ANNUAL REPORT 1976-77

NCL IN RURAL DEVELOPMENT

NATIONAL CHEMICAL LABORATORY, POONA

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

NATIONAL CHEMICAL LABORATORY POONA 1976-1977

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Cover — 'NCL in Rural Development'
A pictorial mural indicating NCL's efforts relevant to rural development programme through the application of science and technology

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CONTENTS

INTRODUCTION

I have great pleasure in presenting the report of the activities of NCL in the year 1976-77. As mentioned in the previous annual report, the major research effort was aimed at development of technology for: (a) increasing agricultural productivity and economic utilization of forest and plant resources; (b) utilization of regenerative resources like cellulosic materials; (c) utilization of mineral resources; (d) rural and backward area development; (e) R and D work in critical sectors such as health care (drugs and pharmaceuticals), defence, petro-chemicals, polymers and elastomers; (f) absorption of technology; and (g) contribution to frontiers of science and technology such as plant tissue culture, development and use of immobilized enzymes as industrial catalysts, use of solar energy and technologies for export.

Awards

During the year under review, some of the scientists of the NCL received professional honours and awards in recognition of their outstanding contribution to scientific research. Prof. K. Venkataraman, former Director of NCL, was elected as the Foreign Member of the USSR Academy of Sciences. He was also presented with the Silver Jubilee Award by the Dyestuffs Manufacturers Association of India, in appreciation of his pioneering contribution to the promotion of Indian Dyestuff Industry. Dr. L. K. Doraiswamy was elected Fellow of the Indian National Science Academy. Dr. S. L. Kapur was awarded the Dr. K. G. Naik Gold Medal for the year 1975 by the M. S. University of Baroda, for his contributions to polymer research. Dr. B. D. Tilak was invited by the Bombay University to deliver K. H. Kabbur Memorial Lecture and by the Indian Chemical Manufacturers Association to deliver the Rajamitra B. D. Amin Memorial Lecture. Dr. K. V. Datye, visiting scientist, NCL, was invited by the Bombay University to deliver K. H. Kabbur Memorial Silver Jubilee Lecture.

Research and Development Projects

Under this section research and development work during the year 1976-77 is described according to the area of activities. These have been

classified into 20 groups. The major areas of product oriented/applied research continued to follow the same pattern as per the last year except for certain minor realignments. Details regarding the fundamental work in each area immediately follows the description of applied work.

There are 83 product oriented research projects in the 20 areas. The numbers of such projects in each area are as follows : Petrochemicals and bulk organic chemicals, 5; Pesticides and agrochemicals, 18; Drugs, dyestuffs and fine chemicals, 7; Organic intermediates, 7; Utilization of plant, forest and marine products, 8; Industrial polymers, elastomers and resins, 8; Mineral resources utilization, 5; Industrial inorganic and organometallic chemistry, 8; Solid state materials including materials for electronic industry, 7; Plant and animal tissue culture, 2; Fermentation technology, 1; Enzyme technology, 4; Development of instruments, 2; and Water management, 1.

Rural Development Project

A brief report on the genesis of this programme and the progress of work done during 1975-76 for formulating an eco-system plan for Chandrapur was reported earlier. During the year under review, NCL scientists have had further discussions with the representatives of the Government of Maharashtra and had prepared a working paper on the basis of the recommendations contained in the task force reports on forests, agriculture, animal husbandry, small and large scale industries and infrastructure schemes. The working paper and the background documents have been printed and will be discussed at a meeting of experts later in this year. The relevance of each project in the context of expeditious utilization of the resources of Chandrapur region and upgradation of local skills; priorities to be assigned to the projects; ecological impact and other factors will be considered by the experts while giving final shape to the eco-system plan for Chandrapur. Further details can be seen in Chapter V of this report.

Patents

During the year, 6 new Indian patents were filed. As on 31st March 1977, 39 Indian patents (22 sealed, 17 filed) and 3 foreign patents were in force.

Basic Research and Publications

During the year under review 71 research papers were published. The number of papers published in each area are as follows : Studies in

chemical engineering, 16; Pesticides and agrochemicals, 1; Utilization of plant forest and marine products, 2; Studies in organic chemistry, 17; Plant and animal tissue culture, 3; Studies in biochemistry, 2; Enzyme technology, 1; Studies in polymer chemistry, 9; Studies in organometallic and inorganic chemistry, 5 and Studies in solid state, thin films, physical chemistry and properties of materials, 15. NCL scientists also presented 25 research papers at various symposia and seminars.

During the year under review 13 NCL staff members, research fellows and guest workers received post-graduate degrees (2 M. Scs and 11 Ph. D s). 46 NCL scientists are recognized as research guides by different Indian Universities.

Consultancy

During the year, institutional consultancy was offered/continued to 5 private sector industries through individual and group of scientists. 4 NCL scientists acted as consultants.

Research Utilization

Table I lists the details of products manufactured based on the NCL know-how. During the year production has been reported for the following 7 new items : (1) Carbazole dioxazine violet pigment, (2) Dimethyl aniline (continuous process), (3) *p*-Menthane hydroperoxide, (4) Phenyl acetic acid; (5) Potentiometric strip chart recorder, (6) Terpineol, (7) Oxalic acid from bark of Ain tree.

Total number of processes in production during 1976-77 were 71 with a turnover of Rs. 15.62 crores as against 64 processes with a turnover of Rs. 12.85 crores in 1975-76. There is thus an increase of nearly 22 % in production value over last year. The cumulative value of industrial production based on NCL technology for the period 1950-77 is over Rs. 62 crores.

Table II lists 34 processes which have been released to industry but have not yet gone into production. Some of the processes listed in Table I have also been released to other parties which have not yet commenced production. Details of such 10 processes have been given in Table IIA. The number of processes released during the year 1976-77 was 6.

A review of research utilization of the processes developed by the NCL on its own from 1972-73 onwards has been presented in Table III. As on 31st March 1977, 139 processes were developed by the NCL on its own, of which 47 are in production, 22 released and awaiting production, 40 not yet

released and 30 processes have been dropped from know-how available list for techno-economic considerations. The production value for 1976-77 of these 47 processess was Rs. 9.79 crores.

The status of the processes developed under sponsorship by industry has been analyzed in Table IV. So far 74 processes have been developed on behalf of 74 parties. Of these 24 are in production and the value of their output during the year was Rs. 5·83 crores. During 1976-77 work on 4 sponsored schemes was completed, 2 new schemes were undertaken and 6 schemes were continued from the last year.

The list of 101 processes/products on which know-how is available is given in Chapter X

Premia/Royalties

The total amounts of premia and royalties received by the NRDC up to 1976-77 on account of the NCL processes were respectively Rs. 22.19 lakhs and Rs. 12·53 lakhs as against Rs. 18·16 lakhs and Rs. 8.69 lakhs received up to 1975-76.

Cost-Benefit Data

Comparative cost benefit data for the years 1975-76 and 1976-77 giving the direct and indirect benefits and cumulative cost benefit data (1950-77) appear on pages 158 and 160. During the year under review the total expenditure was Rs. 176.82 lakhs (Rs. 131·18 lakhs recurring and Rs. 45.64 lakhs capital). As against this expenditure the receipts were Rs. 15 lakhs and the value of production on account of 71 processes in production was Rs. 15.62 crores. The estimated savings in foreign exchange due to this production is about Rs. 6·23 crores.

September, 1977
NCL, Poona

B. D. Tilak
Director

Objectives, Areas of Activities & Perspectives

In January 1972 NCL did an exercise for redefining its obectives and stated the areas in which the activities will be undertaken to achieve these objectives. These were published in our Annual Report 1971-72. A similar exercise is being done again in NCL wherein efforts are being made to reorient the objectives, areas of activities and perspectives. Following are some of the new orientations which are under consideration:

R and D work in the area of chemistry and chemical technology which is not likely to be carried out by in-house R and D in industry.

Projects expected to bring economic benefits to the economically backward sections of our society such as rural, backward and tribal populations.

R and D in area of industrial effluent disposal and pollution.

Contributions to frontiers of science and technology in areas of relevance to chemistry and chemical industry, agriculture, forestry, health care, pollution, solar energy utilization, etc.

Collaborative efforts in implementing innovative scientific and technological methods for the integrated development of rural/ backward areas such as Chandrapur.

Utilization of regenerative resources.

Development of technology which will promote agricultural production and economic utilization of forests.

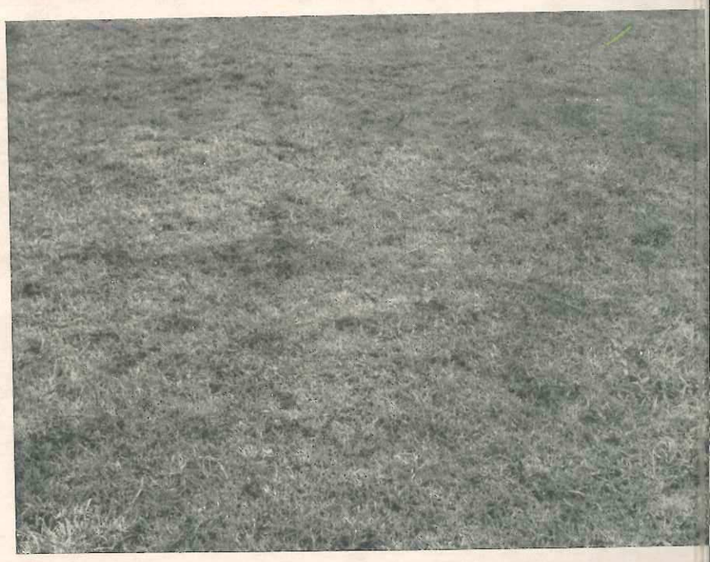
Utilization of mineral resources.

Development, absorption and improvement of technology in public sector enterprises with a view to its diffusion within India and eventual export.

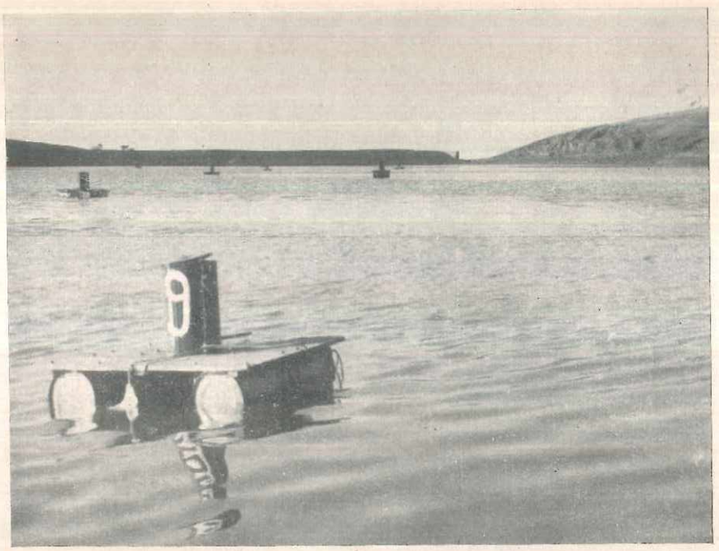
Development of closer links with public sector manufacturing and engineering companies in connection with the above item.

Control of Parthenium hysterophorus (Gajar Gavat) by slow-release herbicide

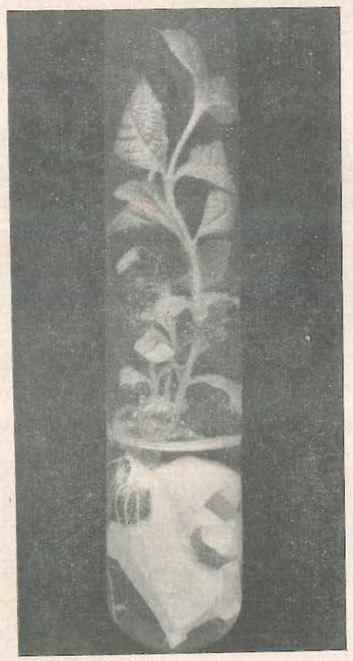
Before treatment



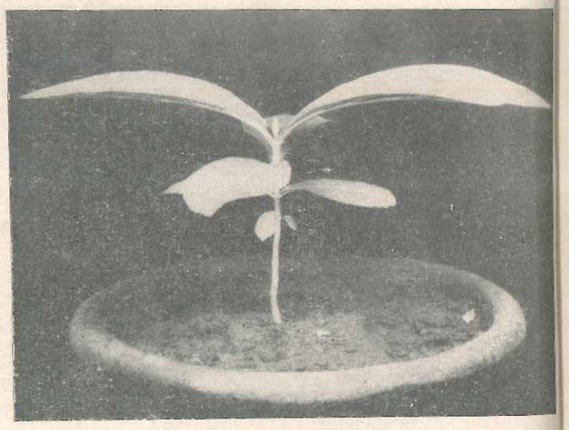
After treatment



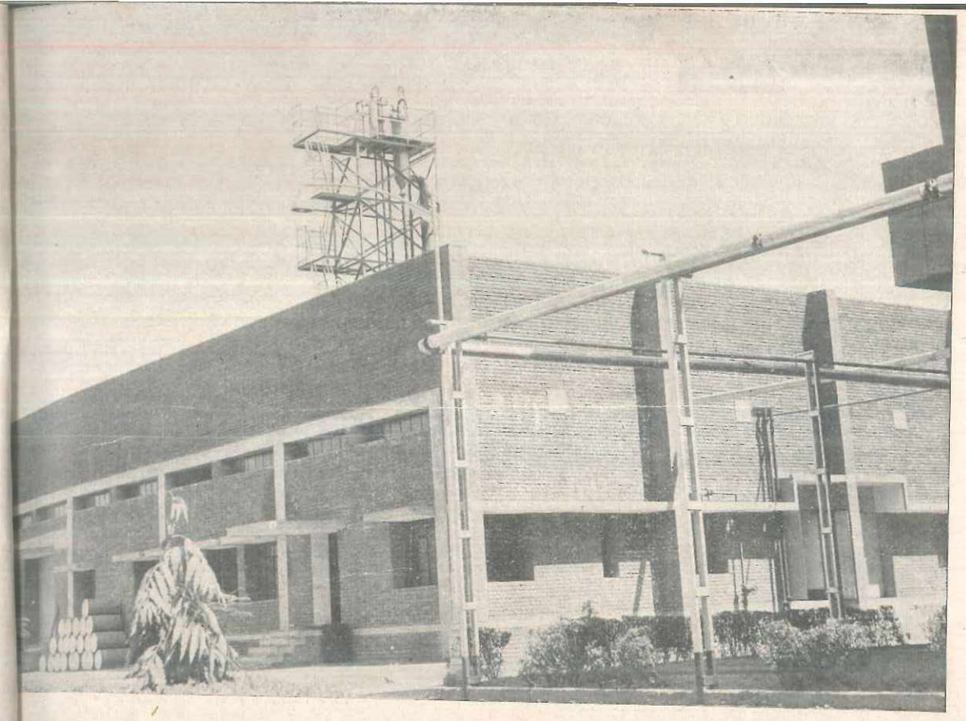
Water evaporation retardation trials at Indira lake



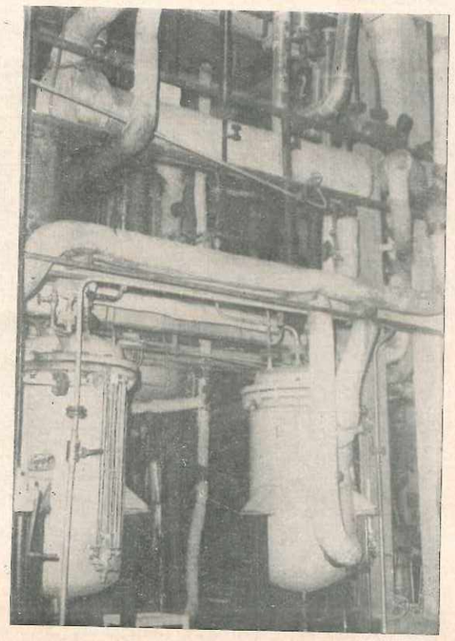
Rooted teak tissue culture plantlet



Potted tissue culture teak plant

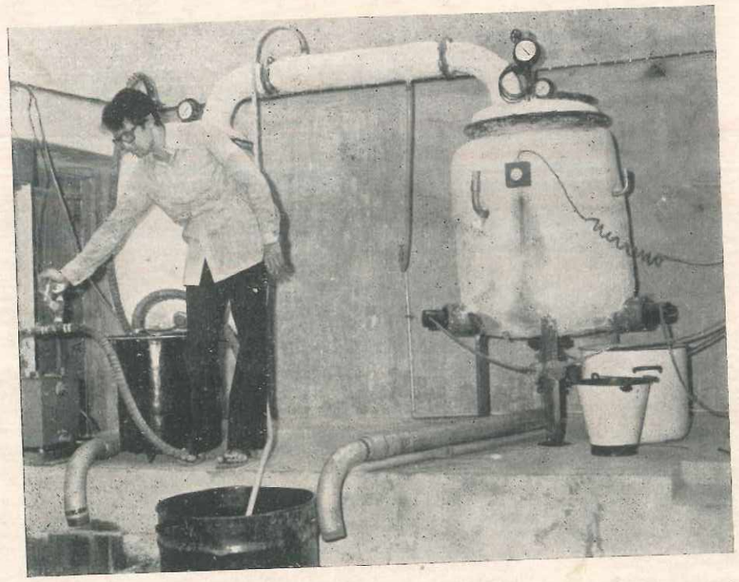


Sorbitol plant of
The Anil Starch Products Ltd., Ahmedabad
Capacity : 500 Tonnes per year



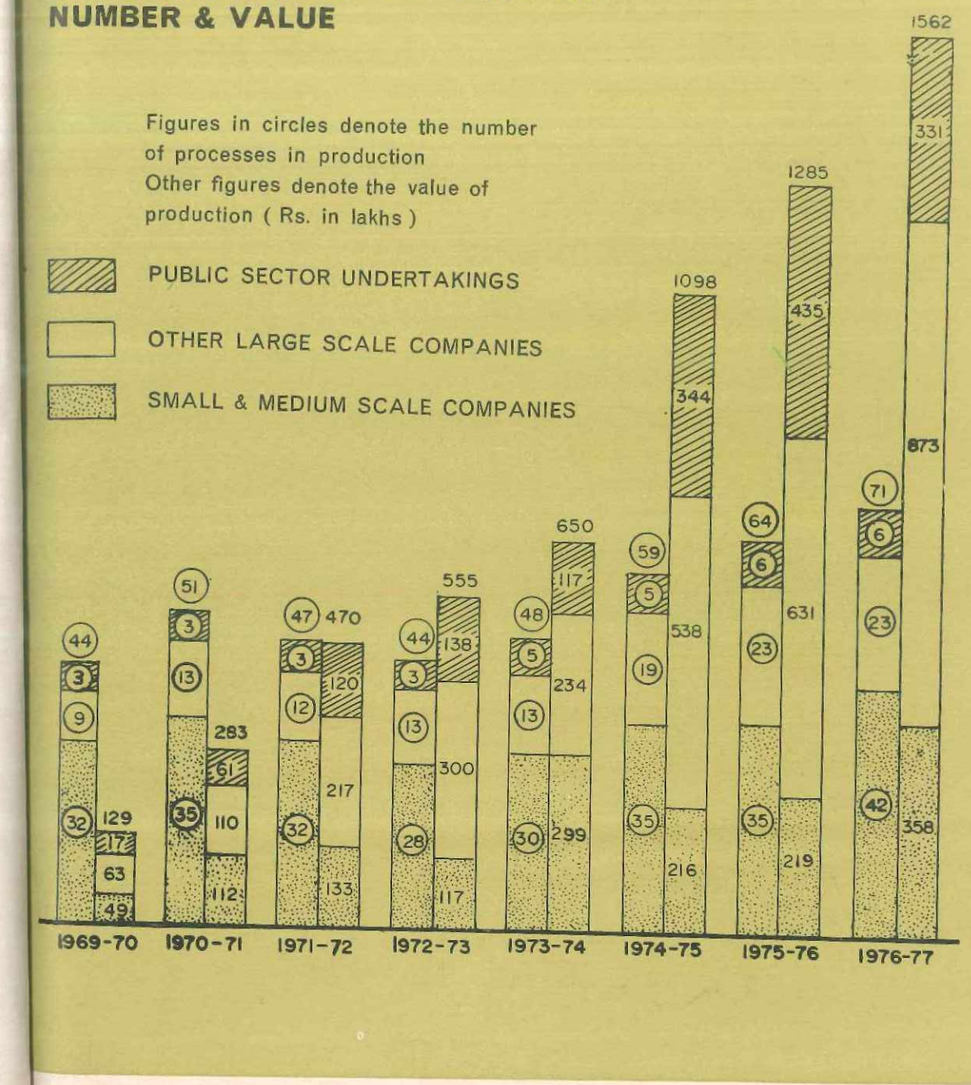
p-Menthane hydroperoxide plant of
M/s Camphor & Allied Products, Bareilly
Capacity : 60 Tonnes per year

Phenylacetic acid plant of
M/s Supranil Chemical Industries,
Poona
Capacity : 60 Tonnes per year



1-Naphthyiacetic acid plant of
M/s Micro Chemicals, Mandsaur (M P)
Capacity : 1·5 Tonnes per year

NCL PROCESSES IN PRODUCTION NUMBER & VALUE



RESEARCH AND DEVELOPMENT PROJECTS

1. PETROCHEMICALS AND BULK ORGANIC CHEMICALS

1·1 *Propylene oxide* : (1/I/70-SP)

The progress of the process development on propylene oxide from propylene, almost upto the completing stage, under the sponsored scheme had already been reported earlier. During the year under report process was demonstrated on a continuous pilot plant to the project engineers of the sponsor and the additional data sought by them were submitted. Certain experiments on corrosion studies and physical properties are in progress as suggested by the sponsor.

Experiments on the conversion of propylene oxide to propylene glycol are in progress.

1.2 *Acrylic acid and acrylates from acrylonitrile* : (2/I/70-SP)

Extensive work on the development of technology for the manufacture of ethyl, methyl, butyl and octyl acrylates is in progress on behalf of the sponsor. During the year under report, pilot plant experiments were carried out on ethyl acrylate. The additional design data, desired by the project engineers associated on the project, on methyl, butyl and 2-ethyl hexyl acrylates were collected and supplied to the sponsor's project engineers.

1.3 *Alkylation of naphthalene and aromatic hydrocarbons* : (3/I/71)

The work involves three steps : alkylation of the aromatic compound, hydroperoxidation of the alkylated product and cleavage of the hydroperoxidated product.

Accomplishment on alkylation of naphthalene and toluene with propylene using sulphuric acid and anhydrous aluminium chloride as a catalyst has been reported earlier. Process conditions, after studying all the variables involved, have been determined to give high yields of mono alkyl derivatives. Hydroperoxidation of these mono alkyl derivatives, however, did not yield encouraging results even after trying different initiators and catalysts. The failure was suspected to be due to the possible presence of sulphur as impurity in the alkylated compounds.

During the year under review, studies in hydroperoxidation of cymene obtained by alkylation of toluene using anhydrous aluminium chloride

were continued. The hydroperoxidation was found to proceed smoothly giving as high as 20% cymene hydroperoxide in the reaction mixture. The purified and concentrated hydroperoxide was used for the experiments on the cleavage step.

A new series of catalysts for alkylation of benzene with ethylene has been prepared and is under screening for their efficiency. The alkylation of benzene has been studied in a new reactor assembly set up during the year under review.

1.4 *Industrial chemicals by catalytic hydrogenation* : (4/I/74)

Industrial processes for a number of organic chemicals and intermediates required in bulk quantities involve catalytic hydrogenation. The laboratory has so far developed quite a few processes involving catalytic hydrogenation and has acquired considerable expertise in this unit process. Out of the processes developed so far, special mention may be made of sorbitol from glucose and metanilic acid which have already been reported.

Last year work on *o*-aminophenol from *o*-nitrophenol, butenediol from butylenediol, continuous hydrogenation of glucose to sorbitol and anisidines from nitroanisoles was carried out.

The reduction of xylose to xylitol is under investigation.

1.5 *Catalytic disproportionation* : (5/I/75)

Catalytic disproportionation of toluene is of importance as it yields industrially important xylenes. In the conventional process, homoengeous catalysts in the form of acidic halides are used which result in sludge formation and loss of catalyst.

A modified zeolite catalyst has been developed which enables continuous vapour phase heterogeneous reaction. The effects of variation of flow rate, molar ratio of reactants, temperature of activation of the catalyst and temperature of reaction were studied. A constant feed system has also been incorporated. The effect of cation substitution in the catalyst will be studied with respect to coke formation.

2. STUDIES IN CHEMICAL ENGINEERING

2.1 *Reaction models and reactor designs* : (1/II/68)

2.1.1 *Solid-solid reactions*

Pellet-pellet system has been analyzed mathematically to account for the unsteady state behaviour. Thereby a relationship for the variation of

reaction zonal thickness has been developed. Also a method has been devised for obtaining diffusivity and rate constant values.

Mathematical analysis has been carried out to show that the parabolic rate law for diffusion controlled systems can also be consistent with diffusion-cum-reaction control.

A model has been developed for the analysis of mixed powder reactions.

2.1.2 *Temperature policy in a deactivating packed-bed reactor*

An optimal temperature policy was obtained for a deactivating catalyst in a packed-bed reactor where the activation energy for deactivation was greater than the activation energy for reaction. The optimal policy demands a constant-conversion, rising temperature path, ending the run as the temperature just reaches the maximum allowable temperature. The method will be extended to immobilized enzyme reactors.

2·1.3 *Fluidized-bed reactor*

(i) For calculating the conversion and product distribution in a fluid bed reactor for complex first order reactions, the design equations have been developed using the simple K-L model. It is shown that the vigorously bubbling fluidized bed reactor can be treated as a fixed bed reactor if the reaction rate constants are appropriately modified to account for the mass transfer effects in the bed. An unexpected prediction of this analysis is that sometimes the selectivity for an intermediate can be greater than that for the plug flow reactor.

(ii) The formation of ensembles due to complex hydrodynamic conditions in the fluidized bed alters the condition of no diffusional resistance in the emulsion phase. This, along with the frequent formation and break-up of the ensemble, affects the transport coefficient across the cloud-emulsion phases. A simple model to take account of this diffusional resistance and the life of the ensemble is proposed. The model reduces to simple K-L model under appropriate conditions.

2.1.4 *Gas-liquid reactions*

(i) The generalized concept of effectiveness factor, employed earlier in isothermal gas-liquid reactions, has been extended to include non-isothermal gas-liquid reactions. A reaction boundary condition at the interface is proposed and the system criteria are derived for various regimes of operation. The most general criterion representing the gas-liquid non-isothermal systems degenerates to simple systems such as gas-liquid and gas-solid (catalytic) isothermal reactions under appropriate conditions.

(ii) Absorption of acetylene in cuprous chloride solution was studied. The kinetics and the controlling regimes were investigated in acidic, neutral and basic solutions. This system is useful in acetylene removal process from olefin streams. The copper-acetylene complexes formed are catalytically active for dimerization and ethynylation reactions. The reaction in ammoniacal solution was found to be in fast reaction regime under certain conditions.

(iii) Ethynylation of formaldehyde to produce propargyl alcohol and butynediol was studied using a copper acetylide acetylene complex as a catalyst in a stirred slurry reactor. The kinetics of this reaction was studied. It was found that under certain conditions the reaction is controlled by intraparticle diffusion. The performance of packed bubble column and a trickle bed column was also studied for ethynylation reaction. Various catalysts were prepared from different copper salts on supports like silica gel, copper carbonate, pumice stone, activated carbon, etc. The effect of copper content and different additives is under investigation. The influence of various parameters on the formation of catalytically active complexes of acetylene and cuprous acetylide was also studied.

(iv) A new theoretical model was developed for predicting the effective interfacial area in a packed bed. The model was successfully applied to data reported in literature on a variety of different chemical systems, falling in different regimes of operation.

2.2 *Hydrocarbon oxidation* : (2/II/75)

Liquid phase oxidation of hydrocarbons presents a low temperature pathway for the production of valuable oxygenated products and exhibits potential as a waste-water treatment technique. A theoretical method was developed to evaluate the termination and propagation rate constants involved in the free-radical oxidation of phenol (a common pollutant) in aqueous solution utilizing intra-particle diffusion limited phenol oxidation data without resorting to the Rotating Sector or other sophisticated free-radical measurement techniques.

2.3 *Catalyst inactivation* (*Enzyme*) : (3/II/75)

A two parameter theoretical model has been developed to evaluate the effect of immobilized enzyme deactivation on substrate conversion in fixed and fluidbed reactors under diffusion-free conditions. The method covers both a simple reaction and a series reaction. Three different immobilized enzyme deactivation forms were considered.

The behaviour of the immobilized enzyme reactor system with respect to loss of activity with time is substantially altered in the presence of diffusion. Taking a first order reaction system, the fall of activity with

time in the presence of both internal and external diffusion has been modelled and preliminary investigations made. With the help of this model the effect of external mass transfer on the enhancement of catalyst stability is to be studied.

2.4 *Catalysis and catalytic engineering* : (4/II/75)

2.4.1 *Development of a catalyst for butylenediol production*

Different catalysts were prepared and tested for their activity and selectivity for butylenediol formation from acetylene and formaldehyde. The various catalysts were prepared from different copper salts on supports like silica gel, copper carbonate, pumice stone, activated carbon, etc. The effect of copper content and different additives is under investigation. The influence of various parameters on the formation of catalytically active complexes of acetylene and cuprous acetylide was also studied.

2.4.2 *Catalyst testing for the aniline project*

(i) A number of copper chromite catalysts were tested for the aniline project. Accelerated life tests for the catalysts chosen from the initial screening were carried out in shifts for about 2500 hours. Regeneration of the deactivated catalysts was successfully carried out and the amount of carbon deposited on the catalysts was determined. The regenerability of the catalyst was established.

(ii) Binary diffusion of nitrobenzene and aniline in hydrogen and effective diffusivities of these compounds in the copper chromite catalyst under reaction conditions were determined by using gas chromatographic technique.

(iii) The nature of adsorption of hydrogen on the copper chromite catalysts and its adsorption/desorption kinetics were studied by using gas chromatographic methods.

(iv) Kinetics of decomposition of copper ammonium chromate to copper chromite catalysts was studied in the temperature range 275-350°.

2·4.3 *Thermal stability of zeolite catalysts*

The thermal stability of zeolite catalysts was studied in the systems viz. alkylation of benzene and disproportionation of toluene. The catalytic activity of modified X and Y type zeolites was found to decrease with time of reaction. One of the causes for deactivation could be the thermal instability of the zeolite lattice under reaction conditions. A series of dealuminated catalysts was prepared by progressive extraction of aluminium from Y type zeolites. Their composition was determined by gravimetric analysis. The

effect of dealumination on the crystalline nature, sorption properties and themal stability of these catalysts have been determined.

3. PESTICIDES AND AGROCHEMICALS

3.1 *Pyrethrins* : (2/III/73)

Trans-chrysanthemic acid has been synthesized from ∝-pinene in an overall yield of 10%. This involves some steps which may not be feasible on industrial scale. The work is being continued with $\triangle^3$—carene to understand the chemistry and handling of these cyclopropane derivatives.

After completion of the present work synthesis of some commercially important pyrethrins and their analogues will be undertaken.

3.2 *Carboxin* (*Vitavax*) : (4/III/73)

Carboxin is a modern fungicide which is selective against pathogen without causing injury to hosts. It is not manufactured in India at present and the present demand is met through imports. Its requirement by 1978-79 is estimated to be 50 TPA valued at Rs. 1.09 crores.

After completion of the laboratory scale work, a few large scale batches 1 kg/batch) on the preparation of technical grade carboxin were carried out to improve efficiency of the process. The technology is being offered to industry for commercial exploitation.

3.3 *Ethephon* (*Ethrel*) : (5/III/73)

Ethephon is mainly used in rubber plantations as a plant growth regulator. Its estimated requirement together with cycocel, 1-naphthylacetic acid, maleic hydrazide and other plant growth regulators by 1978-79 is 100 TPA, the present being 60 TPA.

Process for the preparation of ethephon was developed earlier. During the year, a few large-scale trials on 5kg/batch scale of the technical grade material were successfully carried out and the know-how standardized on that scale.

Some formulations for (i) plant growth regulator and (ii) latex stimulant were also made and they are being analyzed.

Process package for releasing the know-how is being prepared. The process will be available for commercial exploitation, shortly.

3.4 *Paraquat* (*Gramoxone*) : (6/III/74)

Paraquat is a weedicide used for cotton, sugarcane and non-crop areas for removal of aquatic weeds and in tea gardens. It is also used as a defoliation agent and for killing potato virus.

Earlier, work was carried out to study the chemistry involved in the synthesis of paraquat. Further experiments were carried out on laboratory scale using various parameters and yields upto 60% of paraquat on the basis of pyridine methochloride have been achieved.

3.5 *Fenitrothion* : (7/III/74)

Fenitrothion which is a contact insecticide and selective acaricide belongs to organophosphorus group of pesticides. Organophosphatic pesticides are preferred for use in plant protection as compared to conventional chlorinated hydrocarbons, because of their efficacy and less persistent residues.

Fenitrothion is used for controlling chewing and sucking insects on rice, orchard fruits, vegetables, cereals and cotton. Its present demand, together with other insecticides *viz.* methyl-*o*-dimeton and parathion is estimated at 1700 TPA, which is likely to increase upto 3000 TPA by 1978-79.

Pilot plant trials (10 kg/batch of technical grade product) have been concluded. Necessary engineering data, physico-chemical properties of raw materials and reaction products have been collected and effluent disposal problems studied.

A process engineering package for 300 TPA plant is being prepared. The technology is being offered to industry.

3.6 *Dimethoate* : (10/III/74)

Like fenitrothion, dimethoate is an excellent organophosphorus pesticide which is widely used in India. It is mainly used to control a wide range of insects, mites on many vegetables, wheat, sorghum, cotton, apples, oranges, grape fruits, etc. Present requirement of dimethoate is 850 TPA valued at Rs. 6.20 crores of the technical grade material. By 1978-79 its demand is likely to be around 1000 TPA.

The laboratory scale process developed earlier, has now been standardized on a 10 kg/batch scale. Necessary engineering data, physico-chemical properties, analytical procedures for raw materials, intermediates and finished product have been collected.

A process engineering package for 150 TPA plant is being prepared which also includes know-how for effluent treatment. The technology is being offered to industry.

3.7 *Chlordane* : (11/III/74)

This is a contact insecticide used mainly for household or institutional pest control, for lawn termite control and agriculture purpose. Present

requirement of chlordane, heptachlor and aldrin together is estimated to be 900 TPA which is expected to increase upto 1000 TPA by 1978-79.

After standardizing the process on 0.5 kg/batch scale, a few pilot plant runs (10 kg/batch) were carried out. Engineering data required for the preparation of process package are being collected. The process will soon be offered to industry.

3.8 *Imidan :* (12/III/75)

This insecticide is used in controlling pests which are usually encountered during cultivation of paddy. It is also used for the control of codling moth, apple magot, rosy aphids, pear psylla, etc. Imidan, has not yet been registered for use in India. However, there appears to be a scope for registering it and undertaking its manufacture.

A process for manufacture of imidan has been standardized on 1 kg/batch scale, starting from phosphorus pentasulphide and phthalic anhydride. Further work has been discontinued until active user-participation is forthcoming.

3.9 *Utilization of non-gamma-BHC :* (13/III/75)

Hexachlorobenzene, pentachlorothiophenol

Benzene hexachloride (BHC) is used as a general purpose pesticide. The active constituent is the γ-isomer which is only about 14%. The remaining material (non-γ-BHC) is not presently put to any industrial use. Work has been undertaken to convert this waste material into useful industrial products such as trichlorobenzene (TCB), hexachlorobenzene, pentachlorothiophenol, etc.

Process development of TCB from non-γ-isomer of BHC on the pilot plant scale was reported earlier.

Hexachlorobenzene is used as seed dressing agent. It is also used as a starting material in the manufacture of pentachlorophenol, a wood preservative and pentachlorothiophenol, a peptizing agent for synthetic and natural rubber.

The preparation of hexachlorobenzene from non-γ-BHC has been carried out on a bench scale. Studies on different parameters are in progress.

The estimated demand of pentachlorothiophenol is around 250 TPA valued at Rs. 95 lakhs. Preparation of pentachlorothiophenol from hexachlorobenzene has also been carried out on a laboratory scale and further work is in progress.

3.10 *Butenediol :* (14/III/75)

This is an intermediate for endosulfan (an insecticide), vitamin B_6, plasticizers, resins, butadiene diepoxide and polyurethane structural laminates of high flexural strength and modulus. It is not produced in the country at present. The demand is estimated at 2000 TPA valued at about Rs. 6 crores.

After completing preliminary work, as reported last year, detailed experimentation on a scale of 0.5 kg/day was completed successfully, achieving the desired yields of butenediol (90% based on formaldehyde and 80% on acetylene). The process-parameters such as the influence of particle size, catalyst concentrations and feed velocities have been studied.

3.11 *Hexachlorocyclopentadiene (HCCP) :* (15/III/75)

HCCP is mainly required in the manufacture of pesticides, such as endosulfan, chlordane and heptachlor. Endosulfan is expected to be produced in the country in the near future. The demand of endosulfan by 1980 is expected to be 3000—4000 TPA.

A three step process for preparation of HCCP starting from dicyclopentadiene has been established on a bench scale, and pilot plant runs are being planned.

3.12. *Carbofuran intermediate :* (21/III/76)

Carbofuran (also known as furadan) is a broad spectrum carbamate insecticide, nematocide, and miticide. It is used for the control of corn, rootworm, flea beetles, various nematodes, for control of sugarcane borer, wireworm, on rice for control of rice water weevil, on peanuts, etc.

Present requirement of carbofuran is about 100 TPA which is likely to increase upto 250 TPA (valued at Rs. 4.5 crores) by 1978-79.

A process for the manufacture of 2,3-dihydro-2, 2-dimethyl-7-hydroxybenzofuran (intermediate for carbofuran) is being developed, The technology for the conversion of the above intermediate carbofuran is being developed in collaboration with Regional Research Laboratory (RRL), Hyderabad.

3.13 *Phosvel :* (22/III/76)

Phosvel (commonly known as leptophos) is an insecticide used against pests/insects on rice, tomatoes, collards, turf ornamental plants, apples, pears, etc. The estimated requirement for 1978-79 of technical grade material is 50 TPA.

Work has been undertaken to develop technology for the manufacture of phosvel. Syntheses of phenylmethoxythiophosphonyl chloride and bromodichlorophenol which are used as intermediates are also under investigation.

3.14 *Benzene hexachloride* : (23/III/76)

The present methods for the preparation of benzene hexachloride by the addition of chlorine to benzene give only about 13% of the useful γ-isomer though the maximum yields reported in the literature are 20-25%. The remaining non-γ-isomers can be utilized for the preparation of various organic intermediates. However, the scope for their utilization in this manner is quite limited. If the percentage of the active isomer is increased, the product will be less objectionable from ecological point of view. The project has, therefore, been undertaken to investigate possibilities of obtaining higher yields of the γ-isomer.

Estimated demand for benzene hexachloride at the end of 1978-79 will be around 40,000 TPA and the existing market price of the product is around Rs.4,200/tonne.

Experiments carried on 100-150 g scale gave a product with 15-18% γ-content. Radiation dosage has been studied and a method for analysis (GLC) of the final product has been standardized.

3.15 *Slow release herbicide for control of parthenium* : (24/III/76)

Parthenium hysterophorus Linn is an obnoxious widely spread weed which causes allergy and which poses threat to animals and crops. The seeds hardly have a dormancy period and germinate immediately after the fall and remain viable for a long time. Each plant produces thousands of seeds, which are spread by wind resulting in infestation of new areas.

Conventional methods for controlling parthenium have several drawbacks and limitations. A convenient solution to control parthenium would, therefore, be a preventive, pre-emergent, slow-release, selective herbicidal treatment.

A process for such a herbicidal formulation to control parthenium has been developed. The analytical procedures were standardized for the formulation and for the rate of release of active ingredient. Preliminary field trials were carried out to determine the efficacy, dosage, phytotoxicity and residues.

A pilot plant has been set up for producing 100 kg batches of a formulated product and about 1.5 tonnes of the material has been prepared for multilocational field evaluation.

Plots for pre-emergent spraying of the formulation have been identified and the material has been sprayed before the onset of monsoon.

Similar work for the preparation of slow release formulations for the control of monocotyledonous and mosquitoes is being carried out.

AGROCHEMICALS BASED ON NATURAL PRODUCTS

3.16 *Insect hormones and pheromones* : (17/III72)

Work on the synthesis of compounds having insect juvenile hormone activity for possible use in the control of insect pests has been continued.

Twentyeight additional compounds of 4-oxa-dodecaenoic acid series from geraniol were prepared and their juvenile hormone activity was tested against red cotton bug (*Dysdercus koenigii*) in the entomology unit of the laboratory. Detailed investigation on activity of some of these compounds showing score 4 to 5 (80-100% inhibition in adult metamorphosis at the dosage of 10μg/Nymph) is under progress. A few compounds were sent to Virus Research Centre, Poona for testing against 4th instar larvae of *Aedes aegypti* mosquitoes. Of these, four showed that the concentration required for 50% mortality varied from 0.156 to 5.0 ppm.

Extracts of some plants *viz. Tectona grandis* (Sagwan), *Tagetes erecta* Linn (Genda), *Thuja orientalis* Linn (Mayurpankhi), *Bougainvillaea spectabilis* Willd, *Jarca indica* Linn (Ashoka) and *Delonix regia* (Gul Mohr) were screened for JH activity.

Continuation of the further work on the isolation and identification of active constituents will depend on the test reports.

3.17 *Effect of neem oil and cake on slow release of nitrogen* : (18/III/75)

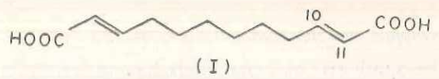
The project has been undertaken to verify whether neem extract has an effect on slow release of nitrogen when added to synthetic fertilizers. If this is true, considerable amount of saving of urea, which is in short supply, can be effected by the suitable addition of neem oil, cake or cake extracts.

Different solvent extracts of neem oil were tested and the extract showing the maximum effect on slow release of nitrogen was identified. After chromatographic separation of this extract the fraction showing most of the activity was identified and studied. The main component was found to be oleic acid. Oleic acid by itself showed high activity in a separate experiment.

A few other unsaturated acids are being studied to see their inhibitory activity on the growth of Nitrosomonas and Nitrobacter bacteria.

3.18 *Undecylenic acid - based products as potential agrochemicals*: (19/III/75)

In connection with the utilization of undecylenic acid for the development of new potential agrochemicals like insecticides, ljuvenile hormone analogues and pheromones, 10, 11—dehydro traumatic acid (I) has been prepared and its diester was tested for biological activity.



(I)

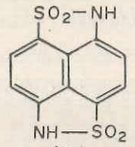
The compound (I) was found to possess a marginal JH activity when compared with other compounds tested and reported earlier.

The work on this project is temporarily discontinued.

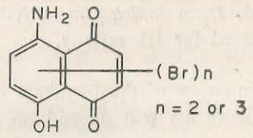
4. DRUGS, DYESTUFFS AND FINE CHEMICALS

4.1 *New disperse and reactive dyes and pigments* : (1/IV/70)

Reaction of sulphur sesquioxide on 1, 5-dinitronaphthalene has been studied in detail. Several novel intermediates such as (I) have been isolated, which when treated with bromine gives a blue dyestuff (II) equivalent to Disperse Blue 20.

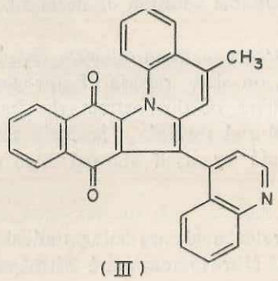


(I)



(II)

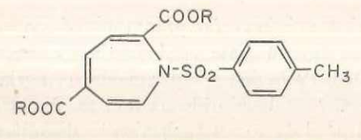
As a continuation of studies on dyes containing heterocyclic quinonoid systems, several phthalylazapyrrocolines such as (III) have been prepared.



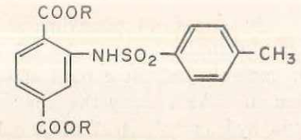
(III)

A number of novel yellow to red disperse dyes with exceptional brilliancy and fastness properties have been prepared.

Reactive disperse dyes containing sulphonazide groups react with polyster fibres. In order to understand the nature of the reaction involved, *para*—toluenesulphonazide was reacted with dimethyl and diethyl terephthalate under thermolytic conditions. It was found that insertion of the generated nitrene results in the formation of the azepine derivative (IV) in addition to the sulphonamido derivative (V).



(IV) R = Me or Et



(V)

The work on the chemical constitution of new disperse dyes has been continued.

4.2. *Cephalexin and 7-ADCA* : (4/IV/73)

Oxidation-rearrangement sequence was studied on penicillin V (as its *p*-nitrobenzyl ester) to get cephalosporin in good yields. Alternate protecting group like trichloroethyl (for penicillin V acid) is also being studied to see the efficiency of the rearrangement sequence. Deacylation step to give 7-ADCA will be taken up shortly.

4.3. *Quinapyramine sulphate and quinapyramine chloride* (*Antrycide prosalt*) : (6/IV/75)

This valuable veterinary drug which is used to prevent loss of cattle due to trypanosomiasis is not produced indigenously and is imported at present. Its estimated requirement is about 9 TPA valued at Rs. 1.5 to 2 crores and is likely to be more after its manufacture in the country.

A laboratory process for antrycide prosalt involving a reaction sequence (batch sizes varying from 25 g to 1 kg) has been standardized. The process will soon be offered to industry.

4.4 *Naproxene* : (7/IV/75-SP)

Naproxene which is a non-steroidal and anti-inflammatory drug is widely used as an anti-rheumatic drug.

Process development work for synthesis of naproxene has been undertaken on behalf of a sponsor.

4.5 *Nitrazepam* : (8/IV/76)

Nitrazepam, which is one of the newer tranquilizers marketed in India, is a drug of 1, 4-benzodiazepines (chlordiazepoxide, diazepam, oxazepam, etc.) series. Estimated demand for this type of drugs is about 16 TPA by 1978-79.

Work on the standardization of the preparation of nitrazepam and its intermediate is in progress.

4·6 *Semisynthetic penicillins* : (9/IV/76)

Starting from phenylmalonic acid, conditions for prepration of monobenzylphenolmalonic acid half-ester, an intermediate used in the synthesis of carbenicillin, have been standardized. Preliminary experiments on acylation of 6-APA using the above half-ester acid chloride as well as on catalytic hydrogenolysis of the condensed product to get carbenicillin disodium have been carried out. Direct acylation of 6-APA with phenylmalonic acid half-acid chloride (from phenylmalonic acid) is also being studied. The disodium carbenicillin obtained compares well with authentic sample.

4.7. *Conversion of* $\triangle^3$*-carene into 1-menthol* : (10/IV/76-SP)

1-Menthol is a versatile chemical used in pharmaceutical and cosmetic industry.

Process development work on the conversion of $\triangle^3$-carene into 1-menthol is in progress on behalf of a sponsor.

5. ORGANIC INTERMEDIATES

5.1 *2-Ethylhexanoic acid*: (1/V/73)

2-Ethylhexanoic acid is used in the form of its salts in paints, PVC stabilizers and in the oxidation of *p*-xylene. Its estimated demand by 1980 is 600-1000 T/y.

A two stage process for the preparation of the acid has been developed on a laboratory scale.

5.2 *D(-)-* α*-Aminophenylacetic acid its acid chloride hydrochloride* : (2/V/74)

There is a world wide shortage of this intermediate which is required in the manufacture of ampicillin. The product is being imported.

As reported last year, preparation of DL-α-aminophenylacetic acid was standardized on 1 kg scale starting from benzaldehyde. Its conversion to acid chloride hydrochloride has been studied on a laboratory scale

90% yield). The product obtained was found to be identical with an (authentic sample.

Analytical methods, process control tests and parameters involved in the preparation are being studied and process will be standardized on 1 kg/batch scale.

5.3 *p-Aminophenol* : (3/V/74)

p-Aminophenol is mainly used in the manufacture of *p*-acetamol. Other uses include photographic developers, dyes, etc. Its estimated requirement is 500 TPA valued at Rs. 3 crores.

This chemical is presently manufactured starting from *p*-nitrophenol. The process developed at the laboratory is based on catalytic hydrogenation of nitrobenzene. The process which appears to be more economical than the conventional route has been standardized on 250 g/batch scale in 75% yield. A good stable product of more than 98% purity has been obtained. Various parameters have been studied.

Further large scale trials will be undertaken.

5·4 *Sorbitol from glucose by continuous process* : (4/V/75-SP)

The successful development of a continuous process for the manufacture of sorbitol under sponsorship of industry was reported last year. During the year under review a project report for a manufacturing unit of 2000 TPA of 70% sorbitol was prepared.

5.5 3,4-*Dichloroaniline* : (6/V/76) *and* (8/III/74)

This is an important organic intermediate required in the manufacture of dyestuffs and the pesticides, propanil and diuron. The present requirement of the dyestuff industry alone is around 500 TPA and that for pesticides nearly 350 TPA.

A process for the preparation of 3, 4-dichloroaniline was developed as a part of the propanil project. Pilot plant runs are now being planned.

5·6 *p-Nitro-m-cresol* (*PNMC*) : (7/V/76) *and* (7/III/74)

PNMC is an intermediate in the manufacture of fenitrothion—an organophosphorus pesticide. This chemical is not produced in the country and the entire demand is met through imports. Its requirement by 1978-79 has been estimated at 400 TPA valued at Rs. 1.8 crores.

Work has been undertaken to develop technology for the preparation of PNMC. Starting from *m*-cresol, PNMC has been prepared on 1 kg/batch scale.

The technology will be further developed on a suitable pilot plant scale and then offered to industry.

5.7 *Anisidines* : (8/V/76-SP)

Ortho and *para* anisidines are widely used in the synthesis of dyes and other organic chemicals and intermediates. The demand is estimated around 500 TPA valued at Rs. 1.5 crores. Catalytic hydrogenation of the corresponding nitroanisoles is a convenient alternative to the conventional acid-iron reduction process.

The hydrogenation process was standardized on a laboratory scale and then scaled up to 20 kg batch sizes. A project report for a plant of 300 TPA capacity has been prepared and handed over to the sponsor.

6. UTILIZATION OF PLANT, FOREST AND MARINE PRODUCTS

6.1 *Flavonoids, tannins, stilbenes, lignans and quinones in some Indian forest trees* : (1/VI/71-SP)

Work on this project was carried out as PL-480 programme since 1971 and was concluded in September 1977.

During the last five years twentyone species were studied. Sixtysix knowa compounds and fortyfive new natural products which are mostly complex phenolics were extracted. Out of these fortyfive, the structures of thirtyeight were determined and several were synthesized in the laboratory. Thirtytwo research papers were published.

Following is a summary of the work done under this project.

Moraceae : The bark of *Morus alba* has been shown to be a rich source of flavone derivatives with complex structures. *Artocarpus integer*, an Indonesian species, contains three new flavones, whose structures are of biogenetic interest because *C*-prenylation has occurred in the 3-position and not in the phloroglucinol-derived A-ring. One of the three flavones is also the first natural product with an oxocin ring system.

There is some evidence that artocarpin may have useful pharmacological properties, but it has been possible to prepare and exmine a series of artocarpin derivatives in which the solubility and ionic properties have been altered.

The stem bark of *Toxylon pomiferum*, a North American species, contains four new and three known xanthones.

Garcinia species (Guttiferae): Attention has been drawn to the remarkable fact that all the hydrogenated xanthone derivatives of the morellin type and the 3, 8-linked biflavonoids so far isolated occur in *Garcinia* species.

Two new pigments with complex structures, biogenetically related to morellin, have been isolated from the heartwood of *G. xanthochymus* and a gamboge probably of *G. cambogia*.

Chloroxylon swietenia (Rutaceae) : Ten new coumarins and two new alkaloids, in addition to seven known coumarins, the known alkaloid skimmianine, and four known lignans, have been isolated from the bark. Among the coumarins, one is the first natural product with a *t*-butyl ketone group.

Erythrina variegata (Leguminosae) : The bark yielded three new isoflavones, together with two known isoflavones, osajin and alpinum, isoflavone, oxyresveratrol and its dihydro-derivative.

Tannins : Among the plants under investigation are *Terminalia tomentosa, Anogeissus latifolia* and *Cassia fistula.* Improved methods of isolation of the monomers and the proanthocyanidins, new degradative procedures, and an end-group method for determining the molecular weight of condensed tannins are three directions in which it is hoped that some advances can be made.

Two new glycosides of ellagic and flavellagic acids have been isolated from the bark of *A. latifolia.* They are the first examples of an ellagic acid xyloside and of any glycoside of flavellagic acid.

Terminalia tomentosa bark contains a " condensed tannin " which has a molecular weight corresponding at last to a hexamer of a catechin.

A. hypogoea : The possibility of using groundnut shell (GNS), an agricultural waste available in vast quantities, for the production of vanillin has been examined.

The Nimz procedure using thiolacetic acid, alkaline hydrogenolysis and other reactions so far studied have shown that GNS lignin is entirely derived from coniferyl alcohol unlike the normal angiosperm lignins. The presence of a 2-phenylcoumaran unit has been demonstrated and further work is in progress to determine the forms taken by the 3-carbon chain and the extent to which the 4-hydroxyl group occurs as an intramolecular ether.

Oxidation of GNS in aqueous sodium hydroxide by cupric oxide and molecular oxygen at 180° yielded 2.6% of isolated and recrystallized

vanillin. Conditions for obtaining the maximum yield are under investigation.

6.2 *Dissolving pulp* : (6/VI/73)

This is a long term project, involving work on utilization of indigenous cellulosic raw materials for rayon making.

At the request of Maharashtra State Forest Development Corporation, Mesta stems (*Hibiscus cannabinus*) without bast fibre and *Dalbergia paniculata* wood was investigated for rayon grade pulp. Both the species give excellent chemical pulp. For its practical use in mill, it will require 40% of long fibre pulp in mixture for sheet making.

Six hard woods from Maharashtra were processed in mixture for rayon pulp and were found suitable. It has been noted that *Tectona grandis* will be unsuitable where resin content of pulp is of primary importance.

Wood of *Boswellia serrata*, *Lannea grandis* and *Garuga pinnata* species were tested for rayon pulp and yarn spinning. *Boswellia serrata* gives standard quality pulp and rayon yarn; while *Lannea grandis* and *Garuga pinnata* give pulp of good quality with medium filterability of viscose. All these species give yarn of acceptable properties.

Mixture of nine hard wood species from Baster forest were pulped at different sulfidity values. No appreciable change was observed in the pulp quality and viscose of these pulps. The results of 15% sulfidity were confirmed on pilot plant scale for pulping and viscose rayon spinning.

Work on testing of cotton linter pulp for viscose rayon spinning has been undertaken for a private firm.

6.3 *Biologically active compounds of plant origin* : (7/VI/73)

A chemical examination of *Parthenium hysterophorus* Linn which is belonging to compositae family was undertaken to isolate its active constituents.

Parthenin isolated from *Parthenium hysterophorus* Linn has been found to possess anti-cancer activity. In an attempt to enhance the activity and reduce the toxicity, a number of derivatives including the common amino acid adducts of parthenin have been prepared. These derivatives will be sent to Cancer Research Centre, Bombay for screening.

It has already been established that parthenin is an insect-anti-feedant and an antigen causing contact dermatitis. Preliminary experiments carried out have indicated the presence of anti-JH compounds in shoot extracts of

parthenium plant and JH compounds in the root extracts. Dermatological studies for establishing structure-activity relationship of the antigen are in progress in collaboration with Dr. A. Y. Lonkar and Armed Forces Medical College, Poona and All India Institute of Medical Sciences.

6.4 *Chemistry of bioactive marine natural products* : (11/VI/74)

This project is undertaken to explore the oceans of the Indian coasts for possible discovery of natural products possessing novel skeletons, unusual functional groups and medicinal properties.

Chemical examination of the brown algae *Padina tetrastomatica* has yielded straight chain hydrocarbons, sterol esters, β-sitosterol, a number of fatty acids and a pigment. Purification and identification of the constituents is in progress.

An unidentified gorgonian supplied by NIO, Goa has been chemically examined to isolate straight chain esters (saturated and unsaturated), β-sitosterol palmitate, β-sitosterol, a new sterol, fatty acids and compounds related to prostaglandins. Identification of these new compounds is underway.

6.5 *Forest and agricultural waste products of Chandrapur* : (13/VI/76)

Chandrapur forest abounds in a number of potentially important plant species; the chemical utilization of which may help the local population. Indian pharmacopoeia records about 100 medicinal plants of which 65 are known to be available in Chandrapur. Some of these plants are on record of pharmacopoeia of other countries and they are also exported. Further there is also scope for cultivation of important botanical drug species in this forest.

A detailed literature survey of some 25 important medicinal plants commonly available in the Chandrapur district has been completed. Similar type of work is in progress for hundred more species. Literature references on the chemical constituents of the important medicinal plants of the district were collected and the methods of analysis of various drugs have been surveyed. A list of medicinal plants in which NCL will be interested to work has been supplied to forest authorities of Chandrapur.

Plants belonging to compositae family are known to be rich in biologically active principles possessing manifold activity, such as anti-tumor, anthelmentic, insecticidal, insect anti-feedant, bactericidal, plant growth regulating (sesquiterpenes), oestrogenic (coumarins) and nematocidal (acetylenic and sulphur containing compounds). Similarly plants belonging to apocyanaceae family contain active principles noted for anti-cancer activity (vinca alkaloids) and hypotensive activity (reserpine alkaloids).

Preliminary screening of six species of plants belonging to the compositae family for anti-JH and other active principles has been initiated. The known anti-JH compounds, precocene-I and II have been isolated from *Ageratum conyzoides* Linn (Osari) and for comparing the biological activity and purity, pure synthetic samples have also been prepared. In addition, some synthetic analogues of precocenes have been prepared to study the structure activity relationship and their testing is under way.

The species of definite medicinal importance and the species belonging to compositae and apocyanaceae families which are the sources for medicinal products will be identified and methods for extracting their active principles will be standardized. The biologically active compounds from identified species of compositae and apocyanaceae families will be extracted, isolated and tested. These extracts will also be tested for their potential pesticidal activity.

6.6 *Oleoresin/heartwood of Salai tree* (*Boswellia serrata* Roxb) : (14/VI/76)

Boswellia serrata is widely spread in many forests (e. g. Chandrapur). The oleoresin obtained from *B. serrata* by tapping is sometimes called guggul—a term which is also used for Indian bdellium obtained from *Commiphora mukul*. Oleoresin of *C. mukul* a member of the same family (Burseraceae) is a rich source for useful steroids and hence a systematic chemical investigation of *B. serrata* oleoresin assumes considerable importance. It is reported in the literature that oleoresins of *Boswellia* species generally contain triterpenes. However, the oleoresin of Salai tree has not been subjected to systematic chemical investigation.

Various solvent extracts from the heartwood have been prepared and systematic chemical investigation of each extract is in progress. Work on the systematic chemical study of the oleoresin will be carried out as soon as more material is available.

6.7 *Chemical/microbial transformation of plant/animal sterols into estrone—a key intermediate for* 19-*norsteroid oral contraceptives* : (15/VI/76)

Transformation of the easily available plant/animal sterols into 19-norsteroids (e. g. estrone and related hormones) by strictly chemical method may not be economically feasible. Chemical accessibility of 19-hydroxysteroids — a precursor for 19-norsteroids — was realised by a combination of chemical and microbiological approaches. The process appears to be commercially viable.

The conversion of cholesterol acetate to the key intermediate 19-hydroxycholesterol acetate has been achieved in 3 steps as reported in the literature.

6.8 *Cold setting binder and accelerator* : (16/VI/76)

At the instance of the Indian Railways some exploratory work was undertaken to produce this binder and accelerator based on indigenous raw materials.

7. STUDIES IN ORGANIC CHEMISTRY

7·1 *Studies in heterocyclic chemistry* : (2/VII/65)

7.1.1 *Novel heterocyclic systems*

A novel route to 4-membered nitrogen heterocycles from 3-membered rings by rearrangement was discovered. The study on this reaction is in progress.

Synthesis of a number of a 1-*S*-phenyl-1-thiouranium salts has now been achieved. Their rearrangement reactions are being studied presently.

7.1.2 *Nitrogen heterocyclics*

Mechanistic studies on the formation and rearrangement reactions of N-arylazetidines were continued further. A general and new synthesis of 1, 5, 1, 7-and 1, 8-naphthyridines has been developed.

7·2 *Mass spectrometry* : (3/VII/65)

7.2.1 *Metabolism studies*

The work on the metabolism of hydroprene—an insect juvenile hormone was continued. The metabolites were seperated by TLC and identified by GC and GC-MS.

7.2.2 *Collision induced decompositions structure of gaseous ions*

Collision induced decompositions of specific ions is a well established technique to gain information on structure of gaseous ions.

The collision induced decomposition spectra of C_6H_8O ions generated by direct ionization and fragmentation of ten different precursors have been studied. In order to accommodate the data it was suggested that isomerization to an α, β-unsaturated aldehyde like structure takes place before fragmentation.

7.2.3 *Chemical ionization*

Skeletal rearrangements induced by electron impact is a well known phenomenon. It was observed that under chemical ionization conditions, skeletal rearrangement processes can occur. Further work is in progress.

7·3 *Studies of chemical reactivity and structure* : (5/VII/70)

7.3.1 *Ascorbic acid and its derivatives*

To understand the chemical susceptibilities of the ascorbic acid molecule and the mechanisms of its biological action, a large number of derivatives have been spectroscopically studied and evidence for the stereochemistry of isodimethyl ascorbic acid has been obtained. A comparison has been made of the reactivities of ascorbic acid and its isopropylidene derivative in benzylation and in oxidations of salicylic acid, toluene and some other materials. A striking difference has been observed. An explanation for this has been advanced which brings out what is believed to be one of the most important properties of the ascorbic acid molecular system.

7.3.2 *Hydroxylation of aromatic compounds with peracids*

Reactions of peracids like peracetic acid with aromatic compouds mediated by aryl iodides proceed *via* iodoso derivatives. The reaction of phenyliodoso acetate with a number of phenols and acetanilides has been studied and new results have been obtained. The results suggest the possibility of producing hydroquinone by a novel method which possibly has commercial potential. A number of new ylides have been prepared whose properties are yet to be examined. The results suggest the need for studying the organic chemistry of trivalent iodine at greater length.

7.3.3 *Reaction of salicylamide with carbon tetrachloride*

It was observed some time ago that salicylamide sodium salt reacts with carbon tetrachloride in DMSO solution to give chloroform as one of the products. The reaction went smoothly at times and poorly at others. In an attempt to find the other products formed, two compouds have been isolated which are yet to be characterized. The conditions which favour the reaction are being investigated.

7·3.4 *Reactivity of aspirin*

Hydrolysis and other reactions of aspirin have been studied extensively and there has been considerable controversy on the mechanisms of these reactions. An attempt has been made to see if spectroscopic evidence could be furnished for the anhydride intermediate often postulated for the hydrolytic reaction. This could not be done since the intermediate, if present, is only at very low concentration even in specially chosen solvents where greater stability could be anticipated for it. There are reasons to think that the pharmacological action of aspirin is triggered by an initial acetylation, perhaps of a protein. However, no rate data are available for the reaction of aspirin with amino acids, peptides or proteins.

It is proposed to do the necessary kinetic work to gather this important information. A method for following the reaction has been worked out.

7.3.5 *Transition metal catalyzed organic reactions*

As part of a programme for the study of some transition metal catalyzed reactions of terpenoid and other derivatives, the reaction of Δ^3-carene with $Pd(OAc)_2$ has been investigated. The products of reaction are temperature dependent and *m*-and *p*-cymenes are among the major final products. The course of the reaction is being studied.

7.4 *Synthesis and reactions of epoxides* : (6/VII/73)

Sodium glycidates have been converted to ∝-acetoxyaldehydes by reacting with lead tetraacetate. 2-Methyl-2-(2-hydroxy-4-methylphenyl)-oxirane has been synthesized and rearranged thermally. Further work will be carried out on the thermal arrangement of related oxiranes.

7.5 *Steroid synthesis* : (7/VII/74)

A trans-olefin was subjected to different cyclization procedures with a view to get a key steroidal intermediate. Cyclization has been achieved and the product is being studied further.

For an alternative route to the transolefin (*via* an exclusive C-alkylation procedure), the requisite enol ether was prepared.

In a different approach for the steroid synthesis starting with BCD rings, some intermediates are made *via* novel routes.

7.6 *Studies in alkaloids, synthesis of steganone and derivatives*: (8/VII/74)

7.6.1 *Studies in alkaloids* :

Some useful intermediates for the synthesis of Dendrobin and Vindoline were made *via* novel routes. Synthetic elaboration on these intermediates is in progress.

7.6.2 *Synthesis of steganone and derivatives*

The penultimate intermediate on the preparation of steganone was synthesized. The final cyclization step is under study.

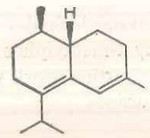
7.7 *Photochemistry of epoxides* : (12/VII/75)

The studies on the photochemistry of epoxides is being pursued with a view to get more mechanistic information about the novel photoreduction observed earlier. The photoaddition of alcohols to styrene epoxide reported in literature has been shown to be in error and a photoreaction of styrene epoxide has been discovered. This new reaction seems to be a general reaction and may have some application from synthetic point of view.

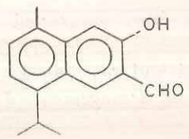
7.8 *Sesquiterpenes* : (13/VII/76)

7.8.1 *Synthetic studies towards sesquiterpenes*

Starting from menthone and carvetoneacetone two naturally occuring compounds (+) epizonarene (I) and 7-hydroxycadelenal (II) have been synthesized. Many experiments have been conducted to study the stereochemistry at various centres of one of the intermediates (III) which has been isolated, both as a solid and liquid.



(I)



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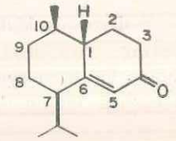
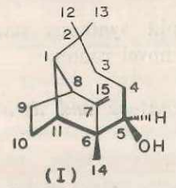


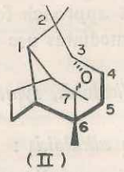
(III)

7.8.2 *Synthesis of Juniperus sesquiterpenes*

Two sesquiterpenes from *Juniperus conferta* longifol 7,15-en-5 β-ol (I) and longifolan-3 ∝, 7 ∝-oxide (II) — have been synthesized by exploiting a novel hypoiodite functionalization reaction of longifolol—a derivative of longifolene.



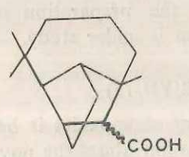
(I)



(II)

7.8·3 *Unique cyclopropanation in oxidative decarboxylation by lead tetraacetate.*

Pb (IV) oxidation of the longifolic acids (III) gave norlongicyclene (IV) in high yield.



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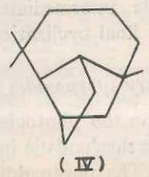
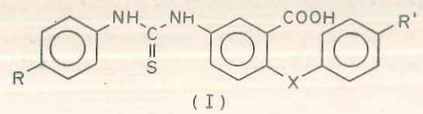


(IV)

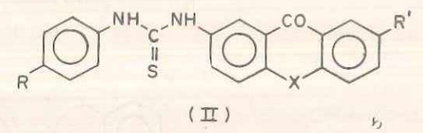
7.9 *Substituted thioureas and their derivatives* : (14/VII/76)

Antibacterial property of thioureas is well-known. A large number of diaryl substituted thioureas have been prepared by various workers and several

have been found to be active. Work has been undertaken to prepare substituted thioureas of the following type :

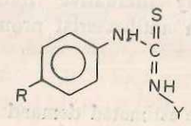


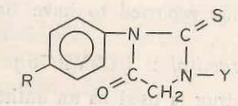
(I)



(II)

Where R = H, CH_3, Cl and OCH_3,
R' = H, CH_3, OCH_3, Cl, OC_4H_9, OC_5H_{11}
and X = S, or SO_2





Where R = H, Cl, CH_3, NMe_2, alkoxy and Y = 8-alkoxyquinolyl
8-chloroquinolyl, 6-quinolyl, 5-chloroquinolyl
and 5-alkoxyquinolyl.

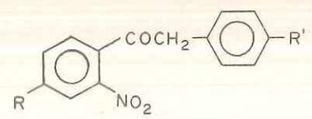
7.10 *Addition of hydroxyl radicals to olefins* : (15/VII/76)

A direct hydroxylation of olefins is of great theoretical and practical importance. A literature survey has revealed that very little work has been reported on the free radical hydroxylation of alicyclic olefins. A programme has therefore, been initiated to study the addition of hydroxyl radicals to these olefins. The hydroxyl radicals are generated by the photodecomposition of hydrogen peroxide *in situ*. The reaction products obtained consists of both *cis*-and *tert*-alcohols along with some allylic products. The effect of the ring size on the nature of the reaction product is also being investigated.

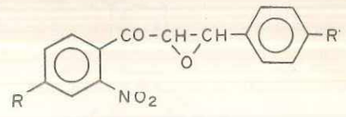
7.11 *Aminoaryl/aryl alkyl ketones and their derivatives* : (16/VII/76)

O-Nitrophenylbenzyl ketones (I) are unknown in literature. Therefore

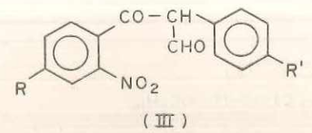
attempts have been made to prepare these by BF_3– ethrerate rearrangement of *o*-nitrosubstituted chalcone epoxide (II) to get ketoaldehydes (III) which on base catalyzed rearrangement should give (I). However, the major product is isatogen (IV) and the yield of (I) is very poor.



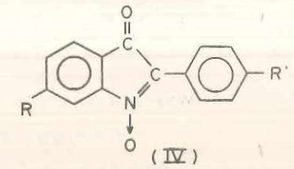
(I)



(II)



(III)



(IV)

Where R=H, Cl, NO_2, OCH_3 and Dimethoxy

R'= H, Cl, CH_3, OCH_3, and Dimethoxy

Attempts are continued to prepare (I) by alternative routes. The isatogens are reported to have broad spectrum antibacterial properties.

7.12 *Tetramisol* : (17/VII/76)

This drug is used as an anthelmentic. The estimated demand is about 10 TPA valued at Rs. 80 lakhs. Work is in progress for the synthesis of this drug. Several synthetic routes to tetramisol are under study.

7.13 *Peptidic juvenile hormones* : (18/VII/76)

Peptidic juvenile hormones have been prepared in order to find out their application as a third generation pesticide. It is proposed to synthesize few more peptides to evaluate the structure function relationship of various small peptides.

7.14 *Vinca alkaloids* : (19/VII/76) and (12/VI/76)

The two alkaloids Vincristine (VCR) and Vinblastine (VLB) from *Vinca rosea* (Sadaphuli) leaves have been proved to be very effective against leukemia. Work on the isolation of VCR and VLB from plant using modern methods of chromatography is in progress.

7.15 *Solid phase synthesis* : (20/VII/76)

Using solid phase synthesis technique, few organic/bio-organic reagents/ catalysts have been prepared and their application to resolve optical isomers or as catalyst in the bio-organic synthesis is under investigation.

Asymmetric synthesis of few ∝-amino acids and similar therapeutic compounds are in progress.

8. INDUSTRIAL POLYMERS, ELASTOMERS AND RESINS

8.1 *Polysulfide rubber* : (2/VIII/68)

Polysulfide rubbers which are known under the trade name Thiokol rubbers have outstanding fuel, ozone and weather resistance. Sealants based on these rubbers find application in the manufacture of aircraft, building, marine, automobile industries, etc. The present requirement of Defence of polysulphide rubber based formulations is met with by imports.

The process for the basic rubber was standardized on 5 kg/batch scale with overall yield of 65% based on the monomer. To economise the process, indigenously available aqueous solution of ethylene chlorohydrin was used for the preparation of monomer (dichloro diethyl formal).

At the instance of Department of Atomic Energy, work on the preparation of 200 kg of a caulking composition based on indigenous polymer has been initiated.

8.2 *Sulfochlorinated polyethylene elastomer* (*SCPE*) : (3/VIII/68)

This is a speciality rubber having outstanding resistance to weather and abrasion. It is used for high temperature gaskets, hoses, shoe soles, tank linings and paint formulations for outdoor use.

The process development work on SCPE using sulfuryl chloride as the sulfochlorinating agent has been reported earlier. However, the use of sulfur dioxide and chlorine gases as the sulfochlorinating agents render the process economically more attractive. Hence work on this route has been undertaken and sulfochlorination of low density polyethylene of various grades with SO_2 and Cl_2, was standardized on a laboratory scale. The sulfochlorinated product has been found to have mechanical properties comparable to the Hypalon-20. Pilot plant runs (2 kg/batch) have also been successfully conducted.

8·3 *Polyurethane rigid foams* : (4/VIII/71)

Rigid urethane foams have many unique properties such as insulating efficiency, light weight, high strength adhesion, low water vapour transmission, buoyancy, solvent and chemical resistance and ideal electrical properties. These foams are used in domestic and industrial refrigeration, transportation, packaging, structural reinforcement and substitute to wood in furniture, etc. At present all the raw materials required for the preparation of rigid urethane are to be imported.

Know-how for the preparation of an aminopolyol has been standardized on 5 kg/batch scale with 95% yield. About 10 kg of the polyol was given to commercial firms for evaluation. Foam prepared from this polyol was found acceptable for packaging. Work on the preparation of rigid foam of thermal insulation grade has been initiated.

8.4 *Synthetic water soluble polyelectrolytes* : (7/VIII/75)

In recent years secondary oil recovery techniques are being extensively studied in the light of energy (oil) crisis. Polymer flooding forms an important aspect of the secondary oil recovery. M/s Oil India Ltd., Duliajan (Assam) have imported about 1.4 million lbs. of anionic polyacrylamide valued at about Rs. 1.7 crores for field trials in secondary oil recovery. Besides, Oil India, Oil and Natural Gas Commission (ONGC) will also require similar quantities as and when they decide to go in for secondary oil recovery.

Cationic polyelectrolytes which find use in paper making industry as fines and filter retention aids, is another important class of water soluble polyelectrolytes.

Laboratory scale experiments have been completed. Yields in most of the experiments are in excess of 97% based on acrylamide. Methods of soiution polymerization, hydrolysis, polymer isolation, drying and improved shelf-life stability have been standardized. The polymers obtained so far are deficient in flow resistance factors. Experiments are in progress to improve these factors.

8.5 *Cellulose acetate butyrate* (*CAB*) : (8/VIII/75)

Several grades of mixed esters of cellulose are used in industry. Major demand is in fountain pen manufacture. Country's entire requirement of CAB is presently being met with through imports.

Due to non-availability of butyric anhydride, experimentation had to be restricted to studies on cellulose acetate as reaction conditions are similar to those required for CAB. Reaction conditions for preparation of cellulose acetate on 2 kg scale have been standardized and a product having an acetyl content equal to the total butyryl and acetyl content required in the grade of CAB, which is in view, has been obtained. A prototype s. s. reactor which would give 100-200 g of the final product has been designed and fabricated.

8·6 *Development of items having short shelf life* : (10/VIII/76-SP)

A number of short shelf life items such as sealing compounds, resins, cements, glues, paints, varnishes, rubber compounds, etc. are being imported

by defence and other industries. The value of these items which are required for a variety of end uses is of the order of Rs. 20 lakhs per annum.

Work has been initiated for developing technology for the manufacture of several of the more critical items.

8.7 *Dimer acids and polyamide resins* : (11/VIII/76)

Dimer acids are prepared from the linoleic acid by Diels-Alder reaction at high temperature (350°) and pressure (1000-1500 psi). Further under suitable conditions they can also be produced at lower temperature and at atmospheric pressure.

These acids have wider applications in manufacture of polyesters, urethane foams, soaps, oil additives, polyamides and epoxy resins. These in turn find applications in plastics, elastomers and in surface coatings.

Polybasic acids can be manufactured either by a synthetic process which principally depends on petroleum based feed stock or from agricultural raw materials. With the world wide acute shortage of petroleum products, and heavy drain in foreign exchange from India, the economic and technological feasibility of utilising agricultural raw materials is being investigated. The latter are distinguished also by the fact that they can yield long chain dibasic and polybasic acids. The current demand for these type of products appears to be around Re. 1 crore, with a potential of about Rs. 2-4 crores in the next few years.

The preparation of the dimer acid has been studied using castor oil fatty acids. Analytical procedures for the raw materials and final products have been established. The polymerization of the above fatty acid at atmospheric pressures and low temperatures of 160°–190° using catalysts have given satisfactory results. The experiments carried on 100 g scale showed monomer 40-45%, dimer 50-60% and trimer 10-15%. The molecular weight, refractive index and acid value for the dimer acid were comparable with the results reported in the literature.

8.8 *Development of a substitute for side seam cement* : (12/VIII/77-Sp)

A polymeric composition known as side seam cement finds application in metal canning industry. It is presently imported to the tune of 6 to 7 tonnes per year valued around Rs. 7 lakhs. The consumption of the above compound is likely to increase substantially if it becomes indigenously available.

Developmental work on the above item has been sponsored by a local firm.

9. STUDIES IN POLYMER CHEMISTRY

9.1 *Physico-chemical studies* : (1/IX/60)

9.1.1 *Solution behaviour of polyelectrolytes*

A series of acrylamide-acrylic acid copolymers with the same degree of polymerization, but with varying acrylic acid content, have been prepared. The viscosities of the copolymers have been measured in a low pH buffer (total supression of ionization) salt solutions and 0.1 M alkali. Further experimental work is in progress.

9.1.2 *Utilization of caprolactam oligomers*

Some experiments for the utilization of oligomers in caprolactam polymerization were carried out. These oligomers known as 'hard oligomers' are waste products from nylon industry and their disposal is a problem. In the experiments carried out, these oligomers were used as 'additives' and the polymerizations were carried out in sealed ampoules at different temperatures (230-270°). It was found that the addition of oligomers did not affect the equilibrium reaction and the analysis of the samples showed the incorporation of oligomers in the polymer. TLC studies showed that the oligomers had linear structure and, since linear oligomers contain active amino and carboxylic groups, a faster reaction is expected. This was confirmed in one experiment.

The results are qualitative but indicate the possibility of using these oligomers in caprolactam polymerization, thus reducing caprolactam in the charge, by substituting with oligomers as additive and at the same time solving the problem of their disposal.

9.1.3 *Kinetics of anionic and Ziegler-Natta polymerization*

Before undertaking studies on the anionic polymerization of butadiene, the anionic initiator was synthesized in high purity by vaccum technique. Polymerization of butadiene by n-butyl lithium in conjuction with polar modifiers in hydrocarbon solvents, was carried out to get medium (35-60%) vinyl content polybutadiene, having molecular weight in the range 50,000.

9.1.4 *Conformational behaviour of polyelectrolytes*

During the study of the copolymerization kinetics of ionizing monomers in acqueous media, it was found that the kinetic parameters are influenced by side chain ionization, pH and the ionic strength of the medium. These factors influence the size and shape of the propagating polymer coil and hence should also influence the polyelectrolyte formed.

As a model for the tertiary structure of biomacro-molecules certain synthetic polyelectrolytes like polymethacrylic acid have been investigated

extensively. The molecule has a compact globular coil stabilized by hydrophobic interactions at low degrees of ionization, expanding to a random coil at higher side chain ionization. The nature of the stabilizing factors —whether short or long range interactions—was not clear.

Based on copolymerization studies on the methacrylic acid systems polymethacrylic acid chains, interposed by a hydrophilic monomer at varying intervals, were prepared and their globule to random coil transitions were studied by combination of potentiometric titration and viscometry. The studies showed that the long range interactions feasible by the sequential twist of the segments stabilize the molecule only marginally while the short range interactions play the major role.

9.2 *Polymer characterization* : (2/IX/69)

Workability of the proposed design of apparatus for measuring stress strain (viscoelastic) properties of SCPE and any other elastomers has been confirmed on a prototype model. Work on the fabrication of this special type of apparatus alongwith a strip chart recorder has been initiated.

9.3 *Thermodynamic properties* : (3/IX/69)

The new bond-energy scheme for calculations of the standard heat of formation of monomers and polymers to nitrogen compounds (Part VI) is in progress.

9.4 *Studies in polyamines and polyimides* : (5/IX/76)

Polyimides, a class of high temperature resistant polymeers, has attained importance in recent years due to the developments in space technology. Polyimides can be used in variety of ways, for instance, adhesives, surface coatings, insulation, bulk plastics, films, etc. Several new polyimides have been prepared and characterized on the basis of various physical methods.

The polyamines, mostly diamines, have been synthesized by monoamine and aldehyde condensations. These diamines are utilized to synthesize diisocyanates. The studies on the reactivities of these diisocyanates with alcohols have been made using IR spectroscopy. These diamines are further utilized in rubber accelerator studies.

Polyimides were prepared from the above diamines and dianhydrides such as pyromellitic dianhydride, BTDA, etc. These polyimides were obtained in the form of tough, flexible and thin films. The thermogravimetric and electrical properties of these polyimides were studied. A new type of coordination compound has been synthesized from the diamines and alkali metal halides.

9.5 *Studies in polysulfides* : (6/IX/76)

Thioglycolates of many glycols and triols were synthesized and utilized in studies on polysulfides. Curing studies of aminofunctional polymers based on a polysulfide liquid polymer and glycol thioglycolates with a commercial liquid epoxy resin were completed. Rubbery products were prepared from castor oil thioglycolate by curing with different curing agents. Their physical properties were studied. Polyimidothioethers were prepared from dimaleimides and thiols, and their physical properties were studied. New thermal stabilizers for PVC were prepared, namely organothiosilanes and their thermal stabilization potency was studied alone and in combination with divalent metal soaps and a dialkyl tin dithioglycolate.

9.6 *Viscoelastic properties of polymers—the creep compliance measurements* : (7/IX/76)

Polymers are viscoelastic materials having characteristics of elastic materials and viscous liquids. The simultaneous determination of steady shear viscosity, η and compliance J_e is useful to clarify the rheological properties of linear polymer in terms of polymer charactetistics. The former is a measure of energy dissipation and the latter is a measure of energy storage. An apparatus for the measurement of steady shear viscosity and creep compliance of concentrated polymer solutions has been fabricated, and the calibration of the appartus has been completed. The apparatus is essentially the same as the torsion creep appartus of Plazek as far as the creep measurement is concerned but is simpler in design. Viscoelastic materials whose viscosity lies between 10^4 and 10^8 poise and compliance is in the range from 10^{-7} to 10^{-2} cm^2/dyne can be studied with this instrument.

The creep compliance measurements for concentrated butyl rubber solutions in toluene and cyclohexane have been carried out at different temperatures. The two parameters, viscosity η and steady shear compliance Je, used to describe the slow deformation of viscoelastic materials have been evaluated by the extrapolation method given by Ninomiya by making use of the plots of J (t)/t versus 1/t and *m* J (t)/t versus 1/t. Here *m* is the slope of the plot of log J (t) versus log t, t is the time in seconds. The limits of low and high concentration of solutions used were 25 and 60 g/dl respectively. The viscosity obtained for toluene and cyclohexane solutions was found to be strongly dependent on concentration. In the double logarithmic plots of η vs. concentration, it is observed that the slope d log η/d log c becomes steeper with increasing concentration. The study is being continued further.

10. MINERAL RESOURCES UTILIZATION

10.1 *Titanium tetrachloride and beneficiation of ilmenite* : (1/X/73)

Titanium tetrachloride is the starting material for the production of rutile grade titania by the chloride route and is also required as a seed material in the manufacture of rutile titania by the sulphate process. The immediate demand for its latter use alone is of the order of 2000 TPA valued at about Rs. 1 crore. $TiCl_4$ is the starting material for the manufacture of titanium metal. Besides this $TiCl_4$ finds application in the production of some intermediates and polymerization catalysts.

The successful development of the process for $TiCl_4$ from ilmenite had been reported earlier. During last year, the pilot plant of 20 kg. $TiCl_4$/hr. was continuously operated for collecting the engineering data, based on which design of plant of 2000 TPA capacity is under preparation.

M/s Travancore Titanium Products Ltd. (TTP), Trivandrum, propose to collaborate with NCL for scaling up of the process on a commercial scale of 2000 TPA. This plant will meet TTP's present requirement of $TiCl_4$ as the nucleating agent for production of rutile titania. This will also serve as a unit to collect engineering data for a still larger plant of the order of 50,000 TPA. TTP has sought association of a reputed project engineering company to engineer the project in collaboration with NCL.

Laboratory scale investigation were also carried out on the beneficiation of ilmenite by selective chlorination in presence of coke in a fluildized bed, whereby the iron oxide component of ilmenite is selectively removed as ferric chloride. Further work is in progress.

10.2 *Bacterial leaching of ores* : (2/X/73)

This project has been identified as an interlaboratory project wherein NCL, Poona, NML, Jamshedpur, CMRS, Dhanbad and RRL, Bhubaneswar will participate in carrying out leaching experiments with actual samples obtained from mine waters and low grade ores with a view to subsequent development of techniques for recovery of strategic metals, particularly copper.

Ore samples obtained from different mining areas when tested with the mixed flora showed (60-80%) leachability of copper. Enrichment experiments carried out with three of the mixed flora and four of the ores proved successful in reducing the total number of days from 60 to 40 to bring about the same percentage of leaching. Copper tolerance limits were raised to 20 g of Cu per litre. Some of the mixed flora were made to grow and extract copper from ores without the extraneous addition of nitrogenous compounds. These are being further subcultured and maintained under the same conditions to see whether they will continue to grow without a source of nitrogen.

Column leaching experiments with two or three ores resulted in 30% extraction of copper in 40 days. Some more experiments under different

conditions are in progress to improve upon the leachability. These column experiments were scaled upto 3-4 kg of ore.

Leaching columns were set up in which ore in the form of coarse particles was packed and the leach liquor was passed continuously through the column counter currently to an air stream. The bacteria contained in the leach liquor have been isolated and are capable of leaching out copper from low grade chalcopyrites. Experiments were conducted on ores from several mines in India. These experiments would simulate the heap leaching operations to be done on a large scale on the field. Experiments have also been conducted on vat type leaching in which a stirred vessel is employed.

10.3 *Cyclic process for solubilizaiion of Indian phosphate rock* : (3/X/73)

Udaipur rock phosphate is at present being tried for phosphoric acid production by the conventional method which involves use of sulphuric acid. A cyclic process has been recently suggested using ammonium bisulphate which is regenerated and recycled, so that consumption of either sulphuric acid or hydrochloric acid can be avoided. The raw materials required are rock phosphate, carbon dioxide and make up ammonia. However, only scanty details are available (from a few patents). NCST has approved the laboratory work being done at NCL on the chemistry of the process, including modifications.

Laboratory work on 100 g scale, on the essential features of the process has been completed. All the postulated reactions, reaction conditions and yields have been confirmed. A patent with complete specifications has been filed. Work is in progress to work out process conditions with rock phosphate of different origins and compositions. The chemical technology of the process have been thoroughly studied, while consultations are being held with a fertilizer unit on the engineering aspects of the technology.

10.4 *Synthetic cryolite (by soda ash recycle)* : (5/X/74)

Studies on the regeneration and recycling of soda ash in the NCL process for synthetic cryolite from sodium silicofluoride were concluded. It was established that there was no build up of impurities like SiO_2 and P_2O_5 in the regenerated soda after several successive cycles. Attempts were also made to improve the bulk density of the cryolite and cryolite of the required bulk density was obtained.

This data has been supplied to M/s. Dharmasi Morarji Chemical Co. (DMCC), Bombay for finally grafting the NCL recycling technique to the existing DMCC process for cryolite manufacture. The process will now be offered to industry jointly by NCL and DMCC through the NRDC.

10.5 *Molybdenum disulphide* : (7/X/76)

Molybdenum disulphide and other raw materials (molybdenite mineral concentrate, molybdenum oxide) are at present imported. Molybdenum disulphide is primarily used as a lubricant. Its physical characteristics, such as high melting point permit it to retain its lubricating ability at high temperature and pressure. Molybdenum disulphide also lubricates effectively in a vacuum and is not affected by high radiation. The probable consumption of MoS_2 is 50-80 MT per annum valued at Rs. 50-80 lakhs. The entire demand is met with by import.

Preliminary experiments using imported molybdenum concentrate on the preparation of MoS_2 have been carried out. The samples are comparable with an imported sample so far as their chemical analysis, particle size and specific gravity are concerned. The samples have been sent to IIP, Dehra Dun for their evaluation as speciality lubricants.

11. INDUSTRIAL INORGANIC AND ORGANOMETALLIC CHEMISTRY

11.1 *Silicone intermediates* : (3/XI/71)

Silicones play an important role in industry because of their organometallic charactertistics. Methyl chlorosilanes are major intermediates for their manufacture. Setting up of a pilot plant (capacity 0.75 kg/hr) for preparation of chlorosilanes has been reported earlier. Further detailed study on this complex gas-solid reaction was carried out for collecting scale-up data. The following additional work was carried out :

A method for the rapid analysis of a mixture of methyl chlorosilanes and their esters was worked out using gas chromatographic technique. The steps involving the separation of dimethyldichlorosilane and methyltrichlorosilane by esterification were studied in greater detail. The effect of the purity of raw materials and the geometry of the reactor on the product pattern and yield was investigated. The pilot plant of 3 kg/hr capacity was suitably modified on the basis of this study.

A pilot plant with a capacity of 15 kg/batch of ferrosilicon was constructed. The distillation columns for separation of methyl chlorosilanes have also been constructed. Samples of pure components have been sent for approval to different parties.

Commercialization of the process in collaboration with industry is being explored.

Preliminary work has been carried out on the preparation of phenyl methyl silicone low polymer and heat dissipating fluids.

11·2 *Organotin compounds* : (4/X1/72)

A process to prepare dibutyltin oxide by the iodide route has been developed on 1 kg per batch scale. The process has been optimized for the recovery of the iodine and soft grade oxide by repeated experimentation. Another route via the Grignard method has also been carried out on the same scale. This route though a little more complicated offers a general route for synthesis of other organotin compouds. The octyl and methyl tin compounds have been prepared on a small scale. Several other new tin compounds have been developed for use as stabilizers for plastics. Analytical procedures and testing methods have also been developed.

Development of the Grignard route for synthesis of butyl, octyl and other organotin compounds on a larger scale is in progress.

Attempts are also in progress to prepare lauryl tin compounds which have been recently reported in literature. These compounds require less tin to give the same stabilizing action.

Samples of dibutyl, dioctyl and dilauryl tin oxides were sent for evaluation to industry.

11.3 *Dicyandiamide (DCD)* : (7/XI/73)

Dicyandiamide is used in the manufacture of melamine, amino resins and as an intermediate in dyes, drugs, plastics, explosives etc. Most of the indigenous demand is met with by import except for a small quantity of DCD prepared from calcium cyanamide (Nitrolim) by the Ordnance Factory at Bhandara for their captive consumption.

The process for the preparation of DCD from calcium cyanamide at present being followed at Bhandara gives low yield of DCD. This process has now been improved and tried out on 5 kg batches of nitrolim. The improved process gives 75% yield as against 25% yield presently obtained by the Bhandara plant. The process has been demonstrated to the representatives of the Ordnance Factory, Bhandara. A complete project report has also been submitted.

Work is in progress to standardize a continuous process for the production of DCD (1 kg nitrolim/hr).

11.4 *Utilization of sulphur sludge* : (12/XI/75)

A plant producing 100 T/day of sulphuric acid normally produces 500 TPA of sulphur sludge containing 50-60% sulphur. Attempts were made to utilize the sludge.

Sulphur sludge was chlorinated to sulphur monochloride and sulphur dichloride. A process has also been developed to prepare thionyl chloride from sulphur monochloride on laboratory scale (5 kg/batch).

Thionyl chloride is an important chlorinating agent and replaces hydroxyl and mercapto groups by chlorine atoms. It finds application in the manufacture of organic chlorides, acid chlorides, dye intermediates, synthetic vitamin A, anhydrous inorganic chlorides and pesticides such as endosulfan.

In order to scale up the process a collaborative agreement has been signed with a firm who will be setting up a semicommercial plant based on NCL technology.

11.5 *Porous mass for acetylene cylinder* : (13/XI/76)

This work was taken up at the instance of a firm who desired to find out a substitute for diatomaceous earth for the prepartion of porous mass for acetylene cylinders. The demand is about 10,000 cylinders per year. The firm is importing about 50 MT of diatomeceous earth from Japan, costing about Rs. 1.8 lakhs.

A few exploratory experiments were carried out using diatomaceous earth, precipitated silica (obtaind from sodium silicate or wollastonite mineral). The preset blocks were autoclaved and the porosity of these was compared. The porosity of the blocks prepared using precipitated silica was found to be in the range of 70-80%. Blocks prepared from diatomaceous earth gave porosity of the order of 90%. This work has been kept in abeyance for want of active interest from the firm.

11.6 *Microfine alumina* : (14/XI/76)

Microfine alumina is extensively used in the form of activated alumina, alumina for catalyst manufacture, sintered alumina, etc. It is also used in solid state devices and in the preparation of CPC (controlled pore ceramic) beds used for immobilizing enzymes in certain biochemical reactions. The total imports during 1974-75 amounted to 465 T valued at Rs. 29.35 lakhs. The technology for the production of special grade of aluminas is not yet established in the country.

A process has been developed for the preparation of microfine alumina by the vapour phase hydrolysis of anhydrous aluminium trichloride by burning the latter in hydrogen in a silica reactor maintained at temperatures between 1000°-1300°. This one-step process eliminates the contamination of alumina with Na_2O, SiO_2 and Fe_2O_3 so that it would become acceptable for the above speciality uses.

Samples of alumina having particle size between 10-100 μ and specific surface area between 150-250m²/g could be obtained by the above method.

Batch process pilot plant studies on a scale upto 3 kg/hr of $AlCl_3$ are in progress.

11.7 *Thiourea* : (15/XI/76)

Thiourea is used in pharmaceutical preparations and in pesticides. Country's requirement is at present met by import. Thiourea can be prepared from monomer cyanamide obtained from calcium cyanamide.

Literature survey on the preparation of thiourea has been completed. Few exploratory experiments (100-250 g of nitrolim/batch) have been tried to prepare thiourea. The yield obtained was around 75%.

Work is in progress to study different parameters and for scaling of the process upto 1 kg nitrolim per batch.

11.8 *Melamine* : (16/XI/76)

Melamine is extensively used in plastic moulding, impregnating and pigments and paints. At present the country's demand is met with by imports. Melamine can be prepared from dicyanadiamide (DCD) for which NCL is developing an improved process.

Literature survey for the methods of preparation of melamine has been completed. The three main approaches are (i) preparation of melamine by pyrolysis of DCD under pressure, (ii) heating DCD at atmospheric or higher pressure in a solvent and (iii) preparation from urea.

Exploratory work using solvent at atmospheric pressures of ammonia resulted in poor yields however heating DCD at higher pressures of ammonia resulted in 75% yields.

Further work is temporarily suspended in view of the possibility of establishment of a commercial plant based on the more economical urea process.

12. STUDIES IN ORGANOMETALLIC AND INORGANIC CHEMISTRY

12.1 *Coordination compounds* : (1/XII/63)

In continuation of earlier studies on alkyl/aryl tin (IV) chelates several new stable chelates with general formulae $RSnL_3$, R_3SnL, R_2SnL_2 and $RSnL_2Cl$, where R = alkyl or aryl and HL = 2-methyl-8-quinolinol were synthesized and characterized by their elemental analysis, IR, UV and mass

spectral studies. The Mossbauer spectra of these compounds along with other alkyltin (IV) chelates with 5- and 5,7-substituted 8-quinolinols and a few Sn (II) chelates with 8-quinolinols were recorded, at liquid nitrogen temperature, 77° K and from the Mossbauer parameters the probable structures for these compounds were inferred. Bis (5,7-dinitro-8-quinolinolato) dialkyltin (IV) compounds (Q. S. = 4.3 mm/sec) are considered to have the two R groups occupying *trans* - positions in the octahedral structure. The somewhat large and significantly varying quadrupole splittings observed in the three series of compounds, R_2SnL_2 studied may be associated with donor-acceptor interactions.

Bis (5,7-dichloro-8-quinolinolato) tin (II), bis (5,7-dibromo-8-quinolinolato) tin (II) and bis (5,7-diiodo-8-quinolinolato) tin (II) have been synthesized by the reaction of anhydrous $SnCl_2$ and the appropriate 5,7-disubstituted-8-quinolinol and were characterized from their spectral data. Tin (II) bisoxinates readily react with diphenyldisulphide, dibenzoylperoxide, iodine monochloride, halogen, etc., to yield the corresponding tin (IV) mixed ligand complexes.

During the studies on coordination compounds of beryllium, 4-chloro-2,5-dimethyl-acetoacetinilide and sodium oxinate were examined as possible reagents for the estimation of Be (II), since search of literature revealed that there is a good general lack of specific organic precipitants for the gravimetric estimation of beryllium. Sodium oxinate was found to precipitate Be (II) from solutions quantitativly in the pH range 7.5 - 8.2. The precipitated complex having the composition, $Be_2O(C_9H_6NO)_2 \cdot 2H_2O$, is stable and can be weighed directly after drying at 105° - 110° for 2 hrs. Bis (8-quinolinolato) beryllium (II) monohydrate, $Be_2O(C_9H_6NO)_2 \cdot H_2O$ was isolated from the dihydrate, the weighable form of the complex and was characterized from its elemental analysis, IR and PMR spectral and TG and DTA studies. The data show the presence of hydroxyl bridge bonds in the monohydrated beryllium complex.

Use of metal complexes as homogeneous catalysts in the hydrogenation of organic unsaturated substrates has attracted considerable attention in recent years. A series of experiments were carried out on the pressure hydrogenation of unsaturated fatty acids such as linoleic and oleic acids using tris (triphenylarsine) dichlororuthenium (II) as a homogenous catalyst. Results of these experiments have shown that these acids undergo complete saturation yielding stearic acid under certain conditions. A detailed study in this connection is in progress.

Interest in certain ferrocenyl compounds, as ligands in metal complexation yielding bimetallic complexes had led us to synthesize two such compounds - acetylferocene thiosemicarbazone and acetylferrocene-5-

methyldithiocarbazone. The latter compound has been isolated for the first time, whereas the preparative mothod for the former has been modified to give better yield. Copper (II) complexes of both the ligands have been isolated and studied. Synthesis and studies of complexes with other metals are being done.

13. SOLID STATE MATERIALS INCLUDING MATERIALS FOR ELECTRONIC INDUSTRY

13.1 *Ferroelectric materials* : (1/XIII/71)

Ferroelectric ceramics are used for phonographic pick-up elements, transducers for high power generation, wave filters, and memory and display devices.

With a view to improving the piezoelectric performances of Pb (Zr, Ti, Sn) O_3 ceramics, the solid solutions of Pb ($Ti_{45\cdot5}$ $Zr_{24\cdot5}$ $Sn_{30\cdot0}$) O_3 + x wt%, where x is the trivalent or pentavalent oxide, were investigated. In the present case the trivalent and pentavalent oxides chosen for doping were La_2O_3, Pr_2O_3, Nd_2O_3 and Sm_2O_3, and Nb_2O_5 and Ta_2O_5 respectively. Altogether 36 different compositions were studied. It was found that the Curie temperature decreased at a much faster rate with 3-valent materials than that of the 5-valent ones. The dielectric constant E_T, the electromechanical coupling coefficient K_P, the piezoelectric charge coefficient d_{31}, and voltage coefficient g_{31} have shown improved values with the addition of small amount of these materials. The highest value of dielectric constant (2700) was found with 3% La_2O_3 doped composition but the Curie temperature was found lowered (120°) considerably. The sample modified with O.5% Nd_2O_3 showed very high d_{31} (166$\mu\mu$coulomb/ Newtron) and g_{31} (11.4 milivolt-meter/Newtron) values. Ceramics modified both with 3- and 5-valent oxides have low mechanical quality factor, Qm (50-110) and low coercive field, Ec (4.0-7.3 KV/^{cm}). This type of ceramics is rather " soft material " suitable for the manufacture of gramophone pick-up elements and for like uses.

13.2 *Metal oxide resistors* : (2/XIII/71) and (8/XIII/75)

Several modifications were made in the existing rotary furnace to get the highest stability at the resistance value in the product, viz. the metal oxide resistor and for standardizing the conditions following parameters were studied.

The flow of metal chlorides and the dopants was studied by using three different carrier gases *viz.* oxygen, nitrogen and air and choice of one particular carrier gas was established from the results obtained during the study.

Formation of the metal oxide on the substrates at various temperature ranges was studied and a suitable temperature range was selected for further work.

The process requires close control over the feeding rate of the substrates pieces, as well as their uniform motion within the furnace for which certain mechanical arrangement was made. This also ensured the higher stability of the resistance values and mechanically stronger hard coating which ultimately improves the electrical properties like temperature coefficient of the resistance and the over load resting. Apart from the above the parameters like the rotations of the revolving furnace, temperature of the reaction and the reactants, various doping compositions, were studied by which the desired electrical properties on 50-60% of the pieces could be obtained.

Explosive Research and Development Laboratory, Poona, has shown interest to develop fast ignitors using metal oxide film technology developed at NCL. Several samples which were proved to be perfect for their work have been supplied. Work will be undertaken to establish the reproducibility in the process.

Coated glass pieces have also been supplied to R and D Organisation, Dighi, for their Decompression Chamber Project where they could be successfully used for de-icing the glass window. A few more large size coated glass pieces will be supplied for their work as per their request.

13.3 *Thick film materials* : (3/XIII/71)

Ruthenium based resistive pastes : Thick film passive elements like conductors, resistors, capacitors are used in hybrid microelectronic circuits. Their applications are on the increasing trend in the manufacture of integrated circuits in television, radio other fields in electronic industry.

Ruthenium based resistor materials have several processing advantages over those of Pd-Ag systems. These have good stability with regard to firing and atmosphere variations. No structural changes occur like those of Pd-Ag systems. They further provide stability during active device bonding, soldering and encapsulation processes. Reproducibility over wide range of sheet resistivities can be achieved.

Ruthenium based resistive pastes have been prepared upto 1-2 g scale. Several parameters such as same glass compositions, glass to RuO_2 ratio, firing time (peak full cycle), firing temperature (peak), adhesions to alumina substrates, wetting characteristics, compatibility with electrodes, TCR were studied.

Formulations of Ru-based resistive pastes containing different proportions of glass wire were prepared. Optimization of the printing parameters using the presently available printing facilites and optimization of firing time temperature schedule for the prints were achieved. TCR properties were measured for different compositions. In addition the resistor pastes were printed and fired on gold electrodes also. Different stencils were made.

13.4 *High permeability ferrties* : (5/XIII/71)

Preparation of toroids on 500 g batches with composition similar to that of Philips $3H_1$ has been reported earlier. Several additional batches were prepared on the some scale with reproducible results. The toroids were tested on G. R. impedance bridge for the following properties : initial permeability, temperature-coefficient of initial permeability, Curie temperature, disaccommodation and the eddy-current losses. These properties of our toroids are found to match closely with those of Philips $3H_1$. Studies on a few more properties for complete replication of Philips $3H_1$. have to be carred out.

13.5 *Metal film resistors* : (6/XIII/73)

Developmental work on the metal and cermet (metal/metal oxide) film resistors was carried out on small batches of 50-80/run for 1/2 W ceramic substrate yielded resistors with basic value ranging from 30 Ω to 500 Ω in the case of metal film resistors and 100 Ω to 1.5 K Ω for cermet films. These film resistors had TCR value betwaen 50 and 200 ppm/°C for the Ni-free and Ni alloys and below 100 ppm/°C for cermet films. Load, humidity and pulse tests were carried out and samples found to vary by 0·1% in both metal as well as cermet film resistors. The above resistors can be prepared from indigenously available raw material.

13.6 *Development of know-how for Hall elements* : (7/XIII/74)

With newly designed and fabricated masks, several thin film Hall probes were made. The samples were found to be highly stable, sensitive and had higher output voltage. The sensitivity of gauss-meter was further increased by suitably designing and modifying the electrical circuit. It showed good response to magnetic field in the range of 100 Gauss to 50 K Gauss.

13·7 *Solar energy* : (9/XIII/76)

Solar energy, which is non-depleting and non-polluting, is the ideal source of energy for future. Furthermore, the utilization of solar energy has an added relevance in context to rural energy needs of the country.

The Department of Science and Technology, Government of India and CSIR has therefore launched an integrated national programme on the utilization of solar energy. Materials development needed for the total

programme in general and for the photovoltaic programme in particular are being tried at this loboratory.

During 1976-77 the following work has been done keeping the above in view.

Preparation of trichlorosilane on 1 kg/batch has been established. This is adequate for further experimental work on materials development for silicon solar cells. Preparation of silicon by hydrogen reduction to trichlorosilane has been established on 100g/batch scale on quartz tube. Units for cell and material parameters such as conductivity, life time, I-V, etc. have been set up.

Some preliminary work suitable for absorbing materials with high $\frac{\alpha}{\varepsilon}$ has been done. Techniques for the preparation of these films have been developed. Units for the quantitative measurements of $\frac{\alpha}{\varepsilon}$ are being set up.

Further work is in progress.

14. STUDIES IN PHYSICAL CHEMISTRY

14.1 *Structures and physics of thin films* : (I/XIV/58)

Considerable amount of work has been carried out on the semiconducting parameters *viz.*, the resistivity, thermoelectric power, TCR, mean free path etc., for vacuum deposited thin films. But no significant effort has been put in so far to carry out systematic work on the other semiconducting parameters *viz.*, activation energy, Hall coefficient, Hall mobility, carrier concentration, thermoelectric power, etc., which are also of equal importance in the electron transport phenomena in case of thin films. For this, above mentioned semiconducting parameters polycrystalline films of MnTe, MnSe, PbTe, PbSe, Ga_2Se_3, etc., were studied. These properties were measured in the temperature range from 78°K to 400°K.

All films were found to be p-type. The films showed two types of conduction.

(i) Impurity scattering mechanism at lower temperature region,

(ii) Piezoelectric scattering at higher temperature range

Thermoelectric power was measured by differential method in the temperature range of 78°K to 400°K. The theoretical value estimated by considering the type of scattering, carrier concentration and effective mass

agrees well with experimental value for MnTe films. Effective mass is also estimated from thermoelectric power. It is found to increase with temperature. Electron and X-ray diffraction techniques were applied to study the structure of above mentioned compounds in thin films as well as in bulk form.

14.2 *Spectrochemical studies* : (2/XIV/63)

14.2.1 *Infrared spectra and molecular structure*

3 and 4-Aminophthalic acids have been prepared. 6 Amino salicylic acid was obtained in very poor yield. Cyclopropane and cyclobutane 1 : 1 dicarboxylic acids have been prepared.

14.2.2 *Association behaviour of trimethylene and tetramethylene glycol monomethyl ethers*

The thermodynamic quantities involved in the equilibrium behaviour between free (M_F) and intramolecularly bonded (M_I) monomers absorbing at 3630 and 3540 and 3450 cm^{-1} respectively are $\triangle H° = 15$ KJ mol^{-1}, $\triangle S = 52.JK^{-1}$ mol^{-1} and K (at 298 K) = 1.4 for trimethylene glycol monomethyl-ether and $\triangle H° = 18$ KJ mol^{-1}, $\triangle S = 68$ $JK^{-1}mol^{-1}$ and K = 2.2 for tetramethylene glycol monomethyl ether. In the concentration range 0.02–0.2 mol. dm^{-3}, the self associated species are found to form a mixture of open/closed dimers and trimers while above 0.2 mol. dm^{-3} higher associated species are present. The self association behaviour of these compounds is thus similar to that of simple alcohols.

14.3 *Thermodynamic properties of solutions—studies on adiabatic compressibility of macromolecules* : (3/XIV/65)

Earlier the adiabatic compressibilility of some anionic and cationic polymers in aqueous solutions were studied separately and then in combination in the form of amphoteric polyelectrolytes to elucidate the nature of interaction between the acid and base groups when they are put together on the same polymer chain.

In order to determine the extent of polymer-solvent interaction in aqueous and non-aqueous solvents (range of dielectric constant is 4 to 80), the adiabatic compressibility of poly (vinylpyrrolidine) in three different solvents namely water, methyl alcohol and dioxane has been studied. The intrinsic viscosity of the polymer in the three solvents at 25° are 1.50, 2.00 and 0·78 dl/g respectively. Both in aqueous and dioxane solution the limiting value of the apparent molal volume, $\phi V_2°$ was found to be the same (88.5 cc/mole) whereas in methanol solution this value was lower by 7.3 cc/mole. Similarly the corresponding $\phi K_2°$ value was found to be lowest in methanol solution (-38.0×10^{-4} cc/bar/mole). Unlike the $\phi V_2°$ values, the $\phi K_2°$

values were not same in aqueous and dioxane solution. They were 2.0×10^{-4} cc/bar/mole and 18.0×10^{-4} cc/bar/mole respectively.

Further study of some anionic and cationic polymers is being carried out whose compressibility in aqueous solution has already been studied.

14.4 *Physics of thin films* : (4/XIV/67)

The optical properties of bismuth oxide and bismuth films were studied in detail and 'n' and 'k' were evaluated in the visible region. Whilst bismuth oxide films were found to be semiconducting, bismuth films were semimetallic in nature.

Bismuth oxide (Bi_2O_3) films annealed in vacuum were found to be having low transmittance and high reflectance. 'n' increasses with λ, reaches a maximum at 5500 A° and decreases for higher wavelengths. ' n ' also increases with the film thickness upto 700 A° then goes on decreasing with the increase of film thickness. 'k' also followed the same trend as 'n'. ' α' the absorption coefficient decreases as λ increases. Values of 'k' (extinction coeff.) calculated from ' α' agreed with those determined by the reflection method.

Bismuth oxide films oxidized in air showed high transmittance and low reflectance. 'n' was high in the low wavelength region and then it decreased rapidly with increasing λ, reaching a minimum at about $\lambda = 7000$ A°. The values of 'n' were much higher for thicker films but their variation with λ were similar for all the films. Values of 'k' on the other hand were quite low and they fall rapidly to negligible values in 5000 A° — 6000 A° region. ' α' increased sharply in the lower wavelength region with the increasing photon energy suggesting the beginning of the absorption edge.

Bismuth films had low transmittance and high reflectance. 'n' is found to decrease with the increase of film thickness and becomes constant for thick film whereas 'k' increases with film thickness upto certain value of film thickness i.e. 500 A°, and then becomes a constant.

14.5 *Crystallography* : (5/XIV/67)

During this period, precise structures of dihydronimbin and of a naphthoquinone dye (2.3-dithio - phenyl-1, 4- naphthoquinone) were determined with the help of full three dimensional X-ray data. Attempts were also made to determine the structure of another natural product named Rubranol; this work is still in progress.

Nimbin is the principal bitter constituent of neem, a plant of great medicinal use. The present knowledge of the structure of nimbin and related natural products (limonoids) is based mainly on NMR data and

is not complete. The crystals of dihydro-nimbin are monoclinic, space group $P2_1$, with $a = 16.24$, $b = 7.61$, $c = 11.47$ A°; $\beta = 95.9°$; $\rho_o = 1.264$ g cm^{-3} and $\rho_c = 1.278$ g cm^{-3}. The structure was solved by direct methods using computer programme MULTAN (1971) and was refined by full matrix least squares method. This work confirms the structure arrived at by chemical methods and elucidates the stereochemistry of the molecule.

2, 3-Dithio-phenyl-1, 4-naphthoquinone is a dye which gives a deep red coloured solution in most organic solvents. However, it crystallizes in two forms (red and blue crystals) from different solvents. The blue crystals go over to the red form when heated upto 122°. The structure analysis was undertaken in order to understand the relation between the colour and the structure of the crystals. It appears that the difference in colour in the two crystal modifications arises on account of the difference in the packing of the molecules in the two forms. The blue crystals are monoclinic, space group $P\frac{2_1}{n}$ with $a = 32.85$, $b = 10.44$, $c = 5.16$ A°; $\beta = 93.5°$; $Z = 4$; $\rho_c = 1.407$ g cm^{-3}. The crystals are all twinned, so a detailed structure analysis could not be undertaken. The red crystals are orthorhombic, space group P_m2_1n with $a = 21.29$, $b = 8.12$, $c = 5.27$ A°; $Z = 2$; $\rho_o = 1.310$ g cm^{-3}; $\rho_c = 1.364$ g cm^{-3}. The structure was solved from packing considerations and refined by the full matrix least squares method. In red crystals, half of each molecule is related to the other half by crystallographic mirror symmetry. There is no such symmetry in the molecule in the blue crystals.

14.6 *Gamma radiation induced polymerization of trioxane* : (7/XIV/71)

Yields and molecular weights of polymers formed at very low gamma intensities indicated that there is a chain reaction involving peroxide free radicals which start the polymerization during the heating. The G values for the primary active species range as high as 80. Room temperature polymerization of trioxane depends upon the age of the sublimed crystals.

14.7 *Mossbauer spectroscopy* : (12/XIV/74)

Mossbauer spectroscopy has been utilized to study the chemical effect brought about by electron capture decay of $^{57}Co^{3+}$. This effect has been utilized to study the chemical effect brought about by the decay of $^{57}Co^{2+}$ in $CoAl_2O_4$. $CoAl_2O_4$ is a constituent of the industrial molecular sieve SiO_2, Al_2O_3 and Na_2O. $CoAl_2O_4$ is paramagnetic at room temperature. Earlier crystallographic, magnetic and IR studies had reported it to be a partially inverse spinel with Co ion occupying about 5 to 30% of octahedral sites.

Mossbauer spectra of $^{57}Co^{++}$ in $CoAl_2O_4$ matched against 90% enrich $^{57}F_e$ stainless steel foil have been studied from 193°K to 457°K. The spectra were resolved graphically and were found to indicate the presence of Fe^{2+} and Fe^{3+} ions both at tetrahedral (A) and octahedral (B) sites. In each case the ion exhibited a quadrupole split spectrum. In addition, a broad unsplit line for Fe^{4+} ion was also observed. The charge states of Fe^{2+}, Fe^{3+} and Fe^{4+} result from the K-capture decay of ^{57}Co. These states are stable for an interval between 10^{-6} and 10^{-9} sec. after the decay of Co-57. The stabilization of Fe^{4+} and Fe^{3+} states in addition to the expected Fe^{2+} state has been attributed to the presence of cation vacancies in the source lattice. By comparing the areas under the different charge ions at A and B sites it was found that the degree of inversion, x, where x is the fraction of tetrahedral sites occupied by the Al ions, was 0.17 ± 0.03 at 298°K.

Cation distribution in $CoAl_2O_4$ at room temperature was also determined by X-ray diffraction method. The degree of inversion of 15% at room temperature (for $x = 0.15$ and $u = 0.3875$) determined by X-ray powder diffraction is in good agreement with the value of 0.17 ± 0.03% determined by Mossbauer spectroscopy.

14.8 *Physico-chemical studies for industrial projects* : (15/XIV/76)

Considering the importance of data on thermodynamic and physical properties in respect of industrial projects taken up in the organic chemistry group of the laboratory, a separate group has been organized to study such properties. These properties are essential for (i) the design of reactors and distillation columns, (ii) the circulation and pumping of various liquids involved in the synthesis of industrial chemicals and (iii) the energy balance of the reactions.

The various physical and thermodynamic properties being studied are : vapour-liquid equilibrium, density, viscosity, thermal conductivity, vapour pressure, heat of reaction, heat of neutralization, heat of dissolution, heat of vapourization, heat of fusion and specific heat.

During the period under report the thermodynamic and physico-chemical properties of two pesticides, i. e. dimethoate and fenitrothion, and their intermediates were studied.

14.9 *Reactions in electric discharges* : (16/XIV/76)

Glow discharge set-up was used to study reactions between hydroxyl radicals and naphthalene. With a simple steam distillation set-up and a D. C. discharge at several hundred volts, no naphthol formation was detected in the absence of oxygen. In presence of ammonia a mixture of naphthalene

and water yields naphthylamines. The amination takes place through the intermediary of the hydroxyl radical. Preliminary runs have been completed.

15. PLANT TISSUE CULTURE

The plant tissue culture technique has now found wide application in agriculture both for the multiplication of plants, and trees which grow slowly or which do not breed true by conventional methods and also for production of mutants. The main objectives of plant tissue culture project are the application of tissue culture to rapid propagation of plantlets of agriculture value, elimination of diseases from plants, screening for agriculturally important mutants and the study of cloning, differentiation and somatic hybridization of plant cells.

15.1 *Virus-free sugarcane* : (1/XV/72)

The high-yielding sugarcane strain CO-740 which is invariably affected by sugareane mosaic virus has been obtaincd virus free by tissue culture as already reported earlier.

Selected sugarcane plants which did not show the symptoms of mosaic virus are being grown on an acre of land for large scale field trials. Similarly sugarcane plants raised directly from callus and after treatment with mutagenic agents are being screened for disease resistance and other useful agricultural characters.

15.2 *Hybrid cabbage* : (2/XV/72)

A vegetative method for the propagation of high yielding hybrid cabbage by tissue culture technique was reported last year. Sufficient number of seedlings are being raised for testing the feasibility and economics of the method in large scale field trials.

Miscellaneous

The work on the application of the tissue culture technique for multiplication of other forest trees like teak, and eucalyptus, spices like turmeric, cardamom, etc. was continued during the year.

Plantlet regeneration was obtained from teak and eucalyptus seedlings, from turmeric rhizomes and from interspecific hybrid papaya immature embryos. Field trials are in progress with the papaya and turmeric plantlets.

Third generation trials on mutant wheat seeds obtained from tissue culture plants are in progress in the fields for determining yields.

16. FERMENTATION TECHNOLOGY

Protein food from cellulosic plant materials : (1/XVI/68)

The objective of the project is to make use of the abundant and renewable cellulosic wastes available in the country for the production of microbial protein for use as a cattle feed or for the production of glucose which can be used for edible purpose or for conversion to alcohol which can be used as a fuel or industrial raw material.

Fermentation experiments for enzyme and single cell protein (SCP) production were carried out in laboratory scale shake-flasks and 3 L. fermentors. Enzyme production was scaled up to the pilot plant on 100 L. scale. Saccharification of cellulosic substrates as well as studies on reuse of enzyme through immobilization techniques were carried out on the laboratory scale.

Yields achieved in terms of enzyme production, saccharification as well as protein content of the SCP grown on cellulosic wastes were found to compare favourably with some of the best yields reported in literature. Optimum conditions for enzyme production and for pretreatment of cellulose and for protein biomass production were studied. Analytical procedures for enzyme activity and protein production were standardized.

Optimization of conditions for maximum enzyme production and shortening of the fermentation cycle were studied in shake-flasks with a *Penicillium* strain designated as Culture B. This strain with high activity on filter paper, alkali-treated bagasse etc., showed many unusual features and is being investigated further in detail. It showed a very high β-glucosidase activity and formed glucose as the main product by hydrolysis. Saccharification studies using different cellulosic substrates including agricultural wastes like straw, bagasse and wood were carried out. The relative saccharification efficiency in relation to pretreatment procedures is also being evaluated. A *Sclerotium* sp. isolate produced a complete and stable cellulase complex and gave high β-glucosidase and C_1 and C_x type activities. Further optimization of enzyme production by this culture is being studied. Saccharification studies showed that the culture filtrate from this organism was very effective in hydrolyzing bagasse. Saccharification of other cellulosic materials like wood etc., are being studied. Production of biomass using St-F-3B and *Aspergillus* was carried out in media containing alkali-treated bagasse or straw as the principal source of nutrition. Rapid growth and favourable protien content have been obtained in shake-flasks as well as aerated cultures on 3–5 L. scale.

17. ENZYME TECHNOLOGY

Immobilized enzymes

The application of immobilized enzymes as industrial catalysts in industrial processes has in recent years revolutionized existing technology. Such

immobilized systems often show greatly enhanced stability and permit repeated reuse of the biocatalyst. Coupled with their extreme specificity and mild reaction conditions, immobilized enzymes hold promise as ideal inudstrial catalysts. Their major applications are in the pharmaceutical and food industries, e. g. for the production of 6 APA required for semi-synthetic penicillin manufacture; the resolution of synthetic amino acids; the hydrolysis of starch to dextrose and its subsequent conversion to invert sugar.

17.1 *Penicillin acylase* : (1/XVII/72)

An immobilized system suitable for the manufacture of 6 APA from natural penicillins was developed in collaboration with Hindustan Antibiotics Limited, (HAL) Poona. Detailed studies on the effect of reaction conditions on the activity and stability of the immobilized system were investigated, and standardized and experiments upto 100 litre scale were carried out in collaboration with HAL.

A batch reactor is now being used at HAL. However, for larger production capacities, a continuous reactor might prove more economical. This is being examined.

In this direction, experiments to find the conversion time behaviour of the reactor were made on a batch reactor. The apparatus set-up for a continuous stirred tank reactor was completed and the engineering parameters in the design of the continuous stirred tank reactor were sudied. The information obtained would be used to compare the performance of the continuous stirred tank reactor and the batch reactor. Based on the data collected, the design for large scale plant will be made.

17.2 *Amyloglucosidase* : (2/XVII/74)

The enzyme, which finds extensive industrial application in the hydrolysis of soluble starch to dextrose, is a relatively cheap extracellular microbial enzyme. Attempts were made to use cheap inorganic supports and a novel approach for immobilizing the enzyme from crude culture broths made available by HAL. Although conditions could be established for the complete immobilization of the activity from solution, leakage of enzyme from the support during actual use could not be restricted within limits in order to make the process economically feasible. The work on this aspect of the project has been concluded.

17.3 *Glucose isomerase* : (3/XVII/74)

A *streptomyces sp.* with glucose isomerase activity comparable to that of strains reported in the literature was isolated. Cultural conditions for optimal growth and activity of the organism are being established. Studies

on the use of alternate cheap carbohydrate sources such as wheat bran, corncobs for the growth of the organism are in progress. The isolation of mutants with enhanced activity is under investigation. Preliminary experiments on the immobilization of the whole cells for carrying out the isomerization were carried out.

17.4 *Immobilized whole cells* : (3/XVII/76)

Exploratory studies on the use of free and immobilized whole cells of *A. suboxydans* for the conversion of sorbitol to sorbose in the synthesis of vitamin C have established the feasibility of repeated reuse of the organism. Prevention of contamination during reuse with various antimicrobial agents and the standardization of conditions for the quantitative transformation are under investigation.

18. STUDIES IN BIOCHEMISTRY

Studies in enzyme chemistry

Investigations of structure-function relationships, active sites and mechanism of action are important problems in biochemistry and knowledge gained in these areas of research could ultimately lead to useful applications in fields as diverse as industry, medicine and agriculture.

18.1 *Citrate lyase* : (1/XVIII/65)

Studies in pure citrate lyase from *Streptococcus faecalis* indicated that the enzyme from this source has unique properties as compared to others of this complex group. The allosteric ligand binding properties of the enzyme complex from *Aerobacter aerogenes* were reported for the first time. Studies on the behaviour of the immobilized enzyme complex as well as of a multi-enzyme system useful for the assay of citrate in biological materials are in progress.

18.2 *Nitrite and nitrite reductase* : (2/XVIII/65)

Nitrite reductase from *A. fischeri* was obtained pure and characterized. The enzyme is uuique in that the six electron reduction of nitrite to ammonia is carried out by a single enzyme. The subunit structure and the kinetics of unfolding and refolding of the enzyme were studied.

18.3 *Acid-stable amylase* : (3/XVIII/68)

Screening a few hundred fungi of the imperfect group indicated the presence of a few strains which showed their amylase to be not only stable to acid but also active at about pH 2.0. A few strains were chosen, the amylases were isolated and in one case the acid stable enzyme was separated from the normal amylase active around neutral pH.

18.4 *Cellulase* : (4/XVIII/68)

During the year under report studies on isolation, purification and characterization of cellulolytic enzymes were in progress. β-glucosidase was obtained in an electrophoretically homogeneous form, and two carboxymethyl cellulases in a fairly purified state. No functiona! differences were found in the two carboxymethyl cellulases and are β-1, 4-glucan cellobiohydrolases.

Purification of β-glucosidases and cellulases of a penicillin strain is in progress.

18.5 *Plant and animal cells*

The objectives of this project are to carry out fusion studies between protoplasts belonging to the same and different species and also to standardize conditions for isolation and regeneration of plants from protoplasts; to test the ability of plant juices and extracts for increasing the cloning efficiency of plant cells; to continue studies on teak seed germination; to carry out detailed studies on the nutrition, and methods of cloning the insect cell line obtained from the potato tuber moth.

18.5.1 *Plant protoplasts and somatic hybridization*

Protoplasts were obtained from several callus and leaf tissues and methods were standardized for regeneration of clones for snapdragon, rose, tobacco and apple callus protoplasts. Fusion of protoplasts was obtained between rose : rose; rose & tobacco protoplasts and also between rose protoplasts and cells of the potato tuber moth. Rose protoplasts after treatment with the fusion inducing agent could be regenerated and clones obtained.

18·5.2 *Cloning of plant cells*

Several plant extracts were tested on cloning of apple cells, and an extract which was found to give a higher plating efficiency was studied for the isolation of active fractions.

18·5·3 *Germination of teak seeds*

Several physical and chemical methods were tested to break the dormancy of teak seeds. By mechanical breaking of the fruit the seeds were made to germinate within 10-20 days.

18.5.4 *Plant proteolytic enzymes and inhibitors*

Work on papain inhibitors of *Vigna catjang* was completed. Three of the papain isoinhibitors were obtained in highly purified form and their properties and kinetics were studied. They were specific for papain, chymopapain and ficin, and had no action on other proteolytic enzymes,

18·5.5 *Transgenosis*

Experiments on transgenosis (of Nif-genes) were continued. Work on isolation and characterization of DNA from different plant tissues was undertaken.

18·6 *Animal cell culture* : (5/XVIII/76)

The nutrition requirements of the potato tuber moth *Gnorimoschema opercuelella* cell line were studied. Work on cloning of this cell is also in progress. A second cell line which grew in the absence of any other supplements such as calf serum, serum albumin etc., was established. This is one of the few insect cell lines which grow on such simple medium.

19. DEVELOPMENT OF INSTRUMENTS

19.1 *UV-Visible spectrophotometer* : (1/XIX/71)

The objective of this developmental work is to design and fabricate prototype of UV-visible spectrophotometer whose performance will be comparable to Perkin-Elmer 137 Model for spectral range of 190-750 mμ in two steps. At present this type of instrument is not manufactured in the country and country's demand is met through imports. The present cost of imported instrument is around $10,000.

The development of the instrument has been successfully completed and the spectra of standard filters such as holnium oxide, didynium have been taken in the visible region of the spectrum. These spectra are fairly comparable to the ones obtained on similar imported instruments.

Deuterium lamp has not been received so far and hence the performance in the UV region could not be checked.

After rigorous performance checks in both UV and visible regions, specifications will be formulated and then it will be ready for commercial exploitiaton.

19.2 *Infrared spectrometer* : (2/XIX/72)

IR spectrometer is a powerful analytical tool for research, education and industry. This sophisticated optoelectronic instrument is currently being imported from hard currency areas. Attempts are under way to design and fabricate a prototype comparable to Perkin-Elmer 137 model which will have medium resolution, high accuracy and reproducibility for qualitative and quantitative analysis of organic compounds.

The first prototype has been completed and its evaluation is over. The second prototype is in the advanced stage of fabrication. It is to

include solid state electronic, flat bed recorder and improved wavelength drive with digitally controlled motor.

20. WATER MANAGEMENT

20.1 *Water evaporation control* : (1/XX/76)

In the early sixties, work on water evaporation control by using monomolecular films of long chain alcohols and alkoxy ethanols was taken up in the laboratory. Extensive laboratory experiments were carried out from both the fundamental and applied point of view. It was established that the alkoxy ethanols of certain fatty alcohols were better evaporation retardants than the corresponding ceto stearyl alcohol.

Larg scale multi-locational experiments/trials have been undertaken with a view to gather field data regarding techno-economic aspects.

Work was undertaken at Indira and Kondapuri lakes (Poona District) to study the water conservation by the compounds mentioned above. The water evaporation retardant, i.e. ethylene oxide condensation product of C_{22}-OH was manufactured by HICO Ltd., Bombay on the basis of technical know-how available from NCL. The experiments at NCL were also geared up again to study the efficacy of these products by using evaporimeter pans, petri-dish experiments and bricklined cemented tanks. Every sample which was sent by the manufacturer was analyzed at NCL and the efficacy was found out in the laboratory by the above mentioned methods before it was sent to the tanks for spreading. These field trials were undertaken in collaboration with the Directorate of Irrigation Research and Development, Maharashtra Govt. The daily observations needed at the site are : (i) Maximum minimum temperature, (ii) humidity, (iii) wind velocity and (iv) drop in tank level, i. e. gauge post reading, and also the evaporimeter pan readings. Based on these observations average drop in the tank level is known under these climatic conditions when the film is being treated. Knowing the water spread area and the drop in level on a particular date it is possible to calculate the total quantity of water and from this one can calculate the actual drop in level in the treated tanks which will be compared with the drop in level in the evaporimeter pans in the same period for knowing the actual water saved. At Indira lake it has been observed that about 6 million gallons of water has been saved during the months of January, February, March and April 1977. In other tanks, i. e. Kondapuri and Aundha Naganath, work was undertaken; however, detailed data on saving of water could not be collected. These experiments will be continued for the next two seasons for collecting more accurate data to assess the actual conservation of water.

FOLLOW-UP ACTION

1. *Aniline*

During the testing of aniline catalysts at Hindustan Organic Chemicals, Rasayani (HOC), it was observed that a pelletted catalyst would be better than the granular catalyst developed by the laboratory earlier. HOC evinced interest in employing the pelletted catalyst for their aniline production. As such, a suitable catalyst was developed and tested at the laboratory and then at HOC. The catalyst has been approved by HOC. Negotiations in respect of undertaking the regular production of the catalyst and its supply to HOC and other parties are in progress.

HOC is also interested in commercializing a fuidized bed technology for aniline developed by NCL. In this direction, procurement of equipment and erection of a pilot plant at HOC site are in progress.

2. *Atrazine and Simazine*

The process for the preparation of atrazine and simazine was developed earlier on 1 kg/batch scale.

As desired by the entrepreneur interested in acquiring the know-how, a few large scale batches (about 3 kg/batch) were carried out and more process data was collected. Further the products were sent for dermal and oral toxicological studies and for field trials.

3. *Bostik sealants substitutes*

Efforts were made to improve the properties of black Bostik sealant substitute with respect to adhesion property and pot life. Work is in progress.

4. *CDV Pigment*

NCL process on CDV pigment was released to M/s Square Chemicals and M/s Vapson Products, Bombay. After the transfer of the technology and as desired by the licensees improvement on the product was made and the details were furnished to the licencees.

5. *Chlordiazepoxide*

The process for chlordiazepoxide was referred to NCL Process Release Committee (PRC) for its approval. As suggested by the committee,

consumption of raw materials, especially recovery of methanol and acetic acid was carefully looked into. Several experiments were carried out and results were discussed with chemical engineering group of the laboratory. The project will be referred again to PRC.

6. *Colchicine*

The development of a laboratory process for colchicine from seeds of *Iphigenia stellata* was reported earlier. The process was released to a party after scaling it up at 2 kg of seeds/batch. Pure colchicine conforming to IP standards was produced on the above scale and reproducibility of results was demonstrated to the licencee.

7. *Dalapon*

The product prepared at NCL when tested in field trials was found to be comparable with the imported dalapon. Necessary physico-chemical data required for design of a commercial plant was collected. The process has been released to two parties for commercial exploitation.

8. *Diazepam*

As reported last year NCL process on diazepam was released to three firms. Subsequently the know-how for the preparation of the intermediate 2-methylamino-5-chlorobenzophenone was improved further and standardized on 0.5 kg/batch scale. The product obtained was tested and found to be acceptable and the details of the improved process have been furnished to the licencees.

9. *Endosulfan*

Continuous assistance to the project engineers of one of the two licencees of this process is being given in the execution of their contract for establishing a commercial plant of endosulfan by Hindustan Insecticides Ltd. (HIL), Delhi.

10. *Expandable polystyrene foam*

With a view to study the improvements in the properties of the final beads, a few new suspending agents were tried but they showed no noticeable improvements.

11. *Fumed silica*

A process was standardized on sponsored basis to yield fumed silica with a surface area around 326 m^2/g (BET method) and particle size of milimicrons and bulk density between 25 and 28 g/l was reported last year. A complete project report of the work done along with the basic designs of the pilot plant was submitted to the sponsor.

The sponsor is putting up a fumed silica pilot plant at Kalyan. NCL scientists took active part in the installation of the plant.

12. *Ketone resins*

Experiments were carried out to improve the transparency of the final resin by the removal of unreacted reactants and dehydration of the resin under vacuum.

13. *Molybdenum chemicals from molybdenum concentrate*

A project was sponsored by M/s. Apex Chemicals, Bombay to develop a method for making molybdenum oxide from molybdenum concentrate and process data was collected for the manufacture of technical molybdenum oxide directly from molybdenum concentrate.

In addition to the process data already collected the sponsor desired to collect some data for the design of a new type of reactor. Based on the above data engineering designs were prepared and supplied to the firm for installation of a commercial plant.

14. *Optical whitening agent*

The process as developed earlier was released to M/s Valia Brothers Pvt. Ltd., Bombay. Accordingly, the process was demonstrated to the firm. Later, as desired by the licencee furher improvement on the process was made. The product of desired specifications was obtained on laboratory scale. The improved process is being standardized.

15. *Polyurethane coatings*

Few samples of two pack system polyurethane resin developed at NCL were prepared and supplied to a party in order to evaluate their performance as moisture resistant lacquer. At the instance of this firm number of pieces of metal film resistors were also coated by polyurethane coating and the same were sent for evaluation. Two pack system coatings were found unacceptable as moisture resistant lacquers.

16. *Silver paste*

A process for the preparation of silver paste for mica capacitors was completed and reported earlier. Although this paste is reported to be suitable for professional capacitors the same would be costlier for consumer types because of higher silver element. Keeping this in view few more samples were formulated and the sample was sent to a party on request. Their report is awaited. The process is being assigned to NRDC shortly.

Silver paste for use in development of resistor materials is also being prepared from time to time.

17. *Trichlorobenzene (TCB) from non-γ-BHC*

Based on the laboratory work, a pilot plant was designed for 100 kg/ batch of TCB. The pilot plant batches gave consistant results. The resultant product was analyzed and found to contain about 90% 1, 2, 4 and 10% 1, 2, 3 trichlorobenzene.

18. *Vitamin* B_6

NCL had developed earlier a four step process for the manufacture of vitamin B_6 starting from paraldehyde which has been released to IDPL, Hyderabad.

A new route, for Vitamin B_6 involving the Diels-Alder addition of *cis*-butenediol with 4- carbethoxymethyl 5- ethoxy oxazole is being studied. For this the oxazole is prepared in 33% overall yield on a laboratory scale.

A few prospective dienes and new dienophiles like di-*p*-nitrobenzoate of 2- butenediol and diethyl maleate were tried for Diels-Alder condensation.

RURAL DEVELOPMENT

Chandrapur Development Project

A brief report on the genesis of this programme and the progress of work done during 1975-76 for formulating an eco-system plan for Chandrapur was reported earlier. During the year under review, NCL scientists have had further discussions with the representatives of the Government of Maharashtra and had prepared a working paper on the basis of the recommendations contained in the task force reports on forests, agriculture, animal husbandry, small and large scale industries and infrastructure schemes. The working paper and the background documents have been printed and will be discussed at a meeting of experts scheduled to be held at Mantralaya, Bombay, in 1977-78. The relevance of each project in the context of expeditious utilization of the resources of Chandrapur region and upgradation of local skills; priorities to be assigned to the projects; ecological impact and other factors will be considered by the experts while giving the final shape to the draft outline of the eco-system for Chandrapur.

The Director and his colleagues had also made another extensive tour of Chandrapur district from 17-11-1976 to 30-11-1976 to study in depth the developmental problems relating to agriculture, animal husbandry, fisheries, education, health and other rural welfare schemes. A consolidated report of the tour has been submitted to the Government of Maharashtra and the CSIR.

In the coming years also NCL will be expected to play a more effective role in developing technologies for rural India and to assist in identifying areas and specific problems of scientific and technological importance and assignment of such problems to R and D institutes/scientists in the country for investigation. In the context of implementation of the eco-system plan for Chandrapur, NCL will act as an active link between R and D groups and implementing units to enable smooth transfer of research results for practical application. As a result of extensive field visits and discussions with the field staff at Chandrapur, local leaders, social scientists and other experts, the NCL scientists have already indentified a number of schemes involving R and D inputs, which, when successfully completed, will have considerable impact on rural development in general and the integrated development of Chandrapur in particular.
A few examples of such schemes are :

1. *Water management (conservation through control of evaporation loss; convservation through special techniques e. g. sprinkler and drip irrigation; reduction of crop cycle time by use of WER chemicals : purification of polluted/brackish water into potable water; mapping of ground water resources; preservation of fruits and vegetables through WER chemicals*).

Studies in water evaporation control by means of forming monomolecular layers of water evaporation retardants on minor irrigation tanks and percolation tanks have been taken up. Success of sucn experiments will ensure availability of water for a longer duration for agriculture particularly in the rabi season. Experimental work on this project is in progress at Indira and Kondapuri tanks in Maharashtra. It is expected that the studies will be extended to three more tanks. It is also proposed to extend these experiments of water evaporation retardation to paddy fields. It is expected that due to less evaporation of standing water from the rice fields, the ambient temperature near the roots is raised with the effect of lessening the period required for the maturity of the crop. If this can be achieved it will be advantageons in India in colder climates as well the crop calender can be improved at several places enabling cultivating second crop in the same field. Waterevaporation retardant (WER) chemicals can also be used for preservation of food, air conditioning and in sprinkler irrigation. (For details please see page no. 54)

2. *Agriculture (plant tissue culture for teak propagation, cashew and other economic plant species; utilization of medicinal plants; use of neem oil and cake, utilization of non-edible oil seeds; utilization of the hydrocarbon constituent of Cedrus deodara*).

Plant tissue culture work has been undertaken for development of virus free sugarcane cultivation, breeding of better species of food crops, cabbage production, etc. Work has been taken up to apply tissue culture technique to the multiplication of trees and plants which offer difficulties in multiplication by the conventional methods e. g. teak, eucalyptus, cardamom, etc. Recently work has also been undertaken to develop virus resistant sugarcane strain. (For details please see page no. 48)

NCL scientists in collaboration with the forest authorities have collected extensive information on the medicinal and aromatic plants available in Chandrapur which can be cultivated in a planned manner on a large scale so that suitable phytochemical essential oil units could be set up. It is proposed to undertake the studies of some of the important medicinal plants e. g. Dikamali (*Gardenia gummifera*), Garari (*Cleistanthus collinus* Benth), Solanium species, Dioscoria species, etc.

A detailed literature survey of some 25 important medicinal plants commonly available in Chandrapur has been completed. Literature references on the chemical constituents of the important medicinal plants of the

district were collected. The methods of analysis of various drugs have been surveyed. A list of medicinal plants in which NCL will be interested to work has been supplied to the forest authorities in Chandrapur. (For details please see page no. 19)

3. *Agrochemicals (elimination of Parthenium weed; development of slow release (microencapsulation) pesticides; slow release oleic acid/neem oil coated fertilizers; biological control of pests*).

NCL has developed a slow release herbicide for the control of Parthenium type of weed (Gajar gawat). This technique is also being applied for the production of slow release pesticides formulations which will economize agriculture and lessen the evil of residual effect.

NCL has an extensive programme for the development of a wide range of pesticides, herbicides and plant growth regulators. It has already developed know-how for a number of important products e. g. dalapon, endosulfan, warfarin, nicotine sulphate, maleic hydrazide, cycocel, nitrofen, tetradifon, fenitrothion, dimethoate, phenthoate, chlordane, ethion, high gamma BHC, vitavax, PCNB and ethephon.

In view of the increasing threat to ecology through use of synthetic chemical pesticides, biological control of insect pests through naturally occurring compounds which will interfere in their life processes is receiving attention. The NCL has undertaken a programme of investigation of plants occuring in Chandrapur belonging to the compositae family to study the biological activity of their chemical constituents. (For details please see page no. 19)

4. *Animal husbandry and fisheries (veterinary medicines; upgradation of veterinary practices; sweet water cultivation of prawns; utilization of slaughter house wastes; technologies for cottage and village industries based on dairy, poultry and other farm products*).

The NCL has developed the know-how for the preparation of mangicide from *Cedrus deodara* oil. It is also developing antrycide for veterinary use.

In collaboration with the research department of Hindustan Lever Ltd. and concerned wings of the Govt. of Maharashtra, the NCL hopes to propagate sweet water cultivation of prawns and develop inland fisheries in the Chandrapur regions. If the efforts prove successful, similar programmes could be organized in other rural/backward areas.

5. *Forests and forest based industries (energy plantation; dissolving grade pulp; economic utilization of effluents of paper plants; technologies for small, medium and large scale industries based on forest products).*

NCL has developed the technology for making dissolving grade pulps from various hard and soft woods available in Indian forests. Thus technology for the manufacture of rayon, tyre cord and HWM grade pulps from composite woods from Chandrapur has been developed and is now awaiting commercialization. In collaboration with Forest Development Corporation of Maharashtra, Ltd. Nagpur, NCL is exploring the possibility of cultivating Mesta (*Hibiscus cannabinus*) and Dhoban (*Dalbergia panniculata*) in identified forest areas. These are fast growing species of plants. Dhoban can be used as a firewood material for producing energy from a fast regenerative resource. Both Mesta stalks and Dhoban wood pulp are suitable raw materials for the NCL technology for manufacture of dissolving grade pulps. Mesta seeds can also be used for the extraction of a fatty oil.

NCL technologies/projects relevant to rural development

During the visit of NCL scientists to the Centre of Science for Villages, Wardha, the Director of the Centre suggested that the NCL could compile a tentative list of its complete technologies and on-going projects relevant to rural development. In May 1977, the CSIR had brought out the first draft of a publication entitled " CSIR in the service of Rural Society " which gave a consolidated discipline-wise descriptive list of technologies, developed by its constituent laboratories.

In the preceeding section an illustrative list of NCL technologies avaiable for implementation as well as those under development in the context of the eco-system plan for Chandrapur has been given. These technologies could also be adopted for the develpoment of other rural and backward regions in the country. Some additional examples of technologies relevant to rural development are : (a) technology for making oxalic acid from the bark of Ain trees (*Terminalia tomentosa*); (b) processes for the production of xylit and xylose from corn cobs and coconut shells; (c) technology for the production of xylose and xylitol starting from bagasse; (d) utilization of cellulosic wastes available in the country for the production of glucose-protein-rich animal feed through enzymatic saccharification; and (e) extraction of sisal wax from sisal waste obtained in retting method used for producing sisal fibres for rope making.

PLANNING CO-ORDINATION AND EVALUATION

The function of the Division of Technical Services (DTS) is to carry out planning, coordination and evaluation of the Research and Development activity of the laboratory and to maintain liaison between the laboratory and the CSIR, NRDC, other governmental agencies and industry. On its own, some activities related to management aspects of the R and D institutes are also taken up by the DTS.

During the year 1976-77, for meeting the changing needs of the laboratory the DTS reviewed the areas of its major activities and considered potential areas of new work. For the first time an yearly plan of the work for DTS was prepared and circulated to the members of the SCR.

Research programming, monitoring and evaluation

The research programme proforma was revised to include phase wise objectives, programme and the resource plan. The area/project wise budgeting was introduced in line with CSIR norms. This exercise was carried out with the help of the Internal Research Programme Committee which included, the Director, the Divisional Heads, Senior Scientists and the representatives of the DTS. The research programme was placed before the various Advisory Panels and the Executive Commitee for their approval. For the formulation of the Research Programme for 1976-77 and 1977-79, DTS played an important role in compilation of the techno-economic information on various projects suggesting the methodology for their implementation including the man power deployment and identification of the bottlenecks in their execution. Suggestions coming out of these meetings were taken up for action.

With the help of the Divisional heads DTS also prepared key note papers on the major thrusts of individual Divisions, methodology, policies and highlights in the NCL Research Programme 1976-77 and on the research work under progress alongwith brief outline of the future work to be undertaken.

The analysis of these Research Programmes indicated that 35 new projects were undertaken during the year 1976-77, 36 projects were concluded,

10 projects were discontinued for various reasons and 27 new projects were approved for inclusion in the Research Programme 1977-79

In October-November 1976, a critical scientific and techno-economic reviews of all the projects which were under implementation were taken. For these reviews, the projects were divided into two catagories 'A' and 'B', depending upon their duration, techno-economic impact and the overall objectives of the laboratory.

Meetings of the projects catagorised 'A' were chaired by the Director and the other meetings were chaired by the Divisional Heads. In these meetings all the members of project teams participated. Actions envisaged inthe minutes of these meetings were followed up.

DTS has started documentation of potentially important projects and this information is being routinely sent to the concerned scientists. Such informations, which is gathered by screening various technical journals, licence application and statistical reports, will be useful to various scientists in the identification of new projects of techno-economic importance and of relevence to the country's needs.

Technical discussions on various important and priority projects of inter-disciplinary nature were organized by DTS. The minutes of such meetings were recorded and all assistance coming under the purview of DTS was rendered for their effective implementation.

A survey cum analysis of the sponsored projects upto August 1968 was undertaken. Out of the 60 sponsored projects 22 were of basic or testing nature wherein no production was envisaged, 6 were abandoned, 13 were in actual production and in 19, the sponsor did not show any interest in commercialization.

Under the terms of sponsorship the project can be released on non-exclusive basis either after the completion of exclusivity period or in the event of sponsore not implementing the technology within a certain period. Attempts are being made to identify projects which fall under above categories and can be offered to other interested parties. This will be done after studying the techno-economic viability of the projects in the present conditions.

A similar survey of the sponsored projects in the laboratory during 1968-77 will be undertaken.

Project follow-up and industrial liaison

Proposals for the following processes were prepared and placed before the NCL Process Release Committee for obtaining its clearance for

the release of these processes to interested parties for commercial exploitation.

(1) Dimethoate and fenitrothion, (2) Carboxin, (3) Ethephon, (4) Trichlorobenzene from non-γ-BHC, (5) Sulphur monochloride from sulphur sludge, (6) Sodium sulphide from sodium sulphite residues, (7) Stabilized sodium hypochlorite and (8) Chlordiazepoxide.

Proposals for the following were also submitted to NCL Process Release Committee for approval.

(a) Mode of offering Process Engineering Packages (PEP) on major pesticides and other technologies developed at the NCL in association with project engineering firms.

(b) Procedure for reference of NCL processes ready for commercial exploitation to CSIR for assignments to NRDC.

Documents for the following processes were prepared and referred to CSIR as per new norms for the assignment to NRDC.

(1) Trichlorobenzene from non- γ—BHC.

(2) Ethephon

(3) Carboxin

Comments on 80 applications received from CSIR for letter of intents, industrial licenses and foreign collaboration were sent to CSIR in consultation with the NCL scientists. These applications were documented.

Draft contractual/collaborative proposal for development of following technologies were prepared and negotiated.

(1) Thionyl chloride, (2) Cryolite, (3) Silicone intermediates, (4) Butenediol, (5) Dimethoate and fenitrothion, (6) Hexachlorocyclopentadiene, (7) Fluidized bed techniques, (8) Methyl chloride, (9) Titanium tetrachloride, (10) Large scale cultivation of cabbage, (11) Tin oxide resistors, (12) Endosulfan, (13) Endosulfan consultancy, (14) Agreement between Project Engineering firms on the preparation of Process engineering Packets, and (15) Development of substitute for side seam cement.

A proforma was designed for the preparation of project reports for the processes ready for commercial exploitation in line with CSIR and NRDC working arrangement. This was circulated to various group/project leaders.

During the period under review 5 patents were filed. Technical appraisal on 150 research schemes referred to us by CSIR was given in consultations with NCL scientists.

Research Analysis

Data on project turn over for the years 1974-75 and 1975-76 was reported last year. Additional data for the year under review has been compiled and the project turn over during the year 1976-77 is detailed in the following table.

		1976-77
(i)	Projects continued from previous year	85
(ii)	New projects undertaken	39
(iii)	Projects completed/ terminated	58*

* Includes some of the projects which were reported as completed during 1975-76, but on which work was carried out during 1976-77. These projects are now concluded.

Publicity and Public Relations

With a view to establish better communication within the laboratory and between all catagories of the NCL staff and community, publication of the 'NCL Bulletin' was undertaken as a new activity by the DTS. The first issue of the bulletin was brought out in August 1976 and since then it has been a regular monthly feature.

The bulletin not only covers the information regarding the laboratory activities like research round up, technology transfer, implementation of NCL technologies, lectures, seminars, visits, awards, honours, filing of patents etc., but also the social and cultural events in the NCL campus.

The NCL bulletin has been widely appreciated by readers and has established itself as a useful communication forum for the NCL community.

A new edition of the brochure describing objectives, achievements, contributions and perspectives, and organisational facilities in NCL was prepared and circulated.

Draft note on 'Contributions and Perspectives of NCL' was prepared for the presentation to the Prime Minister.

Draft notes on the (a) Transfer of Technology, (b) Future o Chemical Industry, (c) NCL projects to be completed by 1980, (d) Transfer of Science and Technology to Rural India and (e) Centre for Advanced Studies for Information system were prepared and submitted to various authorities. Members of the DTS staff also wrote a number of popular articles and delivered lectures on scientific topics in English and regional languages.

About 200 entrepreneurs, 2460 visitors from all strata of the society were received by NCL and 4500 enquiries were attended to.

Rural Development :

Scientists from DTS actively participated in the preparation of the Eco-system plan for Chandrapur district. They also participated in the organisation of Water Evaporation Control Experiments at Indira Lake near Rajgurunagar (Dist. Pune).

Other DTS Activities

Anuual Report for 1975-76 was compiled and published in October 1976. Many additional features e. g. on the utilization of NCL technologies were included in the report.

Documentation of Press cuttings on 31 different areas, Chemical industry and matters of general interest from various newspapers, follow-up of SCR meeting decisions, attending entrepreneurs/routine enquiries, management of museum, participation in exhibitions (2 Nos), arranging press releases and conferences, extending photographic (1804 enlargements, 460 slides, 300 photocopies and microfilming) and draftsman services (357 tracings and 575 ammonia prints) to various projects are some of the activities which were carried out by DTS.

INFRASTRUCTURE ACTIVITIES

1. *Analytical groups*

1.1 *Microanalysis*

Microanalysis of organic and organometallc compounds for the elements (C, H, N, etc.), functional groups and other estimations such as molecular weight determination, neutralization equivalent determination are of great help and guidance to R & D work in the laboratory. A separate section has been working on these requirements of the research work. Adhoc assistance to outside research organizations, universities etc. was also rendered on payment basis.

During the year, in all 2486 samples were analysed ; of which, 2416 were for elements and 70 for functional groups. These included 66 samples analysed for outside institutions and 367 analyses carried out for applied projects of the laboratory.

In addition to the above—a sort of routine—work, the staff from microanalytical group is actively engaged in carrying out fundamental work in the analytical field. During last year, two analytical methods were developed : one for rapid microdetermination of carbon and hydrogen using a modified Hazenberg combustion tube; another for studyng the efficiency of some oxidants for smooth combustion of organic compounds. Cobaltocobaltic oxide and ceric oxide were found to be the most effective oxidants among those studied so far.

1.2 *Mass Spectrometry*

During the period under review, 1059 samples from the laboratory and 21 from the sister laboratories were analysed. 58 samples related to this laboratory's work were analysed by gas chromatography—mass spectrometric technique. Besides these, 94 samples received from universities, research institutes, private parties etc. were analysed on payment basis.

1.3 *Spectrochemical and other analyses*

Physico-organic techniques such as UV, IR, NMR, visible spectra, VPC and GLC are indispensable for the R & D work. Following is the work report in this area during the year.

NMR	6,657
IR	6,048
VPC/GLC	6,770
Spectrometric estimation/ Inorganic anlysis of special nature	778
UV/UV-visible	439
X-ray photographs	226
Thermogravimetric analysis (DTA, TGA, TG etc.)	150
Optical microscopy	80
Determination of surface area by BET technique	27

Besides the above regular analysis work, following analytical methods using spectroscopy have been developed.

(i) Simpler method for estimation of dimethoate has been developed by using usual Silica Gel column chromatography followed by phosphorus estimation.

(ii) The methods for effluent treatments and disposals have been developed and standardized on laboratory scale for organo-phosphorus pesticides and their intermediates processed in NCL.

(iii) Several GLC analytical procedures have been developed and practised for process control tests as well as for final products along with intermediates etc.

(iv) In connection with the project on the dehydrochlorination of non-γ-hexachlorocyclohexane to obtain trichlorobenzenes, the isomers 1, 2, 4; 1, 2, 3 and 1, 3, 5-trichlorobenzenes formed were estimated quantitatively by infrared spectroscopic analysis of the ether extract of the reaction products.

(v) The purity of various samples of vitavax prepared in the laboratory scale experiments was estimated by the intensity measurements of one of its bands.

(vi) The infrared spectra of a large number of zeolites (Molecular sieves) were analysed to establish the various types of surroundings of water molecules in its structure when known changes are brought about in its composition.

(vii) The infrared spectra of various lignin and modified lignins were analysed to understand their structural features and correlate them with other experimental evidence.

(viii) Mossbauer spectroscopy has been successfully employed to identify iron and tin low spin organic compounds, which form cis-and trans-isomers.

2. *Entomology group*

Work of this group is complementary to the laboratory's R & D programme on pesticides, hormones, pheromones, attractants, repellents, plant extracts etc. It involves development of cultures, testing of compounds for various kinds of activities on different insects, studies on metabolism/ degradation of agrochemicals etc.

Six permanent insect cultures of pests of economic importance belonging to Hemiptera, Coleoptera, Lepidoptera and Diptera are maintained to serve as the test insects for initial screenings. Addition of at least two new colonies is shortly envisaged.

Among the various facilities developed are standardized procedures for bioassaying pesticides, miticides, ovicides, larvicides, juvenile hormone analogues, anti-JH compounds, MH analogues, pheromones, antifeedants, atractants and repellents.

During the period under review, more than 300 compounds, both synthetic and natural derivatives were screened for their biological activity in different insects. Significant results were obtained in the examination of *Parthenium hysterophorus*. It was established that the major antigen, Parthenin, acts as an antifeedant for a number of insects and thus contributes to the resistance of this weed to insect attack. These findings were presented at a National Symposium at Madras.

Another significant finding was the discovery of a naturally occuring root and stem borer in *Parthenium* plant which caused devastating damage to the root and the stem, and killed the plant. Efforts will now be made to rear this insect in the laboratory, get it identified and assess its potential as a biological control agent for this notorious weed.

A series of JH analogues prepared from geraniol were assessed for their JH activity on the Hemipteran *D. Koenigii*. More active compounds among this series are now being tested on stored grain pests, mosquitoes and Lepidopterous pests of agricultural importance.

A major break-through was achieved in the field of insectistatics by the isolation, synthesis and bioassay of anti-JH principles, Precocene I and II from the indigenous plant *Ageratum conyzoides*. Bioassay procedures for detecting and establishing anti—JH activity have been standardized. Several other plant species belonging to compositae have also been

examined and anti-JH activity detected in extracts of at least one other weed. Preliminary findings on the anti-JH activity of plant precocenes from *Ageratum* and the range of biological activity of the precocenes on a number of pest species were presented at a National Symposium in Delhi.

Preliminary experimentation on the activity, duration of effectiveness and comparative efficacy of encapsulated pesticides have begun to develop suitable indigenous slow release technology for pesticides.

Facilities are being developed for more sophisticated bioassays for carrying out assessment of biochemical effects of selected agrochemicals. Studies on the fate of various chemicals after their application to insects are contemplated by using radiotracer techniques.

3. *National collection of industrial microorganisms*

The collection so far consists of 2000 non-pathogenic yeasts, fungii and bacteria. The ready availability of these saves time and foreign exchange on the part of industry and research units in the country. During the year under review, 62 cultures were supplied to industry, 161 to research institutes and 34 to CSIR laboratories.

4. *Instrumentation section*

This groups is responsible for the maintenance of sophisticated instruments like NMR spectrometer, UV-visible spectrophotometer, IR spectrophotometer, gas chromatographs, conductivity bridges, potentiometeric recorders, X-ray equipment, electronic power supplies etc. Total about 500 jobs were attended to during the year.

5. *High pressure laboratory*

This section provides maintenance and supervision services in respect of the high pressure experimentation. During the year 240 experiments connected with the R and D programme of the laboratory were conducted; two of which were sponsored programmes.

6. *Engineering section*

6.1 *Mechanical/Electrical engineering* : This section looks after the installation and maintenance of the laboratory units and utility services. It also undertakes fabrication and modifications of equipment as per the requirements of the R and D work. The jobs—completed during the year under review totalled to 3,381 of which the following were of special mention.

(i) Fabrication and installation of the pilot plant for water evaporation control project,

(ii) Installation of pilot plant for the work on slow-release herbicide, including the fabrication of the cartidge filter, air cleaner, condenser unit, spray nozzle etc.,

(iii) Assembly and erection of ceramic columns for ' propylene oxide' pilot plant,

(iv) Fabrication of a tube furnace, wattage 2 kw, temperature range 1000° and

(v) Electrification of the glass-house of the Biochemistry Division and that of the extension of the glass-blowing section.

6.2 *Civil engineering* : Besides the regular maintenance of the laboratory and colony buildings, this section supervised and executed the following new constructions during the year.

(i) Chemical engineering building

(ii) Building for pesticides project

(iii) Extension to RTL to accommodate a spectrometer

(iv) Extension to the chlorination laboratory of Inorganic Division

(v) Building for Horticultural Superintendent

(vi) Scooter-parking shed

(vii) Renovation of the tank meant for the 'water evaporation control' project

(viii) Extension to the silica gel project's shed for herbicides project

(ix) A shed for fire-fighting equipment

(x) A school building

(ix) Compound wall for the colony

The total cost of the construction work completed amounted to Rs. 19.30 lakhs.

7. *Glass-blowing section*

This section undertakes jobs of fabrication, repair, and maintenance of glass equipment. The number of assignments completed during the year amounts to 4534, the face value of which would come to about Rs. 4 lakhs. About 200 jobs were carried out in connection with the sponsored schemes. In addition to the above the section rendered various services to outside parties, which are reported under 'appendices'.

8. *Library*

The library's present stock of 75,000 publications comprises books, periodicals, patents, standards, technical reports etc. It includes the

addition of 4728 publications during the year. The break-up of the addition is : 951 books, 2559 periodicals (bound), 1056 patents/standards, 147 technical reports and 15 theses.

Library facilities are available to clientele from industry, Govt. departments, universities, colleges and other research organizations. More than 500 outsiders made use of our library during 1976-77.

During the period under review 13,938 publications were issued to staff and corporate members. Under interlibrary loan scheme 183 publications were borrowed and 270 publications were issued to other libraries.

Various periodicals were circulated amongst the senior scientists and current awareness services were issued on agrochemicals and pesticides, Indian patents, Solar energy, Chemical reactors, and Library bulletin.

Bibliography on water evaporation and its control covering the period 1907 to 1975 was compiled and distributed to the concerned scientists.

2000 pages of the references available in the library were xeroxed and supplied to interested outside parties on payment. Xerox copies of 3273 pages were supplied to NCL staff for their research work.

The library is an Inspection Centre for Indian patents. About 5000 patents were received by the centre during the period under review.

APPENDICES

1. NORMS FOR RENDERING TECHNOLOGICAL ASSISTANCE TO INDUSTRY

1.1 *Consultancy*

National Chemical Laboratory, can enter into argeements with firms/group of firms and public sector undertakings for rendering technological support to industry. This may cover development, planning, programming, feasibility studies, R and D establishment and trouble shooting. Such institutional consultancy will be operated through the NCL scientist/s particularly desired by the industry with the concurrence of the NCL/CSIR.

1.2 *Sponsorment*

NCL can consider undertaking projects on sponsored basis on specific problems faced by the industry. Under the present terms and conditions of sponsorment, a sponsor is required to spend for R and D work carried out at the NCL on his behalf. The results of sponsored work are made available to the sponsor on exclusive basis for a limited period. In case of sub-licensing of know-how developed to others, the sponsoring firm will be compensated for. Detailed terms for sponsorment will be furnished on request.

1.3 *Ad-hoc assistance*

NCL can render assistance to industry in standardization, optimization, analysis and testing, and trouble shooting on ad-hoc payment basis depending upon the nature of the problem; provided the necessary facilities and expertise are available and can be spared.

1.4 *Pilot plant work*

Based on the laboratory data obtained elsewhere pilot plant work on agreed terms, could be undertaken on behalf of industry, either on sponsored basis or on ad-hoc basis as outlined in item 1.3

1.5 *Feasibility studies*

NCL has been offering assistance on payment to project engineering firms to prepare feasibility reports or turn-key proposals for NCL technology.

1.6 *R and D collaboration with industry*

In projects involving high capital investment/high risk factors and necessitating establishment of semi-commercial units for large scale proving runs, NCL is keen to collaborate with interested industry on such joint development programmes. Such units could preferably be established at the site of the industry and run at the cost of the industry.

7. *Import of foreign technology*

NCL can participate with industry in their negotiations for importing foreign technologies. Such a participation will enable the concerned firm to choose proper technology from various foreign technologies available. Further NCL scientists could be associated with training abroad and commissioning of the plants in India. Such association could be an integral part of foreign collaboration agreements. This will help in assimilation and further improvement of foreign technology.

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

2.1 *Supply of cultures*

During the year under report, 257 cultures from the National Collection of Industrial Microorganisms (NCIM) were supplied to various institutions.

2.2 *Analytical services*

The laboratory extended its services to various concerns and institutes in respect of the following analyses.

Microanalysis	66
NMR	47
IR	90
UV/UV-visible	2
Mass spectral analysis	115
VPC/GLC	100
Thermogravimetric analysis (DTA, TGA, TG, etc.)	17
X-ray powder patterns	10
Optical microscopy	12
Spectrophotometric estimation/inorganic analysis of special nature.	40
Determination of surface area by BET technique.	3

The total receipts on account of analyses/testings carried out during the year amounted to Rs. 0.337 lakhs.

2.3 *Training*

Training in various subjects, such as thin film physics, mass spectrometery, microbiological technique, electrophoresis, glass blowing etc., was given to 7 representatives of industry and institutes.

2.4 *Glass-blowing*

Following assistance/service was rendered to outside parties by the glass-blowing section.

(i) Industrial Chemical Laboratory, Govt. of Maharashtra, were given all help to instal one glass equipment in their laboratory.

(ii) A plan for the glass blowing section at IIT, Powai, was prepared and sent to them.

(iii) A special glass fabrication work was done at the instance of HAL, Pimpri.

2.5 *Special equipment/instrument/testing facilities*

The following special equipment were installed in the laboratory during 1976-77. These are in addition to the special equipment already available in the laboratory as mentioned in the NCL annual report 1975-76.

Name of the equipment	Function
1. Impedance bridge	Measurement of capacitance, inductance and resistance at different frequencies
2. LUVA evaporimeter	Used for removal of moisture, residual solvents from organo-phosphorus pesticides
3. Printing digital analogue integrator (RIKADENKI Model PADAL — 1)	Receive signal from the gas chromatograph, integrating and printing of the peak areas to handle 16 peaks/sample

3. SPONSORED PROJECTS

3.1 *Criteria for undertaking sponsored work and normal terms and conditions*

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

(a) The proposed work is within the scope of present areas of activities of the NCL and the laboratory has the necessary facilities and expertise available to carry out the work subject to the internal load.

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

(c) It has got sufficient socio-economic impact after completion.

(d) It is not repeatitive and the technology to be developed is not already established indigenously in the country.

(e) It is of a kind that the sponsor or only a few parties can implement it. Technologies of wider interests to many parties are usually developed by the laboratory on its own.

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

(a) The sponsor will have to pay for or provide the staff required for the investigation. The sponsor will have to pay 125% of the total salaries of the NCL scientists working on the scheme.

(b) The entire expenditure on chemicals and raw materials will be borne by the firm.

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

(d) The sponsor will pay a fixed charge of Rs. 7,000/— per scientist per annum towards services, depreciations and incidentals. This charge will be made irrespective of whether the scientist is from the NCL or deputed by the sponsor.

(e) A minimum provision of Rs. 1200/—per year will be made for contingencies and sundry expenses and daily wage labour. The charge will vary according to the nature and scale of work. At the end of the scheme the unspent amount from this provision will be returned to the sponsor.

(f) A sum of Rs. 60/— per head per annum will be paid by the sponsor on account of medical facilities provided for the staff.

(g) In addition to the above, a fee is payable by the sponsor as know-how fees for the proposed development which is decided at the time of undertaking the work. Concessions are, however, given to medium scale and small scale firms in this regard.

(h) 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 will be pro-rata.

(i) The annual payment for the project will be made in two equal instalments in advance at an interval of six months.

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

(k) Prior to undertaking work on the scheme, the sponsor will execute an agreement with the NCL/CSIR embodying various terms and conditions of the scheme.

3.2 *Sponsored projects concluded during* 1976-77

Process	Party
1. Anisidines by liquid phase hydrogenation of nitroanisoles	Amar Dye Chem Ltd., Bombay
2. Flavonoids, tannins, stilbenes, lignans and quinones in some Indian forest trees	U. S. Department of Agriculture, Washington
3. Molybdenum chemicals from molybdenum concentrate	M/s. Apex Chemicals, Bombay
4. Sorbitol from glucose by continuous process	Anil Starch Products Ltd., Ahmedabad

3.3 *Sponsored projects undertaken during* 1976-77

Process	Party
1. Naproxene	Rallis India Ltd., Bombay
2. Development of substitute for side seam cement	Nand Industries, Poona

3.4 *Sponsored projects continued during* 1976-77

Process	Party
1. Acrylic acid/acrylates from acrylonitrile (Extension)	Indian Petrochemicals Corporation Ltd., Baroda
2. Anisidines from nitro-anisoles by catalytic hydrogenation	Amar Dye-Chem Ltd., Bombay

Process	Party
3. Development of items having short shelf life	Hindustan Aeronautics Ltd., Nasik
4. Flavonoids, tannins, stilbenes, lignans and quinones in some Indian forest trees	U. S. Department of Agriculture, Washington
5. *l*-menthol from Δ^3-carene	Bhavana Chemicals Ltd., Bombay
6. Preparation of propylene oxide from propylene (Extension)	Indian Petrochemicals Corporation Ltd., Baroda

4. TECHNOLGY TRANSFER

4·1 *Levels of Transfer*

The scope of laboratory and pilot plant work and engineering process and design information which has to be generated varies from case to case. For small volume and low value productions involving simple one or two chemical steps, a process optimized on a laboratory scale (1-5 kg/batch size) is often adequate. A process write-up without elaborate process engineering and design information is satisfactory in most of such cases. On the other hand, for large volume/high value productions involving a high capital outlay, the know-how package has to be much more elaborate. The extent of technological and design information to be offered also depends on the expertise available with the client and his expectation as regards the content of the technological package.

As such three distinct levels have been defined and introduced for the technology development and transfer.

Level 1

For low volume/value products prepared by one or two simple chemical steps, only laboratory work is carried out in 1 to 5 kg/batch scale; based on this work a laboratory process write-up is offered to industry which includes the details of laboratory process, time cycles, specifications of raw materials and products, methods of analysis and process control tests. Indications of materials of construction for the commercial plant and approximate sizing are also given. No pilot plant work and scale-up studies beyond 5 kg/batch are usually carried out. Where considered necessary larger scale trials are conducted to test a particular process step but not with a view to obtaining engineering design data.

Level 2

At this level in addition to laboratory work, pilot plant trials on a scale of 10-100 kg/batch or 2-20 kg/hr (in the case of continuous operations) are carried out, the required scale-up studies done and complete process package including engineering design data are offered to the entrepreneur. This would normally conform to Schedule IA of the American Institute of Chemical Engineer's Code.

No project engineering firm is associated at this level and it is for the entrepreneurs to erect a plant either with the help of their own engineers or with the assistance of a project engineer of their choice.

Level 3

If a client desires a turn-key bid with financial guarantees of commercial plant performance, the technology develoepd by NCL is offered through a firm of reputed project engineers. This level of transfer is similar to the turn-key offers received from abroad for importing know-how and all the design data that foreign know-how vendors give are also given by NCL to the project engineers.

For all the above levels of technology development and its transfer to industry, the NCL normally offers guarantees of performance on the scale of its own laboratory/pilot plant work.

At level 3, technology is transferred to industry through project engineering/consultancy firms with guarantees of performance as stated above. Such firms prepare turn-key proposals based on the process engineering package whose contents are described in the statement for level 2 technology.

4.2 *Demonstrations given during* 1976-77

Process know-how for the following products was demonstrated.

	Process	Licensee
1.	Anisidines from nitroanisoles by catalytic hydrogenation (Sp)	Amar Dye-Chem Ltd., Bombay
2.	Bostik sealant-substitute	Premier Rubber and Cable Industries, Bombay
3.	Can sealing composition (based on natural rubber latex)	Premier Rubber and Cable Industries, Bombay
4.	Colchicine	Shree Ganesh Chemicals, Digras

	Process	Licencee
5.	N, N-Dimethyl biguanide hydrochloride (DMBG-HCl), and Phenethyl biguanide hydrochloride (PEBH-HCl)	Combii Organo Chem Pvt. Ltd., New Delhi
6.	Ethylenediamine	Victor Oil Company Pvt. Ltd., Calcutta.
7.	Fumed Silica (Sp)	Century Rayon, Bombay
8.	β-Ionone	Pappachan K. Elengical, Kothamangalam, Kerala
9.	Maleic hydrazide	Micro Chemicals (India), Mandsaur, M. P.
10.	Phenylacetic acid	Supranil Chemical Industries, Poona
11.	Polyurethane coatings	Cipy Chemicals, Poona
12.	Sodium sulphide	Amar Dye-Chem Ltd., Bombay
13.	Sulphur monochloride	Phosphate Co. Ltd., Calcutta
14.	Staple pin adhesive	Duro Metochem Pvt. Ltd., Bombay

4.3 *Processes leased out during* 1976-77

	Process	Party
1.	Can sealing composition (based on natural rubber latex)	Premier Rubber and Cable Industries, Bombay
2.	Ethylenediamine	Victor Oil Co. Pvt. Ltd., Calcutta
3.	Ferrites—Hard	Dr. S. G. Shet, Hyderabad
4.	Flexible magnets	Dr. S. G. Shet, Hyderabad
5.	β-Ionone	Cauvery Chemicals, Asamannor, Kerala
6.	Maleic hydrazide	Micro Chemicals (India), Mandsaur, M. P.
7.	Optical whitening agent for synthetic fibres	Valia Brothers Pvt. Ltd., Bombay
8.	Phenylacetic acid	Supranil Chemical Industries, Poona
9.	Polyurethane coatings	Cipy Chemicals, Poona

4.4 *Processes approved by NCL Process Release Committee for assignment to NRDC during* 1976-77

1. Carboxin
2. Chlorodiazepoxide
3. Dimethoate and Fenitrothion
4. Ethephon
*5. Trichlorobenzene from non-gamma BHC

*(Assigned to NRDC)

5 PREMIA AND ROYALTIES RECEIVED BY NRDC THROUGH NCL PROCESSES DURINC 1976-77

5.1 *Premia*

Sr. No.	Process	Name of the firm	Premium received (Rs.)
1.	Aniline	Sahyadri Dyestuffs and Chemicals, Poona	10,000**
2.	Antioxidant	Amar Dye Chem. Ltd., Bombay	10,000*
3.	Colchicine	Mr. M. B. Patil, Digras	2,000*
4.	Dalapon	Jaydee Agro Chemicals Pvt, Ltd., Jaipur	15,000
5.	—do—	HICO Products Ltd. Bombay	10,000*
6.	N, N-dimethyl biguanide HCl Phenethyl biguanide HCl	Combii Organo Chem Pvt. Ltd., New Delhi	2,500*
7.	Endosulfan	Bharat Pulverising Mills (P) Ltd., Bombay	1,25,000*
8.	Ethylenediamine	The Victor Oil Co. Ltd., Calcutta	22,000*
9.	Flexible magnets	S. G. Shet and Co., Hyderabad	5,000
10.	Maleic hydrazide	Micro Chemical Industries, Mandsaur	5,000*
11.	Morpholine	Bombay Wire Ropes Ltd., Bombay	17,000*

Sr. No.	Process	Name of the firm	Premium received (Rs.)
12.	Morpholine	Catalyst (India) Ltd., Bombay	33,000*
13.	Nitrile rubber	Synthetics and Chemicals Ltd., Bombay	60,000*
14.	*p*-Nitrophenol	Catalyst (India) Ltd., Bombay	26,500*
15.	Optical whitening agent for synthetic fibres	Valia Bros. (P) Ltd., Bombay	10,000*
16.	Phenylacetic acid	Supranil Chemical Industries, Poona	10,000
17.	Polyurethane coatings	Cipy Chemicals, Poona	5,000
18.	Radiosonde thermistors	Bhagyanagar Laboratories, Hyderabad	5,000*
19.	Theophylline, aminophylline and caffeine	IDL Chemicals, Hyderabad	25,000**
20.	Vitamin B_6	I. D. P. L., Hyderabad	5,000*
		Total	4,03,000

* Part payment

** Negotiations regarding release are in progress.

5.2 *Royalties*

Sr. No.	Process	Name of the firm	Royalties received (Rs.)
1.	2-Amino-5-chloro benzophenone and 2-Methyl amino-5-chloro-benzophenone	Chemical Industrial and Pharmaceutical Laboratories Ltd., Bombay	123.00

Sr. No.	Process	Name of the firm	Royalties received (Rs.)
2.	Bostik sealants—substitute	Swastik Rubber Products Ltd., Poona	677.14
3.	Can sealing composition based on natural rubber	Arya Chemical Works, Calcutta	493.79
4.	Carbazole Dioxazine Violet pigment	Square Chemicals, Bombay	980.00
5.	Clofibrate	(1) Biological Evans Ltd., Hyderabad	2,436.00
		(2) Nivedita Chemicals Pvt. Ltd., Bombay	2,774.74
		(3) S. D's Lab-Chem Industry, Bombay	4.00
6.	Diazepam	S. D's Lab-Chem Industry, Bombay	21.00
7.	Ferrites—Hard	Semiconductors, Ltd., Poona	750.00
8.	Foundry core binder (Sinol core binder)	(1) Card-Chem Industries, Hyderabad	5.90
		(2) Wisca Chemicals, Bhavnagar	400.00
9.	Gum Arabic Substitute	(1) Karnataka Adhesives, Bangalore	106.80
		(2) Malvadkar Industries, Poona	289.49
10.	β-Ionone	Industrial Perfumes Ltd., Bombay	2,43,323.41
11.	Monoethylaniline	The Atul Products Ltd., Atul	39,605.86
12.	Nicotine sulphate from tobacco and tobacco waste	Urvakunj Nicotine Industries, Dharmaj	30,155.73
13.	Phenylacetic acid	Supranil Chemical Industries, Poona	75.00

Sr. No.	Process	Name of the firm	Royalties received (Rs.)
14.	D. C. Recording polarograph	(1) Chromatography and Instruments Co., Baroda	5,201.28
		(2) Elico Pvt. Ltd., Hyderabad	15,613.80
15.	Polystyrene DVB-base cation exchange resin	Bird and Co. Ltd., Calcutta	29,316.00
16.	Polyurethane printing rollers	Sree Saraswati Press Ltd., Calcutta	10,298.49
17.	Sachets — Hot and Cold	Thermo Chem Laboratories, Poona	0.80
		Vasant Industrial Corpn., Nagpur	113.25
18.	Vitamin C	Hindustan Antibiotics Ltd., Poona	865.23
		Total	3,83,630.71
		Total premia and royalties	7,86,630.71

6. LECTURES AND SEMINARS

Lectures

6.1 The following visiting scientists delivered lectures in the Laboratory

Scientist	Subject
1. Prof. Albert Padwa, State University of New York at Buffalo, N. Y. U. S. A.	1. Intramolecular 1,3-Dipolar cycloadditions. 2. Photochemical construction of heterocyclic compounds. 3. Synthetic heterocyclic chemistry.
2. Dr. J. B. Bapat, School of Chemical Science, University of East Anglia, U. K.	Puridine as a leaving group in organic synthesis.

Scientist	Subject
3. Prof. A Bukac, Instt. of Macromolecular Chemistry, Prague, Czechoslovakia.	Side reactions in anionic polymerization of lactams and oligomers of lactams.
4. Dr. H. Cederberg, Fine Chemicals, Uppsala, Sweden.	Gel filtration ion-exchange and affinity chromatography.
5. Dr. S. K. Date, Tata Institute of Fundamental Research, Bombay.	Recent developments in read-write applications with ferroelectric crystals.
6. Dr. K. E. Eriksson, Biochemical & Microbiological Research, Swedish Forest Products Res. Laboratory, Stockholm, Sweden.	1. Enzyme mechanism for degradation of lignocellulosic materials by the white rat fungus *sporotrichum pulverulentum*. 2. Fermentation process for the production of protein by *sporotrichum pulverulentum*
7. Prof. S. Hunig, Institute of Organic Chemistry, University of Wurzburg, West Germany.	1. Two step redoxy systems—a general structural principle. 2. Vinylogous radical ions—synthesis, electrochemical and spectral properties. 3. New results in the chemistry of benzenium ions. 4. Alkoxy-dizenium salts—expectations and surprises.
8. Prof. Ian Fleming, University of Cambridge, U.K.	1. Some uses of silicon compounds in organic chemistry. 2. The regioselectivity of Diels-Alder reactions.
9. Dr. (Mrs.) Kalindi Deshmukh Eli—Lilly Research Laboratories, Indiana, USA	Collagen metabolism.
10. Dr. A. D. Karve, Nimbkar Agricultural Research Instt. (NARI) Phalthan.	Sorghum improvement work at NARI.

Scientist	Subject
11. Prof. S. V. Kessar, Dept. of Chemistry, Punjab University, Chandigarh.	Current research interest.
12. Dr. S. P. Mahadik, Columbia University, New York.	Molecular organization of the synapse.
13. Dr. Marian Kocor, Polish Academy of Sciences, Instt. of Organic Chemistry, Warsaw, Poland.	1. Total synthesis of steroids-I. 2. Total synthesis of steroids-II. 3. Reactions of steroidal 3-oxo-polyenes. 4. Sesquiterpene lactones from genus Lactarius (mushrooms).
14. Dr. J. F. Mascarenhas, New York State University, USA.	Nitrogen fixation—a progress report.
15. Dr. B. Mawal, Ahmednagar College, Ahmednagar.	Galactrosyl transferase in Bovine milk.
16. Dr. G. Mehta, Dept. of Chemistry, Indian Institute of Technology, Kanpur.	1. Molecular games : Design of natural and universal products. 2. Novel isoprenoid rearrangements VIA observable carbocations. 3. Mechanism and stereochemistry of electrophilic additions to strained olefins.
17. Prof. Octave Levenspiel, Oregon State University, Corwallis, USA.	1. Basics of reaction design (2 lectures). 2. Packed bed reactions. 3. Fluidized bed, combination and incineration. 4. Flow patterns and mixing in the behaviours of chemical reactions. 5. Fermentation : An engineering approach.

Scientist	Subject
18. Mr. Peter Willamson, International Manager, Waters Associates, USA.	Modern aspect of high pressure liquid chromatography and its various applications.
19. Dr. A. N. Radhakrishnan, Wellcome Research University, Christian Medical College, Vellore.	Role of peptides in protein digestion.
20. Dr. S. S. Rao, Medical Research Society of Harkisandas Hospitals, Bombay.	Growth of mushrooms.
21. Prof. Robert Simha, Case Western Research University, Cleveland, Ohio, USA.	Viscosities of concentrated polymer solutions.
22. Dr. W. K. Smith, Unilever, U. K.	Some aspects of plant cell culture.
23. Dr. G. S. R. Subba Rao, Dept. of Organic Chemistry, Indian Institute of Science, Bangalore.	1. Dihydro-aromatics in synthesis. 2. Homogenous catalysis using transitional metal complexes : Some applications in the structure and synthesis.
24. Prof. B. Venkataraman, Tata Institute of Fundamental Research, Bombay.	Study of molecular motions on liquids through electron spin relaxation measurements.
25. Prof. Walter J. Gensler, Dept. of Chemistry, Boston University, Boston, USA.	1. Cord factor and related molecules. 2. Defunctionalized podophyllotoxin derivatives.

6.2 *The following NCL scientists delivered lectures at vaious institutes, universities, colleges, etc.*

Scientist	Subject	Venue
1. Dr. K. V. Datye	Colouring polyethylene terephthalate fibre and its blends with cellulosic fibre.	Bombay University Dept. of Chemical Technology, Bombay (K. H. Kabbur Memorial Silver Jubilee Lecture)

Scientist	Subject	Venue
2. Dr. A. Goswami	Thin films and their application	Sardar Patel University, Gujarat
3. Mr. N. S. Iyer	Import procedures	Poona Vidyarthi Graha, Poona (Course on stores & purchase managment)
4. Dr.V.Jagannathan	Plant tissue culture and agriculture	Central Food Technological Research Institute, Mysore
	R & D in Biochemistry	Bhabha Atomic Research Centre, Bombay
	Aspects of brain function	National Botanical Garden, Lucknow
	Plant cells and basic problems in biology	Tata Institute of Fundamental Research, Bombay
5. Dr. S. L. Kapur	Nitrile rubber	University of Baroda, Baroda
6. Mr. A. M. Lele	Sulphuric acid and related industrial development (in Marathi)	Maharashtra Vidyalaya, Poona
	PERT Programming	Garware College of Commerce, Poona
	Prospects of being a self employed entrepreneur	Shivaji University, Kolhapur
7. Dr. A. F. Mascarenhas	Plant tissue culture	Sugarcane Researh Station, Padegaon, Dist. Poona
8. Dr. R. A. Mashelkar	Mass transport phenomena in Non-Newtonian fluids	Bombay University Dept. of Chemical Technolgy,. Bombay
9. Dr. L. M. Pant	Direct methods in crystallography (6 lectures)	Regional Research Laboratory, Hyderabad

	Scientist	Subject	Venue
10.	Dr. P. N. Rangachari	Bacterial leaching of ores	St. Xavier's College, Bombay
		Enzymes (12 lectures)	Maharashtra Association for the Cultivation of Science, Poona
		Industrial fermentation (6 lectures)	Maharashtra Association for the Cultivation of Science, Poona
11.	Dr. P. K. Ranjeker	Repetitive DNA in Eucaryotes (2 lectures)	Virus Research Institute, Poona
12.	Dr. J. C. Sadana	Biochemistry of cellulose breakdown and utilization of cellulose as feeds and for proteins	Association of Microbiologists of India, Manipal (17th Annual Conference)
13.	Dr. A. P. B. Sinha	Solar energy	Fergusson College, Poona
14.	Dr. C. Siva Raman	Biophysical methods in virology	Virus Research Institute, Poona
		Ultra centrifugation electrophoresis and gel filtration	Virus Research Institute, Poona
		Immobilized enzymes	Annual Convention of Association of Microbiologists of India, Manipal
15.	Dr. B. D. Tilak	National goals and R & D Programming	Bombay University Dept. of Chemical Technology, Bombay (K. H. Kabbur Memorial Lecture)
		Integrated rural development	Futurology Workshop, IIT, Bombay
		Integrated rural development through Science and Technology	Machnur
		—do—	University of Poona, Poona
		—do—	Indian Chemical Manufacturers' Association, Baroda. (Rajmitra B. D. Amin Memorial lecture)

7. STAFF STRENGTH * (as on 31-3-1977)

1.	Scientific		
	(i)	Director	1
	(ii)	Dy. Director	1
	(iii)	Scientist F	4
	(iv)	Scientist E	19
	(v)	Scientist C	70
	(vi)	Scientist B	64
	(vii)	Scientist A	35
	(viii)	S. S. A.	84
	(ix)	J. S. A.	39
	(x)	S. L. A. **	75
		Total	392
2.	Technical		234
3.	Administration		105
4.	Class IV technical		146
5.	Class IV non-technical		85
		Total (1—5)	962
6.	Research fellows, Pool Officers, Guest Workers and Graduate Trainees		
	(a)	JRFs and SRFs	58
	(b)	Post-doctoral research fellows	2
	(c)	CSIR Pool Officers	4
	(d)	Guest Workers	3
	(e)	Graduate Trainees	11
		Total	78
7.	Scientific staff working on sponsored projects		
	(a)	NCL staff deputed on sponsored projects	3
	(b)	Staff specially appointed by the sponsor	4
		Total	7

* This denotes Staff in position

** Senior Laboratory Assistants (S. L. A.'s) are included under 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. S. L. Kapur was awarded the 'Dr. K. G. Naik Gold Medal for the year 1975' by the M. S. University of Baroda, for contribution to industrial research particularly in the field of polymer chemistry.

(2) Prof. K. Venkataraman, Scientist Emeritus, was awarded 'Silver Jubilee Award' by the Dyestuffs Manufacturers, Association of India for his pioneering contribution to the Indian dyestuff industry.

(3) Dr. L. K. Doraiswamy was elected Fellow of the Indian National Science Academy.

(4) Dr. B. D. Tilak was invited by the Bombay University to deliver 'K. H. Kabbur Memorial Lecture' and by the Indian Chemical Manufacturers, Association to deliver the 'Rajamitra B. D. Amin Memorial Lecture'.

(5) Prof. K. Venkataraman, Scientist Emeritus, was elected foreign member of the USSR Academy of Sciences.

8·2 *Deputation/Training, etc.*

1. Dr. L. K. Doraiswamy visited Iraq as a member of Indian Delegation (May 1976).
2. Dr. A. Goswami was deputed to West Germany under the CSIR-DAAD exchange programme to study structure and physics of thin films (October 1976-November 1976)
3. Dr. S. S. Mahajan has been deputed to Czechoslovakia to take up post doctoral studies under the UNESCO course in Macromolecular chemistry (9 months from October 1976)
4. Dr. L. K. Doraiswamy has been deputed to take up an assignment as Visiting Professor at the University of Wisconsin (6 months from January 1977)
5. Mr. J. C. Sehra has been deputed to U. K. under the CSIR-British Council exchange programme to study recent advances in the chemistry and technology of polymers (for 3 months from January 1977)
6. Dr. R. B. Mitra has been deputed to USA under India-USA exchange programme to study the latest developments in the field of synthetic organic chemistry and technology of drugs, intermediates and pesticides (March 1977—May 1977)

7. Mr. I. I. Sutar was deputed to attend a refresher course in 'Microbiology and cell biology' at Indian Institute of Science, Bangalore (June 1976-July 1976)
8. Mr. J. D. Patil was deputed to Tata Institute of Fundamental Research, Bombay for participation in the 'Recent on-line data transmission demonstration' (September 1976)
9. Mr. R. K. Dhingra attended a course on Purchasing Management at National Institute for Training in Industrial Engineering, Bombay (2 weeks from 31st January 1977)
10. Mr. C. U. Saraf was deputed to attend a course on 'Managerial skills for technical personnel' at National Institute for Training in Industrial Engineering, Bombay (February 1977)
11. Dr. (Miss) Lalithambika was deputed to BARC, Bombay for training and familiarization course in atomic absorption spectrophotometry, quantitative emission spectrography, anodic stripping analysis, spark emission mass spectrometry and x-ray fluorescence analysis (March 1977)

8.3 *Participation in seminars/symposia, conferences etc., by NCL scientists*

Seminar/symposia/conferences etc.	Scientists
1. Third National Symposium on Catalysis, Dehradun	Dr. V. R. Choudhary
2. Textile Conference, Bombay	Dr. K. V. Datye
3. International Symposium on 'Solid State Physics', Calcutta	Dr. A. Goswami
4. Meeting convened by Controller of Inspection (Ammunition, Min. of Defence) in connection with the problem of polystyrene material in ammunition stores	Dr. S. Gundiah
5. Symposium on 'Recent developments in the chemistry of isoprenoids', Andhra University, Waltair	Mr. P. K. Jadhav
6. Seminar on 'Industrial Microbiology', Baroda	Dr. V. Jagannathan
7. Second 'Tissue Culture' Conference, Lucknow	Dr. V. Jagannathan Dr. A. F. Mascarenhas Dr. K. V. Krishnamurthy
8. All India Seminar on 'Molecular interactions', Tirupati	Dr. C. I. Jose

Seminar/eymposia/conferences etc.		Scientists
9.	Seminar on ' Lac-Chemistry and utilization ', Ranchi	Dr. S. L. Kapur
10.	Internationl symposium on ' New fibres and composites ', Madras	Dr. S. L. Kapur
11.	International symposium on ' Bioconversion of cellulose to chemicals, energy and microbial proteins ', Delhi	Dr. N. G. Karanth
12.	International symposium on ' Bioconversion of cellulosic materials into energy ', Delhi	Dr. (Mrs.) Mala Rao Dr. (Mrs.) V. V. Deshpande
13.	National Seminar on ' Genetics and wheat improvement ', Ludhiana	Dr. A. F. Mascarenhas
14.	Symposium on ' Non-Newtonian liquid processing ', Bombay	Dr. R. A. Mashelkar
15.	Seminar on ' Electronic and special ceramic materials ', Hyderabad	Dr. M. N. S. Murthy
16.	Seminar on ' Parthenium a positive danger ', Bangalore	Dr. B. A. Nagasampagi
17.	Symposium on ' Chemical reaction engineering ', Bangalore	Dr. V. S. Patwardhan
18.	All India seminar on 'High Polymers', Madras	Dr. S. Prakash Rao Mr. S. Ponrathnam
19.	Symposium on 'Telecommunications and meteorology', Poona	Mr. K. J. Rao
20.	Get together of Biochemists, Lucknow	Dr. J. C. Sadana
21.	17th Annual Conference of Microbiogists of India, Manipal	Dr. J. C. Sadana
22.	Advisory group meeting on Biological nitrogen fixation, Bombay	Dr. J. C. Sadana
23.	Symposium on 'Insects and environment ', Delhi	Dr. R. N. Sharma Dr. B. A. Nagasampagi
24.	Second Symposium on 'Oriental Entomology', Madras	Dr. R. N. Sharma
25.	Seventh All India IASLIC Seminar, Burdwan	Mr. R. S. Singh

Seminar/symposia/conferences etc.		Scientists
26.	Third meeting of the Fermentation Panel, Bombay	Dr. M. C. Srinivasan
27.	AIMO Seminar on 'Recovery and reuse of useful materials from pollutants', Bombay	Dr. B. D. Tilak
28.	Seminar on 'Non-formal Education', Poona	Dr. B. D. Tilak

8.4 *Membership of Committees*

	Scientists	Position	& name of the Committee
1.	Dr. L. K. Doraiswamy	Convener	Chemical Engineering Research Committee, CSIR, New Delhi
		Member	Research Review Committee, Dept. of Chem .Eng. Indian Institute of Science, Bangalore
2.	Dr. S. L. Kapur	Member	Scientific Advisory Committee, Coir Board, Cochin
		Member	Board of Studies in applied chemistry, University of Cochin
		Member	Council of Indian Rubber Manufacturers Research Association, Bombay
3.	Mr. M. V. Kunte	Member	Committee to go into the alcohol requirement of The SIRSILK Ltd., Hyderabad
4.	Dr. J. C. Sadana	Member	Advisory Group on Biological Nitrogen Fixation, Science and Engineering Council, Deptt. of Science and Technology, New Delhi
		Member	Guha Research Conference, Chorwad (Gujarat)
5.	Dr. C. Siva Raman	Member	Indian Academy of Sciences, Bangalore

Scientists	Position & name of the Committee
6. Dr. B. D. Tilak	Chairman Board of Directors, Hindustan Organic Chemicals,Rasayani (upto 30-9-76)
	Chairman NCST Futurology Panel, New Delhi
	Director Board of Directors, Forest Development Corporation of Maharashtra Ltd., Nagpur
	Member Board of Diretors, Hindustan Antibiotics Ltd., Pimpri,Poona (upto30-9-76)
	Member National Committee on Science and Technology (NCST), New Delhi
	Member Defence R & D Council, Ministry of Defence, New Delhi
	Member Maharashtra State High Level Coordination Committee for Scientific and Technological Research and its Utilization, Bombay
	Member Study Group for Chemical and Chem. Eng. appointed by the Maharashtra State High Level Coordination Committee for Sci. and Tech. Research and its Utilization, Bombay
	Member Maharashtra State Planning and Development Council, Bombay
	Member Maharashtra State Industrial Research Committee, Bombay
	Member Propellant Factory Committee, Ministry of Defence, New Delhi

8.5 *Post graduate degrees received by NCL staff members and research fellows/guest workers*

Sr. No.	Name	Degree	University	Subject of thesis	Guide
1.	Miss C. D. Barsode	Ph. D.	Poona	Studies on organotin (IV) substituted oxinates	Dr. D. N. Sen
2.	Mr. J. S. Bhomrah	Ph. D.	Poona	Studies on absorption properties of transition metal zeolites	Dr. (Miss) S. B. Kulkarni
3.	Mr. D. K. Dandge	Ph. D.	Poona	Studies in syntheses of isocyanates and polymers using isocyanates	Dr. N. D. Ghatge
4.	Mr. K. J. Divakar	Ph. D.	Poona	Synthesis of terpenoids having α, β -unsaturated ketone, lactone and related functional groups	Dr. A. S. Rao
5.	Mr. K. B. Gujar	Ph. D.	Poona	Studies in syntheses and evaluation of polyurethane polymers (rigid foams)	Dr. N. D. Ghatge
6.	Mr. R. R. Khandekar	Ph. D.	Poona	Structural, electrical and optical properties of some semi-conducting chalcogenides	Dr. A. P. B. Sinha
7.	Mr. M. G. Parande	M. Sc.	Poona	Gas chromatographic study of transport properties under reaction conditions for the system : Reduction of nitrobenzene to aniline on copper chromate	Dr. V. R. Choudhury

Sr. No.	Name	Degree	University	Subject of thesis	Guide
8.	Mr. S. Radhakrishnan	Ph. D.	Poona	Semi-conducting and other properties of thin films	Dr. A. Goswami
9.	Mr. R. Shankarnarayan	Ph. D.	Poona	Studies in sesquiterpenes	Dr. Sukh Dev
10.	Mr. K. A. R. Shastry	Ph. D.	Bombay	Synthesis of heterocyclic compounds containing nitrogen and sulphur	Dr. B. D. Tilak
11.	Mr. V. P. Shiralkar	M. Sc.	Poona	Studies on physico-chemical properties of synthetic zeolites	Dr. (Miss) S. B. Kulkarni
12.	Mr. A. R. Vaidya	Ph. D.	Poona	Synthesis of heterocyclic compounds	Dr. B. D. Tilak
13.	Mr. H. G. Vartak	Ph. D.	Poona	Proteinase inhibitors	Dr. V. Jagannathan

8.6 *NCL scientists recognized by different universities as research guides*

1.	Dr. Ayyangar, N. R.		Poona
2.*	Dr. Chakravarti, K. K.		Bombay, Karnatak, Poona, Shivaji
3.	Dr. Choudhary, V. R.		Poona
4.	Dr. Damodaran, V.		Poona Shri Venkateswara
5.	Dr. Das, K. G.		Bombay, Kalyani, Kerala, Marathwada, Poona
6.	Dr. Doraiswamy, L. K.		Bombay, Calcutta, Jadavpur, Nagpur, Poona
7.	Dr. Ghatge, B. B.		Poona
8.	Dr. Ghatge, N. D.		Bombay, Poona, Shivaji
9.	Dr. Gogte, V. N.		Poona, Shivaji
10.	Dr. Gokarn, A. N.		Poona
11.	Dr. Gopinathan, C.		Poona
12.	Dr. Goswami, A.		Poona, Shivaji
13.	Dr. Ingle, T. R.		Poona, Shivaji
14.	Dr. Jagannathan, V.		Baroda, Bombay, Poona
15.	Dr. Jose, C. I.		Poona
16.	Dr. Joshi, R. M.		Bombay, Poona
17.	Dr. Kapur, S. L.		Bombay, Poona, Punjab
18.	Dr. Katti, S. S.		Bombay, Poona
19.	Dr. Kulkarni, G. H.		Nagpur
20.	Dr. Kulkarni (Miss), S. B.		Poona
21.	Dr. Kulkarni, S. N.		Bombay, Karnatak, Poona, Shivaji
22.	Dr. Mascarenhas, A. F.		Poona
23.	Dr. Mitra, R. B.		Poona
24.	Dr. Nair, P. M.		Andhra, Poona, Shivaji
25.	Dr. Nagasampagi, B. A.		Poona
26.	Dr. Nanavati, D. D.		Bombay
27.*	Dr. Narayanan, C. R.		A. B. Uni. Zaria-Nigeria, Bombay, Poona
28.	Dr. Nayak, U. R.		Poona
29.*	Dr. Pai, M. U.		Bombay
30.	Dr. Pansare, V. S.		Poona
31.	Dr. Panse, G. T.		Poona, Shivaji

32.	Dr. Pant, L. M.	Poona
33.	Dr. Rama Rao, A. V.	Bombay, Poona, Shivaji
34.	Dr. Rangachari, P. N.	Poona, Shivaji
35.	Dr. Ranjekar, P. K.	Poona
36.	Dr. Rao, A. S.	Bombay, Poona, Shivaji
37.	Dr. Ravindranathan, T.	Bombay
38.	Dr. Roy Chowdhury, P.	Marathwada, Poona, Shivaji
39.	Dr. Sadana, J. C.	Aligarh, Poona
40.	Dr. Sen, D. N.	Bombay, Poona
41.	Dr. Sethi, S. C.	Poona
42.	Dr. Sharma, R. N.	Shivaji
43.	Dr. Sinha, A. P. B.	Banaras, Bombay, Poona
44.	Dr. Siva Raman, C.	Poona
45.	Dr. Tilak, B. D.	Bombay, Nagpur, Poona, Shivaji
46.*	Dr. Venkataraman, K.	Banaras, Bombay, Karnatak, Madras, Poona

* Retired/Emeritus scientists

8.7 *Consultancy*

During the year institutional consultancy was offered to the following firms through individual scientists wherein 4 scientists were involved.

1. Arlabs, Bombay
2. Dujodwala Industries, Bombay
3. Hindustan Ferodo Ltd., Bombay
4. Mafatlal Services Ltd., Bombay
5. Sahyadri Dyestuffs and Chemicals Ltd., Poona

9. PUBLICATIONS

9.1 *Papers published*

Studies in chemical engineering

1. Doraiswamy, L. K. and Kulkarni, B. D.
   Effectiveness factors in gas-liquid reactions : the general nth order case.
   A. I. Ch. E., **22**, 597 (1976)

2. Rajadyaksha, R. A., Vasudeva, K. and Doraiswamy, L. K.
   Effectiveness factors in Langmuir-Hinshelwood and general order kinetics.
   J. Catalysis, **41**, 61 (1976)

3. Ramaswamy, V.
   Thermodynamic properties of nitromethane.
   Ind. J. Technology, **14**, 206 (1976)

4. Mantri, V. B., Gokarn, A. N. and Doraiswamy, L. K.
   Analysis of gas-solid reactions : formulation of a general model.
   Chem. Eng. Sci., **31**, 779 (1976)

*5. Acharya, A., Mashelkar, R. A. and Ulbrecht, J.
   Flow of inelastic and viscoelastic fluids past a sphere (I). Drag coefficient in creeping and boundary layer flows.
   Rheol. Acta., **15**, 454 (1976)

*6. Acharya, A., Mashelkar, R. A. and Ulbrecht, J.
   Flow of inelastic and viscoelastic fluids past a sphere (II). Anomatons separation in the viscoelastic fluid flow.
   Rheol. Acta., **15**, 471 (1976)

7. Mashelkar, R. A.
   Gas-liquid contactors in non-Newtonian technology.
   Chem. Ind. Dev., **10**, 17 (1976)

8. Tamhankar, S. S.
   Kinetic study of the solid-state reaction between phthalic anhydride and *p*-nitroaniline.
   Can. J. Chem. Engg., **54**, 655 (1976)

9. Choudhary, V. R.
   Liquid phase methods for the measurement of surface properties of solid catalysts and adsorbents.
   J. Sci. and Ind. Res., **35**, 213 (1976)

*10. Choudhary, V. R. and Menon, P. G.
   Gas chromatographic determination of heats of adsorption and effective diffusivities of C_5–C_8 hydrocarbons in commercial Pt-Al catalyst.
   J. Chromatography, **116**, 431 (1976)

11. Ramaswamy, V. and Balakrishnan, S.

Psycrometric chart of the benzene-hydrogen chloride system.

Chem. Ind. Dev., **10** (7), 61 (1976)

12. Prasad, S. D. and Doraiswamy, L. K.

The adsorption integral equation : a new method of solution.

Physics Letters A, **60** (**1**), 11 (1977)

*13. Brown, R. G., Choudhari, R. V. and Davidson, J. M.

The reaction of metal-ion complexes with hydrocarbons, part 4 : formation of complexes of the types di-μ-acetato-bis [(η^3-allyl) palladium] and tetra-μ-acetato-di (η^3-allyl) tripalladium by reaction of mono-olefins and 1, 3-dienes with palladium acetate.

J. Chem. Soc. (*Datton Trans.*), 176 (1977)

*14. Brown, R. G., Chaudhari, R. V. and Davidson, J. M.

The reactions of metal-ion complexes with hydrocarbons, Part 5 : some catalytic reactions of palladium acetate and its derivatives : the oxidations of cyclohexene, cyclo-octene, 3, 3-dimethylbut-l-ene and n-hexenes, and the isomerization of linear alkene derivatives.

J. Chem. Soc. (*Datton Trans.*), 183 (1977)

15. Choudhary, V. R.

Fluorine promoted catalysts : activity and surface properties.

Ind. & Eng. Chem., Product Res. Dev., **16**, 12 (1977)

16. Choudhari, V. R. and Parande, M. G.

Gas chromatographic study of binary diffusion of nitrobenzene and aniline in hydrogen.

J. Chromatography., **132**, 344 (1977)

Pesticides and agrochemicals

17. Das, K. G. and Thayumanavan, B.

Screening methods for estimating some common pesticides in India.

J. Sci. Ind. Res., **34**, 636 (1975)

Utilization of plant, forest and marine products

18. Abhyankar, S. M. and Nanavati, D. D.

Economic utilization of agricultural residues and other forest products.

Chemical Engineering World, **11**, 55 (1976)

19. Nanavati, D. D.

Polyester of *Celastrus paniculatus* Willd.

The Journal of Oil Technologisis Association of India, **8** (**4**), 129 (1976)

Studies in organic chemistry

20. Rao, A. S. and Chaudhari, P. N.

Stereochemistry of epoxidation and hydrogenation of 1-methyl-2-*trans*-benzalcyclohexanol and 1-benzyl-2-*trans*-benzalcyclohexynol.

Ind. J. Chem., **14B**, 165 (1976)

21. Chaudhari, P. N., Siscovic, E. and Rao, A. S.

Dihydrobromination of ar-bromodihydroturmerone : a convenient preparation of 2-methyl-6-*p*-tolyl-5 (E)-hepton-4-one.

Ind. J. Chem., **14B**, 472 (1976)

22. Kulkarni, B. D. and Rao, A. S.

Action of lead (IV) acetate on sodium glycidates : a convenient route for the preparation of α-acetoxylaldehydes.

Synthesis, 454 (1976)

23. Nanavati, D. D.

High temperature fusion of castor oil with caustic soda : a critical study.

J. Sci & Ind. Res, **March**, 163 (1976)

24. Divakar, K. J. and Rao, A. S.

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J. phy. Chem., **81**, 17 (1977)

Plant and animal tissue culture

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Purification and properties of ox brain nicotinamide adenine dinucleotide (phosphate) glycohydrolase.
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Enzyme technology

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New trends in fermentation engineering.
Hindu (Madras)—Survey of Indian Industry (1976)
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73. Mascarenhas, A. F.
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Science Today, **10**, 13 (1976)

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NCL in the Service of the Nation,
Journal of Industry and Trade **26**, 44 (1976)

9.2 *Papers presented at symposia, seminars etc.*

1. Nagasampagi, B. A.

The chemical and clinical aspects of *Parthenium hysterophorus.*
Seminar on '*Parthenium*-a positive danger',
Bangalore, April, 1976.

2. Prabhakara Rao, S., Ponarathnam, S. and Kapur, S. L.

The applicability of Kelen-Tudos method for the evaluation of monomer activity ratios in high conversions copolymerization.
All India Seminar on 'High polymers', Madras,
August, 1976.

3. Ponarathnam, S., Prabhakara Rao, S. and Kapur, S. L.

Reactivity ratios of ionizing monomers in aqueous solutions, copolymerization of acrylic and methacrylic acid with acrylamide.
All India Seminar on 'High polymers', Madras,
August 1976,

4. Bastawade, K. B., Deshpande (Mrs.), V. V., Joglekar (Miss), A. V., Lakshmi Kantham, B. C., Mishra (Mrs.), C., Phansalkar (Miss), S. B., Rao (Mrs.), M., Seeta (Miss), R., Sahasrabudhe (Mrs.), N. A., Srinivasan, M. C. and Jagannathan, V.

Cellulolytic enzymes.
Seminar on 'Industrial microbiology',
Baroda, November, 1976.

5. Srinivasan, M. C.

Application of enzymes in various industries.
Third meeting of the fermentation panel,
Bombay, November, 1976.

6. Ranjekar, P. K.

Isolation and characterization of cucumber (*cucumis sativus*) satellite DNAs.
Annual meeting of the Society of Biological Chemists of India, Hyderabad, November, 1976.

7. Murthy, M. N. S., Deshpande, C. E. and Shrotri (Mrs.), J. A.

Synthesis of manganous zinc ferrites.
Seminar on 'Electronic and Ceramic materials',
Hyderabad, November, 1976.

8. Jadhav, P. K. and Nayak, U. R.

Unique oxidative decarboxylation by lead tetraacetate to cyclopropane : Formation of *Nor*-longicyclene from longifolic acids.

Symposium on 'Recent development in the chemistry of isoprenoids', Waltair, December, 1976.

9. Jadhav, P. K. and Nayak, U. R.

Novel hypoiodite functionalization of longifolol : Synthesis of sesquiterpenes from *Juniperus conferta.*
Symposium on 'Recent developments in the chemistry of isoprenoids,' Waltair, December, 1976.

10. Sadana, J. C. and Shewale, J. G.

Biochemistry of cellulose degradation and cellulose utilization for feeds and for protein.
Seventeenth Annual Conference of Association of Microbiologists of India, Manipal, December, 1976.

11. Patwardhan, V. S.

Effective interfacial area in a packed bed—a model for liquid flow.
Symposium on 'Chemical reaction engineering',
Bangalore, December, 1976.

12. Singh, R. S.

Information and documentation services in chemistry and chemical technology.
Seventh All India IASLIC seminar, Burdwan, December, 1976.

13. Sharma, R. N., Nagasampagi, B. A., Kasturi Rangachar, S., Hebbalkar, D. S. and Joshi (Miss), V. N.

Investigation on the occurrence and role of Antiallatotropins in some plants and insects and their effects on insect development and host-plant relationships.
Symposium on 'Insects and environment', Delhi, February, 1977.

14. Bastawade, K. B., Deshpande (Mrs.), V. V., Joglekar (Miss), A. V. Lakshmi Kantham (Miss), B. C., Mishra (Mrs.), C. Phansalkar (Miss), S. B., Rao (Mrs.), M., Seeta (Miss), R., Srininivasan, M. C. and Jagannathan, V.

Enzymic hydrolysis of celluloses.
International Symposium on 'Bioconversion of cellulosic materials into energy', Delhi, February, 1977.

15. Bastawade, K. B., Deshpande (Mrs.), V. V., Joglekar (Miss), A. V., Lakshmi Kantham (Miss), B. C., Mishra (Mrs.), C., Phansalkar

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Cellulolytic enzymes of *penicillium* strain.
International symposium on ' Biconversion of cellulosic materials into energy', Delhi, February, 1977.

16. Jagannathan, V., Mascarenhas, A. F., Hendre, R. R., Nadgir, A. L., Bodhe, A. M., Patil, B. G., Kulkarni, D. D., Kulkarni, V. M. and Prabhu (Miss), R. A.

Studies on some applied aspecst of plant tissue culture.
Second Plant tissue culture Conference, Lucknow, February, 1977.

17. Jagannathan, V., Krishnamachar, V. S., Mascarenhas, A. F., Godbole, D. A., Hendre, R. R. and Kulkarni V. M.

Studies on protoplast isolation and somatic hybridization.
Second plant tissue culture Conference, Lucknow, February, 1977.

18. Jose, C. I. and Agashe (Miss), M. S.

Characteristic vibrations of -N $(CH_3)_2$ and $N^+(CH_3)_3$ groups in dimethyl aminophenols and their methiodides.
All India Seminar on ' Molecular interactions', Tirupati, February, 1977.

19. Tilak, B. D.,

Prospect of manufacture of industrial chemicals from cellulosic raw materials.
International Symposium on ' Bioconversion, of cellulosic substances into energy, chemicals and microbial proteins, Delhi, February, 1977.

20. Mascarenhas, A. F., Hendre, R. R., Tarkunde, A. B., Kulkarni, D. D., Patil, B. G., Prabhu (Miss), R. A. and Jagannathan, V.

Innovative approaches in wheat genetic studies.
National Seminar on ' Genetics and wheat improvement ', Ludhiana, February, 1977

21. Rao, K. J.

Optical communications in meteorology.
Symposium on ' Telecommunication and meteorology,' Poona, February, 1977.

22. Bhomrah, J. S. and Kulkarni (Miss), S. B.,
Structural studies of ion-exchanged zeolites.
' Third national symposium on catalysis ', Dehra Dun, March, 1977.

23. Nagasampagi, B. A., Sharma, R. N., Kasturi Rangachar, S., Joshi (Miss), V. N. and Hebbalkar, D. S.
The general resistance of *Parthenium hysterophorus* to insect attack. Elucidation of chemical factors by studying the effects of various chemical constituents on different insects.
Second symposium on ' Oriental entomology', Madras, March, 1977.

24. Tilak, B. D.
Recovery of marketable products from industrial pollutants.
AIMO seminar on 'Recovery, and reuse of useful materials from pollutants', Bombay, March, 1977.

25. Choudhary, V. R.
Gas chromatographic study of adsorption on copper chromate catalysis : I—Adsorption of hydrogen.
Third national symposium on catalysis, Dehra Dun, March,, 1977.

10. PATENTS IN FORCE

10.1 *Indian patents sealed*

1. **77225***
A process for the preparation of β-ionone from pseudoionone.
Joshi, B. N., Chakravarti, K. K., Shah, R. C. and Bhattacharyya S. C.

2. **81072**
Improvements in or relating to the preparation and production of catalysts for the hydrogenation of organic substance with particular reference to fatty oils.
Murthy, M. N. S. and Biswas, A. B.

3. **82822**
A process for the manufacture of high alpha cellulose dissolving grade pulps by alkaline pulping methods.
Vyas, G. M., Bendale, D. S. and Mahajan, M. B.

4. **86541***
A reactor for carrying out highly exothermic and explosive reactions particularly suited for chlorination of methane.
Mukherjee, S. P., Deshpande, A. D., Potnis, G. V. and Pai, M. U.

5. **86991***

Preparation of polyurethane printing rollers.

Ghatge, N. D. and Kapur, S. L.

6. **94766**

Improvements in or relating to the preparation of jatamansi root oil and isolation of a coumarin constituent therefrom.

Unni, I. R., Maheshwari, M. L., Paknikar, S. K. and Bhattacharyya, S. C.

7. **98155***

An improved method for the hydration of sulphonated mixtures of vinyl copolymer beads containing 90-95% sulphuric acid and the sulphonated vinyl copolymer beads.

Kapur, S. L., and Ramakrishnan, K.

8. **98156***

Preparation of solvent modified copolymers of vinyl monomers in bead form.

Kapur, S. L. and Ramakrishnan, K.

9. **117210**

A direct process for the manufacture of dibutyltin diiodide and of the oxide therefrom.

Gupta, J., Gopinathan, C., Gopinathan (Mrs.), S. and Awasarkar, P. A.

10. **123638**

Improvements in or relating to the manufacture of cashewnut shell gum (CNS-gum).

Ingle, T. R., Vaidya, S. H. and Pai, M. U.

11. **126354**

A process for obtaining useful steroids from a new plant source.

Sukh Dev, Patil, V. D. and Nayak, U. R.

12. **126393***

An improved method for the manufacture of calcium hypophosphite.

Goswami, M., Lobo, J. and Brahme, P. H.

13. **127743**

A process for obtaining colchicine from a new plant source.

Kapadia, V. H., Sukh Dev and Rao, R. S.

14. **127750**

A proeess for production of pyridoxine hydrochloride.

Joshi, C. G. and Sukh Dev.

15. **130254**

A process for the manufacture of vulcanizable graft copolymer for use as synthetic rubber and as a base in coating compositions.

Joshi, R. M.

16. **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.

17. **131606**

Improvements in or related to a process for the preparation of gamma ferric oxide.

Lakhbir Singh, Chavan, A. M. and Kotasthane, A. N.

18. **134641***

A device for warming and cooling.

Lakhbir Singh and Kotasthane, A. N.

19. **136418**

Inprovement in or relating to the preparation of new reactive dyes.

Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

20. **136419**

New dyes containing azido groups for cellulosic protein and synthetic fibres.

Ayyangar, N. R., Badami, N. V., Daruwalla, E. H. and Tilak, B. D.

21. **137096**

A new process for the halogenation of copper phthalocyanine.

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

22. **137999 (2232/72)**

Process for the preparation of D-galactose from cashewnut shells.

Ingle, T. R., Vaidya, S. H. and Pai, M. U.

* These patents (7) have been released for exploitation.

10.2 *Indian patents filed*

1. **67513**

   Improvements in or relating to the separation of niobium and tantalum from each other by liquid-liquid extraction.

   Sarma B. and Gupta, J.

2. **113703**

   Improvements in or relating to magnesium zinc ferrites.

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

3. **225872** (Cognates application No. 2229/72)

   Improvements in or relating to the preparation of new reactive dyes.

   Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

4. **2259/72** (Cognates application No. 2235/72)

   Improvements in or relating to the preparation of new reactive dyes.

   Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

5. **1107**/Cal/73

   Improvements in or relating to the preparation of new reactive dyes containing azido acetylamide groups.

   Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

6. **2642**/Cal/73

   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.

7. **2687**/Cal/73

   Method of preparing phosphites metal salts from 3-pentadecyl phenol for use as stabilizers for polymers such as PVC.

   Vernekar, S. P. and Ghatge, N. D.

8. **1630**/Cal/74

   Improvements in and relating to the preparation of synthetic cryolite from fluorspar.

   Damodaran, V., Lobo, J., Padalkar, S. R., Harisangam, S. R. and Dorai, C. S.

9. **417**/Cal/75

   Preparation of aminopolyols using CNSL and making polyurethane rigid foams.

   Ghatge, N. D. and Gujar, K. B.

10. **917**/Cal/75

    Improvements in or relating to the preparation of new dyes containing heterocyclic quinonoid systems.

    Ayyangar, N. R., Purao, S. R. and Tilak, B. D.

11. **1724**/Cal/75

    A process for obtaining the hydrocarbon fraction of the essential oil of *Cedrus deodara*.

    Bose, J. L., Subba Rao, K. and Sukh Dev.

12. **1841**/Cal/75

    Protective blanket for galvanizing baths.

    Lakhbir Singh.

13. **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., Wagle, D. R.

14. **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.

15. **1758**/Cal/76**

    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.

16. **23**/DEL/76**

    Improvements in or relating to a process for hydrogenation of glucose.

    Brahme, P. H. and Verma, R. P.

17. **48**/DEL/77**

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

** These patents have been newly filed during the year.

10.3 *Foreign patents in force*

1. U. S. A. Patent No. 3070625

A process for the preparation of azelaic acid semi-ester
making civetone dicarboxylic acid (corr. to Indian Patent
Nayak, U. G., Chakravarti, K. K. and Bhattacharyya, S

2. U. S. A. Patent No. 2946783

Preparation of costus root oil and the production thereof
Indian Patent No. 59853).
Kelkar, G. R. and Bhattacharyya, S. C.

3. Cuba Patent No. 149082

Manufacture of nico'ine sulphate from tobacco or tob
(ccrr. to Indian Patent No. 45666).
Gedeon, J. and Goswami, M.

118

RESEARCH UTILIZATION

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

(T-Metric tons)

Sr. No.	Name of the process/product (Indian patent No.)	Field of utilization	Name of the manufacturer (Year of commencement of production)	Production		Capacity installed, Nature of release and Remarks
				1976-77 Qty/Value Rs. in lakhs	Upto March 76 Qty/Value Rs. in lakhs	
1	2	3	4	5	6	7
1.	Acetanilide	Intermediate	Hindustan Organic Chemicals Ltd., P. O. Rasayni-410207 (through project engineers M/s R. L. Dalal & Co., Bombay 400018) (1969)	1166.00 T 168.00	9630.49 T 1075.34	2000 T Non-exclusive
2.	Acriflavine	Pharmaceuticals	Western India Fine Chemicals, 38 Agra Road, Mulund (West), Bombay 400080 (1969)	— —	6.50 T 30.67	N. A. Sponsored
3.	Adhesives for decorative laminates	Laminates	Swastik Rubber Products Ltd., Swastik House, Khadki, Poona 411003 (1969)	0.08 T 1.32	76.70 T 9.21	36 T Sponsored

1	2	3	4	5	6	7
4.	Antipriming compositions	Antirpiming in locomotives	Research, Designs and Standards Organization, M & C Wing, Lucknow 226011 (1964)	8.00 T 0.32	129.14 T 12.58	26 T Non-exclusive
5.	Bacterial diastase	Textile desizing	Chemaux (P) Ltd., Rang Udyan, Sitaladevi Temple Road, Mahim, Bombay 400016 (1967)	11.7 T 0.98	383.67 T 21.88	450 T Non-exclusive
6.	Berberine hydrochloride	Pharmaceuticals	Nitin Pharmaceuticals, 180/82, Samuel Street, Bombay 400009 (1965)	— —	32.70 T 73.56	10 T Sponsored
7.	Bostik sealants—substitute	Oil resistant adhesive for aircraft fuel tanks	Swastik Rubber Products Ltd., Poona 411003 (1974)	— —	0.41 T 0.78	6 T Non-exclusive
8.	*tert*-Butyl-catechol	Synthetic rubber	Percynic Chemicals, Bombay Silk Mills Building, Industrial Estate, Lalbaugh, Bombay 400012 (1972)	5.80 T 6.39	15.89 T 16.07	50 T Non-exclusive
9.	Butyl titanate	Varnishes, enamels	Synthochem, 33-A, Laxmibai Nagar, Industrial Estate, Indore 452002 (1973)	7.57 T 4.16	47.00 T 17.08	N. A. Non-exclusive

1	2	3	4	5	6	7
10.	Cadmium sulphide photoconductive cells	Electronics	Chinoy Electronics, 64, Koregaon Park, Poona 411001 (1971)	660 Nos. 0.08	4577 Nos. 0.54	16000 Nos. Non-exclusive
11.	Calcium hypo-phosphite (126393)	Pharmaceuticals	Hypophosphite & Co., 79-F, Princess Street, Bombay 400002 (1967)	20.00 T 18.00	104.25 T 70.30	24 T (includes other hypo-phosphites also) Sponsored
12.	Calcium silicate	Low density insulators	Newkem Products Corpn. Harganga Mahal, Khodadad Circle, Bombay 400014 (1968)	500.00 T 23.40 (estimated)	2477.21 T 94.45	N. A. Sponsored
13.	Can lining composition	Metal can industry	Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700013 (1974)	700.00 kg. 0.15	61.00 kg 0.02	75 T Non-exclusive
14.	Can sealing composition	Metal can industry	—do—(1962)	33.72 T 2.72	301.78 T 18.58	75 T Non-exclusive
15.*	Carbazole Dioxazine violet pigment	Organic pigments	Square Chemicals, 414, 'Giriraj' 4th floor, 73, Sant Tukaram Rd., Bombay 400009 (1976)	140.00 kg 0.98	— —	10 Kg/day Non-exclusive

1	2	3	4	5	6	7
16.	Carbimazole	Pharmaceuticals	Indian Schering Ltd., Sion Trombay Road, Deonar, Bombay 400088 (1970)	30.00 kg 2.50	288.69 kg 23.93	250 kg Sponsored
17.	Catechol	Pharmaceuticals	Percynic Chemicals, Bombay 400012 (1972)	5.97 T 3.88	16.89 T 7.56	50 T Non-exclusive
18.	Cation exchange resin—styrene DVB base (98155, 98156)	Demineralization of liquids	Bird & Co. Ltd., Chartered Bank Buildings, Calcutta 700048 (1968-69)	56,273 Ltrs. 8.32	5.89 lakh ltrs. 61.90	10,000 cft Non-exclusive
19.	Cationic dyes for acrylic fibres	Dyes for Synthetic fibres	Sahyadri Dyestuffs & Chemicals 177, Parvati-Vithalwadi Rd., Poona 411030 (1976)	16.8 T 26.36	3.58 T 4.70	40 T Sponsored
20.	Chloral hydrate	Industrial chemicals	Hindustan Insecticides, PB No. 623, Industrial Area, Rohtak Road, New Delhi 110015 (1975)	575.00 kg 0.10	21.09 T 2.18	36 T Sponsored
21.	Chlorobenzenes	Industrial chemicals	Hindustan Organic Chemicals Ltd. P. O. Rasayani (1976)	1739.00 T 86.00	2111.41 T 127.97	4500 T Sponsored

1	2	3	4	5	6	7
22.	Chloromethanes (86541)	Industrial chemicals	Standard Alkali, Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, P. B. No. 1038, Bombay 400021 (1974)	360.00 T 14.70 (estimated)	819.12 T 35.16	3000 T Exclusive for a limited period
23.	Clofibrate	Pharmaceuticals	(1) Biological Evans Ltd., 18/1 and 3, Azamabad, Hyderabad 500020 (1973)	210.00 kg 1.22	1.80 T 7.93	4 T Non-exclusive
			(2) Nivedita Chemicals Pvt. Ltd., A—14, M.I.D.C., Andheri (East) Bombay 400093 (1974)	538.00 kg 1.72	1.41 T 5.61	6 T Non-exclusive
24.	Diazepam	Anti-anxiety drugs	S.D's Lab. Chem. Industry, Samuel Street, P. B. No. 3232, Bombay 400003 (1975)	— —	5.15 kg 0.04	600 kg Non-exclusive
25.	Diethyl-*m*-aminophenol	Dye intermediate	Sahyadri Dyestuffs & Chemicals, 177, Parvati-Vithalwadi Road, Poona 411030 (1970)	54.24 T 41.91	196.60 T 159.78	120 T Sponsored
26.	Dihydroisojasmone and peach aldehyde	Perfumery chemicals	(1) S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg. Mulund, Bombay 400080 (1965)	339.00 kg 1.03	8.08 T 16.47	2 T Non-exclusive

1	2	3	4	5	6	7
	Dehydroisofas-mone and peach aldehyde		(2) Sonebon Laboratories, Kottayam-5 (1971)	— —	0.295 T 0.76	N. A. Non-exclusive
27.	Dimethylaniline	Industrial chemicals	Sahyadri Dyestuffs & Chemicals, Poona (1972)	— —	236.33 T 53.31	600 T Non-exclusive
28*	Dimethylaniline (continuous pro-cess)	Industrial chemicals	—do— (1976)	315.40 T 77.28	— —	600 T Sponsored
29.	Ethylene oxide condensates	Surface active agents	HICO Products Pvt. Ltd., Mogal Lane, P. B. No. 6467, Mahim, Bombay 400016 (1965)	1068.00 T 195.80	4977.14 T 706.05	2000 T Sponsored
30.	Ferrites—Hard	Electronics	Semiconductors Ltd., Ahmednagar Road, Mile 4/5, Poona 411014 (1968)	0.66 T 0.27	18.53 T 7.37	100 T Non-exclusive
31.	Geraniol, citrone-elal and citronellol from lemon grass oil	Perfumery	Opal Fine Chemicals, 2/9, Three-View Building, Opp. Century Bazar, Prabhadevi, Bombay 400 025 (1970)	3.30 T 3.58	16.00 T 21.00	5 T of each product Sponsored

1	2	3	4	5	6	7
32.	Glyceryl- ∝-mono-*p*-amino benzoate	Pharmaceuticals	Indian Schering Ltd., Bombay (1975)	— —	51.00 kg 0.15	250 kg Sponsored
33.	Gum arabic sub-stitute	Adhesives	(1) Karnatak Adhesives, 19, Mysore Deviation Road, Gopalpuram, Bangalore 560023 (1974)	— —	6.56 T 0.59	N. A. Non-exclusive
			(2) Malwadkar Industries, A-22, Flatted Bldg., F-2 Block, M.I.D.C. Pimpri, Poona 411018 (1974)	2.55 T 0.25 T	1.04 T 0.11	180 TPA Non-exclusive
34.	4-hydroxycou-marin	Pharmaceuticals	Unichem Laboratories Ltd., 'Unichem Bhavan' S. V. Road, Bombay 400060 (1974)	103.21 kg 0.22	113.40 kg 0.24	500 kg Non-exclusive
35.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	(1) Industrial Perfumes Ltd., Hay Bunder Rd., Tank Rd., P. O. Sewri, Bombay 400033 (1968)	87.44 T 118.05	160.25 T 233.77	150 T Non-exclusive
			**(2) S. H. Kelkar & Co. Ltd., Mulund, Bombay 400080 (1975)	238.00 kg 0.64	120.00 kg 0.32	4.4 T Non-exclusive

1	2	3	4	5	6	7
36.*	*p*-Menthane hydroperoxide	Synthetic rubbers	Camphor & Allied Products Ltd., P. B. Clutterbuckganj 243502, Dist. Bareilly (U.P.) (1976)	18.85 T 6.97	— —	60 T Exclusive
37.	Monochloro-acetic acid	Intermediate for weedicide, carboxy methyl cellulose, etc.	HICO Products Pvt. Ltd., Bombay (1975)	330.00 T 33.00	67.37 T 7.6	1000 T Non-exclusive
38.	Monoethyl-aniline	Intermediate for explosives	Atul Products Ltd., Atul-396020 (Dist. Bulsar) (1975)	44.63 T 11.16	25.77 T 8.23	100 T Non-exclusive
39.	l-Naphthyl-acetic acid	Agrochemicals, plant growth regulator	Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur 458001 (M. P.) (1975)	500.00 kg 0.50	100.00 kg 0·10	1.5 T Sponsored
40.	Nicotine sulphate from tobacco & tobacco waste	Insecticides	Urvakunj Nicotine Industries, Petlad Cambay Road, P. B. No. 16, Dharmaj-388430, Dist. Kaira, Gujarat (1963)	127.44 T 25.49	418.55 T 94.98	N.A. Non-exclusive

1	2	3	4	5	6	7
41.	Nitrile rubber	Oil resistant rubber formulations, adhesives	Synthetics & Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400020 (1974)	180.00 T 35.46	302.00 T 53.00	2000 T Exclusive for 4 years
42.	Nonyl phenol	Surface active agent	Aniline Dyestuff & Pharmaceutical Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Rd., Bombay 400026 (1974)	47.40 T 7.20	77.66 T 10.21	1000 T Sponsored
43.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch, M. P. (1975)	3.50 T 75.04	143.00 kg 3.15	8.7 T of various alkaloids (morphine, codeine, narcotine, papavarine, & thebaine) Exclusive
44.	*Ortho*-Tolyl-biguanide	Soap	Industrial Perfumes Ltd., Bombay (1970)	— —	16.09 T 4.37	5 T Exclusive
45.*	Oxalic acid from bark of Ain Tree	Industrial chemical	The Vidarbha Organic Chemical Industries Ltd., Sajan Singh Building, Mount Rd. Extn. Nagpur 440001 (1976)	— —	— —	900 T Sponsored (In production, details not supplied)

1	2	3	4	5	6	7
46.	Perfumery products based on longifolene (Capinone)	Perfumery	Camphor & Allied Products Ltd., Dist. Bareilly (U. P.) (1968)	1.16 T 1.32	61.25 T 51.41	50 T (for both capinone & meracene) Sponsored
47.	Perfumery products based on $\triangle^3$-carene (Meracene)	Perfumery	—do— (1968)	6.31 T 2.59	26.20 T 10.19	Sponsored
48.	β-Phenethyl alcohol	Perfumery	Sunanda Aromatic Industries, Mysore-K.R.S. Road, Mettagalli P.O., Mysore 571106 (1970)	133.00 T 88.00	411.06 T 200.17	225 T Sponsored
49.	Phenthoate	Insecticides	Bharat Pulverising Mills Pvt. Ltd., Shriniketan, 14 Queens Road, Bombay 400020 (1975)	6.00 T 3.00	11.10 T 6.05	600 T Sponsored
50.*	Phenyl acetic acid	Perfumery, Penicillin G	Supranil Chemical Industries, 212/15, Lokmanyanagar, Poona 411030 (1976)	429.00 kg 0.15	— —	60 T Non-exclusive
51.	Phthalates—dioctyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., 'D' Bldg., Shivasagar Estate, Dr. Annie Besant Road, Worli, Bombay 400018 (1971)	2439.00 T 292.75 (DOP)	10015.12 T 819.70 (DOP)	3000 T (DOP) Non-exclusive

1	2	3	4	5	6	7
52.	Phthalate-diethyl and dimethyl	—do—	The Mysore Acetate and Chemicals Co. Ltd., Mysugar Bldg., Sri J. W. Road, Bangalore 560002 (1970)	246.36 T 35.73 (DEP)	654.35 T 76.46 (DEP)	600 T (DEP) Non-exclusive
53.	Polyurethane printing rollers (86991)	Printing	Sree Saraswaty Press Ltd., 32, Acharya P.C. Road, Calcutta 700009 (1965)	1072 Nos. 2.07	2389 Nos. 3.99	3000 Nos. Non-exclusive
54.*	Potentiometric strip chart recorder	Instrument for use in research and industry	Elico Pvt. Ltd., B-90, Sanatnagar, I.E. Extn., Hyderabad 500018 (1976)	3 Nos. 0.17	— —	N. A. Non-exclusive
55.	Radio opaque dyes	Pharmaceuticals	Unichem Laboratories, Bombay (1974—75)	— —	25.4 kg 0.11	50 kg sponsored
56.	Radiosonde thermistors	Meteorology	The Bhagyanagar Laboratories, 11-1523/8 Golkonda Cross Road, Hyderabad (1974)	25000 Nos. 4.9	35000 Nos. 4.70	N. A. Non-exclusive
57.	D. C. Recording polarograph	Polarographic analysis	(1) Elico Pvt. Ltd., Hyderabad (1974)	38 Units 5.20	9 Units 1.03	50 Units Non-exclusive
			(2) Chromatography & Instruments Co., 121-122, Makarpura Indl. Estate, Baroda 390010 (1975)	12 Units 1.73	4 Units 0.86	100 Units Non-exclusive

1	2	3	4	5	6	7
58.	Rigid filters	Tube wells	Ashim filters C-195 Defence Colony, New Delhi 110024 (1965)	— —	12318 Mtrs. 23.38	5000 Mtrs. 4" pipe filters (in production, details not supplied) Non-exclusive
59.	Rubber blowing agent	Rubber chemicals	Swastik Rubber Products Ltd., Poona (1968)	— —	223.51 T 32.16	40 T Non-exclusive
60.	Rubberized cork sheets	Gaskets	Bharat Casements, Prop. M/s. Banco Aluminium Baroda Ltd., P. B. No. 169, Baroda 390001 (1966)	3.58 lakh pieces 16.11	107.18 lakh pieces 51.84	24 lakh pieces Non-exclusive
61.	Rubber reclaiming agent	Rubber chemicals	Swastik Rubber Products Ltd., Poona (1968)	— —	35.80 T 5.92	30 T Non-exclusive
62.	Sachets—Hot and Cold	Substitute for hot water bag and ice bag	Vasant Industrial Corpn., 356, Great Nag Road, Nagpur 440009 (1971)	2225 pads 0.23	6830 pads 0.73	1,00,000 Nos. Non-exclusive
63.	Silica gel	Humidity control	Minco Products, 301/27, T. H. Road, Madras 600081 (1963)	11.00 T 1.00	129.50 T 9.67	18 T Sponsored

1	2	3	4	5	6	7
64.	Sorbide nitrate	Pharmaceuticals	Indian Schering Ltd., Bombay (1969)	261.00 kg 3.61	1131.70 kg 17.73	300 kg Sponsored
65.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	(1) Hindustan Antibiotics Ltd., Pimpri, Poona 411018 (1974)	— —	165.00 T 19.00	N. A. Non-exclusive
			(2) Maize Products, Divn. of Sayaji Mills Ltd., P. O. Kathawada, Ahmedabad 382430 (1976)	640 T 68.18	74.2 T 8.3	2000 T Non-exclusive
			*(3) The Anil Starch Products Ltd., Anil Road, P. O. Box. No. 1062, Ahmedabad 380002 (1976)	119.40 T 11.94	— —	500 T Non-exclusive
66.	Direct reading spectrophotometer/colorimeter	Biochemical research, spectroscopic analysis in visible range	Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Road, Allahabad 211001 (1974)	25 Units 1.60	38 Units 2.59	60 Units Non-exclusive
67	*Terpineol	Perfumery	Dujodwala Industries, 1401, Prasad Chambers, Near Roxy Cinema, Bombay 400004 (1976)	30.00 T 7.5	— —	100 T Non-exclusive

1	2	3	4	5	6	7
68.	Thermistors	Electronics	(1) Semiconductors Ltd., Poona (1963)	5.43 lakh Nos. 7.08	68.79 lakh Nos. 55.73	N. A. Non-exclusive
			(2) Tempo Semiconductors, Divn. of Primco Pvt. Ltd.,	—	1.05 lakh Nos.	N. A. Non-exclusive
			18, Paranjape 'B' Scheme, Subhas Road, Vile Parle (East), Bombay 400057 (1963)	—	5.67	
69.	Vapour phase chromatograph	Instruments	Associated Instruments Manufacturers (India) P. Ltd., Sunlight Bldg., 35, Najafgarh Road, New Delhi 110015 (1969)	— —	142 Units 27.85	48 Units Exclusive
70.	Vitamin C	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Poona (1975)	1.29 T 1.65 (estimated)	4.54 T 5.63 (estimated)	125 T Non-exclusive
71.	Warfarin	Rodenticide	Unichem Laboratories Ltd., Bombay (1974)	152.29 kg 1.27	170.20 kg 1.11	200 kg Non-exclusive

* During the period under review, production has been newly reported on these items (7). The production of opium alkaloids was reported first time during 1976-77 although the production was commenced in 1975-76.
** Production reported for the first time by the party
N.A.=Not available

VALUE OF PRODUCTION BASED ON NCL KNOW-HOW

Year	No. of items manufactured	Value of production (Rs. in lakhs)
1972—73*	48	557.11
1973—74	49	651.39
1974—75	60	1,098.71
1975—76	64	** 1,285.11
1976—77	71	1,562.12
	Total	5,154.44

* Cumulative value of production upto 1950—72 amounts to Rs. 1,038.36 lakhs.

** This includes production figures for 1975—76 of Acriflavine (Rs. 6.50 lakhs) and Opium alkaloids (Rs. 3.15 lakhs) which was received after the printing of 1975—76 Annual Report.

Note : The following processes were at one time under commercial implementation and appeared in Table I of previous Annual Reports (1965-66 to 1975-76). As and when production will be resumed on these items, they will be included in Table I. (1) Anion exchange resin from melamine, (2) Benzoic acid from toluene (Sp), (3) Cation exchange resin from CNSL, (4) DDT—water dispersible, (5) Heat sealable coating composition, (6) Hexylresorcinol, (7) Liquid rubber, (8) Rubber based contact adhesive, (9) Sisal wax, (10) Thermosetting resins for industrial laminates (Sp), (11) Titanium tetrachloride (Sp).

SECTORWISE PRODUCTION OF NCL TECHNOLOGIES (1976—77)

Type of Industry	*No. of processes in production*	*Value of production during* 1976—77 (Rs. in lakhs)
(1) Public sector	6	331.11
(2) Large scale private sector	23	872.97
(3) Medium & small scale sector	42	358.04
	71	1562.12

TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

Sr. No. 1	Name of the process (Indian Patent No.) 2	Field of utilization 3	Name of the party (year of release) 4	Nature of release 5	Remarks 6
1.	Acrylic acid/acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., P. O. Jawaharnagar 391320 Dist. Baroda (1975)	Sponsored	Follow up actions by project engineers in progress
2.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone	Pharmaceutical intermediate	Chemical Industrial and Pharmaceutical Laboratories Ltd. (CIPLA), 289, Bellasis Road, Bombay 400008 (1974)	Non-exclusive	Pilot plant trials in progress
3.	Aniline	Organic intermediate	Hindustan Organic Chemicals Ltd., Rasayani (1973)	Non-exclusive	Pilot plant trials in progress
4.	Anisidines by liquid phase hydrogenation of nitroanisoles	Intermediate for dyestuffs	Amar Dye-Chem Ltd., Rang Udyan, Sitladevi Temple Road, P. B. No.6471, Mahim, Bombay 400016 (1974)	Sponsored	Recently released
5.	Antioxidant TEDQ (2, 2, 4-Trimethyl-6-ethoxy-1, 2-dihydroquinoline)	Rubber antioxidant	—do— (1976)	Non-exclusive	Clearance for location of the factory awaited from the Govt.

1	2	3	4	5	6
6.	1-3-Butylene glycol	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1974)	Sponsored	Follow up action by engineers in progress
7.	B. D. Catalyst	Catalyst for synthetic rubber	Synthetics and Chemicals Ltd., Bombay (1969)	Sponsored	Catalyst base has been recently approved
8.	Cephalexin and 7-ADCA	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Poona (1975)	Sponsored	Follow up work in progress
9.	Colchicine	Pharmaceuticals	Shree Ganesh Chemicals, Digras, Dist. Yeotmal (Maharashtra) (1976)	Non-exclusive	Recently released
10.	N, N-Dimethyl biguanide hydrochloride and Phenethyl biguanide hydrochloride	Anti-diabetic drugs	Combii Organo Chem. Pvt. Ltd., 27, Barakhamba, New Delhi 110001 (1976)	Non-exclusive	Recently released
11.	Dichloropropionic acid (Dalapon)	Pesticides	(1) HICO Products Pvt. Ltd., Bombay (1975)	Non-exclusive	Recently released
			(2) Jaydee Agrochemicals Pvt. Ltd., Majwaji-Ka Bagh, Moti Dugri Rd., Jaipur 302004 (1975)	Non-exclusive	Recently released

1	2	3	4	5	6
12.	Endosulfan	Pesticides	(1) Bharat Pulverising Mills Pvt. Ltd., Bombay (1976)	Non-exclusive	Recently released
			(2) Hindustan Insecticides Ltd., New Delhi (1976)	Non-exclusive	Turn key plant offered through project engineers
13.	N-Ethyl-*o*-toludine	Dye intermediate	Mafatlal Industries Ltd., Asarwa Road, Ahmedabad (1975)	Sponsored	Recently released
14.	Ethylenediamine	Bulk organic chemicals	(1) Diamines & Chemicals Ltd. The Bharat Vijay Mills Ltd. Premises, Kalol 382721 (N. Gujarat) (1973)	Non-exclusive	Pilot plant trials in progress
			(2) Victor Oil Co. Pvt. Ltd., 27, Sir R. N. Mukherjee Road, Calcutta 700001 (1976)	Non-exclusive	Recently released
15.	Flexible magnets	Refrigeration gaskets, toys, educational kits	(1) Ferrites and Electronics Components Pvt. Ltd., Balmiki Marg, Lucknow 226001 (1974)	Non-exclusive	—
			(2) Dr. Shet & Co., 1-2-412-3, Gagan Mahal Colony, Hyderabad 500029 (1976)	Non-exclusive	Recently released

1	2	3	4	5	6
16.	Foundry core binder (sinol core binder)	Core binder in steel foundries for high dimensional accuracy	(1) Card-Chem Industries, B-12, Co-operative Industrial Estate, Balanagar, Hyderabad 500037 (1973)	Non-exclusive	In trial production
			(2) Wisca Chemicals, 508, Shishu Vihar, Bhavnagar 364001 (1975)	Non-exclusive	In trial production
17.	Fumed silica	Bulk inorganic chemicals	Century Rayons, Industry House, 159, Churchgate Reclamation, Bombay 400020 (1976)	Sponsored	Recently released
18.	Gaskets from coir pith	Gaskets	Oberoi Industries, 38, New Vazirpur Industrial Complex, DSIDC Camp, Delhi 110058 (1974)	Non-exclusive	Reported in trial production
19.	Maleic hydrazide	Agrochemicals	Micro Chemicals (India), Mandsaur (1976)	Non-exclusive	Recently released
20.	Matrix-bound penicillin acylase systems	Pharmaceuticals	Hindustan Antibiotics Ltd., Pimpri, Poona (1974)	Sponsored	Pilot plant trials completed. Scale up work in progress

1	2	3	4	5	6
21.	Molybdenum chemicals from molybdenum concentrate	Industrial inorganic chemicals	Apex Chemicals, 117, Himalaya House, Palton Road, Bombay 400001 (1976)	Sponsored	Recently released
22.	Microfilters	Industrial filtrations	Swan Micro Filters Pvt. Ltd., Joseph House, Pudamjee Park, Poona 411001 (1973)	Non-exclusive	—
23.	Morpholine	Intermediate for rubber chemicals	(1) Bombay Wire, Ropes Ltd., 401/405, Jolly Bhavan No. 1, 10, New Marine Lines, Bombay 400020 (1975)	Non-exclusive	Recently released
			(2) Catalyst India Ltd., Chinoy Building, 79 Masjid Bundar Rd., Bombay 400003 (1975)	Non-exclusive	—do—
24.	Nitro musk compounds	Perfumery	Opal Fine Chemicals, 2/9, Three View Building, 2nd Floor, Opp. Century Bazar, Prabhadevi, Bombay 400025 (1973)	Sponsored	Under implementation

1	2	3	4	5	6
25.	*p*-Nitrophenol	Insecticides	(1) Hindustan Organic Chemicals Ltd. Rasayani (1972)	Non-exclusive	Commercial feasibility of process being studied
			(2) Catalyst India Ltd., Bombay (1975)	Non-exclusive	Recently released
26.	Optical whitening agent for synthetic fibres	Whitening agent	Valia Brothers Pvt. Ltd. Ararat, 89, Nagindas Master Rd., Fort, Bombay 400023 (1976)	Non-exclusive	Recently released
27.	Polyurethane coatings	Coatings	(1) Polyurethane Industries, 1904, Ranchhodji's Pole, Sarangpur, Ahmedabad 380001 (1975)	Non-exclusive	Recently released
			(2) Cipy Chemicals, 102 A/2 Hadapsar Industrial Estate, Poona 411013 (1976)	Non-exclusive	—do—
28.	Sodium sulphide	—	Amar Dye-Chem. Ltd., Bombay (1976)	Non-exclusive (Tech. aid)	—do—
29.	Sulphur monochloride	—	Phosphate Co. Ltd., 14, Netaji Subhas Road, Calcutta 700001 (1976)	Non-exclusive (Tech. aid)	—do—

1	2	3	4	5	6
30.	Sorbitol from glucose (continuous process)	Pharmaceuticals	The Anil Starch Products Ltd., Ahmedabad (1976)	Sponsored	Recently released
31.	Staple pin adhesive	Adhesive for staple pins	Duro Metochem Pvt. Ltd., Nirlon House, 254-B, Dr. Annie Besant Road, Worli, Bombay 400025 (1976)	Non-exclusive	Recently released
32.	Thioglycolic acid	Cosmetics, Catalyst	S. D.'s Lab-Chem. Industry, Bombay (1975)	Non-exclusive	—do—
33.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate	Sudarshan Chemical Industries Ltd. 162, Wellesley Road, Sangam Bridge, Poona 411001 (1973)	Sponsored	Production held up for non-availability of catalyst
34.	Xanthates Potassium ethyl and Potassium amyl	Froth flotation	Chrome International, F-381, Vishwakarma Industrial Area, Jaipur 302006 (1976)	Non-exclusive	In trial production

Notes :

(A) The following processes which were included in Table II of Annual Report 1975-76 have now been dropped as the licencees have either not shown any progress towards their implementation for a considerable peiod or not implemented due to economic consideration or the nature and objective of the project.

Process	Party
1. Catalytic vapour phase oxidation of olefins (Sp)	IPCL, Baroda
2. Chlorides from bauxite residue (Sp)	Dharmsi Moraji Chemicals Co. Ltd., Ambernath
3. Coating for oil filter papers	The White Cloud Paper Mills, Poona
4. *p*-Cresol (Sp)	HICO Products Ltd. Bombay
5. 8-Hydroxyquinoline (Sp)	Alta Laboratories P. Ltd., Khopoli
6. l-Menthol from citronella oil of Indian origin (Sp)	Bhavana Chemicals Ltd., Bombay
7. β-Naphthol (Sp)	HOC., Rasayani
8. Nitrofen	Delhi Pesticides Ltd., Bombay
9. Papavarine hydrochloride (Sp)	Parijat Chemicals Pvt. Ltd., Bombay
10. Synthesis of potential pharmacologically active substances (Furoseamide) (Sp)	Sarebhai Research Centre, Baroda
11 Synthesis of resin for friction materials (Sp)	Hindustan Ferodo Ltd. Bombay
12. Solvent extraction of Sandalwood oil (Sp)	Govt. Sandlewood Oil Factory, Mysore
13. Tamarind kernal powder-phosphate and borate	S. K. Enterprises, Bombay

Process	Party
14. Testing of rayon grade pulp from Bastar hard wood (Sp)	The Baroda Rayon Corporation Ltd, Udhana
15. Utilization of fine coarse fibre waste from corn starch industry for manufacture of gums. (Sp)	The Anil Starch Products Ltd, Ahmedabad
16. Fractionation of turpentine oil (Sp)	J & K Industries Ltd., Srinagar
17. Vitamin B_6	IDPL, Hyderabad
18. Xylit from coconut shell (Sp)	Unichem Laboratories Ltd., Bombay
19. D-xylose & xylit from corn cobs (Sp)	Unichem Laboratories Ltd., Bombay

(B) In addition to the above the sponsored project on Flavanoids, tannins, stilbenes, lignans and quinones in some Indian forest trees under PL-480 scheme has been completed during 1976-77. No production is envisaged due to nature and objective of the scheme.

(C) The names of the following firms which were included in Table II of Annual Report 1975-76 have now been dropped as the licencees have not shown any progress towards the implementation of the process for a considerable period.

Party	Process
(1) M/s V. P. Nijhawan, New Delhi	Flexible magnets
(2) M/s Ajanta Enterprises, Bombay	—do—

TABLE II (A) : The following processes which have been mentioned in Table I are also licensed to the following additional firms.

Sr.No.	Name of the process	Field of utilization	Name of the party (Year of release)
1	2	3	4
1.	Bostik sealants—substitute	Oil resistant adhesive for aircraft fuel tanks	Premier Rubber & Cable Industries, Jamal Building, 211, Nagdevi Street, Bombay 400003 (1975)
2.	Can lining composition (based on nitrile rubber latex)	Metal can industry	—do— (1975)
3.	Can sealing composition (based on natural rubber)	Metal can industry	—do— (1976)
4.	Diazepam	Anti-anxiety drugs	(1) Alkem Laboratories Pvt. Ltd., Kumar Engineering Compound, Kalina Road Kalina, Santacruz (East), Bombay 400029 (1975) (2) Orion Chemicals, 8, Mulchand Mansion, Princess Street, Bombay 400002 (1975)
5.	Clofibrate	Pharmaceuticals	S.D.'s Lab-Chem Industry, Bombay (1975)
6.	Ferrites—Hard	Electronics	Dr. Shet & Co., Hyderabad

1	2	3	4
7.	Gum arabic substittue	Adhesives	(1) Suiya, Gum and Chemicals, 'Safalya' 1244 Thakorewas, Old Madhupura, Ahmedabad 380001 (1975) (2) Delta Chemicals, Kuttikkathi Buildings, P. O. Road, Kottayam 686001 (1976)
8.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	(1) Pappachan K. Eiengical, Kothamangalam 686691, Kerala (1976) (2) Cauvery Chemicals, Asamannooi P. O. Via Perumbavoor, Dist. Ernakulam, Kerala (1976)
9.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	(1) Ganesh Tobacco Bye-Products Industries Pvt. Ltd., 32, M. Gandhi Gunj, Borsad (1975) (2) S. K. Sinha, C/o Shri. Nand Kishore Sinha, The Uttar Bihar Hindu Weekly, Patna-Gaya Road, Patna—1 (1975) (3) Harmanbhai S. Patel, Aradhana Hotel, Polc Ground, Mount Abu, Rajasthan (1975)
10.	D. C. Recording polarograph	Polarographic analysis	Laxsons Engg. & Electronics Pvt. Ltd. Opp. Marol Bus Stop, Andheri (East), Bombay 400059 (1973)

Note : The names of the following firms which were included in Table II (A) of Annual Report 1975-76 have now been dropped as the licencees have not shown any progress towards the implementation of the processes for a considerable period.

1.	Ajanta Enterprises, Bombay	Ferrites—hard
2.	Mr. V. P. Nijhawan, New Delhi	—do—
3.	Mr. B. K. Mital, Dist. Thana	Gum arabic substitute
4.	Supreme Enterprises, Ludhiana	—do—
5.	Industrial Solvents & Chemicals (P) Ltd., Bombay	—do—
6.	Coromandal Tobacco By-Products, Gannavaram	Nicotine sulphate from tobacco and tobacco waste
7.	Mr. P. Jaipuria, Bangalore	—do—
8.	Mr. K. V. Rangaswamy Mudaliar, Coimbatore	—do—
9.	Dr. J. A. Naik, Kolhapur	—do—
10.	Spar Chemicals, Nipani	—do—
11.	Agrochemical Industries, Parcharuru	—do—
12.	Laxmi Chemical Industries (P) Ltd., Dist. Krishna	Phenylacetic acid
13.	Orient Aroma Chemical (P) Ltd., Bombay	—do—
14.	Alta Laboratories Ltd., Khopoli	Phthalates—DOP and DBP
15.	United Ink & Varnish Co., Bombay	Polyurethane printing rollers
16.	Cork Products (P) Ltd., New Delhi	Rubberised cork sheets from cork granules
17.	Mr. B. Fatesaria, Calcutta	Sachets—Hot & Cold
18.	Thermochem Laboratoies, Poona	—do—

Note :

The following is a consolidated list of the processes which were dropped from Table II of the Annual Reports 1965-66 to 1975-76, since no progress was made/reported towards their implementation by the licencees. These processes will appear again in Table II of future reports, if the progress is reported by the licencees.

NCL will welcome enquiries from Industry should it be interested in taking up manufacture of any of the products mentioned under 'NCL processes.'

NCL processes

(1) Ammophos-II
(2) Benzoic acid (IP) from crude methyl benzoate
(3) Cation exchange resin-polystyrene base
(4) Coating compositions for textile bobbins
(5) Chlorinated alkyl aryl phenols
(6) Covering materials from CNSL
(7) Diethyl stilbestrol
(8) Dithranol
(9) Ethyl acetoacetate
(10) Ethylene from alcohol
(11) Ethylene dichloride from ethyl alcohol
(12) Foundry core oil
(13) Hexachloroethane
(14) N. P. fertilizer
(15) Recovery of pyridine base
(16) Solvent and heat-exchange liquid from CNSL
(17) Surface active agents from CNSL
(18) Rubberized cork sheets from waste cork granules

Sponsored processes

(1) Butylated hydroxy anisole
(2) Calcium silicate from wollastonite
(3) Chlorinated copper phthalocyanine
(4) Chlorohydroxyquinoline
(5) Conversion of bauxite into anhydrous aluminium chloride
(6) Coumarin
(7) Extraction of morphine and other alkaloids from lanced poppy straw
(8) Isolation of borneol
(9) Kashmir soft woods pulping
(10) Ketone from acetone
(11) Liquid stabilizers for PVC
(12) Megimide
(13) l-Menthol from dementholized peppermint oil
(14) *p*-Nitroacetophenone
(15) Oxy-urea
(16) Pentachlorophenol and other phenolic compounds
(17) *p*-Phenetidine
(18) Propoxyphene
(19) Quinacridon pigments
(20) Removal of silica from black liquor

(21) Sulphacetamide and its sodium salts
(22) Terpene G
(23) Vat Golden yellow GK

In addition, there are 37 sponsored processes/schemes wherein no production has been established so far due to variety of reasons and in some cases due to the nature and objectives of the sponsored schemes. List of such processes from which no production is likely to materialize is given below :

(1) Alizarin
(2) Aminotriazole
(3) Anthraquinonoid dyes
(4) Ceramic compositions—testing methods
(5) Chemicals from castor oil
(6) Composite drug research scheme on Indian medicinal plants
(7) Corrosion studies
(8) Constituents of Punjab costus roots
(9) Constitution of lac
(10) Electron diffraction camera
(11) Emetine from ipecac roots—isolation
(12) Essential oil bearing plants—trial cultivation & extraction there from
(13) Fermentation problem
(14) Indian silk—physico chemical studies
(15) Industrial chemicals from diketene
(16) Infra-red spectrophotometer
(17) Investigation of mixture of hard woods from Bastar
(18) Kerala hard wood —pulping
(19) Lac dye
(20) Maleic anhydride by oxidation of benzene
(21) Methyl vinyl ether—maleic anhydride copolymer
(22) Molecular properties of long chain compounds
(23) New ingrain dyes
(24) Pine oil studies
(25) Rayon grade pulp
(26) Reactive dyes
(27) Refractory materials—chemical and thermodynamic properties at high temperature
(28) Rubber research
(29) Rutile titania from Indian ilmenite
(30) Screening of NCL compounds for their pharmacological activity
(31) Sodium cyclamate
(32) Steroids from sugarcane wax
(33) Studies in wood phenolics
(34) Tetrabromoindigo
(35) Thiodiglycol
(36) Tung oil
(37) Vanillin and ethyl vanillin

TABLE III : REVIEW OF RESEARCH UTILIZATION OF PROCESSES DEVELOPED BY NCL ON ITS OWN

(Position as on 31st March each year)

Year	No. of the processes in production	Value of production (Rs. in lakhs)	Processes released and awaiting production	Processes available not yet released	Processes dropped/ not offered	Total No. of processes developed (2+4+5+6)	Percentage of the processes in production to the total number of processes developed	Total No. of parties who have acquired NCL know-how
1	2	3	4	5	6	7	8	9
1973*	29	401.07	28	43	17	117	25	86
1974	32	388.50	25	41	23	121	26	100
1975	40	654.42	23	44	24	131	30	114
1976	41	885.61	27	40	29	137	30	128
1977	47	978.65	22	40	30**	139	34	151

Note : Table revised to account all the industrial processes developed by NCL taking 1965-66 Annual Report as basis. Out of 22 processes mentioned under Column 4, 14 have been recently released and 8 are being implemented.

* Total cumulative value of industrial production for the years 1950-1972 exclusive of those arising from sponsored research schemes and FCP production was Rs. 677.35 lakhs.

** Out of these 30 processes 18 processes have been dropped since no progress was reported towards their implementation by their licencees. The remaining 12 processes have been dropped for techno-economic considerations.

TABLE IV : REVIEW OF THE PROCESSES DEVELOPED BY NCL UNDER SPONSORSHIP OF INDUSTRY

(Position as on 31st March each year)

Year	No. of processes in production	R & D inputs (Rs. in lakhs)	Value of production (Rs. in lakhs)	No. of processes not in production*	No. of processes on which work was abandoned for tech./ economical/ market reasons	No. of processes on which no production is envisaged**	Total No. of industrial processes developed (2+5)	% Utilization of the processes developed	Total No. of parties who have sponsored the processes
1	2	3	4	5	6	7	8	9	10
1973	15	4.54	154.39	36	13	22	51	29	61
1974	16	4.21	261.85	39	13	23	55	29	58
1975	19	6.34	442.39	49	13	24	68	28	69
1976	22	4.10	399.95	51	13	24	73	30	71
1977	24	4.50	583.47	50	13	27	74	32	74

* This includes sponsored projects awaiting production as well as sponsored projects removed from Tables I and II.

** This column includes projects where no industrial production was expected to be realized. These include PL-480 schemes, Lac Cess Committee project, ICMR schemes, projects for developement of analytical procedures, etc.

KNOW-HOW AVAILABLE

Sr. No.	Name of the process/product	Field of utilization	Remarks
1	2	3	4
1.	Acetanilide	Drugs and dye intermediate	Released, in production, turnkey plant available through project engineers
2.	Aniline	Organic intermediate	Released
3.	Antioxidant TEDQ (2, 2, 4-Trimethyl-6-ethoxy-1, 2-dihydroquinoline)	Rubber antioxidant	Released
4.	L-Arabinose (CP)	Biochemical research	Export potential
5.	Atrazine	Herbicide	—
6.	Benzoic acid from crude methyl benzoate	Pharmaceuticals	Released
7.	Bisphenol-A	Epoxy resin	—
8.	Bostik sealant—substitute	Oil resistant adhesive for fuel tanks	Released, in production
9.	*tert*-Butyl catechol	Stabilizer and polymerization inhibitor for synthetic rubber	Released, in production
10.	Butyl titanate	Insulating varnishes, special paints, catalyst	Released, in production
11.	Cadmium sulphide Photo conductive cell	Instruments, Photoelectric devices	Released, in production
12.	Cadmium pigments	Inorganic pigments	—
13.	Can lining composition (based on nitrile rubber latex)	Lining cans for storing mineral oils, greases, food	Released, in production

1	2	3	4
14.	Can sealing composition (based on natural rubber)	Metal can industry	Released, in production
15.	Carbazole dioxazine violet pigment	Organic pigments	Released, in production
16.	Cashewnut shell gum (Ind. Pat. No. 123638)	Binder, thickening agent in food and pharmaceuticals	—
17.	Catechol	Organic intermediate	Released, in production
18.	Chlorinated paraffn wax	Plasticizers and extenders	—
19.	2-Chloroethyl-trimethyl ammonium chloride	Plant growth regulator	—
20.	Civetone and Dihydrocivetone	Perfumery	—
21.	Clofibrate	Drugs	Released, in production
22.	Coating for oil filter papers	Oil filter	Released
23.	Colchicine	Drugs	Released
24.	Costus root oil, Fructose and Chamazulene	Perfumery, Medicines, Cosmetics	—
25.	Diazepam	Anti-anxiety drugs	Released, in production
26.	Dibutyl tin stabilizers for PVC	PVC industry	—
27.	Dichloropropionic acid (Dalapon)	Weedicide	Released
28.	Diethyl toluamide	Insect repellents	—

1	2	3	4
29.	Dihydroambrettolide & Isoambrettolide	Perfumery	—
30.	Dihydroisojasmone and Peach aldehyde	Perfumery	Released, in production
31.	Dimethylaniline (batch process)	Dyestuff and explosives intermediate	Released, in production
32.	N, N-Dimethyl biguanide-HCl Phenethylbiguanide-HCl	Anti-diabetic drugs	Released
33.	Dissolving grade pulp (Ind. Pat. No. 82822)	Rayon, tyre cord	Process available on turn-key basis through project engineers
34.	Endosulfan	Pesticides	Released, process available on turn-key basis through project engineers
35.	Ethylenediamine	Bulk organic chemicals	Released, turn-key plant available through project engineers
36.	Ethylenedichloride from ethyl alcohol	Solvent, organic intermediate	—
37.	Ethylene from ethyl alcohol	Organic intermediate	Released
38.	Exaltolide and Exaltone	Perfumery	—
39.	Expandable polystyrene beads	Insulation and packaging	—
40.	Ferrites—Hard	Electronics	Released, in production
41.	Ferrites—Soft	Electronics	—

1	2	3	4
42.	Fine chemicals	—	Know-how available for 200 laboratory chemicals
43.	Flexible magnets	Refrigerator gaskets, toys, educational kits	Released
44.	Flocculating agent for sugarcane juice clarification	Flocculating agents	—
45.	Foundry core binder (sinol core binder)	Core binder in steel foundries for high dimensional accuracy	Released, in production
46.	Gaskets from coir pith	Gaskets	Released
47.	D-Glucosamine hydrochloride (C.P.)	Biochemical research, pharmaceuticals	—
48.	Glyceryl guaiacolate	Drugs (expectorant, intestinal antiseptic)	—
49.	Hexachloroethane (Ind. Pat. No. 92997)	Pyrotechnics, smoke screen, veterinary medicine, fluxing agent in foundries	—
50.	4-Hydroxycoumarin	Pharmaceuticals	Released, in production
51.	β-Ionone (Ind. Pat. No. 77225)	Perfumery chemical, intermediate for Vitamin A	Released,
52.	Linseed oil emulsion paint	Emulsion paints	—
53.	Maleic hydrazide	Plant growth regulator	Released
54.	Microfilters	Industrial filtration	Released

1	2	3	4
55.	Molecular sieves	Chemicals, petro-chemicals, cryo-genic industry	—
56.	Monochloroacetic acid	Organic inter-mediate for weedi-cides, carboxy methyl cellulose, etc.	Released, in production
57.	Monoethylaniline	Intermediate for explosives	Released, in production
58.	Morpholine	Intermediate for rubber chemicals, textile chemicals, optical brighteners	Released
59.	Neo-Lavandulol	Perfumery	—
60.	Nicotine sulphate from tobacco & tobacco waste	Insecticide	Released, in production
61.	Nitrofen	Weedicide	Released
62.	*p*-Nitrophenol	Intermediate for parathion and paracetamol	Released
63.	Optical whitening agent for synthetic fibres	Whitening agent for synthetic fibres	Released
64.	Pentachloronitro-benezene	Fungicide	—
65.	Phenacetin	Drugs	—
66.	Phenoxyacetic acid	Penicillin V	—
67.	Phenylacetic acid	Perfumery, Penicillin G	Released, in production
68.	Phthalate—butyl octyl	Plasticizer in non-electrical applications	—

1	2	3	4
69.	Phthalates—dibutyl/dioctyl	Plasticizers	Released, in production
70.	Phthalates—dimethyl/diethyl	Plasticizers	Released, in production
71.	D. C. Recording polarograph	Polarographic analysis	Released, in production
72.	Polyurethane coatings	Coatings for leather, rubber, wood, glass, nylon fabrics	Released
73.	Polyurethane printing rollers (Ind. Pat. No. 86991)	Printing rollers	Released, in production
74.	Potentiometric strip chart recorder	Instrument for use in research and industry	Released, in production
75.	Radiosonde thermistors	Meteorology	Released, in production
76.	Reactive dyes	Dyestuff industry	—
77.	Rigid filters	Tube wells	Released, in production
78.	Rubber blowing agent	Rubber chemicals	Released, in production
79.	Rubberized cork sheets from cork waste/granules	Gaskets	Released
80.	Rubber reclaiming agent	Rubber chemicals	Released, in production
81.	Sachets—Hot and cold	Substitute for hot water bags & ice bags	Released, in production
82.	Silicon tetrachloride	Industrial chemical	—
83.	Simazine	Herbicide	—
84.	Sisal wax	Polishes, cosmetics	Released

1	2	3	4
85.	Sodium hydrosulphite from sodium formate	Reducing agent in textile, sugar and soap industries	Technology on reaction only is offered
86.	Sorbitol/Mannitol from cane sugar	Pharmaceuticals (mannitol), Pharmaceutical syrups, humectant (sorbitol)	—
87.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	Released, in production
88.	Direct reading Spectrophotometer/ colorimeter	Biochemical research, spectroscopic analysis in visible range	Released, in production
89.	Staple pins adhesive	Adhesive for staple pins	Released
90.	Synthetic gemstones	Jewellery, electric meters	—
91.	Terpineol	Perfumery	Released, in production
92.	Tetradifon	Acaricide	Released
93.	Theophylline, aminophylline and caffeine	Drugs (caffeine also used in beverage)	—
94.	Thermistors	Temperature measurement and control, electronic devices, etc.	Released, in production
95.	Thioglycolic acid	Cosmetics, catalyst	Released
96.*	Trichlorobenzene	Pesticides	—
97.	Vapour phase chromatograph	Instruments	Released, in production
98.	Vitamin B_6	Drugs	Released
99.	Vitamin C	Drugs	Released, in production

1	2	3	4
100.	Warfarin	Rodenticide	Released, in production
101.	Xanthates—Potassium ethyl and Potassium amyl	Froth- flotation	Released

* Processes newly added (1) to the know-how available list published in Annual Report 1975-76.

Note : The following processes which were included in Table V of Annual Report 1975-76 have now been dropped from the list on techno-economic considerations.

(1) 2-Amino-5-chlorobenzophenone and 2-Methylamino-5-Chlorobenzophenone, (2) Anion exchange resin from melamine, (3) Antipriming composition, (4) Bacterial diastase, (5) Cellulose powder, (6) Gum arabic substitute, (7) Recovery of pyridine bases from their aqueous solutions, (8) Tamarind kernel powder (TKP)-phosphate & borate.

In addition to above, the following processes will be shortly assigned to NRDC for release to industry :

(1) Carboxin
(2) Chlordan
(3) Chlordiazepoxide
(4) Dimethoate
(5) Ethyl silicate
(6) Fenitrothion
(7) Polyol for making polyurethane rigid foam
(8) Silica gel (Desiccant type)
(9) Silver paste for mica capacitor
(10) Solid state strip chart recorder

COMPARATIVE COST-BENEFIT DATA 1975-76 AND 1976-77

	1975-76 (Rs. in lakhs)	1976-77 (Rs. in lakh)
COST		
1. Recurring expenditure	124.71	131.18
2. Capital expenditure	37.67	45.64
	162.38	176.82
BENEFITS		
Receipts		
1. NCL's share of premia and royalties received from NRDC	0.88	1.77
2. Receipts on account of sponsored projects	4.10	4.50
3. Analytical/testing charges	0.18	0.34
4. Institutional consultancy (CSIR share) including know-how fee/job work	0.05	2.88
5. Sale of laboratory products	0.53	0.12
6. Miscellaneous receipts	6.10	5.70
	11.84	15.31
Indirect benefits		
1. Total number of processes in production	63*	71*
2. Value of production based on NCL know-how	1285.11	1562.12
3. Estimated saving in foreign exchange on account of above production	510.18	624.84

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

	1975-76	1976-77
4. Total number of NCL processes released and awaiting production		
(a) NCL processes	26	22
(b) Sponsored schemes	26	12
5. Total number of parties who have taken up NCL processes for exploitation	118	123
6. Total number of parties who have sponsored the processes	71	74
7. Total number of processes which were not released and which were available for commercial exploitation	44	43
8. Number of processes released during the year		
(a) NCL processes	15	9
(b) Sponsored processes completed/concluded	6	4
9. No. of processes newly added to the list of NCL processes available for exploitation	8	1
10. Papers published	57	71
11. Papers presented/read at symposia, seminars etc.	18	25
12. Doctorate and Masters degrees awarded	17	13
13. No. of recognized guides for Doctorate and Masters degrees	45	46
14. Patents		
(a) Indian patents in force	41	34
(b) Foreign patents in force	5	3

Premia and royalties received by NRDC through NCL processes

		(*Rs. in lakhs*)
(a) Premia	3.72	4.03
(b) Royalties	2.66	3.84
No. of processes assigned to NRDC	7	1

CUMULATIVE COST-BENEFIT DATA (1950-77)

COST		(*Rs. in lakhs*)
1.	Recurring expenditure	1256.19
2.	Capital expenditure	281. 17**
3.	Pilot plant expenditure	71. 47
	Total	1608.83

BENEFITS		
1.	Total money receipts	
(a)	Total premia earned by NRDC through NCL processes	22.19
(b)	Total royalties earned by NRDC through NCL processes	12.53
(c)	Total receipts from sponsors	81.66
(d)	Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sales of laboratory products and other receipts including job work	83.27
	Total	199.65
2.	Total value of production based on NCL know-how	6202.45
3.	Total No. of papers published	2982
4.	Total No. of papers presented/ read at symposia, seminars	157
5.	Total No. of degrees received	402

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

NCL EXECUTIVE COMMITTEE MEMBERS

1. Dr. B. D. Tilak (Chairman),
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6. Dr. R. B. Mitra,
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8. Administrative Officer,
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9. Sr. Accounts Officer,
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Process Release Committee

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10. Administrative Officer,
    National Chemical Laboratory,
    Poona

11. Mr. A. M. Lele (Member Secretary),
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    National Chemical Laboratory,
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