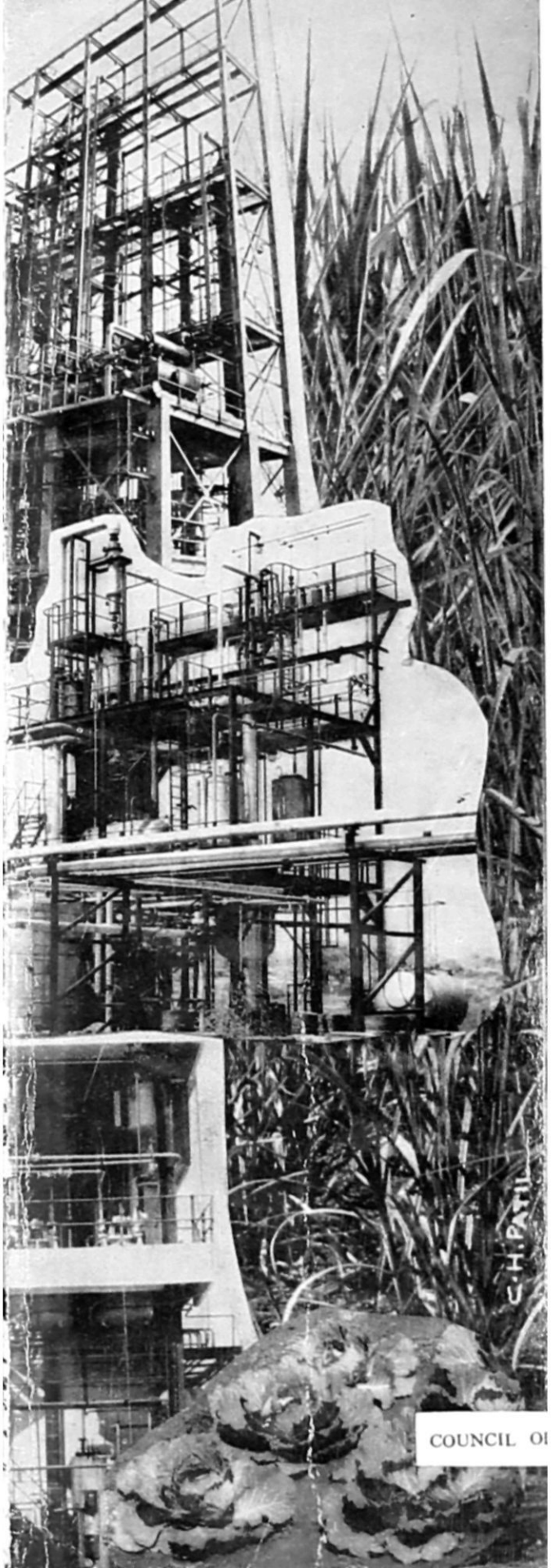


ANNUAL REPORT 1975-76

NATIONAL CHEMICAL LABORATORY POONA

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

NATIONAL CHEMICAL LABORATORY POONA 1975 - 1976

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Cover — Photo mural showing views of plants (Chlorobenzenes, Chloromethanes, Nitrile rubber, Monochloroacetic acid, Ethyleneoxide condensates, etc.) based on NCL Technologies; and applications of Tissue Culture techniques for Sugarcane and Cabbage cultivation.

'ublished by — Dr. B. D. Tilak,
Director, NCL

'ed by — M. S. Kirloskar
Kirloskar Press,
Veer Savarkarnagar,
Poona-411009.

CONTENTS

INTRODUCTION

I have great pleasure in presenting the NCL Annual Report for the year 1975-76. Projects identified by the National Committee of Science & Technology and those relevant to the socioeconomic needs of the country were given priority. The major fields of thrusts for NCL's effort during 1975—85 shall be as follows :—

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

2. Utilization of regenerative resources such as cellulosic materials.

3. Development of much needed technology for critical sectors such as health care (drugs & pharmaceuticals), defence, petrochemicals and polymers and elastomers.

4. Utilization of mineral resources.

5. Projects expected to bring economic benefits to economically backward sections of our society such as rural, backward and tribal populations. Assistance in the development of Chandrapur, a backward district in Maharashtra.

6. Development, absorption and improvement of indigenous technology especially in public sector enterprises with the view of its diffusion within India and eventual exports.

7. Contributions to frontiers of science and technology in areas such as –
   (a) Application of plant tissue culture to horticulture, agriculture and forestry.
   (b) Development and use of immobilized enzymes as industrial catalysts.
   (c) Use of solar energy in association with other CSIR laboratories.
   (d) Exploitation of renewable resources.
   (e) Catalysis and catalytic processes.
   (f) Development of innovative production technologies which will have export potential.

Work on a number of projects in the above fields has been taken up and their progress during 1975-76 has been described elsewhere in the report.

Awards

During the year, NCL and its scientists were receipients of some of the coveted awards for their outstanding contributions in the field of chemistry and chemical technology.

NCL received the award of Indian Merchants' Chamber for the year 1974 for its contributions in the field of chemical technology. Indian Chemical Manufacturers Association (ICMA) also honoured NCL by presenting it with a citation recording the valuable contribution made by the NCL in the design of a sophisticated fluidized bed chlorination reactor. Based on these designs M/s Standard Alkali, Bombay, in collaboration with NCL, successfully established and commissioned a 3000 TPA chloromethanes plant and for this work M/s Standard Alkali received the first ICMA award for Process Design and Process Engineering of Chemical Plants.

Dr. A. P. B. Sinha and Dr. H. B. Mathur received Shri Shanti Swarup Bhatnagar Awards for their outstanding contributions in the field of chemical science (the number of receipients of this award from the NCL so far is now 5). Dr. B. D. Tilak was awarded the H. K. Sen Memorial Medal for contributions to industrial research by the Institution of Chemists (India).

Research and Development Projects

In Chapter III, 134 applied and basic projects of the NCL have been classified under 19 areas. The major areas of product oriented/applied research remain the same as for the last year except for some minor realignments. The basic/fundamental research for each discipline has been allotted a separate area. Follow-up actions and Infrastructure Activities which were classified under two areas last year have been described under separate chapters.

There are 98 product oriented research projects in 19 areas. The numbers of such projects in each area are as follows : Petrochemicals and Bulk Organic Chemicals, 5; Pesticides and Agrochemicals, 20; Drugs, Dyestuffs and Fine Chemicals, 8; Organic Intermediates, 5; Utilization of Plant, Forest and Marine products, 12; Industrial Polymers, Elastomers and Resins, 10; Mineral Resources Utilization, 6; Industrial Inorganic and Organometallic Chemistry 12; Solid State Materials including Materials for Electronic Industry, 8; Plant and Animal Tissue Culture, 3; Fermentation technology, 2; Enzyme Technology, 4 and Development of Instruments, 3.

Rural Development Project (Chandrapur)

In accordance with the CSIR policy of adoption of backward districts in the country for the purpose of their integrated development through science & technology, the NCL, in collaboration with the Maharashtra Government is preparing an Eco-system Plan for development of Chandrapur district in Maharashtra. During the year under review four task forces namely forestry, agriculture, mining and mineral based industries and infrastructure have submitted their sectorial reports. A working paper has been recently prepared to assist the experts in identification of projects which may be included in the Eco-system Plan.

Details regarding the progress of Chandrapur Development Project have been given in Chapter V.

Patents

Three new Indian patents were filed during the year. As on 31st March 1976, 41 Indian patents (22 sealed and 19 filed) and 3 foreign patents were in force.

Basic Research and Publications

57 research papers were published during the year. The number of papers published in each area were as follows : Studies in chemical engineering, 9; Pesticides and agrochemicals 1; Utilization of plant, forest and marine products, 6; Studies in organic Chemistry, 11; Studies in polymer chemistry, 2; Mineral resource utilization, 1; Industrial inorganic and organometallic chemistry, 2; Studies in organometallic and inorganic chemistry, 4; Studies in solid state, thin films, physical chemistry and properties of materials, 21, NCL scientists also presented 18 research papers at various symposia and seminars.

17 NCL staff members, research fellows and guest workers received post-graduate (Ph.D.) degrees during the year. 45 NCL scientists are recognized as research guides by different Indian Universities.

Consultancy

During the year institutional consultancy was offered to two public sector companies (Hindustan Antibiotics Ltd., Pimpri and Hindustan Organic Chemicals Ltd., Rasayani) and five private sector industries through individual and group of scientists. 14 NCL scientists acted as consultants.

Staff

In this annual report we have published for the first time a staff list under various categories giving names of the scientists (from Director to Senior Laboratory Assistant level) and senior staff from the Infrastructure and Administrative groups. The total staff strength is 893 of which scientists are 376 (42%), technical 212 (24%) administration 99 (11%), class IV technical and non-technical, 206 (23%). There are 87 research fellows, pool officers, guest workers and graduate trainees.

Executive Committee and Advisers

The Executive Committee, Process Release Committee and Advisory Panels were reconstituted during the year. Names and addresses of the members of the reconstituted bodies have been given at the end of the report.

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 6 new items— Cationic dyes for acrylic fibres, diazepam, glyceryl-α-mono-*p*-aminobenzoate, monochloroacetic acid, monoethylaniline and l-naphthyl-acetic acid. For the first time production was reported by S. H. Kelkar & Co., for β-ionone and by M/s Maize Products, Ahmedabad for sorbitol. Total number of processes in production during 1975-76 were 63 with a turnover of Rs. 12.75 crores as against 60 processes with a turnover of Rs. 10.98 crores in 1974-75. The cumulative annual production for the period 1950-76 is Rs. 46 crores.

Table II lists 52 processes (released to 49 parties) that have not yet gone in 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 14 processes have been given in Table IIA. The number of processes released during the year 1975-76 were 21.

A review of research utilization of the processes developed by the NCL on its own from 1969-70 onwards has been presented in Table III. As on 31st March 1976, 130 processes were developed by the NCL of which 41 are in production, 45 released and awaiting production and 44 not yet released. The production value (41 processes) was Rs. 8.8 crores during the year. The status of the processes developed under sponsorship has been analysed

in Table IV. So far 73 processes have been developed on behalf of 71 parties. Of these 22 are in production, value of their output during the year was Rs. 3.9 crores. During 1975-76 work on 6 sponsored schemes was completed, 5 new schemes were undertaken and 3 schemes were continued from the last year.

Table V lists 108 NCL processes for which know-how is available to the prospective entrepreneurs. 7 processes were assigned to the NRDC during the year.

Premia/Royalties

The total amounts of premia and royalties received by the NRDC in 1975-76 on account of the NCL processes were respectively Rs. 3.72 lakhs and Rs. 2.66 lakhs as against Rs. 2.90 lakhs and Rs. 1.57 lakhs received during 1974-75.

Cost-Benefit Data

A comparative cost benefit data for the years 1974-75 and 1975-76 giving the direct and indirect benefits and cumulative cost benefit data (1950-76) appear on pages 136 and 138. During the year under review the total expenditure was Rs. 162.38 lakhs (Rs. 124.71 lakhs recurring and Rs. 37.67 lakhs capital). As against this the receipts were Rs. 11.84 lakhs. The value of production on account of 63 processes in production was Rs. 1275 lakhs. The estimated savings in foreign exchange due to this production is about Rs. 510 lakhs.

October, 1976
NCL, Poona

B. D. Tilak
Director

AWARDS TO NCL

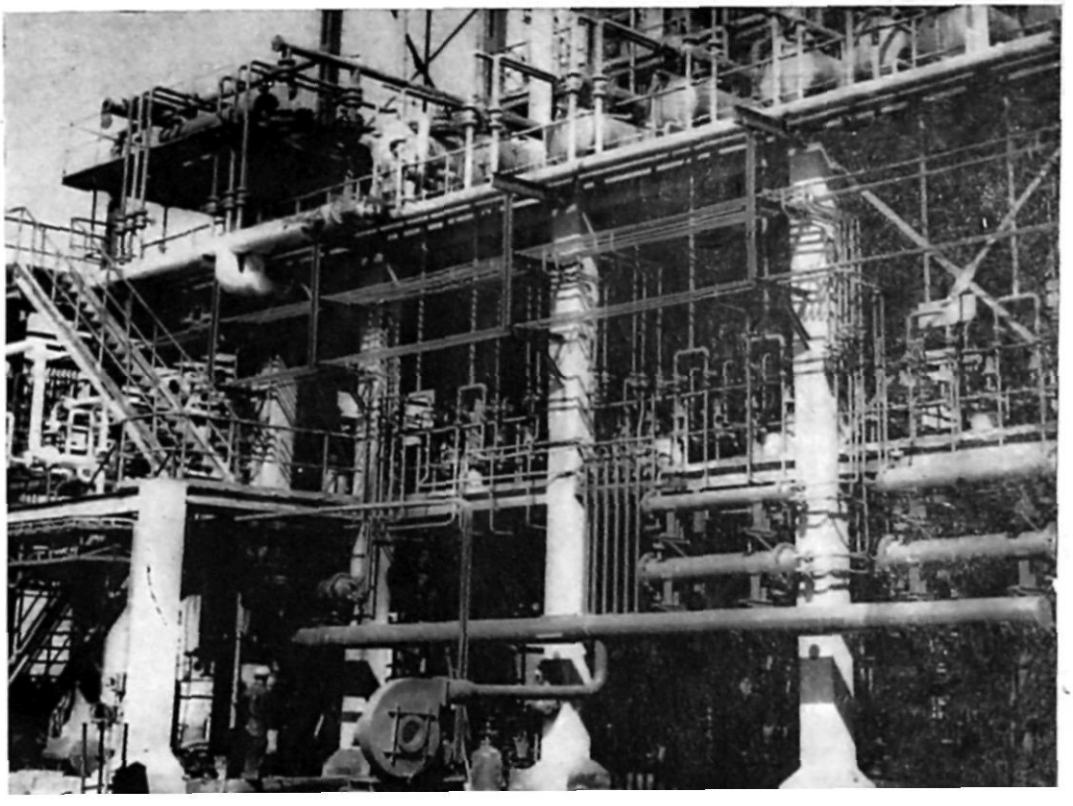
THE INDIAN MERCHANTS CHAMBER AWARD

The Indian Merchants' Chamber Award for the year 1974 for outstanding Research and Development contribution in the fields of chemical technology was awarded to the National Chemical Laboratory, Poona.

THE I. C. M. A. AWARD

The First Indian Chemical Manufacturers' Association (I. C. M. A.) award for Process Design and Process Engineering of Chemical Plants has been conferred on M/s. Standard Alkali, Bombay for outstanding process design and engineering of the plant designed to manufacture chloromethanes from by-products Methane and Chlorine. The Indian Chemical Manufacturers' Association while conferring this Award, recorded the valuable contribution made by the National Chemical Laboratory, Poona, for conceptualising the basic idea and evolving procedures for the design of the complicated and sophisticated fluidized bed chlorinator reactor. This joint collaborative effort of the two organizations also highlights the successful transfer of technology from a National Research Laboratory to a manufacturing industry plant.

Dr. L. K. Doraiswamy receiving the I. C. M. A. award to NCL at the hands of Shri. P. C. Sethi, Union Minister for Chemicals and Fertilizers



A view of Chloromethanes plant of M/s Standard Alkali (Thana-Belapur Road, Bombay)
Capacity : 3000 Tonnes Per Year

SHANTI SWARUP BHATNAGAR AWARD TO NCL SCIENTISTS

The Shanti Swarup Bhatnagar Prize for Chemical Sciences for the year 1972 was given to Dr. A. P. B. Sinha (jointly with Dr. S. V. Kessar of Punjab University) for his outstanding contribution in Solid State Chemistry.

The Shanti Swarup Bhatnagar Prize for Chemical Sciences for the year 1973 was given to Dr. H. B. Mathur (jointly with Prof. M. V. George of the Indian Institute of Technology, Kanpur) for his significant contributions in Physical Chemistry,

PREVIOUS BHATNAGAR AWARD WINNERS

1. Dr. S. C. Bhattacharyya (1962)
2. Dr. B. D. Tilak (1963)
3. Dr. Sukh Dev (1964)

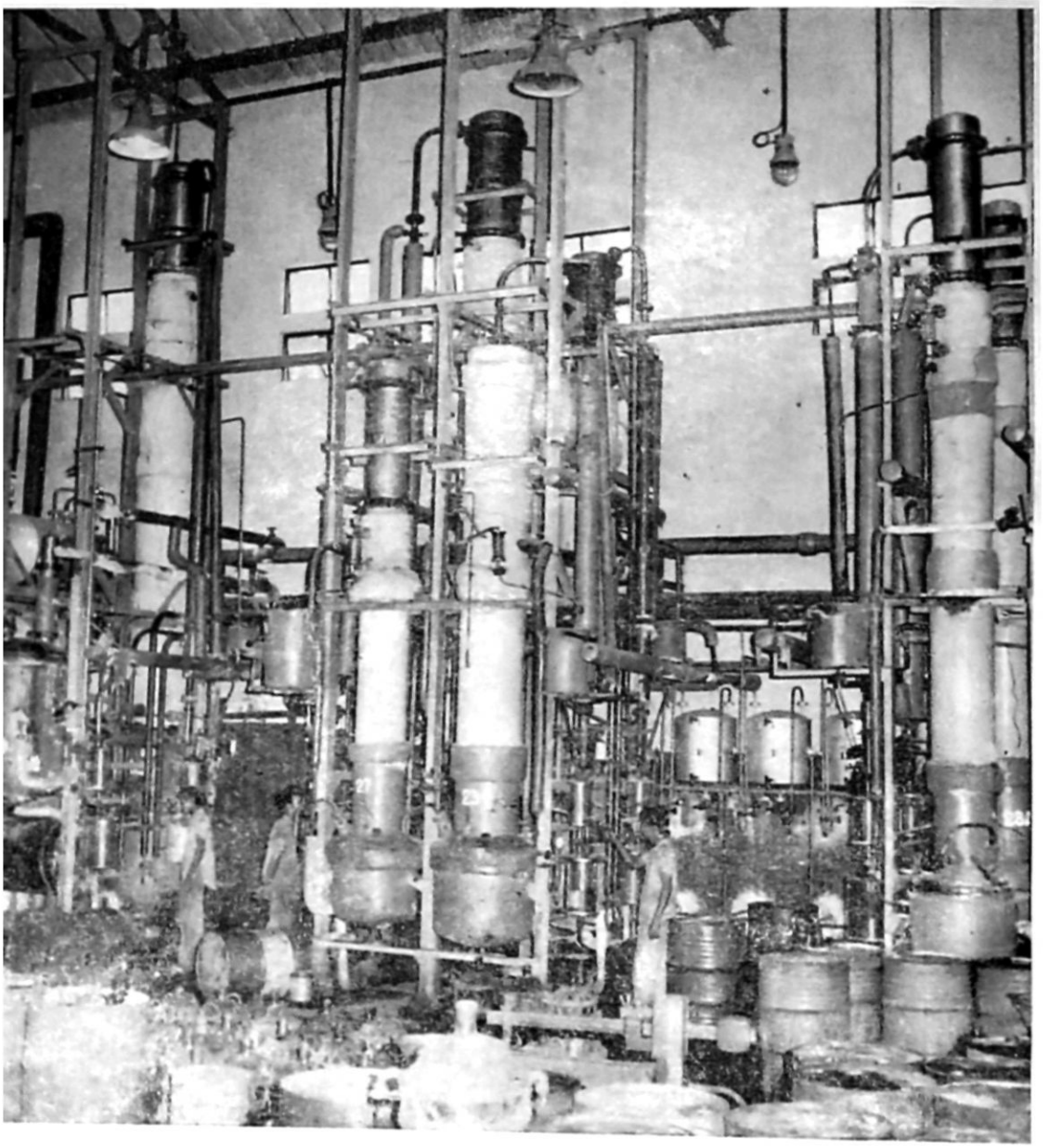
H. K. SEN MEMORIAL AWARD

Dr. B. D. Tilak was awarded the H. K. Sen Memorial medal (1975) for contributions to industrial research by the Institution of Chemists (India), Calcutta.

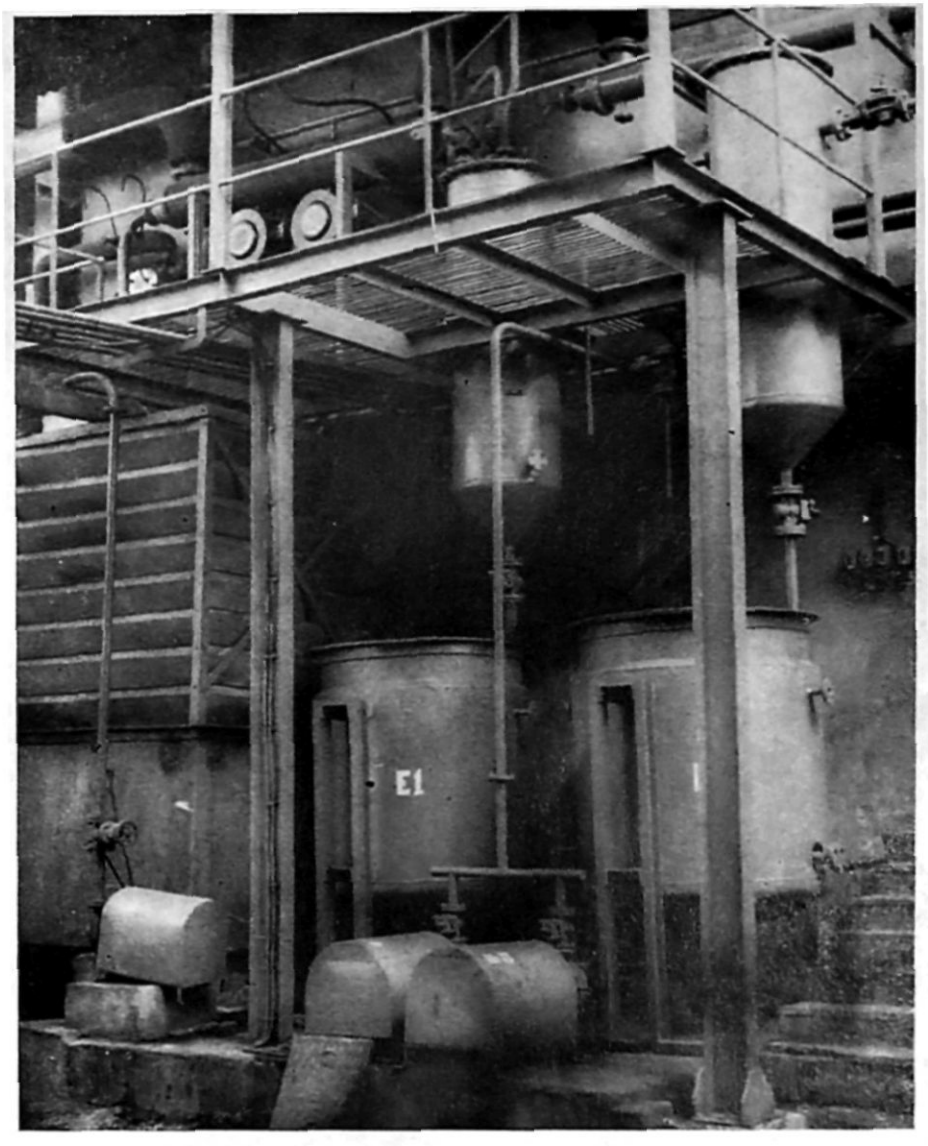
PRESENTATION OF SHANTI SWARUP BHATNAGAR AWARDS TO N. C. L. SCIENTISTS

Dr. A. P. B. Sinha

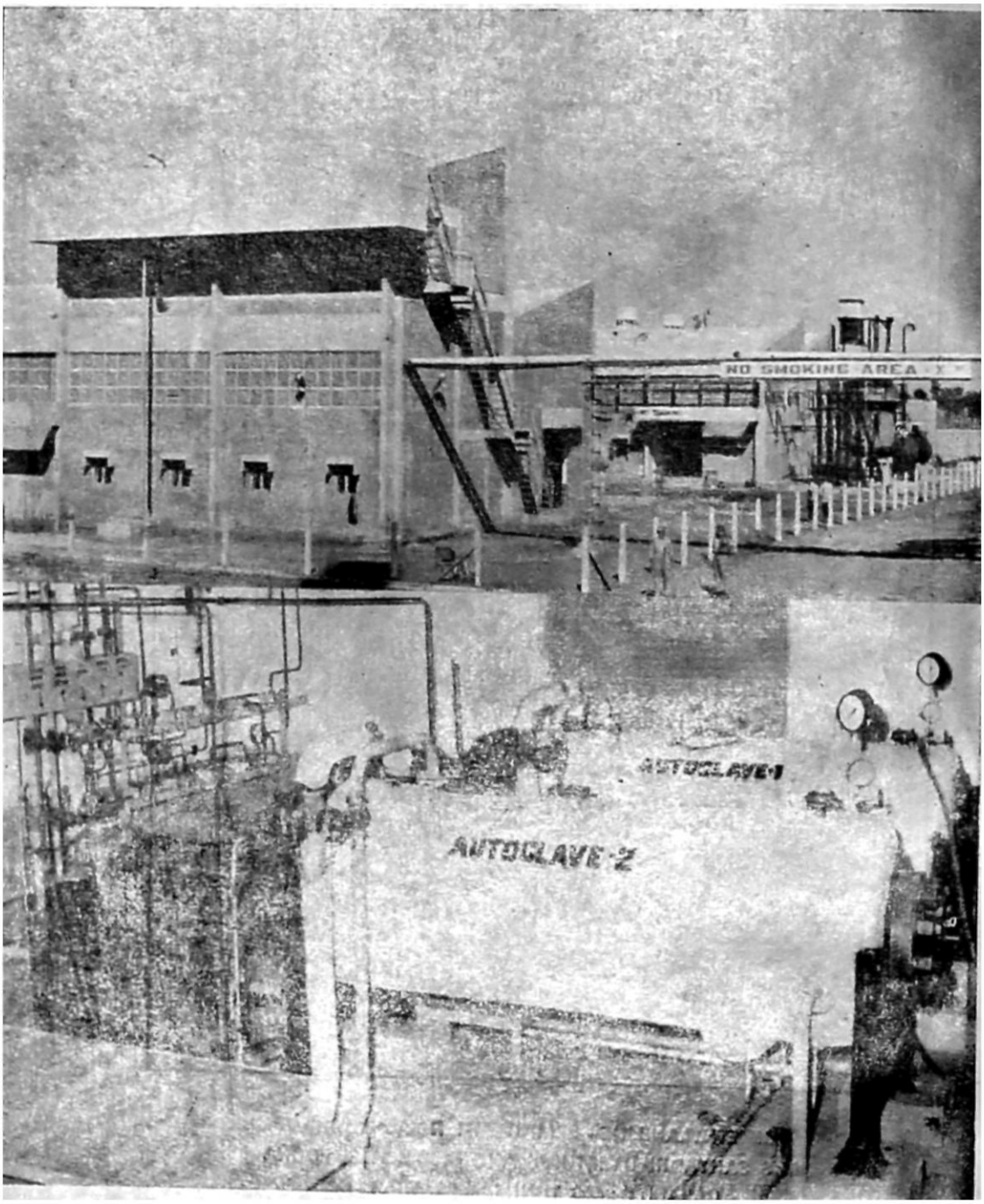
Dr. H. B. Mathur



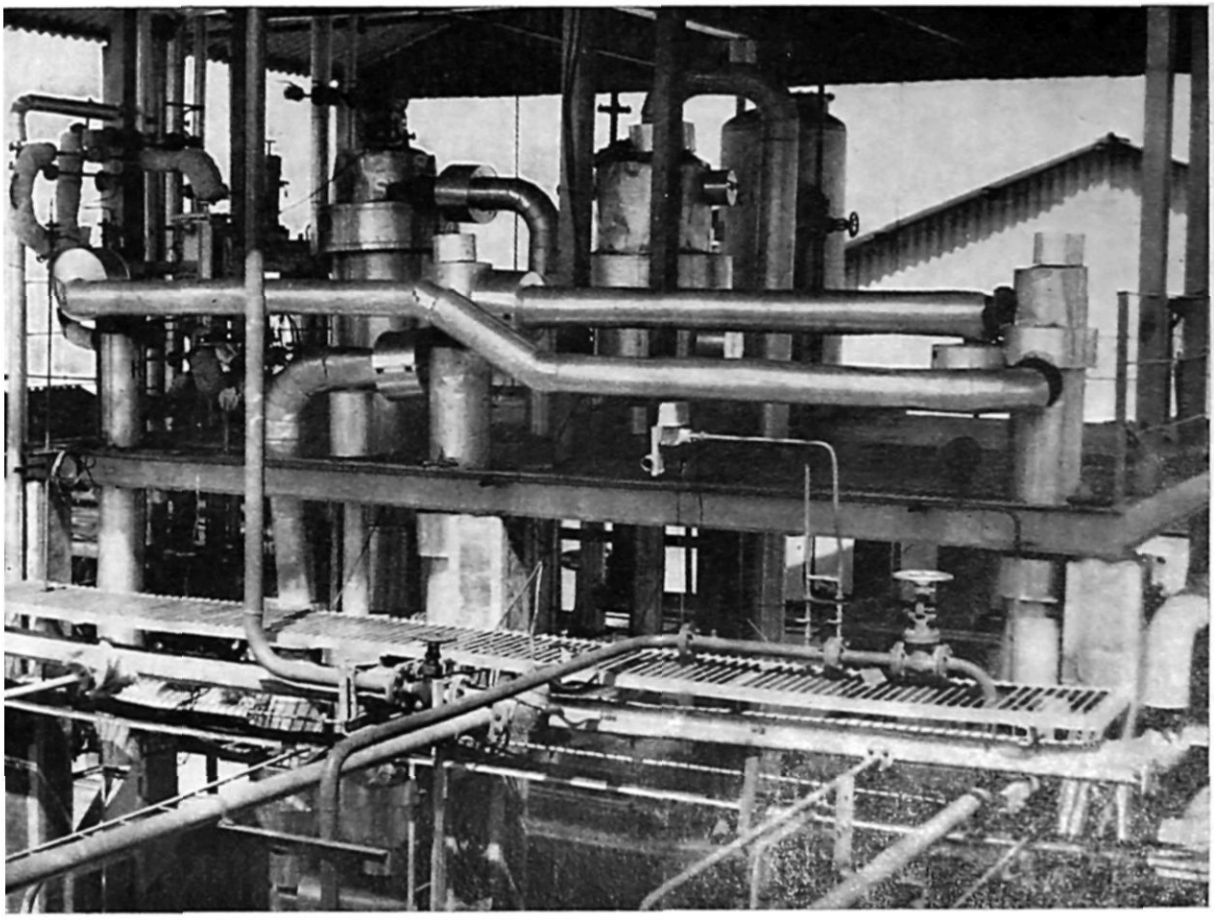
β-IONONE PLANT OF
M/S INDUSTRIAL PERFUMES LTD., BOMBAY
CAPACITY : 80 TONNES PER YEAR



DIMETHYLANILINE - SEMI COMMERCIAL PLANT OF
M/S SAHYADRI DYESTUFFS AND CHEMICALS, POONA
CAPACITY : 400 TONNES PER YEAR

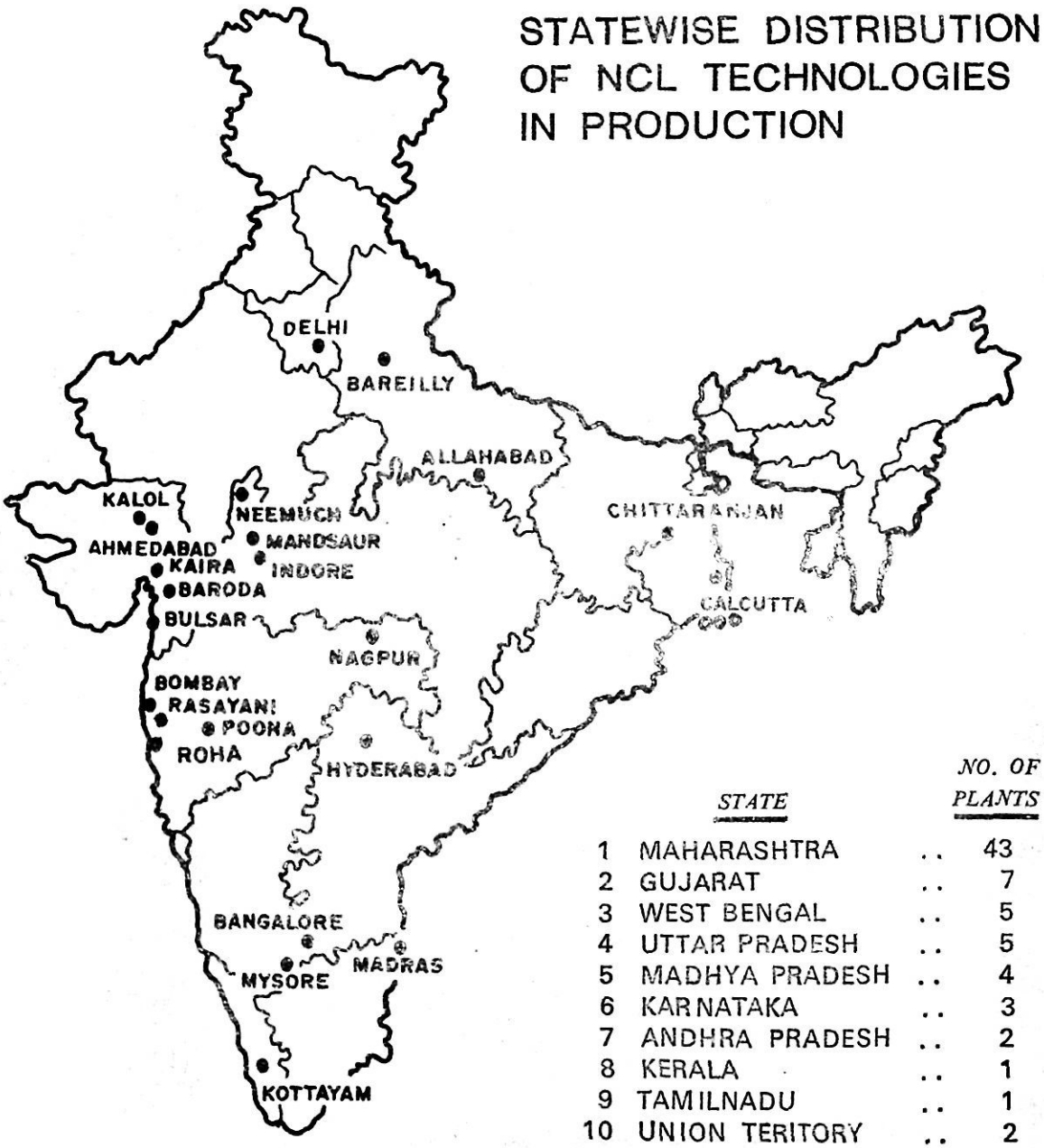


SECTION OF THE SORBITOL PLANT OF
M/S MAIZE PRODUCTS, AHMEDABAD
CAPACITY : 2000 TONNES PER YEAR
(PLANT COMMISSIONED RECENTLY)



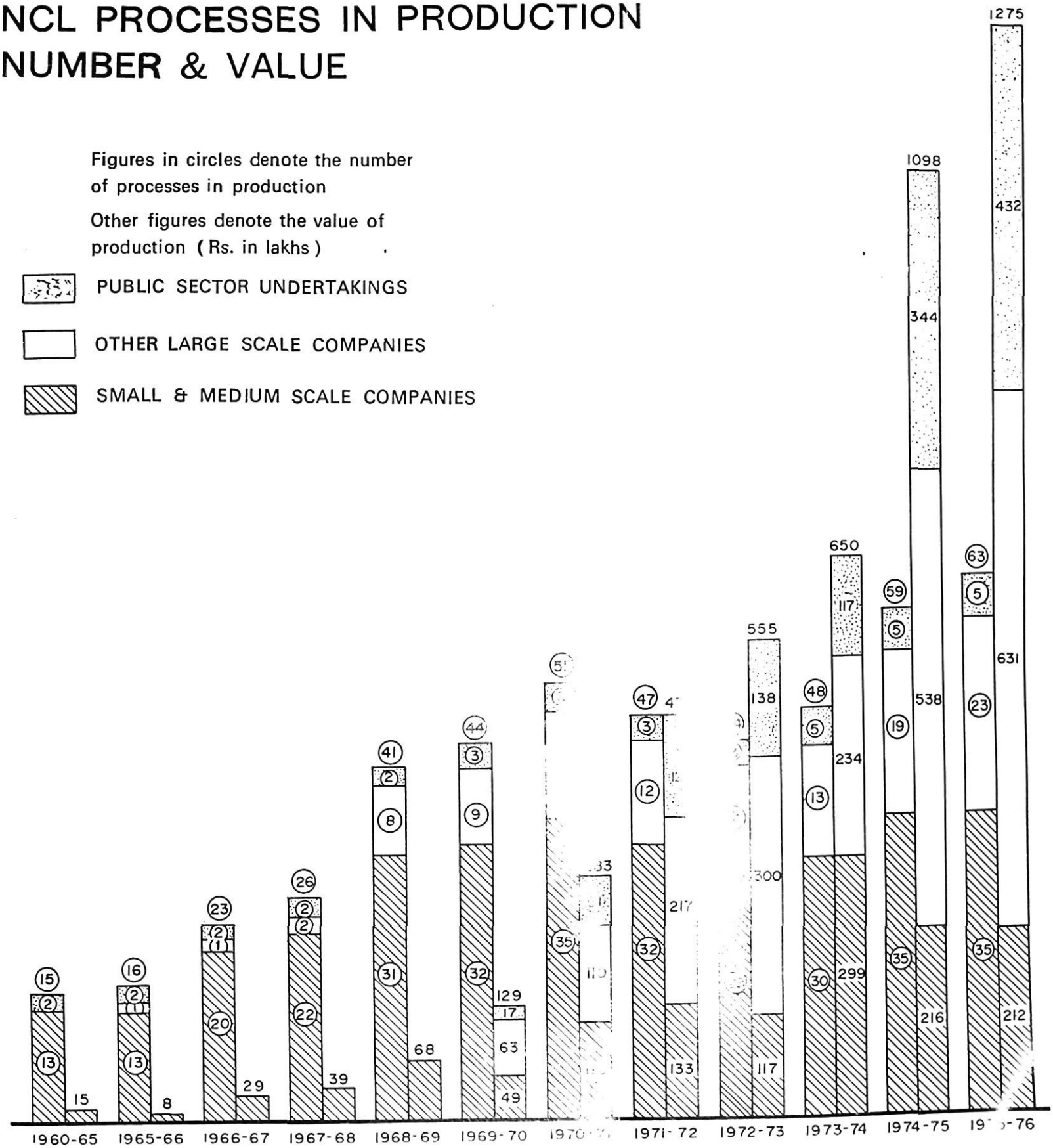
TOLUIDINES PLANT OF
M/S SUDARSHAN CHEMICAL INDUSTRIES LTD., ROHA, (MAHARASHTRA STATE)
CAPACITY : 250 TONNES PER YEAR
(PLANT COMMISSIONED RECENTLY)

STATEWISE DISTRIBUTION OF NCL TECHNOLOGIES IN PRODUCTION



	STATE		*NO. OF PLANTS*
1	MAHARASHTRA	..	43
2	GUJARAT	..	7
3	WEST BENGAL	..	5
4	UTTAR PRADESH	..	5
5	MADHYA PRADESH	..	4
6	KARNATAKA	..	3
7	ANDHRA PRADESH	..	2
8	KERALA	..	1
9	TAMILNADU	..	1
10	UNION TERITORY	..	2

NCL PROCESSES IN PRODUCTION NUMBER & VALUE



RESEARCH AND DEVELOPMENT PROJECTS

1. PETROCHEMICALS AND BULK ORGANIC CHEMICALS

1.1 *Propylene oxide* : (1/I/70-SP)

This sponsored project has been undertaken to develop the know-how for propylene oxide from propylene, which will be available with the sponsor. The process development and the collection of data necessary for engineering the process have been mostly completed. Some work on choice of reactor material is in progress.

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

Acrylic esters are extensively used in various plastics, which in turn find use in polymer, paint, paper, textile, leather and allied industries. Methyl acrylate is used in the manufacture of acrylic fibres.

Development of processes on butyl and octyl acrylates has been reported earlier. More design data were collected on these two acrylates and acrylic acid.

Bench scale experiments were successfully carried out also for methyl and ethyl acrylates. The design data required for the commercial plant has been collected. The sponsor as well as its project engineering company have been closely associated with the investigation.

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

The conventional sulphonation alkali fusion route is generally used for the production of synthetic cresols and naphthols. It is likely that the cymene based process for cresols, similar to manufacture of phenol from cumene may also be an attractive possibility.

The work on alkylation of naphthalene has been reported earlier. During the year under report, experiments on alkylation of toluene to cymene were undertaken.

Experiments on the hydroperoxidation of cymene under different operating conditions were carried out. The effect of different purification methods for cymene on the rate and extent of hydroperoxidation was studied. The purity of cymene was found to have considerable influence on the progress of the reaction. The effect of different initiators and catalyst on the reaction was noted. The feasibility of recycling various streams in different steps of the process will be studied.

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

Industrial processes for a number of organic intermediates involve liquid phase catalytic hydrogenation. The technique is also effectively employed to obtain many commercially important amines from the corresponding nitro compounds. This method is preferable to the conventional iron-acid reduction process since the latter poses problems of handling of large solvent volumes and disposal of iron sludge, as also gives lower yield and less purity of the amines.

Development of metanilic acid from *m*-nitrobenzene sulphonic acid was reported earlier. Processes for the catalytic reduction of *p*-aminoazobenzene to *p*-phenylenediamine and *o*-nitrophenol to *o*-aminophenol are being standardized.

1.5 *A catalyst for disproportionation of toluene* : (5/I/75)

Disproportionation of toluene is of interest as it yields industrially important xylenes. The conventional method is based on homogeneous catalysts in the form of acidic halides. This reaction is accompanied by sludge formation and loss of catalyst.

With a view to develop a continuous vapour phase reaction for the disproportionation using heterogeneous catalyst, a reactor assembly was built. On line GLC unit was set up for quick analysis of the reaction product. A few trial runs were carried out with a synthetic zeolite catalyst which is being developed.

2. STUDIES IN CHEMICAL ENGINEERING

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

2.1.1 *Solid-solid reaction*

A detailed mathematical analysis of solid-solid reactions in the pelletted form was carried out. The model proposed was tested with reported EPMA data. Experimental work is also in progress on the systems $CuO - Fe_2O_3$ $CuO - Cr_2O_3$ using electron probe microanalysis (with the assistance of BARC).

2.1.2 *Gas-liquid reactions*

A generalized theory was proposed for gas liquid reactions based on the concept of catalytic reactions. Under certain well defined conditions the equations developed degenerate into those for catalytic systems. The work is being extended to include solid-solid reactions as well.

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. Experimental data on the aqueous phase oxidation of phenol, a common pollutant, were available; as such, in order to have better insight into the problem, theoretical analyses were performed on critical catalyst concentration, intra-particle diffusional effects and usage of inhibitors in aqueous phase phenol oxidation. Insight is thus obtained on improving selectivity and kinetic chain length in liquid-phase hydrocarbon oxidations.

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

The effect of enzyme inactivation on substrate conversion in fixed, moving and fluid-bed reactors is being theoretically investigated for both simple and complex reactions. Enzyme denaturation (exponential inactivation) and loss of immobilized enzyme from support (linear inactivation) are possible mechanisms of enzyme inactivation which are being studied.

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

The following theoretical and experimental studies in the field of catalysis were carried out :

(i) Several reactor assemblies were set up for testing a variety of catalysts for the aniline project. Those that were found acceptable by the initial screening tests were passed on to HOC Ltd., for continuous pilot plant trials.

(ii) Gas chromatographic studies were carried out on the isomerization of n-butene using a fluorinated alumina catalyst with the object of determining the adsorption equilibrium constant of isobutene, and comparing the values thus obtained with the value determined from purely kinetic studies. This was done with the object of evaluating the reliability of kinetic modelling by statistical procedures. The results have shown that the statistical modelling procedures can give acceptable rate equations.

(iii) Effective diffusivities of butenes in fluorinated alumina were determined by gas chromatography. The values obtained were compared with those predicted from physical diffusion models and one of these models was shown to be the most reliable.

(iv) A theoretical analysis of the effect of *a priori* heterogeneity on the adsorption isotherms was carried out. An original classification of adsorption integral equation into infinite and finite limit problems was suggested. New methods (using Hilbert transforms) were developed for solving both the cases. When the distribution characterizing the surface is nonanalytic it was shown that by using a mean value theorem of the Stieltjes integral the most general isotherm for a heterogeneous surface can be deduced, which explains many apparent paradoxes of heterogeneous kinetics. The case of chemisorption in the presence of chemical reaction was analysed and certain novel results arrived at using the theory of Stieltjes transform.

(v) A transient analysis of a gas solid stirred reactor with positive and negative step inputs of the adsorbent tracer was attempted. Methods were proposed by which adsorption and desorption kinetics can be deduced independently.

(vi) Experimental data were obtained on mass transfer to a rotating disc coated with naphthalene. These experiments confirmed the applicability of the boundary layer theory to catalysis. Further experiments are planned with a catalytic disc.

(vii) Several experiments were carried out to elucidate the role of catalyst poisoning in the vapour phase reduction of nitrobenzene to aniline. These experiments were primarily restricted to feed stock with known quantities of trace impurities.

3. PESTICIDES AND AGROCHEMICALS

3.1 *Dichloropropionic acid* (*Dalapon*) : (1/III/72)

A process for the preparation of dalapon optimized earlier was demonstrated to industry. The process has been released to two parties, one of which has commenced trial production.

3.2. *Pyrethrins* : (2/III/73)

Pyrethrin is a natural insecticide extracted from *Pyrethrins diasies*, grown mainly in East African countries.

A new synthesis of (—) - dihydrochrysanthemolactone, the key intermediate for the synthesis of (+) - *trans*-chrysanthemic acid and the synthesis of methyl (—) - *cis*-chrysanthemate from (+) - 3-carene was established on laboratory scale. The synthesis of *trans*-chrysanthemic acid based on ketone addition to a diene was explored, but the results were not encouraging.

3.3 *Endosulfan* : (3/III/73)

Endosulfan is an excellent broad spectrum contact insecticide with low toxicity to vertibrates. Its requirement by 1978-79 is estimated at 1600 TPA of technical material valued at Rs. 14.5 crores of formulated product. Endosulfan is not manufactured in the country and the demand is met through imports.

The laboratory has developed a process for the manufacture of this insecticide, as reported last year. During the period under review, further studies were carried out on the disposal of waste products and floor washings. The technology has now been released to industry.

The laboratory has offered this technology as a turn-key bid with performance guarantees, through a project engineering firm.

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

Carboxin, a modern fungicide is selective against pathogens without causing injury to hosts. Its requirement in 1975-76 is estimated at 5 TPA valued at Rs. 15 lakhs, which is likely to increase upto 50 TPA by 1978-79. Carboxin is not manufactured in India.

Starting from acetoacetanilide, preparation of carboxin was standardized on a laboratory scale earlier. Work was continued on the project with a view to improve the efficiency of the process. Further scale up work is in progress.

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

Ethephon is a plant growth regulator. The present requirement for ethephon, cycocel, 1-naphthylacetic acid and other plant growth regulators together is estimated at 50 TPA.

The preparation of ethephon has been standardized. The process is based on phosphorus trichloride and ethylene oxide which are indigenously available. The product meets the desired specifications and the field trials on rubber plants conducted at Rubber Research Institute, Kottayam were successful. The trials on other plants are being carried out. After receiving the test reports, the know-how will be released to industry.

3.6 *Paraquat* : (6/III/74)

Process development work on paraquat was continued.

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

Fenitrothion is a contact insecticide, selective acaricide with low toxicity to mammals. It is used for controlling chewing and sucking insects on rice, orchard fruits, vegetables, cereals and cotton. Present demand for this insecticide is estimated at 600 TPA of the technical product valued at Rs. 4.2 crores as formulated material. It is estimated that by 1978-79 the requirement of fenitrothion, methyl-*o*-dimeton and parathion together would be 2000 TPA.

Pilot plant experiments on 10 kg/batch scale have been carried out to prepare fenitrothion from 4-nitro-3-methyl-phenol. Further work is in progress.

3.8 *Propanil* : (8/III/74)

Propanil is a selective weedicide used for killing barnyard grass and various other weeds in rice. The demand for this weedicide is 25 TPA valued at Rs. 4.2 lakhs.

Process development work for its preparation starting from *p*-chloronitrobenzene was continued.

3.9 *Phosalone* : (9/III/74)

Phosalone, a contact and injective acaricidal insecticide, is a promising substitute for DDT and other persistent chlorine containing insecticides. The present demand is 250 TPA valued at Rs. 87 lakhs. By 1978-79, the requirement is likely to be around 400 TPA.

A few more batches on the preparation of phosalone were carried out on 1 kg/batch scale. Further work has been temporarily discontinued until active user participation is forthcoming.

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

This is an excellent systemic insecticide/acaricide which is used to control a wide range of insects, mites and on many vegetables, cotton, sorghum, apples, safflower, wheat, oranges, grape fruits, etc. Dimethoate is widely used in India. Present demand of dimethoate is 800 TPA valued at Rs. 5.86 crores, which is likely to increase upto 1000 TPA by 1978-79.

A laboratory scale process developed earlier is being standardized further.

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

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

Process development work on preparation of chlordane has been undertaken and the know-how standardized on a laboratory scale. Scale up work is in progress.

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

Imidan is an insecticide useful in controlling pests which are usually encountered during cultivation of paddy. It is used for the control of codling moth, apple maggot, rosy aphids, pear psylla and many other insect pests of tree fruits and nuts.

Starting from phosphorus pentasulphide and phthalic anhydride, a laboratory process for the preparation of imidan has been developed. Scale up work is in progress.

3.13 *Utilization of non-γ-BHC* : (13/III/75)

3.13.1 *Trichlorobenzene*

Trichlorobenzenes obtained by the chlorination of technical *ortho*-dichlorobenzene usually contains dichlorobenzenes and tetrachlorobenzenes. Trichlorobenzene is a useful industrial solvent. 1, 2, 4-Trichlorobenzene is a valuable starting material for the acaricide, tetradifon.

A process has been developed for the manufacture of trichlorobenzene from non-γ-BHC on 75 kg batch scale.

Work is also in progress for the preparation of pure 1, 2, 3 - and 1, 2, 4 - trichlorobenzene.

3.13.2 *Hexachlorobenzene, pentachlorophenol and pentachlorothiophenol*

Hexachlorobenzene is a useful seed disinfectant. Pentachlorophenol is valuable as a contact herbicide and wood preservative. Pentachlorothiophenol is used as a peptizer for natural and synthetic rubber.

The demand for pentachlorophenol and pentachlorothiophenol is of the order of 300 TPA and 250 TPA respectively.

Preliminary work has indicated that hexachlorobenzene could be obtained from non - γ - BHC in 75% yield. Hexachlorobenzene was converted into pentachlorothiophenol in 75% yield. Further work is in progress.

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

Butenediol is used as an intermediate in the production of an insecticide-endosulfan, butadiene diepoxide and polyurethane structural laminates with high flexural strength and modulus. At present it is not produced in the country. The demand is estimated at 2000 TPA valued at Rs. 6 crores. The endosulfan plants which are being put up in the country have to depend on imported butenediol. The project has therefore been taken up for achieving self sufficiency.

The commercial synthesis of butenediol is a two stage process : first the reaction of acetylene with formaldehyde to give butynediol and second, the partial hydrogenation of butynediol to butenediol. Investigations were undertaken on the first step at atmospheric pressure with a specially prepared catalyst. Studies on the hydrogenation of 2-butyne 1, 4 diol to 2-butene 1, 4 diol were also carried out.

A proposal for the joint development on a pilot plant scale has been submitted to industry.

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

HCCP is an intermediate used in the manufacture of pesticides (e. g. endosulfan and chlordane) which are expected to be produced in India in the next few years. The estimated demand in the country by 1980 is about 3000 - 4000 TPA. It is produced starting from dicyclopentadiene (DCPD) which is likely to be available indigenously in the near future. A process for the manufacture of HCCP is being standardized. Based on the data collected, a pilot plant has been designed and is being constructed.

A proposal for the establishment of a semi-commercial plant for HCCP has been submitted to industry.

3.16 *Peptidic juvenile hormones* : (16/III/76)

Peptidic juvenile hormones were prepared in order to find out their application as a third generation pesticide.

AGROCHEMICALS BASED ON NATURAL PRODUCTS

3.17 *Insect hormones and pheromones* : (17/III/72)

Attempts are being made to prepare juvenile hormone mimics from suitable natural products and their juvenile hormone (JH) activity is being studied.

Preparation and testing of 17 compounds from geraniol series was reported earlier. Eighteen more compounds belonging to geraniol series and 2 compounds belonging to the indene series were prepared. Preparation of some compounds synthesized earlier was repeated to get additional quantities required for testing. The compounds were tested for JH activity against red cotton bug (*Dysdercus koenigii*) in the entomology unit set up in the laboratory. All compounds showed activity at the dosage of 10μg/nymph. Detailed investigation on activity of some of the compounds is under progress.

Extracts of some plants, *Lantana camara*, *Parthenium hysterophorus* Linn, *Oscimum basilicum*, *Salvia officinalis* were screened for JH activity. Extracts from the roots of the last mentioned only showed some activity.

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

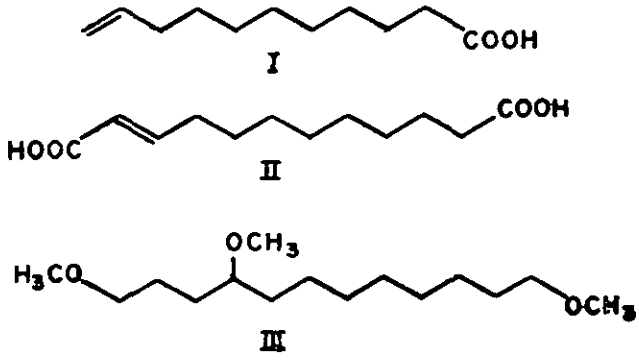
There were reports from field trials that the addition of neem oil and cake has a slow release effect on nitrogenous fertilizers added to the soil. The project has been undertaken to verify this observation.

Different solvent extracts of neem oil and neem cake were added to ammonium nitrate and cultured separately with each of the two types of bacteria, Nitrosomonas and Nitrobacter, which are involved in the utilization of nitrogenous fertilizers. It was found that certain concentrations of some of the extracts inhibit the growth of the bacteria. Further work is being done to fractionate the inhibiting fractions and find out their chemical constituents.

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

Castor oil is one of the cheaper commercial vegetable oils available in large quantities in India. Undecylenic acid (I) is an important pyrolysis product of castor oil and finds use in the perfumery industry. More sophisticated uses for the substrate (I) relatively cheap and abundant, were sought for

while developing newer aspects of the chemistry and utilization of castor oil. Thus in the area of drugs, an efficient undecylenic acid based synthesis of a prostaglandin synthon was worked out. The C_{11} - acid (I) has now been further exploited for the development of new potential agrochemicals (as insecticides, juvenile hormone analogues and pheromones).



A tetrachloroisobutylamide was synthesized from the CCl_4 adduct of (I) thus incorporating two toxophoric groups at the terminal positions of a long chain. Several dodecane based polyethers were synthesized from the C_{12}-acid [(II) optimum chain length for JH activity; easily accessible from (I) by a 3-step route] as potential JH analogues. Bioassay of these compounds, was carried out on the red cotton bug (*Dysdercus koenigii*) and at least one compound (III) has shown good JH activity. Further biological testing work on these compounds (specially against mosquito larvae) is in progress.

3.20 *Plant growth regulators* : (20/III/76)

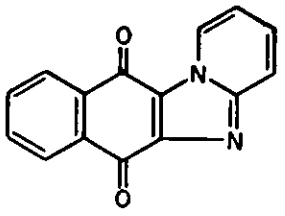
Work on N, N-dimethylaminosuccinamic acid (Alar-85) which promotes flowering in apples, enhances fruit set in grapes, increases yields and imparts drought resistance to groundnuts and potatoes etc., has been initiated. Simultaneously, literature survey on Gibberellic acid, a plant growth hormone which has revolutionized the production of seedless grapes, has also been conducted.

4. DRUGS, DYESTUFFS AND FINE CHEMICALS

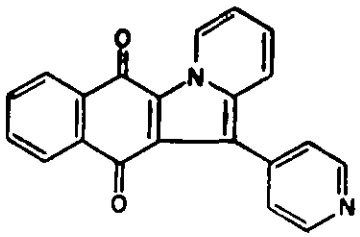
4.1 *New disperse and reactive dyes and pigments* : (1/IV/70)

Disperse Blue 20 is reported in Colour Index to be an aminonaphthoquinone derivative. Reaction sequences involved in the preparation of similar dyes from 1, 5-dinitronaphthalene are being studied.

Studies have been continued on the synthesis of new disperse dyes involving heterocyclic ring systems. In addition to the phthaloylazapyrrocolines (I), the new phthaloyl pyrrocoline (II) has also been synthesized.



I



II

Both (I) and (II) can be quaternized with methyl iodide.

In order to investigate the mode of reaction of reactive disperse dyes containing sulphonazido groups with polyester fibres, thermal decomposition of *para*-toluenesulphonazide in dimethyl and diethyl terphthalate was carried out. It was shown that the insertion of the generated nitrene takes place in the phenyl ring of the terphthalate moeity.

Structure determination of commercial disperse dyes is in progress.

4.2 *Synthesis of potential pharmacologically active substances* (*Furoseamide*) : (2/IV/71—SP)

A laboratory process for the preparation of this drug has been developed. The scheme is now concluded.

4.3 *Prostaglandins* : (3/IV/72)

Prostaglandins exhibit diverse biological properties.

As reported earlier, a new route to synthesize prostanoids *via cis-cis* muconic acid was taken up for developmental work. A lactone acid which is an intermediate for the synthesis of prostaglandins was prepared from the acid.

4.4 *Cephalexin and 7-ADCA/Carbenicillin* : (4/IV/73)

As desired by the sponsor the scheme was concluded. However, further work has been undertaken by NCL on its own.

There is a considerable demand for semisynthetic penicillins such as carbenicillin disodium.

Carbenicillin prepared *via* acylation of 6-APA with phenylchlorocarbonylketene is of low biological activity. In an alternative route, phenylmalonic acid monobenzyl half ester was prepared and used for acylating 6-APA.

4.5 1, 4 - *Benzodiazepines* (*Diazepam and Chlordiazepoxide*) : (5/IV/73)

Process for the anti-anxiety drug diazepam from 2-methylamino-5-chlorobenzophenone was standardized and released to three parties.

Chlordiazepoxide is another important anti-anxiety drug. Its estimated demand is around 6 to 8 TPA.

A process for the preparation of chlordiazepoxide (1 kg scale) has been worked out. The process for the preparation of chlordiazepoxide hydrochloride is being optimized.

4.6 *Antrycide pro-salt* : (6/IV/75)

This drug is essential for preventing loss of cattle due to trypanosomasis. The estimated demand is around 10 TPA valued at Rs. 1.3 crores. There is no indigenous production and the present requirement is met by imports.

The preparation of this important veterinary drug consists of ten steps. All the steps were investigated on the laboratory scale and optimum reaction conditions are being standardized. The drug has been prepared in small quantities.

4.7 *Naproxen* : (7/IV/76)

Preparation of naproxen, a useful anti-rheumatoid drug is under investigation.

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

Nitrazepam is one of the newer tranquilizers marketed in India.

Work for the standardization of conditions for the preparation of nitrazepam has been undertaken. Conditions for the preparation of its starting intermediate, 2-amino-5-nitrobenzophenone are being optimized. The work is in progress.

5. ORGANIC INTERMIDIATES

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

This material is used in industry in the form of its salts in PVC stabilizer compositions and in paint as driers. The demand for the product is estimated to be about 600 TPA valued at Rs. 1.5 crores. There is no indigenous production.

A process for the conversion of 2-ethylhexanol into 2-ethylhexanoic acid in two stages through corresponding aldehyde was reported earlier.

Different catalyst samples were prepared for the first stage and their performance checked under varying reaction conditions. Different catalyst supports were also tried. Conversions in the range of 60 to 75% and yields of about 90% were obtained. Optimum reaction conditions for these were determined and a continuous reactor of about 175 ml/hr capacity was tried out successfully.

It is proposed to compare the performance of the catalyst with the imported catalyst used for similar transformations.

The second stage was studied in small bench scale experiments and optimum conditions ascertained. Yields of about 85% were obtained. ½ to 1 kg. batches are being tried out. Suitable procedures for work up have been developed.

5.2 *D (—)- ∝-Aminophenylacetic acid* : (2/V/74)

Production of ampicillin requires D (—)- ∝-aminophenylacetic acid as the intermediate. Since there is a world shortage of this intermediate its indigenous production is essential.

Experiments were carried out for the preparation of dl- ∝-aminophenylacetic acid (1 kg/batch) followed by resolution with camphor sulphonic acid to obtain D (—)- ∝-aminophenylacetic acid. Testing of the material is in progress.

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

Work on the development of a process for the conversion of nitrobenzene to *p*-aminophenol by catalytic hydrogenation has been continued. Studies on the regeneration of the catalyst and a larger scale preparation of *p*-aminophenol are under way.

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

Sorbitol is a versatile chemical which is used extensively in a variety of products. One of its important uses is in the synthesis of Vitamin C. At present this chemical is produced in India using a batch process. Continuous hydrogenation of glucose to sorbitol offers several advantages over the batch process, particularly in large scale operations.

A continuous process was developed on a scale of about 1/2 kg. sorbitol per hour and the necessary design data was collected.

5.5 *p-Chlorophenol* : (5/V/75)

p-Chlorophenol is a valuable intermediate for dyes and drugs. The preparation of *p*-chlorophenol from phenol and sulphuryl chloride has been optimized. The process is ready for commercial exploitation.

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)

Morus species : Four new complex phenols were isolated from the acetone extract of *Morus alba* bark. Tentative structures were assigned to two of the

compounds on the basis of 200 Hz NMR spectra and ^{13}C spectra. However, X-ray data are being collected to arrive unambiguously at the complete structures.

Chloroxylon swietenia bark : The barks obtained from three different places are found to contain two new alkaloids, swietenidin A and B, nine new coumarins in addition to seven known coumarins, four lignans and skimmianine. Swietenidin A is the first 2-quinolone alkaloid with a 3-methoxy group. Its structure was confirmed by synthesis.

Formation of 2,2-dimethyl-3-methylene-4-hydroxy coumarin was observed during demethylation of 2-pivalyl resorcinol dimethyl ether with anhydrous aluminium chloride in connection with an attempted synthesis of swietenone.

Zanthoxylum species : Examination of three *Zanthoxylum* species, *Z. alatum*, *Z. oxyphyllum* and *Z. accanthopodium* led only to the isolation of a large number of known compounds : the lignans sesamin, eudesmin, epieudesmin, fargasin, syringaresinol; the neutral lactone pluviatide and the alkaloids, dectamine, 8-hydroxydictamine and γ-fagarine.

Garcinia morella gamboge : It was obtained with the object of isolating more of morellic and isomorellic acids in connection with ^{13}C spectral studies, which are being carried out by Prof. Philipsborn at Zurich. However, it was found that this gamboge consisted of (−) xanthochymol and (−) isoxanthochymol. The latter is found identical with cambogin, isolated by Prof. B. R. Pai. Other constituents of this gamboge will be examined.

Tannins : The leaves of *Woodfordia fruticosa* were found to yield 27.4% of water-soluble and 17.6% tannins, the bark and heartwood gave 23.9 and 10% tannins and 4.9 and 4% water-soluble non-tannins respectively. The flowers gave 26% tannins and 17.7% water-soluble non-tannins. The *Woodfordia* bark tannin is intermediate in colour between wattle tannin and the deep red or red-brown tannins of *Terminalia tomentosa*, *Broswellia serrata* and other barks. Both the tannins and non-tannins of *W. fruticosa* are under study.

Anogeissus latifolia bark : In addition to known compounds (3, 4, 3'-tri-*O*-methyl flavellagic, 3, 3'-di-*O*-methyl ellagic, 3,4,3' - tri-*O*-methyl ellagic, ellagic and gallic acids), two new glycosides, 3,3'-di-*O*-methyl ellagic acid 4-β-D-xyloside and 3,4,3'-tri-*O*-methyl flavellagic acid 4'-β-D- glucoside were isolated. The isolation of gallic acid suggests that the bark contains gallotannins in addition to ellagitannins and condensed tannins. Further isolation of bark tannins and heartwood constitutents is in progress.

Groundnut shell lignin : Examination of "Dioxane lignin" has led to the isolation of vanillin and vanilloyl methyl ketone. The structure of dioxane lignin is under investigation.

Synthetic experiments : Some 3-prenylated flavones were synthesized.

6.2 *Modified cellulose products* : (2/VI/72)

The project was undertaken to establish a method of cross linking of bleached jute fabrics. Cross linking of bleached jute fabrics with formaldehyde was reported last year. A few more samples were prepared and sent to the Indian Jute Industries Research Association (IJIRA) for testing.

Work on the project was concluded after standardization of the laboratory process.

6.3 *Chemistry of plant hormones* : (3/VI/72)

Plant hormones evince biochemical, physiological and morphological changes in plants and hence, play an important role in agriculture, horticulture and forestry.

During a search for new plant hormones from pollen extracts a chromatographic fraction obtained from the ether extract of pumpkin pollens (*Cucurbita maxima*) was found to effect a change in the sex ratio of flowers in cucumber plants (*Cacumis sativus*), i. e. the female flowers tended to outnumber the male flowers. The effect of the same active fraction is being studied on economically important crops like cashewnuts, mango, etc.

The effect of ethrel on papaya plants and mango trees was also studied and the interesting results were recorded.

6.4 *Dialdehyde starch* : (4/VI/73)

Work was undertaken to optimize conditions for producing dialdehyde starch (DAS) with maximum aldehyde content. A study of the effect of temperature, dilution, time of reaction and pH was carried out. The sample which gave maximum yield with aldehyde content of 94% was sent to CLRI, Madras for testing its use in leather industry. It was found by CLRI that in combination tannages, it may be helpful for filling up. A sample was also sent for its evaluation in filter paper industry.

6.5 *Thin boiling Tamarind Kernel Powder (TKP)* : (5/VI/73)

Studies were carried out to evaluate TKP at different temperatures, duration of heating and pH using mineral acids. Viscosity, film forming property and pH of the material were tested and the best sample using preservative was sent to industry for evaluation. On the basis of the results obtained, further work will be carried out.

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

Nine hardwood species from Central India, viz. *Terminalia tomentosa, Anogeissus latifolia, Cleistanthus collinus, Broswellia serrata, Lannea grandis, Garuga pinnata, Chloroxylan switenoide, Pterocarpus marsupium* and Eucalyptus hybrid were chipped separately and mixed in equal proportion for pulping. The mixture was pulped by prehydrolysis sulphate process and by acid

sulfite pulping processes using Ca, Mg, Na and NH_3 base in different experiments.

Unbleached pulp yield for prehydrolysis sulfate process was 37.3% while for acid-sulfite process 40.5 to 41.5%. Multistage bleaching gave acceptable chemical composition with 89.5-90% α-cellulose and 0.2% extractives. Brightness of acid sulfite pulp was above 90% G. E.

Similar results were obtained for Eucalyptus hybrid and *Shorea robusta*. Alcohol benzene extractives in case of *Shorea robusta* pulps were in higher range.

Some of the paramcters of prehydrolysis sulphate process were studied on *Diospyros melanoxylan* species.

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

Parthenium hysterophorus Linn, a weed belonging to compositae family has caused considerable agricultural losses and presented health hazards by its very rapid spreading in many parts of the country.

A chemical examination of this weed was undertaken to isolate the active constituents.

The chemical analysis has revealed the presence of straight chain compounds, phyto-sterols, parthenin and carbohydrates. Parthenin, the major sesquiterpene lactone was found to be allergenic to skin and an insect-antifeedant. Chemical modification of the structure of parthenin and its relation to the activity are being studied.

In collaboration with Dr. A Y. Lonkar (Poona) clinical studies of Parthenium allergy are in progress.

6.8 *Testing of rayon pulp from Bastar hardwoods* : (8/VI/74-SP)

Pilot plant trials were undertaken on the mixtures of three hard-wood species of Bastar forest, with freshly prepared wood chips (immediately after felling wood) and with wood chips aged for six months during storage. The unbleached pulps produced were processed on a pilot plant scale for the study of different bleaching sequences, with and without additives, in alkali extraction stage.

The final pulp samples were evaluated for various chemical constituents, filterability and yarn spinning (both bright and spun-dyed with different colours). The results of various tests confirmed the earlier findings.

A few bench scale experiments also were carried out with the mixtures of various wood species and with different percentage compositions of them.

6.9 *Upgrading and modification of gum ghatti (Anogeissus latifolia)* : (9/VI/74)

Gum ghatti is a natural product of Indian origin and its substantial amount is exported. The inferior grade (grade III) of gum ghatti is dark coloured product and contains impurities like bark, leaves, etc.

The project was undertaken to upgrade this grade of gum ghatti and further modify the same to obtain a product having adhesive properties similar or better than that of imported gum arabic.

Earlier development of processes on laboratory scale for upgrading and modification of the grade III were developed and reported.

Bench scale experiments (500 g/batch) for the preparation of final products were standardized. Further work is abandoned as no positive user interest could be identified.

6.10 *Isolation of useful compounds from sugarcane press mud* : (10/VI/74)

On refining of sugarcane juice and filtration, press mud containing wax, sterols, alcohols and fatty acids is obtained. Huge amounts of this mud are available in the sugar industry.

A suitable pilot plant for the extraction of waxes from the sugarcane press mud was assembled. Press muds obtained from three sugar factories were extracted in this plant with different solvents. The products obtained were separated into soft and hard waxes. Suitable methods for the analyis and estimation of products during the extraction were also devised.

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

Various extracts from the brown algae *Padina tetrastomatica*, were obtained and their systematic chemical analysis is in progress.

The chemical examination and the pharmacological tests of the gorgonian obtained from the National Institute of Oceanography, Goa are underway.

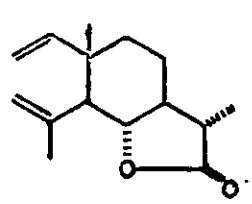
6.12 *Vinca-alkaloids* : (12/VI/76)

Vincristine and Vinblastine sulphates are currently used as anti-leukemic drugs. It is proposed to undertake the study in order to isolate these compounds, using modern techniques, from the leaves of *Vinca rosea* plant. A detailed literature survey was carried out.

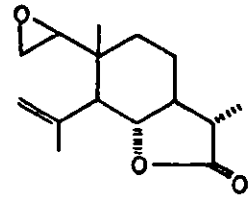
7. STUDIES IN ORGANIC CHEMISTRY

7.1 *Transformation products of constunolide and dehydrocostus lactone* : (1/VII/65)

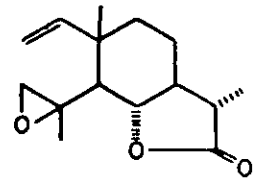
Monoepoxidation of saussurea lactone (I) gave a mixure of two monoepoxides (II) and (III) which were separated and characterized.



I



II



III

7.2 *Studies in heterocyclic chemistry* : (2/VII/65)

(a) *Synthesis of compounds with potential biological activity*

A few more derivatives, of 2,4-disubstituted-1-S-phenyl-1-thionium-cyclobut-2-ene perchlorate have been synthesized and their reactions with nucleophiles are studied.

(b) *Nitrogen heterocyclics*

Some new 1-N- arylazetidines were prepared and the stereochemical factors involved in the synthesis of 1-N- arylazetidines have been studied further. The general method for the cyclization of 3-arylamino alkanols has been further extended to the synthesis of various naphthyridines.

(c) Some new rearrangements in nitrogen containing small ring compounds and 3-phenylthioallylic alcohols are being studied. Nitrene insertion reactions giving heterocyclic systems are being studied.

(d) 1,2,4 - Benzotriazapinones were synthesized and their structures were confirmed by spectroscopic studies.

7.3 *Mass spectrometry* : (3/VII/65)

(a) *Analysis of pesticide residues*

Work on the detection and estimation of pesticide residues in crops was continued. Nitrofen residues were determined.

(b) *Comparative study of the fragmentation modes under EI, IKE CI and FD conditions*

In continuation of the previous work on a comparative study of the fragmentation behaviour under different ionizing conditions, further studies were made to illustrate the complementary nature of these newer ionization techniques. The different behaviour of odd and even electron ions was demonstrated.

(c) *Metabolism studies*

Studies on the metabolism of hydroprene - an insect growth regulator (which is now commercialized in USA)-in red cotton bugs were initiated. The physiological and morphological effects are also being studied.

7.4 *Mass spectral techniques* : (4/VII/65)

Quantitative analysis using suitable labelled internal standards was carried out by the ion current integration method for the analysis of pesticide residues.

7.5 *Studies of chemical reactivity and structure* : (5/VII/70)

(a) Ascorbic acid and its derivatives

There are several poorly understood features in the reported chemistry of ascorbic acid. Their study seemed worthwhile in the context of the numerous studies on the physiological role of this important vitamin. A full understanding of the basic chemical susceptibilities of the ascorbic acid skeleton is an obvious prerequisite for understanding the molecular mechanisms of ascorbic acid mediated biochemical transformations. Spectroscopic studies on ascorbic acid and several of its derivatives were initiated some years ago and some important leads were obtained.

Several of the compounds required are not very easy to obtain in the quantities desired. New chromatographic procedures were therefore developed for their preparation and sizeable quantities obtained. Spectroscopic investigations of these are in progress.

(b) *Hydroxylation of aromatic compounds with peracids*

Some patents have appeared over the past decade on hydroxylation of aromatic compounds with peracids. The amount of published work is however very little. In view of the possible applied potential of transformations of this type, it appeared worthwhile to investigate some of them in some detail. With the view of understanding the role of iodo-derivatives in some of these reactions, the reactivity of aryl-iodoso acetates with aromatic substrates was taken for study and some progress was made.

(c) *Reaction of dimethyl sulphoxide with alcohols*

Dimethyl sulphoxide has been reported to oxidize several alcohols in presence of acetic anhydride or other acid anhydrides or other DMSO polarizing agents. However, the lower aliphatic alcohols give only formaldehyde acetals under the conditions described for the oxidation. The formyl carbon comes from dimethyl sulphoxide. The reason for the marked change in reactivity is not clear and has not been investigated.

Studies have been initiated with the view of obtaining a mechanistic explanation for the observed behaviour. Some suggestive results were obtained. The Pummerer reaction is an important side reaction under conditions of acetal formation. The possibility that the acetals and the well known Pummerer product are obtained through a common intermediate is being considered.

(d) *The reactivity of aspirin*

The mechanism of hydrolysis of aspirin and its reaction with oxy-anions have been the subject of many investigations. The role of an anhydride intermediate has been much debated. The analgesic action of aspirin has been traced in recent years to the inhibition of the release of prostaglandin, but further details of the chain of events and effects obtaining are not available. Although aspirin has been known to acylate proteins, detailed *in vitro* studies are not available.

As part of an attempt to get more information on the reactivity of aspirin, a spectroscopic study of the nature of its anion was initiated and interesting results were obtained. The significance of the results are under evaluation and more experiments are under way. The reactions of simple peptides with aspirin are also proposed to be studied in this connection.

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

Epoxidation of 1-methyl -2-*trans*-benzal-cyclohexan-l-ol was found stereospecific and is formed at the side *cis* to hydroxyl. The resulting epoxy-alcohol underwent acid catalyzed rearrangement to furnish 1-phenyl-octane-2, 7-dione.

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

Experiments on the cation olefin cyclizations are in progress. Some novel routes for exclusive C-alkylation of cyclic β-diketones are also being studied.

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

A few model systems for an internal Diels-Alder reaction were studied for the synthesis of dendrobine.

Towards the synthesis of vindoline a key piperidone derivative was prepared.

7.9 *Synthesis of ∝-methylene lactones* : (9/VII/74)

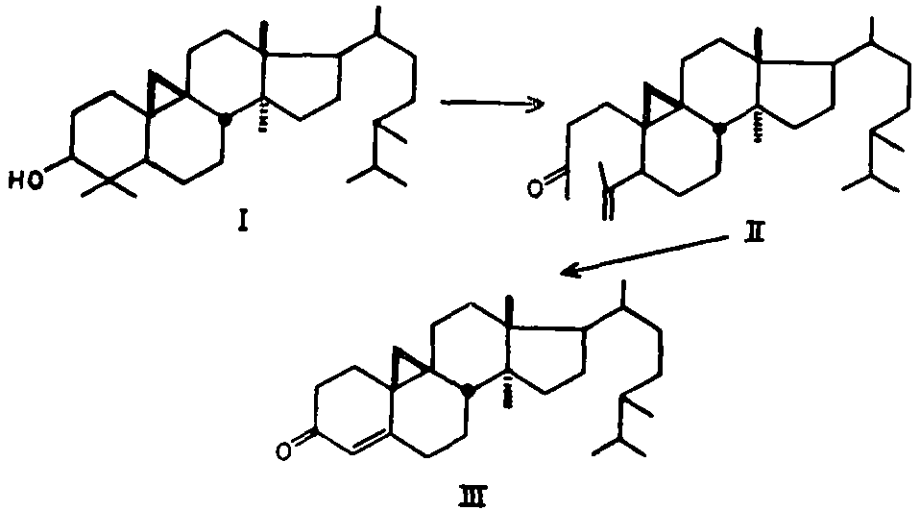
There is considerble interest in the synthesis of ∝-methylene-γ-lactones as this structural unit appears to play an important role in the interesting biological activity exhibited by a number of natural products.

6 -Methyl-3-methylene-2-benzofuranol, a potential intermediate for the preparation of 6 - methyl-3-methylene-2- benzofuranone was synthesized starting from *m*-cresol.

7.10 *Utilization of bye-products of opium alkaloid industry*:(10/VII/75)

Opium marc is rich in two triterpenoids namely cyclolaudanol and cycloartenol. The project was undertaken to transform these triterpenoids into hitherto unknown cyclosteroid hormone analogues.

A new sequence of reactions for the modifications of ring A of cyclolaudanol (I) into 4-en-3-one steroid (III) has been developed *via* 3,4-seco intermediate compounds as (II).



I II III

7.11 *The structures of commercial dyes* : (11/VII/75)

The structures of several disperse dyes, cationic dyes and Fast Bases have been determined and some reactive dyes studied. The main emphasis of the work has,however, been the development of suitable techniques, rather than mere identification of specific dyes. The scope for the use of IR, NMR and mass spectra is being explored. Derivatives suitable for this purpose have been obtained and degradative work kept minimal. Since some difficulty was encountered earlier in the dequaternization of dyes with pendant cationic groups, attempts have been made to make maximum use of NMR and mass spectra. The suitability of various NMR solvents and the usefulness of *N*-picryl derivatives of amines and the picrate of cationic dyes have been examined.

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

The addition of alcohols to epoxides is not a photochemical reaction as reported by others. A regioselective uncatalyzed opening of certain epoxides by methanol and ethanol has been observed. However, these epoxides remain unchanged in isopropanol. On photolysis in isopropanol these epoxides furnished a product involving photoreduction. The mechanism of this novel photoreduction is being looked into.

8. INDUSTRIAL POLYMERS, ELASTOMERS AND RESINS

8.1 *Synthetic polymers for sugarcane juice clarification* : (1/VIII/68)

Water soluble acrylamide polymers are frequently used for coagulation of suspended, insoluble impurities in sugarcane juice after liming and sulfitation in order to aid filtration of the juice. These polymers are imported under the trade name of Separan AP-30 or Sedipur TF-2. The development of the process for the preparation of these polymers was reported earlier. More batches were taken (6 kg/batch) and about 40 kg. of the product was prepared and sent for evaluation to interested manufacturers.

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

Polysulfide rubbers have outstanding fuel, ozone and weather resistance. Polysulfide based sealants are widely used in aircraft, building, marine, automobile and construction industries.

The polysulfide rubber based formulations are used by Defence department and the present requirement is met by imports.

The process for the basic rubber was standardized on 3 kg/batch based on dichlorodiethyl formal monomer. Based on this polymer a composition was developed for Power Project Engineering Division, Department of Atomic Energy, Bombay and found to be suitable. Large scale batches are being standardized and samples are being evaluated.

8.3 *Sulphochlorinated 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. Efforts are being made to assess the demand in various industries.

A process for the wet precipitation of SCPE was standardized and pilot plant runs were taken to collect necessary design data. Cost estimation of a 1 tonne/day plant as well as process flowsheet and material balances were prepared. Since the cost estimates reveal a higher cost of production using sulphuryl chloride as the sulphochlorinating agent, an alternative route for the sulphochlorination of polyethylene using gaseous reactants is being presently tried, the product recovery step remaining the same as before.

Advice was rendered to M/s HAL, Bangalore on a special Hypalon compound used in helicopter engines.

8.4 *Polyurethane rigid foams* : (4/VIII/71)

Polyurethane rigid foams have been used in diversified applications such as domestic and industrial refrigeration, transportation, insulation, packaging, building materials in construction and substitute to wood in furniture, etc.

High density and low density (2 lb/cuft.) foam samples were prepared from cashew nut shell liquid. Foams were found suitable for furniture, packaging and insulation applications.

20 kg. of the basic polyol was given to commercial firms for evaluation.

8.5 *Ketone resins* : (5/VIII/72)

These resins are suitable for air drying lacquers with good adhesion to metal, wood and paper. These are used in printing inks and for paper coatings.

The preparation of this product was reported earlier and small samples were tested by the industry. A product comparable with the one available in the market as far as softening point, viscosity and gloss was made on 10 kg./batch. Large samples were sent for evaluation to interested parties.

8.6 *Polyacetal resins* : (6/VIII/72)

Polyacetal resins are known for their high dimensional stability and find extensive use as a substitute for non-ferrous metals in the manufacture of components such as gears, bushings, pulleys for precision instruments. These resins are linear thermoplastic polymers of formaldehyde or trioxane.

Studies on copolymerization of trioxane with dioxolane were continued. Method for the analysis of the copolymers by VPC was developed and conditions were established using synthetic mixtures of methylene glycol diacetate and ethylene glycol diacetate, which are the resultant products formed on the degradation of the copolymer.

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

Since the oil crisis in the recent years, the secondary oil recovery techniques are being extensively studied and polymer flooding forms an important aspect of the secondary oil recovery. In India, Oil India Ltd. are carrying out field trials in polymer flooding with imported polymers. Their estimated demand of these polymers is 600-800 TPA valued around Rs. 6 crores. In view of the sizeable demand for these polymers and their strategic importance, work has been undertaken to develop the know-how for the manufacture of high molecular weight acrylamide copolymers used in secondary oil recovery.

In order to obtain polymers in the required range of molecular weights, polymerization of acrylamide was standardized and copolymer compositions made on laboratory scale of 30 gm. of monomer per batch. Polymerization free of inhibition period and good reproducibility was achieved with more than 97% monomer conversion.

A new method of polymer isolation was standardized to reduce the drying time and to achieve easily ground polymer free from side effects. The polymers had poor shelf life with respect to their molecular weight stabilization. Additives to improve stability are being investigated and a satisfactory stabilization upto at least 3 months has been achieved. The samples are being evaluated by Oil India Ltd. Scaling up the batch size will be taken up after the receipt of the evaluation report.

8.8 *Cellulose acetate butyrate* : (8/VIII/75)

Various grades of mixed cellulose esters are industrially used in the manufacture of fountain pen bodies and other thermoplastic goods such as handles and housings for different appliances, automobile steering wheels, etc. Major demand is for cellulose acetate butyrate containing 34-39% butryl and 13-15% acetyl groups. The raw materials except butyric acid and butyric anhydride are available in the country.

In the absence of these two chemicals, standardization of the method for preparing cellulose acetate (37-42% acetyl content) was carried out. All the four stages of manufacture of cellulose acetate (37-42% acetyl) viz. activation, esterification, hydrolysis and precipitation were accomplished on 1kg. cellulose pulp scale. A prototype equipment is being designed and fabricated for scale up studies. Recovery of the acetic acid and its conversion to anhydride is being examined.

8.9 *Castable nylon (monomer casting)* : (9/VIII/75)

At present engineering plastics grade nylon-6 chips are imported and extruded in the form of tubes and rods. These rods are machined to give bearings, gears, etc., as finished products. To avoid the material waste and machining cost, the monomer, caprolactam which is indigenously available can be polymerized directly into the moulds to get finished products. Besides saving on the material waste and machining cost, cast nylon-6 is better in properties such as tensile strength and dimensional stability as compared to the extruded or injection moulded nylon-6.

Monomer casting with different catalysts and activators was tried and polymer rods of about 1 to 2.5 inch diameter were prepared. Efforts are

underway to overcome the pinholes problem in the rods of more than 2.5 inch diameter.

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

At present Hindustan Aeronautics Ltd. (HAL), Nasik are importing number of short shelf life items such as sealing compounds, resins, cements, glues, paints, varnishes, rubber compounds, etc. The value of these items is of the order of Rs. 20 lakhs per annum considering the manufacture of items such as canopy, rubber fuel tanks, sealing rings, etc. Indigenization of these items will ensure saving in foreign exchange besides avoiding production bottleneck due to interruption in regular supplies of imported materials.

The work which has been sponsored by HAL consists of two phases (i) identification/charactrization of samples and (ii) development of know-how for the preparation of suitable substitutes for these items. Analytical work on 5 items was initiated.

9. STUDIES IN POLYMER CHEMISTRY

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

9.1.1 *Copolymerization of ionizing monomers*

Ionizing monomers in aqueous solution such as acrylic and methacrylic acids were studied earlier in relation to their copolymerization behaviour with water soluble monomers like N-vinyl pyrrolidone. These studies were extended to the system methacrylic acid-acrylamide and the monomer reactivity ratios were evaluated using a modified computer procedure for the solution of the Mayo-Lewis integrated equation.

Studies on the conformation aspects of synthetic polyelectrolytes involving random coil to rigid rod transition, hydrophobic interactions, etc. were initiated by potentiometric titration and viscosity methods. These synthetic polylectrolytes serve as simpler models to the more complex biological macromolecules like polypeptides and protein.

9.1.2 *Vinyl polybutadiene rubber*

Vinyl polybutadiene rubber is a recent development in the field of general purpose synthetic rubbers. It is a homopolymer of butadiene having 35-65% vinyl content with elastomeric properties similar to SBR and blended *cis*-polybutadiene rubbers. Vinyl polybutadiene rubber has bright prospects for it dispenses away with costly monomer-styrene and at the same time it does not require blending with other rubbers as in the case of cis-polybutadiene. It is being commercialily produced in Europe and is considered as ' the rubber of the future. '

Vinyl polybutadiene is prepared by polymerizing butadiene anionically with butyl lithium initiator and complexing the latter with electron donors, for adjusting the vinyl content in the polymer. Preparation of butyl lithium in 95% purity was achieved. Preliminary experiments on polymerization of butadiene gave a low molecular weight product having 70% vinyl content.

Work is in progress to study the various parameters such as monomer and initiator concentrations to get the polymer of suitable molecular weight and molecular weight distribution with 1-2 vinyl content in 35-55% range.

9.1.3 *Nitrile rubber*

The tensile strength of swollen nitrile rubber networks showed a Z type curve in their behaviour with reference to degree of swelling. Above a critical degree of swelling, due to favourable rubber solvent interactions, the weakening of the rubber-filler interactions were observed.

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

A special apparatus for measuring viscoelastic properties (stress-strain, non-elastic deformation, etc.) of sulfochlorinated polyethylene elastomer (SCPE) and any other elastomers under swollen conditions and at varied temperatures to elucidate the mechanism of vulcanization in the rubber net work under different conditions was designed and is under fabrication.

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

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

9.4 *Studies in dimer acids* : (4/IX/69)

Dimer acids are obtained by thermal polymerization of conjugated fatty acids by Diels-Alder reaction under pressure in an autoclave. Work has been initiated to study the thermal polymerization of triglycerides such as castor oil and its monomeric acids at high pressures and temperatures.

10. MINERAL RESOURCES UTILIZATION

10.1 *Titanium tetrachloride* : (1/X/73)

Titanium tetrachloride is mainly required as a seed material in the manufacture of rutile grade titania by the sulphate process. It also finds application in metallurgy and in the production of some intermediates and polymerization catalysts. The demand is of the order of 2,000 TPA valued at about Rs. 1 crore.

The designs, fabrication and trial runs of the pilot plant (150 TPA) was reported earlier. The pilot plant was operated continuously to collect additional data for the design of a plant of 2000 TPA capacity. A proposal to install a plant of this capacity is under consideration.

A process for the beneficiation of ilmenite by the selective chlorination in presence of coke in a fluidized bed is being worked out. A pilot plant is proposed to be installed to collect data for scale-up purposes. The enriched ilmenite has a purity of 92-94% TiO_2.

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

The bacterial leaching of low grade ores has been shown to be of considerable economic importance. This method has been successfully exploited for winning important metals like uranium and copper from low grade ores and about 5% of total copper production in the world is reported to be by this method. Substantial amounts of copper are imported into India. An inter-laboratory project on bacterial leaching was taken up to develop a technology for the recovery of copper from the low grade ores which are available in considerable amounts in the country.

Different copper ore samples (0.2 to 1.5% Cu) were tested for leaching using enrichment cultures obtained from different mine water samples. The leaching in shake flasks varied between 58 to 86 per cent. The bacteria significantly increased extraction in comparison to the controls with all the ores. Tolerance to 10-12gm of Cu per litre was obtained and further work is in progress to obtain tolerance to higher levels of the metal. Column leaching studies with the mixed bacterial flora are in progress to determine the optimum conditions for rapid leaching. Experiments are also in progress to study the possibility of avoiding the addition of inorganic nitrogen which is the major item of expense in the medium.

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

Exploratory work was carried out to determine the feasibility of converting rock phosphate into ammonium phosphates by reaction with ammonium bisulphate. The results obtained were sufficiently encouraging. A regular research project has now been initiated to study different chemical and engineering aspects of the sulphate-recycle process. This is not an ammonia recycle process and hence is simpler than the RABS process.

10.4 *Aluminium fluoride from low-grade fluorspar* : (4/X/73)

When low-grade fluorspar is treated with sulphuric acid a mixture of HF and H_2SiF_6 is obtained. On the basis of results of experiments done so far, it was felt that the best procedure would be to add active silica to convert the HF into H_2SiF_6 and then proceed to prepare aluminium fluoride as usual by addition of alumina hydrate. Further studies have been discontinued due to lack of interest by industry.

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

The recycle aspect of the NCL process on cryolite is being worked out at M/s Dharmasi Morarji Chemical Co. (DMCC), Bombay. They reported that the bulk density of the final product was not on par with that of samples precipitated in acidic solutions. To overcome this difficulty some work was done in the laboratory and advice rendered to M/s DMCC. Now the party has started trials on a larger scale.

10.6 *Molybdenum chemicals from molybdenum concentrate*.(6/X/75-SP)

Since the Herreshoff furnace method which is being used, almost the world over, for roasting such sulphidic minerals, is not available in the country and its price is prohibitive, the project has been undertaken to develop an alternative method for making molybdeumn oxide from molybdenite ore concentrate.

Attempts to fabricate such a furnace in the country failed due to technical difficulties. Furthermore, this furnace converts the sulphidic concentrate to technical grade oxide which has to be further purified by resublimation.

Process data was collected on laboratory scale during the tenure of the sponsored work for a process wherein the molybdenum oxide is directly sublimed.

11. INDUSTRIAL INORGANIC AND ORGANOMETALLIC CHEMISTRY

11.1 *Aluminium hydroxide gel for vaccine* : (1/XI/69)

Imported aluminium hydroxide gel is at present used in the preparation of vaccines for animal foot and mouth diseases.

As reported last year fresh samples were sent for evaluation to various veterinary institutes, however, conclusive reports could not be obtained. The project is presently suspended.

11.2 *Molecular sieve catalysts for alkylation reactions* : (2/XI/70)

With a view to develop a continuous process for the preparation of ethyl benzene under milder conditions, vapour phase alkylation reactions were studied.

A series of fresh catalyst samples were prepared under modified conditions and their physical characteristics such as X-ray, thermal and sorptive behaviour were investigated. The thermal stability of the catalyst was found to increase with increased concentration of the catalytically active constituent.

A few trial experiments were carried out to prepare ethylene from alcohol using bauxite catalyst.

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

Methylchlorosilanes are major intermediates in the production of silicones. The most important of them is dichlorodimethyl silane. Chlorosilanes are also used in the manufacture of dimethyl polysiloxanes which in turn find extensive applications as damping fluids in instruments, as hydraulic fluids in precision tools, as efficient liquid dielectrics in transformers, in the manufacture of moisture repellants, cosmetics, polishing agents in automobile, furniture polishes, etc. The expected demand for methylchlorosilanes is 500 TPA minimum, valued at about Rs. 3.5 crores.

A new contact mass for the preparation of silicone intermediates was developed in the laboratory from ferrosilicon, catalyst and a promoter. Several bench-scale experiments were carried out with this new contact mass to test its activity and selectivity. It was observed that the new contact mass so developed yields silicone intermediates with a high proportion of the required dimethyldichlorosilane.

Subsequently a pilot plant to convert 5 kg. of ferrosilicon per batch to silicone intermediates at the rate of 0.75 to 0.8 kg/hr. was erected where several experiments were performed. Encouraging results were obtained with respect to the yield of dimethyldichlorosilane.

Efforts are now being directed towards the setting up of a pilot plant to convert 30 kg. per batch of ferrosilicon to yield about 3 kg/hr. of silicone intermediates as well as to operate the plant continuously using the newly developed contact mass.

11.4 *Titanium organics* : (4/XI/72)

New co-ordinated addition complexes of chelated titanium dichloride were synthesized. Preparation of new compounds containing tin, titanium and silicon were attempted; results on their application to industry were not found encouraging.

11·5 *Tin stabilizers* : (5/XI/72)

Preparation of dimethyl tin dichloride was scaled upto 25gm/hr. A metal reactor for producing this item at a rate of 100 gm/hr. was fabricated. Dimethyl tin dichloride is the starting material for making dimethyl tin stabilizers. New compounds of tin containing bidentate chelating ligands were prepared and their properties including stabilizing action on PVC were studied. Results showed that these new tin compounds have poor stabilizing action.

11.6 *Precipitated silica* : (6/XI/73)

As reported last year except for the bulk density several aerogel samples prepared were found comparable to imported ones in other physical properties.

Attempts to bring down the bulk density value to the required level by air elutrition technique, etc., were however found unpromising.

During this year filler grade precipitated silica samples were prepared. These were tested by a Poona firm and were found to be comparable with imported samples.

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

DCD is used in the manufacture of melamine, amino resins and as intermediate in dyes, drugs, plastics, explosives, etc. The entire demand of the country is met by import.

Laboratory work on the preparation of dicyandiamide starting from calcium cyanamide was scaled up to 5 kg. nitrolim/batch. The designs of the extractor and carbon dioxide distributer were tested. Other parameters like solid-water ratio, pH, temperature and rate of carbon dioxide generation worked out on laboratory scale were tested and suitably modified for large scale operations.

Trial runs were successfully demonstrated to the representative of Ordnance Factory, Bhandara. Experiments to work out the material balance and other relevant information for plant scale operations are being undertaken.

11.8 *Fumed silica* : (8/XI/74)

This is a speciality chemical which is required by a number of industries, such as aerosols, adhesives, cosmetics, insecticides, lubricants, rubber, textile, etc. The technology for it is not yet established in the country.

Pilot plant work on the hydrolysis of silicon tetrachloride at high temperatures on a scale of 1-2 kg/hr. of fumed silica was continued. A specialized product of outstanding properties was obtained by control of some very critical parameters. A process was standardized to yield fumed silica with a surface area around 326 m^2/gm (BET method) and particle size of mili-microns and bulk density between 25 and 28 gm/ltr.

Several runs on the fumed silica unit were taken during the year and demonstrated to the sponsor. Data were collected and the design of a prototype semi-commercial unit for burning 30 kg/hr. silicon tetrachloride was worked out.

11 9 *Colloidal silica* : (9/XI/74)

The objective of this project is to prepare colloidal silica which can be used as a catalyst substrate, as a catalyst binder and as a raw material for the synthesis of catalytic grade molecular sieves.

A laboratory scale method to prepare colloidal silica upto 400 gm/ batch was standardized. A dilute solution of sodium silicate was passed

through an ion exchange column. The effluent was heat treated and concentrated. The silica solution thus obtained contained 20-25% silica and was stable for several months.

11.10 *Ferrocyanides from calcium cyananide* : (10/XI/74)

Last year 60% efficiency for conversion of calcium cyanamide to cyanide was reported.

During the period under report high temperature conversion of commercial nitrolim available from explosive factory, Bhandara to calcium cyanide and the interaction of cyanide thus formed with ferrous sulphate and alkali carbonate was studied. Laboratory scale experiments upto half kg. nitrolim per batch were carried out and the optimum temperature, concentration, pH, etc., for maximum conversion were worked out. The yields of sodium, potassium and ammonium ferrocyanides were in the order of 90% and purity ranged from 96-99%.

Further work is in progress.

11.11 *Lithopone* : (11/XI/75)

Lithopone is used in paints, enamels, distemper, linolium, leather cloth and rubber industry.

After preliminary laboratory experiments on the preparation of lithopone by co-precipitation of barium sulphate and zinc sulphide, the experiments were scaled upto 2 kg. lithopone per batch. The reduction of barytes was studied at 1200-1300° and the optimum conditions of temperature of co-precipitation, concentration, drying and calcination were worked out. Small percentages of certain additives in the form of metallic salts were incorporated to improve the quality of the pigment. The samples of lithopone were sent to leading paint manufacturers and were found comparable with the standard imported samples. Further work on this project will be undertaken if sponsored by industry.

11.12 *Utilization of sulphur residues* : (12/XI/75)

(i) At the instance of an industrial firm sodium sulphite residues from naphthol manufacture were successfully converted (1 kg/batch scale) to sodium sulphide.

Sulphur sludge, formed in sulphur pits for making sulphur dioxide is available in large quantities. A plant producing 100 tonnes per/day of sulphuric acid will have about 500 TPA of sulphur sludge containing 50-60% sulphur. All the sulphur monochloride needed for the country for use in rubber industries can be produced from the sulphur sludge.

(ii) In order to find better uses of the sulphur sludge, chlorination was tried to produce pure sulphur monochloride. The process was standardized on 1 kg/batch scale.

Samples of sludges from 11 leading sulphuric acid manufacturers were examined and reports about their sulphur content were sent. Utilization of this sulphur monochloride for making industrially more important sulphur chemicals viz. thionyl chloride, etc., was also examined. Results are encouraging.

12. STUDIES IN ORGANOMETALLIC & INORGANIC CHEMISTRY

12.1 *Co-ordination compounds* : (1/XII/63)

Although considerable work was done on metal complexes of various β-diketones, not much has been reported regarding metal chelates of pongamol, a naturally occurring β-diketone, 1,3-propanedione-1- (4-methoxy, 5-benzofuranyl-3-phenyl). Chelates of copper (II), nickel (II), beryllium (II), aluminium (III) and cobalt (III) with this ligand were synthesized. Infra-red spectral studies with respect to these compounds were carried out. NMR spectral studies of beryllium and aluminium complexes and mass spectral studies of the ligand and the beryllium complex were done. Electrophillic substitution reaction such as nitration, chlorination and bromination of some of these chelates were attempted but the compounds were found to undergo decomposition during the course of these reactions.

o-Hydroxydibenzoyl methane is another β-diketone which has not received much attention of co-ordination chemists. Chelates of this ligand with copper (II), cobalt (III), nickel (II), aluminium (III) and beryllium (II) were prepared and their infra-red spectra were studied. NMR and mass spectra of the ligand were also studied.

In an attempt to gain information on the bonding characteristics of metal complexes of isonitrosoacetoacetanilide, bis (isonitrosoacetoacetanilidato) beryllium (II), bis (isonitrosoacetoacetanilidato) copper (II), bis (isonitrosoacetoacetanilidato) nickel (II), bis (isonitrosoacetoacetanilidato) cobalt (II) and bis (isonitrosoacetoacetanilidato) palladium (II) were synthesized for the first time and their infra-red spectral characteristics were studied.

In continuation of our earlier studies on alkyl tin (IV) chelates several stable new chelates with the general formula, $RSnL_3$, R_3SnL, $RSnL_2Cl$ where R = ethyl or phenyl and L = anion of a 5-substituted or 5,7-disubstituted-8-quinolinol, were synthesized and characterized by their elemental analysis, IR and UV spectral studies. The UV spectra of these mono - or tri-alkyl/aryl tin (IV) chelates along with some dialkyl tin (IV) substituted oxinates were recorded in different solvents and all the spectra showed the presence of a chelated oxine group. Based on the magnitude of the shift of 320 nm absorption band in the spectra of these compounds, which was associated (or corelated) with complex stability, the following sequence of stability in solvents, such as, cyclohexane and methanol could be obtained for these chelates : $R_2SnL_2 > RSnL_2Cl > RSnL_3 > R_3SnL$

The IR spectra of all these compounds were recorded in the region 3500-350 cm^{-1} and were analyzed. The tin-carbon, tin-oxygen and tin-nitrogen stretching frequencies could be located at ca. 570 cm^{-1}, 440 cm^{-1} and 360 cm^{-1} respectively in the spectra of all these organotin (IV) chelates.

In addition, a few mixed chelates of the type $R_2SnL_1L_2$ where R=ethyl, L=H 8-quinolinol and L_2H=a β-diketone, for instance, 1-phenyl-1, 3-butanedione or 1,3-diphenyl-propanedione were isolated in pure state. The IR,NMR,UV and Mass spectral data for these chelates showed that both the ligands were chelated to the metal atom.

The use of organometallic compounds as ligands leading to bimetallic complexes has of late aroused considerble interest. Attempts were made to synthesize ferrocenyl-β-diketones to act as such ligands. The starting material ferrocene was prepared by a new method which utilized directly hydrated ferrous chloride instead of the anhydrous salt.

13. SOLID STATE MATERIALS INCLUDING MATERIALS FOR ELECTRONIC INDUSTRY

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

The project was undertaken to develop improved type of ferroelectric ceramics suitable for high power (10 watts) device applications such as ultrasonic cleaners, transducers, etc.

The PZT (conventional) composition is being modified so as to obtain the ceramic with mechanical quality factor as high as 500. A large mechanical quality factor corresponds to a smaller energy consumption by the material. The material which we have modified so far has the mechanical quality factor as 300.

13.2 *Tin oxide potentiometer* : (2/XIII/71)

Tin oxide potentiometers, because of their ability to dissipate large amounts of power without degradation of characteristics are at present widely used. It has a typical value of 10 watts/sq. inch. Thus they are more suitable to miniaturization than wire wound or carbon film type.

Preliminary trials for coating 50 pieces (substrate) at a time in a rotary furnace gave encouraging results in tests carried out by a firm engaged in the manufacture of other types of potentiometers.

Further work is in progress.

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

Thick film passive elements like conductors, resistors and capacitors are widely used in hybrid microlectronics. Thick film integrated circuits are

getting better appreciation in electronics industry. The simplicity of the process in application is one of the major attractions for thick films. Development of silver pastes for mica capacitors was reported earlier.

Ruthenium based resistive pastes 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 in Pd-Ag systems. They further provide stability during active device bonding, soldering and encapsulation.

Some formulations were screen printed on alumina substrates on which silver electrodes had been printed and fired earlier. The resistor prints were fired in a tubular, three-zone furnace. The preliminary measurements gave TCR value of 120-140 ppm/°C in the temperature range -78° to +150°. This result matched well with that of a similar composition reported in literature.

Efforts to optimize the conditions for printing, firing and evaluation of resistor properties of different Ru-based resistive pastes with Pd-Ag electrodes are underway.

13.4 *Gamma-ferric oxide* : (4/XIII/71)

The magnetic characteristics of the product obtained by varying the. time of precipitation and crystal growth of α-FeOOH stage were studied The product obtained between 40-50 hours was relatively better.

X-ray diffraction study revealed some impurities when mild steel turnings from workshop were used for the precipitation.

13.5 *High permeability ferrites* : (5/XIII/71)

Preparation of toroids on the laboratory scale with matching properties with those of 387 and 3 H1 of M/s Philips was reported earlier from the same compositions.

Pot cores tested at Indian Telephone Industries, Bangalore, were found to agree in most of the properties with Philips 3H1. The process has now been standardized on a laboratory scale of 500 gms/batch over 200 batches. The results, for a given composition, are reproducible within allowable limits.

In this connection , tool room engineering assistance was received from the Armament Research and Development Establishment, Pashan, Poona.

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

Metal film resistors are used mostly for precision instruments, computers, digital voltmeters and laboratory instruments for general purposes. Because of high stability, durability and reliability, metal film resistors are replacing the carbon film and carbon composition resistors. The demand

for these is increasing rapidly and is estimated to be of the order of Rs. 1 crore per year. Preparation of metal film resistors on glass substrates was reported last year.

Further work on development of metal film resistors was continued and a detailed study was made on the performance of these resistors. Two types of metal film resistors namely nickel based as well as nickel free alloys of different compositions were thoroughly studied for their sheet resistivity, TCR, humidity, stabilization tests, etc., according to JSS 50401 specifications.

In addition, preliminary work on cermet films (metal, metal oxide) was also carried out. All these resistors were prepared by flash evaporation technique at suitable substrate temperature, so that 1/2 W ceramic substrate yielded resistance varying from 30 to 500 ohm in the case of metal film resistors and 100 ohm to 1.5 k. ohm for cermet films. The metal film resistors had TCR lower than 50 and 100 ppm/°respectively for nickel and nickel free alloys and about 100 ppm for cermet films. All test results conformed to the specifications of the precision resistor as per JSS. A new design of the system was made for semiproduction scale of 50 to 100 pieces per set of evaporation and trials are now being taken for their efficiency etc.

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

Hall probes have various important applications in measuring magnetic fields over a wide range. Other applications are contactless signal generator, multiplier, modulator and feedback elements in the stabilized power supply etc. Hall generators can be used especially as transducers in electronic instruments. These elements which are normally made from single crystals are being replaced by suitable thin film devices with characteristics of less weight and better sensitivity.

A new electrical circuit was designed for increasing sensitivity of the instrument by a factor of about 20 to be used for the gauss meter. Necessary masks are also being made for production of a large number of thin film Hall elements for the large scale production.

13.8 *Tin oxide resistors* : (8/XIII/75)

Tin oxide resistors are used in high performance applications, where temperature endurance, stability, chemical resistance and miniaturization are important. Typical applications are in defence, tele-communication and professional grade electronic equipment.

The development of a new type of rotary furnace was completed. The furnace is having an automatic feed system and integral temperature sensing devices. The furnace was run successfully and the products, tin oxide resistors, are being evaluated. The resistors had excellent characteristics in regard to TCR and ability to withstand electrical and thermal overloads, stability is within ±5%.

Work is being carried out with the active collaboration of a local firm. Some tests are being carried out at their site. The resistors were checked for the various relevant parameters such as spread TCR, short time overload, loadlife, shelf life, etc. Tests under environmental conditions will also be carried out in a special test ohmmeter.

Preliminary runs showed that a high quality product can be produced in the rotary furnace fabricated in the laboratory. Work is in progress for standardizing of conditions for obtaining a wide range of values and scale-up of operations. The furnace under trial works on a semi-continuous basis and produces about 300 to 500 resistors per hour.

14. STUDIES IN SOLID STATE, THIN FILMS, PHYSICAL CHEMISTRY AND PROPERTIES OF MATERIALS

14.1 *Structures and physics of thin films* : (1/XIV/58)

In recent years considerable interest has been evinced in many polycyclic organic compounds such as phthalocyanine, tetracene, etc. because of their semiconducting, optical, photoconducting and other interesting properties. Even though the chemical structures for most of these are known, only a few investigations have been made on the crystallographic structure especially in thin film forms. Consequently, a detailed study was made on the crystallographic and morphological features of vacuum deposited films formed on single and polycrystalline substrates by electron diffraction and electron microscopy and later on correlating them with the electrical properties.

The deposits studied were mainly copper phthalocyanine, indanthrone, violanthrone and dihydroxyviolanthrone. In the case of copper phthalocyanine it was shown by electron diffraction method that deposits conformed to orthorhombic structures($a=25.92$ Å, $b=3.79$ Å, $c=23.9$ Å and $\beta=90.4°$). It was also found that these vacuum deposits developed mostly $\{ 010 \}$ orientation with C-axis lying on the deposit planes on sodium chloride substrates. Morphological studies, however, showed that there were two types of crystallites, the former being sharp edged thick with rectangular habit whilst the latter consisting of thinner but flaky deposits forming a bundle of thin strips. The flaky types of deposits seemed to have better coverage of surface when copper phthalocyanine was used as pigment. The indanthrone deposits were monoclinic in nature ($a=30.8$ Å, $b=3.83$ Å, $c=7.84$ Å and $\beta \sim 92°$). These deposits grew epitaxially developing 2-d $\{ 100 \}$ orientation on (100) face of NaCl at substrate temperature of about 150° and above, the crystallites however being mutually rotated by 90°. Electron microscopic studies showed that deposits consisted of thin long and narrow striplike crystallites mostly bent at right angles which also explains 90° rotation as observed by electron diffraction method. The violanthrone deposits ($a=15.25$ Å, $b=33.60$ Å, $C=38.0$ Å and $\beta \sim 90°$) however developed $\{ 010 \}$ orientation unlike that of indanthrone on the NaCl cleaved faces.

These were mostly long narrow needle-like crystallites which were disposed mostly at right angle to one another. Dihydroxyviloanthrone also grew epitaxially on sodium chloride crystals at appropriate substrate temperature and had a monoclinic structure with a, b and c very close to that of violanthrone. These deposits had both rod and fibre type of shape unlike those of violanthrone deposits. It is interesting to mention that all these organic compounds grew epitaxially on the cleavage face of NaCl at temperature > 150° even though substrate deposits belonged to different classes and had vastly different lattice parameters. On glass substrates deposits were generally polycrystalline.

14.2 *Thermodynamic properties of solutions - studies in adiabatic compressibility of macromolecules* : (3/XIV/65)

The adiabatic compressibiiity for a poly (dibasic acid) namely the 1 : 1 copolymer of styrene and maleic acid, containing closely pair of carboxyl groups was studied earlier and the same study was extended to copolymers of acrylic acid and maleic acid, containing triplets of backbone carbons carrying carboxy lgroups.

The adiabatic compressibility of a 1 : 0.35 acrylic acid-maleic acid copolymer (AA-MA), containing on an average1.7 acid groups in the repeating unit of the copolymer and of its three sodium salts obtained by neutralizing (25%, 50% and 100%) with sodium hydroxide was studied. In 100% neutralized AA-MA copolymer, the dissociation of counter ions was complete so that the limiting values of the apparent molal compressibility, ϕK_2° and and apparent molal volume ϕV_2° was found to be lowest with values of -83.0×10^{-4} cc/bar/mole and 52.9 cc/mole respectively. This showed a decrease of 89.0 $\times 10^{-4}$ cc/bar/mole and 20.9 cc/mole from that of the unneutralized acid copolymer. The electrostriction caused in the copolymer by an increase of negative charge from 0 to - 0.425, from -0.425 to -0.85 and from - 0.85 to -1.7 produced a decrease of 3.9×10^{-4}, 6.9×10^{-4} and 5.7×10^{-4} c c bar/mole in the macroionic compressibility, ϕK_{2i}° and 3.7, 4.5 and 10.2 cc/mole in the macroionic volume, ϕV_{2i}°. The volume of the macro-ion thus showed a progressive decrease with the increased degree of neutralization, on the other hand, the compressibility showed a disproportionate decrease for the neutralized products. Similar to compressibility data, the viscosity data also showed that the charges in the neutralized copolymer were somewhat reduced due to the presence of the strongly bound sodium ions in the chain. A notable point emerging from this study is that the apparent ion binding on the multivalent site of the polymer chain, as obtained by the two methods, the adiabatic compressibility and density determinations, shows an appreciable variation.

The adiabatic compressibility of poly (vinylpyrrolidone) and a few other similar type of polymers is being studied in dfferent solvent media so as

to ascertain the extent of polymer-solvent interaction in thermodynamically good and poor solvents.

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

In cc ntinuation of studies of thin film physics further investigations were made on elecrical properties of so-called semi-metallic or metallic compounds like bismuth and HgSe. Bismuth films whether thick or thin behaved more like a semi-condcutor unlike the bulk bismuth. Magnetoresistance of these films both at low and room temperature region followed H^2 law with magnetic fields (1-8k gauss) which was also similar to the other semiconducting material. These films were found to be n-type between 70-400°K but changed to p-type at higher temperatures. Similar inversions were also observed with change of film thickness. The semi-conducting behaviour of the bismuth films seemed to arise from the quantum size effect.

High mobility HgSe films prepared by vacuum deposition on glass and mica substrates were studied in details for their electrical behaviour between the temperature range of 78-450°K. The mobility followed the relation $u \alpha T^{-x}$ where x varied from 2.5 to 2.8 depending on film thickness. All these films were found to be semi-metallic similar to the bulk HgSe and the conduction mechanism appeared to be due to the presence of second valence band overlapping with the conduction band or due to the symmetry induced zero gap band structure (inverted band structure) observed initially for grey tin.

Dielectric and optical properties of ionic films such as fluorides of La, Ca and Si as also sulphide of nickel were investigated. The variation of capacitance with frequency was similar to those observed previously for other stoichiometric vacuum deposited films. Both CaF_2 and SrF_2 films however showed a step in C vs temperature graph and TCC was practically zero for that temperature region. SrF_2 films however showed a tan δ_{max} at low temperature region due to dipolar relaxation. The breakdown field of LaF_2 was low (10^5 V/cm) compared to SrF_2 films (10^6 V/cm) and the variation of the breakdown voltage with film thickness followed the Forlani Minaja relation. CaF_2 films were found to be sensitive to moisture and a device was made for making an element for humidity sensor. All the fluorides showed absorption in the UV region and band gaps were found to be 4.67 and 4.2 eV for LaF_2 and SrF_2 films respectively. The refractive indices (n) were found to be 1.6, 1.25 and 1.26 respectively for LaF_2, CaF_2 and SrF_2 films. It is also interesting to note that all the three metals had crystalline structure corresponding to the bulk material even when deposits were made at room temperature.

Nickel sulphide films behaved quite differently from oxide and fluoride films. These were mostly amorphous and found to be nonstoichiometric.

Consequently the variation of capacitance with temperature showed that ϵ was thickness dependent as observed for nonstoichiometric like Nb-O and In-O films. Tan δ_{max} observed at low temperature region was due to the relaxation effect. The optical studies showed that n and k were mostly about 2.5 and 1.2 respectively for NiS films.

The optical properties of various sulphides, selenides and tellurides of copper, tin and lead were studied in details and n and k were evaluated in the visible region. Whilst cuprous selenide films were found to be semiconducting, telluride films were metallic or semimetallic in nature. The photon absorption process in the case of cuprous selenide films was found to be indirect and allowed due to interband transition of electrons whereas in the telluride it was primarily due to the free charge carrier process as α was linear to λ^2. In SnS films n increased continually with wavelength whereas k decreased and became negligible in the red region and the band gap was found to be about 1.6 eV which slightly varied with substrate temperature and film thickness no doubt due to the variation of defect concentration as well as crystallinity of the films.

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

During the period under report the precise structure of 4-methyl-4-hydroxy-1,2,3,4-tetrahydro-6-methoxy-acridine was determined with the help of full three -dimensional X-ray data. Preliminary structural studies of two natural products, dihydro-nimbin and Rubranol, were also made.

4-Methyl-4-hydroxy-1,2,3,4-tetrahydro-6-methoxy-acridine $C_{15}H_{17}NO_2$ was formed as one of the main products by the reaction of *m*-anisidine hydrochloride with 2-*m*-anisidinomethylene - 6 - methyl-cyclohexanone; its structure elucidation was undertaken in order to understand the reaction mechanism. The crystals are monoclinic, space group $P\frac{2_1}{c}$ with a = 9.28 (3), b=15.36 (1), c=9.23 (2) Å; $\beta = 105.0(5)°$; $\rho_o = 1.274$, $\rho_c = 1.271$ g.cm^{-3} for Z=4. The structure was solved by direct methods using visually estimated data, and refined by the full-matrix least squares method to an R value of 0.101 for 1698 observed reflexions. The e. s. d.'s in bond lengths not involving hydrogen and disordered carbon atoms are 0.005-0.007 Å and in bond angles, 0.3-0.5°. The dimensions of the two aromatic rings of the molecules showed small but significant and expected changes from the corresponding dimensions in acridine. There was disorder in the cyclohexene ring with the two terminal carbon atoms going out of the aromatic plane, in opposite directions, in two ways; the two configurations are not symmetrical with respect to the aromatic plane. Pairs of molecules are held together mainly by two centrosymmetrically related OH...N hydrogen bonds of length 2.91 Å.

As part of a general programme to study the strucures of natural products of possible commercial use, the structure analysis of dihydro-nimbin

was undertaken. Nimbin is the principal bitter constituent of Neem, a plant of great medicinal use.The present knowledge of the strucures 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=16.50, b=7.74, c = 11.42 Å; $\beta = 96°$. Full three dimensional data was collected. Detailed structure analysis is in progress.

Another natural product, Rubranol, $C_{39}H_{36}O_8$, on which preliminary work was done is obtained from *Morus alba* and *Morus rubra* bark as pale yellow solid. The crystals of Rubranol are orthorhombic, space group $P2_12_12_1$ with a = 28.11, b = 15.91, c = 8.16 Å. Detailed structure analysis is in progress.

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

(*a*) *Infrared spectra and molecular structure*

Infrared spectral studies of mono potassium salts of dialkyl malonic acids showed that a strong symmetric intramolecular hydrogen bond is present in diethyl and di-*n*-propyl derivatives (and not in dimethyl) which inhibits the dissociation of the second carboxylic group and explains the large K1/K2 values observed for such acids in water.

Complex hydroxyl absorptions in the infra-red spectra of aminophenols and some dimethylaminophenols were found to arise from Ferni resonance interaction between the hydroxyl stretching modes and the overtone and combination modes of C-O stretching and OH deformations and other fundamental vibration of the molecule from a detailed study of their deuterated compounds.

(b) *Association behaviour of ethylene glycol monoalkyl ethers*

Association behaviour of diethylene glycol monoalkyl ethers which contains free monomer (MF), an intramolecularly hydrogen bonded five membered ring monomer (M5) and intramolecularly hydrogen bonded eight membered ring monomer (M8) in dilute CCl_4 solution was investigated. In concentrated solution the dimer was formed and the multiple equilibria involved, contained relative concentrations of the order $C_D \sim C_F << C_8 \sim 1/2\ C_5$ at 298 K. The thermodynamic quantities for the equilibria $M_5 \rightleftarrows M_F$, $M_8 \rightleftarrows M_F$ and $D = 2M_F$ are found to be $\Delta H°_{5F} \sim 12$ KJ mol.$^{-1}$, $\Delta S°_{5F} \sim 22$, $\Delta H°_{8F} \sim 21$ KJ mol^{-1}, $\Delta S°_{8F} \sim 56$, JK^{-1} mol^{-1} and $\Delta H°_{DF} \sim 58$KJ mol^{-1}, $\Delta S°_{DF} \sim 153$JK^{-1} mol respectively. A ten membered ring involving the OH group of one molecule bonded to the β oxygen of the other molecule, similar to that in alkoxy ethanol, is found to be the most likely structure for the dimer.

14.6 *Thermodynamic excess properties of binary liquid mixtures* : (6/XIV/70)

Heats of mixing H^E, and volume changes V^E for the systems n-butyl amine+2 butanol and n-butyl amine +2- propanol were determined at 25°C

throughout the concentration range. Excess free energy of mixing G^E for the above systems were determined at 45°, 55° and 65°C using Colburn type recirculating still. These results revealed that there is a strong interaction between amines and alcohols. V^E and G^E values show negative deviation from ideality indicating a close packing of the molecules after mixing the two components.

The second virial coefficient of chloroform, benzene and methanol was measured at 50°C. The determination of second virial coefficient for n-butyl amine and butanol mixture is under progress. Vapour liquid equilibrium of binary mixtures of benzene + nitrobenzene was measured at 30°, 35° and 40°C using the static still tested and calibrated earlier. The results are being computed for understanding the nature of charge transfer complex formation in the system.

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

Six samples irradiated at high intensities were polymerized and the molecular weights determined. There is a direct dependence of molecular weight and yield upon the intensity. Theoretical analysis of this result is being done.

14.8 *Ternary semiconductors* : (8/XIV/72)

Single crystals of the ternary semiconductors viz. $CdGa_2S_4$, $CdGa_2S_3Se$, $CdGa_2S_2Se_2$, $CdGa_2SSe_3$ and $CdGa_2Se_4$ were grown by employing the chemical transport method. Laue-back Reflection photographs revealed that the big faces were developed parallel to (001) plane for the first two compounds and parallel to (112) plane for other compounds. Analysis of optical absorption data indicated that all the compounds had direct band gaps. The values of band gaps were 3.23, 2.80, 2.67, 2.37 and 2.25 ev respectively for these compounds. All the compositions exhibited photoconductivity. Photoconductivity maximum was observed at the following energies : 3.31, 3.03, 2.85, 2.70 and 2.58 ev respectively. D. C. resistivity variation with temperature indicated that these compounds show intrinsic semiconductivity in temperature range 250°-350°C. All samples showed N-type conduction and the thermoelectric power decreased with increasing temperature.

14.9 *Thermodynamic properties of binary molten salt mixtures* : (9/XIV/72)

As reported earlier, the binary molten salt mixture $AgI + CdI_2$ forms a complex compound Ag_2CdI_4 in the AgI mole fraction range 0.6 to 0.7. These results were confirmed by DTA and X-ray studies. In order to confirm the above, the electrical conductivity measurements for the above system were carried out. For this a suitable conductivity cell was designed, fabricated and calibrated using known systems and the conductivity of molten iodide mixtures measured at 400, 450 and 500°C throughout the concentration range. These results also confirmed the complex formation Ag_2CdI_4 in

the same concentration range. The equivalent conductivity and the activation energy were calculated from the above data.

14.10 *Photolysis of H_2O_2 in presence of benzene* : (10/XIV/72)

Concluding experiments on this study proved the exclusive dissociation of H_2O_2 into OH by light of wave length 3000 Å. A simple procedure for the identification and estimation of OH radicals, based upon this study was sent for publication.

14.11 *Diffusion in solid state* : (11/XIV/74)

Earlier the diffusion of iron-59 in poly-crystalline silver was studied at different temperatures. The experimental results showed deviation from the expected data. The diffusion measurements were therefore carried out using single crystal of silver grown by Bridgman technique.

A good linear plot of log specific activity versus square of penetration depth was obtained in all the experiments. The diffusion coefficient of iron-59 tracer in silver was found to vary with temperature according to the equation.

$$D = 2.12 \exp\left(\frac{-49600}{RT}\right)$$

The observed activation energy of 49.6 Kcal/mole was close to the value for self diffusion in silver and indicated that the diffusion of iron in silver takes place by the formation and movement of the vacancies. These results are in agreement with those reported in literature.

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

Mossbauer spectroscopy has been used for a precise study of the electronic state and the nature of the environment of the Mossbauer nuclei. Mossbauer spectra of industrial catalysts CoO. MoO_3. Al_2O_3 with Co: Mo ratio of 0.13 to 0.5 was studied. Similarly the spectrum of $CoAl_2O_4$ was determined. It was observed that on doping $CoAl_2O_4$, Co^{57} decays to Fe atoms forming Fe^{4+}, Fe^{3+} and Fe^{2+} states lasting for more than 10^{-} to 10^{-9}seconds.

14.13 *Semiconducting vanadium phosphate glasses* : (13/XIV/75)

Semiconductivity in non-crystalline solids has been a subject of intensive study during the recent years because it has opened up interesting application possibilities in switching and memory devices and also because it gives rise to new type of energy states with interesting transport properties. Studies on vanadium phosphate glasses were undertaken as model systems for understanding the energy level distribution and the mechanisms of electron transport in oxide glasses. Samples with controlled amount of V^{4+}/V^{5+} were prepared. The degree of disorder was measured from X-ray diffraction intensity data. Electrical conductivity as a function of temperature and as a function of transverse electric field was measured.

14.14 *Semiconductivity in CdS and ZnO thin films* : (14/XIV/75)

A new method of preparing thin films of semiconductors has been established. The technique of film formation is much simpler than the conventional techniques like vacuum evaporation, sputtering, etc.

Some interesting results for CdS thin films formed by this new method were reported earlier, the special feature being its cubic phase. The other properties studied were conductivity, photoconductivity, relaxation spectral response, optical absorption, etc.

Zinc oxide thin films formed by the above method were also studied. It was observed that under controlled condition either amorphous or crysta-, lline phase in the zinc oxide film can be obtained.

Conductivity at various temperatures in zinc oxide thin films was studied and from the results it was concluded that the ionic state of adsorbed oxygen determines the properties. The moisturing of film after baking at 500° gave interesting results for which suitable interpretation was suggested.

The CdS films were also pepared by a chemical deposition technique. They were tenacious, is showed little or no degradation and were photosensitive as deposited. The stoichiometry is easy to maintain. It was observed that the trace addition of cations like copper, silver, indium etc., had dramatic effect of making the films effectively amorphous. Such amorphous films had a density of states of the order of 10^{19} to $10^{20}/cm^3/ev$ near the Fermi level, as determined by photo decay and field effect measurements. Electrical, photoconducting and optical properties such as IV characteristics, dark and photoconductivity decay of photoconductivity, spectral response of photoconductivity and optical absorption were also studied.

15. PLANT AND ANIMAL TISSUE CULTURE

The main objectives of plant tissue culture project are the application of tissue culture to rapid propagation of plantlets of agricultual 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 sugarcane strain CO-740, which is widely used in Maharashtra State and is invariably affected by sugarcane mosaic virus, was obtained virus-free by tissue culture. In order to minimise re-infection sufficient virus-free cane is being grown for field trials on several acres. Screening for disease-resistant and other agriculturally valuable mutants of sugarcane obtained from callus tissue is being continued.

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

A rapid method for the propagation of a high-yielding hybrid cabbage was developed. Sufficient number of seedlings are being grown for large scale field trials to test the economic feasibility of this method.

Differentiation and somatic hybridization

Plantlets were obtained *in vitro* from several species including snapdragon, capsicum, tomato and *Dioscorea deltoidea.* The suitability of this method for rapid propagation and for obtaining high yielding mutant strains is being studied. The rate of multiplication of snapdragon was extremely high. Several wheat mutants obtained from callus tissue are also being screened for high yielding varieties.

Protoplasts were obtained in high yield from callus and leaf tissues of 12 different plants. Methods were standarized for regeneration of colonies from snapdragon and rose bud callus protoplasts. Work on somatic hybridization is in progress.

Miscellaneous

The study of factors present in tissues which increase the cloning efficiency of plant cells is being continued. The factors were found to be non-volatile and heat-labile.

The study of germination of teak seeds was continued. Freshly collected seeds showed dormancy.In spite of high viability (60 per cent as shown by the tetrazolium blue method) the germination rate was poor, but after mechanical cracking of the seeds nearly 30 to 35 per cent of the seeds germinated within three weeks.

The study of the properties and kinetics of the trypsin, chymotrypsin and subtilisin inhibitors of *Vigna catjang* was completed. Two papain inhibitors were obtained in homogeneous form and two others were partially purified and separated from each other. Further studies on the papain inhibitors which are present in all plant tissues are being continued.

Attempts to transfer nitrogen fixing genes from *Rhizobium* to sugarcane are in progress.

15.3 *Animal tissue culture* : (3/XV/72)

The cell culture obtained from potato tubermoth (*Gnorimoschema opercuelella*) was found to be viable after 76 subcultures for a period of 18 months and appeared to be a viable cell line. It requires foetal calf serum as a growth factor but continuous growth was also observed in the presence of bovine serum albumin supplemented with lactalbumin and yeastolate. The nutritional requirements and the suitability of this culture for the growth of viruses are being studied.

16. FERMENTATION TECHNOLOGY

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

The utilization of cellulosic materials for the production of protein food for cattle or of glucose by enzymic hydrolysis is being studied as an interlaboratory project in collaboration with CFTRI, Mysore and Indian Institute of Science, Bangalore with a CSIR Silver Jubilee grant.

A fungal culture was isolated which gave very high C_1 and C_x activities on an inexpensive medium in about 10 - 12 days in shake flasks. Further work in fermentors is being continued with this culture. A second culture which gave high C_1 and C_x activities was also investigated for optimizing enzyme production. A mutation programme for obtaining strains which give higher enzyme yields is also in progress.

Another culture (St-f-3B) which produces little enzyme but grows rapidly on cellulosic materials is being studied for the production of single cell protein. Preliminary trials showed the absence of toxicity to mice. The conversion of cellulose to protein was approximately 20 per cent in 4 to 7 days. More detailed nutritional studies on this culture are being carried out at CFTRI.

A method of pretreatment which is less expensive than those prescribed in the literature was found to give cellulose which showed high enzymic saccharification rates compared to untreated cellulose. Larger scale trials are being continued on optimum conditions for saccharification. A simple method was developed for matrix-binding of cellobiase for repeated reuse.

The purification of the enzyme from the two high cellulase yielding cultures (Cultures A and B) was continued. Two CMCases had C_1 activity and a CMCase the C_1 activity of which was selectively destroyed were obtained. A rapid enzymic method for assaying cellulose hydrolysis was developed.

Preliminary work on the transfer of nitrogen fixing genes from *Azotobacter* to cellulolytic organisms was initiated.

Under the screening and mutation programme, work on promising isolates was continued. A 3-fold increase in C_x and 1.5 fold increase in C_1 activities of an *Aspergillus* isolate (which produces high cellulase) were obtained.

The feasibility of producing protein from cellulose and ammonium sulfate by surface fermentation for use at village level was studied. The protein levels reached with some cellulosic substrates were 20 to 25% and the conversion of cellulose to protein varied between 10 to 20%. Studies are in progress to reduce the time required to reach high protein levels.

The presence of three CMCases with molecular weights of 10500, 25000 and 38000 were detected in *S. rolfsii* broth. An endocellulase, an exocellulase and β-glucosidase were separated from each other and obtained

in a fairly purified form. Work on further purification of these enzymes to obtain pure proteins and study of their mode of action are in progress.

16.2 *Retardation of loss of ammonia applied as fertilizers in soil* : (2/XVI/70)

The microbiological oxidation of ammonia leads to significant losses of ammonia added as fertilizer. The organisms which oxidize ammonia to nitrite and nitrite to nitrate did not survive on subculturing in the laboatory. Methods were standardized for the isolation and maintenance of *Nitrosomonas* and *Nitrobactor* in the laboratory and several pure cultures were obtained from single cells. Almost all the strains were shown to be viable for the past three years on subculture. The optimum conditions of pH, temperature, etc., for maximal growth of these cultures are being determined. Different fractions of neem oil prepared in the Organic Chemistry Division were tested for their effect on these cultures and some of the fractions were found to have a marked inhibitory action on the oxidation of ammonia and nitrite by these organisms.

17. ENZYME TECHNOLOGY

Immobilized enzymes

Major advances in the industrial applications of enzymes have come about with the recent developments in techniques for enzyme immobilization. These immobilized systems couple enhanced stability and reuse potential with the highly desirable properties of specificity and mild environmental reaction conditions. Such systems are finding extensive applications, particularly in pharmaceutical and food industry, e.g. for the production of 6-aminopenicillanic acid required for semisynthetic penicillin manufacture; the resolution of synthetic amino acids; the hydrolysis of starch to dextrose and invert sugar, etc.

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

An immobilized penicillin acylase system was developed earlier in collaboration with Hindustan Antibiotics Ltd. (HAL), Poona. In the procedure developed, a high proportion of activity is covalently attached to the support even at low protein concentration. The immobilized system showed negligible diffusion restrictions and no substrate or product inhibition even at relatively high substrate concentration. The preparation showed good storage and operational stability.

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

The enzyme finds wide application for the production of dextrose from starch.

Work on immobilized amyloglucosidase is being carried out with the soluble enzyme preparation from HAL. Work on some cheap inorganic supports is in progress and attempts to improve the operational stability of these systems are being made.

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

The enzyme is finding extensive application for the large scale processing of dextrose to invert sugar. Invert sugar is superior as an industrial sweetener in comparison to sucrose.

A high enzyme-yielding *Streptomyces sp.* was isolated from soil and the conditions for growth and enzyme production of the isolate as well as mutation work are now in progress. Preliminary studies on whole cell immobilization have been initiated.

17.4 *Enzyme technology* (*6-APA production*) : (4/XVII/75)

For the manufacture of matrix-bound penicillin acylase for the production of 6-APA, the complete design of a plant producing 10 kg. of the immobilized enzyme per batch was prepared and handed over to HAL, Poona.

To study the engineering parameters involved in the prouction of 6-APA from penicillin, a laboratory glass-stirred tank reactor was constructed and the apparatus is being set up.

18. STUDIES IN BIOCHEMISTRY

18.1 *Studies on structure of citrate oxaloacetate lyase* : (1/XVIII/65)

Streptococcal citrate lyase was obtained pure and characterized. Studies on the active sites of the enzyme are in progress.

18.2 *Metabolism of nitrate by A. fischeri* : (2/XVIII/65)

The acid, urea and GnHCl inactivation of *A. fischeri* nitrite reductase is reversible in contrast to SDS-treated enzyme which is irreversible. The inhibition by SDS appears qualitatively different from that produced by urea, GnHCl and acid treatment. With the pure enzyme, the presence of bovine serum albumin is an absolute requirement for reversal of the enzyme activity. The rate and extent of reversal is dependent on buffer species and concentration of the buffer. The kinetics of reactivation of the denatured enzyme were studied.

The *c*-type *Achromobacter* nitrite reductase resembled cytochrome C_3 nitrite reductase from *D. desulfuricans* but did not conform with siroheme (prosthetic group)— containing assimilatory nitrite and sulfite reductase systems in which siroheme is considered to be mediating the six electron transfer. Enzymes involved in the dissimilation of nitrite to gaseous nitrogen products also did not have the siroheme prosthetic group.

Work on crystallization of *Achromobacter* nitrite reductase and study of its structural characteristics are in progress.

19. DEVELOPMENT OF INSTRUMENTS

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

The basic spectrometer-optically has been assembled and is being aligned and tested in the visible range only by using tungsten lamp as source and photomultiplier as detector, along with certain other components like optical wedge, magnetic reed-switches etc. The electronic amplifier has been wired and is being tested with spectrometer. The electronic amplifier was totally wired including A. G. C. amplifier and it is being tested presently.

It is hoped to obtain a working model soon. After the receipt of the imported components, a commercially viable model would be fabricated.

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

The first prototype was fabricated and it is working satisfactorily. Optical allignment is being optimized for ultimate performance. Electronics module was standardized after 2000 hrs. vigorous testinig in imported spectrometer. Electronic multispeed scanning system with autoreverse was also standardized after 1000 hrs. (without failure) testing.

19.3 *Solid state recorder* : (3/XIX/72)

Three prototypes were fabricated and first of them is in use for more than one and half year and the second prototype was given to Central Electronics Ltd. (CEL), Delhi, for evaluation. Evaluation report is awaited. The following specifications have been achieved.

1.	Basic sensitivity	:	1 mV to 100 mV in 7 ranges
2.	Input impedance	:	50 KΩ off null) General 1 MΩ at null) Standard 2 MΩ off null) Optional 10 MΩ at null) Circuit.
3.	Line rejection	:	60 db
4.	Common mode rejction ratio	:	120 db
5.	Chart width	:	250 m.m.
6.	Chart speeds	:	Single or four in the ratio 1:2:4:8 with mechanical gear box.
7.	Chart loading	:	Magazine type.
8.	Chart display	:	Vertical or tilted as required.

The project is now conluded and the fabrication know-how will soon be offered for commercial exploitation.

FOLLOW-UP ACTIONS

1. *Aniline*

Experiments on pelletted catalysts for fixed bed operation and subsequent testing are in progress. A series of catalysts have been prepared and their suitability tested initially on a bench scale. The catalysts (in pelletted form) found satisfactory after initial screening are being handed over to Hindustan Organic Chemicals Ltd., for subsequent trials in their pilot plant.

2. *Dimethylaniline*

A semi-commercial plant of 400 TPA following the continuous process already developed at the laboratory was designed by NCL scientists, and was installed at the site of M/s. Sahyadri Dyestuffs Chemicals, Poona The plant was commissioned successfully. NCL scientists assisted the firm further by inspecting the plant periodically and suggesting suitable modifications. The plant has been in operation satisfactorily since it was commissioned.

3. *Morpholine*

The NCL process was demonstrated successfully to M/s. Bombay Wire Ropes Ltd., Bombay and M/s. Catalyst India Ltd., Bombay.

4. *Opium alkaloids*

The Opium Alkaloids Factory, Neemuch, set up for the production of 8.7 tons of opium alkaloids per annum based on NCL know-how and design, has been recently commissioned.The NCL scientists actively assisted in the plant start-up.

5. *Sorbitol*

Maize Products, Ahmedabad have erected a plant based on NCL know-how for the production of 2000 TPA of 70% sorbitol. NCL scientists assisted the company in the commissioning of the plant which is now running smoothly.

6. *Toluidines*

A plant for 300 TPA of toluidines installed by M/s.Sudarshan Chemical Industries, Roha, was commissioned. NCL scientists assisted in the plant start-up and in subsequent trouble shooting operations.

7. *Vitamin C*

Assistance was rendered to HAL, Pimpri in connection with large scale production of Vitamin C.

RURAL DEVELOPMENT

CHANDRAPUR DEVELOPMENT PROJECT

As a part of the CSIR programme for the adoption of backward districts in the country for integrated development through intensive application of science and technology, NCL had several discussions with the Maharashtra Government authorities and other social and economic research organizations in and around Poona to select an area in Maharashtra for such an effort. Based on these discussions, Chandrapur district in Maharashtra was considered suitable. To start with NCL scientists prepared a tentative basic document containing some ideas on the formulation of an eco-system development plan for Chandrapur. This document attempted a departure from the usual normative approach of sectorial development and emphasised the need for ecological approach keeping the local backward common man as a centre figure and as the main beneficiary of the developmental efforts. After several deliberations on the methodology and approach with Maharashtra Government authorities, the Government of Maharashtra constituted four task forces viz. forestry, agriculture, mining and mineral based industries and infrastructure to study in depth the problems of development and prepare appropriate schemes for implementation.

The task forces met several times with experts in the field and local leaders of the district and prepared detailed plan of action. These reports were circulated to a number of outside experts in the country to ascertain their comments.

Director, NCL and the Scientist-in-charge, DTS undertook an extensive tour of Chandrapur district, particularly of the forest area and submitted a report to the Government of Maharashtra regarding development of forestry in the region.

The co-ordinating scientists in the NCL on Chandrapur project attempted a consolidated review of all the recommended schemes taking into consideration the pertinent experts' comments. NCL scientists have also prepared basic documents for the purpose of ensuring uniformity of approach in project identification, programme formulation, implementation and integration of individual schemes into a total plan of action. The NCL on behalf of the CSIR and other R & D agencies in the country is actively participating in evolving a total eco-system developmental plan for Chandrapur. Special emphasis is being laid in identifying areas where induction of scientific and technological capability will make a sizeable social and economic impact on generation of added value for the people living in the region, most of whom are backward and belong to adivasi communities.

1. *Studies of flora of Chanda District* : (13/VI/76)

A florestic account of the Chanda District of Maharashtra State was collected. Out of 800 different species available in the various forest reserves of Chandrapur, about 126 have been identified as useful medicinal species. Literature references on the chemical constituents of these medicinal plants are being compiled.

PLANNING, CO-ORDINATION AND EVALUATION

The *Division of Technical Services* (*DTS*) is mainly organized for carrying out several activities pertaining to research planning, co-ordination, evaluation, reporting, and liasion with CSIR, other government agencies and industries. Since all these activities are related to management aspects of R & D institutes, the Division also conducts some analytical studies in the areas of R & D management.

The activities carried out by the Division during the year under report, are presented according to above mentioned functions.

1. *Research programming & planning*

Routine collection of techno-economic data on chemicals and raw materials relevant to NCL Research Programme was carried out. Import figures for various chemicals for January—December 1975 were collected and documented.

Press clippings on chemical industry and matters of general interest divided into following 31 areas are maintained : 1. Chemicals and Petrochemicals, 2. Drugs, pharmaceuticals and phytochemicals, 3. Dyestuff and paints, 4. Electronics, electrical and instrumentation, 5. Fertilizers, 6. Insecticides, pesticides, etc., 7. Manmade fibres, paper & pulp industries, 8. Natural fibres, 9. Rubber and plastics, 10. Metals and minerals, 11. Plant, equipment and chemical engineering, 12. Chemical raw materials, plant products, bye-products, 13. CSIR Labs., NCST, etc., 14. Science planning and policies, Research management, 15. Transfer of technology, 16. Industrial policies—growth and development, 17. Data on licences/letters of intents/foreign collaboration, 18. Patents, 19. New products/processes, 20. Management and managerial techniques, 21. Foreign aid, investment, collaboration, joint ventures, 22. Foreign trade and commerce, 23. Socioeconomic studies (Five-year plans, etc.), 24. Studies of corporate sectors (profitability, structure, investment, organization), 25. Budget, public finance, taxation and monetary policies, 26. Miscellaneous, 27. Biochemical and microbiological processes and products and biogenetics, marine chemicals, 28. Radiation and nuclear technology, 29. Industries-miscellaneous, soaps and detergents, 30. Pollution and wastes, 31. Energy and futurology. Through this activity latest techno-economic information in the above areas concerning Indian situation is continuously documented.

Licence applications referred to NCL were studied and relevant information on imports of raw materials, plant and equipment, foreign exchange drain through collaboration agreements is documented. Separate documentation is also maintained on imported drugs and pharmaceuticals.

The above techno-economic data is used in suggesting initiation of new R & D projects. In order to comply with the information desired by the Planning group of CSIR, proforma for submitting Research Programme was duly modified. The Division actively participated in the Research Programme Committee meetings and Advisory Panel meetings and provided secretarial assistance in finalizing Annual Research Programme of the NCL for 1976-77.

About 36 sulphuric acid manufacturers were contacted for collecting the data on sulphur sludge produced per annum in their sulphuric acid plants and its present mode of utilization. Samples of sulphur sludge were also collected for analysis.

Defence departments were contacted to ascertain their requirements along with specifications of imported 'Hypalon rubbers and their compositions'.

Techno-economic information on (i) Acetal resins (ii) Sorbic acid and (iii) Furfural was collected by contacting several firms engaged either in their manufacture, import or utilization.

With the growth in the number of scientific personnel in the NCL, need was felt to make an assessment of the expertise gathered by the laboratory in various branches of chemistry over the years. As a first step in this direction, a survey of expertise available in organic chemistry (qualification-wise, experience-wise and choice-wise) was undertaken. The data were analysed and presented to the management.

Based on this experience, a new questionnaire is framed to cover the entire scientific staff in NCL to find out their training, experience, contributions, attitudes and related behavioural aspects. It is hoped that this data will be useful to the management of the laboratory in making optimum use of scientific man power available.

Overhead figures for 1976-77 were calulated as per NCL norms.

In addition to the usual conventional budget prepared by Administration, a project-wise budget 1975-76 and 1976-77 was prepared. For this purpose all the activities of NCL were presented as 23 R & D projects and for each of these project areas information on R & D man power and financial inputs was collected and sent to CSIR.

2. *Research co-ordination*

Terms and conditions for undertaking sponsored research were revised as per new CSIR guide lines. Contractual research proposals for the following projects were prepared : (1) l-Menthol from Δ^3– carene (2) Development of items having short shelf life for HAL, Nasik (3) Development of flexible polyester resin (4) Development of short shelfed life chemicals and consumables for HAL, Bangalore (5) N-ethyl-*o*-toluidine (6) Anisidines (7) Naproxene (8) Porous mass for acetylene cylinders (9) Development of an adhesive for rubber blankets.

Collaborative agreement proposals for large scale cultivation of hybrid cabbage with NARI, Phaltan and Tin oxide resistors with Rescon, Poona were prepared. The proposals are being executed.

DTS rendered help to all other Divisions in matters connected with filing and sealing of patents. Data on all NCL patents is also maintained by the Division.

3. *Research evaluation*

Norms for cost analysis of NCL projects were revised by approaching several project engineering and commercial firms, experts, etc., and norms for pricing of utilities, plant costs, etc., were revised. Cost evaluation of the following NCL processes was done : (1) Dimethoate (2) Fenitrothion (3) Dalapon (4) Colchicine. Non-technical notes on 10 NCL projects were revised and their cost analysis updated. In all 100 non-technical notes are now available for circulation to interested parties.

In order to facilitate technology transfer of NCL know-how to industry, it was felt that process and engineering data to be handed over to the industry may be clearly specified and defined. Accordingly two check-lists were prepared in consultation with chemical engineering group for Level I and Level II transfers. These check-lists were circulated amongst all the NCL project leaders and to Directors of the chemical group of CSIR laboratories.

4. *Liasion*

About 4000 enquiries pertaining to NCL projects, general technical enquiries from different individuals, industries, Government organizations. parliamentary starred questions, etc., were attended to.

Over 1850 visitors from educational institutions, industries and other organizations were taken around the laboratory. NCL documentary film was screened for some of the groups and distinguished visitors. This film was also screened in 58 theaters in 37 cities in the country. More than 300 entrepreneurs/parties interested in acquiring NCL technologies were attended to and the requisite information on several projects was furnished to them.

All parties who have implemented NCL know-how were contacted for collection of data on installed capacity of their commercial plants.

NCL comments on 75 licence applications for foreign collaboration and over 185 schemes for financial assistance from CSIR were sent to CSIR in consultation with the concerned scientists.

Following processes were referred to CSIR for assigning them to NRDC. Information on these processes was supplied in prescribed proforma: (1) Adhesive for staple pins (2) Colchicine (3) Silicon tetrachloride, (4) Cadmium pigments.

Information on the following was specially compiled and sent to CSIR: (1) A note on NCL's work on defence (2) Data on specialized equipment/ testing facilities available at NCL (3) Activities of the groups connected with industrial liasion units in the CSIR laboratories (4) Data for CSIR handbook (5) NCL report for CSIR Annual Report Jan. — Dec. 1975.

Information concerning NCL for CSIR News, Research Utilization Data and Summary for Cabinet Committee were routinely compiled and sent to CSIR, every month.

5. *Participation in exhibitions get-to-gethers organized by outside agencies*

During the period under review NCL participated in the following exhibitions :

(i) National Science Exhibition for children at Teen Murthi Bhavan, New Delhi.

(ii) Exhibition held at CDRI, Lucknow on the occasion of their Silver Jubilee celebrations.

Pictorial and photographic murals and charts on NCL projects along with samples were displayed and arrangements were made to explain the exhibits.

Following get-to-gethers were also attended :

(i) NRDC-Industry-CSIR R & D Institutions get-to-gether at IIT, Bombay.

(ii) NRDC-Entrepreneur-CSIR-Indian Bank get-to-gether at IIT Madras.

(iii) CSIR-Industry get-to-gether organized by BITM, Calcutta.

(iv) CSIR laboratories and Pharmaceutical Industries get-to-gether held at CDRI, Lucknow.

During these get-to-gethers discussions were held with several entrepreneurs on know-how being offered by NCL for commercial implementation Non-technical notes along with preliminary economic information were supplied and specific queries were attend to. A number of scientists from R & D groups of the laboratory participated in the get-to-gethers alongwith DTS staff.

6. *Research analysis*

A master list comprising of all the product-oriented projects appeared in the Annual Reports since 1965 and those declared as ready for release before 1965 has been prepared. The analysis of these projects for their completion and utilization aspects is in progress.

Data on project turnover in NCL during 1969-74 was reported last year. During the period under review, project turn-over data for the years 1974-75 & 1975-76 was compiled. The details are given in the following table.

	1974-75	1975 - 76
(i) Projects continued from previous year	... 116	102
(ii) New projects undertaken	... 31	41
(iii) Projects completed/terminated	... 45	21

Separate documentation of all sponsored projects is being compiled. The data are being analysed for study of utilization of sponsored projects. exclusivity versus non-exclusivity provisions in the sponsored projects, etc.

For the survey initiated by Institute of Applied Manpower Research, New Delhi in collaboration with IIT, Bombay, assistance was given to IIT to compile data about NCL in three types of proformae.

7. *Reports & Publicity*

The following reports were prepared during the year under review :

(i) Annual Report 1974 - 75 and Achievements 1974-75

(ii) Research Programme 1976-77

Following articles were prepared and sent to CSIR and Ministry of Communication for publication :

(i) Success story of acetanilide

(ii) NCL's contribution to Indian Drugs and Pharmaceuticals Industry.

(iv) NCL's achievements on chloromethanes

As the Silver Jubilee programme, popular articles in Indian regional languages on "Achievements of NCL" were prepared and published in Marathi, Kannada, Hindi, Malayalam and Gujarathi. Assistance was rendered by DTS to the authors for preparation of these articles. List of the articles published appears under 'Publications.'

8. *Miscellaneous*

Secretarial assistance was rendered to the Director, NCL in the preparation of several notes, papers, lectures. etc., pertaining to the R & D work of the laboratory.

The Division continued to render photographic and draftsman services to the other sections in the laboratory. The number of jobs completed were 350 which included enlargements-1938, projection slides-807 and photocopies of reprints and documents-825.

The following pictorial charts were added to the NCL museum with the help of DTS artists : (1) Vitamin B_6 (2) Theophylline, aminophylline, caffeine (3) Diazepam. The division artists also prepared the following charts : (1) Number of processes in production (2) Distribution of NCL technologies in the country (3) NCL staff deployment — area wise.

Over 60 coloured slides consisting of various commercial plants based on NCL know-how, informative charts, murals, etc., were prepared for audio visual presentation to the Prime Minister and President-CSIR.

INFRASTRUCTURE ACTIVITIES

1. *Analytical groups*

1.1 *Physico-chemical analysis* : This group is primarily engaged in carrying out physico-chemical analysis of raw materials, intermediates and finished products relating to the various projects in progress in the laboratory. During the period under report, spectrophotometric determinations were carried out for pesticides and related projects.

1.2 *Microanalysis* : The main activity of this group is to carry out the microanalysis of organic and organometallic compounds for different elements (C, H, N, etc.,) functional groups and other estimations like molecular weight determination, neutralization equivalent determination etc., relating to the research and development work of the laboratory. Microanalytical work of different compounds is also accepted in this group, on behalf of research organizations, universities, etc., on payment, depending upon the internal work load. During the period under review, 2667 samples were analysed for various elements (2622) and functional groups (45).

The group is also concerned with the development of new analytical methods for applied projects in the NCL, analysis of organic compositions of industrial importance and research in microanalytical chemistry and analytical organic chemistry.

During the year under review, new analytical methods for rapid determination of carbon, hydrogen, halogen, etc. were developed. These are—(i) Development of a method for rapid determination of carbon and hydrogen by the empty tube technique, (i) Standardization of a method for halogen determination in ∝—phenyl glycyl chloride hydrochloride and (iii) A method for the determination of ascorbic acid in the presence of hydrochloric acid.

A method for rapid determination of nitrogen is being standardized.

Analytical methods for the estimation of intermediates as well as final products of several organophosphorus pesticides were developed and standardized using combined techniques of GLC, TLC, column chromatography and phosphorus estimation.

1.3 *Mass spectrometry* : During the period under review, 1083 samples relating to NCL research work were analysed.

1.4 *Spectrochemical and other analysis* : With the help of different physico-organic techniques such as UV, IR, NMR, visible spectra, VPC and GLC, analytical and structure elucidation work was carried out in support of the laboratory's research programme. The types and number of spectral and other analyses carried out are

NMR	7119
IR	6291
VPC/GLC	5110
Spectrophotometric estimation/ Inorganic analysis of special nature	409
UV/UV-Visible	350
X-ray powder patterns	331
Thermogravimetric analysis (DTA, TGA, TG, etc.)	100
Optical microscopy	62
Determination of surface area by BET technique	4

2. *Entomology group* :

The Entomology Unit of the NCL has been recently organized for testing various compounds (pesticides, hormones, pheromones, attractants, repellants, plant extracts, etc.) and for undertaking basic or applied research.

List of cultures developed and being maintained on permanent basis is given below :

(i) *Dysdercus koenigii*, (ii) *Gnorimoschema operculella*, (iii) *Corcyra cephalonica*, (*iv*) *Callasobruchus chinensis* (v) *Tribolium castaneum* and (vi) *Aedes acgypti*

Species reared on short term basis from time to time for testing purposes are— (i) *Periplaneta americana and* (ii) *Local termites.*

Nearly 150 compounds were tested for various kinds of activity on different insects. Besides the NCL compounds, Insect Growth Regulators (IGR) obtained as gifts from abroad were also assayed. Studies on metabolism/degradation of IGR were also carried out in collaboration with the Mass Spectrometry group. This work is being continued.

Screening of various plants and their fractions to identify and isolate biologically active constituents with the objective of obtaining cheap, indigenous insect control chemicals was undertaken. Detailed study on the weed *Parthenium hysterophorus* Linn was done.

Behaviour studies on some species have been initiated as a prelude to isolation, identification and assay of pheromones/analogues.

3. *National collection of industrial microorganisms* :

The laboratory has a collection of about 1900 non-pathogenic yeasts, bacteria and fungi. 35 cultures were added to the collection.

Routine subculturing of the organism and tests on their biochemical performance were continued. 2 compounds from the laboratory were tested for their antifungal activity.

4. *Instrumentation section* :

This section is mainly engaged in maintenance of special types of sophisticated instruments such as spectrometer, UV, IR, NMR, gas chromatograph, X-ray machine, etc., besides routine maintenance of smaller instruments like pH meter, conductivity bridges, furnaces, potentiometric recorders, microvoltmeters, etc.

During the year under review, 380 jobs were completed.

5. *High pressure laboratory* :

Experiments involving high pressure chemical reactions relating to different projects of the laboratory are normally carried out by this section.

During the period under review 190 experiments were carried out for various research and development projects of the laboratory.

6. *Engineering Section* :

6.1 *Mechanical engineering* : This section is mainly looking after the maintenance of the laboratory's installations, utility services and equipment. During the year, the following special fabrications were carried out for laboratory work and sponsored projects :

(i) A bench scale unit for vinyl chloride project comprising a reactor with cyclone separators and control panels.

(ii) Ceramic slicing machine with diamond impregnated wheel.

(iiii) Fabrication and erection of the pilot plants on endosulfan and acrylates.

(iv) Air conditioning of the new Mass spectrometer room, internal electrification for the dispensary building and the library extension.

The total number of internal assignments completed by this section amounts to 3085 having a face value of nearly Rs. 5.4 lakhs.

6.2 *Civil engineering* : In addition to the maintenance works of the laboratory and colony, the following constructions were carried out during the period under review.

(i) Constructions of compound wall for new dispensary building, gas house, curb wall near pilot plant laboratory and canteen; partition wall in open air laboratory, construction of storage tank for furnace oil and watchmen cabins (Nos. 3).

(ii) Construction of a new building for NCL dispensary.

(iii) Construction of approach road and asphalt surface around new store building.

(iv) Extension of the NCL library hall in the basement and glass blowing building.

(v) Construction of a new building for Chemical Engineering and Process Development Division (in progress).

(vi) Construction of glass house in progress.

The total value of these constructions amounted to Rs. 14.6 lakhs, approximately.

7. *Glass blowing section* :

Apart from maintenance of glass apparatus of various research groups in the laboratory, the glass blowing section fabricates glass assemblies of different types required for the research and development work.

During the year under report, 1588 repair jobs were completed.

Glass assemblies of various types were fabricated as per the drawings/ specifications given by the scientists. In all 2334 fabrications of glass apparatus were made. Of these 192 jobs were carried out for sponsored projects.

About 4869 standard ground-glass joints, 40 flange joints, 15 high vacuum stop cocks and 12 sintered glass discs were fabricated for the above work. The estimated value of these items is Rs. 3.65 lakhs.

In addition to above, fabrication of glass column, baffles and repairs were carried out on behalf of outside parties.

8. *Library* :

The library houses about 68,000 publications consisting of books, periodicals, patents, standards and technical reports. etc. During the year under report 2980 publications comprising (i) books-1389, (ii) periodicals (bound)—1361, (iii) patents/standards-200, (iv) technical reports-21 and

(v) theses-9 were added. 598 current periodicas including annual reports of various institutes were received. Translations/photocopies of 25 papers published in foreign languages were also procured. A monthly current awareness service on the following topics viz. (i) Agrochemicals and pesticides (ii) Indian patents (iii) Solar energy and (iv) Library bulletin was rendered to the laboratory.

In addition to above bibliography on endosulfan covering the period 1950-73 was compiled and circulated to the concerned scientists of the laboratory.

Library facilities are available to clientele from industry, Govt. departments, universities, colleges and other research organizations. About 503 persons from these organizations made use of these facilities. Microfilms and photostat copies (1148 pages) of references available in the library were supplied to outside parties on payment.

NCL is a Patent Inspection Centre for Indian patents. The library received 5000 patents specifications during the period under review.

APPENDICES

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

1.1 *Supply of cultures*

During the year under report, 203 cultures from the National Collection of Industrial Microorganisms (NCIM) were supplied to various institutions in India and abroad on payment.

1.2 *Analytical services*

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

Microanalysis	57
NMR	25
IR	171
UV/UV-visible	4
Mass spectral analysis	100
VPC/GLC	59
Thermogravimetric analysis (DTA, TGA, TG, etc.)	11
X-ray powder patterns	13
Optical microscopy	7
Spectrophotometric estimation/ Inorganic analysis of special nature	22

The total receipts on account of analyses/testings carried out during the year amounted to Rs. 0.18 lakhs.

Technical aid was rendered to about 7 agencies including universities, Government departments and industry in the form of experimental work, instrumental repairs, fabrication of special glass apparatus and analyses of special nature.

Training in the areas of maintenance of instruments and chemical and spectroscopic analytical methods and glass assemblies was given to 12 representatives of industries, IITs, colleges and universities.

1.3 *Special equipments/instruments/testing facilities*

The following special equipments were installed in the laboratory during 1975–76. These are in addition to the special equipments already available in the laboratory as mentioned in the NCL annual reports 1971–72 and 1972–73.

	Name of the equipment/instrument	*Function*
1.	Gas chromatograph— Mass spectrometer integrated unit (MS–30–AEI)	Analysis of complex organic mixtures in micro quantities
2.	High pressure liquid chromatograph — (Walers Associates, USA,)	Qualitative and quantitative analysis of organic compounds
3.	Varian 2740 with duel flame ionization detector	Analysis of pesticides

2. SPONSORED PROJECTS

2.1 *Sponsored projects concluded during* 1975-76

	Process	*Name of the party*
1.	Acrylic acid/acrylates from acrylonitrile	M/s. Indian Petrochemicals Corporation Ltd., Baroda.
2.	Preparation of cephalexin and 7-ADCA	M/s Hindustan Antibiotics Ltd., Pimpri, Poona.
3.	N-Ethyl-*o*-toluidine	M/s. Mafatlal Industries Ltd., Asarw Roada, Ahmedabad.
4.	Fumed silica	M/s. Century Rayon, Kalyan.
5.	Synthesis of potential pharmacologically active substances (Furoseamide)	M/s. Sarabhai Research Centre, Baroda.
6.	Testing of rayon grade pulp from Bastar hardwoods	M/s. Baroda Rayon Corporation, Udhna.

2.2 *Sponsored projects undertaken during* 1975-76

1.	Anisidines from nitroanisoles by catalytic hydrogenation	M/s. Amar Dye-Chem, Ltd., Bombay.
2.	Development of items having short shelf life	M/s. Hindustan Aeronautics Ltd., Nasik.
3.	N-Ethyl-*o*-toluidine	M/s. Mafatlal Industries Ltd., Asarwa Road, Ahmedabad.
4.	1-Menthol from Δ^3— Carene	M/s. Bhavana Chemicals Ltd., Baroda.

	Process	*Name of the party*
5.	Molybdenum chemicals from molybdenum concentrates	M/s. Apex Chemicals, Bombay.

2.3 *Sponsored projects continued from* 1974-75

1.	Flavonoids, tannins, stilbenes, lignans and quinones in some Indian forest trees (PL-480)	U. S. Department of Agriculture, Washington.
2.	Propylene oxide	M/s. Indian Petrochemicals Corporation Ltd., Baroda.
3.	Sorbitol from glucose by continuous process	M/s. Anil Starch Products, Ahmedabad.

3. TECHNOLOGY TRANSFER

3.1 *Demonstrations given during* 1975-76

Process know-how for the following products was demonstrated.

	Process	*Name of the party*
1.	Can lining composition (based on nitrile rubber latex)	M/s. Premier Rubber and Cable Industries, Dist. Thana.
2.	Clofibrate	M/s. SD's Lab Chem Industry, Bombay.
3.	Diazepam	1. M/s. Alkem Laboratories Pvt. Ltd., Bombay. 2. M/s. Orion Chemicals, Bombay. 3. M/s. SD's Lab Chem Industry, Bombay.
4.	Gum arabic substitute	M/s. Industrial Solvents and Chemicals P. Ltd., Bombay.
5.	Morpholine	1. M/s. Bombay Wire Ropes Ltd., Bombay. 2. M/s. Catalyst (India) Ltd., Bombay.
6.	Polyurethane coatings	M/s. Polyurethane Industries, Ahmedabad.
7.	Foundry core binder (Sinol core binder)	M/s. Wisca Chemicals, Bhavnagar.

	Process	*Name of the party*
8.	Thioglycolic acid	M/s. SD's Lab Chem Industry, Bombay.
9.	D-xylose and xylit from coconut shells (sponsored)	M/s. Unichem Laboratories, Bombay.

3.2 *Processes leased out during* 1975-76

	Process	*Name of the firm*
1.	Bostik sealants—substitute	M/s. Premier Rubber & Cable Industries, Bombay.
2.	Can lining composition (based on nitrile rubber latex)	M/s. Premier Rubber & Cable Industries, Bombay.
3.	Dalapon	1. Shri. D. N. Nair, New Delhi. 2. M/s. HICO Products Pvt. Ltd., Bombay.
4.	Diazepam	1. M/s. Alkem Laboratoires Pvt. Ltd., Bombay. 2. M/s. Orion Chemicals Ltd., Bombay.
5.	N, N- Dimethyl biguanide hydrochloride (DMBG–HCl) Phenethyl biguanide hydrochloride (PEBG–HCl)	M/s. Combii Organochem Pvt. Ltd., New Delhi.
6.	Endosulfan	M/s. Bharat Pulverising Mills Pvt. Ltd., Bombay.
7.	Foundry core binder (Sinol core binder)	M/s. Wisca Chemicals, Bhavnagar.
8.	Gum arabic substitute	1. M/s. Delta Chemicals, Kottayam. 2. M/s. Surya Gum & Chemicals, Ahmedabad.
9.	β-Ionone	M/s. Pappachan K. Elengical, Kerala.
10.	Morpholine	1. M/s. Bombay Wire Ropes Ltd., Bombay. 2. M/s. Catalyst (India) Ltd., Bombay.

	Process	*Name of the firm*
11.	Nicotine sulphate from tobacco ond tobacco waste	1. M/s. Harmanbhai Shankarbhai Patel, Rajasthan. 2. M/s. S. K. Sinha, Patna.
12.	*p*-Nitrophenol	M/s. Catalyst (India) Ltd., Bombay.
13.	Polyurethane coatings	M/s. Polyurethane Industries, Ahmedabad.
14.	Xanthates — Potassium ethyl and Potassium amyl	M/s. Chrome International, Jaipur.
15.	Staple pin adhesive	M/s. Duro Metochem Pvt. Ltd., Bombay.

3.3 *Processes assigned to NRDC during* 1975-76

1. Cadmium pigments
2. Colchicine
3. 2-Chloroethyl - trimethylammonium chloride
4. Dichloropropionic acid (Dalapon)
5. Endosulfan
6. Maleic hydrazide
7. Staple pin adhesive

3.4 *Premia and royalties received by NRDC through NCL processes during* 1975-76

PREMIA

Sr. No.	*Process*	*Name of the firm*	*Premium received (Rs.)*
1.	Antioxidant TEDQ (2, 2, 4-Trimethyl-6-ethoxy-1, 2-dihydro-quinoline)	M/s. Amar Dye–Chem Ltd., Bombay.	10,000*
2.	Bostik sealants-substitute	M/s. Premier Rubber & Cable Industries, Dombivali (Dist. Thana).	2,500
3.	Can lining composition	—do—	5,000
4.	Diazepam	M/s. Orion Chemicals, Bombay.	20,000

Sr. No.	*Process*	*Name of the firm*	*Premium received (Rs.)*
5.	Diazepam	M/s. Alkem Laboratories Pvt. Ltd., Bombay.	20,000
6.	Dichloropropionic acid (Dalapon)	M/s. HICO Products Pvt. Ltd., Bombay.	5,000*
7.	—do—	Shri. D. N. Nair, New Delhi.	15,000
8.	Dimethylaniline	M/s. Sahyadri Dyestuffs & Chemicals Pvt. Ltd., Poona.	12,500*
9.	N, N-Dimethylbiguanide-HCl (DMBG-HCl) Phenethylbiguanide-HCl (PEBG-HCl)	M/s. Combii Organochem Pvt. Ltd., New Delhi.	2,500*
10.	Endosulfan	M/s. Bharat Pulverising Mills Pvt. Ltd., Bombay.	62,500*
11.	Ethylenediamine	M/s. Bharat Vijay Mills Ltd., Kalol.	25,000*
12.	Flexible magnets	M/s. Ferrites & Electronics Components (P) Ltd., Lucknow.	3,000*
13.	Foundry core binder (Sinol core binder)	M/s. Card Chem Industries, Hyderabad.	2,500*
14.	—do—	M/s. Wisca Chemicals, Bhavnagar.	5,000
15.	Gum arabic substitute	M/s. Surya Gum & Chemicals, Ahmedabad.	5,000
16.	—do—	M/s. Delta Chemicals, Kottayam.	5,000
17.	Micro filters	M/s. Sona Micro Filters, Poona.	2,000*
18.	Morpholine	M/s. Bombay Wire Ropes Ltd., Bombay.	17,000*
19.	—do—	M/s. Catalyst (India) Ltd., Bombay.	17,000*
20.	Nicotine sulphate from tobacco and tobacco waste	Shri. S. K. Sinha, Patna.	2,000
21.	Nitrile rubber	M/s. Synthetics & Chemicals Ltd., Bombay.	60,000*
22.	Nitrofen	M/s. Delhi Pesticides P. Ltd., Bombay.	5,000*

Sr. No.	*Process*	*Name of the firm*	*Premium received (Rs.)*
23.	*p*-Nitrophenol	M/s. Catalyst (India) Ltd., Bombay.	13,500*
24.	Polyurethane coatings	M/s. Polyurethane Industries, Ahmedabad.	5,000
25.	Radiosonde thermistors	M/s. Bhagyanagar Laboratories, Hyderabad.	5,000*
26.	70% Sorbitol from dextrose monohydrate	M/s. Maize Products, Division of Sayaji Mills Ltd., Ahmedabad.	18,750*
27.	Tetradifon	M/s. Delhi Pesticides P. Ltd., Bombay.	5,000*
28.	Staple pin adhesive	M/s. Duro Metochem P. Ltd., Bombay.	6,000
29.	Vitamin B_6	M/s. Indian Drugs and Pharmaceuticals Ltd., Hyderabad.	10,000*
30.	Xanthates-Potassium ethyl and Potassium amyl	M/s. Chrome International, Jaipur.	4,000
		Total	3,70,750

* Part payment

ROYALTIES

Sr. No.	*Process*	*Name of the firm*	*Royalties received (Rs.)*
1.	Bostik sealants—substitute	M/s. Swastik Rubber Products Ltd., Poona.	188.20
2.	Butyl titanate	M/s. Synthochem, Indore.	577.00
3.	Cadmium sulphide photoconductive cells	M/s. Chinoy Electronics, Poona.	140.70
4.	Can lining composition based on nitrile rubber latex	M/s. Arya Chemical Works, Calcutta.	28.18
5.	Clofibrate	1. M/s. Biological Evans Ltd., Hyderabad.	9,570.00
		2. M/s. Nivedita Chemicals P. Ltd., Bombay	3770.00

Sr. No.	*Process*	*Name of the firm*	*Royalties received (Rs.)*
6.	Diazepam	M/s. S D's Lab Chem Industry, Bombay.	67.50
7.	Ferrites-Hard	M/s. Semiconductors Ltd., Poona.	600.00
8.	Gum arabic substitute	1. M/s. Karnatak Adhesives, Bangalore.	146.56
		2. M/s. Malwadkar Industries, Pimpri, Poona.	28.16
		3. M/s. Supreme Enterprises, Ludhiana.	70.12
9.	β-Ionone	M/s. Industrial Perfumes Ltd., Bombay.	1,91,677.46
10.	Monoethylaniline	M/s. Atul Products Ltd., Bulsar.	19,264.00
11.	Nicotine sulphate from tobacco and tobacco waste	M/s. Urvkunj Nicotine Industries, Dharmaj (Dist. Kaira).	22,858.35
12.	D. C. Recording Polarograph	1. M/s. Elico (P) Ltd., Hyderabad.	4,143.00
		2. M/s Chromatography & Instruments Co., Baroda.	750.00
13.	Polyurethane printing rollers	M/s. Sree Saraswati Press Ltd., Calcutta.	7,700.61
14.	Sachets - Hot & Cold	1. M/s. Thermo Chem.Laboratories, Poona.	12.00
		2. M/s. Vasant Industrial Corpn., Nagpur.	68.25
15.	Sisal wax	M/s. Aphali Pharmaceuticals Ltd., Ahmednagar.	61.78
16.	Vapour phase chromatograph	M/s. Associated Instruments Manufacturers (India) P. Ltd., New Delhi.	1,900.00
17.	Vitamin C	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona.	2,738.47
		Total	2,66,360.34
		Total Premia and Royalties	6,37,110.34

5. LECTURES AND SEMINARS

Lectures

5.1 The following visiting scientists delivered lectures in the Laboratory

1.	Prof. G. Narasimhan, Dept. of Chemical Engineering, Indian Institute of Science, Bangalore.	Series of lectures on chemical reactor analysis.
2.	Prof. L. W. Shemilt, Faculty of Engineering, McMaster University, Hamilton, Canada.	Continuous ion exchange using liquid-solid fluidized beds.
3.	Dr. A. Patchornik, Dept. of Organic Chemistry, Weizmann Research Instt., Rehouat, Israel.	Organic reactions on polymer bound catalysts.
4.	Dr. G. K. Kohn, UNIDO Advisor on Pesticides to the Ministry of Petroleum and Chemicals, Govt. of India, New Delhi.	The chemotherapy of plant disease.
5.	Dr. A. S. Narula, Syntex Research Laboratories, Palo Alto, California, U. S. A.	Synthesis of prostaglandin analogues.
6.	Prof. Tatsuo Yamamoto, Research Institute of Electronics, Shizuoku University, Hamamatsu, Japan.	Si switching device by charge controlled tunnelling.
7.	Dr. M. S. Rajagopalan, Formerly with the University of Aberdeen, Scotland.	Synthesis of 18-hydroxy corticosterone and 18-hydroxydeoxy corticosterone.
8.	Prof. Ernest Wenkert, Rice University, Houston, Texas.	Alkaloid synthesis.

9.	Prof. G. Snatzke, Dept. of Chemistry, Ruhr-Universitat Bochum Abteilung Fur Chime, Germany.	Application of circular dichroism in structural chemistry.
10.	Dr. P. Srinivas Rao, U. S. Army Natic Lab., U. S. A.	Redox potentials of free radicals and their clinical and biochemical significance.
11.	Dr. G. Hoffmann-Ostenhof, University of Vienna, Austria.	Enzymes in the metabolism of *myo*-inositol and related compounds.
12.	Prof. Kenji Koga, University of Tokyo, Japan.	Deamination reaction of ∝ -amino acids and its application to the synthesis of natural products.
13.	Dr. R. Venkatraghvan, Cornell University, Ithaca, N. Y., U. S. A.	Computer aided mass spectrometry.
14.	Prof. S. K. Pradhan, Bombay Univ., Dept. of Chemical Technology, Bombay.	Stereochemistry and mechanism of an unique radical–anion cyclization.
15.	Prof. M. V. George, Indian Institute of Technology, Kanpur.	Electrocyclic reactions of hetero-trienes.
16.	Dr. J. P. Mascarenhas, State University of New York Albany, U. S. A.	The transfer of genetic information from bacteria to plants.
17.	Dr. P. V. Sundaram, Max-Planck Institute, Gottingen, W. Germany.	Immobilized enzymes.
18.	Dr. I. Chibata, Research Laboratory of Applied Biochemistry, Tanabe Seiyaku Co. Ltd., Japan.	Immobilized enzyme and industrial application.

19.	Prof. J. M. Honig, Purdue University, U. S. A.	Properties of metallic oxides and oxides undergoing metal to semi-conductor transitions. Theories of metal-to-insulator transitions in solids. Properties of niobium oxide and nickel oxide-a study in contrasts.

5.2 The following NCL scientists deliverd lectures at various institutes, universities, colleges, etc.

	Name of the scientist	*Subject*	*Venue*
1.	Dr. K. K. Chakravarti	Isopatchoula-3, 5-diene.	Maltichem Research Centre, Baroda.
2.	Dr. L. K. Doraiswamy	Experimental reactors.	Indian Institute of Chemical engineers, Calcutta.
		Chemical Engineering (General talk).	Indian Institute of Technology, Bombay.
3.	Dr. V. Jagannathan	Plant tissue culture.	Indian Institute of Science, Bangalore.
		Recent advance in plant tissue culture.	Poona University, Poona.
4.	Dr. M. N. S. Murthy	Ferrites.	Poona University, Poona.
5.	Dr. L. M. Pant	Crystallographic study of organic compounds.	Gorakhpur University Gorakhpur.
6.	Dr. P. N. Rangachari	Series of lectures on industrial fermentation.	Maharashtra Association for the Cultivation of Science, Poona.

	Name of the scientist	*Subject*	*Venue*
7.	Dr. J. C. Sadana	Biological nitrogen fixation.	Poona University, Poona.
		—do—	Ahmednagar College, Ahmednagar.
8.	Dr. A. P. B. Sinha	Defect structure of semiconductor surfaces.	Reactor Research Centre, Kalpakam, Madras.
9.	Dr. B. D. Tilak	New heterocyclic quinonoid chromophoric systems.	M. S. University, Baroda.
		Synthesis of thiocyclobutadiene derivatives and related heterocyclic compounds.	M. S. Univ., Baroda (Dr. C. S. Patel Memorial Lecture)
		Synthesis of new quinonoid chromophoric systems.	Poona University, Poona.
		National goals & R and D programming.	National Institute of Ocenography, Goa.
		Technology transfer.	National Research Development Corporation of India, New Delhi.
		Planning of science and technology in India.	Institution of Chemists (India), Calcutta.

6. STAFF STRENGTH* AS ON 31-3-1976

1.	Scientific	
	(i) Director	1
	(ii) Scientist F	5
	(iii) Scientist E	21
	(iv) Scientist C	71
	(v) Scientist B	60
	(vi) Scientist A	36
	(vii) S. S. A.	82
	(viii) J. S. A.	36
	(ix) S. L. A.**	64
	Total	376
2.	Technical	212
3.	Administration	99
4.	Class IV technical	132
5.	Class IV non-technical	74
	Total (1-5)	893
6.	Research fellows, Pool Officers, Guest Workers and Graduate Trainees	
	(a) JRF and SRF	54
	(b) Post-doctoral research fellows	3
	(c) CSIR Pool Officers	3
	(d) Guest Workers	24
	(e) Graduate Trainees	3
	Total	87
7.	Scientific staff working on sponsored projects	
	(a) NCL staff deputed on sponsored projects	5
	(b) Staff specially appointed by the sponsor	24
	Total	29

* This denotes staff in position.

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

7. STAFF NEWS

7.1 *Deputations / Training, etc.*

1. Dr. B. D. Tilak visited the Netherlands, West Germany and U. S. A. under Indo-German and CSIR-NSF exchange programme (April 1975-May 75). He also participated in International symposium on 'Evaluation of biological activity of pesticides' at Wageningen and delivered a plenary lecture on 'Pest control strategy in India.' He spent 6 weeks in these countries visiting industries, universities and industrial research laboratories. He gave lectures at several of these places on his research interest. The topic of his lectures were :

   (1) New heterocyclic quinonoid chromophoric systems; (2) Synthesis of thiocyclobutadiene derivatives and related heterocyclic compounds; (3) N- Arylazetidines and their rearrangement reactions; (4) Synthesis of nitrogen heterocyclics involving rearrangement reactions; (5) Planning of Science and Technology in India.

2. Dr. H. B. Mathur visited USA under Indo-US exchange of scientists programme for studying disciplines in physical chemistry and chemical engineering (April 1975-June 1975).

3. Dr. M. C. Srinivasan was deputed to USA and UK under F.A.O.-U. N. D. P. programme (May 1975-November 1975).

4. Dr. S. Ghosh has been deputed to West Germany to receive training on 'Kinetic studies on Rappe synthesis and handling of acetylene under high pressure', under the fellowship of the German Academic exchange service (for 16 months from June 1975).

5. Dr. M. Goswami visited some of the prominent organic chemical industries and technical institutes/universities in West Germany under the CSIR-DAAD exchange programme with the German Academic exchange service (October 1975-November 1975).

6. Dr. K. G. Das visited West Germany under the CSIR-DAAD exchange programe for a period of six weeks. He visited a few universities and industries in West Germany (October 1975-November 1975).

7. Dr. B. R. K. Murthy has been deputed to West Germany for training in the field of 'Preparative inorganic chemistry' under the fellowship of the German Academic exchange service (for 16 months from November 1975).

8. Mr. A. M. Lele visited UK under the bilateral agreement between CSIR & British Council to study and understand the modern trends of R & D Management. During his stay, he also participated in two weeks' course on 'Management of innovation,' organized by the Management Centre at Bradford University (March 1976).

9. Mr. K. Y. Shinde attended a course on 'Work study' at Poona Divisional Productivity Council, Poona (July 1975-August 1975).

10. Mr. R. S. Singh was deputed to attend a course on 'Computer based information systems' at SIET Institute, Hyderabad (September 1975).

11. Mr. R. S. Singh attended to a refresher course in 'Modern methods of information work and services' at INSDOC, New Delhi (December 1975).

12. Mrs. S. S. Adke was deputed to attend a course on 'PERT/CPM' at NITIE, Bombay (November 1975-December 1975).

13. Mrs. S. S. Adke and Mr. J. V. Rajan were deputed to attend 'The workshop-cum-training course on R & D and project management' at National Institute of Oceanography, Panjim (Goa) (January 1976).

14. Mr. M. B. Shinde received training in 'Gas chromatography' at CIBA Research Centre, Bombay (February 1976).

15. Mr. P. P. Lohokare attended a course on 'Feasibility survey and analysis' at SIET Institute, Hyderabad (March 1976).

16. Mr. S. D. Bakare attended 'Intensive course on design and technology of digital equipment' organized by the Centre for Electronics Design Technology, Bangalore (March 1976).

7.2 *Participation of NCL scientists in seminars, symposia, conferences, etc.*

1.	Symposium on 'Molecular spectroscopy and molecular structure', Gorakhpur.	Dr. L. M. Pant
2.	National Conference on 'Crystallography', New Delhi.	Dr. S. S. Tavale
3.	Symposium on 'Isoprenoids : Chemistry and applications', Baroda.	Dr. K. K. Chakravarti Dr. B. A. Nagasampagi Dr. C. R. Narayanan and

		Dr. U. R. Nayak Dr. (Mrs.) S. A. Patwardhan Dr. A. S. Rao
4.	Fourth Indo-Soviet symposium on ' Chemistry of natural products and their pharmacology', Lucknow.	Dr. C. R. Narayanan Dr. U. R. Nayak Dr. R. B. Mujumdar Dr. K. Venkatraman
5.	Fourth Inter-laboratory project meeting on 'Bacterial leaching of ores', Jamshedpur.	Dr. P. N. Rangachari Mr. V. S. Krishnamachar
6.	International workshop on ' Enzyme engineering', Poona.	Dr. V. Jagannathan Dr. C. Siva Raman
7.	Eighth Rubber conference, Bombay.	Dr. S. L. Kapur Dr. S. Gundiah
8.	Symposium on ' Basic sciences and agriculture', New Delhi.	Dr. A. F. Mascarenhas
9.	Symposium on ' Cultivaton and utilization of medicinal and aromatic plants ', Jammu.	Dr. A. F. Mascarenhas
10.	Third international conference on ' Culture collections ', Bombay.	Mr. V. S. Krishnamachar Mr. S. R. Modak
11.	Guha Research Conference, Chorwad, Gujrat.	Dr. J. C. Sadana Dr. C. Siva Raman
12.	Seminar on ' Towards the evolution of an information system for national development ', New Delhi.	Mr. R. S. Singh
13.	Tenth conference of Indian Association of special libraries and information centres, Lucknow.	Mr. M. D. Panse
14.	Symposium on ' Role of electronics for industrial security and safety', Poona.	Mr. S. D. Bakare

15.	Seminar on ' Electronics and national growth', Bombay.	Dr. A. Goswami
16.	Seminar on ' Optimum utilization of resources', Rasayani.	Dr. L. K. Doraiswamy
17.	Seminar on ' Titanium technology', Trivandrum.	Dr. L. K. Doraiswamy
18.	Sub-committee meeting of the Ministry of Petroleum and Chemicals on ' Pesticides', New Delhi.	Dr. R. B. Mitra
19.	International symposium on ' Fibres and composites ', New Delhi.	Dr. S. L. Kapur
20.	Meeting on ' Evaluation of Interlaboratory solar energy R & D programme', New Delhi.	Dr. A. P. B. Sinha
21.	' Pesticides seminar', Mysore.	Dr. B. B. Ghatge
22.	Seminar on ' Utilization of paddy waste ', Nagpur.	Dr. D. D. Nanavati
23.	Symposium on ' Photochemistry ' Bombay.	Dr. A. P. B. Sinha Dr. H. B. Mathur Dr. P. M. Nair Dr. M. P. Reddy
24.	Seminar on ' Poverty, rural development and co-operatives,' Poona.	Dr. B. D. Tilak Mr. J. V. Rajan
25.	Futurology Panel meeting of NCST, Poona.	Dr. B. D. Tilak Dr. V. N. Gogte Mr. D. D. Kelkar Mr. J. V. Rajan Mr. M. S. Krishnadas

7.3 *Seminars/Symposia/Conferences/Courses organized at NCL*

1. A short course in pesticides analysis sponsored by Varian, West Germany was held in the Laboratory. Mr. Wiebel of Varian conducted the course. About 30 representatives from different organizations of the pesticide industries and NCL scientists participated.

2. An All India Conference on Plant Tissue Culture sponsored by CSIR was organized at NCL. Over 30 delegates representing National Laboratories, Universities and several Research Institutions participated. It was decided to form an All India Tissue Culture Association.

7.4 *Membership of committees*

	Scientist	*Position & Name of the committee*	
1.	Dr. L. .K. Doraiswamy	Member -	Senate of IIT, Bombay.
		Member -	Scientific Advisory Committee, Central Drug Research Institute, Lucknow.
		Convener -	Chemical Engineering Research Committee, CSIR, New Delhi.
2.	Dr. V. Jagannathan	Member -	Steering Committee on Enzyme Engineering, Department of Science & Technology, New Delhi.
3.	Dr. S. L. Kapur	Member -	Polymer Research Committee, CSIR, New Delhi.
		Member -	Scientific Advisory Committee Coir Board, Cochin.
4.	Dr. J. C. Sadana	Member -	Guha Research Conference, Chorwad, Gujarat.
5.	Dr. C. Siva Raman	Member -	Steering Committee on Enzyme Engineering, Department of Science & Technology, New Delhi.
6.	Dr. A. P. B. Sinha	Member -	Academy Council, Poona University, Poona
		Convener -	Chemical Research Committee, CSIR, New Delhi.
7.	Dr. B. D. Tilak	Member -	National Committee on Science Technology (NCST), New Delhi.
		Chairman -	NCST Futurology Panel, New Delhi.
		Chairman -	Board of Directors, Hindustan Organic Chemicals Ltd., Rasayani.

Dr. B. D. Tilak	Director -	Board of Directors, Hindustan Antibiotics Ltd., Pimpri, Poona.
	Director -	Board of Directors, Forest Development Corporation, Nagpur,
	Chairman -	Pesticides Study Group, Ministry of Petroleum & Chemicals, New Delhi.
	Member -	Governing Council, Indian Investment Centre, New Delhi.
	Member -	Defence R & D Council, Ministry of Defence, New Delhi.
	Member -	Maharashtra State High Level Coordination Committee for Scientific & Technological Research & its utilization, Bombay.
	Member -	Study Group for Chemica' and Chem. Eng. appointed by the Maharashtra State High Level Coord. Committee for Sci. & Tech. Research and its utilization, Bombay.
	Member -	Maharashtra State Planning & Development Council, Bombay.
	Member -	Maharashtra State Industrial Research Committee, Bombay.
	Chairman -	Standing Committee on Dyestuff Industry, Ministry of Chemicals, New Delhi.

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

S. No.	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
1.	Acharekar, A. R.	Ph. D.	Shivaji	Synthesis of heterocyclic compounds	Dr. B. D. Tilak
2.	Bhagwat (Miss), V. M.	Ph. D.	Poona	Studies on organophosphorus insecticides	Dr. B. V. Ramachandran
3.	Bhatwadekar, S. V.	Ph. D.	Poona	Terpenoids	Dr. K. K. Chakravarti
4.	Deshpande, R. J.	Ph. D.	Karnatak	A study of some reactions of dyes and dye intermediates using NMR spectroscopy : Some derivatives of anthraquinone and *s*-triazine	Dr. K. Venkataraman
5.	Dewhare, A. R.	Ph. D.	Poona	Thermodynamic properties of solutions-adiabatic compressibility of polyelectrolytes	Dr. P. Roy Choudhury
6.	Dhruva (Miss), B. R.	Ph. D.	Baroda	Chemical, nutritional and biochemical studies in plant tissues culture such as *Techno grandis* (teak)	Dr. V. Jagannathan
7.	Duttachoudhary, M. K.	Ph. D.	Poona	Thermodynamics of binary polar liquid mixtures	Dr. H. B. Mathur
8.	Gopichand, Y.	Ph. D.	Poona	Chemistry of natural products (steroids and terpenoids)	Dr. K. K. Chakravarti

Sr.No.	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
9.	Husain, M.	Ph. D.	Aligarh	Studies on nitrate reductase *Achromobacter fischeri*	Dr. J. C. Sadana
10.	Kulkarni, S. B.	Ph. D.	Poona	Synthesis of heterocyclic compounds	Dr. B. D. Tilak
11.	Madhusudanan, K. P.	Ph. D.	Kerala	Some aspects of organic mass spectrometry	Dr. K. G. Das
12.	Mullick, G. B.	Ph. D.	Poona	Studies in heterocyclic chemistry	Dr. B. D. Tilak
13.	Natu, A. A.	Ph. D.	Poona	Studies in isoprenoids and their rearrangements	Dr. C. R. Narayanan
14.	Pavaskar (Miss), N. R.	Ph. D.	Poona	Electrical and photoconducting of chemically deposited thin films of CdS	Dr. A. P. B. Sinha
15.	Pawar, V. K.	Ph. D.	Poona	*Bacillus subtilis* phytase	Dr. V. Jagannathan
16.	Pendse (Mrs.), R.	Ph. D. (Tech.)	Bombay	Wood, bark and fruits extractives from some Indian plants	Dr. K. Venkataraman
17.	Varma, R. R.	Ph. D.	Poona	Dielectric and other properties of thin films	Dr. A. Goswami

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

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

* Retired/Emeritus scientists.

7.7 *Consultancy*

During the year institutional consultancy was offered to the following firms either through individual scientists or groups of scientists, wherein 14 scientists were involved.

1. Aniline Dyestuffs and Pharmaceuticals (P) Ltd., Bombay.
2. Dujodwala Industries Ltd., Bombay.
3. Hindustan Antibiotics Ltd., Pimpri, Poona.
4. Hindustan Ferodo Ltd., Bombay.
5. Hindustan Organic Chemicals Ltd., Rasayani.
6. Poona Synthetics Company, Poona.
7. Spaniko Chemicals (P) Ltd., Chiplun, (Maharashtra).

8. PUBLICATIONS

8.1 *Papers published*

Studies in chemical engineering

1. Kulkarni, B. D. and Doraiswamy, L. K.
   Effectiveness factors in gas-liquid reactions.
   A. I. Ch. E., **21**, 501 (1975).

2. Gokhale, M. V., Naik, A. T. and Doraiswamy, L. K.
   Gas-solid reactions: an unusual observation in the disproportionation of potassium benzoate to terephthalate.
   Chem. Eng. Sci., **30**, 1409 (1975).

3. Chaudhari, R. V., Kulkarni, B D., Juvekar, V. A. and Doraiswamy, L. K. Simultaneous absorption of two gases accompanied by a complex chemical reaction : Approximate solutions.
Chem. Eng. Sci., **30**, 945 (1975).

4. Choudhari, V. R. and Doraiswamy, L. K.
Isomerizaton of n-butene to isobutene : A kinetic model.
Ind. and Eng. Chem. Proc. Des. and Dev., **14**, 227 (1975).

5. Ramaswamy, V.
Enthalpy concentration chart of acetone-monochlorobenzene system.
Ind. J. Technology, **13** (**11**), 531 (1975).

6. Ramaswamy, V.
Estimation of surface tension of liquids.
Ind. J. Technology, **13** (**12**), 573 (1975).

7. Brahme, P. H. and Doraiswamy, L. K.
Modelling of a slurry reaction Hydrogenation of glucose on Raney nickel catalyst.
Ind. and Eng. Chem. Proc. : Des. and Dev., **15** (**1**), 130 (1976).

8. Rajadhyaksha, R. A., Vasudeva, K. and Doraiswamy, L.K.
Parametric sensitivity in fixed bed reactors.
Chem. Engg. Sci., **30**, 1399 (1975).

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

Pesticides and agrochemicals

10. Das K. G., Thayumanava, B., Kulshreshtha, J. P. and Dani, R. C.
Mass spectrometric method for estimation of lindane and carbaryl residues in straw, rice and bran.
Research and Industry, **20**, 85 (1975).

Utilization of plant, forest and marine products

11. Nanavati, D. D.
The constituents of *celastrus paniculatus* Willd.
J. Oil. Tech. Asso. India, 7 (**2**), 51 (1975)

12. Ingle, T. R., Vaidya, S. H. and Pai, M. U.
Process for the manufacture of cashew nut shell gum (CNS gum).
Research & Industry, **20**, 132 (1975).

13. Deshpande, V. H., Srinivasan, R. and Rama Rao, A. V.
Wood phenolics of *Morus* species, Part IV : The heartwood phenolics of five *Morus* species.
Ind. J. Chem., **13**, 453 (1975).

14. Nagasampagi, B. A., Sriraman, M. C., Yankov, L. and Sukh Dev.
Siderin from *Cedrela toona*.
Phytochemistry, **14**, 1673 (1975).

15. Paknikar, S. K., Bhatwadekar, S. V. and Chakravarti, K. K.
Biogenetically significant components of Vetiver oil; occurance of (—) ∝—funebrene and related compounds.
Tetrahedron, **34**, 2973 (1975).

16. Adwadkar, P. D., Srinivasan, R. and Yemul, S. S.
Colouring matters of *Garcinia morella*, Part VIII : Morellinol, dihydromorelloflavone and morelloflavone-7''-β-glucoside.
Ind. J. Chem. **14**, 19 (1976).

Studies in organic chemistry

17. Venkataswami, G., Yemul, S. S. and Rama Rao, A. V.
Absolute configuration of xanthochymol and isoxanthochymol.
Ind. J. Chem., **13**, 1355 (1975).

18. Midge (Mrs.), M. D. and Rama Rao, A. V.
Synthesis of Eupatilin and Eupafolin, two cytotoxic principles from *Eupatorium* species.
Ind. J. Chem., **13**, 541 (1975).

19. Lahoti, R. J., Chattopadhyaya, J. B. and Rama Rao, A. V.
Heterocycles, Part V : Reactions of phenylisothiocyanates and phenylisocyanate on 2-amino-5- chlorobenzophenone.
Ind. J. Chem., **13**, 458 (1975).

20. Bankar, N. S. and Kulkarni, G. H.
Monoepoxidation of saussurea lactone.
Ind. J. Chem., **13**, 744 (1975).

21. Bankar, N. S., Chaudhary, P. N. and Kulkarni, G. H.
Preparation of pentaerythritol acetates.
Ind. J. Chem., **13**, 986 (1975).

22. Sane, P. P. and Rao, A. S.
Stereochemistry of hydrogenation of (±)-2-*trans*-benzal 6 ∝ - methylcyclohexan-1 β-oland (+)- 1 β acetoxy-2- *trans*-benzal -6 ∝ - methylcyclohexane : A convenient route for (±) - *trans*--2 - benzyl-6- methylcyclohexanone.
J. Chem., **13**, 1055 (1975).

23. Kulkarni, B. D. and Rao, A. S.
Epoxidation of diethylarylidene and alkylidene malonates : A convenient route for the preparation of α-ketoacids.
Ind. J. Chem., **13**, 1097 (1975).

24. Gopichand, Y., Khanra, A. S., Mitra, R. B. and Chakravarti, K. K.
A new efficient synthesis of (—)-*cis* and (+) trans-chrysanthenic acids from (+) Δ^3-carene.
Ind. J. Chem. **13**, 433 (1975).

25. Panse, G. T. and Kamat, S. K.
New synthesis of 4,5-dihydro- (3H)-1,3,4-benzotriazepine-5-one.
Ind. J. Chem., **13** (8), 834 (1975).

26. Bhedi, D. N., Shaligram, A. M., Narayanaswamy. M. and Rao, A.S.
Synthesis of β-eudesmol.
Ind. J. Chem., **14 B**, 22 (1976).

27. Prakasa Rao, A. S. C., Nayak, U. R. and Sukh Dev.
A convenient preparation of *trans*-2- dodecenedioic acid (Traumatic acid).
Synthesis, 608 (1975).

Studies in polymer chemistry

28. Kapur, S. L.
Research in polymer science in India.
Book Talk, Wiley Estern, **6** (6), 2 (1975).

29. Joshi, R. M.
A new generalized bond energy/group contribution scheme for calculating the standard heat of formation of monomers and polymers-Part V. : Oxygen compounds.
J. Macromol. Sci. Chem., **9** (8), 1309 (1975).

Mineral resources utilization

30. Rangachari, P. N.
Economic extraction of metals by microorganisms.
Chemical Engineering World, **7**, 77 (1975).

Industrial inorganic and organometallic chemistry

31. Gopinathan, C.
Technical preparation of sodium hydrosulphite using sodium formate.
Ind. J. Chem., **10** (2), 19 (1975).

32. Pandit, S. K. and Gopinathan, C.
N-Benzoyl N-phenyl hydroxylamine and cyclohexanol derivatives of titanium (IV).
Ind. J. Chem., **14A**, 132 (1976).

Studies in organometallic and inorganic chemistry

33. Gopinathan (Mrs.), S., Gopinathan, C., Jose, C. I. and Gupta, J. Sulphur dioxide insertion compounds of organotin complexes. *Ind. J. Chem.*, **13**, 78 (1975).

34. Hundekar, A. M., Umpathi, P. and Sen, D. N. 4-Chloro-2, 5-dimethoxyacetoacetanilide as a gravimetric reagent for beryllium (II) and copper (II). *J. Ind. Chem. Soc.*, **52**, 71 (1975).

35. Patil, J. N. and Sen, D. N. 2-Hydroxyl-1-napthaldehyde chelates of Group IV elements. *J. Ind. Chem. Soc.*, **52**, 794 (1975).

36. Gopinathan, C., Pandit, S. K., Gopinathan (Mrs.), S., Sonsale, A. Y. and Awsarkar, P. A. Di- α- thienyl tin diiodide and some chelated tin (IV) compounds. *Ind. J. Chem.*, **13**, 516 (1975).

Studies in solid state, thin films, physical chemistry and properties of materials

37. Dhaneshwar, N. N., Kulkarni, A. G., Tavale, S. S. and Pant, L. M. The crystal structure of a second modification of *m*-nitrobenzoic acid. *Acta cryst.*, **B 31**, 1978 (1975).

38. Dhaneshwar, N. N., Tavale, S. S. and Pant, L.M. The crystal structure of 8-methoxy-1, 2, 3, 4, 5, 6-*cis*- 4a, 10b-octahydro-6-thiaphenanthrene-6, 6-dioxide. *Acta Cryst.*, **B 31**, 2743 (1975).

39. Goswami, A. and Radhakrishnan, S. Electrode effects on the conduction characteristics of copper phthalocyanine films. *Ind. J. Pure and Applied Physics*, **13**, 439 (1975).

40. Goswami, A. and Goswami, A. P. Optical properties of vacuum deposited niobium oxide films. *Ind. J. Pure and Applied Physics*, **13**, 667 (1975).

41. Goswami, A. and Mitra (Mrs.), A. Optical properties of vacuum deposited SnS films. *Ind. J. Pure and Applied Physics*, **13**, 508 (1975).

42. Goswami, A. and Goswami, A. P. Optical properties of praseodymium oxide films. *Thin Solid Films*, **27**, 123 (1975).

43. Goswami, A. and Goswami, A. P. Dielectric properties of antimony trioxide films. *Ind. J. Physics*, **49**, 318 (1975).

44. Goswami, A. and Varma, R. R.
Dielectric behaviour of dysprosium oxide films.
Thin Solid Films, **28**, 157 (1975).

45. Goswami, A. and Radhakrishnan, S.
Electron microscopic study of vacuum deposited copper phthalocyanine films.
Ind. J. Pure and Applied Physics, **13**, 332 (1975).

46. Goswami, A. and Ojha, S. M.
Galvanomagnetic properties of vacuum deposited HgSe films.
Ind. J. Pure and Applied Physics, **13**, 721 (1975).

47. Goswami, A. and Ojha, S. M.
Electrical properties of flash evaporated thallium telluride films.
Ind. J. Pure and Applied Physics, **14**, 190 (1975).

48. Goswami, A. and Ojha, S. M.
Electrical properties of vacuum deposited bismuth films.
Ind. J. Physics, **49**, 847 (1975).

49. Goswami, A. and Mitra (Mrs.), A.
Limitation of $R_s - R_p$ technique for evaluating n and k.
Ind. J. Physics, **49**, 951 (1975).

50. Chattopadhyay, J. B., Deshmukh, M. N. and Jose, C. I.
Infrared spectra of the molecular complexes of *p*-benzoquinone with aromatic bases-evidence for localized charge transfer.
J. Chem. Soc., Faraday Trans, II., **71**, 1127 (1975).

51. Das, K. G., Kulkarni, P. S. and Shinde, M. B.
Comparative study of ion kinetic energy, chemical ionization and field desorption spectra.
Organic Mass Spectrometry, **10**, 335 (1975).

52. Das K. G. and Thayumanavan, B.
EI and IKE spectra of some aldosyl disaccharide peracetates.
Organic Mass Spectrometry, **10**, 455 (1975).

53. Prabhumirashi, L. S. and Jose, C. I.
Infrared studies and thermodynamics of hydrogen bonding in ethylene glycol monoalkyl ethers : Evidence for a ten membered ring dimer.
J. Chem. Soc., Faraday Trans. II., **71**, 1545 (1975).

54. Barsode (Miss), C. D., Umapathy, P. and Sen, D. N.
Mass spectral studies on alkyltin (IV) oxinates.
J. Ind. Chem. Soc., **52**, 942 (1975).

55. Goswami, A. and Rao, B. V.

Optical properties of cuprous selenide and cuprous telluride films.
Ind J. Physics, **50**, 50 (1976).

56. Dewhare, A. R. and Roy-Chowdhury, P.

The adiabatic compressibility of polyelectrolytes : Sodium and hydrochloride salts of acrylic acid-N-dimethylaminoethyl methacrylate copolymer.
J. Appl. Polymer Sci., **20**, 1673 (1976).

57. Pansare, V. S., and Kulkarni, S. Y.

Application of NMR for quantitative analysis in the production of butylacrylate.
Ind. J. Tech., **14**, 148 (1976).

Other publications

58. Joshi. S S.

Monochloroacetic acid.
Chemical Times, Volume II, **32**, 4, 1975.

59. Joshi, S. S.

Plant tissue culture (Marathi article)
Khat Kamdhenu, **5**, 6, 1975.

Articles on 'Achievement of National Chemical Laboratory'

60. Patwardhan (Mrs.), S. A.

Amrut, **6**, 128, 1975 (Marathi).

61. Lele, A. M.

Sampada **10, 13**, 1975 (Marathi).

62. Katti, S. S. and Nagasampagi, B. A.

Vijnanaloka **9**, **No. 11**, 1975 (Part I- Kannada).

63. Katti, S. S. and Nagasampagi, B. A.

Vijnanaloka **9**, **No. 12**, 1975 (Part II- Kannada).

64. Nanavati, D. D.

Janmabhoomi Pravasi 7th and 9th August, 1975 (Gujarathi).

65. Quasim C.

Malayala Manorama, 14 December, 1975 (Malayalam).

8.2 *Papers presented at symposia, seminars, etc.*

1. Jagannathan, V., Mascarenhas, A. F., Hendre, R. R., Nadgir, A. L., Ghugale (Miss), D. D., Krishnamurthy, K. V. and Godbole, D. A.
Propagation of plants through tissue culture.
Symposium on 'Basic sciences and agriculture,' Delhi. October, 1975.

2. Srinivasan, M. C., Rao (Mrs.), M., Deshpande (Mrs.), V. V., Bastawade, K. B., Kulkarni, V. M., Phansalkar, S. B., Joglekar, A. V. and Jagannathan, V.
Utilization of cellulose for the production of glucose and single cell protein.
International workshop on 'Enzyme engineering,' Poona, October, 1975.

3. Subramanian, S. S., Siva Raman (Mrs.), H., Rao, B. S., Ratnaparkhi (Mrs.), R. R. and Siva Raman, C.
Immobilized penicillin acylase.
International workshop on 'Enzyme engineering,' Poona, October, 1975.

4. Kapur, S. L. and Gundiah, S.
Work relating to the development of nitrile rubber.
8th Indian rubber conference, Bombay, October, 1975.

5. Nagasampagi, B. A., Narayanan, C. R., Landage, A. B., Sawaikar, D.D. and Lonkar, A.
Biologically active principles : Identification of the major antigen from *Parthenium hysterophorus* Linn
Symposium on 'Isoprenoids : Chemistry and applications,' Baroda November, 1975.

6. Patwardhan (Mrs.), S. A., Gupta, A. S and Sukh Dev.
Some-4-oxa-farnesane insect juvenile hormone mimics.
Symposium on 'Isoprenoids : Chemistry and applications', Baroda, November, 1975.

7. Jadhav, P. K. and Nayak, U. R.
Anomalous dehydrogenation of 2,6,6-trimethyl bicyclo (5.3.0)-dec-8-ene : A rational new azulenogen from longifolene.
Symposium on 'Isoprenoids : Chemistry and applications', Baroda, November, 1975.

8. Chakravarti, K. K. and Gopichand, Y.
Isopatchoula-3, 5-diene.
Symposium on 'Isoprenoids : Chemistry and applications', Baroda, November, 1975.

9. Yadhav, J. S., Nayak, U. R. and Sukh Dev.
Mechanism of rearrangement of longifolene to isolongifolene.
Symposium on 'Isoprenoids : Chemistry and applications,' Baroda, November, 1975.

10. Narayanan, C. R. and Prakash, S. R.
Conversion of 7-dehydrocholesterol to cholesterol.
Symposium on 'Isoprenoids : Chemistry and applications,' Baroda, November, 1975.

11. Rao, A. S.
Synthesis of α -methylene- γ-lactones and related compounds.
Symposium on 'Isoprenoids : Chemistry and applications,' Baroda, November, 1975.

12. Kapur, S. L.
A brief review of fibres for reinforcement.
International symposium on 'Fibres and composites,' Delhi, January, 1976.

13. Bhide, K. S., Mujumdar, R. B., Rama Rao, A. V. and Venkataraman, K.
Phenolics from the bark of *Chloroxylon swietenia.*
4th Indo-Soviet symposium on 'Chemistry of natural products and their pharmacology.' Lucknow, February, 1976.

14. Deodhar (Mrs.), V. B., Dalavoy (Mrs.), V. S. and Nayak, U. R.
Juvenile hormone analogues from traumatic acid.
4th Indo-Soviet symposium on 'chemistry of natural products, and their pharmacology' Lucknow, February, 1976.

15. Narayanan, C. R., Paul Thomas and Shukla, S. P.
Mechanisms of allylic oxidation by selenium dioxide.
4th Indo-Soviet symposium on 'Chemistry of natural products and their pharmacology.' Lucknow, February, 1976.

16. Mascarenhas, A. F., Hendre, R. R., Nadgir, A. L., Ghugale (Miss), D. D., Godbole, D. A., Prabhu (Miss), R. A. and Jagannathan, V.
Development of plantlets from cultured tissues of *Dioscorea deltoidea* Wall.
Symposium on 'Cultivation and utilization of medicinal and aromatic plants' Jammu, March, 1976.

17. Jagannathan, V., Mascarenhas, A. F., Hendre, R. R., Nadgir, A. L., Ghugale (Miss), D. D., Krishnamurthy, K. V. and Godbole, D. A.
Propagation of plants by tissue culture.
Tissue culture conference, Poona, March, 1976.

18. Krishnamachar, V. S., Modak, S. R., Patil, S. G., Sutar, I. I., Gujarathi (Mrs.), A. K. and Puntambekar (Mrs.), V. S.
Preservation of cultures under paraffin oil.
International conference on 'Culture collections,' Bombay, March, 1976.

8.3 *Books published*

Das, K. G. and Jones, E. P.
Organic Mass Spectrometry.
Oxford and IBH Publishing Co., New Delhi (1976).

8.4 *Books Reviews*

Narayanan, C. R.
Topics in Current Chemistry.
Vol. 47 Stereochemistry 1, Ed. F. Boschke.
Springer-Verlag, Berlin, 1974.

8.5 *Chapters in Books*

1. Venkataraman, K.
Flavones in 'The Flavonoids'.
Ed. J. B. Harborne, T. J. Mabry and H. Mabry,
Chapman and Hall, London (1975).

2. Gurr E, Nitya Anand, Unni, M. K. and Ayyangar, N. R.
Application of Synthetic Dyes to Biological Problems.
The Chemistry of Synthetic Dyes, Vol. VII, Ed. K. Venkataraman,
Academic Press New York, San Fransisco, London, 1974, pp. 277-352.

3. Rajan, J. V. and Tilak, B. D.
'Indian Chemical Industry-An Overview.'
Manual of Chemical Technology, Vol. I, July, 1975.

9. PATENTS IN FORCE

9.1 *Indian patents sealed*

1. **71190***.
Preparation of anion exchange resins.
Krishnaswamy, N., Govindan, K. P. and Dasare B. D.

2. **77081***
Improvements in or relating to the preparation of polyamide compounds and their compositions as antipriming agents in steam generators.
Pathak, K. D. and Subba Rao, B. C.

3. **77225***
A process for the preparation of β-ionone from pseudoionone.
Joshi, B. N., Chakravarti, K. K., Shah, R. C. and Bhattacharyya, S.C.

4. **81072**
Improvements in or relating to the preparation and production of catalysts for the hydrogenation of organic substances with particular reference to fatty oils.
Murthy, M. N. S. and Biswas, A. B.

5. **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.

6. **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.

7. **86991***
Preparation of polyurethane printing rollers.
Ghatge, N. D. and Kapur, S. L.

8. **92977**
Improvements in or relating to the manufacture of hexachloroethane
Mukherjee. S. P., Goswami, M., Soundararajan, S.. Sadasivan, N., Sen, R. K. and Doraiswamy, L. K.

9. **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.

10. **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.

11. **98156***
Preparation of solvent modified copolymers of vinyl monomers in bead form.
Kapur, S. L. and Ramakrishnan, K.

12. **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.

13. **123638**
Improvements in or relating to the manufacture of cashewnut shell gum (CNS-gum).
Ingle, T. R., Vaidya, S. H. and Pai, M.U.

14. **126354**
A process for obtaining useful steroids from a new plant source.
Sukh Dev, Patil, V. D. and Nayak, U. R.

15. **126393***
An improved method for the manufacture of calcium hypophosphite.
Goswami, M., Lobo, J. and Brahme, P. H.

16. **127743**
A process for obtaining colchicine from a new plant source.
Kapadia, V. H., Sukh Dev and Rao, R. S.

17. **130254**
A process for the manufacture of vulcanizable graft copolymer for use as a synthetic rubber and as a base in coating compositions.
Joshi, R. M.

18. **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.

19. **134641***
A device for warming and cooling.
Lakhbir Singh and Kotasthane, A. N.

20. **136148** (223/72)
Improvement in or relating to the preparation of new reactive dyes.
Ayyangar, N. R., Badami, N. V., Tilak B. D. and Daruwalla. E H.

21. **136419** (221/72)
New dyes containing azido groups for cellulosic protein and synthetic fibres.
Ayyangar, N. R., Badami, N. V., Daruwalla, E. H. and Tilak, B. D.

22. **137096** (328/72)
A new process for the halogenation of copper phthalocyanine.
Ayyangar, N. R., Moghe, P. P. and Tilak, B.D.

---

* These patents (9) have been released for exploitation

9.2 *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. **113825**
Nickel zinc ferrites.
Krishna Rao, V. V., Kanade (Miss.), S. B. and Sinha A. P. B.

4. **127750**

A process for production of pyridoxine hydrochloride.
Joshi, C. G. and Sukh Dev.

5. **131606**

Improvements in or related to a process for the preparation of gamma ferric oxide.

Lakhbir Singh, Chavan, A. M. and Kotasthane, A.N.

6. **2229/72**

New dyes containing azido groups for cellulosic protein and synthetic fibres.

Ayyangar, N. R., Badami, N. V. , Tilak, B. D. and Daruwalla, E. H.

7. **2232/72**

Process for the preparation of D-galactose from cashewnut shells.
Ingle, T. R., Vaidya S. H. and Pai, M. U.

8. **2235/72**

New dyes containing azido groups for cellulosic protein and synthetic fibres.

Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla E. H.

9. **2258/72**

Improvements in or relating to the preparation of new reactive dyes.
Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

10. **2259/72**

Improvements in or relating to the preparation of new reactive dyes.
Ayyangar, N. R., Badami, N. V., Tilak B. D. and Daruwalla, E. H.

11. **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.

12. **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.

13. **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.

14. **1630/Cal/74**
Improvements in and relating to the preparation of synthetic cryolite from fluorospar.
Damodaran, V., Lobo, J., Padalkar, S. R., Harisangam, S. R. and Dorai, C. S.

15. **69/Cal/75**
A process for obtaining D-xylose and xylit from corn (*zea mays*) cobs.
Bose, J. L., Nanavati, D. D. and Limaye, S. G.

16. **417/Cal/75**
Preparation of aminopolyols using CNSL and making polyurethane rigid foams.
Ghatge, N. D. and Gujar, K. B.

17. **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.

18. **1824/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.

19. **1841/Cal/75****
Protective blanket for galvanizing baths.
Lakhbir Singh.

** These patents have been newly filed during the year.

9.3 *Foreign patents in force*

1. **U. S. A. Patent No. 3070625**
A process for the preparation of azelaic acid semi ester suitable for making civetone dicarboxylic acid (corr. to Indian patent No. 58868).
Nayak, U. G., Chakravarti, K. K. and Bhattacharyya, S. C.

2. **U. S. A. Patent No. 2946783**
Preparation of costus root oil and the production there of (corr. to Indian Patent No. 59853).
Kelkar, G. R. and Bhattacharyya, S. C.

3. **Cuba Patent No. 149082**
Manufacture of nicotine sulphate from tobacco or tobacco waste (corr. to Indian patent No. 45666).
Gedeon, J. and Goswami, M.

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
				1975-76 Qty/Value Rs. in lakhs	Upto March 75 Qty/Value Rs. in lakhs	
1	2	3	4	5	6	7
1.	Acetanilide	Intermediates	M/s Hindustan Organic Chemicals Ltd., P. O. Rasayani-410207 (through project engineers M/s R. L. Dalal & Co., Bombay-400018) (1969)	2232.35T 357.12	7398.14 T 718.22	2000 T Non-exclusive
2.	Acriflavine	Pharmaceuticals	M/s Western India Fine Chemicals, 38 Agra Road, Mulund (West), Bombay-400080 (1969)	— —	5.39 T 24.07	N. A. Sponsored
3.	Adhesives for decorative laminates	Laminates	M/s Swastik Rubber Products Ltd., Swastik House, Khadki, Poona-411003 (1969)	0.05 T 1.01	76.65 T 8.20	36 T Sponsored

1	2	3	4	5	6	7
4.	Antipriming compositions (77081)	Antipriming in locomotives	Research, Designs and Standards Organization, M & C Wing, Lucknow-226011 (1964)	4.75 T 0.16	124.39 T 3.42	26 T Non-exclusive
5.	Bacterial diastase	Textile desizing	M/s Chemaux (P) Ltd., Rang Udyan, Sitladevi Temple Road, Mahim, Bombay-400016 (1967)	25.29 T 2.10	358.38 T 19.78	N. A. Non-exclusive
6.	Berberine hydrochloride	Pharmaceuticals	M/s Nitin Pharmaceuticals, 180/82, Samuel Street, Bombay-400009 (1965)	3.6 T 10.8 (estimated)	29.10 T 62.76	10 T Sponsored
7.	Bostik sealants-substitute	Oil resistant adhesive for aircraft fuel tanks	M/s Swastik Rubber Products Ltd., Poona-411003 (1974)	0.22 T 0.43	0.19 T 0.35	6T Non-exclusive
8.	*tert*-Butyl-catechol	Synthetic rubber	M/s Percynic Chemicals, Bombay Silk Mills Building, Industrial Estate, Lalbaugh, Bombay-400012 (1972)	4.08 T 4.90	11.81 T 11.17	50 T Non-exclusive
9.	Butyl titanate	Varnishes, enamels	M/s Synthochem, 33-A, Laxmibai Nagar, Industrial Estate, Indore-452002 (1973)	8.21 T 4.43	38.79 T 12.65	N. A. Non-exclusive

1	2	3	4	5	6	7
10.	Cadmium sulphide photoconductive cells	Electronics	M/s Chinoy Electronics, 64, Koregaon Park, Poona-411001 (1971)	1191 Nos. 0.14	3386 Nos. 0.40	16000 Nos. Non-exclusive
11.	Calcium hypophosphite (126393)	Pharmaceuticals	M/s Hypophosphite and Co., 79-F, Princess Street, Bombay-400002 (1967)	18.00 T 20.00	86.25 T 50.30	26 T (includes other hypophosphites also) Sponsored
12.	Calcium silicate	Low density insulators	M/s Newkem Products Corpn., Harganga Mahal, Khodadad Circle, Bombay-400014 (1968)	525.00 T 25.50	1952.21 T 68.95	N. A. Sponsored
13.	Can lining composition	Metal can industry	M/s Arya Chemical Works, 141/2A, Lenin Sarani, Calcutta-700013 (1974)	35.00 kg. 0.01	26.00 kg. 0.01	75 T Non-exclusive
14.	Can sealing composition	Metal can industry	-do-(1962)	16.88 T 1.38	284.9 T 17.20	75 T Non-exclusive
15.	Carbimazole	Pharmaceuticals	M/s Indian Schering Ltd., Sion -Trombay Road, Deonar, Bombay-400088 (1970)	30.19 kg. 2.50	258.5 kg. 21.43	250 kg. Sponsored

1	2	3	4	5	6	7
16.	Catechol	Pharmaceuticals	M/s Pereynic Chemicals, Bombay-400012 (1972)	4.15 T 2.49	12.74 T 5.07	50 T Non-exclusive
17.	Cation exehange resin-styrene DVB base (98155, 98156)	Demineralization of liquids	M/s Bird & Co Ltd., Chartered Bank Buildings, Calcutta-700048 (1968-69)	16,684 ltrs. 1.55	5.72 lakh ltre. 60.35	10,000 cft Non-exclusive
*18.	Cationic dyes for acrylic fibers	Dyes for synthetic fibers	M/s Sahyadri Dyestuffs & Chemicals, 177, Parvati-Vithalwadi Road, Poona-411430 (1976)	3.58 T 4.70	— —	N. A. Sponsored
19.	Chloral hydrate	Industrial chemicals	M/s Hindustan Insecticides, P. Box No. 623, Industrial Area, Rohtak Road, New Delhi-110015 (1975)	355.00 Kg. 0.05	20.73 T 2.13	Sponsored (Prodoction restarted)
20.	Chlorobenzenes	Industrial chemicals	M/s Hindustan Organic Chemicals Ltd., P. O. Rasayani (1974)	1218.25 T 70.29	893.16 T 57.68	4500 T Sponsored
21.	Chloromethanes (86541)	Industrial chemicals	M/s Standard Alkali, Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, P. B. No. 1038, Bombay-400021(1974)	457.00 T 18.39	362.12 T 16.77	3000 T Exclusive for a limited period

1	2	3	4	5	6	7
22.	Clofibrate	Pharmaceuticals	(1) M/s Biological, Evans Ltd., 18/1 and 3, Azamabad, Hyderabad-500020 (1973)	825.00 kg. 4.79	0.98 T 3.14	6T Non-exclusive
			(2) M/s Nivedita Chemicals Pvt. Ltd., A-14, M. I. D. C., Andheri (East) Bombay-400093 (1974)	1085.00 kg. 4.34	0.32 T 1.27	12 T Non-exclusive
23.	Diazepam	Anti-anxiety drugs	M/s S D's Lab. -Chem. Industry, Samuel Street, P. B. No. 3232 Bombay-400003 (1975)	5.15 kg. 0.04	— —	600 kg. Non-exclusive
24.	Diethyl-*m* aminophenol	Dye intermediate	M/s Sahyadri Dyestuffs & Chemicals, 177, Parvati-Vithalwadi Road, Poona-411430 (1970)	34.74 T 26.06	161.86 T 133.72	120 T Sponsored
25.	Dihydroisojasmone and peach aldehyde	Perfumery chemicals	(1) M/s S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay-400080 (1965)	— —	8.08 T 16.47	N.A. Non-exclusive
			(2) M/s Sonebon Laboratories Kottayam-5(1971)	— —	0.295 T 0.76	N. A. Non-exclusive
26.	Dimethylaniline	Industrial chemicals	M/s Sahyadri Dyestuffs & Chemicals, Poona- (1972)	124.90 T 30.60	111.43 T 22.71	600 T Non-exclusive

1	2	3	4	5	6	7
27.	Ethylene oxide condensates	Surface active agents	M/s HICO Products (P) Ltd., Mogal Lane, P. B. No. 6467, Mahim, Bombay-400016 (1965)	798.14 T 130.17	4179 T 575.88	3500 T Sponsored
28.	Ferrites-Hard	Electronics	M/s Semiconductors Ltd., Ahmednagar Road, Mile 4/5, Poona-411014 (1968)	4.33 T 1.12	14.2 T 6.25	100 T Non-exclusive
29.	Geraniol, citronellal and citronellol from lemon grass oil	Perfumery	M/s Opal Fine Chemicals, 2/9, Three-View Building, Opp. Century Bazar, Prabhadevi, Bombay-400025 (1970)	2.2 T 3.3	13.8 T 17.70	10 T of each product Sponsored
30.	*Glyceryl-α-mono-*p*-amino benzoate	Pharma-ceuticals	M/s Indian Schering Ltd. Bombay-400088 (1975)	51.00 kg. 0.15	— —	250 kg. Sponsored
31.	Gum arabic substitute	Adhesives	(1) M/s Karnatak Adhesives, 19,Mysore Deviation Road, Gopalapuram, Bangalore-560023 (1974)	— —	6.56 T 0.59	N. A. Non-exclusive
			(2) M/s Malwadkar Industries, A-22, Flatted Bldg., F-2,Block, M. I. D. C. Pimpri, Poona-411018 (1974)	0.89 T 0.09	0.15 T 0.02	N. A. Non-exclusive

1	2	3	4	5	6	7
32.	4-Hydroxy-coumarin	Pharmaceuticals	M/s Unichem Laboratories Ltd., "Unichem Bhavan", S. V. Road, Bombay-400060 (1974)	32.4 kg 0.07	81.00 kg 0.17	500 kg Non-Exclusive
33.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	(1) M/s Industrial Perfumes Ltd., Hay Bunder Rd., Tank Rd. P. O. Sewri, Bombay-400033 (1968)	58.39 T 99.26	101.86 T 134.51	80 T (58.35T were exported) Non-exclusive
			**(2) M/s S. H. Kelkar & Co. Ltd., Mulund, Bombay-400080 (1975)	120.00 kg 0.32	— —	N. A. Non-exclusive
*34.	Monochloro-acetic acid	Intermediate for weedicide, carboxy methyl cellulose, etc	M/s HICO Products (P) Ltd., Bombay (1975)	67.37 T 7.6	— —	1000 T Non-exclusive
*35.	Monoethyl-aniline	Intermediate for explosives	M/s Atul Products Ltd., Atul-396020 (Dist. Bulsar) (1975)	25.77 T 8.23	— —	125 T Non-exclusive
*36.	1-Naphthyl-acetic acid	Agrochemicals, plant growth regulator	M/s Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur-458001 (M. P.) (1975)	100.00 kg 0.10 (estimated)	— —	6 T Sponsored
37.	Nicotine sulphate from tobacco and tobacco waste	Insecticides	M/s Urvakunj Nicotine Industries, Petlad Cambay Road, P. B. No.16, Dharmaj-388430. Dist. Kaira, Gujarat (1963)	92.86 T 22.86	325.69 T 72.04	N. A. Non-exclusive

1	2	3	4	5	6	7
38.	Nitrile rubber	Oil resistant rubber formulations, adhesives	M/s Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay-400020 (1974)	160.00 T 27.00	142.00 T 26.00	300 T (2000TPA plant being erected) Exclusive for 4 years
39.	Nonyl phenol	Surface active agent	M/s Aniline Dyestuff & Pharmaceutical Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Rd., Bombay-400026 (1974)	66.76 T 8.68	10.9 T 1.53	900 T Sponsored
40.	*Ortho*-Tolyl-biguanide	Soap	M/s Industrial Perfumes Ltd., Bombay (1970)	2.92 T 1.01	13.17 T 3.36	5 T Exclusive
41.	Perfumery products based on longifolene (Capinone)	Perfumery	M/s Camphor & Allied Products Ltd., P. O. Clutterbuckganj-243502, Dist. Bareilly (U. P.) (1968)	5.6 T 5.81	55.65 T 45.60	50 T (for both capinone & meracene) Sponsored
42.	Perfumery products based on Δ^3-carene (Meracene)	Perfumery	—do—(1968)	3.2 T 1.25	23.00 T 8.94	Sponsored
43.	β-Phenethyl alcohol	Perfumery	M/s Sunanda Aromatic Industries, Mysore-K. R. S. Road, Mettagalli P.O., Mysore-571106 (1970)	141.00 T 74.00	270.06 T 126.17	225 T Sponsored

1	2	3	4	5	6	7
44.	Phenthoate	Insecticides	M/s Bharat Pulverising Mills Pvt. Ltd., Shriniketan, 14 Queens Rd., Bombay-400020 (1975)	6.1 T 3.05	5.0 T 3.00	300 T Sponsored
45.	Phthalates-dioctyl and dibutyl	Plasticizers	M/s Amines and Plasticizers Ltd., 'D' Building, Shivasagar Estate, Dr. Annie Besant Road, Worli, Bombay-400018 (1971)	2464.27 T (DOP) 236.86	7550.85 T 582.84	3000 T (DOP) Non-exclusive
46.	Phthalates-diethyl and dimethyl	Plasticizers	M/s The Mysore Acetate and Chemicals Co. Ltd., Mysugar Bldg. Sri J. W. Road ,Bangalore-560002 (1970)	88.00 T (DEP) 11.22	566.35 T 65.24	600 T (DEP) Non-exclusive
47.	Polyurethane printing rollers (86991)	Printing	M/s Sree Saraswaty Press Ltd., 32, Acharya P. C. Road, Calcutta-700009 (1965)	813 Nos 1.5	1576 Nos 2.49	3000 Nos Non-exclusive
48.	Radio opaque dyes	Pharma-euticals	M/s Unichem Laboratories, Bombay (1974-75)	— —	25.4 kg 0.11	50 kg Sponsored
49.	Radiosonde thermistors	Meteorology	The Bhagyanagar Laboratories, 11-1523/8 Golkonda Cross Road, Hyderabad (1974)	20,000 Nos 3.20	15,000 Nos 1.5	N. A. Non-exclusive

1	2	3	4	5	6	7
50.	D. C. Recording polarograph	Polarographic analysis	(1) M/s Elico Pvt. Ltd., B-90, ASTD Pvt. Industrial Estate, Sanatnagar Extn., Hyderabad-500018 (1974)	8 Units 0.93	1 Unit 0.10	50 Units Non-exclusive
			(2) M/s Chromatography & Instruments Co., 121-122, Makarpura Indl. Estate, Baroda-390010(1975)	3 Units 0.52	1 Unit 0.34	100 Units Non-exclusive
51.	Rigid filters	Tube wells	M/s Ashim Filters, C-196, Defence Colony, New Delhi-110024 (1965)	— —	12,318 Mtrs 23.38	5000 Mtrs. 4" pipe filters (In production, details not supplied) Non-exclusive
52.	Rubber blowing agent	Rubber chemicals	M/s Swastik Rubber Products Ltd., Poona (1968)	— —	223.51 T 32.16	40 T Non-exclusive
53.	Rubberized cork sheets	Gaskets	M/s Bharat Casements, Prop. M/s Banco Aluminium Baroda Ltd., P. B. No. 169, Baroda-390001 (1966)	3.98 lakh pieces 9.67	103.20 lakh pieces 42.17	2 lakh pieces Non-exclusive

1	2	3	4	5	6	7
54.	Rubber reclaiming agent	Rubber chemicals	M/s Swastik Rubber Products Ltd., Poona (1968)	— —	35.80 T 5.92	30 T Non-exclusive
55.	Sachets-Hot and Cold	Substitute for hot water bag and ice bag	M/s Vasant Industrial Corpn., 356, Great Nag Road, Nagpur-440009 (1971)	— —	6830 pads 0.73	N. A. Non-exclusive
56.	Silica gel	Humidity control	M/s Minco Products, 301/27, T. H. Rd., Madras-600081 (1963)	12.00 T 1.08	117.5 T 8.59	15 T Sponsored
57.	Sorbide nitrate	Pharmaceuticals	M/s Indian Schering Ltd., Bombay (1969)	97.7 kg 1.35	1034.00 kg 16.38	300 kg Sponsored
58.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C svnthesis	(1) M/s Hindustan Antibiotics Ltd., Pimpri, Poona-411018 (1974)	— —	165.00 T 19.00 T	Non-exclusive
			(2) M/s Maize Products, Div. of Sayaji Mills Ltd., P. O. Kathawada, Ahmedabad-382430 (1976)	74.2 T 8.3	— —	2000 T Non-exclusive
59.	Direct reading spectrophotometer/ colorimeter	Biochemical research, spectroscopic analysis in visible range	M/s Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Road, Allahabad-211001 (1974)	22 Units 1.45	16 Units 1.14	60 Units Non-exclusive

1	2	3	4	5	6	7
60.	Thermistors	Electronics	(1) M/s Semiconductors Ltd., Poona (1963)	5.14 lakh Nos 3.25	63.65 lakh Nos 52.48	N.A. Non-exclusive
			(2) M/s Tempo Semiconductors, Divn. of Primco Pvt. Ltd., 18, Paranjape 'B' scheme, Subhas Road, Vile Parle (East), Bombay-400057 (1963)	7000 Nos 1.04 (estimated)	0.98 lakh Nos 4.63	N.A. Non-exclusive
61.	Vapour phase chromatograph	Instruments	M/s Associated Instruments Manufacturers(India) P. Ltd., Sunlight Bldg. 35, Najafgarh Road, New Delhi-110015 (1969)	10 Units 1.90	132 Units 25.95	48 Units Exclusive
62.	Vitamin C	Pharmaceuticals	M/s Hindustan Antibiotics Ltd., Pimpri, Poona (1974)	3.94 T 4.92 (estimated)	604.00 kg 0.71 (estimated)	125 T Non-exclusive
63.	Warfarin	Rodenticide	M/s Unichem Laboratories Ltd., Bombay (1974)	50.2 kg 0.42	120.00 kg 0.69	200 kg Non-exclusive

* During the period under review, production has been newly reported on these items (6)

** Production reported for the first time by the party (2)

N.A. = Not available

VALUE OF PRODUCTION BASED ON NCL KNOW-HOW

year	No. of items manufactured	Value of production (Rs. in lakhs)
1950—65	15	14.82
1965—70	53	278.15
1970—71	55	283.84
1971—72	51	471.20
1972—73	48	557.11
1973—74	49	651.39
1974—75	60	1,098.71
1975—76	63	1,275.46
	Total	4,630.68

Note : The processes on (1) Anion exchange resin from melamine (2) Carbazole Dioxazine Violet pigment (3)Thermosetting resins for industrial laminates which were included in Table I of the Annual Report 1974-75 have now been dropped since no production was reported for two consecutive years.

NCL process on laboratory chemicals which was included in Table I of NCL Annual Report 1974-75, has now been dropped since NCL has discontinued manufacturing of fine chemicals.

In addition to above the following NCL processes were at one time under commercial implementation and appeared in Table I of previous Annual Reports (1965-66 to 1973-74). As and when production will be resumed on these items, they will be included in Table I. (1) Benzoic acid from toluene (Sp) (2) Cation exchange resin from CNSL (3) DDT-water dispersible (4) Heat sealable coating composition (5) Hexylresorcinol (6) Liquid rubber (7) Rubber based contact adhesive (8) Sisal wax (9) Titanium tetrachloride (Sp).

TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

Sr. No.	Name of the process (Indian Patent No.)	Field of utilization	Name of the party (year of release)	Nature of release	Present status of implementation
1	2	3	4	5	6
1.	Acrylic acid/acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	M/s Indian Petrochemicals Coprn. Ltd., P. O. Jawaharnagar-391320, Dist. Baroda (1975)	Sponsored	A
2.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone	Pharmaceutical intermediate	M/s Chemical Industrial and Pharmaceutical Laboratories Ltd., (CIPLA), 289, Bellasis Road, Bombay-400 008 (1974)	Non-exclusive	B (Pilot plant trials in progress)
3.	Aniline	Organic intermediate	M/s Hindustan Organic Chemicals Ltd., (HOC), Rasayani (1973)	Non-exclusive	B
4.	Antioxidant TEDQ (2,2, 4- Trimethyl-6-ethoxy-1,2-dihydroquinoline)	Rubber antioxidant	M/s Amar Dye-Chem Ltd., Rang Udyan, Sitladevi Temple Road, P. B. No. 6471, Mahim, Bombay-400 016 (1974)	Non-exclusive	B
5.	1-3-Butylene glycol	Petrochemicals, bulk organic chemicals	M/s Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1974)	Sponsored	A

1	2	3	4	5	6
6.	B D Catalyst	Catalyst for synthetic rubber	M/s Synthetics and Chemicals Ltd., Bombay (1969)	Sponsored	B
7.	Catalytic vapour phase oxidation of olefins	Petrochemicals, bulk organic chemicals	M/s Indian Petrochemicals Corpns. Ltd., Dist. Baroda (1974-75)	Sponsored	A
8.	Cephalexin and 7-ADCA	Pharmaceuticals	M/s Hindustan Antibiotics Ltd., Pimpri, Poona (1975)	Sponsored	A
9.	Chlorides from bauxite residue	Industrial inorganic chemicals	The Dharamsi Morarji Chemicals Co. Ltd., Ambernath-421 501, Dist. Thana (1972)	Sponsored	B
10.	Coating for oil filter papers	oil filtration	The White Cloud Paper Mills, 412, Gultekdi Rd., Poona 411 009 (1968)	Non-exclusive	B
11.	*p*-Cresol	Dye intermediate	M/s HICO Products (P) Ltd., Bombay(1974)	Sponsored	A
12.	N, N-Dimethyl biguanide hydrochloride and Phenethyl biguanide hydrochloride	Anti-diabetic drugs	M/s Combii Organo Chem Pvt. Ltd., 27, Barakhamba, New Delhi-110001 (1976)	Non-exclusive	A

1	2	3	4	5	6
13.	Dichloropropionic acid (Dalapon)	Pesticides	(1) M/s HICO Products (P). Ltd., Bombay (1975)	Non-exclusive	A
			(2) Shri D. N. Nair, East Patel Nagar, New Delhi-110 008 (1975)	Non-exclusive	A
14.	Dimethylaniline (continuous process)	Dyestuffs & explosives intermediate	M/s Sahyadri Dyestuffs and Chemicals, Poona (1974)	Sponsored	A
15.	Endosulfan	Pesticides	M/s Bharat Pulverising Mills Pvt. Ltd., Bombay (1976)	Non-exclusive	A
16.	N-Ethyl-o-toluidine	Dye intermediate	M/s Mafatlal Industries Ltd., Asarwa Road, Ahmedabad (1975)	Sponsored	A
17.	Ethylenediamine	Bulk organic chemicals	The Bharat Vijay Mills Ltd., Kalol-382 721, N. Gujarat (1973)	Non-exclusive	B
18.	Flexible magnets	Refrigeration gaskets, toys, educational kits	(1) M/s V. P. Nijhawan, III-F/5, Lajpatnagar New Delhi-110 024 (1973)	Non-exclusive	B
			(2) M/s Ajanta Enterprises, Mahalaxmi Industrial Estate, Gandhinagar Bombay-400013 (1973)	Non-exclusive	B
			(3) M/s Ferries and Electronics Components (P) Ltd., Balmiki Marg, Lucknow-226001 (1974)	Non-exclusive	B

1	2	3	4	5	6
19.	Foundry core binder (sinol core binder)	Core binder in steel foundries for high dimensional accuracy	(1) M/s Card-Chem Industries, B-12, Co-operative Industrial Estate, Balanagar, Hyderabad-500 037 (1973)	Non-exclusive	B
			(2) M/s Wisca Chemicals, 508, Shishu Vihar havnagar-364 001 (1975)	Non-exclusive	B (in trial production)
20.	Fumed silica	Bulk inorganic chemicals	M/s Century Rayons, Industry House, 159 Churchgate Reclamation, ombay-400020 (1976)	Sponsored	A
21.	Gaskets from coir-pith	Gaskets	M/s Oberoi Industries, 12/37, Tilak Nagar, New Delhi (1974)	Non-exclusive	A
22.	8-Hydroxyquinoline	Pharmaceuticals	M/s Alta Laboratories Pvt. Ltd., Giri Vihar, Khopoli (1970)	Sponsored	B
23.	Matrix-bound penicillin acylase systems	Pharmaceuticals	M/s Hindustan Antibiotics Ltd., Pimpri, Poona (1974)	Sponsored	B (in trial production)
24.	*p*-Menthane hydroperoxide	Synthetic rubbers	M/s Camphor and Allied Products Ltd., Dist. areilly (1969)	Exclusive	B (in trial production)

1	2	3	4	5	6
25.	1-Menthol from citronella oil of Indian origin	Fine chemicals, drugs	M/s Bhavana Chemicals Ltd., 53-57 Laxmi Insurance Bldg., Sir P. M. Road, Bombay-400001(1973)	Sponsored	B
26.	Microfilters	Industrial filtrations	M/s Sona Microfilters, ' Joseph House ', Pudamjee Park, Poona-411001 (1973)	Non-exclusive	B
27.	Morpholine	Intermediate for rubber chemicals	(1) M/s Bombay Wire Ropes Ltd., 401/405, Jolly Bhavan No.1, 10, New Marine Lines, Bombay-400020 (1975)	Non-exclusive	A
			(2) M/s Catalyst India Ltd., Chinoy Building, 79 Masjid Bundar Rd, Bombay-400003 (1975)	Non-exclusive	A
28.	β-Naphthol	Dye-intermediate	M/s Hindustan Organic Chemicals Ltd., Rasayani (1974)	Sponsored	B
29.	Nitro musk compounds	Perfumery	M/s Opal Fine Chemicals 2/9, Three, View Building, 2nd Floor, Opp. Century Bazar, Prabhadevi, Bombay-400025 (1973)	Sponsored	B
30.	Nitrofen	Weedicide	M/s Delhi Pesticides Pvt. Ltd., 128, Kotnis Marg, Mahim Bombay-4000 16 (1975)	Non-exclusive	B

1	2	3	4	5	6
31.	*p*-Nitrophenol	Insecticides	M/s Catalyst India Ltd., Bombay (1975)	Non-exclusive	B
32.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch (M. P.) (1966)	Exclusive	B (Commissioning trials in progress)
33.	Oxalic acid from bark of Ain tree	Industrial chemicals	The Vidarbha Organic Chemical Industries Ltd., Sajan Singh Bldg., 219, Mount Road Extension, Nagpur-440001 (1972)	Sponsored	B (Commissioning trials in progress)
34.	Papavarine hydrochloride	Pharmaceuticals	M/s Suneeta Aromatics, 2/9, Three View Building, Opp. Century Bazar, Bombay-400 025 (1974)	Sponsored	A
35.	Phenylacetic acid	Perfumery, Penicillin G	M/s Orient Aroma Chemical Industries Pvt. Ltd., 27, Chinchbunder, Bombay-400 009 (1973)	Non-exclusive	B (Plant installed)
36.	Polyurethane coatings	Coatings	M/s Polyurethane Industries, 1904, Ranchhodji's Pole, Sarangpur, Ahmedabad-380 001 (1975)	Non-exclusive	A

1	2	3	4	5	6
37.	Synthesis of potential pharmacologically active substances (Furoseamide)	Drugs and pharmaceuticals	M/s Sarabhai Research Centre, Wadi-Wadi, Baroda (1975)	Sponsored	A
38.	Synthesis of resin for friction materials	Friction material	M/s Hindustan Ferodo Ltd., Ghatkopar, Bombay-400 086 (1973)	Sponsored	B
39.	Solvent extraction of sandalwood oil	Perfumery	Govt. Sandalwood Oil Factory, Mysore-570 008 (1973)	Sponsored	B
40.	Staple pin adhesive	Adhesive for staple pins	M/s Duro Metochem Pvt. Ltd., Nirlon House, 254-B Dr. Annie Besant Rd., Worli, ombay-400025 (1976)	Non-exclusive	A
41.	Tamarind Kernel Powder - phosphate and borate	Textile sizing' substitute for hydrolyzed maize starch	M/s S. K. Enterprises, 1/1 Krishna Kripa, Gokhale Road (North), Dadar, ombay-400 028 (1974)	Non-exclusive	A
42.	Terpineol	Perfumery	M/s Dujodwala Industries, 14-1 Mile, Delhi-Mathura Road, Faridabad (Haryana) (1972)	Non-exclusive	B (In trial production)
43.	Testing of rayon grade pulp from Bastar hardwood	Rayon, tyre cord	M/s The Baroda Rayon Corpn. Ltd.. P. O. Baroda Rayon, Udhna-394 220, Dist. Surat (1975)	Sponsored	A

1	2	3	4	5	6
44.	Tetradifon	Acaricide	M/s Delhi Pesticides Pvt. Ltd., Bombay (1975)	Non-exclusive	B
45.	Thioglycolic acid	Cosmetics, catalyst	M/s S. D.'s Lab-Chem Industry, Bombay (1975)	Non-exclusive	B
46.	*p*-Toluidine from *p*-nitrotoluene by vapour phase reduction	Organic intermediate	M/s Sudarshan Chemical Industries Ltd., 162, Wellesley Road, Sangam Bridge, Poona-411 001 (1973)	Sponsored	B (In trial production)
47.	Utilization of fine coarse fibre waste from corn starch industry for mfr. of gums	Adhesive	M/s The Anil Starch Products Ltd., Anil Road, P. B. No. 1062, Ahmedabad, 380002 (1975)	Sponsored	A
48.	Fractionation of turpentine oil	Industrial solvent	M/s J & K Industries Ltd., (J & K Govt. undertaking) Srinagar, Kashmir (1974)	Sponsored	B
49.	Vitamin B_6	Drugs	M/s Indian Drugs & Pharmaceuticals Ltd., Kookatpalli, P. O. Balanagar, Hyderabad-500 037 (1974)	Non-exclusive	B (Pilot plant trials in progress)

1	2	3	4	5	6
50.	Xanthates-Potassium ethyl and Potassium amyl	Froth flotation	M/s Chrome International, F-381, Vishwakarma Industrial Area, Jaipur-302 006 (1975)	Non-exclusive	A
51.	Xylit from coconut shells	Pharmaceuticals, fine chemicals	M/s Unichem Laboratories Ltd., Bombay (1972)	Sponsored	B
52.	D-Xylose and xylit from corn cobs	Pharmaceuticals, fine chemicals	—do— (1974)	Sponsored	B

A — Processes recently released

B — Processes likely to be implemented soon

Note : The following processes which were included in Table II of Annual Report 1974-75 have now been dropped as the licencees have not shown any progress towards their implementation for a considerable period :-

1. Extraction of morphine and other alkaloids from lanced poppy straw (sponsored)
2. Oxyurea (sponsored)

These processes will again appear in future reviews as and when any progress for their implementation is reported.

The following is a consolidated list of the processes which were dropped from Table II of the Annual Reports 1965-66 to 1973-74, 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 processes : (1) Ammophos-II (2) Benzoic acid (IP) from crude methylbenzoate (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) Ethylenedichloride from ethyl alcohol (12) Foundry core oil (13) Hexachloroethane (14) Pressure sensitive adhesive tape (15) Recovery of pyridine base (16) Solvent and heat-exchange liquid from CNSL (17) Surface active agents from CNSL (18) Potentiometric strip chart recorder (19) 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) Isolation of borneol (8) Kashmir soft woods-pulping. (9) Ketone from acetone(10) Liquid stabilizers for PVC (11) Megimide (12) l-Menthol from dementholized peppermint oil (13) *p*-Nitroacetophenone (14) Pentachlorophenol and other phenolic compounds (15) Propoxyphene (16) Quinacridon pigments (17) Terpene G (18) 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 producton 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 and 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 hardwoods-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) Vanllin and ethyl vanillin.

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 (Indian Patent No.)	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	M/s Premier Rubber & Cable Industries, C-15/17-MIDC, Industrial Area, Dombivali, Dist. Thana (1975)
2.	Can lining composition (based on nitrile rubber latex)	Metal can industry	—do— (1975)
3.	Diazepam	Anti-anxiety drugs	(1) M/s Alkem Laboratories Pvt. Ltd., Kumar Engineering Compound, Kalina Road, Kalina, Santacruz (East), Bombay-400 029 (1975) (2) M/s Orion Chemicals, 8, Mulchand Mansion, Princess Street, Bombay-400 002 (1975)
4.	Clofibrate	Pharmaceuticals	M/s SD's Lab-Chem Industry, Bombay (1975)

1	2	3	4
5.	Ferrites-Hard	Electronics	M/s Ajanta Enterprises, Bombay (1971)
6.	Gum arabic substitute	Adhesives	(1) M/s Bal Krishan Mital, Quarter No. CN-2/1, NRC Colony, Mohone, Dist. Thana (1973) (2) M/s Supreme Enterprises, Bhagwan Niwas, Kailash Cinema Chowk, Ludhiana (1973) (3) M/s Industrial Solvents & Chemicals Pvt. Ltd., Block No. 2,63 Princess Street, Bombay-400 002 (1974) (4) M/s Surya Gum and Chemicals, 'Safalya.' 1244 Thakorewas, Old Madhupura, Ahmedabad-380 001 (1975) (5) M/s Delta Chemicals, Kuttikkathi Buildings, P. O. Road, Kottayam-686 001, Kerala (1976)
7.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	M/s Pappachan K. Elengical, Kothamangalam-686 691, Kerala (1976)

1	2	3	4
8.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	(1) M/s Coromandal Tobacco By-Products, P. O. Gannavaram, Dist. Krishna (A.P.) (1971) (2) M/s P. Jaipuria, 144, Rajmahal Vilas Extension, 11, Main Road, Bangalore-560 006 (1972) (3) Shri K. V. Rangaswamy Mudaliar, D. No. 37, R. K. V. Street, Chittode P. O. Erode Taluka, Coimbatore (1974) (4) Dr. J. A. Naik, Indian Institute of Advanced Studies, Rashtrapati Nivas, Simla-5 (1974) (5) M/s Spar Chemicals, C/o Shri M. S. Sawadi, Satwai Road, Nipani-591 237 (1974) (6) M/s Agro Chemical Industries, Parchuru, Dist. Prakasam, A.P. (1974) (7) M/s Ganesh Tobacco Bye-Products Industries Pvt. Ltd., 32, M. Gandhi Gunj, Borsad (1975)

1	2	3	4
	Nicotine sulphate from tobacco and tobacco waste (Contd.)		(8) M/s S. K. Sinha, C/o Shri Nand Kishore Sinha, The Uttar Bihar Hindu Weekly, Patna-Gaya Road, Patna-1 (1975)
			(9) M/s Harmanbhai S. Parel, Aradhana Hotel, Polo Ground, Mount Abu, Rajasthan (1975)
9.	Phthalates - dioctyl and dibutyl	Plasticizers	* M/s Alta Laboratories Ltd., Girivihar, Khopoli, Dist. Kolaba (1969)
10.	Polyurethane printing rollers (86991)	Printing	M/s United Ink and Varnish Co., 37/40, Paranjape 'B' scheme, Vile Parle, Bombay-400 057 (1965)
11.	D. C. Recording polarograph	Polarographic analysis	M/s Laxsons Engg. & Electronics Pvt. Ltd. Opp. Marol Bus Stop, Andheri (East), Bombay-400 059 (1973)
12.	Rubberized cork sheets from cork granules	Gaskets	M/s Cork Products P. Ltd., 9, Jor Bagh, New Delhi (1974)

1	2	3	4
13.	Sachets-Hot and cold	Substitute for hot water bag and ice bag	M/s Bishwanath Fatesaria, 5, Ramkumar Rakhit Lane, Calcutta-700 007 (1973)
14.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	M/s The Anil Starch Products Ltd., Ahmedabad-380 002 (1974)

*The firm discontinued the production since 1973-74.

Note : The names of the following firms which were included in Table II (A) of Annual Report 1974-75 have now been dropped as the licencees have not shown any progress towards the implementation of the processes for a considerable period.

Name of the firm	*Name of the process*
(1) M/s Tobacco Bye-Products, M. Vijaya Krishna Gundarao Bahaddar, Fort Narasaraopet, Dist. Guntur	Nicotine sulphate from tobacco and tobacco waste
(2) M/s Adept Laboratories, Karve Road. Poona-411 004	Thermistors

TABLE III : REVIEW OF RESEARCH UTILIZATION OF PROCESSES DEVELOPED BY NCL ON ITS OWN
(Position as on 31st March every year)

Year	No. of processes in production (excluding FCP processes)	Value of Production Rs. in lakhs	No. of processes released and not in production	No. of processes available but not yet released**	Total No.of processes developed (2+4+5)	%of the processes in production to the total No. of the processes developed	No. of parties who have acquired NCL know-how
1	2	3	4	5	6	7	8
1970*	27	60.50	14	34	75	36	48
1971	30	190.43	14	39	83	36	52
1972	29	350.02	22	56	107	27	58
1973	29	401.07	31	51	111	26	75
1974	32	388.50	39	44	115	28	88
1975	40	654.42	38	46	124	32	101
1976	41	885.61	45	44	130	31	118

Break-up of 45 processes which have been released and are awaiting production (column 4) is as follows :-

A— 9 Processes recently released.

B— 18 Processes on which progress has been reported.

C— 18 Processes on which progress has not been reported or on which production hes been discontinued for market/economical/technical reasons.

*Total cumulative value of industrial production for the years 1950-69 exclusive of those arising from sponsored research schemes and FCP production was Rs. 76.40 lakhs.

**These processes have been referred to NRDC for release.

TABLE IV : REVIEW OF THE PROCESSES DEVELOPED BY NCL UNDER SPONSORSHIP BY INDUSTRY

(*Position as on 31st March every 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 technical/ 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
1970	15	7.17	68.08	15	9	18	30	50	42
1971	19	6.68	92.72	15	13	20	34	56	46
1972	16	8·67	120.67	28	13	22	44	36	55
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	393.45	51	13	24	73	30	71

* This includes sponsored projects awaiting production as well as sponsored projects removed from Table I and II.

** This column includes projects where no industrial production was expected to be realized. These includes PL-480 schemes, Lac Cess Committee project, ICMR schemes, Projects for development of analytical procedures, etc.

TABLE V : 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. Turn-key plant available through Project Engineers
2.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone	Pharmaceutical intermediate	Released
3.	Aniline	Organic intermediate	Released
4.	Anion exchange resin from melamine (Ind. Pat. No. 71190)	Demineralization of liquids	Released
5.	Antioxidant TEDQ (2,2,4-Trimethyl-6-ethoxy-1,2-dihydroquinoline)	Rubber antioxidant	Released
6.	Antipriming composition	Antipriming in locomotives	Released; in production
7.	L-Arabinose (CP)	Biochemical research	Export potential
8.	Atrazinc	Herbicide	—
**9.	Bacterial diastase	Desizing agent for textiles	Released; in production
10.	Benzoic acid from crude methyl benzoate	Pharmaceuticals	Released
11.	Bisphenol-A	Epoxy resins	—
12.	Bostik sealant-substitute	Oil resistant adhesive for fuel tanks	Released; in production

1	2	3	4
13.	*tert*-Butyl catechol	Stabilizer and polymerization inhibitor for synthetic rubber	Released; in production
14.	Butyl titanate	Insulating varnishes, special paints, catalyst	Released; in production
15.	Cadmium sulphide photoconductive cells	Instruments, photoelectric devices	Released; in production
*16.	Cadmium pigments	Inorganic pigments	—
17.	Can lining composition (based on nitrile rubber latex)	Lining cans for storing mineral oils, greases, food	Released; in production
*18.	Can sealing composition	Metal can industry	Released; in production
19.	Carbazole Dioxazine Violet pigment	Organic pigments	Released
20.	Cashewnut shell gum (Ind. Pat. No. 123638)	Binder, thickening agent in food and pharmaceuticals	—
21.	Catechol	Organic intermediate	Released; in production
22.	Cellulose powder	Chromatography, coating for electrodes, filter media	—
23.	Chlorinated paraffin wax	Plasticizers and extenders	—
24.	2-Chloroethyl-trimethyl-ammonium chloride	Plant growth regulator	—
25.	Civetone and Dihydrocivetone	Perfumery	—
26.	Clofibrate	Drugs	Released; in production

1	2	3	4
27.	Coating for oil filter papers	Oil filter	Released; in experimental production
28.	Colchicine	Drugs	—
29.	Costus root oil	Perfumery	—
	Fructose	Medicines	—
	Chamazulene	Cosmetics	—
30.	Diazepam	Anti-anxiety drugs	Released; in production
31.	Dibutyl tin stabilizers for PVC	PVC industry	—
32.	Dichloropropionic acid (Dalapon)	Weedicide	Released
33.	Diethyl toluamide	Insect repellents	—
34.	Dihydroambrettolide & Isoambrettolide	Perfumery	—
35.	Dihydroisojasmone and Peach aldehyde	Perfumery	Released; in production
36.	Dimethylaniline	Dyestuff and explosives intermediate	Released; in production
37.	N, N-Dimethyl biguanide HCl Phenethylbiguanide -HCl	Anti-diabetic drugs	Released
38.	Dissolving grade pulp (Ind. Pat. No. 82822)	Rayon, tyre cord	The process is offered on turn-key basis through Project Engineers

1	2	3	4
39.	Endosulfan	Pesticides	Released; The process is offered on turn-key basis through Project Engineers
40.	Ethylenediamine	Bulk organic chemicals	Released; Turn-key plant available through Project Engineers
41.	Ethylenedichloride from ethyl alcohol	Solvent, organic intermediate	—
42.	Ethylene from ethyl alcohol	Organic intermediate	Released
43.	Exaltolide and Exaltone	Perfumery	—
44.	Expandable polystyrene beads	Insulation and packaging	—
45.	Ferrites-Hard	Eecltronics	Released; in production
46.	Ferrites-Soft	Electronics	—
47.	Fine chemicals	—	Know-how available for 200 laboratory chemicals
48.	Flexible magnets	Refrigerator gaskets, toys, educational kits	Released
49.	Flocculating agent for sugarcane juice clarification	Flocculating agents	—
50.	Foundry core binder (sinol core binder)	Core binder in steel foundries for high dimensional accuracy	Released
51.	Gaskets from coir pith	Gaskets	Released

1	2	3	4
52.	D-Glucosamine hydrochloride (C. P.)	Biochemical research, pharmaceuticals	—
53.	Glyceryl guaiacolate	Drugs-expectorant, intestinal antiseptic	—
54.	Gum arabic substitute	Adhesives	Released; in production
55.	Hexachloroethane (Ind Pat. No. 92997)	Pyrotechnics, smoke screen, veterinary medicine, fluxing agent in foundries	—
56.**	4-Hydroxycoumarin	Pharmaceuticals	Released; in production
57.	β-Ionone (Ind. Pat. No. 77225)	Perfumery chemical, intermediate for Vitamin A	Released; in production
58.	Linseed oil emulsion paint	Emulsion paints	—
59.	Maleic hydrazide	Plant growth regulator	—
60.	Microfilters	Industial filtration	Released
61.	Molecular sieves	Chemicals, petrochemicals, cryogenic industry	—
62.	Monochloroacetic acid	Organic intermediate for weedicides, carboxy methyl cellulose, etc.	Released; in production
63.	Monoethylaniline	Intermediate for explosives	Released; in production
64.	Morpholine	Intermediate for rubber chemicals, textile chemicals, optical brighteners	Released

1	2	3	4
65.	Neo-Lavandulol	Perfumery	—
66.	Nicotine sulphate from tobacco & tobacco waste	Insecticide	Released; in production
67.	Nitrofen	Weedicide	Released
68.	*p*-Nitrophenol	Intermediate for parathion and paracetamol	Released
69.	Optical whitening agent for synthetic fibres	Whitening agent for synthetic fibres	—
70.	Pentachloronitrobenzene	Fungicide	—
71.	Phenacetin	Drugs	—
72.	Phenoxyacetic acid	Penicillin V	—
73.	Phenylacetic acid	Perfumery, Penicillin G	Released
74.	Phthalate-butyl octyl	Plasticizer in non - electrical applications	—
75.	Phthalates-dibutyl/ dioctyl	Plasticizers	Released; in production
76.	Phthalates-dimethyl/ diethyl	Plasticizers	Released; in production
77.	D. C. Recording Polarograph	Polarographic analysis	Released; in production
78.	Polyurethane coatings	Coatings for leather, rubber, wood, glass, nylon fabrics	Released
79.	Polyurethane printing rollers (Ind. Pat. No. 86991)	Printing rollers	Released; in production

1	2	3	4
80.	Potentiometric strip chart recorder	Instrument for use in research and industry	Released
81.	Radiosonde thermistors	Meteorology	Released; in production
82.	Reactive dyes	Dyestuff industry	—
83.	Recovery of pyridine bases from their aqueous solutions	20% Aqueous pyridine base solutions are produced in manufacture of soluble vat dyes	—
84.**	Rigid filters	Tube wells	Released; in production
85.	Rubber blowing agent (Dinitrosopentamethylenetetramine)	Rubber chemicals	Released; in production
86.	Rubberized cork sheets from cork waste/granules	Gaskets	Released; in production
87.	Rubber reclaiming agent	Rubber chemicals	Released; in production
88.	Sachets—Hot and Cold	Substitute for hot water bag & ice bag	Released; in production
89.*	Silicon tetrachloride	Industrial chemical	—
90.	Simazine	Herbicide	—
91.	Sisal wax	Polishes, cosmetics	Released
92.	Sodium hydrosulphite from sodium formate	Reducing agent in textile, sugar and soap industries	Technology on reaction only is offered.
93.	Sorbitol/Mannitol from cane sugar	Pharmaceuticals (mannitol), pharmaceutical syrups, humectant (sorbitol)	—
94.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	Released; in production

1	2	3	4
95.	Direct reading Spectrophotometer/ Colorimeter	Biochemical research spectroscopic analysis in visible range	Released; in production
96.	Staple pins adhesive	Adhesive for staple pins	Released
97.	Synthetic gemstones	Jewellery, electric meters	—
98.	Tamarind Kernel Powder (TKP)-phosphate & borate	Textile sizing subsitute for hydrolysed maize starch	Released
99.	Terpineol	Perfumery	Released; in trial production
100.	Tetradifon	Acaricide	Released
101.	Theophylline,amino-phylline and caffeine	Drugs (caffeine also used in beverage)	—
102.	Thermistors	Temperature measure-ment and control, electronic devices, etc.	Released; in production
103.	Thioglycolic acid	Cosmetics, catalyst	Released
104.**	Vapour phase Chromatograph	Instruments	Released; in production
105.	Vitamin B_6	Drugs	Released
106.	Vitamin C	Drugs	Released; in production
107.**	Warfarin	Rodenticide	Released; in production
108.	Xanthates-Potassium ethyl and Potassium amyl	Froth-flotation	Released

* Processes newly added (3) to the know-how available list published in Annual Report 1974-75.

** Denotes additonal NCL processes (5) which were earlier released to licencees on exclusive basis but, which are now available for further release to industry since their exclusivity period is over.

COMPARATIVE COST-BENEFIT DATA 1974-75 AND 1975-76

	1974—75 (*Rs. in lakhs*)	1975—76 (*Rs. in lakhs*)
COST		
1. Recurring expenditure	104.06	124.71
2. Capital expenditure	24.07	37.67
	128.13	162.38
BENEFITS		
Receipts		
1. Premia and royalties	0.57	0.88
2. Receipts on account of sponsored projects	6.34	4.10
3. Analytical/testing charges	0.29	0.18
4. Institutional consultancy (CSIR share)	0.25	0.05
5. Sale of lab. products	0.69	0.53
6. Miscellaneous receipts including job work	6.49	6.10
	14.63	11.84
Indirect benefits		
1. Total number of processes in production	60*	63*
2. Value of production based on NCL know-how	1098.71	1275.46
3. Estimated savings in foreign exchange on account of above production	438.88	510.18

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

4.	Total number of NCL processes released and awaiting production		
	(a) NCL processes	23	26
	(b) Sponsored schemes	26	26
5.	Total number of parties who have taken up NCL processes for exploitation	101	118
6.	Total number of parties who have sponsored the processes	69	71
7.	Total number of processes which were not released and which were available for commercial exploitation	46	44
8.	Number of processes released during the year		
	(a) NCL processes	10	15
	(b) Sponsored processes completed/concluded	14	6
9.	No. of processes newly added to the list of NCL processes available for exploitation	10	8
10.	Papers published	106	57
11.	Papers presented / read at symposia, seminars etc.	5	18
12.	Doctorate and Masters degrees awarded	22	17
13.	No. of recognized guides for Doctorate and Masters degrees	42	45
14.	Patents		
	(a) Indian patents in force	15	41
	(b) Foreign patents in force	6	3

Premia and royalties received by NRDC through NCL processes :

	(*Rs. in lakhs*)	(*Rs. in lakhs*)
(a) Premia	2.90	3.72
(b) Royalties	1.57	2.66
No. of processes assigned to NRDC	9	7

CUMULATIVE COST-BENEFIT DATA (1950-76)

COST		(*Rs. in lakhs*)
1.	Recurring expenditure	1125.01
2.	Capital expenditure	235.53**
3.	Pilot plant expenditure	71.47
	Total	1432.01

BENEFITS		
1.	Total money receipts	
	(a) Total premia earned by NRDC through NCL processes	18.16
	(b) Total royalties earned by NRDC through NCL processes	8.69
	(c) Total receipts from sponsors	77.16
	(d) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, sales of laboratory products & other receipts including job work	74.83
	Total	178.84
2.	Total value of production based on NCL know-how	4630.68
3.	Total No. of papers published	2908
4.	Total No. of papers presented/read at symposia, seminars (1965/66-1975/76)	132
5.	Total No. of degrees received	389

** 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),
   Director,
   National Chemical Laboratory,
   Poona-411 008.

2. Prof. E. H. Daruwalla,
   Director, Bombay University
   Department of Chemical Technology
   Matunga Road,
   Bombay-400 019.

3. Prof. Ravi J. Matthai,
   Indian Institute of Management,
   Vastrapur,
   Ahmedabad-380 015.

4. Dr. S. Varadarajan,
   Chairman and Managing Director,
   Indian Petrochemicals Corporation Ltd.,
   P. O. Jawaharnagar,
   Baroda-391 320

5. Mr. M. V. Kunte,
   Scientist,
   National Chemical Laboratory,
   Poona

6. Dr. R. B. Mitra,
   Scientist,
   National Chemical Laboratory,
   Poona

7. Dr. S. H. Iqbal,
   Scientist,
   National Chemical Laboratory,
   Poona

8. Administrative Officer,
   National Chemical Laboratory,
   Poona

9. Accounts Officer,
   National Chemical Laboratory,
   Poona

ADVISERS

Process Release Committee

1. Dr. B. D. Tilak (Chairman),
   Director,
   National Chemical Laboratory,
   Poona-411 008

2. Prof. E. H. Daruwalla,
   Director,
   Bombay University
   Department of Chemical Technology,
   Matunga Road,
   Bombay-400 019.

3. Dr. H. E. Eduljee,
   Director, Sturdia Chemicals Ltd.,
   Neville House, Graham Road,
   Bombay-400 001.

4. Mr. L. Kumar,
   Adviser (PAD),
   Planning Commission,
   Yojana Bhavan,
   New Delhi.

5. Dr. C. V. S. Ratnam,
   Managing Director,
   National Research Development Corporation of India,
   61, Ring Road, Lajpatnagar-III,
   New Delhi-110 024.

6. Dr. S. Varadarajan,
   Chairman & Managing Director,
   Indian Petrochemicals Corporation Ltd.,
   P. O. Jawaharnagar, Baroda-391 320.

7. Mr. Baldev Singh,
   Chief (Technology Utilization),
   Council of Scientific & Industrial Research, Rafi Marg,
   New Delhi-110 001.

8. Dr. L. K. Doraiswamy,
   Scientist,
   National Chemical Laboratory,
   Poona.

9. Dr. R. B. Mitra,
Scientist,
National Chemical Laboratory,
Poona

10. Administrative Officer,
National Chemical Laboratory,
Poona

11. Mr. A. M. Lele (Member Secretary),
Scientist,
National Chemical Laboratory,
Poona

ADVISORY PANELS

I. *Biochemistry*

1. Prof. P. K. Bhattacharyya,
Department of Organic Chemistry,
Indian Institute of Science,
Bangalore-560 012.

2. Dr. A. D. Karve,
Director, Nimbkar Agricultural Research Institute,
Phaltan (Dist. Satara).

3. Dr. S. C. Maheswari,
Professor of Botany,
Delhi University,
Delhi-110 007.

4. Dr. P. K. Maitra,
Molecular Biology Unit,
Tata Institute of Fundamental Research,
Homi Bhabha Road,
Bombay-400 005.

5. Mr. R. B. Mujumdar,
Managing Director,
Forest Development Corporation of Maharashtra State Ltd.
6-A Tilak Nagar,
Nagpur-10.

6. Dr. G. B. Nadkarni,
Head, Biochemistry & Food
Technology Division,
Bhabha Atomic Research Centre,
Trombay,
Bombay-400 085.

7. Dr. M. S. Pawar,
Vice-Chancellor,
Mahatma Phule Krishi Vidyapeeth,
Rahuri (Ahmednagar).

8. Dr. S. Ramachandran,
Superintendent (Research),
Hindustan Antibiotics Ltd.,
Pimpri,
Poona-411018.

9. Dr. K. S. V. Sampat Kumar,
Head of Research,
Brooke Bond India Ltd.,
White Field,
Bangalore-562136.

II. *Chemical Engineering and Process Development*

1. Mr. N. Biswas,
Development Officer,
Technical Evaluation,
Directorate General of Technical Development,
Udyog Bhavan,
New Delhi-110 011.

2. Dr. H. E. Eduljee,
Director, Sturdia Chemicals Ltd.,
Neville House, Graham Road,
Ballard Estate,
Bombay-400 001.

3. Dr. K. S. Gill,
General Manager,
Indian Farmers Fertilizer Cooperative Ltd.,
No. 11 South Extension (Part I),
New Delhi-110 049.

4. Mr. N. C. Krishnamurthy,
Adviser (Petrochemicals),
Ministry of Petroleum & Chemicals,
Govt. of India, Shastri Bhavan,
New Delhi-110 001.

5. Prof. A. P. Kudchadkar,
Chairman, Department of Chemical Engineering,
Indian Institute of Technology,
Kanpur- 208 016.

6. Mr. L. Kumar,
Adviser (PAD),
Planning Commission,
Yojana Bhavan,
New Delhi.

7. Dr. P. G. Menon,
Manager-in-Charge (R & D),
Indian Petrochemicals Corporation Ltd.,
P. O. Jawaharnagar,
Baroda- 391 320.

8. Dr. M. S. Mitra,
Manager of Technical Services,
Engineers India Ltd.,
Parliament Street,
New Delhi - 110 001.

9. Dr. P. S. Murti,
Deputy Director,
Regional Research Laboratory,
Hyderabad-500 009.

10. Prof. M. M. Sharma,
Professor of Chemical Engineering,
Bombay University Department of Chemical Technology,
Matunga Road,
Bombay- 400 019.

11. Mr. A. Swaminathan,
Managing Director,
Hindustan Organic Chemicals Ltd.,
P. O. Rasayani-410 207.

III. *Inorganic Chemistry*

1. Dr. N. Kondal Rao,
Chief Executive,
Nuclear Fuel Complex
(Deptt. of Atomic Energy),
Chhatrapati Shivaji Maharaj Marg,
Bombay - 400 001.

2. Dr. R. Krishnaswamy,
Manager of Projects (Metallurgy),
Engineers India Ltd.,
Hindustan Times House,
Kasturba Gandhi Marg,
New Delhi-110 001.

3. Mr. P. V. S. Manyam,
Director & General Manager (Works),
Tata Chemicals Ltd.,
Mithapur (Gujarat).

4. Mr. V. Ramadurai,
Chief Executive,
Standard Alkali Limited,
Mafatlal Centre, Nariman Point,
Bombay-400 021.

5. Mr. R. V. Ramani,
Managing Director,
Mettur Chemicals & Industrial Corporation Ltd.,
2nd Line Beach,
Madras-600 001.

6. Prof. M. M. Taqui Khan,
Prof. and Head of Chemistry, Department
Nizam College,
Hyderabad-500 001.

7. Mr. J. L. Thakkar,
Managing Director,
Dharamsi Morarji Chemicals Co. Ltd.,
317, Dadabhoy Nowrojee Road,
Bombay-400 001.

8. Mr. S. A. Trivedi,
Cheif Executive,
Navin Fluorine Industries Ltd.,
Mafatlal Centre,
Nariman Point,
Bombay-400 021.

9. Prof. A. R. Vasudeva Murthy,
Department of Inorganic & Physical Chemistry,
Indian Institute of Science,
Bangalore- 562 012.

10. Mr. S. N. Wazir,
Senior Superintendent
(Coal, Coke & Chemicals),
Metallurgy & Engineering Consultants (I) Ltd.,
Ranchi-834 002.

IV. *Organic Synthesis and Natural Products*

1. Prof. S. V. Kessar,
   Department of Chemistry,
   University of Punjab,
   Chandigarh-160 014.

2. Mr. N. V. Khote,
   Managing Director,
   Rallis India Ltd.,
   Ralli House, 21, Raveline Street,
   Bombay-400 001.

3. Dr. S. K. Mukherjee,
   Head of Agricultural Chemicals,
   Indian Agricultural Research Institute,
   New Delhi-110 012.

4. Dr. Nitya Nand,
   Director,
   Central Drug Research Institute,
   Chattar Manzil Palace,
   Lucknow.

5. Mr. J. R. Patil,
   Director, Res. & Dev.
   HICO Products Pvt. Ltd.,
   Mogal Lane, Mahim,
   Bombay-400 016.

6. Dr. D. S. Rao,
   Res. Manager Colour Chem Ltd.,
   Ravindra Annexe,
   Dinshaw Vachha Road,
   194 Churchgate Reclamation,
   Bombay-400 020.

7. Dr. G. R. N. Sastry,
   Senior Project Co-ordinator,
   Indian Petrochemicals Corpn. Ltd.,
   P. O. Jawaharnagar Baroda-391 320.

8. Dr. K. D. Sharma,
   Development Officer,
   Directorate General of Technical Development,
   Udyog Bhavan,
   New Delhi-110 011.

9. Dr. D. R. Sridhar,
Chief, R & D (SDP),
Indian Drugs & Pharmaceuticals Ltd.,
Hyderabad-500037.

10. Dr. V. Srinivasan,
Director,
Sarabhai Research Centre,
Wadi Wadi,
Baroda-391 007.

11. Dr. Sukh Dev,
Director,
Maltichem Research Centre,
Nandesari,
Baroda-391 340.

V. *Polymer Chemistry*

1. Dr. K. Aghoramurthy,
Manager (Technical Services),
Indian Petrochemicals Corporation Ltd.,
P. O. Jawaharnagar,
Baroda-391 320

2. Dr. S. P. Bhattacharyya,
Industrial Adviser (Chem.),
Directorate General of Technical Development,
Udyog Bhavan,
New Delhi -110 011.

3. Dr. S. K. Datta,
Manager, Tech. Service
National Organic Chemical Industries Ltd.,
Rajan House, Prabhadevi,
Bombay-400 025.

4. Mr. C. B. Garware,
Managing Director,
Blundell Emoite Paints Ltd.,
Rustom Building,
Nariman Road,
Bombay - 400 001.

5. Dr. S. P. Potnis,
Prof. of Polymer Technology, Bombay University
Department of Chemical Technology,
Matunga Road,
Bombay-400 019.

6. Mr. S. Ramaswamy,
General Manager,
Chemicals & Plastics India Ltd.,
Dhun Building. Mount Road,
Madras-600 002.

7. Dr. S. R. Srinivasan,
Project Engineer,
Polyolefins Industries Ltd.,
Mafatlal Centre,
Nariman Point,
Bombay -400 021.

8. Mr. D. M. Trivedi,
Project Manager,
Synthetics & Chemicals Ltd.,
7, J. Tata Road,
Bombay -400 020.

9. Mr. B. G. Vaidya,
Chief Executive, Swastik Rubber Products Ltd.,
Khadki,
Poona -411 003.

10. Dr. S. P. Vora,
General Manager,
Operations of Backelite Hylam Ltd.,
183/184, Rashtrapati Road,
Sanatnagar,
Hyderabad -500 003.

VI *Solid State and Physical Chemistry*

1. Dr. Amba Sankaran,
Director,
Tech. Physics Divn.,
Bhabha Atomic Research Centre,
Bombay-400085.

2. Dr. V. G. Bhide,
Deputy Director,
National Physical Laboratory,
New Delhi-110012.

3. Dr. M. D. Karkhanawala,
Head, Chemistry Division,
Bhabha Atomic Research Centre,
Bombay-400085.

4. Prof. T. Manoharan,
Special Instruments Laboratory,
Indian Institute of Technology,
Madras-600036.

5. Prof. P. T. Narasimhan,
Senior Professor,
Chemistry Department,
Indian Institute of Technology,
Kanpur-208016.

6. Prof. R. P. Rastogi,
Gorakhpur University,
Gorakhpur.

7. Dr. N. Seshagiri,
Director,
Electronic Commission Hq.,
C-3/18, Safdarjung Dev. Area,
New Delhi-110016.

8. Mr. U. Venkateswarlu,
Managing Director,
Central Electronics Ltd.,
NPL Campus,
New Delhi-110012.

Distribution of Advisers

Members from :—		No.
1.	Industry	17
2.	Govt. departments including DGTD	8
3.	Public sector	11
4.	Sister Laboratories	4
5.	Research Institutes, Universities, etc.	19
6.	Bhabha Atomic Research Centre	4
	Total	63

LIST OF SCIENTIFIC STAFF INCLUDING S. L. A. & OFFICERS OF INFRASTRUCTURE GROUPS OF N. C. L. AS ON 31-3-1976.

Out of 376 Scientific staff listed excepting 113, all the others have postgraduate (M. Sc. and above) engineering (B. Sc. Tech., B. Tech., B. E. or B. Chem.) qualifications.

DIRECTOR

Dr. B. D. Tilak

SCIENTIST 'F' (5)

Dr. L. K. Doraiswamy
Dr. R. B. Mitra
Dr. S. L. Kapur
Dr. V. Jagannathan
Dr. A. P. B. Sinha

SCIENTIST 'E ' (21)

Dr. M. U. Pai
Dr. H. B. Mathur
Dr. A. Goswami
Dr. P. M. Nair
Mr. R. V. Kulkarni
Dr. M. Goswami
Dr. D. N. Sen
Mr. M. V. Kunte
Dr. C. Siva Raman
Dr. K. G. Das
Dr. J. C. Sadana
Dr. C. R. Narayanan
Dr. N. D. Ghatge
Dr. L. M. Pant
Dr. (Miss) S. B. Kulkarni
Mr. Lakhbir Singh
Mr. A. M. Lele
Dr. P. N. Rangachari
Dr. S. S. Subramanian
Dr. S. M. Abhyankar
Dr. G. R. Venkitakrishnan

SCIENTIST 'C' (71)

Dr. M. K. Unni
Mr. S. N. Balasubramanian
Mr. S. P. Mukherjee
Dr. G. V. Potnis
Dr. A.S. Rao
Dr. V. P. Fernandez
Dr. S. S. Katti
Mr. D. S. Bendale
Dr. J. P. Varma
Dr. S. C. Sethi
Dr. T. R. Ingle
Mr. V. S. Krishnamachar
Dr. C. I. Jose
Mr. V. Krishnan
Dr. S. N. Kulkarni
Dr. M. P. Reddy
Dr. R. M. Joshi
Mr. A. D. Deshpande
Dr. P. G. Sharma
Mr. D. Raghunath
Dr. B. B. Ghatge
Dr. S. H. Iqbal
Mr. N. A. Bhat
Dr. M. N. S. Murthy
Mr. D. D. Kelkar
Dr. C. A. Menezes
Dr. S. B. Badachhape
Mr. K. J. Rao
Mr. H. G. Vartak
Dr. V. V. Mhaskar
Dr. G. H. Kulkarni
Dr. A. V. Ramarao
Dr. N. R. Ayyangar
Dr. M. C. Srinivasan
Dr. S.S. Tavale
Mr. M. P. Gupta
Dr. V. Damodaran
Dr. U. R. Nayak
Dr. P. Roychoudhary
Mr. P. H. Brahme
Mr. S Balakrishnan
Dr. P. G. Nerlekar
Dr. C. G. Joshi
Dr. D. D. Nanavati

SCIENTIST 'C' (Contd.)

Dr. A. S. Gupta
Dr. V. S. Pansare
Mr. D. Sengupta
Dr. V. G. Naik
Dr. S. Gundaiah
Dr. C. D. Sabane
Dr. G. T. Panse
Dr. T. Ravindranathan
Dr. V. N. Gogte
Dr. V.V. Dhekne
Dr. R. N. Sharma
Dr. Sobhan Ghosh
Dr. V. R. Choudhary
Dr. S. Ramachandran
Dr. V. S. Patwardhan
Dr. S. P. Rao
Dr. N. G. Karanth
Dr. Ajit Sadana
Mr. A. K. Chatterjee
Dr. D. Chakrabartty
Dr. B. Bheemeshwar
Mr. S. Chidambaram
Mr. M. V. Gokhale
Mr. R. V. Choudhari
Mr. V. K. Jinaraj
Mr. A. S. Surve
Dr. B N. Joshi
Mr. Niranjan Singh (C-1)
Mr. E. M. Inamadar (C-1)

SCIENTIST 'B' (62)

Mr. M. S. Krishnadas
Dr. R. Ramarao
Dr. K. G. Gore
Mr. M. B. Mahajan
Dr. R. S. Joshi
Dr. B. A. Nagasampagi
Dr. A. F. Mascarenhas
Mr. N. Rajagopalan
Mr. S. R. Srinivasan
Dr. V. H. Kapadia
Dr. H. G. Vadgaonkar
Dr. U. N. Kantak
Dr. (Miss) V. S. Joshi
Dr. S. K. Krishnappa
Mr. R. K. Sen
Mr. S. R. Modak
Dr. V. K. Powar
Mr. J. Lobo
Dr. H. R. Sonawane
Dr. V. G. Neurgaonkar
Mr. J. V. Rajan
Mr. N. D. Seth
Dr. K. V. Krishnamurthi
Mr. M. V. Kuber
Dr. P. S. Kulkarni
Mr. Josheph Kuruvilla
Mr. S. S. Mahajan
Mr. A. Subbarao
Mr. R. T. Shah
Mr. N. Sadasivan
Dr. A. N. Gokarn
Dr. O. G. B.Nambiar
Dr. (Miss) Z. M. Muljiani
Dr. R. P. Varma
Mr. J. Biswas
Mr. M. G. Sane
Dr. A. R. Mehendale
Mr. C. U. Saraf
Mr. A. G. Lugade
Mr. K. A. R. Sastry
Dr. C. Gopinathan
Mr. A. B. Bastawade
Mr. S. K. Pandit
Mr. M. S. Setty
Dr. P. Umapathy
Mr. B. G. Apte
Dr. S. V. Paranjape
Dr. N. N. Dhaneshwar
Mr. S. Sounderarajan
Mr. S. D. Bakare
Mr. D. R. Apte
Mr. J. C. Sehra
Dr. (Miss) Lalithambika
Mr. P. P. Pai
Dr. E. D. Pandhare
Mr. S. Y. Kulkarni
Mr. D. C. Mehta
Mr. P. N. Khanna

SCIENTIST 'B' (Contd.)

Dr. B. V. Bapat
Mr. M. B. Unde
Mrs. S. S. Adke (B-1)
Mr. K. B. Kaushal (B-1)
Mr. R. Nagarajan
(Information Officer)

SCIENTIST 'A' (36)

Dr. V. K. Hinge
Mr. K. N. Dixit
Dr. C. A. Chinchwadkar
Mr. S. G. Patil
Mr. S. Kasturi Rangachar
Mr. Sankar Ghosh
Mr. R. N. Paul
Dr. (Mrs.) S. A. Patwardhan
Mr. V. Ramaswamy
Dr. S. P. Vernekar
Mr. M. B. Shinde
Dr. (Mrs.) S. Gopinathan
Mrs. H. Siva Raman
Mr. A. M. Hundekar
Dr. K. B. Gujar
Mr. B. S. Nanjundiah
Dr. S. B. Kulkarni
Mr. S. L. Phatak
Dr. G. D. Joshi
Mr. S. A. Tambe
Dr. (Mrs.) Mala Rao
Dr. (Mrs.) V. V. Deshpande
Mr. R. R. Hendre
Dr. Gopal Pathak
Dr. B. S. Rao
Dr. S. Badrinaravanan
Mr. K. R. Srinivasan
Mr. K. B. S. Prasad
Mr. V. R. Patwardhan
Mr. K. R. Bhinge
Mr. P. P. Lohokare
Mr. V. R. Joshi
Dr. V. M. Sathe
Dr. (Miss) M. V. Natekar
Dr. S. V. Hiremath
Mr. Iqbal S. Mulla
Mr. N. S. Iyer (A-1)
Mr. K. B. Chorgi, (A-1)
Mr. R. N. Shukla (A-1)
Mr. P. M. Shinde (A-1)
Mr. P. D. Josheph (A-1)
Mr. I. R. Unni (A-1)
Mr. S. T. Dhume (J.T.O.)
Mr. A. B. Tarkunde (J.T.O)

SENIOR SCIENTIFIC ASSISTANT (80)

Dr. V. G. Gunjikar
Dr. S. S. Mahajan
Mrs. D. Srivastava
Dr. A. S. Vaidya
Mr. S. R. Harisangam
Dr. V. J. Rao
Mr. I. C. Gouroji
Dr. C. S. Dorai
Mr. V. B.Patil
Mr. H. P. Khadilkar
Mr. C. J. Johny
Mrs. H. V. Kamath
Mr. K. G. Deshpande
Mr. S. T. Kshirsagar
Mr. K. C. Brahme
Mr. C. E. Deshpande
Dr. P. N. Coudhary
Mr. P. P. Moghe
Mr. I. Balakrishnan
Mr. B. A. Baliga
Mr. R. B. Malvankar
Mr. H. S. Jagtap
Dr. S. D. Sathaye
Mr. R. S. Karnik
Dr. M. P. Kulkarni
Mr. K. S.Balaraman
Mr. R. A. Modak
Mr. V. K. Bhalerao
Mr. S. S. Ramdasi
Mr. B. M. Dubash
Dr. S. K. Kamath
Dr. Harish Narain
Dr. B. G. Hazra
Mr. M. G. Kotasthane

SENIOR SCIENTIFIC ASSISTANT (Contd.)

Mr. B. Seetharama Rao
Mr. A. Y. Sonasale
Mr. A. N. Singh
Mr. S. S. Joshi
Mr. M. G. Parande
Mr. N. Amarnath
Mr. A. T. Naik
Mr. H. B. Singh
Mr. T. P. Mohandas
Dr. S. D. Patil
Mr. J. V. Sathe
Mr. A. A. Natu
Dr. (Mrs.) V. B. Deodhar
Mr. V. R. Kulkarni
Mr. A. B. Sahasrabudhe
Mrs. M. D. Jaifalkar
Mr. S. S. Tamhankar
Mrs. J. J. Shrotri
Mr. S. S. Kale
Miss A. Mary
Mr. I. I. Sutar
Mr. A. A. Gunari
Mr. A. B. Landge
Miss N. R. Pavaskar
Mr. S. R. Mhaswade
Dr. B. R. K. Murthy
Mr. S. G. Pataskar
Mr. H. G. Joglekar
Mr. P. V. Rao
Mr. Nandkishore
Dr. K. P. Madhusudan
Mr. B. M. Shinde
Mr. C. Bhaskar
Mrs. K. K. Deshmukh
Mr. S. D. Sansare
Mr. C. V. Kavedia
Mr. S. D. Pradhan
Mr. S.G. Hegde
Dr. M. K. Dattachoudhery
Mrs. V. V. Ghaisas
Mr. A. S. Shaikh
Mr. M. N Kamath
Mr. George Samuel
Dr. R. J. Deshpande
Mr. G. G. Roy
Mr. S. R. Sainkar

JUNIOR SCIENTIFIC ASSISTANT (39)

Mr. H. S. Soni
Dr. Prabhat Singh
Mr. K. F. Lunkad
Mr. M. B. Sabne
Mr. A. S. Khanra
Mr. V. P. Shiralkar
Mr. A. B. Mandale
Mr. V. S. Ranade
Mr. R. G. Kelkar
Mrs. A. K. Gujarathi
Mr A. L. Nadgir
Mr. R. R. Khandekar
Mr. P. P. Bakare
Mr. B. G. Patil
Mrs. A. A. Belhekar
Mrs. Bharati Sinha
Mr. M. J. Eapen
Miss M. S. Agashe
Mr. R. Jagannathan
Mr. V. R. Kambali
Mr. V. G. Shah
Mr. M. M. Patil
Mr. R. B. Gujarathi
Mr. A. N. Kothasthane
Mr. J. A. Pires
Mrs. N. V. Bhalerao
Mr. D. G. Panse
Mr. P. A. Awasarkar
Mr. M. D. Bauskar
Mr. S. R. Padalkar
Mr. A. P. Budhkar
Dr. V V. Jatkar
Mr. Imtyaz S. Mulla
Mr. P. D. Godbole
Mr. S. H. Vaidya
Mr. K. Jayarajan
Mr. A. H. Lachke
Mr. P. K. Gupta
Mr. M. V. Deshpande

JUNIOR TECHNICAL ASSISTANT (3)

Mr. R. N. Akkadkar
Mr. J. S. Gujaral
Mr. M. N. Sutaria

SENIOR LABORATORY ASSISTANT (61)

Mrs. A. V. Pol
Mr. D. A. Godbole
Mrs. V. S. Dalvoy
Mr. R. J. Lahoti
Mr. S. G. Joshi
Mr. C. R. Rajan
Mrs. V. S. Bhat
Mr. A. M. Rajput
Mrs. R. R. Ratnaparkhi
Mr. V. G. Kulkarni
Mr. V. K. Sharma
Mrs. G. A. Thite
Mrs. S. H. Phadnis
Miss R. S. Khisti
Mrs. A. J. Chandwadkar
Miss Rita Varma
Mrs. D. M. Barve
Mr. A. N. Kadam
Mr. S. B. Deshpade
Mr. C. D. George
Mr. R. A. Kulkarni
Mr. D. D. Sawaikar
Mr. A. M. Bodhe
Mr. P. S. Ozarde
Mr. K. B. Bastawade
Miss V. N. Joshi
Mr. I. Shivkumar
Mr. N. V. Atre (expired)
Mr. S. M. Toke
Mr. D. D. Kulkarni
Mr. D. V. Gokhale
Mr. S. M. Likhite
Mr. Ajit Singh Maman
Mrs. U. N. Puntambekar
Mr. S. N. Girme
Mr. S. P. Gupte
Miss R. A. Prabhu
Mr. P. L. Joshi
Mr. S. R. Dabke
Mr. R. H. Naik
Mrs. V. S. Shinde
Mrs. M. N. Sainani
Mr. P. B. Jadkar
Mr. D. S. Hebalkar
Mr. B. S. Thengadi
Miss S. G. Sakhare
Mr. S. V. Lonikar
Mr. J. G. Wadkar
Miss A. P. Mathew
Mr. G. D. Shahapure
Mr. R. S. Jagtap
Mr. V. M. Kulkarni
Mr. S. H. Potdar
Mr. D. D. Shinde
Mr. S. B. Bendre
Mr. V. T. Sathe
Mr. S. S. Bhosale
Mr. R. W. Shinde
Mrs. M. P. Ramagude
Mr. H. A. Bajaj
Miss H. A. Patwardhan
Mrs. N. E. Jacobs

ADMINISTRATION

Mr. O. P. Khanna	Administrative Officer
Mr. M.M. Sharma	Section Officer
Mr. R. C. Shastry	Section Officer
Mr. N. Mohandas	Security Officer
Mr. Y. B. Ranade	Stores Officer

ACCOUNTS

Mr. O. M. Parthasarathy	Accounts Officer

LIBRARY

Mr. R. S. Singh	Documentation Officer
Mr. M. B. Patil	Junior Documentation Officer

MEDICAL SERVICES

Dr. M. L. Ram	Assistant Surgeon
Dr. (Mrs.) A .V. Agashe	Assistant Surgeon

CREDITS

Editor	:	Mr. A. M. Lele
Compiled by	:	Scientific staff of the Div. of Tech. Services
Photographs Illustrations Cover Design Secretarial assistance	}	Technical and Ministerial staff of the Div. of Tech. Services