Annual Report

1974-75

Silver Jubilee Year

National Chemical Laboratory, Poona

NATIONAL CHEMICAL LABORATORY POONA 1974–1975

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Published by Dr. B. D Tilak,
Director, NCL.

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INTRODUCTION

NCL Silver Jubilee

I have great pleasure in presenting the report covering NCL's activities during 1974-75. In January 1975, NCL completed twenty-five years of its existence. We had the privilege of having the Prime Minister, Shrimati Indira Gandhi, in our midst to inaugurate the Silver Jubilee celebrations on 1st February. A souvenir recording the achievements of the NCL during the last 25 years and a brochure highlighting NCL's successes in technology transfer were released by the Prime Minister. Service awards to NCL staff and officers who completed 25 years of service were also presented by the Prime Minister.

While reviewing the progress of the NCL over the last 25 years in my welcome speech, I had raised some pertinent issues which affect the development of indigenous technology and its transfer to industry. In her inaugural address, the Prime Minister clarified some of these and other issues which relate to the role of indigenous research in the context of the Government's policies regarding promotion of self-reliance, the practice prevailing in the country of showing preference for foreign goods, processes and designs and the need to undertake innovative research. Thus the Prime Minister observed:

> 'Dr. Tilak has made some pertinent observations about the reluctance of private industrialists and public sector managers to accept indigenous technology even when guarantees of performance are given. Entrepreneurs and officials are afraid of taking risks and still consider foreign equipment, foreign processes, foreign experts and, not least, foreign brand names as glamorous. In many Afro-Asian countries our efforts to export our engineering goods and machinery come up against this same kind of preference for western equipment. There are areas in which we need to import sophisticated technology. But it seems to me that with all our arrangements for multilevel scrutiny we permit inessential foreign technology, when equally good indigenous technology exists. Similarly there is lack of recognition of the research of our laboratories—especially in certain aspects of construction engineering. I am trying to change this outlook.'

The Prime Minister, while advocating the use of indigenous technology, also advised that the "scientists, on their part, must cultivate a more evangeli-

cal attitude in this matter and acquaint the public regarding the scientific work done in the country."

The NCL has maintained that for creative and innovative industrial research of larger economic impact, it is necessary for Laboratories like NCL to have a sound base of fundamental research which is relevant to its applied research programmes. This point was also emphasized by the Prime Minister in her Address :

> 'At a higher level, major centres of scientific research like this one should maintain a creative balance between intellectual discovery and applied developmental work. So I am glad that the aim of NCL is to effect breakthroughs in technology based on sound fundamental research and a high order of scientific capability for innovation.'

The Silver Jubilee inaugural function was presided over by Shri V. P. Naik, Chief Minister, Maharashtra State. The Chief Minister and Dr. Y. Nayudamma, Director General, Scientific and Industrial Research also addressed the gathering.

The Prime Minister had informal discussions with the senior NCL scientists and some leading technocrats from industry that have acquired NCL technologies.

The main features of the celebrations were: a special exhibition depicting NCL's achievements in the form of pictorial charts, murals, models and samples; the release of a documentary film entitled 'NCL in the service of nation'; a get-together with industrialists and organization of two Open Days for the public. In addition, the NCL is planning to publish during 1975-76 two commemoration volumes reviewing the basic and applied work carried out by the NCL in the last 25 years. We also intend to organize two international seminars on recent advances in organic chemistry and in materials research as part of the Silver Jubilee programme.

Taking advantage of the presence of a large number of industrialists during the Silver Jubilee celebration, the NCL organized a get-together to ascertain from them their views and comments on what NCL had done so far and what they would like the Laboratory to do in the future.

Activities during 1974-75

During the year under review, the research activities of NCL covered 21 major areas, including infrastructure activities. The relevant portions pertaining to these areas illustrate the results achieved and the benefits expected out of the research inputs. Programmes identified by the NCST

were given priority and efforts were concentrated towards achieving results in accordance with predetermined time targets.

Product Oriented Research

The report describes work carried out on 107 product oriented projects including follow-up work. These form the smaller components of the 21 major areas of work referred to above and in the body of the report. The number of such projects in each area were as follows:—Petrochemicals and Bulk Organic Chemicals, 12; Pesticides and Agrochemicals, 18; Drugs, Pharmaceuticals and Fine Chemicals, 7; Organic Intermediates, Dyes and Industrial Chemicals, 9; Utilization of Plant and Forest Resources, 10; Chemistry of Biologically Active Compounds, 2; Studies in Organic Synthesis, 3; Industrial Polymers, Resins and Elastomers, 7; Inorganic Chemicals and Catalysts, 11; Utilization of Mineral Resources, 4; Organometallic Compounds, 1; Solid State Materials, 9; Instruments Technology, 3; Tissue Culture Studies, 3; Enzyme Chemistry and Technology, 4; Fermentation Processes. 1; and Process Development and Chemical Engineering Studies, 3.

Basic Research and Publications

Details of basic research projects undertaken during the year under review are given under the relevant areas. Of the 98 research papers published during the year, 2 were on pesticides and agrochemicals, 1 on organic intermediates, dyes and research chemicals, 7 on utilization of plant and forest resources, 31 on studies in organic synthesis, 7 on physico-chemical properties of materials, 11 on studies in physical organic chemistry, 5 on industrial polymers, resins and elastomers, 9 on organometallic compounds, 1 on solid state materials, 4 on tissue culture studies, 2 on enzyme chemistry and technology, 14 on process development and chemical engineering studies, 1 on new analytical methods and 3 on planning, management, publicity and documentation, etc. In addition, 8 papers were published in collaboration with outside scientists and 5 papers were presented at symposia, seminars, etc.

42 NCL scientists were recognized by different Indian Universities as research guides. 22 NCL staff members, research fellows and guest workers received post-graduate (Ph.D.) degrees during the year.

Consultancy

During the year, consultancy was offered to one public sector iudustry (Hindustan Antibiotics Ltd., Pimpri, Poona) and 6 private sector industries through individual scientists or groups of scientists. Ten NCL scientists acted as consultants. The consultancy fees received during the year (CSIR share) were Rs. 0.25 lakhs.

Patents

Three new Indian patents were filed during the year. As on 31st March

1975, 45 Indian patents (23 sealed and 22 filed) and 6 foreign NCL patents were in force.

Research Utilization

Table I lists the details of products manufactured based on NCL technology. The total number of processes which were in commercial production during 1974-75 amounted to 60 with an annual turnover of about Rs. 11 crores as against 49 processes with a turnover of Rs. 6.52 crores during 1973-74. Significant increases in production (more than 10%) were noticed in respect of about 20 processes, during 1974-75. At the end of Table I can be found the annual value of production of NCL technologies commercialized during the period 1950-75.

During 1974-75 production was reported for the first time on 9 processes: Bostik sealants substitute; can-lining composition; cation exchange resin-styrene DVB base; chlorobenzenes; chloromethanes; gum arabic substitute; nonyl phenol; phenthoate; radiosonde thermistors. Production was also resumed on 4 processes, *viz.*, bacterial diastase, 4-hydroxy coumarin, radio opaque dyes and warfarin which was earlier suspended.

Details on 49 processes released to the prospective entrepreneurs and their present status can be seen in Table II. Of these, 24 were released during 1974-75. A consolidated review of research utilization of technologies developed by the NCL is given in Table III and IV. It will be seen that the total number of processes developed by the NCL on its own initiative amounts to 124, of which 40 are in production, 38 have been released and 46 are awaiting release. The total number of industrial projects completed on contractual basis amounts to 68, of which 19 are in commercial production. 14 Sponsored schemes were concluded during the year, 4 schemes newly undertaken and 5 schemes continued from 1973-74.

Table V gives a list of 96 NCL processes available for commercial exploitation. During the year under review the NCL Process Release Committee met thrice and reviewed 11 newly developed processes for their release to industry. As against 8 processes released to industry during 1973-74 the number of processes released to industry during 1974-75 amounts to 10.

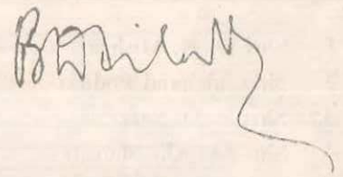
Premia and Royalties

The total amounts by way of premia and royalties received during 1974-75 by the NRDC on account of NCL processes were respectively Rs. 2.90 and Rs. 1.575 lakhs as against Rs. 2.39 and Rs. 0.73 lakhs received during 1973-74.

Cost-Benefit Data (1974-75)

As against an expenditure of Rs. 128 lakhs (Rs. 104 lakhs recurring and Rs. 24 lakhs capital), the total receipts were Rs. 14.6 lakhs. Details of the

costs and direct and indirect benefits appear on page 136. The value of production based on NCL know-how for 1974-75 was Rs. 10.99 crores. Most of these products led to import substitution. The value of foreign exchange thus saved was estimated at about Rs. 4.4 crores.



September, 1975
NCL, Poona.

B. D. Tilak
Director

LIST OF STAFF MEMBERS WHO HAVE COMPLETED
25 YEARS SERVICE (As on 31-12-1974)

Sr.No.	*Name*	*Designation*
1.	Shri D. N. Mishra	Lab. Attendant
2.	Shri Jaichand Poddar	Lab. Attendant
3.	Shri V. D. Sutar	Watchman
4.	Shri Munshi Bharati	Mistry
5.	Shri R. K. Giri	Mistry
6.	Shri Shivram Bane	Mistry
7.	Shri Sukharam	Mistry
8.	Shri Anandi Sahai	Mistry
9.	Shri K. V. R. Nair	Mistry
10.	Shri A. C. Nair	Mistry
11.	Shri F. Gabriel	Sr. Fitter
12.	Shri V. P. Menon	Cataloguer Gr. A.
13.	Shri K. E. Mathew	Machine Operator
14.	Shri D. L. Bhilare	Staff Car Driver
15.	Shri S. K. Patil	Storekeeper
16.	Shri P. K. Maheshwari	Assistant
17.	Shri S. L. Vaidya	Assistant
18.	Shri T. Raghavan Nair	Jr. Lab. Asst.
19.	Shri G. V. Kulkarni	JTA-cum-Translator
20.	Dr. J. P. Varma	Scientist 'C'
21.	Shri Niranjan Singh	Scientist 'C'
22.	Dr. A. S. Gupta	Scientist 'C'
23.	Dr. V. S. Pansare	Scientist 'C'
24.	Dr. P. G. Sharma	Scientist 'C'
25.	Dr. P. N. Rangachari	Scientist 'C'
26.	Dr. S. C. Sethi	Scientist 'C'
27.	Dr. S. S. Subramanian	Scientist 'C'
28.	Dr. J. L. Bose	Scientist 'E'
29.	Dr. J. C. Sadana	Scientist 'E'
30.	Dr. K. K. Chakravarti	Scientist 'E'
31.	Dr. C. Siva Raman	Scientist 'E'
32.	Dr. S. L. Kapur	Scientist 'F'

SILVER JUBILEE CELEBRATIONS AT THE NATIONAL CHEMICAL LABORATORY

Prime Minister Shrimati Gandhi being received at the laboratory

Prime Minister addressing the gathering

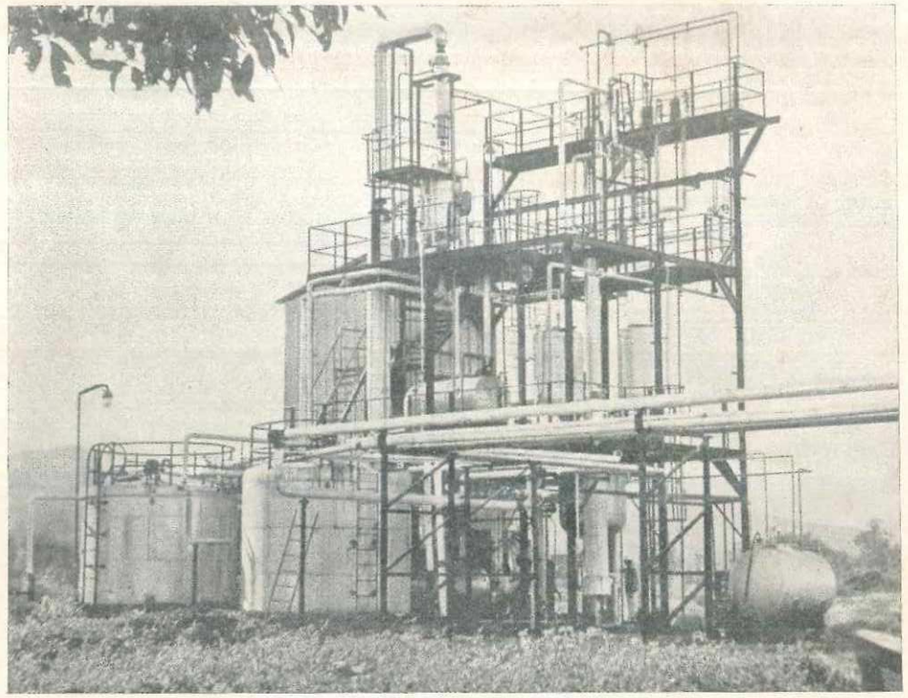
View of the gathering

Presentation of service awards

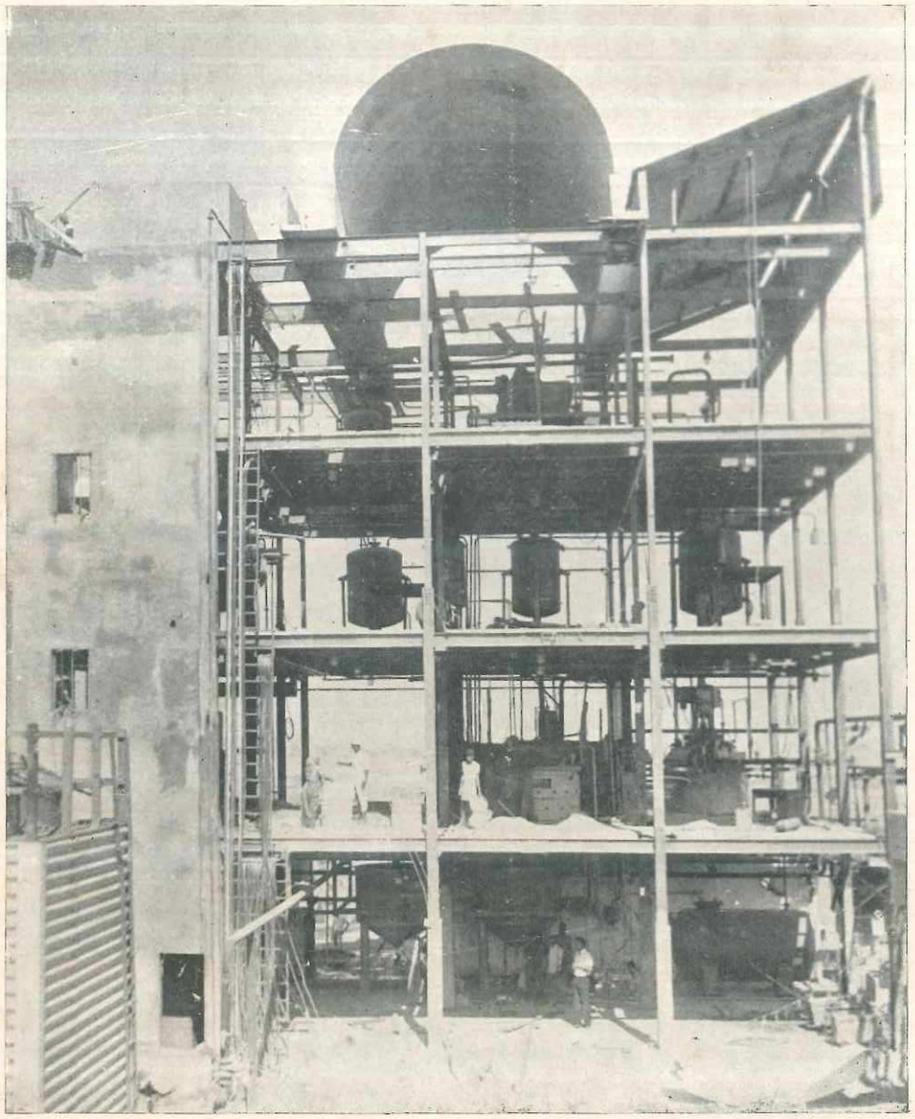
Prime Minister at the Acetanilide plant model

Prime Minister going round the laboratory

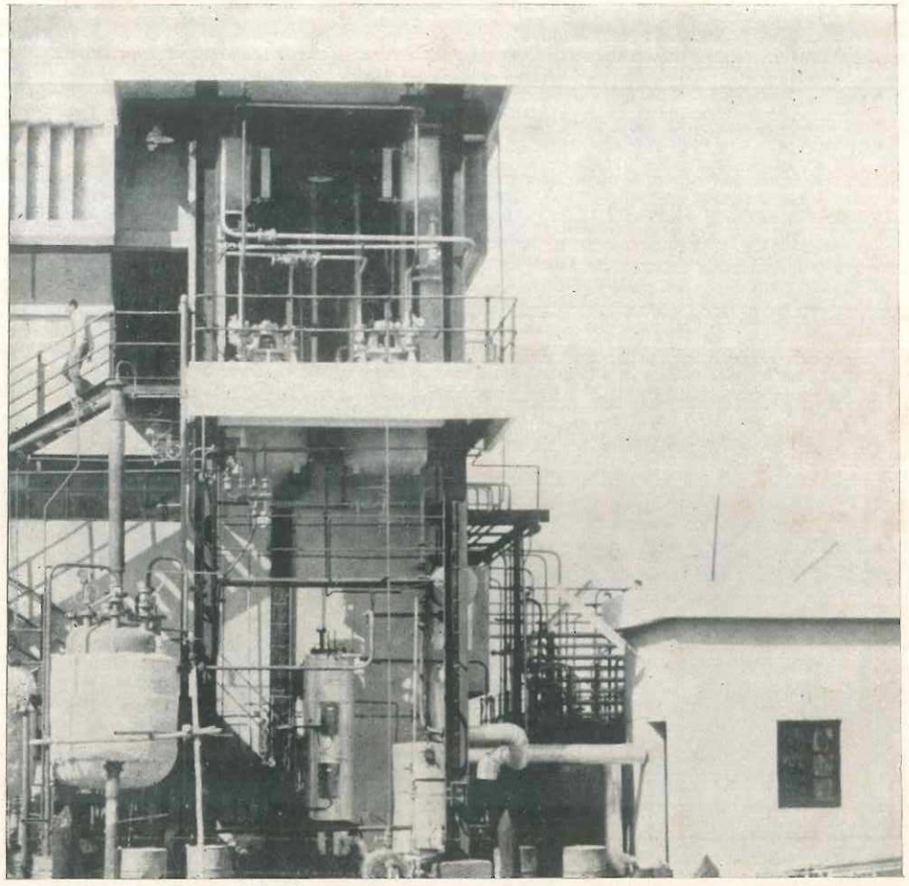
Visitors in pilot plant laboratory



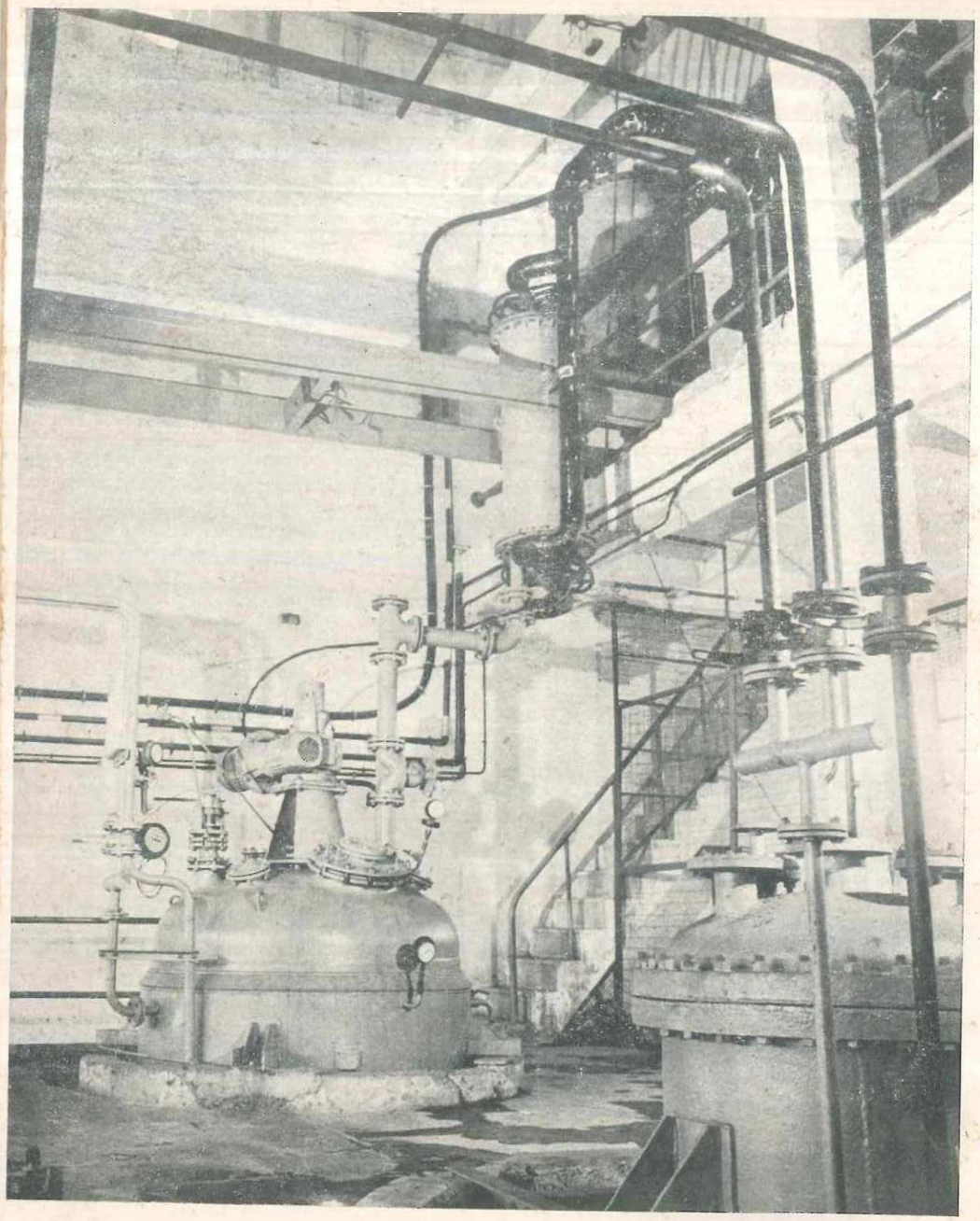
NONYL PHENOL PLANT AT THANA–GHODBUNDER ROAD
CAPACITY : 900 TONNES PER YEAR
ESTIMATED ANNUAL TURNOVER : RS. 1.25 CRORES
M/S. ANILINE DYESTUFFS AND PHARMACEUTICALS PVT. LTD., BOMBAY



PHENTHOATE PLANT AT THANA-BELAPUR ROAD
CAPACITY : 300 TONNES PER YEAR
ESTIMATED ANNUAL TURNOVER : RS. 2.2 CRORES
M/S. BHARAT PULVERISING MILLS LTD., BOMBAY



MONOETHYLANILINE PLANT AT BULSAR
CAPACITY : 125 TONNES PER YEAR
ESTIMATED ANNUAL TURNOVER : RS. 30 LAKHS
M/S ATUL PRODUCTS LTD., BULSAR



MONOCHLOROACETIC ACID PLANT AT KHOPOLI
CAPACITY : 1000 TONNES PER YEAR
ESTIMATED ANNUAL TURNOVER : RS. 1.3 CRORES
M/S. HICO PRODUCTS PVT. LTD., BOMBAY

RESEARCH AND DEVELOPMENT PROJECTS

1. PETROCHEMICALS AND BULK ORGANIC CHEMICALS

1.1 *Acrylic acid and acrylates from acrylonitrile* : (SP-63/70)

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

After successful completion of bench scale runs on acrylic acid, butyl and 2-ethylhexyl acrylates, pilot plant runs were carried out. Necessary engineering data needed for the commercial plant were collected. A complete process package for 2000 TPA acrylic acid, 2000 TPA butyl acrylate and 500 TPA 2-ethylhexyl acrylate was prepared and handed over to IPCL. Demonstration runs on these have also been completed.

2. PESTICIDES AND AGROCHEMICALS

2.1 *1-Naphthylacetic acid* : (SP-96/74)

1-Naphthylacetic acid (1-NAA) is used extensively as a rooting hormone specially for peach, pear and guava. It is used for thinning of blossom, thereby improving the quality and quantity of fruit crops. A 20 ppm solution of 1-NAA reduces the fruit drop. It induces flowering in pineapple, increases boll setting in cotton, inhibits flowering in sugarcane crop and improves the nitrogen content in potato crop.

A process for the preparation of 1-NAA has been developed using indigenous raw materials. After demonstrating the process to the sponsor, the project was concluded.

2.2 *Menazon* : (ATT-198/72)

Menazon, is a systemic insecticide and is very effective for control of aphids on tobacco, mustard and other similar plants. The present demand has been estimated to be 10 TPA. A process for preparation of menazon has been stanbardized and the product has been sent for field trials.

2.3 *Dichloropropionic acid (Dalapon)* : (ATT-200/72)

Dalapon (sodium salt of ∝, ∝-dichloropropionic acid) is widely used as a selective weedicide. It is mainly used for the control of grasses in sugar beet, sugar cane, corn, potato and similar crops.

The demand for 1975-76 of technical grade dalapon is estimated at 200 TPA valued at Rs. 40 lakhs of the formulated product.

A process for the preparation of dalapon has been optimized. Pilot plant trials will be carried out shortly.

2.4 *Endosulfan* : (ATT-207/73)

Endosulfan is an excellent broad spectrum contact insecticide with low toxicity to vertebrates. The consumption of endosulfan in 1975-76 is estimated at 1100 tonnes of technical material valued at Rs. 10 crores of formulated product. A two step process for the manufacture of endosulfan has been developed and pilot plant trials have been carried out.

Additional process and analytical data were collected and testing procedures standardized. through a project engineering firm turn-key offer has been made to industry for a 1800 TPA plant.

2.5 *Vitavax* : (ATT-208/73)

Vitavax, a modern fungicide, is exceptionally active and highly specific and selective against pathogens without causing injury to hosts and has practically no toxicity to mammals. Its requirement by 1975-76 is estimated at 5 TPA, valued at Rs. 5 lakhs of the formulated product. A process for the manufacture of vitavax starting from acetoacetanilide has been standardized.

2.6 *Ethrel* (*2-chloroethylphosphoric acid*) : (ATT-210/73)

This chemical, a plant growth regulator, is imported at present. Technology for the manufacture of ethrel is under development. The estimated requirement for cycocel, ethrel and 1-naphthylacetic acid together is 80 TPA by 1975-76.

A process for the manufacture of ethrel based on indigenous raw materials such as phosphorous trichloride and ethyleneoxide, is being standardized.

2.7 *Paraquat* : (ATT-231/74)

Paraquat is a weedicide used for cotton, sugarcane, tea and non-crop areas for removal of aquatic weeds. The demand for 1975-76 has been estimated to be 100 TPA, valued at Rs. 1 crore.

A detailed literature survey was completed. Preliminary work showed encouraging results. Work is being continued to elucidate the chemistry of the steps involved in the synthesis of paraquat. Further work is in progress towards the standardization of the process on a laboratory scale.

2.8 *Fenitrothion* : (ATT-232/74)

Fenitrothion has relatively low toxicity to mammals. Estimated demand for fenitrothion in 1975-76 is 600 TPA, valued at Rs. 4.2 crores as formulated material.

Optimum conditions for the conversion of 4-nitro-3-methylphenol to fenitrothion have been established on a laboratory scale. The product conforms to ISI specifications. Scale up work is in progress.

Preparation of $_{o,o}$-dimethylthiophosphorylchloride was standardized starting from phosphorus pentasulfide.

2.9 *Propanil* : (ATT-233/74)

Propanil is at present imported. The demand of this weedicide in 1975-76 is estimated to be 25 TPA, valued at Rs. 4.2 lakhs.

A laboratory scale process was developed for propanil starting from 3, 4-dichloroaniline which was prepared starting from *p*-chloronitrobenzene. Scaling up work is in progress.

2.10 *Phosalone* : (ATT-234/74)

Phosalone which is being presently imported is a stable non-volatile contact and injective acaricidal insecticide and is a promising substitute for DDT and other persistent chlorine containing insecticides. The estimated demand by 1975-76 is 250 TPA, valued at Rs. 87 lakhs.

The preparation of phosalone was standardized on a laboratory scale. Pilot plant work is in progress.

2.11 *Dimethoate* : (ATT-235/74)

This organophosphorus (OP) insecticide is widely used in India to control mites, aphids and other sucking plant pests. The requirement of dimethoate for 1975-76 is estimated at 800 TPA valued at about Rs. 1 crore.

The process for its preparation starting from chloroacetic acid, methanol, methylamine and $_{o,o}$-dimethyldithiophosphoric acid has been standardized and pilot plant runs will soon be undertaken.

2.12 *Insect hormones and pheromones* : (AB-105/72)

Control of the insect pests by use of compounds that interfere in their natural growth and reproduction is comparatively a new idea. Considerable effort is being expended in this direction in the industrially advanced countries.

Seventeen compounds of the above type and belonging to the geraniol series were prepared and sent for testing to Bhabha Atomic Research Centre, Bombay during the year. Bioassay report on seven of them was received. It showed that they exhibit good juvenile hormone activity when last instar nymphs of red cotton bug (*Dysderous koenigii*), were topically treated with a dose of 10 µg/nymph. Five of them were more active than farnesyl methyl ether. One of them was at least 10 times more active than the control. The synthesis of a compound starting from indene with a novel skeleton was completed and its activity is under investigation.

2.13 *Plant growth regulators* : (AB-115/73)

Although separate figures of demand of various plant growth regulants are not available, it is estimated that the total demand of such regulants is about 80 TPA. Technology for the following compounds was developed:

2.13.1 *Maleic hydrazide*

A process for the manufacture of maleic hydrazide was standardized on 1 kg / batch scale. This compound is used for the prevention of sprouting (during storage) in onions, potatoes and other root crops. It is also used as a suckericide in tobacco cultivation. Another major use is for supressing the growth of trees, ornamental plants and lawns.

2.13.2 *2-Chloroethyltrimethylammonium chloride* (chlorocholine chloride/CCC/cycocel)

This is extensively used to increase flowering, boll frequency and yield in the cotton crop. CCC also prevents lodging and increases tillering in wheat. It increases drought, cold and salt resistance in soyabeans, cabbage and tomatoes. It also increases fruit set and fruit size in grapes and tomatoes.

A process for the manufacture of CCC has been developed on a pilot plant scale.

2.14 *Pyrethrins* : (AB-123/73)

Pyrethrin is a natural insecticide extracted from *Pyrethrins diasies*, grown mainly in East African countries, Kenya, Congo, Tanzania and also Equador and New Guinea.

The action of pyrethrin is short-lived and its use therefore presents no ecological hazards due to toxic residues. It is also nearly harmless for many domestic animals and wild life.

Synthetic transformation on naturally occurring Δ^3-carene through a 6-step sequence to yield trans-chrysanthemic acid-the key acid component of pyrethrins (which are esters) was successfully carried out.

An alternative feasible synthetic route *via* 2,5-dimethylhexa-2,4-diene is being studied.

3. DRUGS, PHARMACEUTICALS AND FINE CHEMICALS

3.1 *Synthesis of potential pharmacologically active substances (Furoseamide)* : (SP-77/71)

The development work on the preparation of furoseamide a diuretic, has been taken up on a sponsored basis. The drug is being imported presently.

3.2 *Papaverine hydrochloride* : (SP-90/73)

In continuation of earlier work, a process for the preparation of this drug has been established on a laboratory scale. The product compares with the imported drug and conforms to BP specifications. The project is now concluded.

3.3 *Cephalexin and 7-aminodeacetoxycephalosporanic acid (7-ADCA) / carbenicillin disodium* : (SP-91/73)

After a few initial experiments for making cephalexin involving ring-expansion-rearrangement sequence on penicillin V, the work was stopped. At the request of the sponsor, a process, for the synthesis of carbenicillin disodium is under development.

3.4 1, 4-*Benzodiazepines (diazepam and chlordiazepoxide)* : (ATT-218/73)

The benzodiazepines such as diazepam and chlordiazepoxide are widely used as anti-anxiety drugs. These are mainly imported.

The main intermediates required for these drugs are 2-amino-5-chlorobenzophenone and 2-methylamino-5-chlorobenzophenone. The process know-how for these two intermediates was standardized earlier and also released to industry.

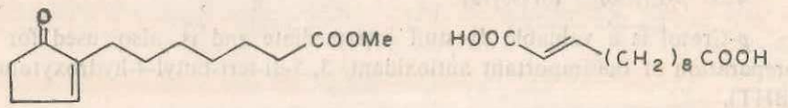
Starting from 2-methylamino-5-chlorobenzophenone, a two step process for the production of diazepam was standardized. The process has been released to industry.

Work on the process development of chlordiazepoxide is being standardized.

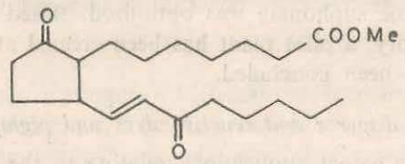
3.5 *Prostaglandins* : (AB-106/72)

Prostaglandins exhibit diverse biological properties, the chief among them being the smooth muscle-contracting activity, which has enabled their use as abortive agents for post-conceptive control in family planning.

A new simple synthesis of the Bagli prostanoid synthon-I described



(I) (II)



(III)

earlier involved intramolecular cyclization of traumatic acid II (as diester) in the final key step. A very convenient three step route to this important olefinic diacid (overall yield of 50% from 10-undecenoic acid-easily accessible from pyrolysis of castor oil) was worked out which supersedes all the existing methods and is specially suitable for large scale preparation of the crucial intermediate II. The synthon-I has been elaborated to 11-deoxy-15-dehydro-PGE_1 III by a precedented route.

Synthesis of the Corey-lactone-aldehyde by the oxidation cleavage of a cyclohexane derivative and aldol condensation/cyclisation of the resulting dialdehyde were studied. This procedure gave the required lactone-aldehyde but along with isomers. The work on this route is wound up and an alternative route to synthesize prostanoids *via* cis-cis muconic acid was taken up. The latter is made efficiently from a readily available starting material in good yield and work on further transformation of this compound is in progress

4. ORGANIC INTERMEDIATES, DYES AND INDUSTRIAL CHEMICALS

4.1 *Cationic dyes for acrylic fibres* : (SP-55/70)

Sponsor is making arrangements to implement the commercial production of blue, orange and pink cationic dyes, based on the processes standardized in the scheme.

Several new cationoid dyes were also prepared and samples sent to the sponsor for evaluation.

Under the project the chemical structures of a few commercial cationic dyes were also determined. The project is now concluded.

4.2 β-*Naphthol* : (SP-92/73)

A technically feasible process for the preparation of—β naphthol was standardized. The project is now concluded.

4.3 *p-Cresol* : (SP-93/73)

p-Cresol is a valuable dyestuff intermediate and is also used for the preparation of the important antioxidant, 3, 5-di-tert-butyl-4-hydroxytoluene (BHT).

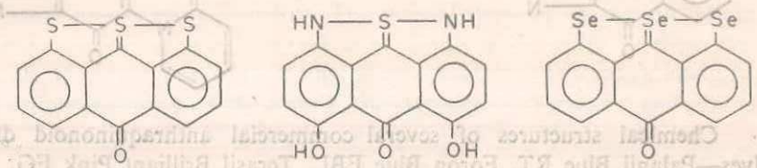
A bench scale (2 kg/batch) process for the preparation of *p*-cresol from sodium *p*-toluene suphonate was optimized. Based on the designs supplied by the laboratory, a pilot plant has been erected at the sponsor's premises. The work has been concluded.

4.4 *New disperse and reactive dyes and pigments* : (ATT-157/70)

Two Indian patent applications relating to the production and application of reactive disperse dyes containing sulphonazido groups have been

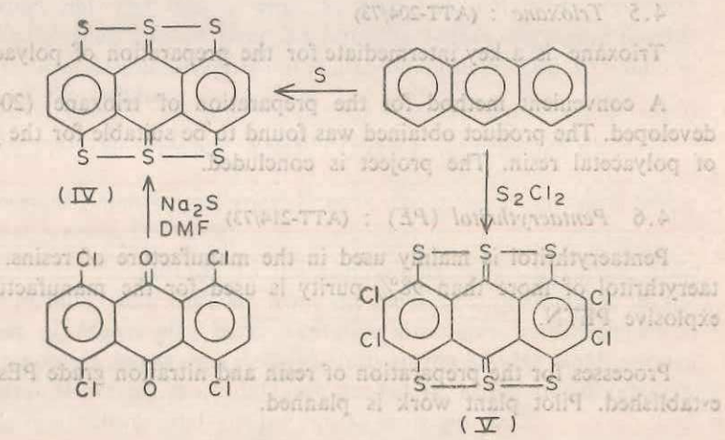
accepted. The chemistry of the reaction of these dyes with fibres is being studied.

Novel sulphur, nitrogen and selenium heterocyclic quinonoid chromophoric systems were derived from anthraquinone intermediates. These dye green (I), violet (II) and pink (III) shades on polyester fibre. However, they were fugitive to light.



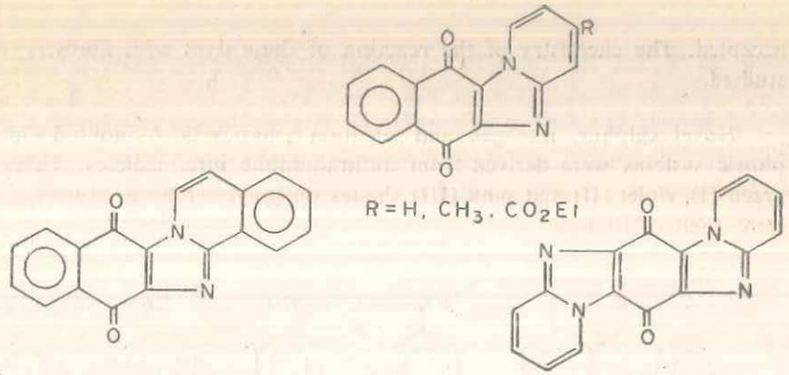
(I) (II) (III)

The olive green vat dyes obtained by thionation of anthracene with sulphur and sulphur monochloride have been shown to be (IV) and (V) respectively. Compound (IV) was also derived from 1,4,5,8-tetrachloroanthraquinone by thionation.



The structures of the above compound were confirmed by a study of their spectral properties and by a study of their reductive methylation products.

A number of aza analogues of phthaloylpyrrocoline were synthesized and their structures confirmed from analytical and spectral data. The dyeing properties of these compounds were studied. Some examples of azapyrrocolines are the following :



Chemical structures of several commercial anthraquinonoid disperse dyes—Palanil Blue RT, Foron Blue EBL, Terasil Brilliant Pink FG, Foron Brilliant Red E. RLN, Foron Turquoise SBL and Cibacet Violet RB, were determined from their IR, NMR and mass spectral studies. The structures were confirmed by direct comparison with authentic synthetic samples.

Sevaral new disperse dyes were prepared from *N*-phenylcyclohexylamine, bye-product from HOC's aniline plant. Some of these dyes possess excellent fastness properties.

4.5 *Trioxane* : (ATT-204/73)

Trioxane is a key intermediate for the preparation of polyacetal resins.

A convenient method for the preparation of trioxane (200g/hr) was developed. The product obtained was found to be suitable for the preparation of polyacetal resin. The project is concluded.

4.6 *Pentaerythritol (PE)* : (ATT-214/73)

Pentaerythritol is mainly used in the manufacture of resins. Monopentaerythritol of more than 98% purity is used for the manufacture of the explosive PETN.

Processes for the preparation of resin and nitration grade PEs have been established. Pilot plant work is planned.

4.7 4-*Nitro*-3-*methylphenol* : (ATT-225/74)

4-Nitro-3-methylphenol, the key intermediate for the manufacture of fenitrothion is at present imported. It was prepared in good yield starting from *m*-cresol. Further work is in progress.

4.8 *D*(-)-∝-*Aminophenylacetic acid* : (ATT-237/74)

This intermediate, required in the manufacture of ampicillin, is presently imported. There is a world shortage of the intermediate and hence its indigenous production is urgent.

Laboratory scale experiments were carried out for the preparation of optically active D(-)-∝-aminophenylacetic acid. A method for the racemisation of L (+)-∝-aminophenylacetic acid has been established. Experiments were carried out for the preparation of acid chloride hydrochloride of D(−)-∝-aminophenylacetic acid. Scale up work is in progress.

4.9 *p-Aminophenol* : (ATT-238/74)

p-Aminophenol is an important intermediate in the pharmaceutical, photographic and dyestuff industry. The annual demand in the country is estimated to be around 500 TPA and most of this requirement is being met by imports. However it is reported that some quantity is now being made by the conventional route as well as by a one step catalytic process from nitro benezne. The indigenous product is reported to have a short shelf life.

The method selected for the present investigation is the catalytic hydrogenation of nitrobenzene to *p*-aminophenol. Several runs were carried out on a bench scale (½ kg/batch) and a yield of 65% *p*-aminophenol and 15% (bye-product) aniline has been obtained. The nitrobenzene conversion was around 96%. The recycling and recovery of catalyst are under study. The development of a more efficient catalyst in order to cut down the reaction time is also under investigation.

The product obtained was a white to pale buff coloured crystalline powder and had a shelf life of over six months before acquiring darker colour. A suitable stabilizer composition is also being developed to enhance the shelf life of the product.

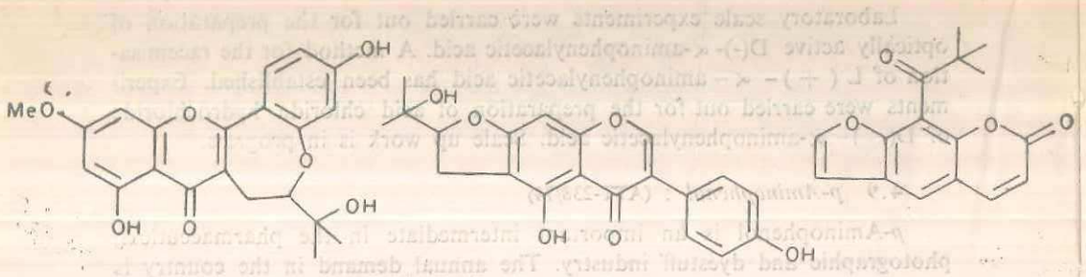
5. UTILIZATION OF PLANT AND FOREST RESOURCES

5.1 *Flavonoids, tannins, stilbenes, lignans and quinones in some Indian forest trees* : (SP-76/71)

Morus species: In addition to the compounds reported earlier, four new complex phenols were isolated from the slow-moving fractions of the acetone extract of *Morus alba* bark. Tentative structures were assigned to two of the compounds, based on a detailed study of the 220 Hz NMR spectra and 13_C spectra. However, more data are needed to arrive unambiguously at the complete structures and further work is in progress.

Artocarpus integer heartwood: From this Indonesian species, ten known flavonoids and two new flavones (cyclo-integrin and integrin) were earlier reported.

A minor constituent, oxyisocyclointegrin, was isolated and characterized as (I) .The three new flavones are found to be of special biogenetic interest because they are the first representatives of flavones carrying an alkyl or alkenyl substituent in the 3-position in the absence of such substitution in the A-ring derived from phloroglucinol.



I II III

Erythrina variegata : In addition to the three new isoflavones with prenyl groups reported earlier, a new isoflavone was isolated and its structure (II) determined.

Chloroxylon swietenia bark : A note on the structure of a new coumarin, swietenone (III) containing a *tert*-butyl ketone group, has appeared in *Tetrahedron Letters* (1975, 867). Other constituents, including a new coumarin and a new lignan, are under investigation.

Tannins : With the overall object of obtaining basic data on some of the important tannins of Indian plants, several extracts were prepared and sent to the Central Leather Research Institute, Madras, for screening the tanning potential in terms of the micro-shrinkage temperature.

Routine tannin estimation is being carried out by a simplified procedure using polycaprolactam powder.

The chemistry and utilization of *Terminalia tomentosa* bark and *Anogeissus latifolia* bark tannins are being studied. In this connection attempts are being made to develop new methods for determining the molecular weight of a condensed or hydrolysable tannin.

Groundnut shell lignin : Nitrobenzene oxidation of GNS powder gave 1% vanillin and 1.5% vanillic acid. These results provided a preliminary indication that a substantial proportion of the guaiacol residue in GNS lignin is present as an ether.

The structures of the "lignins" isolated by different methods (e.g. methanol lignin and dioxane lignin) are under investigation.

5.2 *Production of D-xylose and xylit from corn cobs* : (SP-81/72)

A process was developed under the sponsorship of industry for the production of D-xylose and xylit from corn cobs which is an agricultural waste. A patent covering the process has been filed.

The process developed earlier for the production of D-xylose and xylit from coconut shells on sponsored basis was demonstrated to the sponsor.

5.3 *Production of gum from coarse and fine fibre wastes of corn starch industry* : (SP-95/74)

Corn fibre is a waste product obtained in the manufacture of corn starch by the wet-milling process. About 3000 tonnes of this waste is available in India annually. It has no other use except as a cattle feed mix.

Corn fibre waste originates from the pericarp of the grain and contains hemicelluloses and cellulose. The hemicellulosic part, in particular, the pentosan fraction, is utilized for making corn fibre gum.

A process was developed to obtain a gum from this waste product which utilizes the pentosans as well as the easily hydrolysable glucans. The gum has good adhesive property for paper to glass, paper to metal and paper to wood. The efficiency of conversion of pentosans and hydrolysable glucans to gum in this process is about 90%. The work was carried out under sponsorship of industry. The project is now concluded.

5.4 *Testing of rayon pulp from Bastar hardwoods* (SP-97/74)

Pilot plant trials were undertaken on a suitable mixture of hardwoods from Bastar district of Madhya Pradesh. The pulp produced was tested at the laboratory and also by the sponsor in their rayon mill. The results of these trials were found by and large satisfactory.

5.5 *Modification and upgrading of gum ghatti (Anogeissus latifolia)* : (ATT-107·1/74)

A process was developed earlier for the preparation of a substitute for gum arabic by chemical modification of ghatti gum. Although the modified gum had excellent adhesive properties, it was not acceptable to industry due to its dark colour and specks. The modified gum is now processed further to obtain a light-coloured product with retention of the earlier adhesive properties.

Third-grade ghatti gum which is dark coloured and contains considerable quantities of embedded bark and other extraneous matter has no export potential. A process is developed to upgrade this gum to a light coloured product cantaining no extraneous matter.

Both the processes will be shortly offered to industry.

5.6 *Modified cellulose products* : (ATT-193,194/72)

Crosslinhing of cotton textiles with trioxane was not successful owing to the great instability of the crosslinking reagent under acidic conditions.

Cotton fabrics were aminated successfully with aryl isocyanate

generated *in situ* from aryl urethanes. Their dyeing properties were found good with some of the acidic dyes but not with reactive dyes.

Bleached jute fabric was successfully crosslinked with formaldehyde under certain specific conditions. The dry and wet crease recovery of some of these samples was tested at Indian Jute Industries Research Association (IJIRA). One particular crosslinked sample was found to have excellent crease recovery values, dry 261 and wet 285 (w+f). There appears to be some loss in fibre strength. Work is in progress to modify the present process so as to retain the fibre strength of the treated jute fabrics.

5.7 *Dialdehyde starch* : (ATT-219/73)

Dialdehyde starch is used as a tanning agent in leather industry and in the manufacture of soft garment leather. It is used in textile and tissue paper industry and also as a cross linking agent in polymer, adhesive and coating compositions.

Work on the project has been concluded after standardization of the process on 1 kg batches. Samples were sent to various industries for consumers acceptability trials and results are awaited.

5.8 *Thin boiling Tamarind Kernel Powder (TKP)* : (ATT-220/73)

Thin boiling TKP (TBT) is used mainly in jute, cotton and paper sizing.

A sample was sent to Indian Jute Industries' Research Association for trials. Their test experiments showed that there was improvement in reduced warp break and loom caddies in warp beam sized with 50% TBT. Other interested parties to whom samples were sent wanted cream colour of TBT to be made white, so work of decolourization of TBT is under prograss.

5.9 *Isolation of useful compounds from sugarcane press mud* : (ATT-229/74)

The sugarcane contains some wax and lipids (about 1% on weight basis). India is having a very big sugarcane industry. There are about 220 sugar factories spread all over the country, each crushing on an average 1500 tons of sugarcane per day and for an average season of 150 days. Thus a huge amount (more than 2000 tonnes of press mud per day, per season per average sugar factory) of press mud is available. At present it is only used as a cheap manure.

Tde press mud can be extracted to give hard and soft waxes. The yields vary from 6 to 12% (on the weight of dry mud). The soft wax can be further fractionated to afford fatty acids, fatty alcohols and sterol mixtures. Hard wax can substitute carnauba wax to a great extent. In addition, the extracted press mud can still be used as a manure and soil conditioner.

Laboratory scale work on the extraction of press mud and separation

of soft wax into its constitutents was accomplished. Based on these results, a suitable pilot plant is being assembled.

5.10 *Dissolving pulp* : (AB-114/73)

Dissolving pulp of various grades is in growing demand; at the same time there is world wide shortage of the raw materials such as Bamboo, Eucalyptus etc. Several cellulosic materials including hardwoods available in different parts of the country, and the suitable mixtures of hardwoods are being tested in this project for assessing their suitability for making different types of dissolving grade pulps. Part of the work reported below has been undertaken on sponsored basis.

Shorea robusta (Sal) is found abundantly in the forests of Central and North India. This wood was investigated by various pulping techniques such as calcium and sodium acid sulfite process. Pulps produced from this species had abnormally high resin content (alcohol-benzene solubles). Reduction of resin content by using aged chips, surface active agent and following oxidative bleaching sequence is under investigation.

5.11 *Study of the chemistry and pharmacology of extractives from marine flora and fauna* : (AB-132/74)

Six samples of algae were received from the National Institute of Oceanography, Goa. Three of these mentioned below have been investigated so far. Work on these will be continued on receiving further supplies.

Padina tetrastomatic yielded a complex acidic fraction and a neutral fraction containing at least two major components.

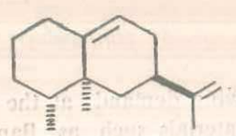
Ulva lactis yielded a neutral fraction consisting of several components. Methyl esters of the acidic fraction were prepared for GLC studies.

Sargassum tenerrerium yielded a complex mixture of basic, neutral and acidic components. Further studies on the extracts are in progress.

5.12 *Chemical examination of Essential oils, transformation products and synthesis of terpenoids* : (B-7.4/60)

(a) *Vetiver oil (V. zizanoides)*

Dextro-rotatory North Indian vetiver oil (Moosanagar) was examined for isolation and characterization of its constituents. Several known constituents were isolated and characterised. The structures of two new terpenoids hydrocarbon (I) and alcohol C (II) were assigned. The structure of isokhusinol (III) earlier isolated from South Indian vetiver oil was revised. Structure of alcohol E (IV) and zizanone (V) were established.



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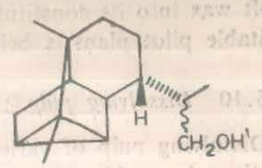

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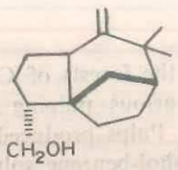

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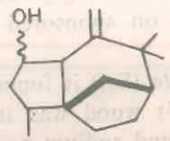

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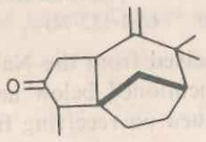

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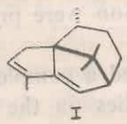
(b) *Nagarmotha oil* (*C. Scariosius*)

A new sesquiterpene hydrocarbon (I) was isolated and characterized.



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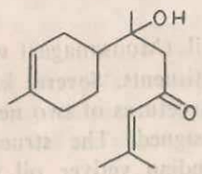
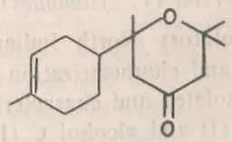
(c) *Synthesis of ∝–bisabolol-3-one and deodarone*

∝-Bisabol-3-one (1) was isolated from *chrysanthemum flosculosune* L and the structure was established as (I) on the basis of IR, NMR and mass



(I)



(II)

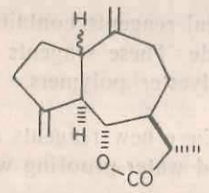
spectral data. The isolation and characterization of deodarone (II), a sesquiterpene keto-ether, from the essential oil of *Cedrus deodora sond* has also been reported. The total synthesis of both ∝–bisabolol-3-one (I) and deodarone (II) was carried out to confirm the assigned structures.

5.13 *Glycosides* : (B-7.16/71)

Formation of acetochloro sugars was detected in several stannic chloride catalysed glycosidation reactions. This led to investigations on the possible use of acetochloro sugars for glycosidation under acidic conditions and led to the development of a new elegant method of synthesis of glycosides. Several aryl, aralkyl and alkyl glycosides and thioglycosides including mannosides and maltosides were successfully synthesized by the new method.

5.14 *Transformation products of costunolide and dehydrocostus lactone* : (B-8.15/66 and B-8.19/65)

Partial hydrogenation of dihydrodehydrocostuslactone (I) (EtOH/Pt) gave in addition to lactone (II) two other double bond isomers to which structures (III) and (IV) were assigned on the basis of spectral data and chemical reactions.



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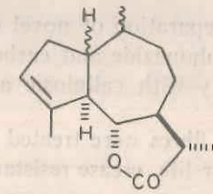

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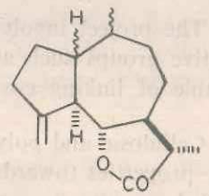

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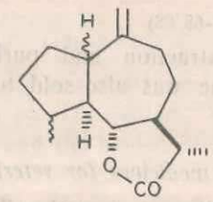

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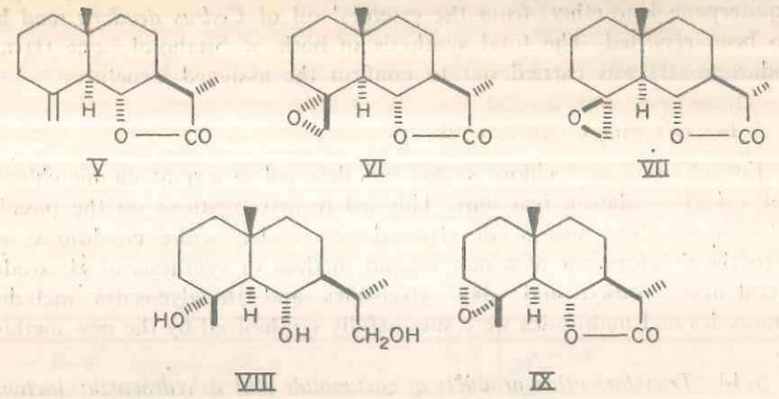
Epoxidation of β-cyclodihydrocostunolide (V) furnished two stereo-isomeric epoxides (VI) and (VII). LAH reduction of (VI) furnished a triol (VIII) which was found identical with tne triol obtained by LAH reduction of epoxy ∝-cyclodihydrocostunolide of known stereostructure (IX). This identity establishes the stereochemistry of epoxides (VI) and (VII).



V VI VII

VIII IX

5.15 *Synthesis and reaction of epoxides* : (B-8.57/73)

The epoxidation of a number of alkylidene and arylidene malonates were studied. They were transformed in satisfactory yields to ∝-ketoacids and ∝–ketoesters.

5.16 *Reagents for improving the wear life of cotton fibres* : (B-8.58/72)

The project involves preparation of novel chemical reagents containing reactive groups such as sulphonazide and carboxyazide. These reagents are capable of linking covalently with cellulosic and polyester polymers.

Cellulosic and polyester fibres were treated with these new reagents and their properties towards wear life, crease resistance and water-proofing were studied.

6. CHEMISTRY OF BIOLOGICALLY ACTIVE COMPOUNDS

6.1 *Colchicine* : (ATT-68/68)

The process for the extraction and purification of colchicine was standardized. Pure colchicine was also sold to various research institutes and universities.

6.2 *Chemistry of folk medicines for veterinary use* : (ATT-192/72)

'Mange' is a parasitic disease of cattle affecting the skin severely and often causing the death of the affected animal. The essential oil of *Cedrus deodara* although known to cure the disease has some adverse side-effects.

Field trials were undertaken on cattle affected with 'mange', in collaboration with Bharatiya Agro Industries Foundation at Uruli Kanchan near Poona. Using a hydrocarbon fraction of the essential oil, complete cure was obtained in all cases and no adverse side-effects were observed.

The oxygenated fraction, which contains the essential oil principles of the original oil in a more concentrated form, can still be used as a perfume for inexpensive soaps. Presently the whole essential oil is used as a perfumery compound.

6.3 *Chemistry of plant hormones* : (AB-104/72)

The work was undertaken with a view to isolate and identify naturally occuring new plant hormones from pollen extracts.

Various fractions obtained by chromatography of Sorghum and Pumpkin pollen extracts were assayed to test their physiological activity. Two hydrocarbons from Sorghum pollen were found to possess insect attractant activity. Similarly, an acid portion from Pumpkin pollens was found to exhibit root growth inhibitory activity during germination. Identification of the above active principles is under way.

6.4 *Biologically active compounds of plant origin* : (AB-125/73)

Parthenium hysterophoras Linn or popularly known as 'Gajar gavat' is a notorious weed spreading all over the country. Since the plant exhibits insect repellant and allergenic properties, work was initiated to isolate the active principles.

From the petroleum ether extract of the shoot portion various fractions were obtained by column chromatography. Of them a known crystalline compound called parthenin and a polar fraction were found responsible for contact dermatitis.

Preliminary screening of some of the active principles showed insect antifeeding activity. Expermiments are being conducted to confirm these results and to identify the insects which are so affected.

7. STUDIES IN ORGANIC SYNTHESIS

7.1 *2-Ethylhexanoic acid* : (AB-126/73)

This acid, is used extensively in industry in the form of its salts in PVC stabilizer compositions and in paints as driers. The demand for the acid is estimated at about 1000 TPA and the landed cost is around Rs. 20/- kg.

Earlier work had indicated that the two stage conversion of 2-ethylhexanol to the required product is to be preferred over the single stage conversion. Attention was therefore concentrated on the former, and the activities of a member catalyst preparations for the conversion of the alcohol to the aldehyde was ascertained. Conversions of 60 to 75 percent were obtained. Change of catalyst activity with time was studied and procedures for reactivation of catalysts were worked out. The aldehyde was converted in very high yields to the acid.

Several liquid soaps of the acid were prepared and sent for testing for suitability as PVC stabilizers. A new reactor for the determination of optimum values of process variables is under construction.

7.2 *Synthesis of oxytocin by solid phase method* : (AB-135/74)

Solid phase technology for the synthesis of peptide hormone oxytocin was established. Oxytocin which is known as unitocin and pitosin in market is imported in India costing about Rs. 5 lakhs in foreign exchange. It is used to induce labour during delivery cases and also as an abortifaciant. A method using protected *p*-nitrophenyl esters of amino acids on styrene DVB polymer was standardized yielding 60% protected nonapeptide amide. Further experiments to improve yields by using different solid supports are in progress.

7.3 *Synthesis of Biologically active and inhibitory analogues of peptide hormones* : (AB-136/74)

Peptide hormones secreted by the hypothalamus play a specific role in human system. Recently it has been shown that small peptide amides present in the hypothalamus are responsible for the release of these hormones. Few peptide amide sequences were prepared in order to study the mechanism of action of gonadotropin releasing factors. The work on biological assays of such compounds would be carried out at the Institute for Research in Reproduction

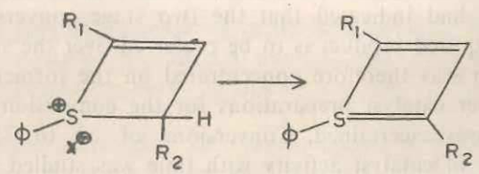
7.4 *Synthesis of* 1, 2, 4-*Benzotriazapinones as potential antiviral and antipsychosedative drugs* : (AB-137/74)

A series of compounds related to 1,2,4-benzotriazapinone were prepared Their pharmacological evaluation as potential antiviral and psychosedative drugs is under study.

7.5 *Studies in Heterocyclic chemistry* : (B-8·7/65)

7.5.1 *Synthesis of compounds with potential biological activity*

2,4-Disubstituted-1-S-phenyl-1-thionium-cyclobut-2-enes (I) which are the intermediates in the cyclodehydration reactions of β-phenylmercaptoethyl aryl/alkyl/cycloalkyl ketones were reacted with sodium hydride to yield 2, 4-disubstituted-S-phenyl-1-thioniocyclobutadines (II)—a new class of organic compounds. Some of the properties of (I) and (II) were investigated.



(I) (II)

7.5.2 *Nitrogen beterocyclics*

The general method developed earlier for the synthesis of 2-methyl-4-phenyl-1N-(3′-methoxy) phenyl azetidine was further modified and used for the synthesis of benzoquinolines and 1,8-naphthyridine ring systems.

Cyclodehydration methods developed earlier in the synthesis of acridines and phenanthridines, were applied for the synthesis of more complex acridines and phenanthridines.

7.6 *Steroid synthesis* : (B-8.59/74)

Synthesis of a key trans-olefin derivative was achieved by an efficient synthetic sequence. Further work on this material i.e. C-alkylation of cyclopentanedione/cyclohexanedione and cyclisation are in progress. For this, the corresponding m-methoxy derivatives of the trans olefin (both for natural and sulphur analogue) are being synthesized.

7.7 *Studies in alkaloids* : (B-8.60/74)

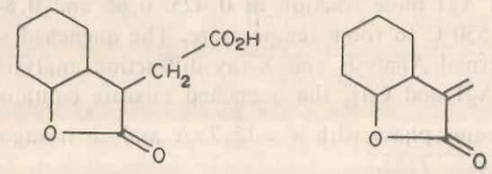
Synthesis of Dendrofin : Model compounds were made and the key step involving an internal Diels-Alder addition is being studied.

7.8 *Synthesis of* ∝-*methylenelactones* : (B-8.61/74)

Many recent publications have described a variety of routes for the synthesis of ∝-methylene-γ-lactones since this structural unit appears to play an important role in the interesting biological activity exhibited by a number of natural products.

A convenient route was developed for the synthesis of ∝-methylene-γ and δ-lactones in which the key reaction was oxidative decarboxylation with lead tetraacetate.

Different routes were explored for preparing in satisfactory yields the lactone acid (I), a potential intermediate for the synthesis of the ∝-methylene lactone (II).



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8. PHYSICO-CHEMICAL PROPERTIES OF MATERIALS

8.1 *Thermodynamic excess properties of binary liquid mixtures* : (B-2.13/70)

Excess free energies of mixing G^E for the systems ethanol + n-butyl-

amine and l-propanol + n-butylene were determined at 40° throughout the concentration range in a re-circulating still. These results along with the results of the earlier studies on the heats of mixing, H^E at 25° and 40° were used to determine the thermodynamic excess functions S^E and C_P^E. The strongly exothermic heats of mixing with positive value of C_P^E suggested complex formation between butylamine and (C_1-C_4)-n-alcohols. The symmetry of plots of G^E H^E S^E and V^E *vs* mole fraction of n-butylamine for binary mixtures of n-butylamine with (C_1-C_4)-n-alcohols, suggested the formation of 1:1 complex through hydrogen bonding between the amine and the alcohols. The value of heats of mixing at infinite dilution were used in a thermochemical cycle to determine the strength of the hydrogen bond between n-butylamine and (C_1-C_4)-n-alcohols. It was found that the increase in the chain length of the n-alcohols from C_1 to C_4 did not have significant effect on the energy of the hydrogen bond between n-butylamine and the n-alcohols. The energy of the hydrogen bonding between n-butylamine and methanol was 37.5± 1 KJ per mole. The energy of the hydrogen-bonding between n-butylamine and (C_2-C_4)-n-alcohols was 35.5±1 KJ per mo'e.

The apparatus for determining virial coefficients of vapours was calibrated by making use of the already known value of the second virial coefficients of cyclohexane and benzene.

A static still for studying vapour-liquid equilibrium at constant temperature was built and tested by use of benezene-cyclohexane mixture.

8.2 *Thermodynamic properties of binary molten salt mixtures* : (B-2.14/72)

Earlier studies on the determination of activities of AgI and CdI_2 in the binary molten salt mixture AgI+CdI_2 indicated the presence of complex compound Ag_2CdI_4 in the AgI mole fraction range of 0.6—0.7. In order to confirm the presence of the complex species Ag_2CdI_4, molten mixture of AgI+CdI_2 with AgI mole fraction of 0.425, 0.66 and 0.847 were quickly quenched from 550°C to room temperature. The quenched solid samples on Differential Thermal Analysis and X-ray diffraction analysis confirmed that in addition to AgI and CdI_2 the quenched mixture contained Ag_2CdI_4 in two phases: a cubic phase with a°=12.7 Å and a hexagonal phase with a° = 4.49 and c° = 7.35.

8.3 *Thermodynamic properties of solutions—studies in adiabatic compressibility of macromolecules* : (B-2.16/65)

During this period the adiabatic compressibility for the 100% neutralized sodium and hydrochloride salts of three copolymers of acrylic acid and N-dimethylaminoethyl methacrylate namely AA-DAM 58, AA-DAM 43 and AA-DAM 33 was studied. Similar to the three unneutralized amphoteric

polyelectrolytes, the ϕK_2 and ϕV_2's for the corresponding sodium and hydrochloride salts were found to be concentration independent. Since in amphoteric polyelectrolytes, both anionic and cationic groups were present, fully neutralized sodium salts and hydrochloride salts of these polylectrolytes were expected to show a decrease in $\phi K_{2i}°$ and $\phi V_{2i}°$ values due to maximum electrostriction. In fact, in case of AA-DAM 58 with excess amino groups in the chain (58%), this expectation proved to be true. The experimentally obtained values were found to be-9.6X10^{-4} cc/bar/mole and 159.6 cc/mole, and -3.3×10^{-4} cc/bar/mole and 164.4 cc/mole for sodium and hydrochloride salts respectively which showed a decrease of 7.1×10^{-4} cc/bar/mole and 4.9 cc/mole for the sodium salt and 0.8×10^{-4} cc/bar/mole and 0.1 cc/mole for the hydrochloride salt of the amphoteric copolymer. Contrary to this decrease, the hydrochloride salt of AA-DAM 43 showed an increase of 6.2×10^{-4} cc/bar/mole and 2.2 cc/mole respectively, while in case of AA-DAM 33, both the hydrochloride salt (56.2×10^{-4} cc/bar/mole and 24.7 cc/mole increase) and the sodium salt (6.2×10^{-4} cc/bar/mole and 6.2 cc/mole increase) showed an increase. This increase of $\phi K_{2i}°$ and $\phi V_{2i}°$'s for hydrochloride salts over the unneutralized amphoteric copolymer was ascribed to suppression of dissociation of carboxyl groups by HCl acid (common ion effect) added for neutralization. However, in all the three amphoteric copolymers, when neutralized with NaOH solution of HCl acid, the viscosity increased over that of the unneutralized copolymers.

A copolymer of acrylic acid and maleic acid, a poly (tribasic acid) was synthesized and its adiabatic compressibility is being studied.

With a second ultrasonic interferometer the adiabatic compressibility of poly (vinylpyrrolidone) in non-aqueous medium is being studied.

8.4 *Diffusion of iron in silver* : (B-2.20/74)

An investigation on the diffusion of iron-59 in polycrystalline silver was carried out at nine different temperatures in the temperature region 789-928° to resolve the existing contradictory results on the impurity diffusion of iron in silver. A plot of D *vs* 1/T showed that the experimental values at lower temperature 804° and 789° deviate from the straight line plot due to significant contribution from the grain boundary diffusion. Diffusion measurements with single crystals of silver are in progress.

8.5 *Surface viscosity measurements of n-long chain organic compounds* : (B-2.21/74)

Surface viscosity measurements were undertaken for the monomolecular film C_{16}-OC_3H_6OH at various shear rates and film pressures at 25°. The transition obtained by π–A isotherms agreed well with that obtained by μ–π curves. Since the film showed non-Newtonian character the viscosity was plotted with different shear rates to obtain μ_o and μ_∞ values for calculating the activation energy for viscous flow and relaxation time. Results obtained

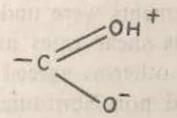
were compared with the corresponding alkoxy ethanol. The work for other series of propanols and butanols is in progress.

8.6 *Crystallography* : (B-2.5/67)

During this period, precise structures of *cis*–8 methoxy–1, 2, 3, 4, 4a, 5, 6, 10 b–octahydro-6-thiaphenanthrene-6, 6–dioxide and of a second modification of *m*-nitrobenzoic acid were determined with the help of full three-dimensional x-ray data. Preliminary structural studies of the two crystalline forms of a naphthaquinone dye were also carried out in order to account for the differences in their physical properties.

The structure analysis of *cis*-8-methoxy-1,2,3,4, 4a, 5,6, 10 b-octahydro--6-thiaphenanthrene-6,6-dioxide was undertaken in order to support the conclusions of the chemical work on the mechanism of the stereo-selective hydride transfer in the thia-series of compounds. The crystals were found orthorhombic, space group Pbnb with $a=30\cdot60$ (2), $b=10\cdot56$ (1), $c=8\cdot03$ (1)Å; $\rho_o = 1.355$ g.cm^{-3}; ρ_c for $Z = 8$, 1.351 g. cm^{-3}. The structure, solved with the help of sulphur phased 3D-Fourier map, was refined to an $R = 0.105$ for 1635 observed structure factors. The molecular dimensions were found to be normal. The bonds around the sulphur atom have a slightly distorted tetrahedral configuration suggesting greater *s* character of S = 0 bonds than of S–C bonds.

As part of a general programme to study the influence of lattice forces on the molecular structure, the structure analysis of a second crystalline modification of *m*-nitrobenzoic acid was undertaken in order to compare it with the structure of the first modification. The structure of the first modification was already determined earlier. Crystals of the second modification were monoclinic, space group P21/n with $a = 7\cdot78(1)$, $b = 11\cdot15(1)$, $c = 17\cdot15(1)$ Å; $\beta = 93\cdot4(3)°$; $\rho_o = 1.498$ g. cm^{-3}; ρ_c for Z = 8, 1.495 g. cm.$^{-3}$. The structure, solved by direct methods with visually estimated data refined to an $R = 0\cdot099$ for 1485 observed structure factors. As in the first modification, the structure consists of dimeric units, each having crystallographically independent molecules A and B; however, the nitro groups of the dimer are in the *cis* configuration in this structure. The only significant difference between the molecular dimensions in the two crystal modifications is that the two C-O bonds of the carboxylic group in both A and B are nearly equal in this structure whareas they are about 0.04 Å different in both A and B in the first modification. Apparently, there is less contribution of the structure



in the molecules of the first modification.

8.7 *Spectrochemical Studies* : (B-5/63)

8.7.1 *Infrared spectra and molecular structure*

A literature survey showed that there was some uncertainty in the assignments of CH_3 rocking modes and C-H stretching modes in $N^+(CH_3)_3$ and $N(CH_3)_2$ groups. Therefore, IR spectra of trimethyl, *o*, *m* and *p*-hydroxy phenyl ammonium iodide and *o*, *m* and *p*-dimethyl aminophenols and their methyl-d_3 derivatives were studied. The latter compounds were prepared by using CD_3I. The results showed that in $N^+(CH_3)_3$ group, $p\,CH_3$ vibrations occur at 1240 and 930-960 cm^{-1} and γ C_3N asym. and γ C_3N sym. vibrations at 1260-1280 cm^{-1} and 830-860 cm^{-1} respectively. In $N(CH_3)_2$ group p CH_3 vibrations are found at 1150-1180 cm^{-1} and γ C_2N asym. γ C_2N sym. modes at 1125-1160 cm^{-1} and 825-860 cm^{-1} respectively.

An analysis of the IR spectrum of mono sodium salt of malonic acid showed that there is an intermolecular unsymmetrical hydrogen bonding in this compound as against intermolecular symmetrical hydrogen bonding reported in the corresponding monopotassium salt. In order to investigate the reasons for this difference, IR spectra of monolithium rubidium and caesium salts were studied. The spectrum of lithium salt was similar to that of sodium salt while the spectra of rubidium and caesium salts were similar to that of K salt showing that the ionic radius is influencing the hydrogen bonding behaviour of these salts.

8.7.2 *Association behaviour of alkoxyethanols*

Previously obtained data on the association behaviour of alkoxyethanols were analysed to determine the nature of associated species (open or closed dimer, trimer, tetramer etc.). The analysis showed that these molecules form closed dimers in which the ether oxygen entered into intermolecular hydrogen bonding with the hydroxyl groups forming a ten membered ring in the concentration range < 0.1 M.

9. STUDIES IN PHYSICAL ORGANIC CHEMISTRY

9.1 *Studies on conjugated systems*: (B-5·2/62)

The interaction between the carboxyl groups of phthalic acid and electron donor groups in the 4-position was investigated earlier in great detail and very interesting results were obtained. It has now been proposed to see if these results can be made use of for purposes of optical resolution of alcohols. Some preparatory work was done in this connection.

9.2 *Mass spectrometry* : (B-5·7/65)

(a) *Analysis of pesticides*

In continuation of the previous work on the detection and estimation of pesticide residues in crops, analytical methods were standardized for

estimation of lindane and carbaryl residues in straw, rice and bran. Both gas chromatographic and mass spectrometric methods were used to qualitatively estimate the pesticide residues. The residue levels were found to be below the tolerance level recommended by WHO/FAO.

Work was initiated on the identification and estimation of nitrophene and its metabolites in the soil and ground nut plants.

Analytical support was given to Organic Synthesis Group in the characterisation of impurities and in the estimation of some organophosphorous pesticides developed by them.

(b) *Ion Kinetic Energy (IKE) spectroscopy*

The previous results obtained on the electron impact spectra of some pesticides and some disaccharides were confirmed by newer IKE technique. The importance of IKE spectroscopy in differentiating between the various glucoside linkages in some disaccharides was conclusively established.

(c) *A comparative study of the fragmentation behaviour under IKE, FD and CI conditions*

A series of compounds which show Retro-Diels-Alder fragmentation mode under electron impact conditions was studied under different ionising conditions such as Field desorption, chemical ionisation and IKE conditions. The fragmentation modes which compete with Retro-Diels-Alder reaction were rationalised.

9.3 *Mass spectral techniques* : (B-5·8/65)

(a) *Mass spectra of doubly charged ions*

Normal mass spectrum contains peaks due to the fragmentation of singly and doubly charged ions. A novel technique which records peaks due to the fragmentation of only doubly charged ions into two singly charged ions was developed. This technique requires high sensitivity and consists in recording the spectrum at 8000 volts accelerating voltage and 200 V electrostatic sector voltage. The doubly charged ion spectra of naphthalene, its phenyl derivatives and tri-phenylbenzenes were recorded. The fragmentations of singly charged and corresponding doubly charged ions were studied.

(b) *Quantitative analysis by ion current integration method using isotopically labelled compound as internal standard*

The ion current integration method of quantitative estimation of organic components of complex mixtures by mass spectrometry was employed to analyse many products developed in the NCL.

Menazon residue levels in aqueous solutions and in mixtures containing dibromide were estimated. Impurities like diols in endosulfan and chlorobenzene samples were analysed to determine the purity.

The method of estimating known components of mixtures using isotopically labelled compounds as internal standard was standardized. This method gave better accuracy. The amount of benzene in alkylated benzenes (ethyl benzene) was estimated.

9.4 *Studies of chemical reactivity and structure* : (13-5·10/70)

(a) *Reactivity of o-hydroxy aryl amides in alkaline solution*

A PMR study of the salts of *o*-hydroxy arylamides was undertaken so that some apparent contradictions in their reported reactivity may be accounted for. A hitherto unrecognised tantomerism is now established and its significance for the reactivity differences observed is under evaluation.

(b) *Ascorbic acid derivatives*

A number of ascorbic acid derivatives were earlier studied with the help of NMR spectra, and some tentative conclusions were drawn. The leads obtained from the earlier work are being pursued and further preparatory work necessary in this connection is being carried out. It is hoped that the chemical susceptibilities of the ascorbic acid skeleton can be brought out more fully than was possible so far and that the study will contribute to an understanding of the biological role of vitamin-C.

(c) *Polyhalogenated derivatives*

The reactivity of carbon tetrachloride and other polyhalogenated derivatives towards basic reagents was further studied. With sodium phenoxide and carbon tetrachloride in DMSO chloroform and a chloro derivative of DMSO seems to be obtained. When methylene chloride was used as solvent diphenyl acetal of formaldehyde was obtained. Further work is in progress.

10 INDUSTRIAL POLYMERS, RESINS AND ELASTOMERS

10.1 *Nitrile rubber* : (ATT-52/67)

Nitrile rubber—a copolymer of acrylonitrile and butadiene—is eminently suited for various types of oil resistant rubber products. It is usually available in three grades depending on the acrylonitrile content. The present import of nitrile rubber is of the order of 800 tons valued at Rs. 1.5 crores. The demand is likely to be much higher if the product is indigenously manufactured.

The process conditions, optimum conversions, efficient shortstop combinations were standardised for the low nitrile content (25% combined nitrile content) rubber with about 10 kg. monomer charge per batch. Reproducibility of the procedure for the high nitrile content (42% combined nitrile content) rubber earlier standardised with about 10 kg. monomer charge, was checked.

The process for the high and low nitrile content rubbers were demonstrated to M/s. Synthetics and Chemicals Ltd. Four batch runs of each grade were demonstrated. The conversions, bound nitrile content, Mooney plasti, city values, short stop efficiencies, coagulation conditions, material balances, residual non-rubber constituents etc., were found satisfactory. The physical processing and solvent resistance properties of the rubbers were found to be in the required ranges. The project on nitrile rubber is, thus, successfully concluded. The firm have produced 112 metric tons of medium nitrile content rubber (during 1974-75). Consumer acceptability reports are satisfactory. Commercial production of nitrile rubber based on NCL know-how is expected to be started in about a year.

10.2 *Synthetic polymer for sugar cane juice clarification :* (ATT-86/68)

Synthetic water soluble polyelectrolyte (Separan AP-30 or Sedipur) is being imported for use in sugar cane juice clarification. The current demand of the product is estimated to be worth Rs. 10 lakhs per year. It was reported earlier that two samples prepared on small scale were found satisfactory in factory trials. The process was scaled up to 6 kg./batch to prepare the two accepted grades and samples from 6 kg. batches were re-evaluated by sugar industry on factory scale trials. The results were identical to those obtained for smaller batches. The process has been referred to NRDC for release to industry.

10.3 *Polysulphide rubber :* (ATT-89/68)

Polyusulphide rubbers have outstanding fuel, ozone, weather resistance, low temperature and dielectric properties and are impermeable to gas and moisture. Compounds based on these rubbers are used as sealants in air craft, building, marine, automobile and construction industries. They are also used as flexible adhesives and flex moulding compounds.

These rubbers are needed for defence applications and the present requirement is met by imports. The import of these rubbers varies from 20 to 100 TPA. They have also an export potential.

The process was standardized on 3 kg./batch, based on dichloro diethyl formal (DDF) monomer. Samples of polysulphide liquid rubber compounds prepared from polymer were sent to BARC, Bombay for evaluation. Reports are awaited. Standardization of the process with dichlorodiethyl ether (available in the country) will be undertaken.

10.4 *Sulphochlorinated polyethylene elastomer* (SCPE) : (ATT-90·1/68)

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

The process development for the wet precipitation of the SCPE in crumbs form was well established. Pilot plant scale work on both the steps, viz., sulphochlorination of polyethylene and wet precipitation in crumbs form, is in progress to collect the necessary design data. The dried polymer will be produced in bulk for sending to various parties for user's acceptability and also for complete testing of the physical and mechnical properties.

10.5 *Stabilizers for polyvinyl chloride (PVC)* : (ATT-161/70)

Stabilizers are required to protect polyvinyl chloride (PVC) against discolouration and deterioration in mechanical and electrical properties during processing. Four important imported samples of PVC-stabilizer formulations were received from a private party interested in acquiring the know-how. These were identified and matched in the laboratory. Samples of matching formulations were sent to the party for testing. Samples of dibutyl tin maleate, dibutyltin thioglycolate, cadmium zinc maleate and cadmium barium maleate have been sent to the party interested for its commercial exploitation.

The process is being offered to industry for commercial implementation.

10.6 *Polyacetal resins* : (ATT-196/72)

Polyacetals are linear thermoplastic polymers of formaldehyde or trioxane. They are good substitutes for non-ferrous metals and find applications in varied types of end- uses e.g. gears, bushings, pulleys, speed meters etc. Polyacetal resins are not yet manufactured in the country and the indigenous demand may be around one thousand tonnes per year, valued at Rs. 2.5 crores (NCST report).

Emphasis was laid on the preparation of a copolymer of trioxane with dioxolane or other co-monomers. The trioxane homopolymer is not preferred since it involves the acetylation step which can be dispensed with in the case of the copolymer. The latter has also better processing properties.

The optimum conditions for catalyst concentration and time of reaction were established. It was found that induction period varies with water concentration and with the percentage of the copolymer varying from 69-95%. Efforts are being made to standardize the analytical and testing procedures.

10.7 *Polyurethane rigid foams* : (AB-96/71)

Polyurethane rigid foams have unique properties like strength to weight ratio, low thermal conductivity, low water vapour transmission, buoyancy and ideal electrical properties.

High density (5 lb/cu. ft.) foams as per specifications given by Atomic Energy Establishment Bombay were developed. Low density urethane foams are prepared and are under study.

10.8 *Physico-chemical studies in polymers.* (B-13·1/60).

10.8.1 *Copolymerization of ionizing monomers*

In free radical copolymerizations the monomer reactivity ratios are independent of the dielectric constant of the solvent and other polar, dipolar or induced dipolar interactions. Little work that has been reported on ionizable monomers in aqueous systems varied widely, probably due to variations in ionizations.

The copolymerization behaviour of the following ionizable systems were investigated. Acrylic acid/N-vinyl pyrrolidone, methacrylic acid/N-vinyl pyrrolidone, acrylic acid/acrylamide as a function of the degree of ionization of the acids were involved.

The effect of the degree of ionization and electrolyte monomer interactions, on the monomer reactivity ratios, were established.

The copolymerizations were carried out at arrested pHs 2, 3, 4, 5, 6, 7, 8, 9 and 10 and at pHs 3, 5, 7, and 10 under one molar concentration of a univalent electrolyte (NaCl). High conversions were obtained.

The monomer reactivity ratios were determined under each set of conditions using computerized integrated copolymer composition equation.

Literature survey was undertaken to have a knowledge of the nature of the work done on solution properties of polyelectrolytes.

10.8.2 *Nitrile rubber*

Viscosity and osmotic pressure behaviour of nine batches of medium nitrile content rubbers in different solvents is being examined. The results indicated that the number average molecular weights for the lowest Mooney number were in agreement with the number average molecular weight calculated from the modifier consumption. The osmotic second virial coefficients and the Huggins' slope constant k' were significantly different for samples where temperature maintenance difficulties were noticed during polymerization probably due to the presence of branched molecules.

A variation in the concentration and type of compounding ingredients was tried with medium nitrile content rubbers with a view to optimise the compounding recipe and cure time. It was observed that the compounding recipe used for demonstration trials gave the optimum balanced physical properties of the rubber.

Equilibrium swelling and tensile properties of swollen sulphur vulcanizates of medium nitrile content rubbers were evaluated. The tensile properties of the swollen vulcanizates were well presented by the ideal statistical theory of rubber elasticity.

10.8.3 *Polymer characterization*

A method for accurate determination of small quantities of sulfur in SCPE has been established.

10.8.4 *Thermodynamic properties*

The new bond energy scheme for calculating the standard heat of formation has been extended to oxygen compounds. The work has been communicated for publication.

10.8.5 *Radiation polymerization of trioxane*

Stabilization studies on the radiation polymer were completed using six available antioxidants, secondary amines and bisphenols. Thermal stability of the product in vacuum and in air was good.

Six control experiments with a high intensity gamma source showed that the yield of polymer is the same if the time of irradiation is greatly reduced provided the intensity of the source is higher by the same factor.

11. INORGANIC CHEMICALS AND CATALYSTS

11.1 *Aluminium hydroxide gel* : (ATT-122/69)

Aluminium hydroxide gel, used in the preparation of vaccines for animal foot and mouth disease, is at present being imported to the tune of Rs. 20 lakhs. Development of know-how for this was initially taken up in 1969-70 at the instance of I.V.R.I Mukhteshwar (UP), but the work was later kept in abeyance for want of testing facilities. The project was again revived in view of renewed interest by industry.

Fresh samples of this material were prepared on 3 to 4 kg. scale and sent for evaluation.

11.2 *Silicon tetrachloride and ethyl silicate*: (ATT-187/72)

A detailed feasibility report on the project is being prepared by an engineering firm. According to the contract, the process was demonstrated to them on a pilot plant of 10 kg/hr capacity. Samples of the silicon tetrachloride obtained and the ethyl silicate — 40 prepared therefrom were sent to prospective entrepreneurs for evaluation.

11.3 *Fumed silica* : (SP-98/74) (*Formarly*-ATT-197/72)

The technology for the manufacture of fumed silica is not yet established in the country. The requirement of this speciality chemical for its variety of applications is entirely met by imports, which are priced very high.

Fumed silica is used in more than thirty five industries and for a large

number of applications which range from aerosols, adhesives coatings, cosmetics, insecticides, lubricants, pharmaceuticals, plastics, polishes, printing inks, rubber, textiles, etc. Particles of fumed silica range in size from 10 — 100 millimicrons. Fumed silica has extremely low bulk density.

Pilot plant work on the hydrolysis of silicon tetrachloride at high temperatures (900° — 1400°) on a scale of 1-2 kg/hr of fumed silica is in progress. Data was collected and the design of a prototype unit for burning 30 kg/hr silicon tetrachloride was obtained. Based on the pilot plant results, a semi-commercial unit is expected to be set up by the sponsor at their site.

11.4 *Colloidal silica* : (ATT-228/74)

A colloidal suspension of silica particles in water with silica content : 20-30% by weight has many specialised applications in paper, plastic laminate and textile industries. It can also be used as catalysts substrate and raw material for synthesis of high SiO_2/Al_2O_3 ratio synthetic zeolites.

Starting from sodium silicate, containing 28 wt. % SiO_2 and 9 wt. % Na_2O, colloidal silica samples containing $\simeq$ 25 wt. % SiO_2 and with SiO_2/Na_2O ratio $\simeq$ 70 : 30 were prepared. They had a shelf life of about 2 months, after which they set into gels. Studies are in progress to increase the shelf life of the colloidal silica suspension.

11.5 *Molecular sieve catalysts for alkylation reactions*: (AB-84/70)

Ethyl benzene is an important raw material for the manufacture of styrene. With a view to developing a continous process for the preparation of ethyl benzene under milder conditions, vapour phase alkylation reactions were studied.

The catalyst samples with varying compositions were prepared from X and Y type zeolites and their catalytic activity was tested in an all-glass reactor assembly. The stability of the catalysts was checked by running the reactions for 40 to 60 hours. A few catalysts showed higher stability than the previous samples.

The adsorption of reactants and reaction products on the catalysts under reaction conditions was evaluated. The BET surface areas of the catalysts were also determined.

11.6 *Pearl pigments* : (AB-91/71)

The major synthetic inorganic pearl pigments are basic lead carbonate used for imparting brightness and pearly lustre to plastics and bismuth oxychloride used in cosmetics. The annual demand for these materials which are imported is valued about Rs. 60 lakhs. Although the know-how for the laboratory scale production of these was reported earlier, dispersion of the

pigment in proper vehicle offered difficulties. Examination of the imported samples showed the presence of some surface active agents and attempts were therefore made to incorporate surface active agents and plasticizers to make a suitable paste. However, this led to very little improvement. The samples were tested by a firm interested in the technology by incorporating the material in low density polyethylene powder. Further work is kept in abeyance for want of active interest on the part of the industry.

11.7 *Dicyandiamide* : (AB-119/73)

Dicyandiamide (DCD), presently imported, is an important intermediate for the manufacture of melamine, nitroguanidine and sulfa drugs.

The basic raw material for the manufacture of DCD is calcium carbide. Calcium carbide is azotized at high temperature to get cacium cyanamide. Calcium cyanamide is extracted in aqueous medium with simultaneous car bonation. The resulting cyanamide solution is dimerized to give dicyandiamide.

Work on the preparation of DCD starting from calcium cyanamide is completed on a laboratory scale. Various parameters like the effect of temperature, pH etc. have been optimized for the extraction and dimerization of the cyanamide.

Work on the scaling up of the above experiments on a 5 kg/batch has been undertaken.

11.8 *Precipitated silica* : (AB-121/73)

Precipitated silica is used as a filler in rubber, plastic and pigment industries. It is also used in paper coating and printing inks and as an additive in greases. At present, this is being imported.

Several samples of silica aerogel were prepared and analysed. Optium conditions of temperature and pressure have been determined. The samples were found to be comparable in physical and chemical properties with an imported sample, except for a little higher bulk density. Further work is in progress.

11.9 *Special grade alumina for electronics industry* : (AB-131/74)

High purity alumina (above 99%) is required by the electronics industry on account of its low electrical conductivity, relatively high thermal conductivity and low moisture retention. Such high purity alumina is at present imported.

Alumina was prepared by first purifying ammonium alum and then calcining it. The product which was in the gamma form, was very light and had low sintering temperature. The bulk density and chemical purity

of the sample were comparable with the reported values of the imported sample. The alpha form was obtained by sintering the gamma form. Both the products are under evaluation.

11.10 *Sodium ferrocyanide from calcium cyanamide* : (AB-134/74)

Sodium ferrocyanide is used in the manufacture of a blue pigment, blue print paper, sodium ferricyanide, aniline black and other dyes. It is also used in metal industries, in tanning leather and in photography. The country's requirement, estimated to be at Rs. 10 lakhs/year worth, is presently met by imports.

Exploratory work on high temperature (950-1150°) conversion of calcium cyanamide to cyanide was carried out. Conversion efficiency of the order of 60% has been achieved. Further work is in progress.

A new method to analyse $Ca(CN)_2$ in a mixture of calcium cyanamide and cyanide has been developed.

11.11 *Recovery of silver from waste paper*

This problem was referred by Hindustan Photo Films Ltd., Ootacamund. They were interested in the recovery of silver from photographic paper.

As reported by Hindustan Photo Films the Silver content of the paper is 2%. According to our analysis silver content varied from 0.5 — 0.8% only. Few preliminary experiments were carried out, but further work was discontinued in view of unattractive economics.

12. UTILIZATION OF MINERAL RESOURCES

12.1 *Titanium tetrachloride* : (ATT-224/73)

Titanium tetrachloride is at present imported in the country. It is mainly usd as a seed-material in the manufacture of rutile grade titania by the sulphate process, and also finds application in metallurgy and in the manufacture of some intermediates and polymerization catalysts. The present demand for $TiCl_4$ in the country is of the order of 2,000 TPA, valued at about Rs. 1 crore.

A continuous autothermal pilot plant reactor of about 150 TPA capacity was installed for the chlorination of beneficiated ilmenite in a fluidized bed in the presence of oxygen acceptors like coke at high temperature. Several runs were taken to optimise various parameters. The process was successfully demonstrated to M/s MECON, who are consultants to M/s Kerala Minerals and Metals and to M/s Travancore Titanium Products.

The process is being offered to industry for release.

12.2 *Bacterial leaching of ores* : (AB-67.7/73)

The role of microorganisms in geological processes has led to the development of the new field of "Geomicrobiology". Bacteria have been employed for recovering valuable metals like copper, uranium, zinc etc. With the view to recovering copper from low grade ore which is available in sizeable quantity, an inter-laboratory project was undertaken to isolate and identify bacteria capable of leaching out copper.

Several mining agencies were contacted and 30 mine water samples were received from different locations. 17 of the samples were chemo-autotraphs capable of oxidation of sulphur or ferrous sulfate. Some of them had activities comparable to those of standard thiobacilli cultures obtained from abroad. A few of these mixed flora containing sulfur and iron oxidizers were used in preliminary copper leaching experiments with one of the ore samples containing about 1% copper. Experiments are now in progress for studying the different parameters for effective leaching of copper from different ores.

12.3 *Studies on the utilization of Indian fluorspar* : (AB-118/73)

Work on the utilization of Indian fluorspar (90% grade) was continued. It was shown that no P_2O_5 was volatilized when this grade of fluorspar was treated with acid and the product cryolite was free of phosphorus. Further work was suspended for want of user interest.

12.4 *Cryolite from effluent fluosilicic acid* : (ATT-243/74)

At the instance of M/s Dharamsi Morarjee Chemical Co., the recycle section of the NCL cryolite process was further investigated. It was demonstrated by several recyclings that there is no build-up of SiO_2 or P_2O_5 in the regenerated liquors and that the requirements of make-up soda ash are much less than what was reported earlier.

13. ORGANO METALLIC COMPOUNDS

13.1 *Tin and Titanium organics* : (AB-99/72)

Organotin intermediates, required for manufacturing stabilizers for plastics, valued at Rs. 2 crores are imported every year. Most of them are butyl and octyl derivatives of tin. A new class of stabilizers which use methyl tin compounds has been developed abroad. Direct synthesis of dimethyl tin dichloride and dibromide has given encouraging results. Testing of stabilizers prepared from those dimethyl tin dihalides is in progress. Preparation of dibutyl tin dichloride through the chloride route (pressure reaction) is in progress.

Investigation of the reaction between bidentate chelating ligands, containing carbonyl groups with aluminium alkoxides gave conclusive proof of the formation of chelated aluminium complexes without undergoing any

molecular rearrangement. The chelated aluminium compounds reacted with thionyl and sulphonyl chlorides giving chlorinated products and addition compounds with tin and titanium tetrachlorides.

N-Benzoyl-N-phenylhydroxylamine formed chelate compounds with titanium tetrachloride and isopropyl titanate with the elimination of HCL and isopropanol respectively. The isopropoxy derivative further reacted with bidentate ligands. Cyclohexanol derivatives of titanium chelates were obtained from cyclohexyl titanate or dichloro dicyclohexanoxy titanium and chelating ligands. IR spectra and molecular weight of these compounds were studied.

Reaction of organo antimony compounds and their chelates with 2-ethylhexanoic acid salt of cobalt and copper are under study. The latter compounds find use as drying agents for paints.

13.2 *Co-ordination compounds* : (B-6/63)

In a general programme of synthesis and study of coordination compounds, complexes of copper (II), nickel (II), zinc (II), chromium (III) and cobalt (III) with some substituted biguanides were prepared. The far infrared and reflectance spectra of these compounds are under study.

Some Group IV metal chelates with the ligand (LH) 2-hydroxy-1-naphthaldehyde, of the composition $LMCl_3$, ($M=Ti^{IV}$ or Si^{IV}), L_2MCl_2 ($M=Ti^{IV}$, Zr^{IV}, or Sn^{IV}), $L_2Sn^{IV}X_2$ ($X=Br$ or I), $L_nTi^{IV}(^iOC_3H_7)_{4-n}$ ($n=1$ or 2) and L_2Sn^{II}, were isolated and characterised for the first time. Ammonia and methylamine adducts of the chloro chelate compounds were also studied.

In continuation of previous work on the reactivities of coordination compounds, the iodination and thiocyanation reactions of beryllium (II) chelates of N-substituted acetoacetamides, for instance, 2-chloro, 3-chloro-4-chloro-, 2, 4-dichloro-, 2, 5-dichloro-, 2-methoxy-, 4-methoxy- and 2, 5 dimethoxy-acetoacetanilide were completed.

With a view to elucidating the structure of the dimetallic complexes isolated from the reactions of bis-π-cyclopentadienyltitanium (IV) dichloride with thiosalicylic acid and toluene-3, 4-dithiol in the presence of zinc. magnesium and tin, spectral studies in the far infrared region were carried out,

As a part of investigations initiated on alkyl tin (IV) chelates of the composition $RSnLnL'_{5-n}$ R_2SnL_2, R_2SnLL' and R_3SnL, several bis-chelated tin compounds R_2SnL_2 where R = methyl, ethyl or butyl group and LH= substituted 8-quinolinol, namely, 5-nitro-, 5-nitro-7-bromo-, 7-nitro-, 7-nitro-5-bromo-, 5, 7-dinitro-, 5, 7-dichloro-, 5, 7-dibromo- or 5, 7-diodo-8-quinolinol, were synthesized and their I.R., N.M.R. and mass spectra studied. The proton nuclear resonance spectral studies on several of these chelates revealed

that in general on complex formation the alkyl groups exhibit shielding in conformity with an increased electron density on the tin via ligand donation. The N.M.R. and I.R. spectra of the diethyl compounds indicated that the two ethyl groups most probably occupy trans-coordination sites in the octahedral structure assumed for these chelates. In the mass spectra of these chelates, parent ions were either low abundant or absent and the fragmentation of the molecular ion by elimination of an alkyl or ligand radical was a major mode of dissociation.

14. SOLID STATE MATERIALS

14.1 *Tin oxide potentiometers* : (ATT-61/71)

Potentiometers of various types are indispensable components of all electronic instruments. Recently, a new type of potentiometer track using tin oxide in place of the common carbon track was developed. This new track has the following advantages:

(a) Wide operating temperature
(b) Imperviousness to moisture
(c) Negligible V.C.R.
(d) Excellent high-frequency performance

During the period under review, the process was scaled upto 50 pieces at a time using a circular rotating furnace. Several problems relating to mechanical and electrical design were solved by modification of the original furnace. A remote temperature sensor was installed to monitor the surface temperature of the substrates during deposition. A batch of 100 substrates on which suitable tracks were deposited were sent to industry for fabrication into complete potentiometers. On receiving a report on the completed potentiometers, steps will be taken to transfer the know-how to industry. Samples were tested for I. V. characteristics, temp. coefficients of resistance, power dissipation, moisture resistance and were found to be quite suitable in these respects for use in electronic circuits.

Some samples were thermally cycled between room temperature to 200° several times. There was no change in the resistance values.

Typical values obtained for some characteristics are given below:

Resistance in	Resistance after TCR thermal cycling	Wattage (3 hrs) Temp. rise during loading
3365	3365	110 ppm°/C 1.62 65°C
1170	1170	139 ppm°/C 2.34 90°C
4500	4500	163 ppm°/C 1.83 50°C

14.2 *Sodium chloride single crystals* : (ATT-206/73)

These crystals which are mainly used as windows in spectrophotometers and also in Defence are presently being imported. Cost of the imported NaCl, KBr and CaBr windows is Rs. 50/-, Rs. 60/- and Rs. 80/- per piece respectively. The estimated requirement of these crystals is around Rs. 3 lakhs/year.

Bridgmann-Stockberger technique was developed and many single crystals of NaCl of 3 cm. dia were grown successfully. These were cut in the form of windows, polished and got them tested for IR transmission. The transmission was found to be about 93% which is quite comparable to the imported samples. The crystals were grown in silica containers. These containers developed cracks owing to the reaction with NaCl and could not be used for the next run. Thus the cost of growing the NaCl crystals would be high since the silica tube is to be discarded after every run. In order to overcome this, it was decided to use graphite containers. The graphite container was encapsulated in a silica tube and the same set of graphite-silica tube was tried for 8-10 runs and found to be satisfactory. With the quality of graphite available, it was observed that the crystals were having some defects. It was found that a special grade of graphite was required with very finely polished walls. This would help to get defect-free crystals.

Since similar work is being carried out by the National Physical Laboratory, further work was discontinued.

14.3 *Thermally conducting compositions* : (ATT-239/74)

Composition/pastes are widely used to increase the conduction of heat from all power dissipating semiconductor devices. These compounds are not available indigenously and the cost of the imported material is high. It is estimated that the net annual demand of such composition will be worth Rs. 10 lakhs.

Several compositions were formulated. The assembly for measuring the thermal conductivity is being fabricated. On completion of this the compositions will be evaluated for thermal conductivity. Meanwhile the electrical-conductivity, breakdown voltage and dielectric behaviour of these compositions are being evaluated.

The following data was collected on the behaviour of these pastes.

Dielectric strength of a 2 mm. specimen within an annular spacer was found to be in excess of 5000 volts/cm. This is comparable with the imported Wakefield sample. The volume resistivity at 25° of a specimen of thermally conducting paste with D.C. field was found to be of the order of 10^{n} ohm. cm^{-1}.

14.4 *Ferroelectric materials* : (AB-2/71)

The project was undertaken to develop ferroelectric ceramics suitable for gramophone pickups, gas igniters, ultrasonic cleaners, wave filters and memory and display devices.

Earlier the process technology for the improved PZT ceramic material for gramophone pickups was developed. The technology for converting the ceramic material into binorphs was developed during the period under report. Laboratory trials wtih the NCL developed bimorphs in HMV record player were quite satisfactory.

Preliminary work for the development of PZT slugs for gas igniters was done. The slugs are being made for sending them to different parties for evaluation.

Preliminary work for the development of hard type ferroelectric ceramics suitable for ultrasonic cleaners, transducers, etc., is being carried out.

14.5 *Thick-film materials* : (AB-75/71)

Thick film passive elements like conductors, resistors and capacitors are widely used in hybrid microelectronic circuits along with active devices. Their applications are on the increasing trend in the manufacture of integrated circuits in television, radio and other fields in the electronic industry.

The process for thep reparation of silver paste for mica capacitors was offered to industry. Although this paste is reported to be suitable for professional capacitors, the same would be costlier for consumer types because of higher silver content. Further samples are being formulated to reduce costs.

Although 96% Al_2O_3 substrates are usually used for thick film integrated hybrid circuits, some work was done for preparing a few compositions of steatite. This was taken up to work out certain formulations for initial evaluation. Work on steatite was discontinued after obtaining the necessary data.

Work is initiated to formulate ruthenium oxide resistive glazes. This project has been identified by Electronics Commission and CSIR for development during 1975-77.

14.6 *High permeability ferrites* : (AB-90/71)

High-permeability ferrites are used in telecommunication deflection-yokes, fly-back transformers, E.H.T. transformers, television sets, high permeability antennae etc. The NCST and the Electronics Commission have estimated the need of this type of ferrite in the country to be about Rs. 4 to 5 crores annually.

Toroids with properties matching with those of $3B_7$ and $3H_1$ of Philips were prepared and the reproducibility of the product was confirmed in about hundred batch runs. Some pot cores were pressed and sintered to the required mechanical strength.

The toroids and pot cores are now being evaluated by industry.

14.7 *Liquid crystal display devices* : (AB-120/73)

Literature survey on the new liquid crystal materials used in display devices was completed. Number of liquid crystals were procured from abroad.

Two samples synthesized in organic division were examined for their IR, NMR, Mass spectral studies, m.p. and mesamorphic behaviour. On comparing with the properties of imported samples, it was found that these samples required to be prepared with higher purity to show their mesamorphic behaviour. Since similar work is in progress at the National Physical Laboratory, further work was discontinued.

14.8 *Thin film resistors* : (AB-122/73)

In continuation of the earlier work on the development of thin metal film resistors, several compounds were deposited and their properties viz TCR, stability, humidity and load effects, etc. were studied in details. Resistance of the samples varied from a few ohms to kilo ohms or higher depending on the deposition conditions. These samples were, however, made mostly on the glass substrates. Further trials are being made on appropriate ceramic substrates. In some cases TCR was brought down to < 200 ppm/°C.

14.9 *Development of know-how for Hall elements* : (AB-130/74)

Development of Hall elements was taken up by vacuum deposition method. The fabricated samples showed high stability and good response to magnetic field. A suitable circuit was also designed to be used with the above Hall element for measuring the magnetic field. The sensitivity of the Hall element and other characteristics with respect to the designed circuit are being studied in detail.

14.10 *Structure of thin films* : (B-4.3/58)

In continuation of earlier efforts to the understanding of the semiconducting properties of vacuum deposited films, detailed studies were made on their structural, electrical, optical and other properties. Since film properties are structure sensitive, studies on structures, crystal growth process, phase transition, etc., on vacuum deposited films, especially the chalcogenide compounds such as sulphides of indium, copper, thallium and also oxides of indium and bismuth, etc., formed on various substrates at different temperatures were made by electron diffraction methods.

The above studies revealed that indium sulphide films developed a new spinel structure ($a = 10.73$ Å), a defect-spinel type when deposited at higher substrate temperatures. Depending on the substrate temperature the spinels grew epitaxially on the different faces of rock salt. Thallium sulphide deposits had the normal hexagonal structure ($a=12.2$ Å, $c=18.2$ Å) without any phase change during the vacuum deposition process. These also grew epitaxially at higher substrate temperatures with 2-d { 00.1 } orientations on rock salt. At lower temperatures, however, these developed preferred orientation such as { 10.0 }, { 10.1 } etc.

Cuprous sulphide films showed different polymorphs depending on the substrate temperature and these often grew epitaxially when temperature was high. In the case of indium oxide films, they retained the normal bcc structure ($a = 10.12$ Å) at low temperatures but developed two new cubic phases viz. $a = 10.8$ Å and 8.12 Å, the former being a spinel type with probable composition In_3O_4 (R_3X_4 type). None of these phases have yet been reported. With appropriate substrate temperatures, these also grew epitaxially on the NaCl faces.

Studies on Bi-O system from vapour phase showed the presence of different phases such as bismuth suboxide (Bi O) with cubic structure (5.52 Å) and another one bcc type of structure ($a=9.94$ Å) depending on the substrate temperature. At a still higher temperature two more cubic phases with lattice parameters namely 11.3 Å and 10.45 Å were also observed.

The growth of vapour phase deposits of GaSb and GaAs by thermal evaporation was also studied and it was found that though the compounds were susceptible to dissociation, epitaxial growth on NaCl crystals of these vapour phase could be obtained with appropriate control of substrate temperature.

14.11 *Physics of thin films* : (B-4·4/67)

Dielectric properties of several oxides and fluorides were studied in details for their capacitance, dielectric constant, loss factors with varying frequency at different temperatures. In the case of lanthanum oxide films, it was found that both C and tan δ decreased by ageing, annealing and eventually became constant on stabilization. C was linearally proportional to d^{-1} and tan δ was low and independent of film thickness. Both capacitance and tan δ decreased with frequency but increased with temperature. Dielectric constant was about 10.3. TCC was low which varied from 300 to 4000 ppm/°C at different temperatures. Breakdown field also followed the Forlani-Minaja law. The d.c. and I-V characteristics were also studied and they showed SCLC effect and obeyed the relation $I \propto V^4/d^7$. The optical properties of these films were studied in the visible near UV region and an energy band gap was found to be 4.6 eV.

Unlike the dielectric behaviour of previously studied films it was found that vacuum deposited niobium oxide and indium oxide films showed entirely different features. These films showed thickness dependent dielectric constant but thickness independent capacitance. Tan δ peak was observed at lower temperatures and lower frequencies. These features along with Cole-Cole diagram suggested that the tan δ peak was the relaxation effect due to the dipole orientation in vacuum deposited films caused by the non-stoichiometric nature of the deposits as a result of dissociation during vacuum deposition. This was also confirmed from the high optical absorption. Other optical constants such as n, k and α etc., were also measured for these films. It is interesting to mention that these vacuum deposited films when oxidised in air became more or less transparent and showed behaviour conforming to In_2O_3 or Nb_2O_5.

Semiconducting properties of various organic molecular compounds e.g. copper phthalocyanine, indanthrone, etc., were also studied in details. It was found that the vacuum deposited copper phthalocyanine showed energy band gap 1.7 eV from electrical measurements whereas those obtained from photocurrent and optical absorption spectra of thin films had higher values (e.g. 2.0 eV). All these films were p-type. The studies of I-V characteristics of sandwich structures such as $M_1/CuPh/M_2$ with different types of electrodes (M_1 and M_2) showed that Al formed a blocking contact, whereas Au, Ag and Cu formed ohmic contact. The rectification was also observed for Al/CuPh/Au structures with ratio of nearly 10^4 at 1 V. These deposits also showed SCLC mechanism where $I \propto V^{10}$. These features along with the photocurrent effects were explained from the nature of the electrode semiconductors junctions, presence of traps, etc., in the above system. A good correlation between photocurrent response and absorption spectra was observed.

14.12 *Ternary semiconductors* : (B-2·10/72)

Thin films of $CdSnAs_2$, a ternary diamond like semi-conductor belonging to the II-IV-V_2 series, were obtained by evaporation of bulk $CdSnAs_2$ in vacuum. From the analysis of conductivity data obtained earlier, it was concluded that the resistivity varied with temperature according to the equation given below :

$$\frac{1}{\rho} = \sigma_1 \exp \frac{-\Delta E_1}{kT} + \sigma_2 \exp \frac{-\Delta E_2}{kT}$$

Amorphous samples had a very small value of thermo e.m.f. (< 10 μ V/°k). The crystalline film was p-type at low temperature changing over to n-type at higher temperature.

It was concluded that the conduction behaviour in amorphous films ould be explained by invoking the idea of the percolation edge. The

crystalline film was p-type at room temperature, presumably due to arsenic deficiency. With rising temperature, electrons were promoted across the gap and as their mobility was much larger than that of holes, the sample became n-type even when the number of holes was much larger than that of electrons. For this reason, the activation energy was equal to the band gap. Resistivity of crystalline samples was affected by non-stoichiometry, cadmium excess. Cd-Sn-As_2 had a very low resistivity while arsenic excess samples had a very high resistivity. On the other hand, non-stoichiometry had no effect on the electrical conductivity of amorphous samples.

The variation of the absorption coefficient α with photon energy at the absorption threshold followed the relation $(\alpha h\nu) \propto (E - h\nu)^{3/2}$. The transition was "direct" and "allowed". There was an absorption peak at 0.20 ev which could be due to V_2-V_1 transition between sub-bands of the valence band or due to impurity level-band transition.

Another system of ternary photoconducting semiconductors was taken up for studies.

Photoconducting materials with chemical formula AB_2X_4 (A=Cd, Zn; B=Ga, In; X=S, Se) were prepared. The compounds were identified by x-ray powder diffraction technique. Thin films of $CdGa_2S_4$ and $CdGa_2Se_4$ were prepared by vacuum evaporation technique. Stoichiometric films were obtained only when the evaporation temperature was just below the m.p. of the compound and the substrate temperature was around 300°. The structure of the thin films was confirmed by electron diffraction technique. Optical absorption characteristics of these films were examined and the values for forbidden band gaps of 3.4 ev and 2.5 ev were obtained for thicker films of $CdGa_2S_4$ and $CdGa_2Se_4$ from the plots α^2 vs h ν and $\alpha^{1/2}$ vs h ν. However, higher values of forbidden gap were observed when the films were thinner or non-uniform.

14.13 *Chalcogenide semiconductors* : (B-2·22/74)

Aresenic and antimony chalcogenides find applications in optics, electronics, electrophotography especially in electrostatic imaging, television engineering, switching and memory devices.

A new chemical method of preparation of thin films of binary chalcogenides of As, Sb, Cd was developed. Electron and x-ray diffraction, electrical conductivity and optical absorption of these films were studied. Thermoelectric power measurements were also made on Sb_2Te_3 thin films.

Vitreous compound As_2Se_4 was prepared by melt quenching method and DTA and TGA were carried out in addition to the properties mentioned above.

Except Sb_2Se_3 which was amorphous, all the other As, Sb, and Cd chalcogenides prepared by the chemical method were crystalline as checked by electron diffraction. As_2Te_3 and As_4Se_4 were monoclinic, Sb_2Te_3 was rhombohedral, CdTe was mixed cubic and hexagonal, CdSe was cubic.

Optical absorption studies showed that all the prepared chalcogenides were direct band gap materials. The optical band gaps calculated from absorption curves for As_2Te_3, As_4So_4, Sb_2Te_3, Sb_2Se_3, CdSe, CdTe were 1.10, 1.90, 0.30, 1.3, 1.70, 1.60 ev whereas for the melt quenched As^4Se^4 sample it was 1.87 ev.

Thermoelectricpower coefficient S, for Sb_2Te_3 gave a constant value (50 ± 20 $\mu V/°K$) in temperature range from 28° to 110°. DTA, TGA and TG curves showed no phase change taking place during continuous heating of vitreous As_4Se_4 upto 400° and then compound itself started subliming without any decomposition. This confirmed the homogeneity of the compound.

Electrical conductivity showed the single activation energy for the following compounds as indicated against each compound :

Film As_2Te_3 0.47 ev, As_2Se_4 (bulk) 0.99 ev, film Sb_2Te_3 0.12 ev, film Sb_2Se_3 0.37 ev, film CdTe 0.8 ev, film CdSe 0.22 ev.

The crystalline film of As_4Se_4 obtained by chemical deposition showed two activation energies $\triangle E_1 = 0{\cdot}15$ ev, $\triangle E_2 = 0{\cdot}92$ ev.

The evaporated thin film from quenched As_4Se_4 material also showed two slopes with $\triangle E_1 = 0{\cdot}13$ ev, $\triangle E_2 = 0{\cdot}94$ ev.

The bulk material As_4Se_4 showed only one activation energy with ($0{\cdot}8 \sim 0{\cdot}9$) no effect of following impurities Zn, Cd, Sn, Ge, but the impurities Ag and Cu in As_4Se_4 gave two slopes.

$As_4Se_4 + 2\%$ Ag — $\triangle E_1 = 0{\cdot}20$, $\triangle E_2 = 0.55$ ev.
$As_4Se_4 + 2\%$ Cu — $\triangle E_1 = 0{\cdot}13$, $\triangle E_2 = 0.58$ ev.

15. INSTRUMENTS TECHNOLOGY

15.1 *UV-Visible spectrophotometer* : (ATT-173/71)

All the mirror mounts and stands were fabricated. The slit mechanism was also completed. Work is in progress regarding the wavelength drive mechanism fabrication and fabrication of cams for the same. Pen drive mechanism, the drum for that, the chopping mechanism etc., are yet to be fabricated. Nearly 60% of the mechanical fabrications were completed.

The electronic amplifier assembly along with the printed board is being presently done.

Every effort is being made to complete a working prototype early.

15.2 *Infra red spectrophotometer* : (ATT-190/72)

Development work on the instrument was suspended for some time for want of essential components to be imported.

Optical layout of the spectrometer was completed and the alignment checked from the source to the detector. Few mechanical components are yet to be made for slit mechanism drive.

Electronic part was finalized and finished assembly on printed circuit board was substituted in the imported spectrometer permanently for evaluation. It is working for several weeks satisfactorily.

Final assembly work will be shortly undertaken.

15·3 *Solid state recorder* : (ATT-195/72)

Two prototypes were fabricated and are under evaluation and third one is in the final assembly stage. Feedback from the first recorder was utilized in improving the writing pen mechanism in all the three machines. Two more special high impedance recorders, with different physical layout are under fabrication using the same electronics.

16. TISSUE CULTURE STUDIES

16.1 *Plant tissue culture* : (AB-96·1/72)

This project consists of the application of tissue culture to the study of cloning, differentiation and somatic hybridization of plant cells and the production of plantlets of agricultural value.

16.1.1 *Virus free sugar-cane*

The high-yielding sugarcane strain CO-740, which is invariably affected with sugarcane mosaic virus, was obtained virus-free by tissue culture. Field trials are being continued at the Nimbkar Agricultural Research Institute, Phaltan. Reinfection of the small number of virus-free plants in the middle of a large number of virus infected plants in that area was a major problem. Experiments are in progress for obtaining a sufficiently large number of virus-free seedlings to plant at least an acre with this cane for comparison of yields with the virus infected strains.

The production of mutant varieties of sugarcane obtained from callus cultures or as apical meristems and screening for strains of agricultural importance is being continued.

16.1.2 *Hybrid cabbage*

A method was developed for the large scale vegetative propagation of high yielding hybrid cabbage and other varieties of cabbage. The hybrid

plants can be grown throughout the year. About 6000 plants were raised from 2 seeds. Preliminary field trials at Phaltan and Poona showed that the yield of the hybrid variety propagated by this method is at least twice that of the commercial varieties grown in this area. The economic feasibility of the method will be tested in large scale field trials prior to release of this technique to agriculturists.

16.1.3 *Miscellaneous*

Work is in progress for the rapid propagation of other commercially important plants such as Dioscorea. Experiments on standardizing conditions for obtaining reproducibly high germination from teak seeds have also been undertaken.

Multiple plantlets were obtained, from seedling segments of hybrid snapdragon-floral carpet. The capacity for differentiation was undiminished even after six subcultures.

Work on obtaining protoplasts, regenerating plants from the protoplasts and cell fusion is being continued. Protoplasts from some of the plants regenerate the cell wall and underwent a few cell divisions. Attempts to obtain continuous growth and differentiation from protoplasts are in progress. Increased cloning efficiencies were obtained with apple and Parthenocissus (normal and crown gall) and the factors required for the growth of single cells are being investigated.

Work on the inhibitors of proteases present in *Vigna catjang* was continued. The properties and kinetics of three inhibitors acting on trypsin and chymotrypsin, three subtilisin inhibitors and five papain inhibitors, which were separated from each other and obtained in pure form, were studied. Studies on the effect of these inhibitors on plant tissue cultures are being continued.

16.2 *Animal tissue culture* : (AB-96·2/72)

A cell culture obtained from potato tuber moth (*Gnorimoschema operculla*) has undergone about 25 subcultures without any diminution in its capacity to grow. Its viability as a cell lines is being further studied. More than one morphologically distinguishable cell type is present in this culture and attempts are in progress to obtain clones from single cells.

A simplified method for screening for antiviral compounds was developed. Two compounds were obtained which showed promising antiviral activity against vaccinia virus.

Attempts are being made to transfer nitrogen fixing genes from *Azotobacter* and *Rhizobium* and blue green algae to plant cells in culture.

17. ENZYME CHEMISTRY AND TECHNOLOGY

17.1 *Matrix - bound pencillin acylase systems* : SP-73/74))

This enzyme is used industrially in the production of 6-aminopencillanic acid, a key intermediate in the manufacture of semisynthetic penicillins.

The main objective of the sponsored work was to scale up preparation of immobilized systems and obtain adequate amounts for pilot plant trials.

The preparation of immobilized systems of penicillin acylase was optimized and adequate amounts of one of the systems was made for pilot plant trials. Pilot plant trials carried out at the Hindustan Antibiotics Ltd., Poona have confirmed earlier laboratory scale data on the performance and reusability of this system.

The project is now completed

17.2 *Immobilized enzymes* : (AB-97/72)

17.2.1 *Penicillin acylase* : (AB-97·1/72)

The investigations on immobilized penicillin acylase were continued and studies on the kinetics and use of alternate supports were carried out.

17.2.2 *Amyloglucosidase* : (AB-97·2/74)

The microbial enzyme is used industrially for the hydrolysis of starch to dextrose.

Several immobilized systems were prepared from the soluble enzyme supplied by Hindustan Antibiotics Ltd., and tested for their usefulness in preparation of dextrose from starch.

17.2.3 *Glucose isomerase* : (AB-97·3/74)

The microbial enzyme converts dextrose to invert sugar and has important potential application in the sugar industry for the production of a sweetener superior to cane or beet sugar.

Preliminary studies on screening and isolation of cultures with high isomerase activity are in progress. Studies on the isolation and immobilization of the enzyme would be undertaken after a high yielding strain is obtained.

17.2.4 *Citrate oxaloacetate lyase (Citrase)* : (B-12·5/65)

The enzyme was obtained pure from different bacterial sources and the properties of the preparations are being studied.

Immobilization of the enzyme on solid matrices and reactivation of the product-inhibited immobilized system are being investigated.

17.2.5 *Metabolism of nitrate by A. fischeri* : (B-12.6/65)

Studies with isolated enzymes involved in nitrate metabolism of *A. fischeri* were continued. The kinetics of inactivation of *A. fischeri* nitrite reductase with protein denaturants as well as incubation at acid pH were studied in detail. The process of inactivation of the enzyme in urea, Gn. HCl and SDS was apparently first order and the rate constants were calculated to be 0.46 and 3.9 min^{-1} for 1M and 2M urea, 6.1 and 10.4 min^{-1} for IM Gn. HCl and 0.025% SDS, respectively. In the presence of urea the enzyme showed maximum stability at pH 8.0 as compared to 6.5 in the absence of urea. The $\triangle$ Ha for inactivation of these enzymes in 2M urea was calculated to be 9.2 KCal compared to 60.1 KCal in the absence of urea. The inhibition by urea involved 2 molecules of urea per molecule of enzyme and was non competitive with respect to the substrate. The Ki for urea was calculated to be 1.45 M by Laidler's method. The Ackerman-Potter plot for the inhibition of the enzyme by urea indicated that the inhibition is of pseudo-irreversible type. Inactivation by urea, Gn. HCl and acid pH does not involve dissociation of the enzyme into its subunits. Analysis of the kinetic data indicated that urea induces structural changes and its effect was within a small region of the enzyme molecule. Phosphate at high concentrations protected the enzyme almost completely against urea (2M) inhibition. The role of nitrite, hydroxylamine and nitrate in stabilizing the quaternary structure of the enzyme under dissociating conditions was studied. Studies on the detail kinetics of reactivation of the denatured enzyme are in progress.

18. FERMENTATION PROCESSES

18.1 *Protein food from cellulosic plant materials* : (AB-67.2/68)

This is an inter-laboratory project supported by a CSIR grant under a Silver Jubilee Scheme in collaboration with CFTRI, Mysore and Indian Institute of Science, Bangalore. The object is the utilization of cellulosic materials for the production of protein food for use by cattle either directly or after enzymic hydrolysis of the celluloses to glucose followed by growth of suitable organisms on glucose.

After preliminary screening of cultures from several sources 94 isolates were selected for test in shake flasks for rapid enzyme production or cellulose utilization. 10 cultures showed high enzyme activity of which two were taken up for detailed studies on the determination of optimum conditions for enzyme production. Methods were also standardized for increasing the yield of Cx and C_1 activity of *T-viride* strains obtained from abroad.

Four cultures were obtained which were able to utilize agricultural cellulose wastes such as straw, bagasse etc. They showed good growth in shake flask experiments with alkali-treated straw. Preliminary experiments showed that these cultures were non-toxic to mice. The nutritional evaluation

of these cultures as single cell protein is being undertaken in collaboration with CFTRI, Mysore.

An improved method of pretreatment of celluloses for increasing susceptibility to digestion by cellulase is being investigated.

Under the work on purification and separation of enzymes one *myrothecium* isolate obtained showed appreciable activity and is being studied further. Mutation programme on known high cellulose yielding cultures also is in progress. Purification of the cellulase systems of *Sclerotium rolfsii* gave evidence of two CMCase components having different pH optimum.

18.2 *Retardation of loss of ammonia applied as fertilizers in soil* : (AB-67·5/70)

The loss of ammonia fertilizers in soil due to microbiological oxidation and leaching or denitrification is of agricultural importance. The ammonia oxidizing organisms generally do not survive subculture in the laboratory. 44 cultures were obtained of which all except two were shown to be viable for periods ranging from one to three years by an improved method of subculture. 31 pure cultures of *Nitrosomonas* and *Nitrobacter* were obtained from single cells and are also being maintained by periodic subculture.

19. PROCESS DEVELOPMENT AND CHEMICAL ENGINEERING STUDIES

19.1 *Industrial chemicals by catalytic hydrogenation* : (ATT-241/74)

The conventional iron-acid reduction process involves handling of large volumes, difficulties in the purification of the products, low yields, and poses the problem of iron sludge disposal. As against this, the catalytic hydrogenation process, though requiring high initial-investments, should prove advantageous in many ways in case of several industrial chemicals.

It is proposed to develop the catalytic hydrogenation process for some of these chemicals, under this project.

During the year under report, a process for the catalytic reduction of nitrobenzene to metanilic acid in the liquid phase was developed on a bench scale of 3 kg./batch.

19.2 *Vinyl chloride* : (ATT-242/74)

The conventional process for the manufacture of vinyl chloride is by the liquid-phase chlorination of ethylene to yield ethylene dichloride followed by the thermal cracking of the ethylene dichloride, or by the hydrochlorination of acetylene. In view of the shortage of ethylene from the petrochemical sources in India, the work has been initiated for the development of the process know-how for the hydrochlorination of acetylene route.

19.3 *Alkylation of naphthalene and aromatic hydrocarbons* : (AB-92/71)

New routes for production of naphthols, cresols and polyhydroxybenzenes, analogous to the cumene-based processes for phenol, are of commercial interest.

Studies in alkylation of naphthalene were continued to further improve the previously obtained 70% yield of alkylnaphthalenes. Statistically designed experiments carried in a baffled flask to fix the conditions of three important variables of the reactions indicated the possibility of raising the yield to above 80%on naphthalene.

From the experiments conducted to purify the product it was observed that the impurity of sulphur compounds present in it could be reduced by treating the product with concentrated sulphuric acid. Some experiments were also carried out to separate unreacted naphthalene from the product by steam distillation and crystallization. Both the procedures were found to be inefficient and time consuming.

Bench scale experiments in the propylation of toluene counducted to select the process variables showed the feasibility of obtaining about 80% of cymene, the yield of total alkylated product being about 84% on toluene.

Investigations on hydroperoxidation of cymene instead of monoisopropyl naphthalene was undertaken first as the former was more easily separated in pure form from the reaction mixture. The work on hydroperoxidation of cymene is in progress.

19.4 *Reaction models and reactor design* : (B-14.8/68)

19.4.1 *Studies in gas-liquid reactions*

Work on the preparation of a comprehensive review on the approximate methods of solution used in chemical reaction engineering was practically completed. The general approach proposed earlier for expressing the diffusional effect in gas-liquid reactions in terms of an effeetiveness factor has been extended to gas-solid-liquid systems. The basic developments of Aris on the diffusion-cum-reaction problem in solid catalysts has been extended to gas-liquid reactions. The generalized equation developed can be readily reduced to those proposed by Aris.

19.4.2 *Fundamental studies on mass transfer to a catalytic surface*

Experimental investigations have been commenced. As soon as sufficient data are obtained, the proposed theoretical equation would be tested with the object of determining whether the empirical correlations for packed bed mass transfer do represent mass transfer from a gas to a solid surface.

19.4.3 *Modelling of fixed-bed catalytic reactors* (in collaboration with BUDCT)

After completing the sensitivity analysis of the fixed bed reactor and

the development of effectiveness factor charts for the most general case involving adsorption and diffusion under nonisothermal conditions, work on experimental simulation of the aniline reaction was commenced. Data was collected in a single tube reactor. Simultaneously the kinetics of the reaction is also being studied using a standard catalyst. The testing of various models using this data is now in progress.

19.4.4 *Solid-solid reactions*

Experimental studies are in progress to determine the controlling steps in the solid catalyzed formation of chlorosilanes from ferrosilicon and methyl chloride. A theoretical model for solid-solid reactions which also incorporates the concept of the effectiveness factor is under development.

19.4.5 *Ammoxidation*

Experimental studies on the various reactions comprising the ammoxidation network are in progress. A reactor has been developed which can give very accurate rate data. Work on the extension of the Wei-Prater method to the analysis of more complex networks is in progress.

19.4.6 *Studies on catalyst properties during reaction*

Very encouraging results were obtained on the determination of the catalyst properties during reaction. By carrying out the isomerization of 2-butene in a chromatographic reactor the adsorption characteristics were determined under reaction conditions. Correlations are being developed for the diffusivities determined in this manner. The work will then be extended to examine the correctness of the presently used statistical methods for determining the adsorption constants.

20. FOLLOW-UP ACTIONS

20.1 *Monochlorobenzene*

A 4500 TPA plant erected at HOC, Rasayani, by M/s R. L. Dalal and Co. based on NCL know-how and designs has been commissioned. The capability of the plant to produce the products of the required purity and capacity has been demonstrated over an extended period of time. But some engineering problems remained and are being solved.

20.2 *Chloromethanes*

A 3000 TPA plant has been commissioned at the site of M/s Standard Alkali, Thana; based on the know-how and designs jointly developed by the NCL, and the firm. The NCL was closely associated with the firm during the trial runs. Production up to 90% of its rated capacity has so far been achieved.

20.3 *Monoethylaniline*

The commercial plant of 125 TPA capacity installed at M/s Atul Products Ltd., Bulsar, based on NCL know-how and designs, was commis-

sioned. NCL scientists were associated at the trial runs as well as at the final commissioning of the plant.

20.4 *Dimethylaniline*

A continuous vapor-phase catalytic process had been developed for the manufacture of dimethylaniline. M/s Sahyadri Dyestuffs and chemicals Poona, the sponsor, has now installed a 300 TPA semi-commercial plant based on the designs prepared by NCL. Trial production on this plant is expected to commence in July 1975.

20.5 *p-Toluidine*

The indigenous production of this important intermediate is at present based on a batch process. A continuous process for the chemical by vapour-phase catalytic hydrogenetion of p-nitrotoluene was developed under a scheme sponsored by M/s Sudarshan Chemical Industries Private Ltd. The firm has now installed a plant to produce 300 TPA of toluidine based on the designs prepared by NCL. The plant is to commence trial production soon.

20.6 *Aniline*

The NCL catalyst was tested for its active life in a single tube reactor at the site of M/s Hindustan Organic Chemicals Ltd., (HOC) Rasayani. A proposal to instal a commercial plant based on NCL know-how and designs is under consideration.

20.7 *Acetanilide*

To increase the capacity of the acetanilide plant at HOC, certain changes were suggested and implemented. They were found to work satisfactorily, resulting in an increase of 15% in production.

20.8 *Oxalic acid*

A problem of dye disposal as referred by The Vidarbha Organic Chemicals Industriss Ltd., Chandrapur was solved. A plant of 900 TPA oxalic acid is being erected and would be ready for commissioning soon.

20.9 *Fractional distillation of turpentine oil*

A plant to distil 1000 TPA of turpentine oil to obtain α-pinene, β-pinene, Δ^3-carene and longifolenes has been designed based on the data collected at the NCL. The design have been submitted to the J and K Govt., Kashmir, the sponsor.

20.10 *Ethylenediamine*

Project coordination meeting was held with Chemical and Metallurgial Design Company and Bharat Vijay Mills at New Delhi. Help was extended in the equipment design and process utility improvements.

Collection of data on corrosion for different materials of construction at various stages is in progress.

20.11 *Phenthoate*

Based on the process developed at the Laboratory, the sponsor had carried out pilot plant trials at their factory. The sponsor has installed a plant of 300 TPA capacity which was recently commissioned.

20.12 *Nitrofen*

The process development on this weedicide was reported last year. The know-how was released to M/s Delhi Pesticides P. Ltd., Bombay and the demostration on a 10 kg/batch scale was successfully given to the licencee. The product was found to be chemically identical in all respects with the product isolated from commercial formulated sample.

The firm has already started trial production.

20.13 *Tetradifon*

The know-how was released to M/s Delhi Pesticides P. Ltd., Bombay and demonstrated on 1 kg./batch scale. The product obtained was tested. It was chemically identical in all respects (elemental analysis, m.p., IR, UV) with commercial sample.

20.14 *Vitamin C*

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

20.15 *Vitamin* B_6

A 4 step process for synthesis of Vitamin B_6 was developed at the Laboratory, earlier. This know-how was released to M/s The Indian Drugs and Pharmaceuticals Ltd., (IDPL), New Delhi. The demonstration of the process was given to the representatives of M/s IDPL, in the preparation of DL-Alanine. Further, the NCL scientists actively assisted the firm in carrying out pilot plant trials at their factory at Hyderabad.

20.16 *Antioxidant TEDQ* (2, 2, 4-*Trimethyl*-6-*ethoxy*-1, 2-*dihydro-quinoline*)

Work on this project was reported during 1971-72. The process for the preparation of the antioxidant was released to M/s Amar Dye Chem Ltd., Bombay. The know-how was successfully demonstrated on 1.5 kg/batch scale.

20.17 *Glyceryl-* α*-mono-para-aminobenzoate*

A process for the preparation of glyceryl- α-mono-para-aminobenzoate was standardized earlier. However, at the request of the sponsor, further large scale trials were caried out. Work on this project is now concluded.

20·18 *Phenylacetic acid*.

Facilities were rendered to the the licencee for carrying out large scale trials (10 kg/batch) on the process at the NCL.

21. NEW ANALYTICAL METHODS

21.1 *Polyesters as stationary phases in GLC analysis* : (AB-33/73)

Gas liquid chromatography (GLC) method was developed and standardized for the estimation of impurities in micro-quantities like HCCP (hexachlorocyclopentadiene) etc., in intermediates and the final product obtained in the process for the development of Endosulfan.

22. INFRASTRUCTURE ACTIVITIES

22.1 *Analytical groups*

22.1.1 *Physico-chemical analyses* : The main activity of this group is to carry out physico-chemical analyses of raw materials, intermediates and finished products relating to the various projects in progress in the laboratory. Chemical examination of complicated samples from industries is also undertaken to a limited extent.

22.1.2 *Microanalysis* : This group is primarily engaged in microanalysis of organic and organometallic compounds for various 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.

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 period under review 2404 samples were analysed for various elements (2261) and functional groups (143).

22.1.3 *Mass spectrometry* : During the period under review 1159 samples were analysed.

22.1.4 *National collection of industrial microorganisms* : The collection consists of about 1800 non-pathogenic yeasts, bacteria and fungi. 63 cultures were added to the collection.

Cultures isolated from different mine water samples for the project on 'Bacterial leaching of ores' are being maintained. 48 compounds prepared in this laboratory were tested for their antibacterial and antifungal activities.

22.1.5 *Spectrochemical and other analyses*: With the help of various physico-organic techniques such as UV, IR, NMR, Visible spectra, VPC and GLC, analytical and structure elucidation work was carried out in the laboratory in support of the laboratory's research programme.

Number of samples studied :

NMR	3824
IR	6223
VPC/GLC	6940
X-ray powder patterns	360
Thermogravimetric analysis (DTA, TGA, TG, etc.)	88
Optical microscopy	60

22.2 *Instrumentation section*

The section is primarily engaged in maintenance and upkeep of special type of analytical instruments such as IR, UV, NMR, spectrometers, visible gas chromaotgraphs, x-ray machines etc., besides normal routine maintenance and repairs of smaller instruments like pH meters, conductivity bridges, furnaces, potentiometric recorders, microvoltmeters etc.

During the period under review, 418 jobs were completed.

22.3 *High pressure laboratory*

This section primarily provides equipment for carrying out experiments involving high pressure reactions relating to the various projects in the laboratory.

During the period under reference, 239 experiments were carried out for various projects of the laboratory.

22.4 *Engineering section*

22.4.1 *Mechanical engineering* : Apart from maintenance of the laboratory's installations, utility services and equipment, the following special fabrications were carried out for laboratory work and sponsored projects :

(i) Wire extruding machine with special type of driving mechanism, mini shop-lifter, ball rolling/mixing mill, special blow torch, drilling machine vices, double wall cabinet for flask shakers.

(ii) Snow man (dry ice forming machine)-two Nos.

(iii) Fabrication and assembly of various types of display boards with portable stands and allied fixtures for NCL exhibition.

(iv) Complete fabrication, erection and commissioning of the pilot plant for titanium tetrachloride project.

The total turnover of this section during the year was—jobs executed 2695, valued at Rs. 4.54 lakhs.

22.4.2 *Civil engineering* : During the period under review, the following constructions were carried out in addition to the maintenance works of the laboratory and colony.

(i) Construction work of a new building for stores.

(ii) Construction of compound wall in front of main laboratory building.

(iii) Construction of garages (4 Nos.) in the NCL premises.

(iv) Renovation of fountain, tanks in the NCL premises.

(v) Widening the road in front of main laboratory building.

The total value of these constructions amounted to Rs. 8.92 lakhs approximately.

22.5 *Glass blowing section*

The section primarily undertakes repairs of glass apparatus for various research groups in the laboratory. During the year under report, 1816 repair jobs were completed.

Glass assemblies of various types were fabricated as per specific drawings furnished by the scientists. In all 1852 fabrications of glass apparatus were made. Of these, 162 jobs were carried out for sponsored projects.

About 4093 standard ground-glass joints, 112 sintered glass discs and 24 high vacuum stop cocks were fabricated for the above work.

22.6 *Library*

The library houses about 65,036 publications consisting of books, periodicals, patents, standards and technical reports etc., in its stock. Around 3335 publications comprising of (i) books—1766, (ii) periodicals—1420 and (iii) patents, standards, technical reports and theses—148 were added during the period under review. 824 periodicals including annual reports of various institutes were received on continuation basis. Library facilities are extended to readers from Govt. departments, universities, colleges and other research institutions. The facilities are also made available to the representatives of industry on membership basis. About 464 persons from these organizations made use of the library facilities during 1974-75. In addition to the above, current awareness services on the following topics viz. (i) Pesticides and agrochemicals and (ii) Indian patents were rendered to the laboratory.

Microfilms and xerox copies of the references available in the library were supplied to outside parties on payment.

NCL is a Patent Inspection Centre for Indian patents. During the year under review, the library received 4000 patent specifications.

22.7 *Division of Technical Services*

Commercial intelligence

Techno-economic information of (i) mefenamic acid, (ii) antrycide–a veterinary drug & (iii) gibberelic acid was collected.

With a view to study the possibility of undertaking the project on 'Utilization of cellulosic wastes for the production of alchohol', efforts were made to identify a suitable location in Maharashtra where maximum quantity of cellulosic wastes will be available.

Routine data on prices and techno-economic information on chemicals of relevance to NCL work was maintained.

Classified press cuttings were maintained in 31 areas of interest. Some of these areas are chemicals and petro-chemicals, drugs, fertilizers, pesticides, rubbers and plastics, industrial policies, management techniques, studies of corporate sector, pollution etc.

Industrial liaision and co-ordination

Over 3200 enquiries pertaining to NCL projects, general technical enquiries from different individuals, industries and government organizations and starred questions from the Parliament were attended to. 300 licence applications for foreign collaboration and over 200 schemes for financial assistance from CSIR were scrutinised in consultation with the concerned scientists and comments of NCL were sent to CSIR.

2370 visitors from educational institutions, industries and other organizations were shown round the laboratory. Discussions were held with more than 250 entrepreneurs/parties interested in acquiring NCL processes for commercial exploitation and requisite information on their techno-economic aspects was furnished.

Non-technical notes on processes approved by Process Release Committee (PRC) were prepared along with tentative cost estimates. 14 notes were revised because of the change in the cost structure. In all 99 non-technical notes are available for circulation to interested parties.

Contractual research proposals were prepared for the following projects.

(i) Utilization of coarse and fine fibre wastes from corn starch industry for production of gums, (ii) l-Naphthylacetic acid, (iii) Propylene glycol by catalytic hydrogenation of propylene oxide, (iv) Sorbitol from glucose by continuous process, (v) Flexible polyester resin.

Liaision with CSIR

Following processes were referred to CSIR for assignment to NRDC (i) Maleic hydrazide, (ii) Flocculating agent for sugarcane juice clarification, (iii) Diazepam, (iv) Chlorinated paraffin wax, (v) Endosulfan, (vi) Nitrofen, (vii) Tetradifon, (viii) 2- Chloroethyl-trimethyl ammonium chloride (ix) Pentachloronitrobenzene.

Assistance to states/regions

The development plans of Bihar, Gujarat, Jammu & Kashmir & Karnataka States, prepared by CSIR laboratories situated in respective states, were studied in details. Areas and problems where NCL can render assistance in this development were identified and these were communicated to the concerned CSIR laboratories.

Chandrapur district is a backward area in Maharashtra State having extensive and rich mineral, forest and agricultural resources which have remained unexploited for all these years. A methodology for formulation of an ecosystem plan for the development of this district as well as the organizational pattern for its execution has been suggested to the Maharashtra Government.

Participation in exhibition organised by outside agencies

NCL participated in the 'Agro-Industrial' exhibition which was held in Poona. The NCL pavilion highlighted research and development work carried out on agrochemicals—pesticides, plant growth regulators and plant tissue culture.

Research analysis

Techno-economic reports for the following processes were prepared and placed before the NCL Process Release Committee for obtaining its clearance for the release of these processes to interested parties for commercial exploitation :—

(i) Nitrofen, (2) Tetradifon, (3) Menazon, (4) 2, 2-Dichloropropionic acid and its sodium salt, (5) Rayon grade pulp, (6) Endosulfan, (7) Maleic hydrazide, (8) Cadmium pigments, (9) Diazepam, (10) Trioxane, (11) 2-Chloroethyl-trimethylammonium chloride, (12) Vegetative propagation of hybrid cabbages.

Data on project turnover in NCL during 1969-74 was compiled to get an idea about (i) new projects undertaken every year and (ii) projects concluded (iii) projects terminated. Findings are presented in the tables I and II on the next page.

TABLE 1

PROJECT TURN-OVER IN NCL

	1969—70	1970—71	1971—72	1972—73	1973—74
1. Projects continued from previous year	115	117	106	101	105
2. New projects undertaken	45	49	51	61	47
3. Projects terminated*	43	60	56	57	27
4. Projects carried over to the next year	117	106	101	105	125

* Details about the terminated projects are given in Table 2.

TABLE 2

DETAILS ABOUT THE PROJECTS TERMINATED DURING 1969-70 TO 1973-74.

	1969—70	1970—71	1971—72	1972—73	1973—74
* 1. Projects referred to PRC	13	12	14	10	12
** 2. Projects completed	9	20	21	16	11
*** 3. Projects discountinued	21	28	21	31	4
Total projects terminated :	43	60	56	57	27

* All projects referred to CSIR/NRDC for release, are approved by NCL-PRC (Process Release Committee).

** This category includes (i) sponsored projects on which work is completed and the project know-how handed over to the sponsor.

(ii) Applied basic and basic projects which have resulted in research degrees/publications.

*** This category includes projects which are discontinued for various reasons such as :

(i) non-availability of raw material
(ii) unfavourable market situation
(iii) unsatisfactory experimental results etc.

Research planning and management

Norms for following topics were prepared. (i) Preparation of process manual for the processes completed and ready for release (ii) Preparation of status report for the project in progress, (iii) Charges to be recovered for use of NCL equipment by outside parties.

Norms for input calculations for 1975-76 were revised. Technical assistance was given to Director in respect of NCST follow up work, seminars, conferences, etc.

SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of NCL was compiled and based on this a plan for NCL's effort in next 10-15 years was formulated. In this context, 'Key Research Areas' (KRAs) for achieving the results targetted in the plan were identified.

Reports

The following reports were prepared by the division during the year under review :

(i) Annual report 1973-74 and Achievements 1973-74.
(ii) Research programme 1975-76
(iii) Achievements in technology transfer
(iv) Souvenir

} Released on the occasion of NCL Silver Jubilee Celebrations.

Miscellaneous

'Physical verification of chemical stores' was carried out and the report was submitted to authorities.

The division continued to render photographic and draftsman services to other sections in the laboratory.

APPENDICES

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

1.1 *Supply of cultures*

During the year under report, 668 cultures from the National Collection of Industrial Microorganisms (NCIM) were supplied free of charge to various institutions in India and abroad.

1.2 *Analytical services*

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

Micronalysis	67
NMR	61
IR	99
UV/UV-visible	12
Mass spectral analysis	133
VPC/GLC	82
Thermogravimetric analysis (DTA, TGA, TG, etc.)	33
X-ray powder patterns	9
Optical microscopy	20

Technical aid was rendered to about 13 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 was given to 22 representatives of industries, IITs, colleges and universities.

High pressure reaction facilities were extended to 2 outside parties for carrying out 38 experiments.

2. SPONSORED PROJECTS

2.1 *Sponsored projects concluded during* 1974-75

Process	*Name of the party*
1. 1,3-Butylene glycol	M/s Indian Petrochemicals Corporation Ltd., Baroda.

Process	*Name of party*
2. Catalytic vapour phase oxidation of olefins	M/s. Indian Petrochemicals Corporation Ltd., Baroda.
3. Cationic dyes for acrylic fibres	M/s. Sahyadri Dyestuffs and Chemicals Pvt. Ltd., Poona.
4. Composite drug research scheme on Indian medicinal plants	Ministry of Health, Govt. of India, New Delhi.
5. *p*-Cresol	M/s. Hico Products Pvt. Ltd., Bombay.
6. Dimethylaniline by continuous process	M/s. Sahyadri Dyestuffs and Chemicals Pvt. Ltd., Poona.
7. Glyceryl- ∝-mono-*p*-aminobenzoate	M/s Indian Schering Ltd., Bombay.
8. Matrix bound pencillin acylase systems	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona.
9. β-Naphthol	M/s. Hindustan Organic Chemiclals, Ltd., Rasayani.
10. 1-Naphthylacetic acid	M/s. Micro Chemicals (India), Mandsaur. (M.P.)
11. Papavarine hydrochloride	M/s. Suneeta Aromatics, Bombay.
12. Testing of rayon grade pulp from Bastar hardwoods (Temporarily discontinued)	M/s. Baroda Rayon Corporation, Udhna.
13. Utilization of coarse and fine fibre wastes from corn starch industry for the manufacture of gums	M/s. Anil Starch Products Ltd., Ahmedabad.
14. D-xylose and xylit from corn cobs	M/s. Unichem Laboratories, Bombay.

2.2 *Sponsored projects undertaken during* 1974-75

1. Fumed silica	M/s. Century Rayons, Kalyan.
2. 1-Naphthylacetic acid	M/s. Micro Chemicals (India), Mandsaur. (M.P.)

Proecss	*Name of party*
3. Sorbitol from glucose by continuous process	M/s. Anil Starch Products, Ahmedabad.
4. Utilization of coarse and fine fibre wastes from corn starch industry for production of gums	M/s. Anil Starch Products, Ahmedabad.

2.3 *Sponsored projects continued from* 1973-74

1. Acrylic acid/acrylates from acrylonitrile	M/s. Indian Petrochemicals Corporaration Ltd., Baroda.
2. Preparation of cephalexin and 7-ADCA	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona.
3. Flavonides, tannins, stilbenes, lignans and quinones in some Indinan forest trees (PL-480)	U. S. Department of Agriculture, Washington.
4. Propylene oxide (temporarily suspended)	M/s. Indian Petrochemicals Corporation Ltd., Baroda.
5. Synthesis of potential pharmacologically active substances	M/s. Sarabhai Research Centre, Baroda.

3. TECHNOLOGY TRANSFER

3.1. *Demonstrations*

Process know-how for the following products was demonstrated.

1. 2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chloro benzophenone	M/s. Chemical, Industrial and Pharmaceutical Laboratories Ltd., (CIPLA) Bombay.
2. Clofibrate	M/s. Nivedita Chemicals Pvt. Ltd., Bombay.
3. Gaskets from coir pith	M/s. Oberoi Industries, New Delhi.
4. Gum arabic substitute	1. M/s. Bal Kishan Mital, Kalyan (CR.) 2. M/s. Malwadkar Industries, Poona. 3. M/s. Supreme Enterprises, Ludhiana.
5. Nitrile rubber (High and low nitrile content rubber)	M/s. Synthetics and Chemicals Ltd., Bombay.

	Process	Name of the party
6.	Rubberized cork sheets from waste cork granules	M/s. Cork Products Pvt. Ltd., New Delhi.
7.	70% Sorbitol from dextrose monohydrate	M/s. Maize Products, Divn. of M/s. Sayaji Mills Ltd., Ahmedabad.
8.	Tamarind Kernel Powder (TKP) -phosphate and borate	M/s. S. K. Enterprises, Bombay.
9.	Vitamin B_6	M/s. Indian Drugs & Pharmaceuticals Ltd., New Delhi.

3.2 *Processes leased out during* 1974-75

1.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone	M/s. Chemical, Industrial and Pharmaceutical Laboratories, Ltd., (CIPLA), Bombay.
2.	Antioxidant TEDQ (2, 2, 4-Trimethyl-6-ethoxy-1,2-dihydroquinoline)	M/s Amar Dye-Chem Ltd., Bombay.
3.	Clofibrate	M/s. S. D's Lab-Chem Industry, Bombay.
4.	Diazepam	M/s. S.D's Lab-Chem Industry, Bombay.
5.	Gum arabic substitute	1. M/s. Malwadkar Industries, Poona. 2. M/s. Industrial Solvents and Chemicals P. Ltd., Bombay.
6.	Nicotine sulphate from tobacco and tobacco waste	1. M/s. Ganesh Tobacco Byeproducts Industries P. Ltd., Borsad. 2. Mr. K. V. Rangasamy Mudaliar, Chittod P. O., Coimbatore. 3. Dr. J. A. Naik, Simla. 4. M/s. Spar Chemicals, Nipani 5. M/s. Agro Chemical Industries, Parchure, Dist. Prakasam, (A. P.)

	Process	*Name of the party*
7.	Nitrofen	M/s. Delhi Pesticides P. Ltd., Bombay.
8.	70% Sorbitol from dextrose monohydrate	M/s. Anil Starch Products Ltd., Ahmedabad.
9.	Tetradifon	M/s. Delhi Pesticides P. Ltd., Bombay.
10.	Thioglycolic acid	M/s. S. D's Lab-Chem Industy, Bombay.

3 3 *Processes assigned to NRDC during* 1974-75

1. 2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone
2. Chlorinated paraffin wax
3. Diazepam
4. Diethyl toluamide
5. Endosulfan
6. Expandable polystyrene beads
7. Flocculating agent for sugarcane juice clarification
8. Nitrofen
9. Tetradifon

3.4 *Premia & royalties received by NRDC through NCL processes during the year* 1974-75

Premia

S. No.	*Name of the process*	*Name of the firm*	*Premium received (Rs.)*
1.	2-Amino-5-chloro-benzophenone and 2-Methyl-amino-5-chlo-robenzophenone	M/s. Chemical, Industrial & Pharmaceutical Laboratories Ltd., (CIPLA), Bombay.	30,000
2.	Antioxidant TEDQ (2,2,4-Trimethyl-6-ethoxy-1,2-dihydro-quinoline)	M/s. Amar Dye Chem Ltd., Bombay.	10,000*
3.	Clofibrate	1. M/s. S.D.'s Lab.-Chem Industry, Bombay.	10,000

S. No.	Name of the Process	Name of the firm	Premium received (Rs.)
		2. M/s. Nivedita Chemicals Pvt. Ltd., Bombay.	10,000
4.	Diazepam	M/s. S.D.'s Lab-Chem Industry, Bombay.	20,000
5.	Flexible magnets	M/s. Ferrites & Electronic Components P. Ltd., Lucknow.	2,000*
6.	Gum arabic substitute	1. M/s. Malwadkar Industries, Poona.	5,000
		2. M/s. Industrial Solvents & Chemicals Pvt. Ltd., Bombay.	5,000
7.	Microfilters	M/s. Sona Micro Filters, Poona.	10,000*
8.	Nicotine sulphate from tobacco & tobacco waste	1. M/s. K. V. Rangasamy Mudaliar, Chittod P. O.	2,000
		2. Shri M. M. Patel, P. O. Sunav.	2,000
		3. M/s. Spar Chemicals, Nipani.	2,000
		4. Mr. J. A. Naik, Simla.	2,000
9.	Nitrile rubber	M/s. Synthetics & Chemicals Ltd., Bombay.	70,000*
10.	Radiosonde thermistors	M/s. Bhagyanagar Laboratories, Hyderabad.	5,000*
11.	70% Sorbitol from dextrose monohydrate	M/s. Anil Starch Products Ltd., Ahmedabad.	75,000

S. No.	Name of the process	Name of the firm	Premium recetved (Rs.)
12.	Tamarind kernel powder (TKP)—Phosphate & Borate	M/s. S. K. Enterprises, Bombay.	5,000
13.	Terpineol	M/s. Dujodwala Industries. Faridabad.	15,000*
14.	Thioglycolic acid	M/s. S.D.'s Lab-Chem Industry, Bombay.	10,000
		Total	2,90,000·00

* Part payment

Royalties

S. No.	Name of the process	Name of the firm	Royalties received (Rs.)
1.	Antipriming compositions	Research, Design & Standard Orgn., M&C Wing, Lucknow.	717.18
2.	Bacterial diastase	M/s. Chemaux (P)Ltd. Bombay	2,093.53
3.	Bostik sealants-substitute	M/s. Swastik Rubber Products, Ltd., Khadki, Poona-3.	438.92
4.	*tert*-Butyl catechol	M/s. Percynic Chemicals, Bombay.	2,029.30
5.	Butyl titanate	M/s. Synthochem, Indore.	21,010.85
6.	Cadmium sulphide photoconductive cells	M/s. Chinoy Electronics, Poona.	684.90
7.	Catechol	M/s. Percynic Chemicals, Bombay.	1,926.00
8.	Clofibrate	(1) M/s. Biological Evans Ltd., Hyderabad.	7,507.47

S. No.	Name of process		Name of firm	Royalities Received (Rs.)
		(2)	M/s. Nivedita Chemicals (P) Ltd., Bombay.	2,536.00
9.	Ferrites- Hard		M/s. Semiconductors Ltd., Poona.	2,698.33
10.	Gum arabic substitute	(1)	M/s. Karnataka Adhesives, Bangalore.	313.38
		(2)	M/s. Malwadkar Industries, Poona	2.33
11.	β-Ionone		M/s. Industrial Perfumes Ltd., Bombay.	51,790.67
12.	Nicotine sulphate from tobacco and tobacco waste		M/s. Urvakunj Nicotine Industries, Dharmaj.	38,294.28
13.	D. C. Recording polarograph		M/s. Chromatography & Instruments Co., Baroda.	1,005.00
14.	Polyurethane printing rollers		M/s. Sree Saraswaty Press Ltd., Calcutta.	5,127.67
15.	Sachets—hot and cold	(1)	M/s. Thermo Chem Laboratories, Poona.	13.15
		(2)	M/s. Vasant Industrial Corpn., Nagpur.	209.75
16.	Sisal wax		M/s. Aphali Pharmaceuticals Ltd, Ahmednagar.	13.75
17.	Vapour phase chromatograph		M/s. Associated Instrument Manufacturers (India) P. Ltd., New Delhi.	19,000.00
18.	Vitamin C		M/s. Hindustan Antibiotics Ltd., Pimpri.	32.10
			Total	1,57,444.56
			Total Premia and Royalties	4,47,444.56

4. SEMINARS AND LECTURES

4.1 *Lectures*

The following visiting scientists delivered lectures in the Laboratory

1.	Dr. B. L. Kaul, Sandoz Ltd., Basel, Switzerland.	Inverse indigo synthesis — reaction.
2.	Prof. Alok K. Chakrabarti, DePaul University, Chicago, Illinois, U.S.A.	Barriers to innovation.
3.	Prof. R. Srinivasan, Thomas J. Watson Research Centre, Yorktown Heights, New York, U.S.A.	Thermal transformations of the photochemical 1, 3-Adducts of benzene to olefins.
4.	Prof. S. Rangaswami, Dept. of Chemistry, University of Delhi, Delhi.	New tetracyclic triterpenes of *fomes senex*.
5.	Dr. R. C. Pandey, Dept. of Chemistry and Chemical Engineering, University of Illinois, U.S.A.	Mass spectrometry and 13 C-NMR spectroscopy in structural studies of peptide antibiotics.
6.	Dr. B. L. Horecker, Roche Institute of Molecular Biology, Nutley, N. J., U.S.A.	A possible role of lysosomal proteases in the regulation of gluconeogenesis.
7.	Dr. T. M. Paul, National Dairy Research Institute, Aarey Milk Colony, Bombay.	Recycling of wastes.
8.	Prof. B. M. Johri, Dept. of Botany, Delhi University, Delhi.	Endosperm and embryo culture. Contemporary botanists.
9.	Prof. D. Devaprabhakara, Indian Institute of Science, Bangalore.	Chemistry of cyclononadienes.
10.	Dr. K. Vaidyanathan, Hindustan Lever Ltd., Bombay.	Planning and execution of research project.

11.	Prof. M. M. Sharma, Bombay University, Dept. of Chemical Technology, Bombay.	Series of lectures on Gas-liquid and gas-liquid-solid reactions.
12.	Prof. D. T. Wasan, Illinois Institue of Technology, Chicago, USA.	A newer method of separation for dispensed organic from aqueous media.

4.2. The following NCL scientists delivered lectures at various institutes, universities, colleges, etc.

Name of the scientist	*Subject*	*Venue*
1. Dr. J. L. Bose	Organic marine chemicals of importance.	National Institute of Oceanography, Panaji, Goa.
2. Mr. A. D. Deshpande	Use of stainless steel as material of construction in chemical and process industries.	Institute of Engineers, Poona.
3. Dr. A. Goswami	Physics of thin films.	Ahmednagar College, Ahmednagar
4. Dr. C. R. Narayanan	Some oxidation studies of ethylenic linkages.	Laboratorie de Chimie Organique, Universite de Paris IV France.
	Restricted rotation around some carbon carbon single bonds.	-do-
	Conformation of the ester carbonyl in steroids.	Czechoslovak Academy of Sciences, Institute of Organic Chemistry and Biochemistry, Prague.
	Some unusual oxidation products of unsaturated steroids.	Slovenska Chemick Spolocuost Prisav, Bratislavia, Czechoslovakia.

Name of the Scientist	*Subject*	*Vanue*
	Conformational studies of some carboxylic acids by PMR spectroscopy.	Chemical faculty Polytechnika. Warsaw Poland,
	Restricted rotation around some carbon-nitrogen single bonds.	Laboratory of Organic Chemistry, National Technical University of Athens, Greece.
5. Dr. A. V. Rama Rao	Biogenetic concepts in structural elucidatino of some phenolic compounds.	Imperial College of Science and Technology, London, U. K.
	-do-	Reading University, Reading, U.K.
	-do-	Aberdeen University, Aberdeen, U.K.
	-do-	Nottingham University, U.K.
	Applications of NMR spectroscopy and mass spectrometry to some problems concerning synthetic dyes.	Leeds University, Leeds, U.K.
	Some aspects of the chemistry of synthetic dyes and related compounds.	Salford University, Salford, U.K.
6. Dr. P. N. Rangachari	Industrial fermentation	Abasaheb Garware College, Poona.
	-do-	Maharashtra Association for the Cultivation of Science, Poona.
7. Dr. T. Ravindranathan	Synthesis of prostaglandins :	Indian Institute of Technology, Kanpur

Name of the scientist	*Subject*	*Venue*
	Problems, Methods and Results	
	-do-	Central Drug Research Institute, Lucknow.
8. Dr. A. P. B. Sinha	Metal-insulator transition in V_2O_3	Poona University, Poona
	Mechanism of electron transport in Cr doped V_2O_3	Pennsylvania State University, U.S.A.

5. STAFF STRENGTH* AS ON 31-3-1975

1. Scientific		
(i)	Director	1
(ii)	Scientist F	6
(iii)	Scientist E	20
(iv)	Scientist C	63
(v)	Scientist B	47
(vi)	Scientist A	42
(vii)	S. S. A.	87
(viii)	J. S. A.	40
(ix)	S. L. A.**	67
	Total	373
2. Technical		204
3. Administration		100
4. Class IV technical		134
5. Class IV non-technical		81
	Total (1-5)	892
6. Research fellows, Pool Officers and Guest Workers		
(a)	JRF & SRF	54
(b)	Post-doctoral Research fellows	2
(c)	CSIR Pool Officers	4
(d)	Guest workers	26
	Total	86

7. Scientific staff working on sponsored projects		
(a)	NCL staff	3
(b)	Staff deputed by sponsors	27
	Total	30

* This denotes actual working staff.

** 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.

6. STAFF NEWS

6.1 *Deputations/training etc.*

1. Dr. A. V. Rama Rao visited U. K. under the CSIR British Council (Bursar award) exchange programme. He spent eight weeks in Prof. Sir D. H. R. Barton's Laboratory at the Imperial College of Science and Technology. Dr. Rama Rao also visited a few pharmaceutical concerns (Oct.-Dec. 1974).

2. Dr. S. P. Vernekar attended a post-graduate training course in "Macromolecular chemistry", in Prague, Czechoslovakia under UNESCO programme (Oct. 1974 — June 1975).

3. Dr. C. A. Chinchwadkar received training in gas chromatograph-mass spectrometer operation technique for one week at Fertiliser Corporation of India, Sindhri (March 1975).

4. Mr. S. S. Joshi attended a course on "Information storage and retrieval systems" at SIET, Hyderabad (August 1974).

5. Mr. K. P. Madhusudanan received training in "The methodology involved in the determination of drug levels in biological fluids", at CIBA Research Centre, Bombay (January 1975).

6. Mr. N. Mohandas attended training course on "Civil defence organizatoin" at Civil Defence Staff college, Bombay (February 1975).

7. Mr. J. V. Rajan attended a curse on "PERT—CPM", at NITIE, Bombay (December 1974).

8. Dr. A. P. B. Sinha was deputed to U. S. A. under CSIR-NSF exchange programme (March 1973-May 1974).

6.2 *Participation of NCL scientists in seminars and symposia.*

1.	Seminar on industries based on petrochemicals, Baroda.	Dr. S. M. Abhyankar Mr. V. Krishnan.
2.	Seminar on 'Optimum utilization of productive resources in chemical industries, Rasayani.	Dr. L. K. Doraiswamy Dr. S. M. Abhyankar
3.	Gobar gas meeting, New Delhi.	Dr. V. Jagannathan Dr. M. Goswami
4.	International sysmposium on "Regulation of growth and differentiated function in Eukaryote cells," Delhi.	Dr. V. Jagannathan
5.	Seminar course organized by Ahmednagar College at Mahabaleswar.	Dr. V. Jagannathan
6.	Seminar on 'Appropriate technology', Hadapsar, Poona.	Mr. V. S. Krishnamachar Mr. S. R. Modak
7.	Interlaboratory project meeting on bacterial leaching, Bhubaneswar.	Mr. V. S. Krishnamachar Dr. P. N. Rangachari
8.	Interlaboratory project meeting on bacterial leaching, Poona.	Dr. V. Jagannathan Dr. P. N. Rangachari Mr. V. S. Krishnamachar
9.	Chandrapur development plan meetings, Bombay.	Mr. J. V. Rajan
10.	Meeting for the formulation of S & T plan for Maharashtra, Bombay.	Mr. J. V. Rajan
11.	'Singlet molecular oxygen-symposium', Bombay.	Dr. T. Ravindranathan
12.	Third international study Conference on 'Classification research,' Bombay.	Mr. R. S. Singh
13.	Gobar gas meeting, Nagpur.	Dr. B. D. Tilak Dr. M. Goswami Dr. J. C. Sadana

14.	Seminar on 'Information services business and industry', Bangalore	Mr. R. S. Singh
15.	Seminar on 'Research Management,' for CSIR Directors, Hyderabad.	Dr. B. D. Tilak
16.	All India Chemists' Convention, Madurai	Dr. A. P. B. Sinha

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

Sr. No	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
1.	Badami, N. V.	Ph.D.	Bombay	Studies in synthetic dyes—dyes containing azido groups	Dr. B. D. Tilak
2.	Chattopadhyaya, J. B.	Ph.D.	Poona	Some aspects of the chemistry of sulphur dyes and other sulphur compounds	Dr. A. V. Rama Rao
3.	Chaudhari, P. N.	Ph.D.	Poona	Reactions of compounds related to dimethyloctane, L-menthane and cholestane	Dr. A. S. Rao
4.	Gandhi, V. G.	Ph.D.	Poona	Polymerization studies with Ziegler-Natta catalyst systems	Dr. S. L. Kapur
5.	Kulkarni, A. K.	Ph.D.	Poona	Studies in polyisoprenoids and related compounds	Dr. C. R. Narayanan
6.	Kulkarni, P. S.	Ph.D.	Poona	Studies on unimolecular ion decompositions induced by electron impact	Dr. K. G. Das

Sr No.	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
7.	Lahoti, R. J.	M.Sc.	Shivaji	Studies in disperse dyes derived from aminoanthraquinones and synthesis of heterocyclic compounds using phenylisothiocyanate	Dr. A. V. Rama Rao
8.	Mitra (Mrs.), A.	Ph.D.	Poona	Some studies on optical and other properties of some semiconducting films	Dr. A. Goswami
9.	Mundle, A. S.	M.Sc.	Bombay	Studies in rubber chemicals	Dr. N. D. Ghatge
10.	Namjoshi, A. G.	Ph.D.	Poona	Synthesis of heterocyclic compounds	Dr. B. D. Tilak
11.	Ojha S. M.	Ph.D.	Poona	Studies on Hall effect and other properties of vacuum deposited thin films	Dr. A. Goswami
12.	Paknikar, U. M.	M.Sc.	Bombay	Chemical investigation on terpenes and related compounds	Dr. K. K. Chakravarti
13.	Parameswaran, V.	Ph.D.	Bombay	Application of NMR spectroscopy and mass spectrometry to some problems concerning synthetic dyes	Dr. K. Venkataraman

Sr. No.	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
14.	Parkar (Miss), M. S.	Ph.D.	Poona	Nitration of unsaturated steroids and related studies	Dr. C. R. Narayanan
15.	Pendse, A. D.	Ph.D.(Tech.)	Bombay	Wood extractives	Dr. K. Venkataraman
16.	Prabhat Singh	Ph.D.	Poona	Electron diffraction studies of some vacuum deposited semi-conducting thin films	Dr. A. Goswami
17.	Rao, B. V.	Ph.D.	Poona	Some studies on optical properties of thin films	Dr. A. Goswami
18.	Takwale, M. G.	Ph.D.	Poona	The crystal and molecular structures of *p*-toluic acid and 2-nitro-4-methyl-benzoic acid by X-ray diffraction	Dr. L. M. Pant
19.	Talele, G. D.	Ph.D.	Poona	Electron diffraction studies of some chalcogenide and oxide films	Dr. A. Goswami
20.	Thayamanavan, B.	Ph.D.	Poona	Some applications of mass spectrometry in biochemistry	Dr. K. G. Das

Sr. Nn.	*Name*	*Degree*	*University*	*Subject of thesis*	*Guide*
21.	Uppal, K. S.	Ph.D.	Poona	Studies of new stationary phases and their application in gas-liquid chromatography.	Dr. B. B. Ghatge
22.	Vaidya S. V.	Ph.D.	Poona	Synthesis and evaluation of compounds for polymers (PVC) using indigenous raw materials	Dr. N. D. Ghatge

6.4 *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, Poona, Shivaji, Karnatak
4.	Dr. Damodaran, V.	Shri Venkateswara
5.	Dr. Das, K. G.	Bombay, Kalyani, Kerala, Marathwada, Poona
6.	Dr. Doraiswamy, L. K.	Bombay, Calcutta, Jadavpur, Nagpur, Poona.
7.	Dr. Ghatge, B. B.	Poona
8.	Dr. Ghatge, N. D.	Bombay, Poona, Shivaji
9.	Dr. Gogte, V. N.	Shivaji
10.	Dr. Gopinathan, C.	Poona
11.	Dr. Goswami, A.	Poona, Shivji
12.	Dr. Ingle, T. R.	Poona
13.	Dr. Jagannathan, V.	Baroda, Bombay, Poona
14.	Dr. Jose, C. I.	Poona
15.	Dr. Joshi, R. M.	Bombay, Poona
16.	Dr. Kapur, S. L.	Bombay, Poona, Punjab
17.	Dr. Katti, S.S.	Bombay, Poona
*18.	Dr. Kelkar, G. R.	Bombay, Poona, Shivaji
19.	Dr. Kulkarni, G. H.	Nagpur
20.	Dr. Kulkarni (Miss), S. B.	Poona
21.	Dr. Kulkarni, S. N.	Bombay, Karnatak, Poona, Shivaji
22.	Dr. Mathur, H. B.	Agra, Banaras, Bombay, I.I.T. Bombay, Madras, Poona
23.	Dr. Mitra, R. B.	Poona
24.	Dr. Nair, P. M.	Andhra, Poona, Shivaji
25.	Dr. Nanavati, D. D.	Bombay
26.	Dr. Narayanan, C. R.	A. B. Univ. Zaria, Nigeria, Bombay, Poona
27.	Dr. Nayak, U. R.	Poona
28.	Dr. Pai, M. U.	Bombay
29.	Dr. Pansare, V. S.	Poona
30.	Dr. Pant, L. M.	Poona
*31.	Dr. Ramachandran, B. V.	Poona, Shivaji

32.	Dr. Rama Rao, A. V.	Bombay, Poona, Shivaji
33.	Dr. Rangachari, P. N.	Poona, Shivaji
34.	Dr. Rao, A. S.	Poona, Shivaji
35.	Dr. Roy Chowdhury, P.	Marathwada, Poona, Shivaji
36.	Dr. Sadana, J. C.	Aligarh, Poona
37.	Dr. Sen, D. N.	Bombay, Poona
38.	Dr. Sethi, S. C.	Poona
39.	Dr. Sinha, A. P. B.	Banaras, Bombay, Poona
40.	Dr. Siva Raman, C.	Poona
41	Dr. Tilak, B. D.	Bombay, Poona
*42.	Dr. Venkataraman, K.	Banaras, Bombay, Karnataka, Madras, Poona,

* Retired/Emeritus scientists

6.5 *Consultancy*

During the year consultancy was offered to the following firms either through individual scientists or groups of scientists, wherein 10 scientists were involved.

1. Aniline Dyestuffs and Pharmaceuticals (P) Ltd. ,Bombay
2. Hindustan Antibiotics Ltd., Pimpri, Poona
3. Hindustan Ferodo Ltd., Bombay
4. Indian Dyestuffs Industries Ltd., Bombay
5. National Rifles Ltd., Ahmedabad
6. Poona Synthetics Company, Poona
7. Spaniko Chemicals (P) Ltd., Chiplun

7. PUBLICATIONS

7.1 *Papers published*

Pesticides and agrochemicals

1. Bhagwat (Miss), V. M., Ramchandran, B. V. and Nair, P. M.
   Action of alkali and hydroxylamine on S-(1, 2-dicarbethoxyethyl) *o*, *o*-dimethyl phosphorodithioate (malathion).
   Indian J. Chem., **12**, 502 (1974).

2. Bhagwat (Miss), V. M. and Ramchandran, B. V.
   Estimation of malaoxon in the presence of malathion by the ferric hydroxamate method.
   J. Ass. Off. Anal. Chem., 57, 1043 (1974).

Organic intermediates, dyes and industrial chemicals

3. Ayyangar, N. R.
Chemistry of cationic dyes.
Colourage, **21** (17), 29 (1974); *Man-made Textiles in India Annual* 3 (1974).

Utilization of plant and forest resources

4. Deshpande, V. H., Rama Rao, A. V., Venkataraman, K. and Wakharkar, P. V.
Wood phenolics of *Morus* species, Part III Phenolic constituents of *Morus rubra* bark.
Ind. J. Chem., **12**, 431 (1974).

5. Rama Rao, A. V., Sarma, M. R., Venkataraman, K. and Yemul, S. S.
A benzophenone and xanthone with unusual hydroxylation patterns from the heartwood of *Garcinia pedunculata*.
Phytochem, **13**, 1241 (1974).

6. Nanavati, D. D. and Bose, J. L.
Flame retardant finishes for cotton textiles.
J. Industry and Trade, **24**, 34 (1974).

7. Nanavati, D. D.
Effecting of aging on the performance of nickel formate as a catalyst in oil hydrogenation.
Ind. J. Tech., **72**, 61 (1974).

8. Narayanan, C. R. and Natu, A. A.
Triterpene acids from Indian clove buds.
Phytochemistry, **13**, 1999 (1974).

9. Nayak, U. R.
Turpentine as a raw material for perfumery.
Chemical Engineering world, **9**, 97 (1974).

10. Majumdar, R. B., Rama Rao, A. V., Rathi, S. S. and Venkataraman, K.
Swietenone, the first natural *t*-butyl ketone from *Chloroxylon swietenia*.
Tetrahedron Letters, 867 (1975).

Studies in organic syntnesjs

11. Narayanan, C. R. and Parkar (Miss), M. S.
A spontaneous abnormal Backmann rearrangement.
Chemistry and Industry, 163 (1974).

12. Narayanan, C. R., Prakash, S. R. and Nagasampagi, B. A.
A Simple method to convert a cyclosteroid to an unsaturated steroid.
Indian J. Chem., **12**, 991 (1974).

13. Narayanan, C. R., Kulkarni, A. K., Landge, A. B. and Wadia, M. S.
A novel cleavage of a steroid epoxide by Ritter reaction.
Indian J. Chem., **12**, 992 (1974).

14. Narayanan, C. R. and Kulkarni, A. K.
Simple methods to identify a methyl group on a carbon bearing a hydroxyl group.
Indian J. Chem., **12**, 677 (1974).

15. Narayanan, C. R., Parkar (Miss), M. S. and Ramaswamy, P. S.
Oxidation product of cholesteryl acetate with sodium nitrite and acid.
Chemistry and Industry, 208 (1974).

16. Narayanan, C. R., Pachapurkar, R. V. and Kornule, P. M.
A novel hexacyclic tetranortriterpenoid.
Chemistry Letters (Japan), 357 (1974).

17. Narayanan, C. R., Prakash, S. R. and Nagasampagi, B. A.
A simple method to convert a 3, 5-cyclo steroid to a Δ^5-steroid.
Chemistry and Industry, 966 (1974).

18. Narayanan, C. R. and Natu, A. A.
Synthesis of some bridged triterpene ethers.
J. Org. Chem., **39**, 2639 (1974).

19. Nanavati, D. D.
Catalytic dehydrogenation of alcohols.
J. Ind. Chem., Soc. **51**, No. 5, 551 (1974).

20. Patwardhan (Mrs.), S. A. and Sukh Dev.
Amber lyst-IS, a superior catalyst for the preparation of enol ethers and acetals.
Synthesis, 348 (1974).

21. Gogte, V. N., Mullick, G. B. and Tilak, B. D.
Synthesis of heterocyclic compounds Part X : Synthesis of dibenzacridines and dibenzophenanthridines.
Indian J. Chem., **12**, 1227 (1974).

22. Berde (Miss), H. V., Gogte, V. N., Mullick, G. B. and Tilak B. D.
Synthesis of heterocyclic compounds Part XI : Synthesis of some dibenzophenanthridines.
Indian J. Chem., **12**, 1230 (1974).

23. Gogte, V. N., Mukhedkar (Mrs.), V. A., H-Namaky, H. M., Salama, M. A. and Tilak, B. D.
Synthesis of heterocyclic compounds Part XII : Cyclodehydration of 1-arylamino-3-alkanols.
Indian J. Chem., **12**, 1234 (1974).

24. Deodhar, R. S., Gogte, V. N. and Tilak, B. D.
Synthesis of heterocyclic compounds Part XIII : Synthesis of 1-phenyl 1-thioniumcyclobut-2-ene perchlorates and their rearrangement through 1-S-phenylthiacyclobutadiene.
Tetrahedron Letters, 3911 (1974).

25. Gogte, V. N., More, K. M. and Tilak, B. D.
Interaction of dimethylsulphoxonium methylide with quinoline-N-oxide 4,7-methoxyquinoline-N-oxide.
Indian J. Chem., **12**, 1238 (1974).

26. Gogte, V. N., Mullick, G. B. and Tilak, B. D.
Synthesis of heterocylic compounds Part XV : Synthesis of dibenzo (b, j) (4,7) phenanthroline.
Indian J. Chem., **12**, 1324 (1974).

27. Chattopadhyaya, J. B. and Rama Rao, A. V.
Silica gel induced isomerization of aldoximes to amides; a general method.
Tetrahedron, **30**, 2899 (1974).

28. Deshpande, R. J. and Rama Rao, A. V.
Synthesis-*s*-triazolo (4,3-a)-*s*-triazines and their isomerization to *s*-triazolo (2,3-a)-2-triazines.
Synthesis, **12**, 863 (1974).

29. Prakasha Rao, A.S.C., Nayak, U. R. and Sukh Dev.
Psoralea corylifolia Linn-4 : Acid catalyzed cyclization of Bakuchiol-methyl ether.
Tetrahedron, **30**, 1107 (1974).

30. Gokhale, P. D., Dalvoy, (Mrs.), V. S., Prakasha Rao, A.S.C., Nayak, U. R. and Sukh Dev.
A new simple synthesis of a prostanoid synthon.
Synthesis, **718** (1974).

31. Nair, P. M. and Gogte, V. N.
Proton-chemical shifts in some condensed thiophenes.
Indian J. Chem., **12**, 589 (1974).

32. Gopichand, Y. and Chakravarti, K. K.
Total synthesis of ∝-bisabolol-3-one and deodarone.
Tetrahedron Letters, 3851 (1974).

33. Chakravarti, K. K., Hazra, B. G. and Gopichand, Y.
Synthesis of 17-hydroxy-ll-methoxy-18-norandrosta-4, 8(9), 11, 13 (14)-tetraene-3-one, a ring-C aromatic steroid.
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7.2 *Publications in collaboration with outside scientists*

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7.3 *Chapters in Books*

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7.4 *Papers presented at symposia, seminars etc.*

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3. Goswami, A. and Ojha, S. M.
The transport properties of nickel sulphide films.
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Dielectric relaxation in Indium oxide films.
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Electron transport in Cr-doped V_2O_3.
International symposium on Metal Oxides.
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8. PATENTS IN FORCE

8.1 *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. **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.

5. **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.

6. **86991***
   Preparation of polyurethane printing rollers.
   Ghatge, N. D. and Kapur, S. L.

7. **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.

8. **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.

9. **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.

10. **98156***
    Preparation of solvent modified copolymers of vinyl monomers in bead form.
    Kapur, S. L. and Ramakrishnan, K.

11. **109489**
    Production of aryl-glycosides.
    Ingle, T. R. and Bose, J. L.

12. **116453**
    Disperse dyes for polyesters with good affinity and sublimation fastness.
    Raman, S. K. and Tilak, B. D.

13. **116675**
    Improvements in or relating to polymers possessing polyamide linkages for plastics, fibres and like industrial applications.
    Ghatge, N. D., Patil, S. B. and Patil, V. S.

14. **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.

15. **118476**
    Methods of preparing isocyanates, mono and polyureas from pentadecenyl phenol (anacardol).
    Ghatge, N. D. and Yadav, S. D.

16. **121538**
    A process for the shellac-polyester urethane compositions for use in textiles, water proofing adhesives, paints and varnishes and in electrical insulating varnishes.
    Ghatge, N. D. and Srinivasan, S. R.

17. **123638**
    Improvements in or relating to the manufacture of cashewnut shell gum (CNS-gum).
    Ingle, T. R., Vaidya, S. H. and Pai, M. U.

18. **125138**
    Method of preparing polyisocyanates and polyureas from pentadecenyl phenol (anacardol).
    Ghatge, N. D. and Mahajan, S. S.

19. **126354**
    A process for obtaining useful steroids from a new plant source.
    Sukh Dev, Patil, V. D. and Nayak U. R.

20. **126393***
An improved method for the manufacture of calcium hypophosphite.
Goswami, M., Lobo, J. and Brahme, P. H.

22. **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.

21. **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.

23. **134641**
A device for warming and cooling.
Lakhbir Singh and Kotasthane, A. N.

* These patents (9) have been released for exploitation.

8.2 *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. **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.

3. **113703**
Improvements in or relating to magnesium zinc ferrites.
Krishna Rao, V. V., Kanade (Miss), S. B. and Sinha, A. P. B.

4. **113825**
Nickel zinc ferrites.
Krishna Rao, V. V., Kanade (Miss.), S. B. and Sinha, A. P. B.

5. **127743**
A process for obtaining colchicine from a new plant source.
Kapadia, V. H., Sukh Dev and Rao, R. S.

6. **127750**
A process for production of pyridoxine hydrochloride.
Joshi, C. G. and Sukh Dev.

7. **131606**
Improvements in or related to a process for the preparation of gamma ferric oxide.
Lakhbir Singh, Chavan, A. M. and Kotasthane, A. N.

8. **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.

9. **328/72**
A new process for the halogenation of copper phthalocyanine.
Ayyangar, N. R., Moghe, P. P. and Tilak, B. D.

10. **1894/72**
A new method for beneficiation of minerals, ores and industrial waste products through direct high temperature chlorination in absence of a reducing agent.
Neurgaonkar, V. G., Dadape, V. V. and Kuruvilla, J.

11. **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.

12. **2331/72**
Improvement in or relating to the preparation of new reactive dyes.
Ayyangar, N. R., Badami, N. V., Tilak, B. D. and Daruwalla, E. H.

13. **2232/72**
Process for the preparation of D-Galactose from cashewnut shells.
Ingle, T. R., Vaidya, S. H. and Pai, M. U.

14. **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.

15. **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.

16. **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.

17. **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.

18. **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.

19. **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.

20. **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.

21. **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.

22. **417/Cal/75****
Preparation of aminopolyols using CNSL and making polyurethane rigid foams.
Ghatge N. D., and Gujar, K. B.

** These patents have been newly filed during the year.

8.3 *Foreign patents in force*

1. **Belgium Patent No. 751806**
A process for obtaining useful steroids from a new plant souce (corr. to Indian Patent No. 126354).
Sukh Dev, Patil, V. D. and Nayak, U. R.

2. **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.

3. **U. S. A. Patent No. 2946783**
Preparation of costus root oil and the production thereof (corr. to Indian Patent No. 59853).
Kelkar, G. R. and Bhattacharyya, S. C.

4. **Cuba Patent No. 149082**
Manufacture of nicotine sulphate from tobacco or tobacco waste (corr. to Indian patent No. 45666).
Gedeon, J. and Goswami, M.

5. **U. S. A. Patent No. 2749247**
Air drying wrinkle finish coating composition (corr. to Indian patent No. 44737).
Aggarwal, J. S. and Sharma, P. G.

6. **U. S. A. Patent No. 2685593**
Manufacture of useful compounds and products from the seed oil of *Mallotus philippinensis Muell, Arg.* (Kamala) (Corr. to Indian Patent No. 44736).
Aggarwal, J. S., Sharma, V. N. and Gupta, S. C.

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 1974—75 Qty/Value Rs. in lakhs	Production Upto March 74 Qty/Value Rs. in lakhs	Nature of release and Remarks
1	2	3	4	5	6	7
1.	Acetanilide	Intermediates	M/s. Hindustan Organic Chemicals Ltd., P. O. Rasayaani-410207 [through project engineers M/s. R. L. Dalal & Co., Bombay-18] (1969)	1683.59 T 270.68	5714.55 T 447.54	Non-exclusive
2.	Acriflavine	Pharmaceuticals	M/s. Western India Fine Chemicals, 38, Agra Road, Mulund (West), Bombay-400080 (1969)	0·84 T 4.31	4.55 T 19.76	Sponsored; 0.65 T of the material worth Rs. 2.97 lakhs was exported.

1	2	3	4	5	6	7
3.	Adhesives for decorative laminates	Laminates	M/s. Swastik Rubber Products Ltd., Swastik House, Khadki, Poona-411003 (1969)	0.90 T 0.51	75.75 T 7.69	Sponsored
4.	Anion exchange resin from melamine (71190)	Demineralization of liquids	M/s. Tulsi Industries, Bhosari Industrial Area, Poona-411026 (1963)	— —	845 Cu.ft. 2.07	Non-exclusive
5.	Antipriming compositions (77081)	Antipriming in locomotives	Research, Designs and Standards Organization, M & C Wing, Lucknow-226011 (1964)	5.79 T 0.19	118.6 T 3.23	Non-exclusive
6.	Bacterial diastase	Textile desizing	M/s. Chemaux (P) Ltd., Rang Udyan, Sitladevi Temple Road, Mahim, Bombay-400016 (1967)	16.8 T 0.78	341.58 T 19.00	Non-exclusive
7.	Berberine hydrochloride	Pharmaceuticals	M/s. Nitin Pharmaceuticals, 180/82, Samuel Street, Bombay-400009 (1965)	4.80 T 14.40	24.30 T 48.36	Sponsored
*8.	Bostik sealants-substitute	Oil resistant adhesive for aircraft fuel tanks	M/s. Swastik Rubber Products Ltd., Poona-411003 (1974)	0.19 T 0.35	— —	Non-exclusive

1	2	3	4	5	6	7
9.	*tert*-Butyl-catechol	Synthetic rubber	M/s. Percynic Chemicals, Bombay Silk Mills Building, Industrial Estate, Lalbaugh, Bombay-400012 (1972)	4.01 T 5.22	7.8 T 5.95	Non-exclusive
10.	Butyl titanate	Varnishes, enamels	M/s. Synthochem, 33-A, Laxmibai Nagar Industrial Estate, Indore-452002 (1973)	2.34 T 0.70	36.45 T 11.95	Non-exclusive
11.	Cadmium sulphide photo-conductive cells	Electronics	M/s. Chinoy Electronics, 64, Koregaon Park, Poona-411001 (1971)	1656 Nos. 0.20	1730 Nos. 0.20	Non-exclusive
12.	Calcium hypophosphite (126393)	Pharmaceuticals	M/s. Hypophosphite and Co., 79-F, Princess Street, Bombay-400002 (1967)	18 T 14.00	68.25 T 36.30	Sponsored
13.	Calcium silicate	Low density insulators	M/s. Newkem Products Corpn., Harganga Mahal, Khodadad Circle, Bombay-400014 (1968)	620 T 22.10	1332.21 T 46.85	Sponsored

1	2	3	4	5	6	7
*14.	Can lining composition	Metal can industry	M/s. Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta-700013 (1974)	26 Kg 0.01	— —	Non-exclusive
15.	Can sealing composition	-do-	-do- (1962)	31.5 T 2.95	253.4 T 14.25	Non-exclusive
16.	Carbazole Dioxazine Violet pigment	Organic pigment	M/s. Square Chemicals, 414, Giriraj, 4th Floor, 73, Sant Tukaram Road, Bombay-400009 (1974)	— —	5 kg. 0.03	Non-exclusive
17.	Carbimazole	Pharmaceuticals	M/s. Indian Schering Ltd., Sion-Trombay Road, Deonar, Bombay-400088 (1970)	28.5 kg 2.40	230 kg 19.03	Sponsored
18.	Catechol	Pharmaceuticals	M/s. Percynic Chemicals, Bombay-400012 (1972)	3.59 T 2.16	9.15 T 2.91	Non-exclusive
*19.	Cation exchange resin — styrene DVB base (98155, 98156)	Demineralization of liquids	M/s. Bird & Co. Ltd., Chartered Bank Buildings, Calcutta-700048 (1968-69)	42,195 ltrs. 7.14	5.305 lakh litrs. 53.21	Non-exclusive

1	2	3	4	5	6	7
*20.	Chlorobenzenes	Industrial chemicals	M/s. Hindustan Organic Chemicals Ltd., P. O. Rasayani (1974)	893.16 T 57.68	— —	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)	362.12 T 16.77	— —	Exclusive for a limited period
22.	Clofibrate	Pharmaceuticals	(1) M/s. Biological Evans Ltd., 18/1 and 3, Azamabad, Hyderabad-500020 (1973)	0.36 T 2.09	0.62 T 1.05	Non-exclusive
			**(2) M/s. Nivedita Chemicals Pvt. Ltd., A-14, M.I.D.C., Andheri (East), Bombay-400093 (1974)	0.32 T 1.27	— —	Non-exclusive
23.	Diethyl-*m* aminophenol	Dye intermediate	M/s. Sahyadri Dyestuffs and Chemicals, 177, Parvati-Vithalwadi Road, Poona-411430 (1970)	47.90 T 40.37	113.96 T 93.35	Sponsored

1	2	3	4	5	6	7
24.	Dihydroisojasmone and peach aldehyde	Perfumery	(1) M/s. S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay-400080 (1965)	0.52 T 1.22	7.56 T 15.25	Non-exclusive
			(2) M/s. Sonebon Laboratories, Kottayam-5 (1971)	75 kg. 0.23	0.22 T 0.53	Non-exclusive
25.	Dimethylaniline	Industrial chemicals	M/s. Sahyadri Dyestuffs and Chemicals Poona-411430 (1972)	75.30 T 18.54	36.13 T 4.17	Non-exclusive
26.	Ethylene oxide condensates	Surface active agents	M/s. HICO Products (P) Ltd., Mogal Lane, P. B. No. 6467, Mahim, Bombay-400016 (1965)	965.0 T 183.0	3214 T 392.88	Sponsored
27.	Ferties-Hard	Electronics	M/s. Semiconductors Ltd., Ahmednagar Road, Mile 4/5, Poona-411014 (1968)	5.5 T 1.65	8.7 T 4.60	Non-exclusive
28.	Geraniol, citronellal and citronellol from lemon grass oil	Perfumery	M/s. Opal Fine Chemicals, 2/9, Three-View Building, Opp. Century Bazaar, Prabhadevi, Bombay-400025 (1970)	1.6 T 2.4	12.2 T 15.30	Sponsored

1	2	3	4	5	6	7
*29.	Gum arabic substitute	Adhesives	(1) M/s. Karnatak Adhesives, 19, Mysore Deviation Rd., Gopalapuram, Bangalore-560023 (1974)	6.56 T 0.59	— —	Non-exclusive
			(2) M/s. Malwadkar Industries Matruchaya', 767/5, Bhandarkar Road, Deccan Gymkhana, Poona-411004 (1974)	0.15 T 0.02	— —	Non-exclusive
30.	4-Hydroxy-coumarin	Pharmaceuticals	M/s. Unichem Laboratories Ltd., "Unichem Bhawan," S. V. Road, Bombay-400060 (1974)	81 Kg. 0.17	— —	Exclusive (Production restarted)
31.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	M/s. Industrial Perfumes Ltd., Hay Bunder Road, Tank Road P. O., Sewri, Bombay-400033 (1968)	15.05 T 27.75	86.81 T 106.76	Non-exclusive
32.	Nicotine sulphate from tobacco and tobacco waste	Insecticides	M/s. Urvakunj Nicotine Industries, Petlad-Cambay Road, Dharmaj-388430, Dist. Kaira, Gujarat (1963)	151.88 T 38.3	173.81 T 33.74	Non-exclusive

1	2	3	4	5	6	7
33.	Nitrile rubber	Oil resistant rubber formulations, adhesives	M/s. Synthetics and Chemicals Ltd., 7, Jamshedji Tata Road. Bombay-400020 (1974)	112.0 T 20.00	30 T 6.00	Exclusive for 4 years.
*34	Nonyl phenol	Surface active agents	M/s. Aniline Dyestuff & Pharmaceutical Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Road, Bombay 400026 (1974)	10.9 T 1.53	— —	Sponsored
35.	*Ortho*-Tolyl-biguanide	Soap	M/s. Industrial Perfumes Ltd., Bombay-400033 (1970)	3.71 T 1.16	9.46 T 2.20	Exclusive
36.	Perfumery products based on longifolene (Capinone)	Perfumery	M/s. Camphor & Allied Products Ltd., P.O. Clutterbuckganj-243 502 Dist. Bareilly (U.P.) (1968)	15.9 T 15.4	39.75 T 30.20	Sponspred
37.	Perfumery products based on Δ^3 Carene (Meracene)	Perfumery	M/s. Camphor & Allied Products Ltd., Bareilly (1968)	8.1 T 3.38	14.9 T 5.56	Sponsored
38.	β-phenethyl alcohol	Perfumery	M/s. Sunanda Aromatic Industries, Mysore-K.R.S.Road, Mettagalli P.O., Mysore, 571106 (1970)	122.0 T 71.0	148.06 T 55.17	Sponsored

1	2	3	4	5	6	7
*39.	Phenthoate	Insecticides	M/s. Bharat Pulverising Mills Pvt.Ltd., Hexamar House, 29 Sayani Road, Bombay-400025 (1975)	5.0 T 3.0	— —	Sponsored; (Experimental production)
40.	Phthalates-dioctyl and dibutyl	Plasticizers	M/s. Amines and Plasticizers Ltd., 'D' Building, Shivasagar Estate, Dr. Annie Besant Road, Worli, Bombay-400018 (1971)	1420.85 T (DOP) 171.67	6130.0 T 411.17	Non-exclusive
41.	Phthalates-diethyl and dimethyl	Plasticizers	M/s. The Mysore Acetate and Chemicals Co. Ltd., "Mysugar Bldg." Sri. J. W. Road, Bangalore-560002 (1970)	171.78 T (DEP) 24.91	394.57 T 40.33	Non-exclusive
42.	Polyurethane printing rollers (86991)	Printing	M/s. Sree Saraswaty Press Ltd., 32, Acharya P.C. Road, Calcutta-700009 (1965)	644 Nos. 1.18	932 Nos. 1.31	Non-exclusive
43.	Radio opaque dyes	Pharmaceuticals	M/s. Unichem Laboratories, Bombay-400060	25.4 kg. 0.11	— —	Sponsored; (Production restarted)

1	2	3	4	5	6	7
*44	Radiosonde thermistors	Meteorology	The Bhagyanagar Laboratories 1-1-523/8 Golkonda Cross Road, Hyderabad (1974)	15000 Nos. 1.5	— —	Non-exclusive
45.	D. C. Recording Polarograph	Polarographic analysis	(1) M/s. Elico Pvt. Ltd., B-90, ASTD Pvt. Industrial Estate, Sanatagar Extn., Hyderabad-500018 (1974)	— —	1 unit 0.10	Non-exclusive
			**(2) M/s. Chromatography & Instruments Co., 121-122, Makarpura Indl. Estate, Baroda-390009 (1975)	1 unit 0.34	— —	Non-exclusive
46.	Rigid filters	Tube wells	M/s. Ashim Filters, C-196, Defence Colony, New Delhi-110024 (1965)	1363 Mtrs. 2.33	10,955 Mtrs. 21.05	Non-exclusive
47.	Rubber blowing agent	Rubber chemicals	M/s. Swastik Rubber Products Ltd., Poona-411003 (1968)	20.65 T 3.75	202.86 T 28.41	Non-exclusive
48.	Rubberized cork sheets	Gaskets	M/s. Banco Aluminium Baroda Ltd., P. B. No. 89, Baroda (1966)	—	95.61 lakh pieces 34.77	Non-exclusive
49.	Rubber reclaiming agent	Rubber chemicals	M/s. Swastik Rubber Products Ltd., Poona-411003 (1968)	5.25 T 1.05	30.55 T 4.87	Non-exclusive

1	2	3	4	5	6	7
50.	Sachets—Hot and Cold	Substitute for hot water bag and ice bag	(1) M/s. Thermo Chem Laboratories, A-39 H. Block, MIDC Pimpri, Poona-411018 (1972)	— —	6,275 pads 1.04	Non-exclusive
			(2) M/s. Vasant Industrial Corpn. 356, Great Nag Road, Nagpur 440002 (1971)	3,930 pads 0.44	2,900 pads 0.29	Non-exclusive
51.	Silica gel	Humidity control	M/s. Minco Products 301/27, T.H.Rd., Madras-600081 (1963)	10 T 0.9	107.5 T 7.69	Sponsored
52.	Sorbide nitrate	Pharmaceuticals	M/s. Indian Schering Ltd., Bombay-400088 (1969)	427.5 kg. 5.9	606.5 kg. 10.48	Sponsored
53.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona-411018 (1974)	125 T 15.0	40.0 T 4.00	Non-exclusive
54.	Direct reading spectrophotometer/colorimeter	Biochemical research, spectroscopic analysis in visible range	(1) M/s. Neotronics Corpn., P. B. No. 7776, Mulund Bombay-400080 (1974)	— —	10 units 5.24	Non-exclusive

1	2	3	4	5	6	7
	Direct reading spectrophotometer/colorimeter (contd.)		(2) M/s. The Scientific Instruments Co. Ltd., 6, Tej Bahadur Sapru Rd., Allahabad-211001 (1974)	12 units 0.85	4 units 0.29 (estimated)	Non-exclusive
55.	Thermistors	Electronics	(1) M/s. Semiconductors Ltd., Poona-411014 (1963)	10 lakh Nos.5 7.0	3.65 lakh Nos. 45.48	Non-exclusive
			(2) M/s. Tempo Semiconductors, Divn. of Primco Pvt. Ltd., 18, Paranjape 'B' Scheme, Subhash Road, Vile Parle (East), Bombay-400057 (1963)	6,846 Nos 0.87	91,069 Nos. 3.76	Non-exclusive
56.	Thermosetting resins for industrial laminates	Industrial laminates	M/s. Formica India Ltd., Chinchwad, Poona-411019 (1974)	— —	3 T	Sponsored ; (for captive consumption)
57.	Vapour phase chromatograph	Instruments	M/s. Associated Instruments Manufacturers (India) P. Ltd., Sunlight Bldg., 26-27, Asaf Ali Rd., New Delhi-110001 (1969)	19 units 3.61	113 units 22.34	Exclusive

1	2	3	4	5	6	7
58.	Vitamin C	Pharmaceuticals	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona-411018 (1974)	519 kg. 0.61	85 kg. 0.10 (estimated)	Non-exclusive
59.	Warfarin	Rodenticide	M/s. Unichem Laboratories Ltd., Bombay-400060 (1974)	0.12 T 0.69	— —	Non-exclusive (Production restarted)
60.	Laboratory chemicals	—	Produced by NCL	0.41	—	—

* During the period under review, production has been newly reported on these items (9)
** Production reported for the first time by the party.

Note : Blanks under column 5 indicate that the production data have not been received, though the parties are reported to be in production.

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
	Total	3,355.22

Note: The process on Chloral hydrate which was included in Table I of the Annual Report 1973-74 has now been dropped since no production was reported for two consecutive years.

This is in addition to the processes on (1) Hexylresorcinol (2) Liquid rubber (3) Rubber based contact adhesive (4) Sisal wax (5) Cation exchange resin from CNSL, which were dropped in the last report.

TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

Sr. No.	Name of the process (Indian Patent No.)	Field of utilization	Name of the party and (year of release)	Nature of release	Present status of implementation
1	2	3	4	5	6
1.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chloro-benzophenone	Pharmaceutical intermediate	M/s. Chemical Industrial and Pharmaceutical Laboratories Ltd., (CIPLA) 289, Byculla Bellasis Road, Bombay-400008 (1974)	Non-exclusive	A
2.	Aniline	Organic intermediate	M/s. Hindustan Organic Chemicals (HOC), Rasayani-410207, Dist, Kolaba (1973)	Non-exclusive	B
3.	Antioxidant TEDQ (2, 2, 4-Trimethyl-6-ethoxy-1, 2-dihydroquinoline)	Rubber antioxidant	M/s. Amar Dye-Chem Ltd., Rang Udyan, Sitladevi Temple, Rd. P. B. No. 6471, Mahim, Bombay-400016 (1974)	Non-exclusive	A
4.	1, 3-Butylene glycol	Petrochemicals, bulk organic chemicals	M/s. Indian Petrochemicals Corporation Ltd., P. O. Jawaharnagar-391320, Dist. Baroda (1974)	Sponsored	A

1	2	3	4	5	6
5.	BD Catalyst	Catalyst for synthetic rubber	M/s. Synthetics and Chemicals Ltd., 7, Jamshedji Tata Rd., Churchgate Reclamation, Bombay-400020 (1969)	Sponsored	B
6.	Catalytic vapour phase oxidation of olefins	Petrochemicals, bulk organic chemicals	M/s. Indian Petrochemicals Corporation Ltd., Dist. Baroda. (1974-75)	Sponsored	A
7.	Cationic dyes for acrylic fibres	Dyes for synthetic fibres	M/s. Sahyadri Dyestuffs and Chemicals, 177, Parvati-Vithalwadi Road, Poona-411430 (1974)	Sponsored	B
8.	Chlorides from bauxite residue	Industrial inorganic chemicals	The Dharamsi Morarji Chemicals Co. Ltd., Ambernath-421501. Dist, Thana (1972)	Sponsored	B
9.	Coating for oil filter papers	Oil filtration	The White Cloud Paper Mills. 412, Gultekdi Road, Poona-411009 (1968)	Non-exclusive	B
10.	*p*-Cresol	Dye intermediate	M/s. HICO Products (P) Ltd., Mogal Lane, P. B. No. 6467, Mahim, Bombay-400016 (1974)	Sponsored	A

1	2	3	4	5	6
11.	Diazepam	Anti-anxiety drugs	M/s. S. D.'s Lab-Chem Industry, 7, Indu Chambers, 349/353, Samuel Street, P. B. No. 3232, Bombay-400003 (1975)	Non-exclusive	A
12.	Dimethylaniline (continuous process)	Dyestuffs & explosives intermediate	M/s. Sahyadri Dyestuffs and Chemicals, Poona-411430 (1974)	Sponsored	A
13.	Ethylenediamine	Bulk organic chemicals	The Bharat Vijay Mills Ltd., Kalol-382721, N. Gujarat (1973)	Non-exclusive	B
14.	Flexible magnets	Refrigeration gaskets, toys, educational kits	(1) M/s. V. P. Nijhawan, III-F/5, Lajpatnagar, New Delhi-110024 (1973)	Non-exclusive	B
			(2) M/s. Ajanta Enterprises, Bombay-400013 (1973)	Non-exclusive	B
			(3) M/s. Ferrites and Electronics Components (P)Ltd., Balmiki Marg, Lucknow (1974)	Non-exclusive	B

1	2	3	4	5	6
15.	Foundry core binder	Core binder in steel foundries for high dimensional accuracy	M/s. Card-Chem Industries, B-12, Co-operative Industrial Estate, Balanagar, Hyderabad-500037 (1973)	Non-exclusive	B
16.	Gaskets for coir pith	Gaskets	M/s. Oberoi Industries, 12/37,Tilak Nagar, New Delhi (1974)	Non-exclusive	A
17.	Glyceryl- ∝-mono-para-aminobenzoate	Pharmaceuticals	M/s. Indian Schering Ltd., Sion-Trombay Road, Deonar, Bombay-400088 (1975)	Sponsored	A
18.	8-Hydroxyquinoline	Pharmaceuticals	M/s. Alta Laboratories Ltd., Giri Vihar, Khopoli (1970)	Sponsored	B
19.	Matrix-bound penicillin acylase systems	Pharmaceuticals	M/s. Hindustan Antibiotics Ltd., Pimpri, Poona-411018 (1974)	Sponsored	A
20.	*p*-Menthane hydroperoxide	Synthetic rubbers	M/s. Camphor and Allied Products Ltd., Dist Bareilly (1969)	Exclusive	B
21.	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

1	2	3	4	5	6
22.	Microfilters	Industrial filtrations	M/s. Sona Microfilters, 'Joseph House', Pudamjee Park, Poona-411001 (1973)	Non-exclusive	B
23.	Monochloroacetic acid	Weedicide, carboxy methyl cellulose	M/s. HICO Products (P) Ltd., Bombay-400016 (1972)	Non-exclusive	B
24.	Monoethylaniline	Intermediate for explosives	M/s. Atul Products Ltd., Atul, Dist. Bulsar (1973)	Non-exclusive	B
25.	Extraction of morphine and other alkaloids from lanced poppy straw	Pharmaceuticals	Ministry of Finance, Govt. of India, New Delhi (1972)	Sponsored	B
26.	β-Naphthol	Dye intermediate	M/s. Hindustan Organics Ceemicals Ltd., Rasayani (1974)	Sponsored	A
27.	1-Naphthylacetic acid	Plant growth regulator	M/s. Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur (M.P.) (1975)	Sponsored	A
28.	Nitro musk compounds	Perfumery	M/s. Opal Fine Chemicals, 3, View-Building, 2nd Floor, Flat No. 9, Opp. Century Bazar, Prabhadevi, Bombay-400025 (1973)	Sponsored	B

1	2	3	4	5	6
29.	Nitrofen	Weedicide	M/s. Delhi Pesticides Pvt. Ltd., 128, Kotnis Marg, Mahim, Bombay-400016 (1975)	Non-exclusive	B (in trial production)
30.	*p*-Nitrophenol	Insecticides	M/s. Hindustan Organic Chemicals Ltd., Rasayani, (1972)	Non-exclusive	B
31.	Opium alkaloids	Pharmaceuticals	Ministry of Finance, Govt. of India, New Delhi (1966)	Exclusive	B
32.	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
33.	Oxy-urea	Textile chemicals	M/s. Calico Chemicals, Plastics and Fibres Division, Anik-Chembur, Bombay-400074 (1971)	Sponsored	B

1	2	3	4	5	6
34.	Papavarine hydrochloride	Pharmaceuticals	M/s. Suneeta Aromatics, 2/9, Three View Bldg., Opp. Century Bazar, Bombay-400025 (1974)	Sponsored	A
35.	Phenylacetic acid	Perfumery, Penicillin G	M/s. Orient Aroma Chemical Industries Pvt. Ltd., 27, Chinch-bunder, Bombay-400009 (1973)	Non-exclusive	B
36.	Synthesis of resin for friction materials	Friction materials	M/s. Hindustan Ferodo Ltd., Ghatkopar, Bombay-400086 (1973)	Sponsored	B
37.	Rubberized cork sheets from waste cork granules	Gaskets	M/s. Cork Products P. Ltd., 9, Jor Bagh, New Delhi (1974)	Non-exclusive	A
38.	Solvent extraction of sandalwood oil	Perfumery	Govt. Sandalwood Oil Factory, Mysore-571008 (1973)	Sponsored	B
39.	Tamarind kernel powder (TKP)-Phospha teand Borate	Textile sizing-substitute for hydro-lized maize starch	M/s. S. K. Enterprises, 1/1 Krishna Kripa, Gokhale Road (North) Dadar, Bombay-400028 (1974)	Non-exclusive	A

1	2	3	4	5	6
40.	Terpineol	Perfumery	M/s. Dujodwala Industries, 14-1 Mile, Mathura Road, Faridabad (1972)	Non-exclusive	B
41.	Testing of rayon grade pulp from Bastar hardwood	Rayon, tyre cord	M/s. The Baroda Rayon Corpn. Ltd. P. O. Baroda Rayon, Udhna-394220, Dist. Surat (1975)	Sponsored	A
42.	Tetradifon	Acaricide	M/s. Delhi Pesticides Pvt. Ltd., Bombay-400016 (1975)	Non-exclusive	B
43.	Thioglycolic acid	Cosmetics, catalyst	M/s. S. D's Lab-Chem Industry, 7, Indu Chambers, 349/353 Samuel Street, P. B. No. 3232, Bombay-400003 (1975)	Non-exclusive	A
44.	*p*-Toluidine from *p*-nitro-toluene by vapour phase reduction	Organic intermediate	M/s. Sudarshan Chemical Industries P. Ltd., 162, Wellesley Road, Sangam Bridge, Poona-411001 (1973)	Sponsored	B

1	2	3	4	5	6
45.	Utilization of fine coarse fibre waste from corn starch industry for the manufacture of gums	Adhesives	M/s. The Anil Starch Products Ltd., Anil, Road, P. B. No. 1062, Ahmedabad-380002 (1975)	Sponsored	A
46.	Fractionation of turpentine oil	Industrial solvent	M/s. J & K Industries Ltd., (a J & K Govt. undertaking) Srinagar, Kashmir (1974)	Sponsored	B
47.	Vitamin B_6	Drugs	M/s. Indian Drugs & Pharmaceuticals Ltd., Kookatpalli, P. O. Balanagar Township, Hyderabad-500037 (1974)	Non-exclusive	B
48.	Xylit from coconut shells	Pharmaceuticals, fine chemicals	M/s. Unichem Laboratories Ltd., Bombay-400026 (1972)	Sponsored	B
49.	D-Xylose and xylit from corn cobs	-do-	-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 1973-74 have now been dropped as the licencees have not shown any progress towards their implementation for a considerable period:—

1. Benzoic acid (IP) from crude methyl benzoate
2. Calcium silicate from wollastonite (Sponsored)
3. Composite drug research scheme on Indian medicinal plants (Sponsored)-Production not envisaged
4. Conversion of bauxite into anhydrous aluminium chloride (Sponsored)
5. Ethylene from alcohol
6. Hexachloroethane
7. Ketene from acetone (Sponsored)
8. Liquid stabilizer for PVC (Sponsored)
9. Megimide (Sponsored)
10. 1-Menthol from dementholized peppermint oil (Sponsored)
11. *p*-Phenetidine (Sponsored)
12. Potentiometric strip chart recorder
13. Removal of silica from black liquor (Sponsored)
14. Sulphacetamide and its sodium salt (Sponsored)

These processes will again appear in future reviews as and when any progress for their implementation is reported.

TABLE II(A): The following firms are implementing the processes mentioned before their names which also appear in Table .

S. No.	Name of the process (Indian Patent No.)	Field of Utilization	Name of the party (Year of release)
1	2	3	4
1.	Clofibrate	Pharmaceuticals	M/s. S. D's Lab-Chem Industry, Bombay-400003 (1975)
2.	Ferrites—Hard	Electronics	M/s. Ajanta Enterprises, Mahalaxmi Industrial Estate, Gandhinagar, Bombay-400013 (1971)
3.	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 and Chemicals Pvt. Ltd., Block No. 2, 63, Princess St., Bombay-400002 (1974)

1	2	3	4
4.	β-Ionone (77225)	Perfumery, intermediate for Vitamin A	M/s. S. H. Kelkar and Co. Pvt. Ltd., Lal Bahadur Shastri Marg, Mulund (West), Bombay-400080 (1964)
5.	Nicotine sulphate from tobacco and tobacco waste	Insecticide	1. M/s. Tobacco Bye-products, M. Vijaya Krishna Gundarao Bahaddar, Fort Narasaraopet, Dist, Guntur (1963) 2. M/s. P. Jaipuria, 1A, S. N. Banerjee Road, Calcutta-700013 (1972) 3. M/s. Coromandal Tobacco By-Products P. O. Gannavaram, Dist. Krishna (A. P.) (1971) 4. Shri K. V. Rangasamy Mudaliar, D. No. 37, R. K. V. Street, Chittode P. O. Erode Taluk, Coimbatore (1974) 5. 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.)		6. Dr. J. A. Naik, Indian Institute of Advanced Studies Rashtrapati Nivas, Simla-5 (1974) 7. M/s. Spar Chemicals, c/o. Shri M. S. Sawadi, Satwai Road, Nipani-591237 (1974) 8. M/s. Agro Chemical Industries, Parchuru, Dist. Prakasam A.P. (1974)
6.	Phthalates- dioctyl and dibutyl	Plasticizers	* M/s. Alta Laboratories Ltd., Girivihar, Khopoli, Dist. Kolaba (1969)
7.	Polyurethane printing rollers (86991)	Printing	M/s. United Ink and Varnish Co., 39/40, Paranjape 'B' scheme, Vile Parle, Bombay-400057 (1965)
8.	D. C. Recording Polarograph	Polarographic analysis	M/s. Laxsons Engg. & Electronics Pvt. Ltd., opp. Marol Bus stop, Andheri, (East), Bombay-400059 (1973)

1	2	3	4
9.	Sachets—Hot and cold	Substitute for hot water bag and ice bag	M/s. Bishwanth Fatesaria, 5/1 Ramkumar Rakhit Lane, Calcutta-700007 (1973)
10.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	1. M/s. Maize Products, Div. of M/s. Sayaji Mills Ltd., P. O. Kathwada-Maize Products Ahmedabad-382430 (1974) 2. The Anil Starch Products Ltd., Ahmedabad-380002(1974)
11.	Thermistors	Temperature measurement and control electronic devices etc.	M/s. Adept Laboratories, Karve Road, Poona-411004 (1963)

* The firm discontinued the production since 1973-74.

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 tothe total No. of processes developed	No. of parties who have acquired NCL know-how
1	2	3	4	5	6	7	8
1969*	26	31.65	10	29	65	40	47
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

Break-up of 38 processes which have been released and are awaiting production (column 4) is as follows:—

A — 3 Processes recently released.

B — 9 Processes on which progress has been reported.

C — 26 Processes on which progress has not been reported or on which production has been discontinued for market/ economical/technical reasons.

* Total cumulative value of industrial production for the years 1950-68 exclusive of those arising from sponsored research schemes and FCP production was Rs. 44.75 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
Upto	1968	5	28.34	46.02	9	2	5	14	36	18
	1969	13	7.11	48.06	16	2	8	29	45	30
	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

* This includes sponsored projects awaiting production as well as sponsored projects removed from Tables I and II.

** This column includes projects where no industrial production was expected to be realized. These include PL-480 schemes, Lac. Cess Committee Project, ICMR Schemes, Projects for 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	Relased; in production. Turnkey plant available through Project Engineers.
2.	2-Amino-5-chlorobenzophenone and 2-Methylamino-5-chlorobenzophenone	Pharmaceuticals 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.	Atrazine	Herbicide	—
9.	Benzoic acid from crude methyl benzoate	Pharmaceuticals	Released
10.	Bisphenol-A	Epoxy resins	—
11.	Bostik sealant—substitute	Oil resistant adhesive for fuel tanks	Released; in production
12.	*tert*-Butyl catechol	Stabilizer and polymerization inhibitor for synthetic rubber	Released; in production

1	2	3	4
13.	Butyl titanate	Insulating varnishes, special paints, catalyst	Released; in producton
14.	Cadmium sulphide photoconductive cells	Instruments, photoelectric devices	Released; in production
15.	Can lining composition (based on nitrile rubber latex)	Lining cans for storing mineral oils, greases, food	Releaseed; in production
16.	Carbazole Dioxazine Violet pigment	Organic pigments	Released
17.	Cashewnut shell gum (Ind. Pat. No. 123638)	Binder, thickening agent in food and pharmaceuticals	—
18.	Catechol	Organic intermediate	Released; in production
19.	Cellulose powder	Chromatography, coating for electrodes, filter media	—
20.	Chlorinated paraffin wax	Plasticizers and extenders	—
21.	Civetone and Dihydrocivetone	Perfumery	—
22.	Clofibrate	Drugs	Released; in production
23.	Coating for oil filter papers	Oil filters	Released; in experimental production
24.	Costus root oil	Perfumery	Costus roots are available in Kashmir and Punjab
	Fructose	Medicines	—
	Chamazulene	Cosmetics	—

1	2	3	4
25.	Diazepam	Anti-anxiety drugs	Released
26.	Dibutyl tin stabilizers for PVC	PVC industry	—
27.	Diethyl toluamide	Insect repellents	—
28.	Dihydroambrettolide & Isoambrettolide	Perfumery	—
29.	Dihydroisojasmone and Peach aldehyde	Perfumery	Released; in production
30.	Dimethylaniline	Dyestuff and explosives intermediate	Released; in production
31.	N,N-Dimethylbiguanide- HCL (DMBG-HCL) Phenethylbiguanide -HCL (PEBG-HCL)	Anti-diabetic drugs	—
32.	Dissolving grade pulp (Ind. Pat. No. 82822)	Rayon, tyre cord	The process is offered on turn-key basis through Project Engineers.
33.	Endosulfan	Pesticides	The process is offered on turn-key basis throgh Project Engineers.
34.	Ethylenediamine	Bulk organic chemicals	Released; Turn-key plant available through Project Engineers.
35.	Ethylenedichloride from ethyl alcohol	Solvent, organic intermediate	—
36.	Ethylene from ethyl alcohol	Organic intermediate	Released
*37.	Exaltolide and Exaltone	Perfumery	—

1	2	3	4
38.	Expandable polystyrene beads	Insulation and packaging	—
39.	Ferrites-Hard	Electronics	Released; in production
40.	Ferrites-Soft	Electronics	—
41.	Fine chemicals	—	Know-how available for 200 laboratory chemicals
42.	Flexible magnets	Refrigerator gaskets, toys, educational kits	Released
43.	Flocculating agent for sugarcane juice clarification	Flocculating agents	—
44.	Foundry core binder (sinol core binder)	Core binder in steel foundries for high dimensional accuracy	Released
45.	Gaskets from coir pith	Gaskets	Released
46.	D-Glucosamine hydrochloride (C.P.)	Biochemical research, pharmaceuticals	—
47.	Glyceryl guaiacolate	Drugs-expectorant, intenstinal antiseptic	—
48.	Gum arabic substitute	Adhesives	Released: in production
49.	Hexachloroethane (Ind. Pat. No. 92997)	Pyrotechnics, smoke screen, veterinary medicine, fluxing agent in foundries	—
50.	β-Ionone (Ind. Pat. No. 77225)	Perfumery chemical, intermediate for Vitamin A	Released; in production

1	2	3	4
51.	Linseed oil emulsion paint	Emulsion paints	—
52.	Microfilters	Industrial filtration	Released
53.	Molecular sieves	Chemicals, petro-chemicals cryogenic industry	—
54.	Monochloroacetic acid	Organic intermediate for weedicides, carboxy methyl cellulose, etc.	Released; in trial production
55.	Monoethylaniline	Intermediate for explosives	Released
56.	Morpholine	Intermediate for rubber chemicals, textile chemicals, optical brighteners,	—
57.	Neo-Lavandulol	Perfumery	—
58.	Nicotine sulphate from tobacco & tobacco waste	Insecticide	Released; in production
59.	Nitrofen	Weedicide	Released; in trial production
60.	p-Nitrophenol	Intermediate for parathion and paracetamol	Released
61.	Optical whitening agent for synthetic fibres	Whitening agent for synthetic fibres	—
62.	Pentachloronitrobenzene	Fungicide	—
63.	Phenacetin	Drugs	—
64.	Phenoxyacetic acid	Penicillin V	—

1	2	3	4
65.	Phenylacetic acid	Perfumery, Penicillin G	Released
66.	Phthalate-butyl octyl	Plasticizer in non-electrical applications	—
67.	Phthalates-dibutyl/ dioctyl	Plasticizers	Released; in production
68.	Phthalates-dimethyl/ diethyl	Plasticizers	Released; in production
69.	D.C. Recording Polarograph	Polarographic analysis	Released; in production
70.	Polyurethane coatings (Ind. Pat. No. 121538)	Coatings for leather, rubber, wood, glass, nylon fabrics	—
71.	Polyurethane printing rollers (Ind. Pat. No.86991)	Printing rollers	Released; in production
72.	Potentiometric strip chart recorder	Instrument for use in research and industry	Released
73.	Radiosonde thermistors	Meteorology	Released; in production
74.	Reactive dyes	Dyestuff industry	—
75.	Recovery of pyridine bases from their aqueous solutions (Indian Pat. No. 111311)	20% Aqueous pyridine base solutions are produced in manufacture of soluble vat dyes	—
76.	Rubber blowing agent (Dinitrosopenta methylene tetramine)	Rubber chemicals	Released; in production
77.	Rubberized cork sheets from cork waste/granules	Gaskets	Released; in production
78.	Rubber reclaiming agent	Rubber chemicals	Released ; inproduction

1	2	3	4
79.	Sachets-Hot and Cold	Substitute for hot water bag & ice bag	Released; in production
80.	Simazine	Herbicide	—
81.	Sisal wax	Polishes, cosmetics	Released
82.	Sodium hydrosulphite from sodium formate	Reducing agent in textiles, sugar and soap industries	Technology on reaction only is offered.
83.	Sorbitol / Mannitol from cane sugar	Pharmaceuticals (mannitol), pharmaceutical syrups, humectant (sorbitol)	—
84.	70% Sorbitol from dextrose monohydrate	Pharmaceuticals, Vitamin C synthesis	Released; in production
85.	Direct reading Spectrophotometer/ colorimeter	Biochemical research spectroscopic analysis in visible range	Released; in production
86.	Staple pin adhesive	Adhesive for staple pins	—
87.	Synthetic gemstones	Jewellery, electric meters	—
88.	Tamarind kernel powder (TKP)—phosphate & borate	Textile sizing substitute for hydrolyzed maize starch	—
89.	Terpineol	Perfumery	Released
90.	Tetradifon	Acaricide	Released
91.	Theophylline, aminophylline and caffeine	Drugs (caffeine also used in beverage)	—
92.	Thermistors	Temperature measurement and control electronic devices, etc.	Released; in production

1	2	3	4
93.	Thioglycolic acid	Cosmetics, catalyst	Released
94.	Vitamin B_6 (Ind. Pat. No. 127750)	Drugs	Released
95.	Vitamin C	Drugs	Released; in production
96.	Xanthates-Potassium ethyl and Potassium amyl	Froth-flotation	—

* Processes on Exaltolide and Exaltone which were shown separately in Table III of the Annual Report 1973-74, have now been combined and offered as one process.

Following are the additional processes available for exploitation (as on 15th Sept. 1975)

1.	Maleic hydrazide	Plant growth regulator	—
2,	2-Chloroethyl-trimethylammonium chloride	Plant growth regulator	—
3,	Colchicine	Pharmaceuticals	—
4.	Dichloropropionic acid (Dalapon)	Weedicide	—

COMPARATIVE COST-BENEFIT DATA FOR 1973-74 AND 1974-75

	1973—74 (*Rs. in lakhs*)	1974—75 (*Rs. in lakhs*)
COST		
1. Recurring expenditure	79.51	104.06
2. Capital expenditure	11.32	24.07
	90.83	128.13
BENEFITS		
Receipts		
1. Premia and royalties	0.58	0.57
2. Receipts on account of sponsored projects	4.21	6.34
3. Analytical/testing charges	0.22	0.29
4. Institutional consultancy (CSIR share)	0.23	0.25
5. Sale of lab. products	1.74	0.69
6. Miscellaneous receipts including job work	4.52	6.49
	11.50	14.63
Indirect benefits		
1. Total number of processes in production	49*	60*
2. Value of production based on NCL know-how	651.39	1098.71
3. Estimated savings in foreign exchange on account of above production	260.40	438.88

* Parties who 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	25	23
(b) Sponsored schemes	23	26
5. Total number of parties who have taken up NCL processes for exploitation	88	101
6. Total number of parties who have sponsored the processes	58	69
7. Total number of processes which were not released and which were available for commercial exploitation	44	43
8. Number of processes released during the year		
(a) NCL processes	8	10
(b) Sponsored processes completed/concluded	5	14
9. No. of processes newly added to the list of NCL processes available for exploitation	4	10
10. Papers published	100	106
11. Doctorate and Masters degrees awarded	11	22
12. No. of recognized guides for Doctorate and Masters degrees	40	45
13. Patents		
(a) Indian patents in force	51	45
(b) Foreign patents in force	6	6

Premia and royalties received by NRDC through NCL processes :

	(*Rs. in lakhs*)	(*Rs. in lakhs*)
(a) Premia	2.39	2.90
(b) Royalties	0.737	1.575
No. of processes assigned to NRDC	4	9

CUMULATIVE COST-BENEFIT DATA (1950-75)

COST

		(*Rs. in lakhs*)
1.	Recurring expenditure	1000.30
2.	Capital expenditure	197.86**
3.	Pilot plant expenditure	71.47
	Total	1269.63

BENEFITS

1.	Total Money receipts	
	(a) Total premia earned by NRDC through NCL processes	14.44
	(b) Total royalties earned by NRDC through NCL processes	6.03
	(c) Total receipts from sponsors	73.06
	(d) Miscellaneous receipts including CSIR share of consultancy, analytical and testing charges, Sales of laboratory products & other receipts including job work.	67.97
		161.50
2.	Total value of production based on NCL know-how	3355.22
3.	Total No. of papers published	2851
4.	Total No. of degrees received	372

** 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-8.

2. Shri L. Kumar,
   Adviser (P. A. D.)
   Planning Commission,
   Yojana Bhavan,
   New Delhi.

3. Prof. C. N. R. Rao,
   Dean of Research & Development,
   Department of Chemistry,
   Indian Institute of Technology,
   Kanpur-16.

4. Shri Darbari S. Seth,
   Director,
   Tata Chemicals Ltd.,
   Bombay House, Bruce Street,
   Fort, Bombay.

5. Dr. L. K. Doraiswamy,
   Scientist,
   National Chemical Laboratory,
   Poona-8.

6. Dr. A. P. B. Sinha,
   Scientist,
   National Chemical Laboratory,
   Poona-8.

7. Shri A. M. Lele, (Member Secretary)
   Scientist,
   National Chemical Laboratory,
   Poona-8.

8. Administrative Officer,
   National Chemical Laboratory,
   Poona-8.

9. Accounts Officer,
   National Chemical Laboratory,
   Poona-8.

ADVISERS

Process Release Committee

1. Director, NCL (Chairman)

2. Shri C. N. Chari,
Managing Director,
Hindustan Antibiotics Ltd.,
Pimpri, Poona-18.

3. Dr. H. E. Eduljee,
Sturdia Chemicals Ltd.,
Neville House, Graham Road,
Ballard Estate,
Bombay-1.

4. Shri L. Kumar,
Adviser (P. A. D.),
Planning Commission,
Yojana Bhavan, Parliament Street,
New Delhi-1.

5. Shri P. C. Nayak,
Industries Commissioner,
Directorate of Industries,
New Administrative Bldg.,
Opposite Sachivalaya,
Madame Cama Road,
Bombay-21.

6. Dr. C. V. S. Ratnam,
Managing Director,
National Research Development Corpn. of India,
61, Ring Road, Lajpatnagar-III,
New Delhi-24.

7. Shri Darbari S. Seth,
Tata Chemicals Ltd.,
Bombay House, Bruce Street,
Fort, Bombay-1.

8. Shri Baldev Singh,
Chief. Technology Utilization ,
Council of Scientific & Industrial Research,
Rafi Marg, New Delhi-1.

9. Dr. L. K. Doraiswamy, NCL

10. Dr. R. B. Mitra, NCL

11. Administrative Officer, NCL

12. Shri A. M. Lele, NCL (Member Secretary)

ADVISORY PANELS

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1. Dr. B. K. Bachhawat,
Professor of Biochemistry,
Christian Medical College,
Vellore (Tamil Nadu).

2. Dr. P. K. Bhattacharyya,
Indian Institute of Science,
Bangalore-12.

3. Dr. N. P. Gupta,
Director,
Virus Research Centre,
Poona-1.

4. Dr. A. D. Karve,
Director,
Nimbkar Agricultural Research Institute,
Phaltan (Dist. Satara).

5. Dr. S. Ramachandran,
Hindustan Antibiotics Ltd.,
Pimpri, Poona-18.

6. Dr. M. B. Sahasrabudhe,
Head, Chemotherapy Division,
Tata Memorial Centre,
Parel, Bombay-12.

7. Dr. S. Varadarajan,
Managing Director,
Indian Petrochemicals Corporation Ltd.,
P. O. Jawaharnagar, Dist. Baroda.

II. *Chemical Engineering and Process Development*

1. Dr. H. E. Eduljee,
Director,
Sturdia Chemicals Ltd.,
Neville House, Ballard Estate
Bombay-1.

2. Mr. N. C. Krishnamurthi,
Adviser (Petrochem),
Ministry of Petroleum and Chemicals,
Shastri Bhavan,
Dr. Rajendra Prasad Road,
New Delhi.

3. Shri L. Kumar,
Adviser (P. A. D.),
Planning Commission,
Yojana Bhavan,
New Delhi.

4. Prof. R. Kumar,
Department of Chemical Engineering,
Indian Institute of Science,
Bangalore-12.

5. Dr. P. G. Menon,
Manager, Catalyst Group,
Indian Petrochemicals Corporation Ltd.,
P. O. Jawaharnagar,
Dist. Baroda.

6. Dr. P. K. Mukhopadhyay,
Manager, Research and Development,
Engineers India Ltd.,
4, Parliament Street,
New Delhi-1.

7. Dr. P. N. Pandit,
Factory Manager,
Hindustan Organic Chemicals Ltd.,
Rasayani, Dist. Kolaba.

8. Dr. T. K. Roy,
Managing Director,
Chemical and Metallurgical Design Co. (P) Ltd.,
A-60, Kailash,
New Delhi-48.

9. Prof. M. M. Sharma,
Bombay University, Department of Chemical Technology,
Matunga Road,
Bombay-19.

III. *Inorganic Chemistry*

1. Dr. H. V. R. Iyengar,
Manager, Technical Development Division,
EID Parry Ltd.,
Dare House, Madras-1.

2. Dr. V. Rama Iyer,
Chief, Project Planning and Development,
Ministry of Industrial Development,
Govt. of India.
New Delhi.

3. Shri B. K. Kamat,
General Manager (Works),
Dharamsi Morarji Chemical Co.,
Ambarnath, Dist. Thana.

4. Dr. M. D. Karkhanawala,
Head, Chemistry Division,
Bhabha Atomic Research Centre,
Bombay-85.

5. Dr. D. J. Mehta,
Scientist-in-Charge,
Central Salt and Marine
Chemicals Research Institute,
Bhavnagar.

6. Dr. P. N. Nayak,
Tata Chemicals Ltd.,
Okhamandal,
Mithapur,

7. Mr. R. V. Ramani,
Managing Director,
Mettur Chemicals and Industrial Corporation Ltd.,
7, Second Line Beach,
Madras-1.

8. Shri A. K. Roy,
Superintendent (CRW),
Fertilizer Corporation of India (P and D Division),
CIFT Building,
Sindri, Bihar.

9. Prof. A. R. Vasudeva Murthy,
Department of Inorganic and
Physical Chemistry,
Indian Institute of Science,
Bangalore-12.

10. Mr. K. Venkataraman,
Ministry of Industrial Development,
Govt. of India,
Udyog Bhavan,
New Delhi-11.

IV. *Organic Synthesis and Natural Products*

1. Prof. E. H. Daruwala,
Director, Bombay University
Department of Chemical Technology,
Matunga Road, Bombay-19.

2. Dr. T. R. Govindachari,
Director,
CIBA-GEIGY Research Centre,
Goregaon, Bombay-63.

3. Mr. N. V. Khote,
Managing Director,
Rallis India Ltd.,
Ralli House,
21, Raveline Street,
Bombay-1.

4. Dr. Nitya Nand,
Director,
Central Drug Research Institute,
Chattar Manzil Palace,
Lucknow.

5. Dr. P. N. Pandit,
Factory Manager,
Hindustan Organic Chemicals Ltd.,
Rasayani, Dist. Kolaba.

6. Dr. G. R. N. Sastry,
Senior Project Co-ordinator,
Indian Petrochemicals Corporation Ltd.,
P. O. Jawaharnagar, Dist. Baroda,

7. Shri Shivanand J. Shah,
Aniline Dyestuffs and Pharmaceuticals (P) Ltd.,
Mahalaxmi Chambers,
22, Bhulabhai Desai Road,
Bombay-26.

8. Mr. Rajendra Shankar,
Works Manager,
Indian Dyestuffs Industries Near Shahad Rly. Station,
P. B. No. 27,
Kalyan.

9. Shri Joginder Singh,
Industrial Adviser (Chem.),
Directorate General of Technical Development,
Udyog Bhavan.
New Delhi-1.

10. Dr. V. Srinivasan,
Director,
Sarabhai Research Centre,
Wadi Wadi,
Baroda-7.

V. *Polymer Chemistry*

1. Dr. S. P. Bhattacharyya,
Industrial Adviser (Chem.),
Directorate General of Technical Development,
Udyog Bhavan,
New Delhi.

2. Dr. S. K. Datta,
National Organic Chemical Industries Ltd.,
Rajan House,
Prabhadevi,
Bombay-25.

3. Dr. D. Y. Gaitonde,
President (Finance and Adm.) ,
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Bhosari Post,
Poona-26.

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Bhor Industries Ltd.,
16, Apollo Street,
Bombay-1.

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Bombay University, Department of
Chemical Technology,
Matunga Road,
Bombay-19.

6. Mr. T. G. Punwani,
B-12, Darshan Apartments,
Mt. Pleasant Road,
Malabar Hill,
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VI. *Solid State and Physical Chemistry*

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Central Electronics Engineering
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Central Leather Research Institute,
Adyar, Madras-20.

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Dy. General Manager,
Semiconductors Department,
Bharat Electronics Ltd.,
Jalhalli, Bangalore-13.

7. Dr. N. Seshagiri,
Electronics Commission HQ.,
New Delhi.

8. Shri U. Venkataswaralu,
Central Electronics Ltd.,
NPL Campus,
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Behram Wadia and Associates,
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