona |
| 39 | Dr. Rao, A. S. | Bombay, Poona, Shivaji |
| 40. | Dr. Ravindranathan, T. | Bombay, Marathwada, Shivaji |
| 41. | Dr. Roy-Chowdhury, P. | Marathwada, Poona, Shivaji |
| 42.* | Dr. Sadana, J. C. | Aligarh, Poona |
| 43. | Dr. Sen, D. N. | Bombay, Poona, Shivaji |
| 44. | Dr. Sethi, S. C. | Poona |
| 45. | Dr. Sharma, R. N. | Poona, Shivaji |
| 46. | Dr. Sinha, A. P. B. | Banaras, Bombay, Poona, Shivaji |
| 47. | Dr. SivaRaman, C. | Poona |
| 48. | Dr. Sonawane, H. R. | Poona |
| 49. | Dr. Tewari, R. | Poona |
| 50. | Dr. Umapathy, P. | Poona |
| 51. | Dr. Vartak, H. G. | Poona |

*Retired/Emeritus scientists

## 9. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

1. Sethi, S. C. and Natu, A. D.,
   Autooxidation of terpenes,
   Seminar on the Chemistry of Natural Products, Vikram University, Ujjain, June 1980.

2. Amalnerkar, D. P., Setty, M. S., Pavaskar (Miss), N. R. and Sinha, A. P. B.,
   Optoelectronic properties of cadmium sulphide thick films
   Symposium on Electronic Devices-Development and Future Trends organized by the Institution of Electronic and Telecommunication Engineers, Poona, September 1980.

3. Deshpande, M. V. Shewale, J. G. and Sadana, J. C.,
   Coupled saccharification/fermentation of cellulose to ethanol using *S. rolfsii* culture filtrate, 21st Annual Conference of the Association of Microbiologists of India, Bombay, October 1980.

4. Hegde, R. I., Sainkar, S. R. and Badrinarayanan, S.,
   Effect of near neighbour interactions on core electron levels in dilute tin alloys-XPS study,
   Symposium on Surface and Interface Properties in Materials Science, University of Roorkee, October 1980.

5. Sainkar, S. R. and Badrinarayanan, S.,
   X-ray photoelectron spectroscopic studies on some solid state devices,
   Symposium on Surface and Interface Properties in Materials Science, University of Roorkee, October 1980.

6 Roy-Chowdhury, P.,
   Studies of polyelectrolytes and polyampholytes by adiabatic compressibility measurements, National Seminar on Acoustics and Ultrasonics, University of Allahabad, October 1980.

7. Murthy, M. N. S., Deshpande, C. E., Bakare, P. P. and Shrotri (Mrs.), J. J.,
   Professional soft ferrites : Manganous zinc ferrous ferrites,
   Workshop on Electronic Components and Materials Technology Development, New Delhi, November 1980.

8. Balakrishnan, I, Rao, B. S., Shiralkar V. P., Kotasthane, A. N., Kulkarni, S. J., Chandwadkar (Mrs.) A. J., Kulkarni (Miss), S. B. and Ratnasamy, P.
   Conversion of methanol and ethanol to BTX aromatics over high silica zeolite catalysts, 5th National Catalysis Symposium, Hyderabad, December 1980.

9. Doraiswamy, L. K. and Rajan, J. V.,
   Fuels and feedstock for chemical industry in the 1980's,
   33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi, December 1980.

10. Deshpande (Miss), V., Laxmi (Miss), S. and Ranjekar P. K.,
    Nuclear DNA comparison of three millet species,
    2nd Congress of Golden Jubilee Annual Meeting of the Society of Biological Chemists ( India ), IISc, Bangalore, December 1980.

11. George, C.D., Mitra (Mrs.), A. and Sinha, A.P.B.,
    Electron microscopic studies on solar selective coatings,
    Symposium on Electron Microscopy, Vallabh Vidyanagar, December 1980.

12. Ghosh, B. K., Jogdand, V. V., Karanth, N. G., Vyas (Mrs.), A. K., Subramanian, S. S. and SivaRaman, C.,
    Some aspects of conversion of sorbitol to sorbose by microbial whole cells,
    33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi, December 1980.

13. Joshi, C. P. and Ranjekar, P. K.
    A novel technique of chromosome banding,
    2nd Congress of FAOB/SBC(I), Golden Jubilee Session, IISc, Bangalore, December 1980.

14. Kulkarni, S. J. and Kulkarni (Miss), S. B.,
    Dehydrogenation of ethyl benzene on crystalline aluminosilicates,
    5th National Catalysis Symposium, Hyderabad, December 1980.

15. Lachke, A. H., Sadana, J. C. and Gundiah, S.,
Viscometric assay of endoglucanases of *S. rolfsii*,
2nd Congress of Oceanian Biochemists, Golden Jubilee Annual Meeting of Biological Chemists (India), IISc, Bangalore, December 1980.

16. Maldar, N. N.
Vulcanization of butyl rubber, curative effects of 2-pentadecylbenzoquinonedioxime,
International Conference on Structure Property Relations of Rubber, IIT, Kharagpur, December 1980.

17. Manchanda, A. C., Jogdand, V. V. and Karanth, N. G.,
Studies on the rheology of cellulose fermentation broths using a penicillium strain,
33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi, December 1980.

18. Patwardhan, V. S.,
Liquid distribution in a packed trickle bed,
33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi, December 1980.

19. Ravetkar, D. D. and Ramachandran, P. A.,
Computer simulation of azeotropic distillation columns,
33rd Annual Session of the Indian Institute of Chemical Engineers, IIT, Delhi, December 1980.

20. Roy-Chowdhury, P.
Piezoelectric ceramic $Pb_{0\cdot94}\ Sr_{0\cdot06}\ (Ti_{0\cdot47}\ Zr_{0\cdot53})O_3$ +0·05 Wt % NiO modified by Pb $(Ti_{0\cdot455}\ Zr_{0\cdot245}\ Sn_{0\cdot300})_3$+Wt % Rare Earth Oxide,
Conference on Ferroelectric, IIT, Delhi, December 1980.

21. Sainkar, S. R. and Sinha, A. P. B.,
Electron microscopic studies on intergranular layers of zinc oxide ceramic,
Symposium on Electron Microscopy, Vallabh Vidyanagar, December 1980.

22. Choudhary, V. R.,
Temperature programmed desorption under chromatographic conditions,
5th National Symposium on Catalysis Hyderabad, December 1980.

23. Sinha, A. P. B., Murthy, M. N. S. and Setty, M. S.,
Papers on important electronic materials, high permeability ferrites and thick film materials respectively,
Workshop on Electronic Components and Materials Technology Development, New Delhi, December 1980.

24. Tewari, R.,
Factors influencing the extent of backbone flexibility in single stranded polynucleotides,
International Conference on Theoretical Biochemistry and Biophysics, Goa, December 1980.

25. Gupta, P. K., Iyer (Miss), R. and Mascarenhas, A. F.,
Tissue culture of fruit trees : Rapid clonal multiplication of *Punica granatum* (Pomegranate) from mature trees,
6th All India Plant Tissue Culture Conference, Pune, February 1981.

26. Kulkarni, V. M., Mehta (Mrs.) ,U., Gupta, P. K. and Mascarenhas A. F.,
Tissue culture of woody trees : Clonal propagation of *Tamarindus indica* L. (Tamarind) by tissue culture,
6th All India Plant Tissue Culture Conference, Pune, February 1981.

27. Nadgauda (Mrs.), R. S., Mascarenhas, A. F. and Jagannathan, V.,
Tissue culture of plantation crops : Clonal multiplication of *Electaria cardamom*,
6th All India Plant Tissue Culture Conference, Pune, February 1981.

28. Murthy, M. N. S. and Deshpande, C. E.,
Stabilization of unstable oxides,
Indo-US Workshop on Preparation and Characterization of Materials, IISc, Bangalore, February 1981.

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

5. 144875 (23/DEL/76)
   Improved continuous high pressure process for hydrogenation of glucose to produce sorbitol.
   Brahme P. H. and Verma, R. P.

6. 146029 (1463/CAL/76)
   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.

7. 146327 (70/DEL/77)
   Improvements in or relating to the preparation of *o*-isopropylphenols.
   Divakar, K. J., Dhekne, V. V., Kulkarni (Mrs.), B. S. and Rao, A. S.

8. 147337 (48/DEL/77)
   Improvements in or relating to the preparation of laevomenthol.
   Divakar, K. J., Kulkarni, S. B. and Rao, A. S.

9. 147527 (523/DEL/77)
   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.

### Indian patent applications accepted

1. 144636 (1328/CAL/76)
   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.

2. 146272 (76/DEL/77)
   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.

3. 147817 (15/DEL/78)
   A process for the preparation of new red triazinylazonaphthol disperse dyes for polyester fibres.
   Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

4. 147825 (14/DEL/78)
   Process for the preparation of new yellow pyrimidanthronyl triazine disperse dyes for polyester fibres.
   Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

5. 147868 (59/DEL/78)
   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.

6. 147994 (16/DEL/78)
   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.

7. 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.

8. 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.

9. 148159 (20/DEL/79)

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.

10. 148462 (558/DEL/78)

A process for the preparation of new yellow to scarlet azo cationic dyes using para-amino-phenacyltrimethyl-ammonium chloride as the diazo component for application to polyacrylonitrile fibres.

Ayyangar, N. R. and Khanna, I. K.

**Indian patent applications filed**

1. 113703

Improvements in or relating to magnesium zinc ferrites.

Krishna Rao, V. V., Kanade (Miss), S. B. and Sinha, A. P. B.

2. 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.

3. 318/DEL/78

A process for the preparation of new yellow to violet azo-N-substituted homophthalimide disperse dyes for synthetic fibres.

Ayyangar, N. R., Rao, U. S. and Tilak B. D.

4. 489/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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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

10. 347/DEL/79

A novel process for the recovery of D( + ) camphorsulphonic acid during the resolution of DL-phenylglycine.

Mitra, R. B., Joshi, B. N., Hinge, V. K. and Natekar (Miss), M. V.

11. 411/DEL/79

Process for the preparation of 3-phenoxybenzyl 1R-*cis*-2, 2-dimethyl-3 (2-cyanoprop-1-enyl) -cyclopropane carboxylate.

Mitra, R. B., Kulkarni, G. H., Muljiani (Miss), Z. and Khanna P. N.

12. 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.

13. 703/DEL/79

A process for the preparation of new yellow to blue azopyrid-2-one pendant cationic dyes for acrylic fibres.

Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

14. 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.

15. 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.

16. 798/DEL/79

Process for the preparation of ∝-cyano-3-phenoxybenzyl 1R-*cis*-2, 2-dimethyl-3 (2-chloroprop-1-enyl) cyclopropane carboxylate, a new insecticide belonging to the synthetic pyrethroids group.

Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi G D. and Bhawal, B. M.

17. 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.

18. 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.

19. 942/DEL/79

Process for the preparation of a novel controlled release mosquito larvicide.

Das, K. G., Mirajkar, S. P. and Tungikar, V. B.

20. 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.

21. 950/DEL/79

A process for the preparation of blue naphthostyril cationic dyes.

Ayyangar, N. R., Moghe, P. P. and Tilak, B. D.

22. 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.

23. 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.

24. 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.

25. 378/DEL/80*

A process for the selective isolation of vinblastine sulphate from the leaves of *Vinca rosea* (*Catharanthus roseus* G. Don)

Rama Rao, A. V. Venkatswamy, G., Sathaye, K. M. and Yadagiri, P.

26. 425/DEL/80*

An improved method for the preparation of 1R *cis*-2, 2-dimethyl-3-(2-hydroxy-2-carboxy propyl) 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.

27. 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.

28. 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.

29. 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.

30. 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.

31. 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.

32. 663/DEL/80*

A process for the isolation of active principles from the plant *Lavendula 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.

33. 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.

34. 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.

35. 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.

36. 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.

**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 Indien Patent Application No. 761/DEL/78-Synthesis of a new insecticide belonging to the synthetic pyrethroids group).
   Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D., Khanra, A. S. and Bhawal, B. M.

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*These patents were newly filed during the year.

# RESEARCH 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 |
|---|---|---|---|---|---|---|
| | | | | 1980-81 Qty./Value Rs. in lakhs | Up to March' 80 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) | 1,864.00 T<br>344.84 | 14,914.49 T<br>1,847.74 | 2000 T<br>Non-exclusive |
| 2. | Acriflavine | Pharmaceuticals | Western India Fine Chemicals, 38, Agra Road, Mulund (West), Bombay 400 080 (1969) | —<br>— | 7.50 T<br>36.92 | 3 T<br>Sponsored |
| 3. | Antipriming compositions | Antipriming in locomotives | Research, Designs and Standards Organization, M & C Wing, Lucknow 226 011 (1964) | 2.00 T<br>0.25 | 154.54 T<br>14.62 | 26 T<br>Non-exclusive |
| 4. | *tert*-Butyl catechol | Synthetic rubber | Percynic Chemicals, Bombay Silk Mills Bldg., Industrial Estate, Lalbaug, Bombay 400 012 (1972) | 7.05 T<br>8.47 | 50.29 T<br>52.71 | 50 T<br>Non-exclusive |
| 5. | Butyl titanate | Varnishes, enamels | Synthochem, 33A, Laxmibainagar Industrial Estate, Indore 452 006 (1973) | 29.05 T<br>17.43 | 128.03 T<br>55.73 | 36 T<br>Non-exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 6. | Calcium hypophosphite | Pharmaceuticals | Hypophosphite & Co., 79-F, Princess Street, Bombay 400 002 (1967) | 12.00 T<br>9.00 | 160.25 T<br>120.30 | 24 T (including other hypophosphites also) Sponsored |
| 7. | Calcium silicate | Low density insulators | Newkem Products Corpn., Harganga Mahal, Khodadad Circle, Bombay 400 014 (1968) | 425.00 T<br>27.62 | 4,513.21 T<br>202.85 | 4200 T Sponsored |
| 8. | Can lining composition | Metal can industry | Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700 013 (1974) | 1.29 T<br>0.32 | 1.15 T<br>0.65 | 500 Kg/day Non-exclusive |
| 9. | Can sealing composition | Metal can industry | —do— (1962) | 21.83 T<br>1.89 | 423.13 T<br>28.55 | 500 Kg/day Non-exclusive |
| 10. | Carbimazole | Pharmaceuticals | Nicholas Laboratories India Ltd., Sion-Trombay Road, Deonar, Bombay 400 088 (1970) | —<br>— | 391.59 Kg<br>32.42 | 250 Kg Sponsored |
| 11. | Catechol | Pharmaceuticals | Percynic Chemicals, Bombay (1972) | 6.68 T<br>5.01 | 44.89 T<br>24.84 | 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) | —<br>— | 28,662.18Cft<br>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) | 23.50 T<br>23.00 | 97.27 T<br>113.66 | 120 T Sponsored |
| 14. | Chlorobenzenes | Industrial chemicals | Hindustan Organic Chemicals Ltd., P. O. Rasayani (1976) | 3,716.00 T<br>396.10 | 13,437.41 T<br>818.33 | 4500 T Sponsored |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 15. | Chloromethanes | Industrial chemicals | Standard Alkali, Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1974) | 182.00 T<br>10.17 | 3,370.12 T<br>146.73 | 3000 T<br>— |
| 16. | Clofibrate | Pharmaceuticals | Biological Evans Ltd. 18/1 & 3, Azamabad, Hyderabad 500 020 (1973) | —<br>— | 2.89 T<br>14.30 | 4 T<br>Non-exclusive |
| 17. | Diethyl-*m*-aminophenol | Dye intermediate | Sahyadri Dyestuffs & Chemicals, Pune (1970) | 43.90 T<br>50.50 | 537.83 T<br>574.19 | 150 T<br>Sponsored |
| 18. | Dihydroisojasmone and peach aldehyde | Perfumery chemicals | S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay 400 080 (1965) | 0.46 T<br>2.34 | 61.62 T<br>21.07 | 2 T<br>Non-exclusive |
| 19. | Dimethoate | Pesticides | (i) Mico Farm Chemicals Ltd., 'Lotus Court', 165, Thambu Chetty Street, Madras 600 001 (1979) | —<br>— | 0.15 T<br>0.11 | 100 T<br>Non-exclusive |
| | | | (ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979) | 12.29 T<br>9.42 | 0.25 T<br>0.19 | 15 T (Pilot plant)<br>Non-exclusive |
| 20. | Dimethylaniline (continuous process) | Industrial chemicals | Sahyadri Dyestuffs & Chemicals, Pune (1976) | 570.00 T<br>108.86 | 1,537.88 T<br>574.67 | 3000 T<br>Sponsored |
| 21. | *Endosulfan | Pesticides | Bharat Pulverising Mills Pvt. Ltd., 'Shriniketan', 14 Queens Road, Bombay 400 020 (1980) | 24.16 T<br>20.54 | —<br>— | 600 T<br>Non-exclusive |
| 22. | Ethion | Pesticides | Shaw Wallace & Co. Ltd., Calcutta (1979) | 14.74 T<br>11.46 | 0.98 T<br>0.73 | 15 T (Pilot plant)<br>Non-exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 23. | Ethylene oxide condensates | Surface active agents | Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400 016 (1965) | 1,897.00 T<br>489.60 | 9,971.14T<br>1,692.35 | 2500 T<br>Sponsored |
| 24 | Ferrites-Hard | Electronics | (i) Semiconductors Ltd., Ahmednagar Road, Miles 4/5, Pune 411 014 (1968) | —<br>— | 20.07 T<br>+1,225 lakh Nos.<br>9.34 | 200 T<br>Non-exclusive |
| | | | (ii) Dr. Shet Magnetics Pvt. Ltd., 1069, V Block, 1st floor, Rajajinagar, Bangalore 560 010 (1978) | n. a.<br>0.75 | —<br>— | 20 T<br>Non-exclusive |
| 25. | *Foundry core binder (Sinol core binder) | Core binder in steel foundries for high dimensional accuracy | Card Chem Industries, B-12 Coop. Industrial Estate, Balanagar, Hyderabad 500 037 (1980) | 9,919 Ltrs<br>0.61 | —<br>— | Not available<br>Non-exclusive |
| 26. | 4-Hydroxycoumarin | Pharmaceuticals | Unichem Laboratories Ltd., 'Unichem Bhavan', S. V. Road, Bombay 400 060 (1974) | 3.63 Kg<br>0.09 (including warfarin) | 270.06 Kg<br>0.97 | 540 Kg<br>Non-exclusive |
| 27. | $\beta$-Ionone | Perfumery, intermediate for Vitamin A | S. H. Kelkar & Co. Ltd., Bombay (1975) | 0.23 T<br>0.89 | 0.801 T<br>2.45 | 4.4 T<br>Non-exclusive |
| 28. | Maleic hydrazide | Agrochemicals | Micro Chemicals (India). Scheme No. 1, Road No.3, Nai Abadi, Mandsaur 458 001 (1978) | 0.40 T<br>0.26 | 0.72 T<br>0.46 | 1 T<br>Non-exclusive |
| 29. | $p$-Menthane hydroperoxide | Synthetic rubber | Camphor & Allied Products Ltd., P. O. Clutterbuckganj 243 502 Dist. Bareilly (1976) | 10.08 T<br>4.48 | 89.10 T<br>33.70 | 60 T<br>Exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 30. | Monochloroacetic acid | Intermediate for weedicides, carboxymethyl cellulose, etc. | Hico Products Ltd., Bombay (1975) | 250.00 T<br>28.75 | 1,130.37 T<br>96.39 | 720 T<br>Non-exclusive |
| 31. | Monoethylaniline | Intermediate for explosives | The Atul Products Ltd., Atul 396 020, Dist. Valsad (1975) | 100.00 T<br>39.00 | 338.83 T<br>89.50 | 100 T<br>Non-exclusive |
| 32. | 1-Naphthyl acetic acid | Agrochemicals, plant growth regulator | Micro Chemicals (India), Mandsaur (1975) | 0.70 T<br>0.70 | 2.40 T<br>2.40 | 1.5 T<br>Sponsored |
| 33. | Nicotine sulphate from tobacco and tobacco waste | Insecticides | Urvakunj Nicotine Industries, Petlad-Cambay Road, Dharmaj 388 430, Dist Kaira (1963) | —<br>— | 953.99 T<br>212.78 | 150T<br>Non-exclusive |
| 34. | Nitrile rubber | Oil resistant rubber formulations, adhesives | Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400 020 (1974) | 204.00 T<br>16.63 | 2,101.00 T<br>423.36 | 2000 T |
| 35. | *p*-Nitrophenol | Intermediate | Hindustan Organic Chemicals Ltd., P. O. Rasayani (1978) | —<br>— | 4.00 T<br>1.16 | 900 T<br>Non- exclusive |
| 36. | Nonyl phenol | Surface active agent | Aniline Dyestuffs and Pharmaceuticals Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Road, Bombay 400 026 (1974) | 3.00 T<br>0.75 | 166.73 T<br>22.56 | 1000 T<br>Sponsored |
| 37. | Opium alkaloids | Pharmaceuticals | Govt. Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975) | 6.66 T<br>275.44 | 23.86 T<br>513.37 | 16.66 T of various alkaloids (morphine, codeine, narcotine, papavarine and thebaine) Exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 38. | 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) | 141.58 T<br>10.68 | 179.20 T<br>12 75 T | 1500 T<br>Sponsored |
| 39. | Perfumery products based on longifolene (Capinone) | Perfumery | Camphor & Allied Products Ltd., Dist. Bareilly (1968) | 16.41 T<br>23.56 | 95.94 T<br>97.77 | 50 T (for both Capinone and Meracene)<br>Sponsored |
| 40. | Perfumery products based on $\Delta^3$-carene (Meracene) | Perfumery | -do- | 6.02 T<br>3.13 | 58.65 T<br>25.49 | -do- |
| 41. | $\beta$-Phenethyl alcohol | Perfumery | Sunanda Aromatic Industries, Mysore-K. R. S. Road, Mettagalli P. O., Mysore 571 106 (1970) | 100.27 T<br>64.16 | 972.56 T<br>538.97 | 270 T<br>Sponsored |
| 42. | Phenthoate | Insecticides | Bharat Pulverising Mills Pvt. Ltd., Bombay (1975) | —<br>— | 27.10 T<br>17.55 | 600 T<br>Sponsored |
| 43. | Phthalate-butyl octyl | Plasticizers | Herdillia Chemicals Ltd., Air India Bldg., Nariman Point, Bombay 400 021 (1979) | 59.00 T<br>11.80 | 16.00 T<br>2.53 | 5000 T (including other phthalates)<br>Non-exclusive |
| 44. | Phthalates-diethyl and dimethyl | Plasticizers | The Mysore Acetate and Chemicals Co. Ltd., A-19,Acetate Town, Mandya 571 404 (1970) | —<br>— | 1,594.87 T<br>216.79 | 600 T<br>Non-exclusive |
| 45. | Phthalates-dioctyl and dibutyl | Plasticizers | Amines and Plasticizers Ltd., 'D' Bldg. Shiv Sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971) | 4,020.00 T<br>861.00 | 23,154.18 T<br>2,795.55 | 5000 T<br>Non-exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 46. | Polyurethane coating | Coatings | Cipy Chemicals,<br>229, Rasta Peth,<br>Pune 411 011 (1977) | 4,200.00 Ltrs<br>1.40 | 2,718.00 Ltrs<br>0.78 | 30 T<br>Non-exclusive |
| 47. | Polyurethane printing rollers | Printing | Sree Saraswaty Press Ltd.,<br>32, Acharya P. C. Ray Road,<br>Calcutta 700 009 (1965) | 852 Nos.<br>2.60 | 4,596 Nos.<br>8.34 | 3000 Nos.<br>Non-exclusive |
| 48. | Radiosonde thermistors | Meteorology | The Bhagyanagar Laboratories,<br>11-1523/8, Golkonda Cross Road,<br>Hyderabad (1974) | 30,000 Nos.<br>5.93 | 1,30,000 Nos.<br>21.00 | Not available<br>Non-exclusive |
| 49. | D. C. Recording polarograph including potentio-metric strip chart recorder for captive consumption | Polarographic analysis | (i) Elico Pvt. Ltd.,<br>Sanatnagar Ind. Estate,<br>Hyderabad 500 018 (1974) | 22 Units<br>3.96 | 147 Units<br>+3 Nos.<br>20.98 | 50 Units<br>Non-exclusive |
| | | | (ii) Chromatography & Instru-ments Co.,<br>121/122, Makarpura Indl. Estate,<br>Baroda 390 010 (1975) | 2 Units<br>0.34 | 70 Units<br>12.01 | 100 Units<br>Non-exclusive |
| 50. | Rubberized cork sheets | Gaskets | Bharat Casements,<br>Prop. Banco Aluminium Baroda Ltd.,<br>Baroda 390 001 (1966) | —<br>— | 110.76 lakh pieces<br>+177.00 T<br>104.17 | 24 lakh pieces<br>Non-exclusive |
| 51. | Silica gel | Humidity control | Minco Products,<br>17, Thiruvottyur<br>High Road,<br>Madras 600 081 (1963) | 12.00 T<br>1.20 | 170.50 T<br>13.72 | 18 T<br>Sponsored |
| 52. | Sorbide nitrate | Pharmaceuticals | Nicholas Laboratories India Ltd.,<br>Bombay (1969) | —<br>— | 2,840.50 Kg.<br>41.30 | 300 kg<br>Sponsored |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 53. | 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) | 721.00 T<br>75.00 | 3,043.20 T<br>262.27 | 2000 T<br>Non-exclusive |
| | | | (ii) The Anil Starch Products Ltd., P. B. No. 10009, Anil Road, Ahmedabad 380 025 (1976) | 325.00 T<br>32.26 | 1,061.40 T<br>117.80 | 1000 T<br>Non-exclusive |
| 54. | Direct reading spectrophotometer/ colorimeter | Biochemical research, spectroscopic analysis in visible range | Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Road, Allahabad 211 001 (1974) | 15 Units<br>0.99 | 147 Units<br>9.51 | 100 Units<br>Non-exclusive |
| 55. | Staple pin adhesive | Adhesive for staple pins | Esdee Paints, Near Power House, Kolshet Road, Thane 400 607 (1979) | 373 Ltrs<br>0.68 | 444 Ltrs<br>0.20 | Not available<br>Non-exclusive |
| 56. | Terpineol | Perfumery | Dujodwala Industries, Tulsiani Chambers, 8th floor, 212, Nariman Point, Bombay 400 021 (1976) | 90.00 T<br>27.00 | 310.00 T<br>85.50 | 200 T<br>Non-exclusive |
| 57. | Thermistors | Electronics | Semiconductors Ltd. Pune (1963) | —<br>— | 92.44 lakh Nos.<br>75.62 | 20 lakh Nos.<br>Non-exclusive |
| 58. | *p*-Toluidine from *p*-nitrotoluene by vapour phase reduction | Organic intermediate | Sudarshan Chemical Industries Ltd., 162,Wellesley Road, Sangam Bridge, Pune 411 001 (1977) | 78.00 T<br>25.74 | 110.00 T<br>34.48 | 300 T<br>Sponsored |
| 59. | Vitamin C | Pharmaceuticals | Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1975) | —<br>— | 5.83 T<br>7.28 (estimated) | 125 T<br>Non-exclusive |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 60. | Trichlorobenzene | Intermediate | Mycol International Agencies, 'Lotus Court', 165, Thambu Chetty St., Madras 600 001 (1978) | —<br>— | 2.30 T<br>0.16 | 100 Kg/batch<br>Non-exclusive |
| 61. | Warfarin | Rodenticide | Unichem Laboratories Ltd. Bombay (1974) | 4.50 Kg (value included under item 26) | 379.79 Kg | 840 Kg<br>Non-exclusive |

*During the period under review, production has been newly reported on these items (2).

**Note** : The following processes were at one time under production and appeared in Table I of previous Annual Reports (1965–66 to 1979–80). As and when production is resumed on these processes, they will be included in Table I.

(1) CdS photoconductive cells, (2) CDV pigment, (3) Geraniol, citronellal and citronellol from lemon grass oil, (4) Nitromusk compounds, and (5) *o*-Tolylbiguanide.

VALUE OF PRODUCTION BASED ON NCL KNOW-HOW

| Year | No. of items manufactured | Value of production (Rs. in lakhs) |
|---|---|---|
| 1976—77 | 71 | 1562.12 |
| 1977—78 | 71 | 1965.27 |
| 1978—79 | 68 | 2174.06 |
| 1979—80 | 65 | 2923.70 |
| 1980—81 | 61 | 3056.60 |
| | | 11,681.75 |

Cumulative value of production based on NCL know-how (excluding FCP production) during 1950-76 amounted to Rs. 4622.36 lakhs.

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1980-81)

| Type of industry | No. of processes in production | Value of production during 1980-81 (Rs. in lakhs) |
|---|---|---|
| 1. Public sector | 6 | 1016.63 |
| 2. Large scale private sector | 19 | 1799.37 |
| 3. Medium and small scale sector | 36 | 240.60 |
| | 61 | 3056.60 |

## TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

| Sl. No. | Name of the process | Field of utilization | Name of the party (Year of release) | Nature of release | Remarks |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 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. | Butene diol | Pesticides, polymers | Hindustan Organic Chemicals Ltd., Rasayani | Collaborative work | — |
| 7. | 1, 3-butylene glycol | Petrochemicals, bulk organic chemicals | Indian Petrochemicals Corpn. Ltd., Dist. B roda (1974) | Sponsored | — |
| 8. | Camphene from pinene | Pharmaceuticals, perfumery | Resin and Terpene Industries, 812/815, 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 Pvt. Ltd., Bombay (1978) | —do— | —do— |
| | | | (iii) Laxmi Traders, 2, India Exchange Place, Calcutta 700 001 (1980) | —do— | Recently released |
| 10. | Citrate plasticizers-tributyl/acetyl tributyl citrate | Plasticizers | Sturdia Chemicals Ltd., NeVille House, J. N. Hardia Marg, Ballard Estate, Bombay 400 038 (1980) | Sponsored | —do— |
| 11. | *Clofibrate | Pharmaceuticals | S. D.'s Lab-Chem Industry, Samuel Street, P. B. No. 3232, Bombay 400 003 (1975) | Non-exclusive | — |
| 12. | Diazepam | Anti-anxiety drugs | Orion Chemicals, 8, Mulchand Mansion, Princess Street, Bombay 400 002 (1975) | Non-exclusive | — |
| 13. | Dibutyl tin oxide | PVC stabilizers | Dura Chemical Corpn. P. Ltd., Wakefield House, 11, Sprott Road, Ballard Estate, Bombay 400 038 (1977) | —do— | Under implementation |
| 14. | Dichloropropionic acid (Dalapon) | Pesticides | (i) Hico Products Ltd., Bombay (1975) | —do— | — |
| | | | (ii) Jaydee Agrochemicals P. Ltd., Majwaji Ka Bagh, Moti Dugri Rd., Jaipur 302 004 (1975) | —do— | — |
| 15. | *Dimethoate | Pesticides | P. N. M. Company, Thindal, Perundurai Main Road Erode 638 009 (1978) | —do— | In trial production |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 16. | *Endosulfan | Pesticides | Hindustan Insecticides Ltd., Hans Bhavan, Wing I, Bahadur Shah Zafar Marg New Delhi 110 002 (1976) | Non-exclusive | Turn-key plant offered through project engineers. Under implementation |
| 17. | Ethephon | Pesticides | Varson Chemicals Pvt. Ltd., 9th Mile, Hosur Road, Singasanda P. O., Bangalore 560 068 (1978) | —do— | — |
| 18. | Ethylenediamine | Bulk organic chemicals | (i) Diamines and Chemicals Ltd., The Bharat Vijay Mills Ltd. Premises, Kalol 382 721 (1973) | —do— | Plant expected to be commissioned by December 1981 |
| | | | (ii) The Victor Oil Co. P. Ltd., 27, Sir R. N. Mukherjee Road, Calcutta 700 001 (1976) | —do— | Production likely to be established by March 1984 |
| 19. | Flexible magnets | Refrigeration gaskets, toys, educational kits | Dr. Shet Magnetics Pvt Ltd., Bangalore (1976) | —do | — |
| 20. | Fumed silica | Bulk inorganic chemicals | Century Rayon, P. B. No. 22, Murbad Road, Shahad 421 103, Thane (1976) | Sponsored | — |
| 21. | Hexachlorocyclopentadiene (HCCP) | Pesticides | Hindustan Organic Chemicals Ltd., Rasayani (1981) | Collaborative work | — |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 22. | *β-Ionone | Perfumery, intermediate for Vitamin A | (i) Pappachan K. Elengical, Kothamangalam 686 691 Kerala (1976) | Non-exclusive | — |
| | | | (ii) Cauvery Chemicals, Punnayam, Asamannoor P. O., Dist. Ernakulam, Kerala (1976) | —do— | — |
| 23. | Items having short shelf life | Sealants, adhesives | Hindustan Aeronautics Ltd. (Nasik Divn.), Ozher Township P. O., Nasik 422 007 (1980) | Sponsored | Recently released |
| 24. | Matrix-bound penicillin acylase systems | Pharmaceuticals | Hindustan Antibiotics Ltd., Pimpri, Pune (1974) | —do— | — |
| 25. | l-Menthol from $\Delta^3$–carene | Perfumery | Bhavana Chemicals Ltd., 64-65 and 53-57, Laxmi Insurance Building, Sir P. M. Road, Bombay 400 001 (1978) | —do— | Under implementation |
| 26. | Morpholine | Intermediate for rubber chemicals | (i) Bombay Wire Ropes Ltd., Kavesar Village, Ghodbunder Road, Thane (1975) | Non-exclusive | — |
| | | | (ii) Catalyst (India) Pvt. Ltd., Embassy Centre, 10th Floor, 207, Backbay Reclamation, Nariman Point, Bombay 400 021 (1975) | —do— | — |
| 27. | Nitrofen | Weedicide | Amar Dye-Chem. Ltd., Bombay (1978) | —do— | — |
| 28. | *p-Nitrophenol | Intermediate | Catalyst (India) Pvt. Ltd., Bombay (1975) | Non-exclusive | — |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 29. | *Nicotine sulphate | Insecticides | Keen Agro Chemicals and Eng. Pvt. Ltd., Tower House, M. G. Road, Ernakulam 682 011 (1978) | Non-exclusive | — |
| 30. | Phthalates-dibutyl and dioctyl | Plasticizers | Mysore Petrochemicals Ltd., Station Road, P. B. No. 34. Raichur 584 101 (1980) | —do— | Recently released |
| 31. | Propylene oxide from propylene (extension to propylene glycol) | Petrochemicals | Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1978) | Sponsored | — |
| 32. | Quinapyramine sulphate/ chloride | Veterinary drug | Chintamani Fine Chemicals, 1313, Shukrawar Peth, Sathe Colony, Pune 411 002 (1981) | Non-exclusive | Under implementation |
| 33. | Simazine | Herbicide | Amar Dye-Chem. Ltd., Bombay (1978) | —do— | — |
| 34. | Silver paste for mica capacitor electrodes | Electronics | (i) Jyoti Refinery, 216, Lakad Gani, Nagpur (1978) | —do— | In trial production |
| | | | (ii) Ramans (India), 9882/6, Ambala City (1978) | —do— | —do— |
| | | | (iii) Luxmi Traders, Calcutta (1981) | —do— | Recently released |
| 35. | Sodium sulphide | Various industries | Amar Dye-Chem. Ltd., Bombay (1976) | —do— (Technical aid) | — |
| 36. | Sorbitol from glucose (continuous process) | Pharmaceuticals | The Anil Starch Products Ltd., Ahmedabad (1976) | Sponsored | — |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 37. | *Staple pin adhesive | Adhesive for staple pins | Duro Metochem Pvt. Ltd., Nirlon House, 254-B, Dr. Annie Besant Road, Worli, Bombay 400 025 (1976) | Non-exclusive | — |
| 38. | Substitute for side seam cement | Adhesive | Nand Industries, 324, Shaniwar Peth, Pune 411 030 (1978) | Sponsored | — |
| 39. | Sulphur monochloride | Various industries | Phosphate Co. Ltd., 14, Netaji Subhash Road, Calcutta 700 001 (1976) | Non-exclusive (Technical aid) | — |
| 40. | Theophylline, aminophylline and caffeine | Pharmaceuticals | Dr. R. Maheshwari, Plot No. 10, Off Dr. Moses Road, Worli, Bombay 400 018 (1978) | Non-exclusive | Trial production to start by end of 1982 |
| 41. | Thionyl chloride | Various industries | Dharamsi Morarji Chemical Co. Ltd., Prospect Chambers, 317/21, Dr. D. N. Road, Bombay 400 001 (1977) | Collaborative work | Under implementation |

*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 1979-80 have now been dropped as the licensees have not shown any progress towards their implementation for a considerable period.

1. Diazepam.
2. N-Ethyl-*o*-toluamide
3. Gaskets from coir pith
4. Molybdenum chemicals from molybdenum concentrate
5. D. C. recording polarograph
6. Xanthates

# 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 | —do— |
| 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 | —do— |
| 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 | —do— |
| 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 | —dc— |
| 20. | Diethyl toluamide | Insect repellent | Xylene and diethylamine | A | — |
| 21. | Dimethoate | Pesticide | Phosphorus pentasulphide, methanol, monochloroacetic acid, methyl amine and caustic lye | C | Released, in production |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 22. | Dimethylaniline (batch process) | Dyestuff and explosives intermediate | Aniline and methanol | C | Released |
| 23. | N, N'-dimethyl biguanide HCl phenethyl biguanide HCl | Drugs | Dicyandiamide, dimethyl amine/β-phenylethyl-amine and solvents | A | —do— |
| 24. | 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) |
| 25. | Endosulfan | Pesticide | Hexachlorocyclo-pentadiene, butene diol, thionyl chloride and epichlorohydrin | C | Released, process available on turn-key basis through project engineers |
| 26. | Ethylenediamine | Bulk organic chemical | Ethylene dichloride, ammonia and caustic soda | C | —do— |
| 27. | Ethephon | Pesticide | Phosphorus trichloride, ethylene oxide, hydro-chloric acid and sulphuric acid | A | Released |
| 28. | Ethion | Pesticide | Phosphorus pentasul-phide, ethyl alcohol, dibromomethane and caustic soda | C | Released, in production |
| 29. | Ethylene dichloride from ethyl alcohol | Solvent and organic intermediate | Ethyl alcohol, chlorine and catalyst | C | — |
| 30. | Ethylene from ethyl alcohol | Organic intermediate | Ethyl alcohol and catalyst | A | Released |
| 31. | Ferrites-Hard | Electronics | Iron oxide, barium carbonate, additive and binder | B | Released, in production |
| 32. | Gaskets from coir pith | Gaskets | Coir pith, nitrile rubber and rubber chemicals | A | Released |
| 33. | Gaskets from cork granules | Gaskets | Cork granules, nitrile rubber and rubber chemicals | A | —do— |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 34. | $\beta$-Ionone | Perfumery chemical, intermediate for Vitamin A | Lemon grass oil, caustic soda, acetone and sulphuric acid | C | Released, in production |
| 35. | Maleic hydrazide | Plant growth regulator | Maleic anhydride, and hydrazine hydrate | A | —do— |
| 36. | Microfilters | Industrial filtration | Pulp, melamine and formaldehyde | A | Released |
| 37. | Monochloroacetic acid | Intermediate for weedicides, carboxy-methylcellulose, etc. | Acetic acid, chlorine and catalyst | B | Released, in production |
| 38. | *Monochlorobenzene | Bulk organic chemical | Benzene and chlorine | C | Released, in production |
| 39. | Monoethylaniline | Intermediate for explosives | Aniline, ethyl alcohol and catalyst | B | Released, in production |
| 40. | Morpholine | Intermediate for rubber chemicals, textile chemicals, optical brighteners, etc. | Diethanolamine, sulphuric acid and caustic soda | C | Released |
| 41. | Nicotine sulphate from tobacco and tobacco waste | Insecticide | Tobacco/tobacco waste, lime, kerosene and sulphuric acid | A | Released, in production |
| 42. | Nitrofen | Weedicide | *p*-Nitrochlorobenzene, potassium hydroxide and 2, 4-dichlorophenol | B | Released |
| 43. | *p*-Nitrophenol | Intermediate for parathion and paracetamol | *p*-Nitrochlorobenzene, sodium hydroxide lye and hydrochloric acid | C | Released, in production |
| 44. | 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 |
| 45. | Phenylacetic acid | Perfumery, Penicillin-G | Benzyl chloride, sodium cyanide and sodium hydroxide | B | Released, in production |

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

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 57. | Rubber reclaiming agent | Rubber chemicals | Xylene and sulphur monochloride | A | Released |
| 58. | Silica gel (desiccant type) | Humidity control | Sodium silicate and sulphuric acid | A | Released, in production |
| 59. | Silicon tetrachloride | Industrial chemical | Ferrosilicon, chlorine and hydrochloric acid | C | — |
| 60. | Silver paste for mica capacitor electrodes | Electronic industry | Silver nitrate, acetone, caustic soda, glass and filler | A | Released |
| 61. | Simazine | Herbicide | Cyanuric chloride and ethylamine | C | Released |
| 62. | Solid state strip chart recorder | Instrument | Chopper, input transformer, field effect transistors and other components | B | — |
| 63. | 70% Sorbitol from dextrose monohydrate | Pharmaceuticals and Vitamin C synthesis | Dextrose monohydrate, hydrogen and catalyst | C | Released, in production |
| 64. | Direct reading spectro-photometer/colorimeter | Biochemical research and spectroscopic analysis in visible range | Components and boxes | B | —do— |
| 65. | Staple pin adhesive | Adhesive for staple pins | Synthetic resin and solvent | A | —do— |
| 66. | Terpineol | Perfumery | $\alpha$-Pinene | B | —do— |
| 67. | Tetradifon | Acaricide | Trichlorobenzene, chlorosulphonic acid monochlorobenzene and aluminium chloride | B | Released |
| 68. | Theophylline, aminophylline and caffeine | Drugs (Caffeine also used in beverages) | Dimethylurea, mono-chloroacetic acid, acetic anhydride, sodium cyanide, dimethyl sulphate and ethylenediamine | C | Released |

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| 69. | Thermistors | Temperature measurement and control, electronic devices | Oxides of high purity, components and binder | A | Released, in production |
| 70. | Thioglycolic acid | Cosmetics, catalyst for Bisphenol-A | Monochloroacetic acid, sodium hydroxide, sodium thiosulphate, zinc dust and solvents | A | Released |
| 71. | Trichlorobenzene | Intermediate | Non-gamma BHC residue and caustic lye | B | Released, in production |
| 72. | Xanthates — potassium ethyl and potassium amyl | Froth-flotation | Ethyl/amyl alcohol, potassium hydroxide and carbon disulphide | A | Released |

* Processes newly added (2) to the know-how available list published in Annual Report 1979-80.

# DATA ON NCL EXPENDITURE, RECEIPTS AND ACHIEVEMENTS
## (1979-80 AND 1980-81)

| | 1979-80 | 1980-81 |
|---|---|---|
| **EXPENDITURE (Rs. in lakhs)** | | |
| 1. Recurring | 163.84 | 186.29 |
| 2. Capital | 113.63 | 115.44 |
| 3. Pilot plant | 0.50 | — |
| | 277.97 | 301.73 |
| **RECEIPTS (Rs. in lakhs)** | | |
| 1. Scientists' share of premia and royalties received from NRDC | 0.91 | 0.16 |
| 2. Receipts on account of sponsored projects | 2.78 | 6 85 |
| 3. Analytical/testing charges | 0.51 | 0 65 |
| 4. Institutional consultancy (CSIR share) including know-how fee/job work | 0.50 | 0.56 |
| 5. Sale of laboratory products | 0.29 | 0.11 |
| 6. Miscellaneous receipts | 9.78 | 6.86 |
| | 14.77 | 15.19 |
| **ACHIEVEMENTS** | | |
| 1. Total number of processes in production | 65* | 61* |
| 2. Value of production based on NCL know-how (Rs. in lakhs) | 2923.70 | 3056.60 |
| 3. Estimated saving in foreign exchange on account of above production (Rs. in lakhs) | 1172.88 | 1222 64 |
| 4. Total number (cumulative) of processes released and awaiting production | | |
| (a) NCL processes | 21 | 19 |
| (b) Sponsored schemes | 12 | 10 |
| (c) Collaborative work | — | 3 |
| 5. Total number of parties who have taken NCL processes for exploitation | 140 | 143 |
| 6. Total number of parties who have sponsored processes | 84 | 87 |
| 7. Total number of processes which were not released but which were available for commercial exploitation | 10 | 10 |
| 8. Number of processes released during the year | | |
| (a) NCL processes | 4 | 4 |
| (b) Sponsored processes completed/concluded | — | 3 |
| 9. No. of processes newly added to the list of NCL processes available for exploitation | — | 2 |
| 10. Papers published | 125 | 134 |
| 11. Papers presented/read at symposia, seminars, etc. | 22 | 33 |
| 12. Doctorate and Masters degrees received by NCL staff | 26 | 23 |
| 13. No. of recognized guides for Doctorate and Masters degrees | 46 | 51 |
| 14. Patents in force | | |
| (a) In India | 43 | 55 |
| (b) Abroad | 2 | 2 |
| 15. Premia and Royalties received by NRDC through NCL processes (Rs. in lakhs) | | |
| (a) Premia | 4.92 | 0.57 |
| (b) Royalties | 0 50 | 1.17 |
| 16. No. of processes assigned to NRDC | — | — |

* Processes for which parties have not reported production for two consecutive years are excluded from this total.

# CUMULATIVE DATA (1950–81)

EXPENDITURE (Rs. in lakhs)

| | | |
|---|---|---|
| 1. | Recurring | 1901·55 |
| 2. | Capital | 682·98** |
| 3. | Pilot plant | 74·47 |
| | | 2659·00 |

ACHIEVEMENTS

| | | |
|---|---|---|
| 1. | Total value of production based on NCL know-how (Rs. in lakhs) | 16,304·52 |
| 2. | Total No. of papers published | 3,473 |
| 3. | Total No. of papers presented/ read at symposia, seminars | 257 |
| 4. | Total No. of degrees received | 499 |

RECEIPTS (Rs. in lakhs)

| | | |
|---|---|---|
| 1. | Total money receipts | |
| | (a) Total premia earned by NRDC through NCL processes | 45·09 |
| | (b) Total royalties earned by NRDC through NCL processes | 21·49 |
| | (c) Total receipts from sponsors | 92·97 |
| | (d) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sales of laboratory products, job work and other receipts | 118·06 |
| | | 277·61 |

** *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 31-3-1981 )

| | |
|---|---|
| Director,<br>National Chemical Laboratory,<br>Pune 411 008. | Chairman |
| Prof. Goverdhan Mehta,<br>Professor and Dean,<br>School of Chemistry,<br>University of Hyderabad,<br>Hyderabad 500 001. | Member |
| Dr. H. E. Eduljee,<br>Managing Director,<br>Dai-Ichi Karkaria Pvt. Ltd,<br>Liberty Building,<br>Sir Vithaldas Thackersey Marg,<br>Bombay 400 020. | Member |
| Prof. P. T. Narasimhan,<br>Department of Chemistry,<br>Indian Institute of Technology,<br>Kanpur 208 016. | Member |
| Dr. R. B. Mitra,<br>Scientist,<br>National Chemical Laboratory,<br>Pune 411 008. | Member |
| Dr. A. V. Rama Rao,<br>Scientist,<br>National Chemical Laboratory,<br>Pune 411 008. | Member |
| Administrative Officer,<br>National Chemical Laboratory,<br>Pune 411 008. | Member |
| Sr. Finance & Accounts Officer,<br>National Chemical Laboratory,<br>Pune 411 008. | Member |
| Dr. C. Siva Raman,<br>Scientist,<br>National Chemical Laboratory,<br>Pune 411 008. | Member-<br>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 31-3-1981)

| | |
|---|---|
| Dr. S. Varadarajan,<br>Chairman & Managing Director,<br>Indian Petrochemicals Corpn. Ltd.,<br>P. O. Petrochemicals,<br>Baroda 391 346. | Chairman |
| Dr. P. R. Mahadevan,<br>Director,<br>Foundation for Medical Research,<br>84-A, R. G. Thadani Marg, Worli,<br>Bombay 400 018. | Member |
| Dr. U. R. Ghatak,<br>Professor, Organic Chemistry,<br>Indian Association for the Cultivation of Science, Jadavpur,<br>Calcutta 700 032. | Member |
| Prof. Goverdhan Mehta,<br>Professor and Dean,<br>School of Chemistry,<br>University of Hyderabad,<br>Hyderabad 500 001. | Member |
| Dr. J. L. Thakkar,<br>Managing Director,<br>Dharamsi Morarji Chemical Co. Ltd.,<br>Dadabhoy Naoroji Road,<br>Bombay 400 001. | Member |
| Shri. D. M. Trivedi,<br>Chief Executive,<br>The National Rayon Corpn. Ltd.,<br>Everest House,<br>Homi Modi Street,<br>Bombay 400 023. | Member |
| Dr. H. E. Eduljee,<br>Managing Director,<br>Dai-Ichi Karkaria Pvt. Ltd.,<br>Liberty Building,<br>Sir Vithaldas Thackersey Marg,<br>Bombay 400 020. | Member |
| Shri. K. V. Raghavan,<br>Chairman & Managing Director,<br>Engineers India Ltd.,<br>PTI Building, Sansad Marg,<br>New Delhi 110 001. | Member |
| Prof. P. T. Narasimhan,<br>Department of Chemistry,<br>Indian Institute of Technology,<br>Kanpur 208 016. | Member |
| The Director-General,<br>Scientific & Industrial Research,<br>CSIR, Rafi Marg,<br>New Delhi 110 001,<br>or his nominee. | Member<br>(Ex-officio) |
| The Director,<br>National Chemical Laboratory,<br>Pune 411 008. | —do— |
| Chairman, Coordination Council,<br>Chemical Sciences Group. | —do— |
| Dr. C. SivaRaman,<br>Scientist,<br>National Chemical Laboratory,<br>Pune 411 008. | Member-<br>Secretary |

# NATIONAL CHEMICAL LABORATORY, PUNE 411 008

TELEX : 0145-266

TELEGRAM : CHEMISTRY

| | | Telephone* |
|---|---|---|
| 1. Dr. L. K. Doraiswamy | Director | 56151 |
| 2. Dr. R. B. Mitra | Head<br>Organic Synthesis Division | 55153 |
| 3. Dr. A. P. B. Sinha | Head<br>Physical Chemistry Division | 54353 |
| 4. Dr. R. A. Mashelkar | Head<br>*Chemical Engineering Division* | 51716 |
| 5. Dr. A. V. Rama Rao | Head<br>Organic Natural Products Division | 57614 |
| 6. Dr. N. D. Ghatge | Head<br>Polymer Chemistry Division | 53234 |
| 7. Dr. G. R. Venkitakrishnan | Head<br>Process Development Division | 56243 |
| 8. Dr. C. SivaRaman | Head<br>Biochemistry Division | 58234 |
| 9. Dr. P. Ratnasamy | Head<br>Inorganic Chemistry Division | 56451<br>(Extn. 10) |
| 10. Dr. S. H. Iqbal | Head<br>Technical Services Division | 57338 |
| Administrative Officer | | 57044 |
| Sr Finance and Accounts Officer | | 56702 |
| Purchase Officer | | 50708 |
| Scientists and all other staff | | 56451<br>56452<br>56453 |
| NCL Guest House/Hostel (1) | | 56155 |
| NCL Medical Centre | | 58954 |

* As in August, 1982.

editor ■ Dr. S. H. Iqbal

compilation & design

technical services division of the n c l