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PREFACE

This report highlights the research work carried out at the NCL from April 1983 to March 1985. While in the sixties and early seventies short-term projects of immediate industrial relevance accounted for the major share of NCL's research efforts, in the late seventies these efforts were largely reoriented towards long-range projects of social and industrial significance. This, however, has not resulted in short-term projects being pushed to the rear or in weakening links between the laboratory and the industry. On the contrary, these have become stronger as evident from the large number of sponsored and collaborative research projects being undertaken on behalf of user industries at the NCL.

Research at the NCL is made up of three well-defined components : short-range projects, long-range projects, and the basic research associated with the overall programme of the laboratory. During the period under review research at the NCL has been carried out in 10 areas. In each area NCL has been striving to maintain a high degree of excellence, using sophisticated tools and methods to achieve the R&D goals in keeping with the current approach to research adopted the world over, and in doing so the established pattern of interdisciplinary approach has remained the cornerstone of NCL's activities with equal emphasis on long-range and short-range projects.

A brief account of the R&D activities during the period is given below.

Research and development activities

A catalyst (silver with promoters supported on porous silicon carbide) for the oxidation of ethylene to ethylene oxide, giving about 80% selectivity for ethylene oxide at an ethylene conversion of 12%, was developed on laboratory scale. The catalyst prepared by the catalyst manufacturing firm, United Catalysts India Ltd. (UCIL), by the NCL process, was found to give the desired performance.

A high-silica catalyst has also been developed for the disproportionation of toluene to xylene, jointly with Indian Petrochemicals Corporation Ltd. (IPCL), Baroda. This catalyst has been tested at IPCL for more than 1000 hours and found to match the best available catalyst in its activity and selectivity, Tests carried out at ICI, UK, have also confirmed this.

The highly successful trials carried out at IPCL on *Encilite*—1, the high silica catalyst developed at NCL for the selective conversion of C_8 feedstock to a product rich in *o*-and *p*-xylenes, may be regarded as one of the crowning achievements of the laboratory during this period. The NCL's new zeolite catalyst, *Encilite* -1, was charged in the IPCL's 45,000 TPA xylene isomerization reactor in March 1985 and has been performing exceptionally well to this day. *Encilite*-1 has proved to be even superior in some respects to the best available catalyst anywhere in the world. Based on this trial, IPCL will use *Encilite*-1 in the expansion of their isomerizer capacity to 90,000 TPA within the next two years. An entirely new plant of this capacity with imported catalyst would cost around Rs. 100 crores. The importance and international significance of the successful trials on *Encilite*-1 in IPCL have been recognised through the Forward Development of Technology Award by the Indian Chemical Manufacturer's Association (ICMA) for the year 1985 to IPCL. In this award NCL and Associated Cement Companies (ACC), the manufacturers of the catalyst, have been recognised individually through appropriate citations.

Development work on catalysts/processes for the selective removal of normal paraffins by catalytic hydrodewaxing has been started. Bench-scale trials with these catalysts, lasting hundreds of hours, have been carried out using gas oil IV from Bharat Petroleum Corporation Ltd., Bombay. The catalyst developed at NCL and manufactured by UCIL is currently undergoing trials abroad.

The process for the isolation of the anticancer drug, vinblastine, from the leaves of *Vinca rosea* was earlier released to CIPLA, Bombay. Subsequently, the method of conversion of vinblastine to vincristine was also released to the same company which has since been regularly producing both these drugs. The company is not only meeting the country's requirement but has also started exporting the drugs.

Protoplast fusion approach was used to achieve intergeneric cellulase gene(s) transfer. Such transfer was successfully carried out between *Cellulomonas* and *Bacillus subtilis* and the entire cellulase gene complex was found to be expressed in *B. subtilis* fusants. Both endo-and exo-glucanases were found in the culture filtrates of a few hybrids.

In continuation of the work on the synthesis of of active photostable pyrethroids from the indigenously available, cheap and abundant (+)-3-carene, the synthesis of seven pyrethroids, possessing the desired IR-trans-configuration has been carried out. Some of them are reported to possess ecto-parasiticidal and insecticidal activity.

A process was standardised for isolation of Neem-rich II from neem seed oil for use as antifeedant against *Spodoptera litura*. A method has also been developed for estimation of azadirachtin in various neem oil fractions. A pure compound responsible for oviposition deterrance activity has been tentatively identified.

A process for the synthesis of polyphenylene sulphide. an engineering thermoplastic with excellent thermal and chemical resistance. was demonstrated on laboratory scale. Coating trials were successfully completed on metal and glass substrates. The crystallization behaviour of the polymer was studied, on the basis of which processing guidelines for injection moulding were arrived at.

The development of polymer alloys is a frontier research area in materials engineering. Melt compounding of two alloy systems, namely polyphnylene sulphide (PPS)/high density polythylene (HDPE) and polyethylene terephthalate (PET)/polymethyl methacrylate (PMMA) was successfully developed.

In collaboration with Indian Organic Chemicals Ltd. (IOCL), Bombay, a water absorbing polymer named *Jalshakti* having water capacities in the range 100-500 g/g has been developed. Extensive field trials that have been carried out on it by numerous agencies have been shown that it is an invaluable agricultural aid when used as soil additive and seed coating. Earlier field trials carried out by the Department of Agriculture. Govt. of Maharashtra, and the Bharatiya Agrochemicals Industries Foundation, Pune, have shown a 15-40 % increase in the yield of groundnut. Trials have also been carried out on grain and fodder jowar, fodder bajra, fodder maize, and tomato, and yield increases of the order of 20-35 % have been observed. The increased productivity is accompanied by attractive cost-benefit ratios. The process for *Jalshakti* has been demonstrated on a 20 kg batch scale. A semi-commercial plant (200 TPA) to produce a specific water absorbing polymer (JALSHAKTI) is expected to go on stream in July 1986 at the Khopoli factory of Indian Organic Chemicals Ltd. *Jalshakti* continues to provide increasing evidence of its amazing properties. Experiments carried out recently have shown that with the use of *Jalshakti* the irrigation frequency of mango plantations can be significantly reduced. It has been found that *Jalshakti* treated plots increase the wilting time of mango saplings considerably. *Jalshakti* has also been found to increase the production of mushrooms, with the an astonishingly high benefit-to-cost ratio.

Preparation of hydroxy terminated polybutadiene with an average molecular weight of 2000 and 3000 has been standardised on a 2 kg monomer/- batch scale. The polymers have been characterised for average molecular weight. molecular weight distribution, hydroxyl number and bulk viscosity.

In the project on heat pumps, taken up in collaboration with the University of Salford, U. K., three different equipment have been installed. These are being used extensively for generating data and for demonstration purposes.

As mentioned earlier, basic work forms an integral component of NCL's research efforts. During the period under review, basic work of a high order was carried out on chloramphenicol, polymer characterization, new perfumery products from longifolene, polymer modification, UV stable polymers for solar application, theoretical chemistry, chemicals reactions on solid surfaces and cobalt catalyzed oxidation of alicyclic olefins.

Patents and publications

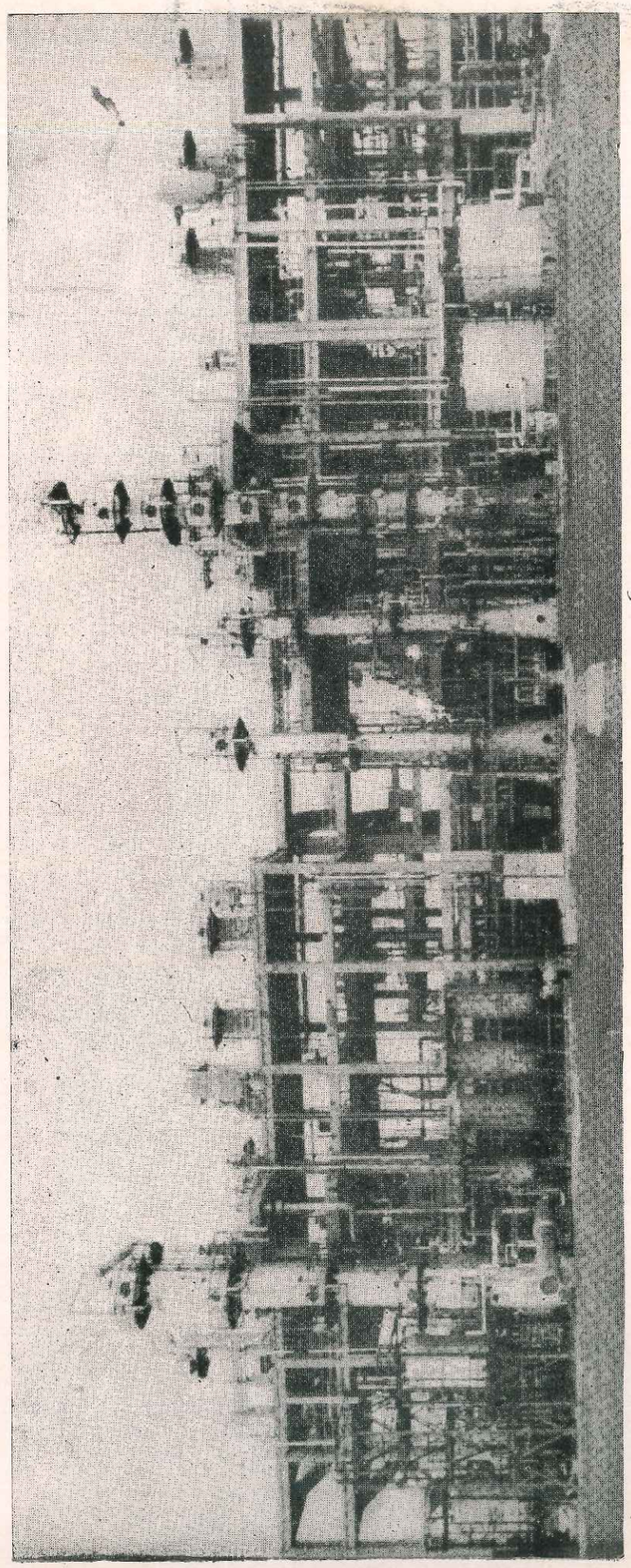
22 new patents were filed during these two years. 76 Indian patents (9 sealed, 16 accepted and 51 filed) and 17 foreign patents were in force as on 31-3 85. 378 research papers were published. 70 staff members, research fellows and guest workers received post-graduate degrees (16 M. Sc. and 54 Ph.D.). 48 NCL scientists are recognised as research guides by different universities.

Research utilization

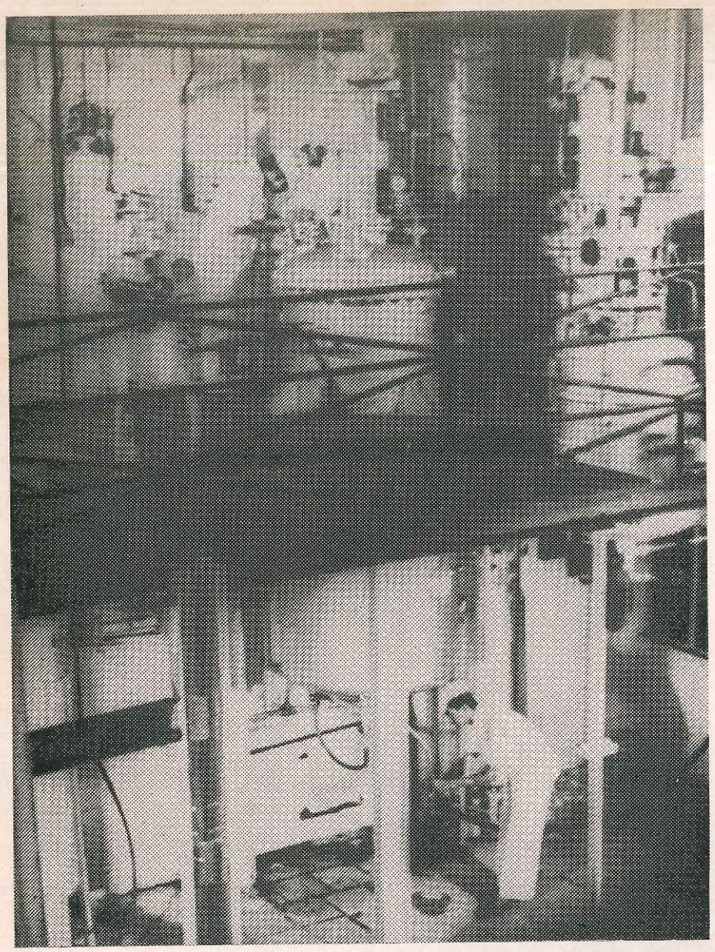
During 1983-85, 60 NCL processes were in production with a turnover of about Rs. 84 crores. The foreign exchange saving on account of production during this period is estimated at about Rs. 34 crores.

April, 1986
NCL, Pune

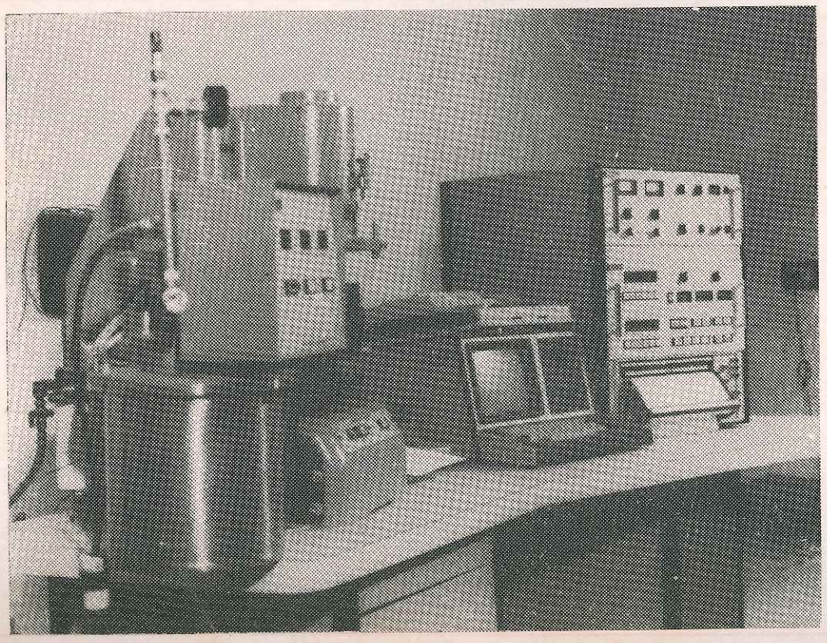
(L. K. Doraiswamy)
Director



Acrylates plant of Indian Petrochemicals Corporation Ltd., (IPCL), Baroda. Capacity : 10,000 TPA



Extraction unit for Vinca Rosea at CIPLA, Bangalore



Rheometrics Dynamic Mechanical Spectrometer (RDS-7700).

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RESEARCH AND DEVELOPMENT PROJECTS

1. CATALYSIS AND CATALYTIC REACTION ENGINEERING

1.1 Vapour phase oxidation of ethylene to ethylene oxide/ethylene glycol (1-1-467)

A catalyst (silver with promoters supported on porous silicon carbide) giving about 80% selectivity for ethylene oxide at an ethylene conversion of 12% was developed on laboratory scale. The catalyst prepared by the catalyst manufacturing firm United Catalysts India Ltd., by the NCL process was found to give the desired performance. It will soon be tested in a pilot plant under actual commercial process conditions.

The installation of the ethylene oxide pilot plant (capacity : 07 k/hr) and the ethylene generation unit (capacity : 3 k/hr) was completed. The testing of the catalyst and collection of process design data for the oxidation process in the pilot plant will be undertaken soon.

An extensive study on the influence of alkaline earth and alkali metals on the sintering and oxygen chemisorption properties of the silver catalyst was carried out for understanding their role in the improvement of the activity and selectivity of the catalyst.

The measurement of effective diffusivity of the catalyst and adsorption of the reaction species (viz. oxygen, ethylene, carbon dioxide) under catalytic conditions is in progress.

1·2 Adsorption and diffusion in high silica zeolites (1-7-046)

Sorption and diffusion of benzene in H–ZSM–5 zeolites under catalytic conditions have been studied extensively. The diffusion of benzene has been found to be highly concentration and temperature dependent. It is strongly influenced by the Si/Al ratio, degree of H^+ exchange and the pretreatment conditions of the zeolite.

Temperature programmed desorption of aromatic hydrocarbons from H-ZSM–5 has also been investigated. The heat of sorption of aromatic hydrocarbon (obtained from the TPD data) was found to increase linearly with the number of CH_3-groups attached to the benzene nucleus and also with the ionisation potential of the aromatic hydrocarbon indicating a charge tranfer interaction between aromatics and H-ZSM-5 zeolite.

Multicomponent sorption and diffusion of aromatic hydrocarbons from their iso octane solution on H-ZSM-5 at 20-45° have been investigated; the sorption selectivity for the hydrocarbons has been found to be strongly dependent on the sorption time. The work on the equilibrium multicomponent sorption of the hydrocarbon in the zeolite is in progress.

A simple but precise method using a specific gravity bottle has been developed for measuring crystal density, intracrystalline sorption capacity, inter crystalline (macro) pore volume of ZSM-5 type zeolite and also for measuring diffusion of very slow diffusing liquid species in the zeolite.

1.3 Catalytic reactions over synthetic zeolites (1-6-467, 1-13-267, 1-18-046)

The aim is to synthesize known and new zeolites with commercial applications. Besides well-known applications novel applications have also been investigated. The aim has also been to study catalytic processes using known/new zeolite formulations for industrial use. In keeping with the current research policy basic research aimed at a better understanding of zeolite catalysis has also been carried out.

1.3.1 Zeolite synthesis

(a) **Aluminium-silicate types**

Aluminium silicate (high silica content) zeolites belonging to the pentasil family have been synthesized using indigenous raw materials and patented. These zeolites are now being manufactured by Associated Cement Companies Ltd. (ACC), Bombay, and United Catalysts of India (UCIL), Bombay.

(b) **Non-aluminium zeolites**

Novel zeolite catalysts with industrial application potential have also been synthesized. By replacing

aluminium in the zeolite framework with iron, ferrisilicate zeolites, designated. Encilites, have been developed and patented in India and twenty other countries. Other types of pentasil zeolites containing Cr, B, La and other rare earth element have also been prepared. These are expected to be useful in reactions for which the Al and Fe types are unsuitable. ACC, UCIL, and Laporte, U. K., have been licensed by NCL to manufacture these. The Encilites are the only class of zeolites developed in India that are manufactured abroad.

1.3.2 Catalyst development for petroleum refining and petrochemical industries and for coal conversion processes

(a) Xylene isomerization catalyst

This catalyst developed jointly with ACC, can function with a feed containing/high proportion of ethylbenzene, and maintain a high level of para-xylene under equilibrium conditions. It has been extensively tested at the Indian Petrochemicals Corporation Ltd. (IPCL), Baroda, the Imperial Chemical Industries Ltd. (ICI), U. K. and Engelhard USA, and found to match the catalysts of Mobil Oil Co. USA, in all respects. The catalyst is to be tried out in the commercial plant at IPCL.

(b) Manufacture of ethylbenzene

The one-step vapour phase process for alkylation of benzene over a catalyst of the high silica class has already undergone plant trials in India and been found to be economically attractive.

(c) Selective alkylation of toluene to p-xylene

Catalysts for this process are being developed. Selectivities for para-xylene greater 95% have been obtained, and the use of the catalysts obviates the need for a separate xylene isomerization unit. A collaboration with a large international company for the development of the catalysts and processes is being worked out.

(d) Conversion of ethanol to ethylene

Encilite has also been found to be a very efficient catalyst for the dehydration of ethanol to ethylene. It is superior to the Syndol catalyst widely used at present In collaboration with Davy Power Gas, this catalytic process is being commercialised. Two other commercial organizations have shown interest in the NCL catalyst.

(e) Toluene disproportionation catalyst

A high-silica catalyst has also been developed for the disproportionation of toluene to xylene, jointly with IPCL, Baroda. This catalyst has been tested at IPCL for more than 1000 hours and found to match the Mobil catalyst in its activity and selectivity. Tests carried out at ICI, U. K have also confirmed this. Efforts are underway to commercialise the catalysis.

(f) Reforming catalysts for the production of aromatics

The reforming catalysts, that are under development, are based on the principle that some (or all) of the acid functions on which the catalysis depends can be provided by a zeolite (in this case, an Encilite). The advantages of using Encilite-based catalysts for reforming are :

(i) both liquid (C_5^+) and aromatic yields are higher at constant conversion than those found in conventional monometallic catalysts;

(ii) being monometallic with activities similar to those of bimetallics the sulphur tolerance of the catalysts is higher than that encountered in conventional catalysts. There is therefore no need to erect expensive pretreatment units in the commercial plant, as is the case when bimetallic catalysts are used; and

(iii) as the acidity of the catalysts arise primarily from the zeolite portion, there is no need for Cl injection during the operation to adjust the acidity levels.

A collaboration with an international company for the joint development of the Encilite-based forming cataiysts is in the offing,

(g) Hydrodewaxing catalysts

Development work on catalysts/processes for the selective removal of normal paraffins by catalytic hydrodewaxing has been started. Bench-scale trials with these catalysts lasting hundreds of hours have been carried out using gas oil IV from Bharat Petroleum Corporation Ltd., Bombay. The catalyst developed at NCL and manufactured by UCIL is currently undergoing trials abroad.

(h) Fluid catalytic cracking (FCC) catalysts

An agreement is to be signed with Indian Oil Corporation (R and D) for carrying out joint development of FCC catalysts. The project will be oriented towards the development of catalysts which could

be tuned to indigenous feedstocks to achieve maximum yield of middle distillates with low pour points.

(i) Coal conversion catalysts

Methanol to light olefins : Research to develop a catalyst/process for conversion of coal or industrial gas derived methanol to light olefins is in progress under a joint agreement with Davy McKee, U. K. The Encilite catalyst for achieving this has been developed and the pilot plant for testing it is being designed by Davy McKee.

Production of distillates from natural gas (UNDP project)

It has been predicted that after 2,000 A. D., petroleum alone will not be able to meet the requirements for middle distillates in India. Coal and natural gas reserves will have to be used for producing middle distillates to augment the supply from petroleum sources. The well-known route for converting coal and natural gas by Fischer-Tropsch synthesis has poor selectivity for middle distillates owing to certain inherent limitations. A better strategy would be to convert coal and natural gas into methanol or olefins and transform these into middle distillates by shape selective oligomerization, were selectivity levels exceeding 80% can be achieved.

Recognising the importance of this development work the UNDP has been approached for a grant. The objective of the work is to develop catalyst/process for the production of middle distillates from methanol.

(j) Characterisation and screening of Encilite and other zeolite catalysts

Basic studies for understanding the functioning of the catalysts and for designing new catalysts are being carried out. These support and complement the research on the development of catalysts and catalytic processes. Facilities for the characterization of the zeolite catalysts by X-ray diffraction, scanning electron microscopy, IR spectroscopy, ESCA, and adsorption and temperature programmed desorption of various probe molecules have been established, and the procedures standardized. The catalytic activity of the various zeolities is screened in various types of reactors ranging from micro reactors to semi pilot plants.

1.4 Applications of homogeneous catalysis (1-10-267)

1.4.1 Hydroformylation of olefins

Hydroformylation of allyl alcohol was studied using homogeneous Rh complex catalyst. This is a new route to the manufacture of 1, 4 butanediol.

The activity and the selectivity of several types of Rh complex catalysts and the role of ligands, promoters and solvents in the hydroformylation of allyl alcohol was investigated. Using an appropriate solvent system and two immiscible liquid phases, higher selectivity of n-hydroxy butyraldehyde was achieved with the additional advantage of ease of separation of the catalyst.

The detailed kinetics of this reaction was also studied. It was found that the reaction rate vs CO pressure and allyl alcohol concentration shows a maximum, which typical of substrate inhibited kinetics. These observations have been interpreted in terms of a postulated mechanism of hydroformylation and a rate equation has been proposed.

Similarly, hydroformylation of allyl acetate, vinyl acetate and n-hexene was studied using an Rh complex catalyst. The generalized observation of a complex kinetics with respect to CO for different olefins and its implications have been examined both experimentally and theoretically. Mass transfer effects for this complex case have also been investigated theoretically.

1.4.2 Carbonylation of nitrocompounds (MDI and other derivatives)

Carbonylation of several derivatives of nitrocompounds using Pd and Rh complex catalysts was investigated. The work on screening of catalysts, ligands, solvents and effect of process parameters on activity and selectivity was studied for 2, 4 dinitrotoluene, p-nitrocumene and nitrobenzene. The major side product formed in these reactions was a diaryl urea derivative which was characterized for a variety of substrates.

IR spectroscopic characterization of catalytic intermediates was also carried out and a mechanistic scheme for carbonylation of nitrocompounds proposed for the first time.

Exploratory process development work on p-nitrocumene to p-isocyanatocumene and nitrobenzene to methylene diphenyl isocyanate MDI was undertaken. For P-isocyanatocumene, 73-80% selectivity was achieved. For MDI the route via phenyl

urethane was investigated in which carbonylation of nitrobenzene to phenyl urethane is the key step. For this step a selectivity greater than 95% has been achieved. Further work on these processes is in progress.

1.4.3 Acetic anhydride/vinyl acetate via syngas and methyl acetate

A catalyst system has been developed which gives a high selectivity (95%) for carbonylation of methyl acetate to acetic anhydride. A similar catalyst with modified solvent system converts methyl acetate and syngas ($CO+H_2$) to a mixture of acetic anhydride and ethylidine diacetate and ethylidine diacetate can be easily cracked to vinyl acetate. The aspects of catalytic activity and selectivity, role of ligands, solvents, promoters have been studied extensively.

1.4.4 Methylethyl ketone (MEK)

Oxidation of mixed C_4 olefins to methylethyl ketone using homogeneous Pd complex catalyst was studied. This route is selective for oxidation of n-olefins. A preliminary work on different feed-stocks, reactor type, product distribution has been completed. This could be on attractive process for MEK productlon, while also separating pure isobutene.

1.5 Synthesis and structural characterisation of novel complexes, especially carbonyls (1-19-024)

Synthetic studies in carbonyl chemistry of ruthenium, rhodium and iridium were carried out resulting in the publication of 15 research papers. Mono-nuclear complexes of ruthenium (II) having Ru-C bonds were obtained by the insertion of an unsaturated olefin molecule such as allyl halide, acrylic ester, acrylonitrile and vinyl pyridine into Ru-H bonds. Also the insertion of carbon disulphide into the Ru-H bonds resulted in Ru-S bonded compounds. Stable cationic complexes of ruthenium of the type $(RuCo\ (PPh_3)_2\ (L)\ (RCN)^+\ (ClO_4)^-$ derived from acetonitrile or acrylonitrile and a bidentate chelating ligand such as β-diketones were also synthesised. Binuclear rhodium complexes of rhodium (I) with tetradentate azine ligands and pentacoordinated iridium (I) complexes of the type $IrCO\ (PPh_3)_2\ (L)$, where LH is a bidentate chelating ligand were also prepared. Since all these complexes are derived from carbonyl forming metals, they can be seriously considered for use in homogeneous catalysis.

1.6 Basic research in fluidization with reference to acrylonitrile reactor (1-20-006 S)

Mathematical modelling of fluid-bed reactor taking into account the complications such as those of heat effects, changes in molar volume and presence of multicomponents was carried out. The mathematical model developed also takes into account the distributed feed used in the industrial reactor and specially accounts for the end regions such as the jet zone and the freebroad region. The model requires the information on the hydrodynamic characteristics of the actual catalyst and the kinetic information regarding the several possible reactions. The hydrodynamic characteristics of the catalyst have been experimentally determined in a 2-d bed. The results reveal an interesting behaviour in terms of bubble growth, their coalescence, dense phase voidage etc. and is perhaps unique to this catalyst.

The model with the quantitative information on the properties of the bed as determined experimentally and the available kinetic information simulates the actual behaviour of the bed satisfactorily. The analysis also leads to additional clues for the improvement of the actual performance of the reactor.

1.7 Basic Studies

1.7.1 Influence of various preparation conditions and presence of additives such as barium and alkali metals at different concentrations on the thermal decomposition of silver carbonate in the preparation of silver catalyst has been thoroughly investigated by TG, DTG and DTA and the solid products of the decomposition at different temperatures has been characterized by ESCA, SEM, XRD and surface area analyzer.

1.7.2 A simple method for measuring acid strength distribution on zeolites, based on step-wise thermal desorption of ammonia using simple laboratory facilities has been developed. Acid strength distribution on catalytically important zeolites (viz. H–ZSM–5, Ce NaY, Ce Na X, HY and HM) has been measured.

1.7.3 Thermal decomposition of TPA–ZSM–5 in presence of inert and oxidizing atmosphere has been investigated. Also the effect of decomposition conditions of TPA–ZSM–5 on the surface and catalytic properties of the resulting zeolite has been studied.

1.7.4 Sorption of benzene in Ce Na Y zeolite at catalytic conditions has been investigated using gas chromatographic methods. Temperature programmed desorption of benzene from H-ZSM-5, Ce Na Y (with different degrees of cation exchange), Ce Na X and HY zeolites at different heating rates and initial sorbate loadings has also been investigated.

1.7.5 Various problems on multiphase catalytic reactors were investigated. The collaboration with University of Erlangen (Prof. Hofmann), West Germany, has progressed satisfactorily and the following problems have been investigated :

(a) Kinetic modelling of a complex consecutive reaction in a slurry reactor : hydrogenation of phenyl acetylene to styrene to ethylbenzene.

(b) Effect of catalyst pretreatment on activity and selectivity of hydrogenation of phenylacetylene over Pd/C catalyst.

(c) Gas-liquid mass transfer in 'dead end 'autoclave reactors; critical evaluation of different methods of KaC determination and a new correlation.

(d) Analysis of pore diffusion and external heat and mass transfer effects in a non-isothermal complex consecutive reaction.

(e) Product characterization, distribution and selectivity in hydrogenation of butynediol over Pd/C catalyst in a slurry reactor.

1.7.6 Kinetics hydrogenation of butynediol using specially prepared $Pd\text{-}Zn\text{-}CaCO_3$ catalyst was studied in a slurry reactor. Here, a simple but more accurate dynamic method was used in which the kinetics were interpreted only on the basis of pressure vs. time data in a batch slurry reactor. The order of the reaction was found to be 0·5 with respect to hydrogen and showed substrate inhibited kinetics with butynediol. This study was carried out with a feedstock and catalyst used in the NCL process to be commercialized. Using this information, the industrial scale simulation can be carried out reliably.

1.7.7 Kinetics of hydrogenation of *o*-nitroanisole was studied in a high pressure slurry reactor. A Langumir-Hinshelwood type rate model was proposed. Under certain conditions, this reaction was found to be limited by gas-liquid mass transfer. For this situation, a theoretical model was developed and utility of this model to evaluate mass transfer coefficient demonstrated. This work was presented at the International Symposium on Chemical Reaction Engineering (ISCRE 8) held in Edinburgh in September 1984.

1.7.8 The conventional macroscopic modelling of chemical reactions, while adequate for most situations, fails to give the correct qualitative and quantitative features of the systems that are finite in size. It is inadequate for situations where chemical instabilities in the form of multistationarity, oscillating behaviour, etc., prevail. A more refined analysis such as the one involving probabilistic arguments, is then necessary. Several systems have therefore been analysed from a probabilistic point of view and the main results are as follows :

(a) A large number of systems exhibiting bistability have been studied from a stochastic viewpoint to ascertain the role of internal fluctuations. The systems analysed include those that can be described in terms of single or multiple variables. The general results indicate that fluctuations cannot always be ignored and, in fact, in most cases these lead to qualitatively different results than can be expected from a macroscopic viewpoint. A more refined analysis correctly reduces to the macroscopic description to appropriate limits.

(b) The work also examines a large number of model system exhibiting oscillatory behaviour. Stochastic analysis reveals that the fluctuations can induce new transitions in such situations. Also the macroscopic limit cycle is often distorted in the case where it exists in the stochastic sense.

(c) In many chemically reacting system involving autocatalytic feedback, as the stationary state is approached, the rate of approach becomes infinitely slow. The present work evaluated the effects of fluctuations in such a situation. The analysis reveals that the phenomenon of critical slowing down disappears for additive type of fluctuations. In the presence of multiplicative noise the phenomenon persists and has the origin in the noise term. For internal noise the analysis reveals that even the fluctuations show the phenomenon of critical slowing down. The results have far reaching implications in parameter estimation porcedures.

1.7.9 The role of external fluctuations in modifying the system behaviour especially when it exhibits exotic behaviour from a macroscopic viewpoint has also been analysed. The important results are as follows :

(a) A model Brusselator reaction scheme exhibiting the phenomenon of multistationarity, oscillations

and existence of unique state in certain regions of the parameter space has been analysed in presence of noise. In each case a new transition to oscillatory behaviour is noted even for infinitesimally small fluctuations. The results clearly reveal the existence of noise induced transitions that are forbidden in the macroscopic analysis.

(b) Several model systems to explain the oscillatory behaviour of chemically reacting systems have been proposed and they contain the main step of autocatalytic feed back in the reaction sequences. It is shown that in the presence of detailed balancing and rigorous laws of the mass conservation these models fail to explain the oscillatory behaviour. In view of the mandatory nature of these conditions the alternative explantions for the existence of oscillations have to be found out. An analysis with a model system meeting the above mentioned conditions in presence of noise has been carried out as how the existence of ocillations. The simple result suggest that oscillations in chemical system can be a derived property of the system.

(c) A large number of systems exhibiting bistability have been examined in the presence of white and coloured noise. This analysis reveals that (1) the effects of white and coloured noise on the system behaviour are different. In certain cases only coloured noise can bring about drastic variations in the system behaviour and white noise alone is not enough, (2) the region where bistability exists shrinks with the extent of noise, and (3) in certain situations, new solution not permissible in the macroscopic limit can get generated,

1.7.10 As a sequel to our earlier studies, the consequences of the non idealities in adsorption phenomena (like interaction between and mobility of adsorbed molecules) in reactor design have been analysed using the ideal plug flow model of the reactor. It has been shown that, depending on the type of interaction forces and surface heterogeneity, the space time needed for achieving a desired conversion level or realising a preset conversion averaged selectivity can be several fold different. The effects are more pronounced when the adsorbed molecules are localized. Methods have been devised ro determine the critical inlet partial pressure and exit conversion level for achieving a desired selectivity.

1.7.11 A new approach using information theory is being developed for quantifying surface heterogeneity and identifying adsorption isotherms especially to delineate the roles of interaction mobility and surface heterogeneity. Surprisal analysis as well as negentropy criteria are used for discriminating among rival site energy distributions and validating the adsorption isotherms for comparison with experiment. The method can thus complement the integral equation and pressure derivative methods.

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□ □ □

2. DRUGS AND DRUG INTERMEDIATES

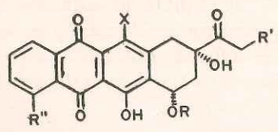
2.1 Vinca alkaloids (3-1-003 N-Sp)

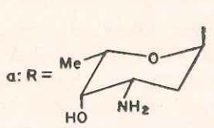
The process for the isolation of vinblastine from the leaves of *Vinca rosea* was earlier released to CILPA, Bombay. Subsequently the method of conversion of vinblastine to vincristine was also released to the same company which has been regularly producing both these products. The company is not only meeting the country's requirements but has also started exporting the drugs.

2.2 Synthesis of anti-tumour agents-Anthracyclines (3-2-013 N-Sp)

In the earlier reports, the total synthesis of anthracyclinones such as daunomycinone (1b) and 4-demethoxydaunomycinone (2b) were reported. NCL's contributions in this field are significant compared to what has already been reported by other schools especially from U. S. The synthetic procedures developed at NCL are known for their simplicity, selectivity (chemo-regio-stereo selectivity) and eminently suited for large scale preparation of some of these aglycones. Unlike other major schools which have been concentrating only on the total synthesis of anthracyclinones and leaving the synthesis of the sugar to schools specializing in carbohydrate chemistry, NCL scientists have simultaneously embarked on the synthesis of L-daunosamine starting from easily accessible carbohydrates such as D-glucose and D-glucosamine. The synthesis of L-daunosamine established from D-glucosamine (a product obtained from fish cells) is elegant and suitable for large scale preparation.

In view of the fact that 4-demethoxydaunomycine (2a) a synthetic analogue has been proved to be 9-10 times more effective as an anti-tumour drug





1 R' = H; R'' = OMe X = OH
2 R' = R'' = H; X = OH
3 R' = X = OH R'' = OMe
4 R' = X = H R'' = OMe
5 R' = OH; X = H, R'' = OMe

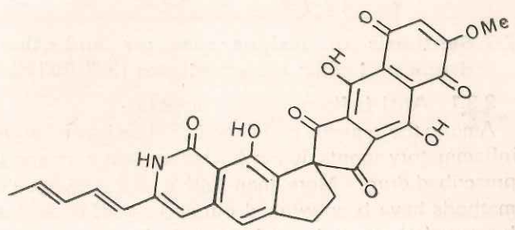
compared to daunomycine (1a) or adriamycin (3a) its total synthesis based on Sharpless asymmetric epoxidation (kinetic resolution method) has been worked out and optimised. This product will be given for clinical trials in the next few months to determine its efficacy compared to that of adriamycin.

11-Deoxydaunomycine (4a) and 11-deoxyadriamycin (5a), the two second generation anthracyclines, are important natural antitumour antibiotics exhibiting strong antineoplastic activity similar to that of adriamycin, but with less cardiotoxicity. The synthesis of the aglycone corresponding to 11-deoxydaunomycine (11-deoxydaunomycinone (4b)), by two different approaches starting from simple and easily accessible organic intermediates has been successfully completed. Further the asymmetric synthesis of 11-deoxydaunomycinone has also been completed starting from (±) 2, (2-hydroxyethyl)-5-methoxy-1, 4-dihydronaphthalene and converting the same to *R* – (–) – 2-acetyl – 2-hydroxy-1, 2, 3, 4-tetrahydronaphthalene by adopting sharpless asymmetric synthesis and its conversion to 11-deoxy daunomycinone.

2.2.1 Total synthesis of other antitumour antibiotics

(1) Fredericamycin-A

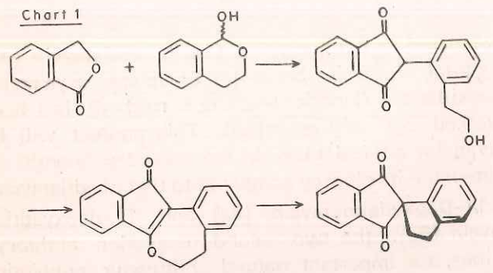
Fredericamycin-A (6), an antitumour antibiotic produced by *Streptomycin griseus*, possesses an entirely novel spiro (4, 4)-nonane system which has not been observed in any other type of antibiotic and work on its total synthesis has been initiated.



(6)

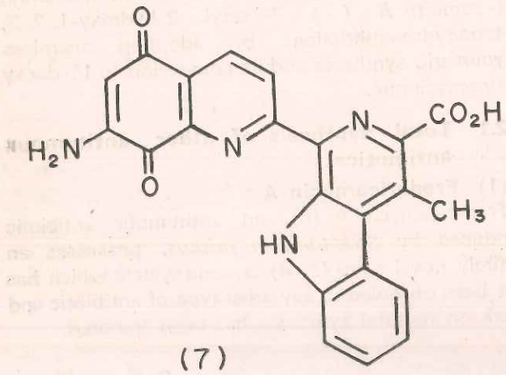
Synthetic analysis of Fredericamycin-A, suggests the need for working out a methodology for the construction of the spiro system. A simple model system representing this spiro molecule has been built starting from 2-(2-hydroxyethyl)-phenylindan 1, 3-dione and its conversion to the spiro system (see chart 1).

Chart 1



(2) Lavendamycin

Lavendamycin (**7**), a pentacyclic quinone and an antitumour antibiotic isolated from Streptomyces lavendulae, has a variety of functional groups and is biogenetically related to the most effective tetracyclic antitumour quinone, streptonigrin. Total synthesis of Lavendamycin has been accomplished starting from β-methyltryptophan and 8-hydroxyquinoline, which may be its biogenetic precursors.



(7)

2.3 Synthesis of various receptor and other drugs and their intermediates (3-7-003 N)

2.3.1 Anti-inflammatory agents

Among the recently developed analgesics and anti-inflammatory agents, ibuprofen is the most commonly prescribed drug. More than half a dozen synthetic methods have been worked out and one of these has been scaled up and implemented by the sponsor, CIPLA, Bombay, on commercial scale. Two other different approaches have also been worked out in greater detail and the company is taking steps to manufacture this drug by a new approach with an intention of doubling or trebling its present production.

2.3.2 Naproxen

This is another widely used anti-inflammatory agent and is at present imported for formulations. Laboratory work on a process for making naproxen has been completed and steps are being taken by the sponsor to commercially implement it.

2.3.3 Dapsone

An anti-leprotic agent, it is an essential drug and large quantities of it continue to be imported. The two general methods followed for its production in this country are tedious and uneconomical. In view of its importance, a two step synthesis has been worked out starting from chlorobenzene and the same has been passed on to CIPLA for implementation. The company is taking steps to implement this process at an early date.

Work has also been initiated to optimise a laboratory process for the production of ranitidine, a new H_2–receptor antagonist used in the treatment of duoderal ulcers. This drug has been introduced recently in the West by Glaxo Laboratories, UK, and is reported to have better than cimetidine in therapeutic efficacy.

In addition to the above products, some new methodologies have been explored for the synthesis of atenolol, lebetalol (β–blockers), carbamazepine (anticonvulsant) and etoposide (antineoplastic agent).

2.4 Synthesis of nucleosides and C-nucleosides (3–8–0038)

Since nitriles can be reduced to aldehydes in good yields under mild conditions, the transformation of halides to nitriles is a useful reaction for the synthesis of deoxysugars and their analogues which can be transformed into nucleosides. Though the conversion of simple halides to nitriles has been extensively studied, there are not many reports on the transformation of halides containing other functional groups (e. g. ester, ketone, epoxide) to nitriles. The reaction between a number of halcesters, haloketones and haloepoxides with sodium cyanide has therefore been studied.

The transformation of 1, 2-diols to oxiranes has been widely used in carbohydrate chemistry as well as other areas. 2-Acetoxybenzoylbromide, a new reagent, has been shown to be very efficient for transforming 1, 2-diols to oxiranes.

2.5 Vitamin B_6 (3-10-0037N)

Some improvements have been worked out in the process developed earlier for the manufacture of vitamin B_6. The process was released to Lupin Laboratories and Themis Chemicals, Bombay through NRDC for commercial exploitation. The product is expected to be produced by them during 1985-86.

2.6 Synthesis of ketoprofen and cimetidine (3-11-003N)

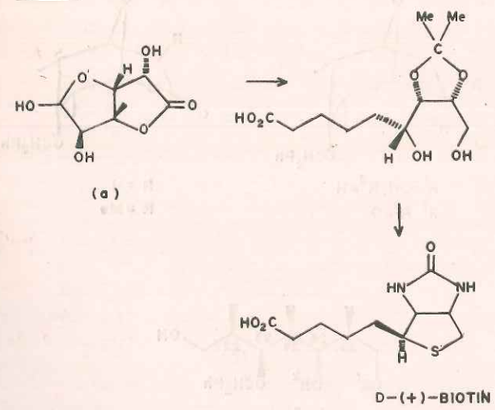
More than half a dozen different approaches have been looked into for the synthesis of ketoprofen. Some of these are new and feasible for commercialisation. These methods have been passed on to the sponsor P. C. I. Ltd., Bombay, who have taken active steps to implement this project. Work has also been initiated to optimise the laboratory process for the manufacture of cimetidine which is expected to be completed in the next six months.

2.7 Synthesis of biologically active compounds (3-12-003N)

2.7.1 Biotin

Further work on biotin (11) with the object of developing of a feasible synthetic route starting from chiral materials to obtain optically active biotin has been undertaken. The starting materials chosen are L–D-glucose and L-cystein. A practical syhthesis of (+) biotin was developed from L-D-glucose, which appears to be the best route starting from sugars and is amenable for scale-up and further studies. This method consists in converting D–glucose by oxidation to D-glucurono-3, 6–lactone which is reduced to L-gulonolactone. Gulonolactone is converted to the key optically active diol as shown (chart 3) from which (+) biotin is made by well-known and simple chemical manipulation.

Chart 3



(a)

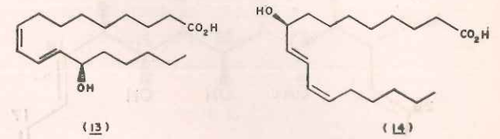
D–(+)–BIOTIN

2.7.2 Synthesis of 1,4-Dicarbonyl compounds

1,4-Dicarbonyl compounds are versatile intermediates for the synthesis of a variety of natural products such as jasmonides, prostaglandines, steroids and terpenoids. Although many synthetic routes for the preparation of these compounds are known and continue to be reported, most of the existing methods involve lengthy procedures. A conveneint three-step approach has been worked out for the synthesis of 1, 4- dicarbonyl compounds, starting from tosylmethyl isocyanide (TosMIC). This approach has been successfully applied to the synthesis of jasmone, dihydrojasmone and a key prostaglandin intermediate.

2.7.3 Ionophores

The synthesis of coriolic acid (**13**) and dimorphocolic acid (**14**) isolated from bovine heart mytochondria, which possesses unique calcium specific ionophoric activity, has been accomplished by a convenient approach starting from E-2-penten-4-yn-1-ol.



(13) (14)

Recently, both these products have been isolated from the blast-resistant rice plant and demonstrated to act as self defensive substances against rice blast disease.

2.8 New Methodology in organic synthesis (3-14-003 N)

2.8.1 Synthesis of Macrolides

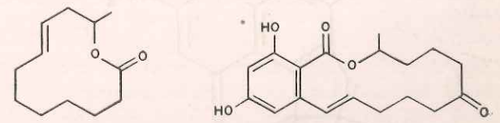
The synthesis of macrolides, the large ring lactone molecules, has attracted the attention of organic chemists, because of their biological and physiological properties. NCL is the only centre in this country which has planned to carry out the total synthesis as a part of capability development in organic synthesis. This includes studies related to the synthesis of recifeiolide (8).

2.8.2 Recifeiolide

Recifeiolide is one of the simplest molecules synthesised by several groups after the first report by Corey's group in 1976. Two different approaches have been worked out for the synthesis of (±) 11–hydroxy-trans-8-dodecenoic acid. Both the approaches have made use of simple acetylene precursors for constructing this molecule.

2.8.3 Zearalenone (9)

An antibiotic with anabolic and uterotropic activity was the first molecule to be synthesised by both Merck and Syntex groups. The aliphatic portion of this



(8) (9)

molecule was made utilising dihydropyran and 2–acetylbutyrolactone. The final condensation of the aliphatic segment with the aromatic part and subsequent cyclisation led to zearalenonedimethyl ether.

2.8.4 Rifamycin-S (10)

Belonging to ansamycin family of antibiotics, rifamycin has been a target compound for many synthetic chemists. Subsequent to its first total synthesis by Kishi and co-workers in Harvard University in 1980, a number of papers have appeared on the synthesis of the multi-chiral ansa chain and the heavily substituted naphthaquinone. In all these studies, the acyclic stereo control was the method of choice in the synthesis of ansa chain. NCL scientists have worked out a different approach employing acyclic building block for the stereo control functionalisation of the ansa chain. The strategy was to build an acyclic molecule which (a) can be utilised for stereo control functionalisation, and (b) has a "lock and key" system to cleave it to an acyclic unit. The two criterion were fulfilled by the acyclic system, *endo, endo*–2, 4-dimethyl-8-oxabycyclo 3,2,1-oct-6-en-3-one, which has an inherent rigidity for stereo control functionalisation and olefinic moiety, with ether linkage to serve as a key to open the system. By this approach, stereoselective synthesis of C-21 to C-27 segment of refamycin has been completed (see chart 2). Further work on the total synthesis of ansa chain is in progress.

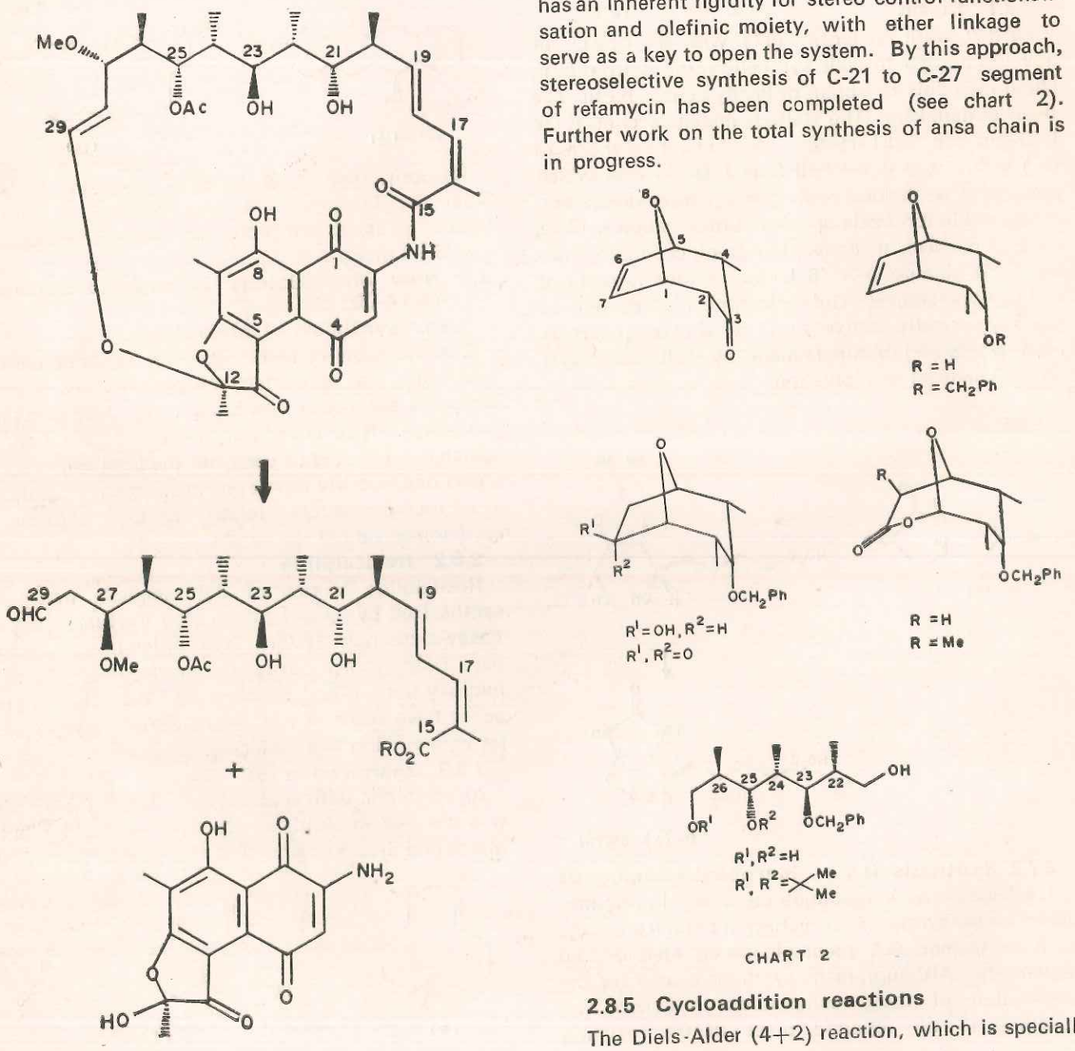


CHART 2

2.8.5 Cycloaddition reactions

The Diels-Alder (4+2) reaction, which is specially suited for the synthesis of complex organic molecules like natural products has been studied starting from chiral precursor-dienes obtained from simple pyridine derivatives. Several dihydropyridines from substituted pyridine derivatives have been made and their cycloaddition was studied with the specific objective of developing synthetic strategies for complex alkaloids like dendrobin.

2.9 Calcium channel blockers (3-15-003N-Sp)

2.9.1 Verapamil

Of late, increased attention is being focused on calcium channel blockers, besides the use of various β-blockers. Verapamil continues to be one of the widely used calcium channel blockers and is entirely imported for making formulations. Under the sponsorship of Centaur Laboratory, Bombay, an elegant and economically viable approach has been worked out and steps are now being taken to implement it.

The work on dextropropoxyphene-HCl initiated under sponsorship from Centaur Laboratories, Bombay, has been completed and optimised on kilogram/batch scale. The process has been demonstrated to the sponsor and the firm has already taken steps to implement it so that this basic drug can now be made in the country starting from locally available organic intermediates.

2.10 Synthesis of basic drugs and Intermediates (3–16-003N)

2.10.1 Pyrazinamide

It is one of the important anti-tubercular drugs and its use is increasing in this country. At present it is being imported or made from imported pyrazine carboxilic acid. Earlier, two different approaches were tried starting from dichloro propionic acid and from succinic acid, but both these approaches were not viable for commercial exploitation. A different and innovative process involving two steps has now been worked out and is being optimised on a kilo per batch scale.

2.10.2 Chloroquine phosphate

A novel route for the commercial synthesis of chloroquine phosphate in which the raw material cost is only 60% of that in the conventional process and which avoids the use of expensive and imported intermediates (triethylorthoformate and/or ethoxymethylene dimethylmalonate) has been developed on a 1 kg scale. Steps are now being taken by the two sponsors (Standard Organics Ltd. Hyderabad, and Sudarshan Chemical Industries Ltd. Pune) for further scale up of the process and its effective translation into a technology.

2.11 Phenylglycyl chloride hydrochloride (3-17-003 N)

This is an important intermediate for the manufacture of ampicillin and is at present imported. Under sponsorship of Sudarshan Chemical Industries Ltd., Pune, a laboratory process for the manufacture of this intermediate was worked out earlier starting from phenyl acetic acid. However, in view of the fact that the price of phenylacetic acid has escalated, an alternative process starting from benzaldehyde has been developed. Steps are now being taken by the sponsor to implement this process.

2.12 Vitamin E (3-20-003 N)

The project has recently been sponsored by Chemfab, Madras. A feasible approach for the manufacture of trimethylhydroquinone, an intermediate for vitamin E, has been worked out starting from *p*-xylene. Further work is in progress.

2.13 Basic Studies

2.13.1 O-Aminophenyl/aryl ketones and their derivatives

The synthesis of quinazoline analogue of papaverine was reported last year. However, in the last step of the formation of quinazoline, using formic acid and formamide, low yields of the required product were obtained due to the oxidation of l-benzyl moiety to l-benzoyl. In order to eliminate the by-product, a new variant was developed using BF_3-etherate and formamide. This modification has been introduced in the synthesis of various aryl substituted 4-alkyl, 4-phenyl and 4-benzylquinalozines. Some of these compounds are under pharmacological screening.

2.13.2 New methodology

Substituted 2-arylisatogens are of current interest since they show antitubercular and fungicidal activities and also play a vital role in physiology. Some time back a new method for the synthesis of these isatogens was developed by cyclodehydration of O-nitrophenyl benzyl ketones. In the new approach the above ketones have been prepared by acylation of phenylacetaldehyde enamines with O-nitrobenzoyl chloride followed by hydrolysis and deformylation. The enamines were prepared from activated nitrotoluenes and trimorpholinomethane.

2.13.3 Stereochemical disposition of the isopropyl group

Two isomers of conjugated ketone 7-isopropyl-10-methyl-4-oxobicyclo (4.40) dec-5-ene have been prepared in our laboratory. One of the ketone is a solid which becomes gummy on keeping and changes into a different compound. Spectral studies mainly ^{13}C NMR, has shown it to be a hydroperoxide of the solid conjugated ketone having peroxide linkage at C_7 carbon atom. This has been further confirmed by chemical transformations.

2.13.4 Use of photochemical reactions in organic synthesis

A systematic study of the photo-induced rearrangement of certain vinylcyclopropanes into cyclopentenes (VCR) has proved highly fruitful. It has led to the development of a new methodology for the preparation of synthetically useful bicyclo (3.2.0) heptenes from Cis-methylvinylcyclopropanes. From the point of view of synthesis the present methodology becomes useful in several ways: (i) it selectively affords the VCR products to the total exclusion of products due to competing retroene reaction; (ii) it provides bicyclo (3.2) heptenes bearing a wide variety of substituents; and (iii) it has considerable synthetic utility. Recently, use of this transformation has been made as a key step in the synthesis of (±)-grandisol, a pheromone of male boll starting from δ-carene, its further applications in the synthesis of another important pheromone, lineatin and some novel sesquiterpenes like capnellenes are being explored.

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3. BIOTECHNOLOGY

3.1 Fermentation of molasses to ethanol-UNDP (4–1–167) (i, ii, iii)

As the open pore gel system developed for the immobilization of yeast cells in the laboratory scale gave rise to several operational difficulties when used in a large scale reactor, several other matrices were tried and calcium alginate matrix has been finally selected. Physical stability of calcium alginate matrix based beads have been tested for over three months. A 10L/day ethanal producing pilot plant (9" dia glass column) has been run for over two months with this system. Studies are being continued to increase the ethanol productivity and maximise the operational life of reactor.

A 50-100L/day ethanol pilot plant reactor has also been fabricated.

3.2 Biotechnology of cellulose utilization (4-4-167)

Studies to optimize biomass growth of *Penicillium funiculosum* on pretreated cellulosic substrate and also the identify the parameters favouring high extracellular cellulose/soluble protein secretion were carried out in shake flasks as well as instrumented fermenters. The wild strain as well as three promising mutants selected on the basis of shake flask trials were compared for optimal enzyme production. Laboratory scale investigations were completed on optimizing hydrolysis of pretreated lignocellulosic substrates giving good conversion to glucose were observed. Preliminary studies holding promise for further development were completed on immobilization of cellulose components, enzyme recovery and reuse after saccha rification, etc. The occurrence of a procellulase in cellulolytic culture filtrates has also been demonstrated. Hemicellulase activites of some of the interesting strains were also investigated.

3.3 Molecular biology and genetic engineering (4-5-001)

3.3.1 Plant molecular biology

(1) Plant genome organization

Based on genome organization studies on nineteen plant species, it appears that nuclear DNA content plays an important role in determining the size and modes of arrangement of repeated DNA sequences. For example, plants with nuclear DNA content (1C) more than 4.5 picograms have predominantly short period interspersion patterns while those with DNA content (1C) less than 4.5 picograms have either long period or mixed patterns of interspersion.

Employing the cytological approach of visualization of condensed chromatin in interphase nuclei using a specially developed, rapid and generally applicable method, namely, HCL Giemsa banding technique, it has been shown that plant species with reticulate nuclei reveal short period interspersion patterns while those with chromocentric nuclei have diverse patterns of genome organization. This correlation indicates that the molecular arrangement of DNA sequences influences the organization of interphase nucleus in plants. Another interesting observation in this area is that condensed chromatin is underreplicated during root differentiation in leguminous plant species.

(2) Plant genetic engineering

The main aim of work in this area is the study structure and regulation of expression of specific major storage protein genes in rice and tur dal.

Partial shotgun libraries of rice and tur dal DNA have been constructed in *Escherichia coli* HB 101 using PBR 322. Bam H1 fragments of genomic DNA are ligated at the Bam HI site of PBR 322 and transformants are selected on the basis of their Amp^r, Tet^s. Recombinant plasmids harbouring bacteria are also screened by colony hybridization using labelled total DNAs.

Polysomal preparations from plant tissues are isolated by isokinetic sucrose gradient centrifugation RNA is isolated from polysomes, fractionated on oligo (dT) cellulose columns and poly (A) RNAs used to prepare cDNA.

3.3.2 Intergeneric transfer of cellulase genes

Protoplast fusion approach was used to achieve intergeneric cellulase gene (s) transfer. Such transfer was successfully carried out between *Cellulomonas* and *Bacillus subtilis* and the entire cellulase gene complex was found to be expressed in *B. subtilis* fusants. Both endo–and exo-glucanses were found in the culture filtrates of a few hybrids. Transfer and expression of such multicomponent gene systems have not been achieved hitherto through conventional genetic engineering approaches. Cellulase coding DNA has also been transferred into *Zymomonas mobilis*. An important observation was the significant decrease in the extent of methylation in DNA of fusants.

Using highly specific antibodies against 5-mC, an affinity matrix has been successfully developed for selective retention of 5mC rich DNA fragments.

3.4 Studies on separation methods (4-6-001)

3.4.1 Seperation methods

Elegant bioseparation methods play an essential role in basic and applied research in biotechnology. Five elegant techniques have been developed for the separation, purification and characterization of bilogiccally active macromolecules. Some of these techniques promise to be simple and inexpensive substitutes for the imported models.

3.4.2 Alkaline protease

Among the 50 different industrial enzymes, protease are among the largest produced in the world, accounting for 40% of total enzyme sales. A strain of **Conidiobolus** (NCL. 82-1-1) isolated is NCL, has shown high alkaline protease activity. Being equal to 35 Anson units/ml achieved in a 40 hour feremen-tation cycle. This is equivalent to 5·5 g of crystalline typsin per litre of broth. Evaluation ot this enzyme for irs feasible application in various fields is under consideration.

3.4.3 Glucose isomerase

The established market for this enzyme in developed countries for the production of high fructose syrup is of the order of 7 billion pounds per annum. A strain of **Chainia** (NCL 82-5-1) isolated in NCL has been found to produce both intra and extracellular glucose/xylose isomerases. The interesting feature of this organism is that it produces extracellular glucose and xylose isomerases which are specific and distinct enzymes.

3.5 Basic studies

3.5.1 Theoretical studies on structure and function of biologically active molecules

Quantum chemical investigations of conformational preferences of severai extensively (hyper) modified nuclear acid bases have been ccnducted using PCILO bases, occurring naturally at strategic locations of tRNA for translation of genetic information.

Various tautomers resulting from different protonation schemes in modified base N^6-(N-glycyl carbonyl) adenine as well as its anion have been studied to predict ionic control of conformational flipping for possible regulatory mechanisms.

Conformational preferences of analogous plant growth regulating molecules such as Kinetin and 6-benzy amino purine are also being investigated.

For dependable practical calcuations of electronic structure, potential energy surfaces, reaction paths, transition states and reaction, intermediates of polyatomic bioorganic moleucules, the quantum chemical MNDOC method has been recently made adopted for use in the ICL 1904S computer. This improved MNDOC method incorporates refinements specifically introduced for reliable treatment of hydrogen bonding situations, crucial in determining molecular structure, physicochemical properties and biochemical response of bioorginic compounds.

Investigations of constrained ring closure in puckering of 4·5 dihydroxy cyclopentene have been initiated using the improved MNDOC method.

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4. MATERIALS SCIENCE

4.1 Amorphous silicon thin films for photovoltaic appilcations (7-2-004 (11))

Amorphous hydrogenated silicon (a-Si : H) films are known to possess low density of gap states and have shown great promise for low cost non-polluting electrical power applications. Low efficiency a-Si : H solar cells for electronic calculators and wrist watches are already on the market. However for the power applications, higher efficiency and longer life are necessary. It has by now been realized that neutralization of defect states due to dangling bonds alone is not enough but, in addition it is necessary to improve the short range order (SRO) in the amorphous state so that improved doping efficiencies could be achieved. It has been shown at NCL [Kshirsagar et. al. (Phys–Rev. B 26(6) 3506 (1982)] that a strong correspondence exists between the electronic and vibrational states in a-Si and that the optical gap is predominantly determined by the intrinsic structural order. The improved order is more likely to introduce increased conductivity. A study has therefore been initiated on improvement of SRO and its effect on the gap state density and the doping efficiency. A reactor, for a-Si : H films deposition by capacitance coupled plasma decomposition of silane has been installed. Other facilities include a computer controlled laser Raman Spectrometer for SRO characterization and an r.f. sputter deposition unit for the preparation of pure a-Si films. Several films of a-Si : H and pure a-Si have been prepared and are being characterized by IR and Raman spectroscopy.

A study on improvement of short range order and its effect on the gap state density and the doping efficiency was initiated. During the period of report a-Si : H films were deposited under various conditions and their Raman and IR spectra were recorded. IR studies helped in identifying various hydrogen clustering modes in the a-Si : H film. The films with monohydride species showed stretching modes at 2000 cm^{-1} and wagging mode at 630 cm^{-1} whereas, the films with dihydride species showed stretching mode at 2080 cm^{-1}, and bending at 880 cm^{-1} and wagging mode at 640 cm^{-1}. Other films having different relative concentrations of Si:H and SiH_2 species showed mixture of the above vibrational frequencies in the IR spectra. The peak near 2000-2100 cm^{-1} was then analysed for determining the relative concentrations of these species. The control on the preparation of a-Si : H films has been achieved ensures that the films contain either monohydride species or the dihydride species exclusively. The effect of these hydrogen clustering reflected in Raman scattering was then studied, The films with monohydride clusters exhibited high ordering as revealed by the low full width at half maximum (FWHM) of TO-peak at 480 cm^{-1} and absence of structure in the LO-region. On the other hand, ihe films with dihydride clusters exhibit low degree of order i. e. high FWHM of TO-peak and a strong structure in LO-region. The former films are therefore interpreted to consist of six membered rings and the latter of higher membered rings. Correspondence between the ratio of the relative concentrations of the Si : H and SiH_2 species to that of various features in Raman spectra were observed. The Raman spectra were also found to vary as a function of the parameters employed in the preparation of the films. viz. r, f. power, gas pressure, and substrate temperature. The variations in Raman spectra are attributable to rate of breaking bonds and their reconstruction, bombardment effects due to ionic species and secondary electrons. The films with dihydride species indicated thickness dependent changes in Raman scattering.

4.1.1 Defect states in amorphous-Si

It has now been established that a-Si prepared from Silane (SiH_4) contalns a significant amount of hydrogen. Hydrogen saturates the dangling bonds and thereby removed the states in the gap to give rise to superior quality material. Mere presence of hydrogen is, however, not enough to ensure good quality material. It is necessary that hydrogen gets incorporated in the structure in certain definite configurations so as to ensure a material with low density of states (DOS). Since the material with a low DOS is required for most device applications, a technique known as admittance spectroscopy has been developed for obtaining information above DOS. In this techniques information about g (E_f) is obtained by studying the frequency and/or the temperature dependence of the zero bias capacitance of Schottky diodes.

4.1.2 Si/SiO_2 interfaces

Grain boundaries are known to create recombination centres or traps for minority carriers in poly-Si devices. Effect of grain boundaries on interface states have been investigated. The conductance and capacitance of thick oxide MIS junctions (SiO_2 thickness > 200A°) have been measured from 25 Hz to 10^5Hz. It has been demonstrated that the use of a thick oxide MIS junction enables one to obtain the surface state data throughout the whole Si band gap with better resolution and better sensitivity. A model is being developed for states and charges at the Si/SiO_2 interface based on the expected existence at this interface of coordinated Si atoms, strained Si-Si bonds, etc., and also at grain boundaries. It is being shown that the reconstructing character of interface states due to grain boundaries so obtained has a number of interesting experimental implications, which include device instabilities, the dependence of the interface density of states on the conductivity type of the semiconductor.

4.1.3 Phosphides

Group II-V compounds particularly Zn_3P_2 and XnP_2 (both α and β) appear to be promising semiconductors for solar cell applications. Little is known about the defect structure, common electrically active imperfections and other aspects of optical properties. Structural and optical properties of electron beam evaporated thin films of Zn_3P_2 have been investigated. The as–deposited film is annealed at 200° and the film becomes crystalline at 300° with the structure matching that of the bulk material. Studies on optical absorption of these films have been carried out with emphasis on the region of the interband absorption. Analysis of thin film data showed that Zn_3P_2 is a direct band gap material. Photoelectron spectroscopy has been used to determine accurately the binding energies and spin-orbit splittings of Zn-3d.

4.1.4 Density of states in a-Si

A amorphous Si is known to have a large density of localized states in the mobility gap. These, normally, pin down the fermi level effectively and make it difficult to see any doping effects in this material. These localized states are partly the result of disorder and partly because of other defects. Information of these defects states has been obtained by admittance technique as well as by space charge limited current measurements.

4.1.5 Amorphous Si/crystalline Si heterojunctions

A theoretical approach for deriving an equation for the photogenerated current in a P/N junction of a-Si over crystalline Si, has been developed Amorphous Si prepared by glow discharge is free from grain boundaries. Furthermore, because of its higher absorption coefficient, and an energy gap close to optimum, it holds great promise in the fabrication of solar cells, even though the lifetime of the minority carriers is slightly lower.

Computations have been made for J_{se} and V_{oc} as a function of the thickness of the a-Si layer at a given mobility in the base layer. The calculations show that at a thickness $\sim 0.1\ \mu$, the efficiency of the device is maximum. By taking this optimum thickness, the effect of carrier mobility in base material has been examined. Even if the carrier mobility is very low ($\sim$ 200 cm^2/volt sec.), this configuration has a reasonably good photo-response. Thus after optimizing the thickness of a-Si layer, the effect of carrier mobility on a-Si photo-response has been studied. It remains more or less constant in the region of 2-5 cm^2/volt sec. beyond which it starts decreasing. Thus one could get the required efficiency with a-Si P/N junction, if the thickness of the a-Si is properly chosen. These studies have opened up many possibilities and it would be interesting to explore them experimentally.

Surface states in Zn_3P_2

Z_3P_2 is a P-type semiconductor for a variety of applications, because of the following qualities : (1) a direct optical band gap $\sim$ 1.5 eV which is the optimum for solar energy conversion and (2) a minority carrier diffusion length of $\sim$ 10 μm which permits efficient current collection. The characterisation of surface state properties is an important indicator of the material quality. Since these states may control minority-carrier life time and hence, conversion efficiency for solar cell performance. Surface states or deep majority carrier traps are being studied by admittance spectroscopy in as-grown Zn_3P_2 crystals by the perforated capsule technique and also in thin film Schottky diode by evaporating Mg and Ag on opposite sides of each sample. The chemical origin of these states is being determined.

4.1.6 Thick films materials (7-5-004)

(1) Gold Paste

The Imported gold paste and NCL formulated gold paste were screen printed, dried and fired under identical conditions. Adhesion strength for both the samples was 4 to 4.4 kg for a 2×2 mm print area. The film thickness of the present NCL samples

was slightly lower than that of the imported ones. Formulations are being modified to make the NCL formulation match fully with the imported paste.

(2) Silver epoxy

A large quantity of silver epoxy was prepared for batch chip bonding trials. Imported samples and NCL samples were evaluated under the identical conditions by Semiconductor Complex Ltd., Chandigarh. The results were satisfactory. The electrical resistivity of the film cured at 150°/1½ hours was $1-2\times10^{-4}$ cm which similar to that of the imported sa nples. Lateral bonding between the copper strips was adequate and comparable to that of the imported sample. Silver epoxy made at NCL was used by IIT Delhi in its evaluations of semiconductor thin films. The performance was reported to be satisfactory.

(3) Cadmium oxide thick films

(a) Cadmium oxide thick films prepared by a new method starting from cadmium octoate were fired at 300–800°. X-ray analysis of the films showed they had cubic structure up to 600°. The conductivity measurement carried out dur'ng serveral heating cooling cycles showed the effect of adsorbed oxygen on the conductivity.

(b) Work on Cdo–based thick film resistors (70% glass) was initiated. The preliminary work indicated that the composition of the glass frit used had to be modified. The electrical and structural properties of thick films of CdO (with 5% glass) similar to those of (a).

(4) Glasses

Conductivity measurements for five glass compositions were carried out. The glass pastes were screen printed on aiumina substrates and fired at above their softening temperatures. The sheet resistivity varied from 5 Ω/Sq to 5 Ω M/Sq. This shows that the glass composition will have a substantial effect on the electrical properties of the thick films.

(5) Palladium-silver conducting paste

This paste was evaluated independently by CEERI, Pilani, as per the Dupont's evaluation procedure. The conductivity, adhesion strength, solder leach resistance, resolution etc., were also measured at NCL. CEERI reported that the NCL sample was comparable to Dupont's Pd-Ag (No 9308) paste in its performance.

(6) Low cost substrates

Some work was initiated in formulating enamel compositions to be printed and fired on stainless steel substrates.

(7) Copper oxide coatings

A new method of preparing copper oxide coatings was worked out. Copper octoate is screen printed, fired at 250-600°. The bluish green films change to black colour. The adhesion of the films to the substrates needs to be improved. Possible applications of this metho d are in solar collectors.

(8) Bismuth ruthenate

Resistor pastes using $Bi_2Ru_2O_7$ were formulated, screen printed and fired at various temperatures. The resistor evaluation of properties is in progress.

(9) Cadmium oxide thick films

It is very important that the oxide system used as active material should be chemically stable at the thick film processing temperatures. It is possible to get a wide range of Ps values with such a system. Cadmium oxide based thick film resistors are gaining importance because of the raw material cost, It is essential to study the effect of dopants on the oxygen deficient CdO in order to control the resistor properties. Fe_2O_3 was the first dopant to be investigated. The X-ray data revealed that Fe_2O_3 (0.5 to 3.5 w/o) goes into a solid solution with CdO. Further work is in progress.

A special type of silver paste (thermosetting single component) to attach very fine leads to the IR detector crystals was successfully develcped.

(10) Multirilratex thick film circuit

A stable multivibrator thick film circuit for square wave generation was successfully designed and fabricated at NCL. This was part of the M.Sc. course work of a student of Physics department, Poona University. Resistor and conductor paste formulations were specially prepared, Designed resistance values were obtained in a particular specified area. Printing and firing conditions were optimised to get the desired resistance values (10.0, 6.6, and 4.8 KΩ) in a single firing. By attaching a capacitor and an I. C. a hybrid circuit was prepared. This is the second successful project completed in the area of thick film circuits. Earlier, a thick film amplifler circuit was developed on similar lknes.

(11) Fabrication of thermo-emf unit

A special sample holder for measuring the thermo emf of thick film semiconducting materials was designed and fabricated.

Vacuum of the order of 2 torr can be maintained in the system. Enough care is taken to avcid pick ups due to stray signals. The unit has been successfully used for all the thermo-emf measurements.

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5. AGROCHEMICALS

5.1 Synthetic pyrethroids (8-1-03S7)

In continuation of the work on the synthesis of active photostable pyrethroids, from the indigenously available, cheap and abundant (+)–3-carene, the synthesis of seven pyrethroids, possessing the desired IR-trans-configuration has been carried out. They are (1) 3–phenoxybenzyl IR-**trans** 2,2-dimethyl -3-(2-chloroproop-l-enyl) cyclcpropane carboxylate (2) 3-phenoxybenzyl (+) IR-trans-2, 2-dimethyl -3-(2–phenyl prop-l-enyl) cyclopropane carboxylate (3) 3-phenoxybenzyl (+) IR-**trans**, 2,2-dimethyl-3-(2-p-totylprop-l-enyi) cycloprcpene carboxylate, (4) 3-phenoxybenzyl (+) IR-**trans**-2,2-dimethyl-3 (2-p-chlorophenylprop–l–enyl) cyclopropane carboxylate (5) 3–phenoxybenzyl (+) IR-**trans**–2,2–dimethyl –3–(2E–p–chlorostyryl cyclcpropane carboxylate, (6) 3-phenoxybenzyl (+) IR-**trans**-2, 2-dimethyl-3- (2-p-chlorophenyl -2-chlorovinyl) cyclopropane carboxylate and (7) 3-phenoxybenzyl (+) IR-**trans**-2-dimethyl-3-(2-p-chlorophenylethynyl) cylopropane carboxyl esters compounds (1) to (6) were obtained as E,Z mixtures. Some of the esters mentioned above are reported to posses secto parasiticidal and insecticidal activity.

5.1.1 Deltamethrin

The synthesis of IR-cis-2, 2-dimethyl-3-formyl cyclopropane carboxylic acid (caronaldehyde acid), an important intermediate for the acid moieties of highly potent pyrethroids like deltamethrin has been carried out from (+)-3-carene via IR-**cis** -2,2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylic acid. The development of a laboratory scale process for the above intermediate is in progress,

5.1.2 DV acid

2,2–Dimethy1–3–(2, 2–dichlorovinyl) cyclopropane–1–carboxylic acid (d1 mixtures of **cis** and **trans** isomers), commonly known as DV acid, was synthesized in 3 steps, starting from 3–methyl–but-2-ene–l–ol and triethylo–rtho–acetate, by Sagami's method. A process has been standardispe for obtaining 3–methyl-but-2-ene-l–ol in high yields from isoprene monomer. DV Acid is the acid moiety of commercially important pyrethroids like permethrin and cypermethrin. A laboratory scale process is being developed for methyl (±) -cis-2. 2-dimethyl-3-formyl cyclopropa-ne-l-carboxylate, by a total synthetic approach via caronic acid anhydride.

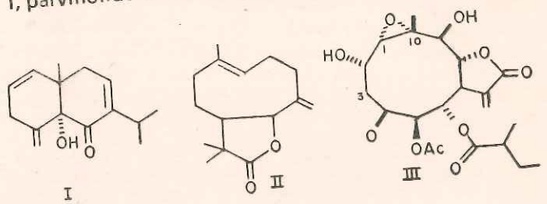
5.1.3 Secopyrethroids

Several 1, 3 and 2, 3-secopyrethroils have been synthesised by the total synthetic approach as well as from naturally occurring substrates like (+) citronellal and (+) citroneilol. Of these, 2, 3-sccopermethrin and 2, 3-secodeltamethrin (as dl mixtures) were found to be active against houseflies at 1 g. dose per housefly. Some of the other secopyrethroids synthesised exhibit moderate larvicidal activity.

5.2 Development of pest control agents and other bioactive principle (8-2-0035)

A process has been standardised for isolation of Neem rich II from neem seed oil for use as antifeedant against *Spodoptera litura*. A method has also been developed for estimation of azadira chtin in various neem oil fractions. A pure compound responsible for oviposition deterrance activity has been tentatively identified.

Sixty new plant extracts were screened. Detailed and exhaustive chromatographic separations, monitored by bioassay reports of on insect control activity like insecticidal, ovicidal, antifeedant and developmental inhibition were carried out. This resulted in isolation of a number of new compounds in the area of fatty acids, terpenoids and flavonoids. in addition to known compounds which were characterized earlier. Structures of some of these were established. Important among them are stemonolone I, parvinolide II and a gremacrolide III



Some alkyl-aryl ethers have been prepared which exhibit significant mosquito controlling activity.

5.3 Controlled release pesticides (8-5-3156)

5.3.1 CR carbofuran system for agricultural application

The technique of encapsulation of carbofuran in starch xanthate matrix was standardised and a CR system having a fairly uniform release over a period

of 60 days in static water was developed. Field evaluation of the standardised formulation in rice cultivation at the Agricultural Research Station, Konkan Agricultural University Karjat, is in progress for the second season. Field evaluation against root knot nematodes in tobacco cultivation is also in progress at three different research stations of the Central Tobacco Research Institute.

The drawback of the starch based system is the limited scope it offers for varying the release properties. Hence, development of alternative polymer systems was taken up. This includes incorporation in polystyrene microspheres by the solvent evaporation technique and microencapsulation in a urea condensate. The latter system appears quite promising since it shows a definite correlation between rate of release and degree of encapsulation (25 to 80%) and the rate levels at low loadings are much lower than for the starch system. This system definitely shows promise for developing formulations with tailor-made release properties. In addition, this process leads to coating of the individual particles of carbofuran with the polymeric matrix and consequently is expected to markedly reduce its toxicity.

5.3.2 Microencapsulation of fenitrothion

After preliminary investigations of the polyamide and polyurea systems, the latter was chosen for detailed studies as it is much cheaper. Microencapsulation of fenitrothion (for use as mosquito adulticide as well as foliar spray in agriculture) in polyurea matrix by interfacial polycondensation of toluene diisocyanate with ethylenediamine and hexamethylenediamine was standardised with miximum degree of encapsulation of (85-90%) Particle size could be adjusted in the range of few micron to 100 micron so that the dispersion could pass through the spraying nozzle. An all glass assembly was set up for studying the release properties of the microcapsules in air. The rate of release was, however, found to be too low for detection and estimation. Hence, correlation of its release properties in a suitable solvent is being standardised for the purpose of comparative evaluation of the products.

5.3.3 Controlled release abate

Controlled release formulations of abate made with latex continued to be evaluated in the laboratory and the fields. However, owing to problems such as irregular and low toxicant incorporation and stoppage of release due to algal and other deposits under field conditions, and cost efficiency factors use of synthetic polymers such as polyethylene and polypropylene as substrates was resorted to, Initial results in the laboratory with these dispensors were promising and some selected simulated and later actual trials were carried out on selected dispensors. However, drawbacks similar to those associated with latex dispensors, namely, low toxicant incorporation, high insecticide hold up and occlusion of dispensors by silt and algal deposits resulting in abrupt stoppage of release were observed and this led to the abandonment of the monolithic matrix system generally.

In both the monolithic matrix systems used the dispenser performed satisfactorily in the laboratory but failed to live up to the expectations in the field.

An entirely novel system in which insecticides are stored between packings of hydrogels was developed and assessed in laboratory. Geometric designs and encasing materials were prepared using different resins of the gel and the insecticide. It was established that toxicant release in this system could be regulated to requirement through different combinations of gel concentration. dimension and amount. It could also be demonstrated that toxicant hold up here was minimum and strictly proportional in a particulate ratio to the amount of gel used. Again as there is no limit on the amount of insecticide that can be stored in these hydrogel dispensers, the designing of devices of stipulated longevity is possible. Field trials also established the remarkable fact that these dispensers do not get occluded by algal deposits. This was attributed to the very small size of the micropore channels in the hydrogel which act as conduits for the passage and release of the toxicants. This small size exerts a molecular sieving elfect and prevent the entry of larger entities such as algal cells into these conduits. In actual trials, some of these dispensers have lasted for more than five months at reservoir doses of the insecticide. The high pliability and other unique features of the novel hydrogel dispenser system for aquatic larvicides make it an extremely likely candidate for product development and universal adoption in mosquito larvicidal operations in the very near future.

Bioevaluation procedures for assessment of efficacy for different controlled release formulations in laboratory and field trials as well as definition of doses, application strategies and other parameters

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were presented at the Xth International Conference on Controlled Release of Bioactive Materials held in San Fransisco, USA, in 1983.

Work at NCL on the new hydrogel dispenser systen for aquatic larvicides has been communicated to the international symposium scheduled to be held in Switzerland later this year and has been accepted.

5.4 A new group of cyclopropane derivatives with miticidal activity (8-6-003S)

A cyclopropanoid ester which was effective when evaluated against pink mites and purple mites occurring in tea plantations has been sent to FMC corporation (USA) for evaluation against red spider mites.

5.5 Synthetic studies in agrochemicals (8-8-0357)

Homobrassinolide (22S, 23S and 22R, 23R isomeric mixture) was synthesised starting from commercial pure stigmasterol. Field trial with this isomeric homobrassinolide mixture conducted by the tissue culture group of the Biochemistry Division showed increase of paddy yield by 15% and increase of tomato yield 70% by over control. Sample of brassinolide mixture was also given to Rice Research Station, Karjat, for field trial study on summer paddy. Field trial study on leguminous plants such as Chawli is also in progress at NCL by the tissue culture group.

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Chapters in Book

Patwardhan, S. A. and Das, K. G.

1. An overview of controlled release technology
2. Chemical methods of controlled release
3. Microencaptulation

In book entitled 'Controlled release technology Bioengineering aspects edited by Dr. K. G. Das, Published by John Wiley & Sons, USA, (1983).

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6. PLANT TISSUE CULTURE

6.1 Plant Tissue Culture for agriculture and forestry (9-1-001)

The main highlights of the work during the past two years have been on the following basic and applied projects.

6.1.1 Isoenzyme profiles during organogenesis in cultured plant cells

Organised development in plant callus cultures is known to involve metabolic shifts reflected by change in the content and spectrum of both structural and functional proteins. Isoenzymes are built-in markers of gene expression and their patterns are known to change during cell differentiation. Using sugarcane callus it was observed that : (a) mobilisation of nitrate was better in the shoot forming than in the non-shoot forming callus, (b) the glutamine synthetase/glutamate synthase pathway of ammonia utilisation deminates over the glutamate dehydrogenase pathway prior to shoot differentiation, and (c) the channelisation of the glucose moiety in the shoot forming callus is preferentially through the pentose pathway.

6.1.2 Molecular biochemistry of chloroplast biogenesis in plant tissue culture

DNA modification like methylation has been implicated in regulation of eukaryotic genome. In plant tissue cultures one faces the problem of loss of morphogenetic potential which cannot be ordinarily reversed. It is probable that such phenomena are due to DNA methylation and if this is so, they could be manipulated by *in vivo* demethylation.

(i) Preliminary observations made in the studies on *Vigna unguiculata* and *Saccharumoficinarum* suspension cultures indicate that biogenesis of chloroplasts can be manipulated by the use of 5-azacytosine and significant changes during the devolopmental patterns of key enzymes in *S. ollcinarum* are initiated during the greening of tissues and occur concurrently with it.

6.1.3 Protoplasts

There are only few published reports in literature on protoplast regeneration from legumes. The drought resistant legume *Vigna aconitflolia* has been successfully regenerated from protoplasts.

6.1.4 Applied Research

(a) Micropropagation

Methods are now available for the following three tree species.

1. *Salvadra*
2. *Eucalyptus torelliana, E. camaldulensis*
3. *Dendrocalamus strictus* (seeding)

Work is in progress on following tree species.

1. Coconut, 2. Rubber, 3. Mango, 4. Cashew 5. Eucalyptus globulus, 6. Bambusa vulgaris, 7. Dendrocalamus stricuts (Mature)

(b) Somaclonal variation

Ginger

A rhizome not resistant ginger variety has been isolated from callus cultures tolerant to culture filtrare of *Pythium aphanidermatum.* Field trails on the second generation of these potential resistant rhizomes are in progress to test the heritability of the disease tolerant trait.

(c) Embryo culture

Interspecific hybrids between *Gossypium hirsutum* and *G. arboreum* have been reared by the embryo rescue method. The interspecific hybrid was confirmed cytologically and found to contain 39 chromosomes.

6.1.5 Field trials

(a) Sugarcane

NCL Sugarcane will be planted in an area of about 6000 acres as part of the large scale testing programme planned to be carried out by Maharashtra State Farming Corporation (MSFC) during next planting season.

(b) Banana

Over 100 virus free plants of two varieties of banana (Basarai, Robusta) have been tested at Banana Research Station, Yawal and at NCL, Poona. Plants raised from rhizomes of these plants were found to be disease free.

(c) Turmeric

The high curcumin containing variants isolated from tissue culture were multiplied at Turmeric Research Station, Sangli. The variety is now included in the trials for promising strains.

(d) Cardamom

Trials at the Indian Cardamom Board on Tissue Culture raised cardamom plants have indicated early flowering, fruit setting and rapid growth of the plants.

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7. POLYMER SCIENCE AND ENGINEERING

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

7.1.1 Understanding of the rheology of polymer melts is required for the design of processing machinery, process optimization and product quality improvement. A correlation was successfully developed for estimating the rheograms of polymer melts from melt flow index. The melt rheograms of ferrite filled thermoplastic elastomers such as styrene isoprene-styrene, thermoplastic urethane, and Hytrel (polyether ester) at filler loading of 75-85% were investigated to arrive at processing guidelines for extrusion and molding of polymer magnets.

7.1.2 The properties of moulded polymer products are governed by the morphology of the semi-crystalline polymers in the solid state. The morphology is affected by the process conditions and the crystallization behaviour of the polymer. The crystallization behaviour of a number of engineering thermoplastics such as PETP, PPS and PEEK were studied. A method was successfully demonstrated for defining guidelines for injection moulding of the semicrystalline polymers by superposition of the isothermal crystallization kinetics and the computed temperature profiles during the cooling stage of the moulding cycle.

7.1.3 The structure development in solid state processing of high performance polymers such as PPS, PTFE and polymer alloys were investigated using X-ray diffractometry, IR spectroscopy and electronic microscopy. On the basis of the results optimum conditions for the processing were suggested.

7.1.4 Presently over 100,000 TPA of polyethylene terephthalate (PET) is melt spun in India but there very little scientific understanding regarding the is complex interrelationship between the polymer characteristics, spinning variables, hardware design and the fibre properties. A comprehensive computer simulation programme of the PET spinning process, capable of *a priori* estimation of spinning conditions, given the derived spun fibre properties, was undertaken. The salient features of this programme are :

(a) development of a mathematical model (single filament analyses) for predicting spun fibre properties related to aerodynamics, heat transfer, melt rheology, extensional deformation and orientation development.

(b) development of a sensibility analysis to identify critical process variable in PET melt spinning.

(c) development of an effective simulation procedure for multifilament spinning.

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

7.2.1 Computer simulations of PET reactors (both batch and continuous) led to the development of software which was used successfully by commercial PET manufacturers. A number of anomalies of relevance in the industrial operation of reactors were resolved through such simulations

7.2.2 Modelling of co-polymerisation reactors led to new analysis and design strategies for continuous reactors. Concentration and thermal multiplicities and their consequence in the operation of continuous reactors were elaborated.

7.3 Polyphenylene sulphide (10-4-567)

Polyphenylene sulphide is an engineering thermoplastic with excellent thermal and chemical resistance. A process for the synthesis of PPS was demonstrated at laboratory scale. The polymer powder produced by the process can be used directly for corrosion resistance coating publications. Coating trials were successfully completed on metal and glass substrates. The crystallization behaviour of the polymer was studied on the basis of which processing guidelines for injection moulding were arrived at. The structure development in solid state processing of PPS and HDPE blends was investigated.

7.4 Development of novel polymeric materials (10-5-356)

7.4.1 Polyurethane formulations from castor oil

The preparation of castable polyurethane elastomers from castor oil was successfully demonstrated. The use of fillers to upgrade the properties of elastomers was also demonstrated Possible applications for the material include castor wheels, rollers, etc.

7.4.2 Liquid crystalline polymers

Research was initiated in the frontier area of liquid crystalline polymers, which are capable of giving mechanical performance equivalent to fibre reinforced composites. Preliminary synthesis work is in progress. Available property data are being analysed to arrive at structure-property correlations.

7.4.3 Asphalt modification

Various routes were being explored for physical and chemical modification of asphalt to improve the high temperature flow resistance and low temperature crack resistance. The thermo-mechanical properties of the modified asphalts were being investigated. Preliminary results indicated that chemically modified asphalts using vinyl monomers exhibit significantly better high temperature flow resistance and low temperature crack resistance.

7 5 Drag reducers for oil transport (10-7-567 (C))

The objective of the project was to develop a drag reducer for the transportation of Assam crude. It was identified that the critical parameters involved in the development of a drag reducer are

(a) a thorough understanding of the complex rheology of the crude.

(b) the extensional flow behaviour of the additive, and

(c) the shear stability of the additive to withstand mechanical degradation.

More than 20 prospective polymers were synthesized with a view to tailor-making them for obtaining reasonable levels of drag reduction even at concentrations as low as 50–150 ppm along with a high level of shear stability to likely mechanical degradation in the pipeline. The critical material parameter for the evaluation of drag reduction efficacy was the elongation viscosity or the stretchability of the polymer. A novel rod-pull technique was developed in-house for quick estimation of the drag reducer efficacy.

Four out of the twenty polymers synthesized were selected for tests in model pipelines. A 1/4 inch pipeline rig was erected in the laboratory wherein these tests could be carried out. In order to determine scale-up factors, the same experiments were planned to be conducted later in a 2 inch pipeline loop available at Merado, Pune.

7.6 Polymer alloy resins for composites (10-8-006 G)

The development of polymer alloys is a frontier research area in materials engineering. It is a novel way to tailor make materials without resorting to time consuming and expensive material development through chemistry. Melt compounding of two alloy systems, namely PPS/HDPE and PET/PMMA was successfully completed. The melt compounding conditions for the preparation of the alloys were defined on the basis of the melt rheology and thermal behaviour of the component polymers. The thermal and viscoelastic characteristics of the alloys were determined. It was shown that alloying of PPS with HDPE improves the impact resistance in addition to reducing the cost. The alloying of PETP with PMMA resulted in accelerated crystallization leading to better processability. The toughness of PETP was also improved.

7.7 Development of water absorbing polymers (10-9-006(Sp))

Water absorbing polymers are a family of products distinguished by their ability to absorb and retain large quantities of water (up to 1000 g/g). The product has a wide range of applications in diverse fields, such as agriculture, horticulture, oil recovery, etc. The polymer can be used as a seed coating (for better emergence), as a soil additive (for retaining moisture), and in a gel-dip technique for transplanting plants. If successful, the impact of such a material on the agricultural community can be enormous.

A specific project to produce a starch based water absorbing polymer was sponsored by Indian Organic Chemicals Ltd. A series of polymers having water retention capacities in the range 100-500g/g distilled water were developed in the laboratory and the process was demonstrated on a 5 kg. batch size, and subsequently on a 20 kg. batch scale. Efforts have been under way to optimize the process for improving the cost effectiveness of the process and to minimize the product costs. Initial field trials for agricultural applications were quite encouraging. They are being continued. Product development for other applications and performance evaluation thereof was in progress.

A semi-commercial plant (200 TPA) to produce a specific water absorbing polymer (with the trade name JALSHAKTI) is expected to go on stream in July 1986.

7.8 Polymeric materials based on cashew nut shell liquid (CNSL) (10-10-006)

The objective of the project is to develop polymeric materials from CNSL for replacing wood in low cost housing. The synthesis of polymeric liquid resins has been demonstrated by co-polymerization of CNSL and phenol with formaldehyde. Solid and foamed cast products have been demonstrated from these resins. Use of mineral and cellulosic fillers has been successfully attempted. The cast pieces are water resistant and can be readily drilled, machined and generally worked upon in a manner similar to wood. Potential applications include wall panels, partition boards, electrical fittings, etc.

7.9 Basic Studies

7.9.1 New free volume models for viscosity of structured fluids

A new altered free volume state (AFVS) model was developed to correlate the viscosity behaviour of polymer lattices. In addition to elucidating the effect of various parameters such as concentrations. particle size, shear rate and electrolyte concentration, on latex viscosity, it is possible to isolate the geometric and electrostatic contributions to latex viscosity.

The AFVS model has been further successfully extended to correlate viscosity of polymer solutions. A novel scaling parameter, ϕ, was defined which could take into account the effect of polymer concentration, as well as molecular weight, on the solution viscosity, thus, obviating the need for empirical shift factors used for the past few decades to bring about the superposition of the two effects.

7.9.2 Rheology of highly filled systems

Steady state and dynamic rheological properties of various thermoplastic elastomers such as S–I–S block copolymers, polyester elastomers and thermoplastic polyurethane containing 75–85% by weight of barium ferrite have been determined. The rheological bahaviour was studied as a function of temperature, filler loading and shear rate, and this gave a considerable insight into the temperature and shear sensitivity, filler–filler interaction and polymer–filler interaction. Exhaustive studies on mechanical behaviour in terms of tensile and flexural properties of the polymer composites gave valuable guidelines for the selection of the matrix for a particular application depending upon end use performance. Magnetic properties in terms of peak energy products of these highly filled composites have also been measured.

7.9.3 Turbulent flow of non-Newtonian fluids

Detailed theoretical studies were performed on various aspects of turbulent flow of non-Newtonian fluids. New velocity profiles, both for power law fluids as well as drag reducing fluids, which were devoid of incongruity such as a non-zero velocity gradient at the centre of the pipeline were proposed for the first time. A method for estimating the entrance lengths during the turbulent flow of inelastic as well as elastic fluids was worked out for pipeline design. The effect of buoyancy on the heat transfer to turbulent flowing non-Newtonian fluids was elucidated and this made quick estimations of the changes in heat transfer coefficient due to superimposition of free and forced convection possible.

7.9.4 Studies in polymer crystallization and structure development in polymer processing

Studies have been carried out on the crystallization kinetics crystal structure and morphology of various engineering plastics of industrial significance. The specific polymers chosen for the studies included thermoplastic polyesters, nylons, polyaryletherketones, thermoplastic alloys such as PPS/HDPE and PET/PMMA. The modification of the crystallization behaviour of the component polymers in the alloys has been investigated from the point of view of nucleation and crystal growth kinetics.

In case of polymers with chain structure capable of manifest trans and gauche conformations, the melt temperature can influence the morpholcgy and dimensional stability of the moulded parts. The influence of the melt temperature on the crystallization behaviour of such engineering polymers has been investigated.

7.9.5 Transport phenomena in polymeric systems

(a) Stress-induced macromolecular migration

The mechanism of stress-induced migration and its consequences in important practical situations have been examined. In the former area, analysis of the phenomenon for dilute solution led to the discovery of the FDCF asymptote (the upper bound on the migration effect) in the process raising some fundamental questions regarding flow length. In the latter area, the research demonstrated the potential of a heuristic analysis based on stress-induced migration phenomenon to provide a rational interpretation of anomalous behaviour in areas as diverse and as important as secondary oil recovery, free coating, laminar drag reduction, heat and mass transfer involving viscometric and non-viscometric flows.

7.9.6 Unification of diffusion phenomena in polymeric systems.

A model utilising the concept of altered free volume state (AFVS model) has been proposed. One of the merits of the AFVS model lies in its simplicity and its ability to correlate a wide range of transport phenomena for diverse polymeric systems. The model has already been shown to be useful in correlating diffusive transport in polymer solutions, gels, semicrystalline oriented polymers. The model parameters can be meaningfully correlated with the characteristics of the diffusant and this correlation validates the physical significance ascribed to them.

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8. POLYMER SYNTHESIS AND MODIFICATION

8.1 Polymeric memberanes for desalination (11-3-056)

Chemical modification of cellulose acetate with propylene oxide was carried out to improve creep resistanc, microboial resistance etc. Memberanes were cast from the modified cellulose acetate and evaluated for transport properties. Salt rejection was higher, but water flux was lower. Synthesis and chemical characterization of polyamides containing silicone and sulfone ether linkages in the polymer main chain were carried out.

8.2 Aromatic polymers — polyamides for desalination and effluent treatment (11-3-056-Sp (i))

In continuation of the earlier work, the synthesis of 'Nomex' ploymer from 1, 3-phenylene diamine and isophthaloyl chloride with a film forming viscosity (n) of about 0.9 dl/gm has been standardised. The polymer was found satisfactory for desalination in the trials carried out by BARC, Bombay.

Polybenzimidazole (PBI) ($n \sim 0{\cdot}7$ to $2{\cdot}5$ g/dl) was prepared from 3,3'-diamino benzidine and isophthaloyl chloride.

Polyhydrazide polymer prepared from 1, 3-isophthalic dihydrazied and isophthaloyl chloride was carried out. The polymer viscosity ($n \sim 0{\cdot}75$ dl/g) was found satisfactory for desalination. The polyhydrazide polymer was further utilised to prepare polytriazine polymer. Novel silicone containing polyhydrazides and polytriazines were also prepared.

8·3 Hydroxy terminated polybutadienes (HTPB) (11-6-567-Sp)

Preparation of hydroxy terminated polybutadienes with an average molecular weight of 2000 and 3000 has been standardised on a 2 kg monomer/batch scale. The polymers have been characteristed for average molecular weight, molecular weight distribution, hydroxyl number and bulk viscosity. A pilot plant has been assembled for scaling up the process to 10 kg polymer/batch size.

Work on the preparation of HTPB by anionic polymerization was continued. Polymerization could be carried out in hydrocarbon solvent with isoprene seeded lithium methylnaphthanate as the initiating species. Narrow molecular weight distribution polymers ($M_w/M_n = 1{\cdot}2$) with an average molecular weight of 2000 and 3000, and functionality $\sim 2{\cdot}0$ were prepared in 50 gm yields.

8·4 Polymers from renewable resources (11-9-567)

The project aims at utilizing castor oil, an agricultural product, as polyols, which are important intermediates in the production of polyurethane elastomers, coatings and adhesives. The chemical modifications of castor oil that have been studied are : (i) transesterification with different molecular weight diols; (ii) preparation of isocyanate-terminated prepolymers from the transesterified polyols; (iii) partial blocking of the hydroxyl groups to reduce the average functionality to 2; (iv) preparation of resolinic amide by transesterification with an amine; (v) partial dehydration of castor oil; etc Castor oil, chemically modified diols and isocyanate terminated prepolymers have been utilised in the preparation of castable polyurethanes along with chain extenders. Eastable rubbers with very good physical properties were obtained when isocyanate terminate prepolymers with chain extenders were used.

8·5 Thermoplastic polyurethanes (11-10-567)

Thermoplastic elastomers are polymers which are processed as thermoplastics by extrusion, injection moulding etc., but possess useful elastomeric properties at working temperatures. The aim of the project is to develop know-how for the manufacture of thermoplastic polyurethane of moulding and extrusion grades.

Works is in progress to standardise the conditions for the preparation of (i) polyoxytetramethylene diol by cationic polymerization of tetrahydrofuran and (ii) the polyester from adipic acid and 1, 4-butanediol.

8.6 Engineering plastics (Polyphanylene oxide) (11-11-567)

Polyphenylene oxide (PPO) based resins are among the important classes of engineering plastics with low water absorption, high strength, stiffness and toughness over a wide range of temperatures. At present limited quantities of these resins are imported for special engineering applications.

Laboratory work on the preparation of PPO is being carried out using about 50 gm 2, 6-dimethyl phenal perbatch. Polymers with molecular weights in the required range have been obtained in about 90% yield. Use of other amine complexing agents and hydrocarbon solvents in the synthesis of PPO is being evaluated.

8.7 Polymers for electronics (11-12-567)

Synthetic polymers find extensive applications in electronics, and photoresists (light activated image forming polymers) are the most important of these. The initial phase of the work aims at the development of negative photoresist polymers based on polyvinyl acetate.

Conditions for the synthesis of poly-vinyl acetate of the desired molecular weights were optimised. The experiments to optimise the conditions for the controlled hydrolysis are being carried out.

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9. PROCESS DESIGN AND SIMULATION

9·1 Process simulation optimisation and synthesis (12–1–067)

9.1·1 Computer-aided energy optimisation of p-toluidine plant (SCIL)

An optimal network of heat exchangers around an exothermic reactor (in a medium scale process plant of Sudershan Chemical Industries Ltd. (SCIL) Roha) was developed. This was integrated in an, efficient manner. The process stream pre-heating and cooling requirements were such that large savings in the utilities have been clearly demonstrated to be possible. Based on the complete report on the energy integration submitted by the NCL team, the company will implement the changes shortly.

9·1·2 Computer simulation of IPCL's naphtha reformer

Development of a simulation model of the complete naphtha reformer loop of the aromatics plant of IPCL has been in progress. The simulator has a sequential modular architecture and predicts the performance of the reformer loop well enough given the rate model. This simulator is now being applied to the actual process conditions obtaining at the IPCL plant.

9·1·3 Development of computer packages and aids

A number of packages have been implemented on the in-house SN-23 computer system

(i) A flash package using several gas phase and liquid phase non-ideality calculation options has been successfully used for naphtha reformer semulation as well as for predicting phase-splits for ethanol-water system.

(ii) Two versions of a generalised heat exchange equipment simulator based on modern concepts in software system design have been prepared. These have a modular structure and a dedicated properties packages. These can be conveniently applied to common classes of heaters, coolers and condensers.

(iii) An adiabatic reactor simulator which can handle complex kinetic models was developed. This package has found extensive use in the naphtha reformer simulation.

(iv) Certain computer aids for heat exchanger network synthesis have been developed.

9·2 Project design (12–2–067)

Designs were prepared for several NCL projects. These included ultrapure silicon, hydroxy-terminated polybutadiene, water absorbing polymer, methyl ethyl ketone, polyacrylamide, hexachlorocyclopentadiene, polyphenylene sulfide and a continuous fermentation unit using immobilised whole cells. The design cell members also rendered help in collecting necessary design data from pilot plants in some of the projects.

9·3 Regular packing development (12–3–066-C)

The aim of the project is to develop regular packings for the use in the distillation columns, especially for vacuum services. These packings have high efficiency of mass transfer and low HETP and they also cause less pressure drop.

The trial runs started in late 1984 and preliminary data were gathered. An analysis of the data show that these packings have the attractive characteristics of low HETP and low pressure drop. Data generation is continued for a thorough characterization of these packings, which will help in producing the necessary design base.

Vigorous efforts to ensure usage of these packings in the Indian chemical industry are being done.

9·4 Heat pumps (12–4–006-C)

Heat pumps are devices aimed at reducing the primary energy consumption of processes by recovery, upgradation and recycle of waste energy. There is a growing awarness in our industry of the potential of heat pumps in industrial applications. This project is aimed at developing expertise in the area of heat pumps in general, and utilising such expertise towards the exploitation of heat pumps in our industry for energy conservation. This project has been taken up on a collaborative basis with the University of Salford, U. K. which has developed considerable expertise in the area of heat pumps over the last ten years. The current status and the, achievements in various aspects are described below.

9.4.1 Establishing heat pump equipment

Three different equipment have been installed in NCL so far, viz. a water-to-water heat pump, a heat pump assisted dryer and equipment for stability

studies on working fluids. These are being used for generating extensive data and for demonstration purposes.

9.4.2 Industrial collaborations

Since heat pumps are economically quite attractive the current context, considerable interest has been shown by industries who are seriously evaluating proposals for incorporating heat pumps in their operations. Preliminary economic evaluations were worked out for specific applications like preheating of boiler feed water, simultaneous heating and cooling, drying and ethanol distillation on behalf of several user industries.

9.5 Basic Studies

9.5.1 The performance of a water-to-water heat pump using R 11 and R 114 was studied especially for high condensing temperatures. A computer simulation package has been developed for this heat pump and the simulated results are being compared with the experimental results.

9.5.2 Studies on the use of non-azeotropic mixtures of working fludis in heat pumps has been initiated both theoretically and experimentally. A thermodynamic approach for the analysis of Lorenz cycle using non-azeotropic mixtures is being developed.

9.5.3 The performance of the heat pump assisted dryer unit at NCL is being studied for a variety of operating conditions. These performance data will be useful in the design of such units. A computer simulation package has been developed for this system. If the experimental results could be satisfactorily corelated using this package it can be conveniently used for design purposes. A computer programme has also been developed to assess the economics of heat pump assisted dryer unit of a given drying capacity for certain techno-economic parameters.

9.5.4 A new procedure was developed for predicting the vapour pressure of aqueous solutions of single electrolytes at different concentrations. It makes use of a single empirical constant for each electrolyte. Values of these constants for over one hundred electrolytes were determined.

9.5.5 A novel thermodynamic approach was developed for predicting ten different properties of aqueous solutions of mixed electrolyte system, using information on single electrolyte solutions. The predictions have an accuracy of 0·1 percent to 2 percent depending on the particular property.

9.6 A generalised model of gas absorption followed by equilibrium reactions (single or multiple) involving any number of components solvent/product desorption, and gas phase resistance has been put forward.

9.7 A generalised across-the-regime continuous contact absorber simulator has been developed and has been applied to several simpler model reactions. Attempts are in progress for application to gas treating (H_2S/CO_2, SO_2, Cl_2 etc).

9.8 The effect of mixing of chain centres in photochemical reactors has been theoretically analysed and new results not reported in literature have been obtained.

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10. TIME TARGETED PROJECTS

10.1 Ethylene to ethylene oxide (1-1-467)

A catalyst for the conversion of ethylene to ethylene oxide has been developed. The selectivity and conversions obtained are comparable to those in the in commercial process. An integrated pilot plant incorporating a single tube reactor has been erected. The catalyst used for the pilot plant will be the one manufactured by an industrial organisaion. The project work has been undertaken jointly with Engineers India Ltd., New Delhi.

10.2 Ethylbenzene (1-6-467)

A catalyst that was developed for the reaction between ethanol and benzene to give ethylbenzene directly was tested in a pilot plant reactor and the data required for the design were collected. Subsequently tests were carried out with the catalyst manufactured by ACC., Thane in a large reactor at the site of. Hindustan Polymers Ltd., Vizag (HPL). Steps are being taken for the commercial exploitation of this new process by HPL.

10.3 Catalytic vapor phase oxidation of toluene to benzaldehyde (16-1-467-Sp)

After the successful operation of a single tube reactor assembly at NCL, designs were prepared for the installation of an integrated pilot plant. Whereas no final decision has been taken on the installation of the above pilot plant, experiments are proposed to improve the catalyst further with reference to conversion and selectivity.

10.4 Hexachlorocyclopentadiene (HCCP) (16-2-007)

The work was taken up as a collaborative project with HOC, Rasayani. After the successful completion of the operation of the integrated pilot plant at NCL, designs for a 600 TPA semi-commercial plant were prepared. HOC has not yet taken a decision regarding the installation of a semicommercial plant and the continuation of the joint developmental work at their site.

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

The work at NCL was concluded. Based on the designs and data provided the commercial plant of 135 TPA was successfully commissioned at Pefco, Roha. NCL scientists were associated in the start up and troubleshooting of the commercial plant.

10.6 O-Aminophenol (1-4-067)

After completing work on the bench scale, the work at NCL has been suspended. Additional experimental work in the pilot plant will be carried out if an industrial organisation is interested.

10.7 Citrate plasticizer (16-14-067-Sp)

The process development has been carried out on behalf of Sturdia Chemicals, Bombay. A commercial plant of 1000 TPA based on the NCL technoogy has been established by Citroflex India Ltd., Surat. The party is successfully manufacturing these products.

10.8 Modified rosin and resin derivatives (16-15-007 Sp.)

Rosin was maleinated using various proportions of maleic/fumaric acid. The maleinated rosin was esterified with different polyols to give products with varying amount of acid values. The degree of esterification and the softening point of the final product determine the end use of these resins.

Effect of the presence of impurities in the raw materials on the clarity and the physico-chemical properties of metal salts of rosin were also studied, and a suitable method of preparation was devloped.

Work is in progress on terpene resins and terpene phenolic resins. These are used in adhesives and automative tyres respectively.

10.9 Sucrose esters (16-16-007)

Sucrose esters were prepared by three entirely different routes, involving transesterification reactions of sucrose and various triglycerides or the methyl esters of their fatty acids, namely (i) using solvent like DMF, (ii) without using any solvent and (iii) microemulsion technique using either propylene glycol or aquaous medium. All the three routes need specific catalysts and methods were developed for their preparation.

Various oils such as those of castor, rice bran, neem, sal, pilu coconut, groundnut etc. were used and after standardization of conditions at bench scale the reaction has been scaled up to 1-2 Kg material per batch.

Methods were also developed and standardized for the preparation of methyl esters of fatty acids from oils. An additional advantage of the method

is the near quantitative recovery of glycerine in good purity as a valuable side by-product. The yields of the methyl esters are also quantitative.

The products obtained by these methods are comparable and in some cases better than the standard products in the market in detergency and other surfactant properties.

Further scale-up as well as formulation work is in progress.

10.10 Follow-up work (16-18-007)

10.10.1 Sulphochlorinated polyethylene elastomer (SCPE)

The NCL process was released to Shriram Rayons, Kota, Rajasthan for further joint development and commercialsaltion. The laboratory process was demonstrated to the company. A pilot plant to produce 2-3 Kg/batch of SCPE has been installed by it and the product obtained from this plant was found to pass the desired physical and mechanical specifications.

NCL is now preparing the design for a 150 TPA plant that is expected to be commissioned by the company in early 1986.

10.10.2 Endosulfan (16-18-007-i)

NCL was entrusted with the task of commissioning the plant for endosulfan established by Hindustan Insecticides Limited, Udyogamandal, Kerla. The process was successfully demonstrated to the company. The need for additional equipment to bring the plant to desired operating capacity has been felt and to it is being procured by the company.

10.10.3 Butenediol (16-18-007-ii)

HOC had installed a semi-commercial plant of 150 TPA capacity for the manufacture of butenediol. After the first trial run it was observed that the product of the desired quality was not obtained. As a result of additional work carried out at NCL it has been possible to get the catalyst manufactured by a commercial organisation on a guaranteed performance basis. Additional problems relating to stability and colour on storage have also been solved. HOC is now due to start regular production in their plant.

10.10.4 Methylchlorosilanes (16-18-007-iii)

HICO Products Ltd., Bombay have established a commercial plant to manufacture 1000-1200 TPA of methylchlorosilanes plant at Kharsundi, Raigad Dist. The plant was commissioned in November, 1982, and commercial production was started in July, 1983. The products have specifications comparable to those obtainable in the international market. The NCL/HICO process has been assigned to NRDC and is now available to interested parties with guarantees of performance.

10.10.5 Ethylenediamine (16-18-007-iv)

The commercial plant established by Diamines and Chemicals Ltd., at Baroda was successfully commissioned. The products were acceptable to all the indigeneous consumers. As a result of further joint efforts of NCL and DACL the plant capacity has been further increased to 1500 TPA so that the market demands of higher amines can be met. NCL was also involved in the process for conversion of DETA to PEHA, an important additive used by Lubrizol. NCL is associated with the company for incorporating further process/plant improvements. Already the consumption of raw materials and utilities are comparable to those obtained in plants abroad.

10.10.6 Acrylic esters

NCL scientists were associated with the commissioning and trouble shooting of the acrylic esters plant as a consultant and adviser to Indian Petrochemicals Corporation Ltd., Vadodara.

10.11 Ethylene from ethanol (16-20-467)

A pilot plant was erected to generate 2-3 kg. hr. of ethylene and commissioned. Initial trials have been conducted using an alumina catalyst. A zeolite catalyst has been developed in the laboratory which gives higher selectivity conversion and also operates at a lower temperature. The new catalyst will be tested in the pilot plant. The pilot plant is also being used to generate and supply ethylene to the ethylene oxide pilot plant.

10.12 Molasses to ethanol (16-21-167)

NCL has developed an immobilized yeast biocatalyst for the continuous fermentation of molasses to alcohol. This catalyst has shown higher productivity and yield in the laboratory reactors. Several batches of the catalyst were prepared in larger scale and tested continuously for activity, life, mechanical properties etc. In a 10 lit/day ethanol reactor. Whereas further improvements are being effected on the catalyst a pilot plant of 100 lit/day capacity is being erected.

10.13 Pyrethroid intermediates (16-26-0357-Sp)

The process for the production of dichlorovinyl cyclopropane carboxylic acid chloride, a valuable intermediate for pyrethroid class of pesticides, was demonstrated on pilot plant scale to NOCIL Ltd., Bombay.

10.14 Methylation of morphine to codeine (16-27-03N7-Sp)

Process parameters were standardised for the methylation of morphine to codeine by a novel route making use of phase-transfer catalysis. Based on the bench scale work carried out at NCL, pilot plant work was taken up at the factory of Govt. Opium & Alkaloid Works Udertaking, Neemuch (M.P.). Even though the yields are not up to the expectations, the factory has changed over to the NCL process as it is simple and the cost of raw materials is lower. The work at NCL is being continued to achieve the expected targets.

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OTHER BASIC AND EXPLORATORY PROJECTS

1. Chloramphenicol (10-7-003)

Regiospecificity in the ring opening of 2-hydroxymethyle-3-phenyloxirane and 2-acetoxymethyl-3-phenyloxirane with a variety of nucleophiles was investigated. Ring opening of nitrociannamyl dibenzoyl artaric anhydride epoxide was studied.

D, 1 and d1, 4-benzyloxazolidines were prepared and acylated with pivaloyl, benzoyl. acetyl and dichloroacetyl derivatives. Swing resolution of some of the dl-derivatives was achieved to furnish potential intermediates for the synthesis of 2-amino-1-phenylpropen-1, 3-diol.

For synthesising optically active phenylalanine, Michael addition of thiophenol to methyl ∝-acetamido cinnamate in the presence of quinine and quinidine derivatives as catalysts was examined. This method was also extended for the synthesis of ∝-methyl and ∝-hydroxy carboxylic acids.

To utilise the unwanted S, S enantiomer of 2-amino-1-phenylpropan- 1, 3-diol it has been transformed to RS isomer as a first step in the transforamation to RR enantiomer.

Conditions have been established for the exclusive C-alkylation of ethyl nitroacetate.

The reaction of *trans*-4-bromo-5-pheny 1-1, 3-dioxane with ammonia to furnish *cis*-4-amino-5-phenyl-1, 3-dioxane, a key intermediate for the synthesis of chloramphenicol has been critically studied. The influence of a number of paramters, particularly temperature, solvent and pressure on the yield and quality of the product was examined. The bromophenyldioxane was prepared from cinnamyl alcohol

Since styrene is cheaper than cinnamyl alcohol, the preparation of bromophenyldioxane from styrene is being studied. Styrene has been reacted with bromine water to furnish styrene bromohydrin which has been dehydrated to give bromostyrene. The Prins reaction of bromostyrene with formaldehyde to furnish bromophenyldioxane is being investigated.

2. Polymer characterization (0-22-005)

Light scattering and viscosity measurements were carried out for the solution of polymethacrylic acid fractions in the theta solvent and for aquaous solutions at various degrees of ionization and concentration of the added NaCl. The intrinsic viscosities were observed to vary linearly with the composite variable (i/C_s 1/2) where it is the degree of ionization and C_s is the concentration of the added salt. Expansion coefficients were computed from the measured dimensions and the intrinsic viscosities with reference to the values in the theta solvent. The expanston coefficients obtained from light scattering were uniformly higher than those obtained from viscosities. In view that the Flory's universal viscosity constant ϕ were independent of molecular weight, degree of ionization and concentration of the added salt, (though lower by about 50% of the expected value), the uncertainties in the determined dimensions due to the non-applicability of the fluctuation theory to the light scattering in polyelectrolyte-water-salt systems were assumed to independent of these parameters. The expansion coefficients obtained both from viscosity and light scattering were evaluated according to various macroicn expansion theories. Theories based on volume exclusion gave a better account of the data though the long range electrolytic interactions are contrary to the assumed short-range nature of the interaction potential in the volume exclusion theories. Ionization induced conformational transition in polymethacrylic acid were probed in dioxane-water mixtures and it was inferred that these hydrophobic groups containing polyelectrolytes exist in a more expanded conformation in organic solvents.

3. New perfumery products from longifolene (0-31-003S)

The process for Necelone - a new speciality perfumery chemical developed from longifolene has been prepared and the process released to Malti-Chem-Research Centre, Vadodara. New simple in *situ* processes for the established perfumery compounds viz. 8-oxo-isolongifolane (patchouli-woody aroma) and -8-acetoxymethyl-isolongifolane/8- acetoxymethyl cycloisolongifolene (cedar-vetiver aroma) have been developed.

The difficult structure assignment problem concerning alloisolongifolene (the new *catalyst-specific* isomer of longifolene discovered by us recently) has been solved by X-ray structure analysis of alloisolongifolol-p-nitro-benzoate. The transformation of longifolene into the naturaliy occurring mould metabolities namely (—)-seco-longifolene diol (from *Helminthosporium sativum*) and culmorin (from *Fusaria culmorum*) has been achieved.

4. Polymer modification (0-32-005)

In continuation of the work carried out using wood pulp as source of cellulose, the entrapped insecticide content in the samples, was found to be about 50%. Reduction of degree of substitution did not improve the results.

Treatment of cellulosic materials with urea before activation followed by other reactions gave better release rates even at low degree of substitution.

With a view to examining the possibilities of utilization of cellulosic materials from agricultural wastes, encapsulated products were prepared from delignified cellulose obtained from groundnut husk. These products gave encouraging results of release rates. The process of release of encapsulated insecticide is also dependent on particle size of the final-product. It has been observed that a particle size between 5 to 10 mesh is quite suitable for the purpose.

Activation of the cellulose at various temperatures and X-ray diffraction studies of such activated cellulosic materials were also carried out.

5. Studies on UV stable polymers for solar application (0-40-004)

The homopolymer of methyl vinyl ketone and its copolymer with methyl methacrylate have been prepared in the laboratory for the study of photo-degradation of the polymers. The ketonic groups in the polymers act as a photo-degradable units in the chain. The degradation was followed both by measurement of the tensile strength and the solution viscosity of the exposed samples. However, for the kinetic analysis by the latter method, a previous knowledge of the relationship between molecular weight and intrinsic viscosity of polymers in different solvents is necessary. For this reason this relationship for poly (methyl vinyl ketone) in four different solvents, namely butanone, dioxiane, dimethyl formamide and chloroform at 25° has been determined.

The zero shear viscosity $n°$ of three polybutadiene samples (100% cis, linear chain molecules) having different molecular weights (range : $1.54\text{-}6.17\times10^5$) over a wide range of concentration (1.0-35% polymer) in good and ϕ solvents has been studied. Superposition of viscosity data has been made so as to give a single composite curve for each solvent by shifting them vertically by a factor $(M°/M)^{3.4}$ where M° represents the molecular weight of the reference sample. The shift factor is found to be proportional to $M^{3.4}$, in the region of higher concentration which indicates that the 3.4 power law is valid for the data of polybutadiene. The double logarithmic plots of relative viscosity, $n°r$ as a function of $c^5\ M^{3.4}$ yielded a single composite curve approximating a straight line with a slope of unity at the higher values of the variables. The results indicate that, over a considerable range of the variables (molecular weight and concentration) at a constant temperature the relative viscosity is a single function of $c^5\ M^{3.4}$. In order to correlate the viscosity data obtained in good and poor solvents, two methods, discribed by Grassley and by Dreval and coworkers, involving the correlating variable, c (n) were considered. The plots of relative viscosity, $n°r$ vs. the correlating variable c (n) in benzene (a good solvent) yielded one curve but in case of solvent (dioxane and isobutyl acetate), the same plots yielded three separate curves instead of a single one which is rather unusual. The appropriate correction on correlating variable for chain contraction in concentrated region in the good solvent moved the data to a common, curve especially in lower conentration region, but at the higher concentration region a slight overestimation of data seems to have been effected. On the other hand the plots of log, $(n°sp/c\ n])$ as a function of correlating variable c (n) (Dreval and coworkers method) yielded a single curve for three samples in the good solvent, benzene, but in poor solvents (dioxane and isobutyl acetate) the same plots yielded three separate curves for three samples instead of a single one, the reason for which is not known at present, However, the normalization of the correlating variable, c (n) with Martin constant, K_M reduced all experimental data of the polymer samples to a common curve. The correlation of the viscosity data by either of the two methods seems to be possible in case of non-polar flexible polymer, polybutadiene.

In order to prepare the pure, superfine uniform sized powders for PLZT ceramics by the sol-gel process, the four alkoxdies pf the required metals, namely, lead, lanthanum, zirconium and titanium, have been synthesized in the laboratory by employing the methods given by Brown and Mazdiyasni. The sol-gel method involves the conversion of a sol to a gel by the addition of water to the mixture of the metal alkoxides. The products is subsequently heated at 200-500° to remove the liquid and to convert the gel to finely divided metal oxide powder with particle sizes in the range of 0.003 to 0.1 μ m.

Efforts are being made to develop highly dense PLZT ceramics (transparent) with this submicron sized metal oxide powders by the conventional sintering process and by hot-press sintering method.

Low temperature densification (~980°) of Pb (Zr.Ti.Sn) O_3 ceramics with both vanadium pentoxide (0-5, 0 Wt%) additive as well as with a mixture of NaF and $2PbF_2$ (0-5.0 mole%) additive has been carried out. The preliminary studies indicate that the densification with V_2O_5 additive is comparatively better than that with the $NaF + 2PBF_2$ mixture.

6. Theoretical chemistry (0-41-004)

The main emphasis of this new group is to develop accurate methodologies for studying phenomena relating to catalysis theoretically. To this end formalisms have been developed that can accurately predict the nature of chemisorption bonding of gaseous molecules to metal surfaces (approximated as clusters). One essential ingredient of such formalisms is a proper treatment of the intra-system correlation problem. Methods based on Coupled-Cluster-Approach (CCA), already successfully developed and applied for closed-shell systems are being developed for open-shell systems. Various, formulations of CCA-based methods for static electronic properties have been completed. Ab-initio calculations of dipole moment, polarizability on some prototype systems have been initiated using these methods.

7. Chemical reactions on solid surfaces (0-42-004)

This new project was taken up to study surface/interface phase phenomena through the chemical reactions on solid surfaces. Technical problems covering these reactions are in various branches such as corrosion, chemisorption, catalysis and semiconductor devices. Further, experimental surface physics studies using ESCA. PAS, FTIS and CEMS is conjuction with theoretical formulations will improve our understanding of these reactions on a solid surface. For proper basic understanding, oxidic materials such as 3d monoxides, manganites, ferrites, chromites, titanates etc., were studied. The following materials were prepared by a novel preparative technique which has been worked out at NCL and used successfully :

(1) stabilised MnO and FeO
(2) manganites of Ni, Cu, Zn, Cd & Mg
(3) chromites and titanates of Mn & Fe using stabilized oxides.

These were characterized using suitable techniquesn like XRD, chemical analysis, thermogravimetry, electrical conductivity, Mossbauer spectroscopy, reflectance spectroscopy, XPS available in the NCL. Papers on this technique for the peparation and the resluts of the measurements have either been presented in various national and international seminars/symposia or communicated/reported in the journals.

8. Cobalt catalyzed oxidation of alicyclic olefines

A few olefines were oxidized in a new reactor using cobalt naphthenate as catalyst. Under these conditions «-pinene gave mainly verbenone, trans-verbenol and «-pinene epoxide (87% conversion). In addition the trans-verbenol could be oxidized further with PDC to yield verbenone. Cis-verbonal can be obtained by the LAH reduction of verbenone, in quantitative yields.

Oxidation of car-3-ene under these conditions yields predominantly products with the cyclopropane ring intact viz. Car-3-ene-5-one, Car-3-ene-2-one and Car-2-5 dione. This is in contrast with the results reported earlier wherein the products with their cyclopropane ring opened predominated the reaction.

Cobalt catalyzed oxidation of camphene gave camphenilone and camphene epoxide (mainly the endo-isomer). Similarly longifolene gave longi-camphenilone.

In these oxidations three major reaction types are observed viz. (i) allylic oxidstion, (ii) epoxide formation and (iii) carbon-carbon double bond cleavage.

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(* not appeared in the last annual report)

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INFRASTRUCTURE ACTIVITIES

1. National collection of industrial micro-organisms (NCIM) (Infra-1)

The laboratory has a collection of about 3300 nonpathogenic yeasts, bacteria and fungi. Routine subculturing tests on their biochemical performance and long term preservation were continued. These cultures are made available to industrial, educational and research establishments. During the years under review 1533 cultures were supplied to industry and research institutes, including CSIR laboratories.

Seventy-seven new cultures were added to the collection. Four hundred cultures were lyophilized. Two samples of water absorbing polymer developed in the laboratory were tested for their suitability as an agar substitute. Six organic compounds belonging to the Hymaxazole group were tested for their anti-fungal activity. Screening of yeast cultures for another laboratory project was carried out.

Chapters in books

1. Microbial cultures—Collection and Preservation of Cultures, Chapter in the book, "Fermentation Prospects in India", published by B. V. Patel Education Trust, 1984, pp. 1-9.

2. Centralised chemical analysis and instrumental services (Infra-2).

2.1 Spectrochemical studies (Infra-2(i))

This group provides infrared spectral analysis to the scientists of the laboratory and outside parties. Besides it also undertakes some basic studies on specific compounds. During the years under review, 3763 samples by infrared and 749 by ultraviolet visible were analysed for the laboratory.

In continuation of the studies on the conformational behaviour of compounds of the type $X(CA_2)_{2,3}OH$, where $X=OCH_3$, F, Cl, Br and I, the amino derivatives where $X = OCH_3$, F, Cl, Br and I, the amino derivatives where $X=NH_2$, $N(CH_3)_2$ and compounds $CH_3N(CH_2CH_2OH)_2$ and $N(CH_2CH_2OH)_3$ have been investigated. The amino alcohols formed strong intramolecular hydrogen bonds so that 80-90% of the species in solution remained in the hydrogen bonded form and reduced their tendency to associate in concentrated solution. Diethanol and triethanolamines formed bicyclic and tricyclic intramolecular hydrogen bonds such that the oxygen of the hydroxyl group hydrogen bonded to nitrogen was involved in further hydrogen bonding with the second and third hydroxyl groups respectively. In triethanol amine this resulted in the formation of a highly symmetrical structure, which is able to explain its metal co-ordination behaviour.

Infrared intensity measurement of the NH stretching bonds of the dipeptides N-acetyl glycine (alamine or leucine) N-methyl amide in chloroform have confirmed the recent findings of Scharega et al (1982) that there are only two types of species, the fully extended and the intramolecularly hydrogen bonded five membered ring species in solution which contradicted the findings of French and Russian workers (1969-1984).

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2.2 Physico-chemical analysis (Infra-2(ii))

The group carries out routine chemical and instrumental (spectrometric, spectrographic, atomic absorption, flame photometry, etc.) analysis of inorganic chemicals for NCL scientists and outside parties. It also undertakes development of new methods and improvement of the existing methods of chemical analysis.

2.3 Microanalysis (Infra-2 (iii))

This group provides microanalytical service to NCL and outside scientists. 4544 analyses were carried out for NCL research projects during the year under review.

2.4 Nuclear magnetic resonance (NMR) spectrometry (Infra-2 (iv))

The group provides NMR spectroscopic help to the scientists and also develops and applies NMR spectroscopy to chemical and biochemical problems.

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

The group provides mass spectrometry and GC-MS analytical service to NCL and outside scientists. During the period under review 2273 samples were analysed by mass spectrometry and 85 by GC-MS technique.

The following basic studies were carried out.

The electron impact induced cycloreversion reactions of a novel heterocyclic system, viz. tetrahydro-1, 3, 2-oxazaphosphorinane-2-oxides have been investigated. The cyclo-reversions occur by stepwise simple cleavage, single and double hydrogen migrations and were found to be initiated by C-O bond cleavage of the ring. The results were supported by metastable ion, shift technique and high resolution data.

Redox processes involving oxygen transfer in *ortho*-nitro substituted β-keto aldehydes have been investigated by low electron energy metastable defocussing and shift-technique.

The competing and consecutive heterolytic ring cleavages occurring under chemical ionization conditions in the mass spectra of substituted tetrahydro-1, 3, 2-oxazaphosphorin-2-oxides were studied. The heterolytic system undergoes stepwise expulsion of the potential nucleophilic and electrophilic groups via zwitter ionic intermediates formed by the heterolysis of the C-O bond. The CI-MS of the heterocyclic system shows many features of the Grob type of fragmentation mechanisms observed in solution.

Mass spectra of some tetraacetylated anomeric glycosides under electron impact and chemical ionization conditions were examined with a view to characterise somer c pairs from differences in the relative abundances of common fragment ions.

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

ESCA facilities to the scientists of the laboratory and outside parties are provided by the group. During the period under review 597 samples were analysed by ESCA using various techniques such as XPS UPS, AES, etc. In addition to maintaining the service facilities the following basic studies were also undertaken by the group.

Segregation studies in dilute tin alloys were completed. Nature of chemical bonding segregation and chemisorption in monochalcogenides such as NiSe, SnSe, SnTe, were studied. The INSA sponsored project on 'The Physics and Chemistry of Oxide Surfaces' was successfully completed. XPS studies on $SnSe$-O_2 system was completed. Metal-support interaction studies on Rh/SiO_2, Rh/AL_2O_3, Rh/MgO and Rh/TiO_2 were carried out. SnO_2/α-Si system was studied by AES and depth profile technique for interface composition.

Studies on the oxygen chemisorption on Zr, ZrFe, Ti, etc. are in progress. XPS studies on PhMnTe system were initiated.

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2.7 Analytical group of the process development division (Infra 2 (viii))

Major activities of this group are, (a) to give analytical support to various projects, (b) development of analytical procedures required for the ongoing projects (c) preparation of analytical manuals for the processes developed in the division, and (d) basic research in the field of analytical chemistry.

During the years under review the group handled more than 1100 samples from various projects.

2.8 Analytical group of organic chemistry I division (Infra-2 (ix))

Analytical service was rendered to the division of Organic Chemistry I and other divisions of the laboratory, by standard instrumental methods. Attempts were made to develop new methods of analysis with special reference to pesticides, drugs, organic intermediates, etc. Work on the development of new liquid substrates for gas liquid chromatography as well as metal complex phases for high performance liquid chromatography. The problems of chemical analysis for slow release pesticides formulation developed under UNDP projects are also undertaken at a very low concentration of 'ppb' level.

The group carried out the following analyses for NCL projects : UNDP project of slow release formulations of Abates and Fenitrothion (743), pyrethroids, O. P. pesticides, endosulfan, drugs and organic intermedi. tes. Instrumental analyses for NCL projects : GLC-4230, IR-4180, UV-84, HPLC-971.

Research in the synthesis of liquid crystals and their use as column packing material in gas chromatography was continued. Polymeric Schiff's bases were synthesized and used in liquid chromatography for separation of alkyl benzenes. Hexachlorocyclopentadiene derivatives are being synthesized and characterised. Twenty compounds were prepared many for the first time. Their biological activity is being evaluated against houseflies and mosquito larvae. It is proposed to establish a correlationship between chromatographic behaviour of a compound and its biological activity. Once a pattern is designed it will be possible to predict activity of a compound in a homologous series from its chromatographic behaviour.

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2.9 Netzsch thermal analyser (Infra-2 (x))

During the years under review thermograms of 581 samples received from NCL scientists working on different projects were recorded. Thermal decomposition products and phase changes during the heating were studied from these data.

Thermal decomposition of Barium citrate was studied and found to occur in three stages, viz., anhydrous salt, intermediate (possibly aconitic acid) and modified aconic acid.

Heat capacity of the system Sr_2WMeO_6 ($Me = Co^{2+}Ni^{2+}$) was studied. Anomalies in heat capacity were observed around 487 and 526°K which appeared to be associated in the slight changes in band structure resulting from structural transition (tetragonal-cubic).

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

Eight hundred and seventy-seven samples received from NCL scientists were studied by SEM for particle size and distribution.

SEM photographs were taken to give information on particle size and clustering of different species in iron based industrial catalysts promoted by Cr_2O_3. MoO_3, CeO_2, K_2O, etc., used to the dehydrogenation of ethyl benzene to styrene. The EMPA studies indicated uniform concentration of the promoters

on the surface and in the bulk in fresh catalysts and their migration towards the centre after the catalysts have been used.

SEM photographs also clearly showed the quantitative difference in the cell growth between inoculum immobilised in (1) aliginate and (2) open pox agar matric, and similarly between cell immobilised in an open pox gelatine or agar matric and a gelatin alginate composite matrix.

Ferroelectric ceramics doped in the MnO_2, Cr_2O_3 and V_3O were studied for microstructure and other related properties associated with grain size distribution.

Microstructure studies were carried out on thin amorphous silicon films, polymer materials, fractured surface of metallurgical samples, geological and botanical samples, tunston coils, thin film resistor cut by laser, etc.

2.11 X-ray diffractometer (XRD) (Infra-2(xii))

During the review period XRD was widely used by NCL scientists, and scientific and educational institutions. XRD spectra of 2752 NCL samples were recorded, the data yielding valuable information on crystallinity, degree of amorphousness, particle size, presence of different phases, etc.

The recorded XRD spectra have been used in the study of : (a) Synthesised zeolite samples containing Na, Fe, and Al, and promoted by Mo, Ce, La, Pt, Co oxide, etc. for the quantitative zeolite phase identification and the degree of crystallisation. The spacing of peaks was correlated to give different quantity intents of aluminium and silicon. Nature and shape of the particle size were also correlated with the degree of zeolite activity.

Different compositions of Cd-Ni, Cu-Cd oxides fixed at different temperatures were analyzed by XRD for identification of their oxides and their formation of a solid solution. These systems were used in thick films.

Iron-based catalysts prepared in the industry and the laboratory, promoted by Cr_2O_3, MoO_3, etc. and used for the preparation of styrene from ethyl benzene were studied using XRD pattern and their 'd' spacings. Various phases in the catalyst were identified and the crystallite size was measured.

Identification of the existence of new phases such as $BaZnO_2$ and $CaZnO_2$ in the system BaO + ZnO and CaO+ZnO was made during careful study of the XRD patterns of these compounds. Similarly phase transition in Bi_2O_3 was also observed in $ZnO+Bi_2O_3$.

2.12 GLC and HPLC analysis (Infra-2 (xiii))

The group provides facilities in gas liquid chromatographic (GLC) and high performance liquid chromatographic (HPLC) analyses to all the divisions of the laboratory The analytical services rendered during the year were : HPLC-525 and GLC-750 samples.

2.13 High pressure laboratory (Infra-2 (xiv))

The group provided and maintained facilities for carrying out reactions at pressures and temperatures higher than ambient pressures and temperatures, and for compressing various gases in the cylinders. It also undertook work on specific projects of the process development division. Facilities were also provided to outside parties on occasion.

During the period under review 251 experiments were carried out for various research and development projects of the laboratory including experimental facilities provided to three outside parties.

2.14 Mossbauer spectroscopy (Infra-2 (xv))

Mossbauer effect study on Mn_xMg_{1-x-} Fe_2O_4 samples (X=0·5 to 1·00) was carried out at room temperature. Mossbauer parameters were computed using an iterative least square MOSFIT programme using ICL 1409 **S** computer.

2.15 Magnetic susceptibility (Infra-2 (xvii))

Magnetic susceptibility measurements of 65 laboratory samples were carried out at room temperature for a variety of compounds. Cahn-1000 Research Magnetic Susceptibility System with cryostat assembly was set up and calibrated for study of magnetic susceptibility in the temperature range 85 to 300 K.

Stabilized MnO:Ni system was prepared using a novel method, which was earlier used successfully to prepare stabilized MnO:Zn, MnO:Mg systems. Physico-chemical characterization studies were carried out using XRD, DTA/DTG, optical and magnetic measurements of Mn_{1-x} Ni_x O (X=0·1 to 0·9) system. Thermal stability in air up to about 320 K is shown by DTA/DTG. On the basis of LFT formalism, optical spectra (380-760 nm) were analysed. The analysis revealed nearly perfect octahedral symmetry around Mn^{2+} and Ni^{2+} ions. Shifts in characteristic transitions indicated transfer between Mn^{2+} and Ni^{2+} ions. Magnetic susceptibility data between 85 and 300K showed progressive increase in the Neel temperature of MnO with increasing concentration of Ni^{2+} ions in the mixed system.

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   Proceedings of Indian Academy of Sciences (Chemical Sciences), **93** (8), 1349 (1984)

2·16 Cell for assistance to small scale chemical industry (Infra-2(xix)),

The normal activities of the Cell in attending to enquiries from small scale chemicals manufacturers and maintaining liaison with government directorates, nationalised banks and public institutions connected with the small scale sector were continued. In addition the problems of six parties concerning resins/adhesives for abrasive product, polyurethane products, polyester resins, in-plant problems in chlorination of organic compounds, hot-moulded pre-sets and potentiometers, and polyester resins were tackled on a consultancy basis.

Fifteen parties were registered with the cell and given advice on their problems.

Work was initiated in the preparation of a directory of speciality chemicals. About 2000 items are being listed and classified, their properties, preparation techniques and other relevant information is being collected.

2.17 Crystallography (Infra-2 (xx))

Structure elucidation was carried out of key intermediates obtained in various active priority projects like drugs and drug intermediates, catalysis, natural products, organo-metallics, coordination complexes, etc. Over 60 such structures have been solved and several publications have appeared in leading journals.

The group now has an automatic structure determination package on the existing ICL 1904-S facility which enables the elucidation of structures quickly and almost wholly automatically. It is, however, not always possible to obtain structures by just a crank through the programme package. Several new recipes to overcome such situations have been developed by the group. The current status in programme strength is that structures with 100 atoms per molecule can be easily solved. It is obvious that studies on conformation, structure-activity relationships and other chemically related phenomena emerge from such studies.

Electron density distributions in molecular crystals to obtain leads to molecular interactions, bond formation and chemical reactivity are being studied. Such studies need large amounts of accurate data. The experimental set-up is functional. Several mathematical tools for the analysis of such election density distributions have been set up. A new model to study intermolecular interactions in molecular crystals has been developed.

Studies on point group symmetry in relation to the valence charge distribution around the atom as well as the thermal vibration of the atom have been made. Effects of forcibly induced distortions (like an electric field) in electron density distributions are being analysed.

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   Mathematical methods for the analysis of charge density from X-ray diffraction
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   The structure of 2-(2-hydroxy-S-methylphenyl) propenyl acetate.
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Proc. Ind. Acad. Sci., **93**, 183 (1984).

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3. Properties measurement (Infra-3)

The main aim of the group is three-fold :

(i) To measure various physical, thermodynamic and surface properties of various compounds obtained from different NCL projects.

(ii) To try to build up a data bank of these as well as some common compounds with relevance to NCL needs.

(iii) To undertake basic research in thermodynamic and surface chemistry of monolayers so as to keep the background of the subject up-to-date and improve upon the existing facilities either by changing the methods of measurements or by replacing them with more precise sophisticated instruments.

During the period under review the following physical, thermodynamic and surface properties were measured for different NCL projects. Viscosity at different temperatures (150) density at different temperatures (80), refractive index at room temperature (25), specfic heat at room temperature (12), surface tension at different concentrations (18), gas chromatographic analysis (270), Pour point (4), Detergency (60), Emulsification (25), Draves test (30), Electrical Conductivity (11), Foam height (18) and VLE (Isobaric and isothermal) (2 binary mixtures).

Basic research on heats of mixing of the following binary systems were carried out to understand molecular interactions and possible complex formation :

(a) Acetone and carbon tetrachloride at 45°C,
(b) Sec-butylamine and chloroform at 40°C in dilute region,
(c) Ethylenediamine and water (below 0.05 mole fraction)
(d) (Butylamine and butanol) complexes with n-hexane.

Monomolecular film properties of mixed monolayers of polyvinyl stearate and C_{22}-OC_3H_6OH were studied by TI-A and μ-IT isotherms. These binary mixtures were found to be miscible and non-ideal in their behaviour.

Using VLE static method vapour pressure measurements were carried out for benzene + chloroform binary mixture at 25°C and 35°C. Vapour composition was calculated by computerising x-p data by Barker's method.

Free energy of mixing for the binary systems isomeric butanols + n-octane were calculated from isothermal VLE data at 60°C.

Second virial coefficient for iso and sec-butylamines were determined at 40°C. Volume change of mixing for isomeric butanols + n-octane were determined using continuous dilution dialatometer.

Data for 12 different properties of about 50 compounds have been collected and tabulated. Source of the data available for various properties of inorganic and organic compounds and some of their mixtures have been tabulated.

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Calorimetric study of isomeric and steric effects, amine-alcohol interactions,
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J. Chem. Thermodynamics, (17) **2**, 101 (1985).

4. Entomology (Infra-4)

The insect colony component of the biological screen was enhanced by incorporation of additional important pest/vector species while the numerous bioassays were further refined and streamlined for greater efficiency.

The project on Development of New Pest Control Agents was pursued by continuing screening of new plant species. More than 80 total extracts of new species and over 400 fractions were examined. From these, over 70 leads of promise were obtained. These included insecticidal, hormonal and behavioural. More than 100 synthetic compounds were examined for the widest possible range of activities on all insects being reared in the laboratory. Noteworthy results deserving special mention have been a series of compounds showing good insecticidal activity and another exhibiting very encouraging growth regulatory, ovicidal and oviposition deterrent activities (singly or in combination) against some insects. Apart from continuing with efforts to identify active principles newer strategies entailing use of enriched fractions were also tried out. Intensive re-examination of more abundantly available indigenous plants and reassessment of older extracts by putting them through the enlarged screen were also undertaken.

Follow-up product development work with Neemrich-I was announced at a national seminar in New Delhi and an international conference on the same in West Germany. It is noteworthy that this is the first report in the world of a finalised formulation for pest control by behaviour manipulation from a plant source.

In the Controlled Release Project the latex formulations of Abate were gradually phased out and replaced with new ones using synthetic polymers. These were also abandoned due to various inherent defects of monolithic matrix systems. An entirely novel system has been developed employing hydrogels as polymer matrices in which the insecticide is incorporated *per se*. In this new system there is no limit to the amount of insecticide which can be stored. There is only a nominal toxicant hold up which is proportional in particulate ratio to the amount of gel used. A further improvement on the monolithic matrix system is the lack of toxicant release inhibition by algal film. This has been attributed to the molecular sieving effect of the micropores in the hydrogel which are impervious to larger entities such as algal cells. In laboratory and field trials, successful maintenance of lethal concentrations of Abate in water for periods up to 5 months (still continuing) have been demonstrated. Over 50 different Controlled Release formulations of Abate have so far been examined in laboratory and field trials. In the other Controlled Release undertaking, viz. Carbofuran, a stimulated field trial was carried out with the NCL formulation in the laboratory's experimental garden and by the scientists of the Rice Research Station, Karjat, at their fields.

Basic studies were undertaken on insect plant interactions and host preferences of insects. Role of Protein Carbohydrate and lipids as well as effect of different allelochemies on them were also investigated. Respiratory metabolism studies were also continued and the allometric equation for red cotton bug was derived. In the field of behavioural research systems were developed for studying responses of mosquitoes to contact and volatile repellents. Smoke coils and other vapour generating devices were devised and assessed. Work on cockroach behaviour as well as entrapment and annihilation was also initiated. In the field of pheromones, bioassays have been developed for evaluation of synthetic pheromones of the housefly, potato tuber moth and the rice weevil, synthesized in the laboratory. Effect of primer pheromones on lipids and glycogen as also been studied. Bioactivity of selected seed oils of Indian trees was further examined on a wide variety of insect pests and vectors. Effects on the biology, growth, develop-

ment and reproduction, as well as aging process of insects by a number of synthetic organometallic compounds was also studied. Toxicant movement within the hydrogel dispersors was studied by elaborate sectioning technique.

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Chapter in Books

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5. Instrumentation (Infra-5)

The instrumentation section looks after the maintenance of the sophisticated analytical equipment of the laboratory. The section also helps in the procurement of new equipment. After the new equipment is procurred it is tested for its specification and performance by this section.

Under the DST sponsored project on the I. R. Spectrometer, a second prototype was handed over to Central Electronics Ltd., Ghaziabad, for further action. The third prototype was in the last phase of completion. This prototype will have microprocessor based controls.

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

As in the previous years, the DTS took part in research coordination, industrial liaison and technology transfer, documentation, market survey, publicity and public relations and similar planning and monitoring activities. Thus the division was in, some way or the other, closely associated with all the research divisions and helped them to draw up their research programmes.

Planning monitoring and research coordination

The preparation of three important documents fall in this category. The first was the Review of Achievements 1980–83 and S & T plan for the area, Chemicals. This is a revised documents incorporating recommendations of the various working groups of the Chemical Sciences Group (CSG) of laboratories. The objective was to review the achievements of the seven laboratories in the CSG during this period and highlight some of the more significant of these achievements.

The second was the five year plan document (revised) for the period 1985-90.

In recognition of the importance of information science as a separate entity in its own right, a detailed plan of the activities proposed to be taken up in this area was drawn. This document assumes a special relevance in the light of the laboratory's plan to computerize many of its activities in this area.

DTS also successfully organized the meeting of the chemical sub group of the working group appointed by the Planning Commission. It was held on 5 February 1984. Members of DTS staff attended this meeting.

As in the earlier, the research programmes (1984-85 and 1985-86) were prepared and placed before the Research Advisory Council (RAC) for ratification at its 9th meeting and also before the Executive Committee (EC). Two important documents were prepared as required by DGSIR. The first was the annual plan 1984-85, containing, besides details of the individual projects, the project budget, revised estimates 1983–84, budget estimate 1984–85 and the sixth five year plan projections (1980-85). A similar document for 1985-86 was also prepared. This included the seventh five year plan (1985-90) projections, besides the other features.

Six meetings of the EC (62 nd to 68th) were held during the period of reporting. Besides organising these, DTS prepared the final proposals for sponsorship, collaborative, grant-in-aid and consultancy projects and placed them before the E. C. during these meetings.

Area meetings were held to review the progress in the projects under the area and to find ways of removing the difficulties that tended to slow down the progress. These meetings have now become a regular feature and have evolved into forums to exchange creative ideas.

Close to a thousand enquiries were received from private and government agencies, the parliament, NRDC, CSIR HQs, the sister laboratories and from AGCR/CSIR audit groups. The scrutiny of the centralized project File Bank was carried out as usual and reports on the progress of various projects were sent to the Director.

Industrial liaison, technology transfer, etc.

NCL's links with industry have become stronger in recent times. Knowing that the laboratory is capable of developing viable technologies, big and small, and offering technical consultancies, numerous entrepreneurs and interested people approach it or different kinds of help During the period under review 7 consultancy, 6 sponsorship/grant-in-aid and 6 collaborateiv agreements were executed.

As part of NCL's assistance to industries that do not have in-house analytical and testing facilities, 1368 samples were analysed for 477 parties. The drawing office, reprography and photography rendered the required help to the various divisions. More than 810 tracings, 130 ammonia prints and 1,67,600 xerox copies, 13,759 photographs, 13,660 prints and 5680 slides were prepared.

In a collaboration with the State Bank of India DTS helped the Small Scale Industries Cell of NCL, to organize a get-together.

DTS received 250 applications for financial assistance for research schemes. These were scrutinized and sent to CSIR with suitable comments.

Quarterly and annual reports giving the research utilization data in respect of the laboratory were sent to CSIR.

Documentation, market data collection

The activities in this category were (i) surveying and indexing of literature on research management; (ii) techno-economic survey of important projects; (iii) collection of marekt data on selected products; (iv) collection of information on current market prices, licenses applied for, licences granted, etc. and storage of these on cards.

Eleven instalments of the feature, 'Surveying the scene from NCL' were prepared and published in *Colourage* and three other journals published by Colour Publications Limited, Bombay.

Comments on five questions raised in Lok Sabha were sent to CSIR.

Publicity, public relations, extramural activities, special tasks, etc.

Eight issues of NCL Bulletin, the house journal were brought out.

Ten press releases on the awards won by NCL scientists and other important events were issued. News about staff and events was sent to CSIR News regularly.

Information on NCL's activities was compiled and sent to CSIR in the form of monthly summaries to the Cabinet.

The high mark of the extramural activities was the International Chemical Reaction Engineering Conference held in January 1984. DTS. was actively involved in the organization of the conference. A special souvenir was prepared to commemmorate the occasion. Special efforts were made to have the event covered by the media (AIR. Doordarshan and newspapers) exhaustively.

Two CSIR Junior Research Fellowship examinations were organized and conducted by DTS. The first was in October 1983 and the second in December 1984, DTS also organized the CSIR competitive examinations for the posts of Section Officer (General and Finance and Accounts (F & A) and Assistant (General and F & A) held in July 1984. Apart from this DTS also assisted in organising a seminar on heat pump, a workshop on plant molecular biology, a training course on plant tissue culture, 52nd annual meeting of SBC and 49th annual meeting of the Indian Academy of sciences.

NCL took part in the Indian International Trade Fair organized by the Trade Fair Authority of India in November 1983. Attractive and informative exhibits and displays were prepared at DTS to draw the attention of the visitor to the Fair to the achievements of NCL.

More than 2000 visitors were taken round the laboratory including many VIPs.

7. Documentation services (Infra-7)

The library houses about 1,00,120 publications consisting of books, periodicals, patents, standards, technical reports, etc. During the period under review 1650 books, 4274 bound periodicals, 2406 patents and standards, 197 photocopies, microfilms and translations, 36 technical reports and 72 theses were added to the library. 667 periodicals were received, of which 480 were on payment and 187 gratis and on exchange.

Besides the NCL staff, the library was used by 8857 outsiders. 29,548 publications were issued to the staff and the corporate members. Under the inter-library loan scheme 361 publications were borrowed and 188 were issued to other libraries. 3728 current journals were circulated amongst Heads of Divisions for browsing through.

Current awareness bulletins on the following topics were compiled and circulated amongst the scientists; Indian Patent Bulletin, Chemical Reactors, Library Bulletin, Solar Energy, Biomass Energy and Nitrogen Fixation.

C. A. Selects—S. D. I. services prepared by Chemical Abstracts Service, USA, were procured on herbicides, fungicides, insecticides, zeolites, catalysts and solar energy. Copies of these selects were prepared and circulated amongst the concerned scientists.

The reprographic section supplied 2.00,204 exposures to NCL scientists and 34, 362 exposures to outside parties on payment.

The NCL library is an Inspection Centre for Indian patents. 3479 patents were received during the period under review.

The library brought out quarterly technical bulletins in the areas of Polymer Sciences, Engineering and Technology, Drugs and Drug intermediates and Biomass. Based on literature available, these bulletins highlighted new developments, breakthroughs, statistical information on production/pricing, export/import, etc. and government policy.

Copies of 138 papers published by NCL scientists were procured for documentation. 6228 copies were reproduced and distributed to various scientific workers on request.

The binding section of the library completed the binding and repair of 3955 volumes of library books and journal and 1004 jobs for other divisions.

The library has established contact with Dialog Information Services Inc. California. for conducting computerised on-line searches of data bases available with them. On-line searches on 26 topics were conducted in these two years.

8. Engineering services (Infra-8)

This section looks after the installation and maintenance of the laboratory units and utility services. It also undertakes fabrication and modification of equipment as per the requirements of the R & D work. During the period under review 3733 jobs were completed by the mechanical section and 1247 by the electrical and refrigeration section, of which the following deserve special mention.

Mechanical

1. A pilot plant for the ethylene oxide project was erected. All the structures that went into this project were fabricated in the workshop. Complete piping work was also carried out. All the welded pipe joints are of very high quality. They can withstand pressures up to 25 kg/cm² and have been tested radiographically, About 75% of the piping is stainless steel and the joints were made by the TIC welding process. Equipment like air heater and steam generator reactors was designed and fabricated.

2. Design and laying of service lines like water, compressed air and gas for the new building of the Biochemical Sciences division was carried out.

3. Erection of a pilot plant for Vitamin B_6 which included fabrication of equipment, steel structure and installation of equipment was carried out.

4. Design and laying of service lines like water, gas. compressed air, vacuum and chilled water was carried out for the Polymer Science building. An exhaust blower with complete ducting was designed and installed.

5. A highly sophisticated fermentor imported under a UNDP project was installed.

6. The highly sophisticated imported liquid Nitrogen plant. which had gone out of order, was repaired thus effecting a great saving of foreign exchange and time.

7. Equipment was manufactured for the oil drag reducing pilot plant and assembled and installed.

Electrical and Refrigeration

1. An additional electric sub-station of capacity 1000 KVA was designed, erected and commissioned.

2. The new Polymer Sciences and Bicchemical Sciences buildings were connected to the new substration. Similarly the Sophisticated Instruments Laboratory building was connected to Sub-station directly by 400 mm² × $3\frac{1}{3}$ ore electrical cables. The complete design for laying was also done by this section.

3. Three 50 KVA Diesel generating sets were installed in different parts of the laboratory.

4. The electrification of the two new buildings was carried out.

5. Electrification in the colony for 72 staff quarters, Guest House, Shopping Centre, Community Centre cultural centre and open air theatre was designed and completed.

6. Re-wiring was carried out in 20 staff quarters.

7. Eighty-three 1.5 T air conditioners were installed in various divisions.

8. Underground cable and switchgear for the silicon project at MERADO were installed.

9. Major repairs were carried out at the laboratory ice plant.

The following facilities were added in the period under review.

1. A new fabrication shop with a floor area of 120 M² was built. Complete designing .fabrication and erection was done departmentally.

2. Electric brazing machine.

3. 'Rototech' of Larson and Toubro make : This equipment is used for depositing metals of various grades by spraying on worn-out parts and then machining it.

4. Pipe/angle/channel bending machine.

5. Precision drill machine. This can drill holes as small as 0.2 mm dia.

Civil

Besides the regular maintenance of laboratory and colony. this section supervised and completed the construction of the new building for Polymer Science and Engineering. Plant Tissue Culture (Biochemical Sciences Division) building & 72 Nos. staff quarters. In addition to this Open Air Theatre has been constructed and commissioned. Various roads in colony have been resurfaced and a new bypass road in colony is also constructed. The construction of 64 Nos. of staff quarters is in progress.

9. Glass blowing (Infra-10)

NCL has a well equipped modern Glass Blowing Section with well trained glass blowers, who can design and fabricate many types of special glass apparatus. The section looks after the maintenance, repair and modification of glass equipment and apparatus. During the last two years over 8940 regular jobs were carried out and more than 15,000 ground glass joints and 1000 high vacuum stopcocks were fabricated.

Some of the jobs that required special skill were the fabrication of silica reactors, BET units, cryostat for the magnetic susceptibility unit, high vacuum units and heat exchangers.

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APPENDIX

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

The laboratory has been extending its assistance. whenever possible, to industry, R & D units, educational institutes and project engineering organizations by way of, (1) consultancy on product development, trouble shooting and establishment of in-house R & D units; (2) undertaking specified developmental work on sponsored basis; (3) rendering *ad hoc* assistance on industrial problems of standardisation, optimization, analysis, material testing and trouble shooting; (4) associating with project engineers in preparing feasibility reports and making turnkey offers on NCL technologies; (5) collaborating with industry for the development of complex and high-risk technologies of the laboratory on semicommercial scale; and (6) participating in the industry's negotiations for the import of technologies and in their assimilation. The norms and nature of such assistance are as follows :

1.1 Modes of technological assistance to industry by the NCL

1.1.1 Consultancy

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

1.1.2 Sponsored schemes

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

1.1.3 Ad hoc assistance

NCL can render assistance to industry on exploratory work, standardisation, optimization, feasibility studies , analysis and testing, etc., on payment of *ad hoc* fees depending upon the nature of the problems. Such assistance is usually extended for short periods.

1.1.4 Pilot plant work (Level II data)

NCL can undertake pilot plant studies for collection of level II data (see 3.1) needed for the establishment of a commercial plant, based on laboratory data either obtained at NCL or available with the party. Such work may be taken up on behalf of the party on either sponsored or ad hoc basis.

1.1.5 Designs for commercial plants

Based on the level II data collected in the pilot plant, NCL can undertake to prepare chemical engineering designs for a commercial plant of desired capacity on payment of mutually agreed upon fees.

1.1.6 Assistance to small scale chemical industries

In consultation with various government and financial agencies concerned with the development of small scale chemical industries, the NCL cell for assistance to small scale chemical manufacturers started its activities keeping the following objectives in view :

(a) rendering help / advice / consultancy in solving in-plant technological problems, (b) providing assistance in the assesment of know-how from the technological point of view, (c) assisting in the development of know-how on a short-term sponsorship basis, (d) maintaining a data bank and a liaison with the industry, (e) monitoring the assistance rendered, and, (f) organising short term courses, lectures and seminars for the benefit of small scale manufacturers.

1.1.7 R & D Collaboration with industry

NCL is collaborating with industry on some important projects that are engineering intensive and which involve the development of complex technologies with high investment risks. In such cases based on the developmental work at NCL a proving pilot / semi-commercial plant is set up at the collaborating industry 's site. Data obtained on this plant is used in the scale-up and design of the full scale commercial plant.

1.2 Supply of culture

During the year under report 1533 cultures from the National Collection of Industrial Micrcorganisms were supplied to various institutions.

1.3 Analytical services

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

1.	Atomic absorption	30
2.	ESCA	110
3.	Flame photometry	26
4.	GC/MS	72
5.	IR	119
6.	Magnetic susceptibility	52
7.	Microanalysis	347
8.	Netzsch thermal analysis	76
9.	NMR	20
10.	SEM/XRF	397
11.	Spectrographic	11
12.	Spectrophotometric estimation, inorganic analysis of special nature	19
13.	UV, Vis-spectra	18
14.	VPC/GLC/HPLC	41
15.	X-ray diffraction	286

The total receipts on account of analysis testing carried out during the period amounted to Rs. 2.09 lakhs.

1.4 Training

During the period, 52 representatives of various industries and students from IIT's and Institutes were given training in chemistry of natural products, analytical instruments, molecular biology & genetic engineering technique, plant tissue culture technique, microbiological technique, gel electrophoresis, chemical engineering, polymer sciences, pilot plant and modern glass blowing etc.

2. SPONSORED AND COLLABORATIVE WORK

2.1 Criteria for undertaking sponsored work and normal terms and conditions

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

(i) The proposed work is within the scope of the present areas of activity of the NCL and the laboratory has the necessary facilities and expertise to carry out the work, subject to consideration of internal load.

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

(iii) The technology to be developed will have sufficient socioeconomic impact after completion.

(iv) The technology to be developed is not repetitive and is not already established indigenously.

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

Broad terms and conditions for charging expenses and fees for sponsored schemes are as follows :

(i) The sponsor pays for or provides the staff required for the investigation. The expenditure borne by the sponsor is computed at 125 % of the total salaries of the NCL scientists working on the scheme.

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

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

(iv) A fixed charge of Rs. 18,000/- per scientist per annum is payable towards services, depreciation and incidentals. The charge is payable irrespective of whether the scientist is from the NCL or deputed by the sponsor.

(v) A minimum provision of Rs. 15000/- per year is made for contingencies, sundry expenses and daily wage labour. The charge will vary according to the nature and scale of work.

(vi) A sum Rs. 60/- per head per annum is payable by the sponsor on account of medical facilities provided for the staff.

(vii) In addition to the above, a fee is payable by the sponsor as know -how fees for the proposed development which is charged as a percentage of the total expenditure. The percentage of the fee charged depends upon the status of the sponsor. Concessions are given to medium scale and small scale firms in this regard.

(viii) The investigation will be carried out for a period of one year in the first instance. However, if the scheme is extended further the charges payable will be as per the prevailing rates of the sponsorship charges at that time.

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

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

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

2.2 Sponsored projects concluded during 1983-84 and 1984-85

1983-84

	Process	Party
1.	Adhesive from renewable resources	Carborundum Universal Ltd., Madras.
2.	Carbonylation of ethanol to propionic acid	Deccan Sugar Institute, Pune
3.	Conversion of crotonaldehyde to maleic anhydride	Deccan Sugar Institute Pune
4.	Isolation of active alkaloids (vincristine and vinblastine sulphate) from *Vinca rosea*	Education & Youth Services Dept., S and T Cell, Govt. of Maharshtra, Bombay
5.	Multiplication of Napier grass by tissue culture	National Organic Chemical Industries Ltd., Bombay
6.	Phenylglycylchloride hydrochloride and p-hydroxyphenyl glycene	Sudarshan Chemical Industries Ltd., Pune

1984-85

	Process	Party
1.	Aromatic polymers/polyamides	Department of Atomic Energy (DAE), Bombay
2.	DVO acid chloride	National Organic Chemicals Industries Ltd., Bombay
3.	Enzyme reagents	Department of Science & Technology, New Delhi
4.	Physics and Chemistry of oxide surfaces	Indian National Science Academy (INSA), New Delhi
5.	Studies on fluidization with reference to acrylonitrile reactor	Indian Petrochemical Corpn., Ltd., Baroda
6.	Solar grade polysilicon	Department of Science and Technology, New Delhi
7.	Synthesis of basic drugs and intermediates	Dexo Laboratories Pvt. Ltd., Hyderabad.

2.3 Sponsored projects continued during 1983-84 and 1984-85

1983-84

	Process	Party
1.	Ampicillin and amoxycillin	Sudarshan Chemical Industries, Pune
2.	Aromatic polymers/polyamides	Department of Atomic Energy (DAE), Bombay
3.	Chloroquin phosphate	i) Sudarshan Chemical Industries Ltd. and ii) Standard Organics Ltd., Hyderabad
4.	Development of absorbing black paints	Department of Science & Technology, New Delhi
5.	Development of process for dextropropoxyphene HCl and other basic drugs	Centaur Laboratories, Bombay
6.	Development of IR spectro-photometer	Department of Science & Technology, New Delhi

Process	Party
7. Drag reducers for oil transport	Oil Development Board, New Delhi.
8. Enzyme reagents	Department of Science & Technology, New Delhi
9. Eucalyptus territocornis by tissue culture	Forest Development Corpn. Tamilnadu.
10. Exploratory work on synthesis of various receptor drugs and their intermediates	Chemical Industries and Pharmaceutical Laboratories (CIPLA) BOMBAY
11. Hydroxy terminated polybutadiene	Explosive Research and Development Laboratory, (ERDL) Govt. of India (Ministry of Defence), Pune.
12. Multiplicity and stability in chemically reacting sytems	Indian National Science Academy (INSA), New Delhi
13. Physics and Chemistry of oxide surfaces	Department of Science & Technology, New Delhi
14. Polymer alloy resins	Department of Science & Technology, New Delhi
15. Rosin and modified resins	Dujodwala Resins & Terpenes Pvt. Ltd., Bombay
16. Solar grade polysilicon	Dept. of Science and Technology, New Delhi
17. Studies in fluidization with reference to acrylonitrile reactor	Indian Petrochemicals Corpn. Ltd., Baroda
18. Synthesis of basic drugs and intermediates	Dexo Laboratories Pvt. Ltd., Hyderabad
19. Synthesis of doxepin and ketoprofen	Pharmaceutical Company of India (PCI), Bombay
20. Synthesis of various drugs and their intermediates such as atenolal and metoprolol etc.	Chemical Industries and Pharmaceutical Laboratories Ltd. (CIPLA), Bombay
21. Total synthesis of anti-tumour agents anthracyclinones — adriamycine and its analogues	Eductiaon & Youth Services Dept. S & T Cell, Government of Maharashtra, Bombay

1984-85

Process	Party
1. Development of absorbing black paints	Dept. of Science & Tech., New Delhi
2. Development of IR spectro-photometer	Dept. of Science & Tech., New Delhi
3. Development of process for dextropropoxyphene hydrochloride and other basic drugs	Centaur Laboratories Pvt. Ltd.. Bombay
4. Development of process know-how for the drugs doxepin and ketoprofen	The Pharmaceutical and Chemical Industries, Bombay
5. Drag reducers for oil transport	Oil Industry Development Board, New Delhi
6. Hydroxy terminated polybutadiene	Explosive Research Laboratory (ERDL) Govt. of India (Ministry of Defence) Pune.
7. Modified resin and rosin derivatives	Dujodwala Rosin and Terpenes Ltd., Bombay
8. Multiplicity and stability in chemically reacting systems	Indian National Science Academy, New Delhi.
9. Polymer alloy resin	Dept. of Science & Tech. New Delhi.
10. Synthesis of various drugs and their intermediates such as atenolal, metoprolal etc.	Chemical Industries and Pharmaceutical Laboratories Ltd. (CIPLA), Bombay
11. Total synthesis of anti-tumour agents anthracyclinones adriamycene and its analogues	Education & Youth Service Dept., S & T Cell, Govt. of Maharashtra, Bombay

2.4 Sponsored projects newly undertaken during 1983-84 & 1984-85

1983-84

Process	Party
1. Ampicillin and amoxycillin	Sudarshan Chemical Industries Limited, Pune
2. Chloroquin phosphate	1) Sudarshan Chemical Industries Limited, Pune 2) Standard Organics, Hyderabad
3. DVO acid chloride	National Organic Chemical Industries Ltd., Bombay
4. Eucalyptus territocornis by tissue culture	Forest Development Corpn., Tamilnadu
5. Methylation of morphine to codeine	Government of India, Ministry of Finance, (Dept. of Revenue), New Delhi

1984-85

Process	Party
1. Exploratory work on preparation of chlorcrysanthamate	NOCIL, Bombay
2. Sulphochlorinated polyethylene	Delhi Cloth & General Mills Co. Ltd., New Delhi
3. Vitamin E	Chemfab, Madras
4. Water absorbing polymers	Indian Organic Chemicals, Ltd., Bombay

2.5 Collaborative work

Wherever possible and desirable, the laboratory collaborates with industry on industrially important projects that are engineering intensive and involve development of complex technologies with high investment risk.

The terms and conditions for such collaborative work depend upon the type of process that has to be developed. However, in general, the following terms are applicable to collaborative work.

(i) The scale of development will be decided by consultation between the NCL and the collaborating firm.

(ii) Initial time targets will be fixed for the completion of major activities. These would, however, be reviewed periodically in joint meetings with the collaborator taking into account the progress made and the bottlenecks being faced.

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

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

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

(vi) Normally NCL on its own will furnish a process package with basic chemical engineering design data for the semi-commercial plant. In some cases a project engineering firm may be associated in the work. The charges for such designs will depend upon the process and the size of semi-commercial plant to be installed and will be included in the share of the expenses to be borne by the collaborator as under (iv). In case the collaborator is involved in the preparation of the process package, his inputs will be taken into account while deciding the total expenditure payable by him as under (iv).

(vii) NCL scientists will be deputed for assisting in setting up and commissioning the

semi-commercial plant. The collaborator will pay for such deputation according to the CSIR norms and will bear all expenses of the scientists on travel, boarding, lodging and local transport.

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

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

(x) Within 90 days of the successful commissioning of the semicommercial plant the collaborating firm will have to exercise its option for the commercial exploitation of the process. If the firm does no exercise its option within the said 90 days or after opting for it fails to establish commercial production within a specified period (2-3 years). NCL will be free to release the technology to other parties. In such an eventuality the collaborator will be compensated to the extent of the amount he has paid to NCL for the development of the project.

(xi) The collaborating firm will enjoy a limited exclusivity of about 5 years from the successful operation of the semi-commercial plant or about 3 years from the establishment of regular production on the commercial plant, whichever is earlier. The period of exclusivity would however be reduced or the process will be non-exclusive if it is funded by NRDC, DST or some other government agency. It would also be governed by the rules and regulations of such agencies.

(xii) After the completion of the period of exclusivity NCL will be free to offer the process know-how to other parties. In case collaborating firm fully participates in the transfer of technology, it will equally share premia/royalties received from these other parties. If the process is released to other parties before the expiry of the exclusivity period with the concurrence of the collaborater, the terms and conditions for such releases will be decided by mutual agreement. However, in such cases, if the collaborater does not fully participate in the transfer of technology he will be compensated only to the extent of the expenses paid by him to NCL for the development of the project.

(xiii) Notwithstanding clause (xi), in cases of national importance where Government may direct CSIR/NCL to release the developed technology to a third party in the interest of defence, atomic energy, space research or for prevention of import of foreign technology, CSIR/NCL, in consultation with the collaborater, will be free to release the technology to the said third party. The benefits arising from such releases will be shared by the collaborator in accordance with the provisions of clause (xiii).

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

(xv) NCL and the collaborating firm will periodically exchange the information generated on the project by way of reports. They will also periodically hold meetings to review the progress of the project.

(xvi) The collaborator shall provide insurance cover against injury/death to all the staff (other than NCL regular staff) working on the project at NCL, as also to the NCL staff deputed to the firm's site for pilot plant/semi-commercial plant / commercial plant work.

(xvii) The collaborating firm will keep confidential all the data received and generated under the collaborative agreement. NCL will also keep such information confidential subject to clauses (x) to (xiii).

These are the broad terms for undertaking collaborative work at NCL and can be modified to a certain extent depending upon the merits of the case. An agreement on stamp paper is executed between NCL/CSIR and the collaborator, embodying the terms and conditions agreed upon by the two parties.

2.5.1 Collaborative projects in progress during 1983-84 & 1984-85

Process	Collaborating firm
1. Bioscience and engineering	UNDP Project
2. Complex reactions in three phase slurry reactor	University of Erlangen, West Germany
3. Heat Pumps	Salford University, UK
4. Regular packing development	Engineers India Ltd., New Delhi
5. Toluene disproportionation	IPCL, Baroda
6. Vapour phase oxidation of ethylene to ethylene oxide and glycol	Engineers India Ltd., New Delhi

3. TECHNOLOGY TRANSFER

3.1 Levels of transfer

The processes developed at the laboratory are worked out and offered at three levels, depending upon the complexity involved in the process, the engineering content and the material volumes to be handled in n economic unit.

Level I covers chemicals of low volume production and which involve simple reactions/process steps. Here the work is carried out on a less than 5 Kg per batch scale and the know-how comprises the process, the analytical methods, and process control tests, the specifications of raw materials and products, and a list of major equipment with suggestions on sizes and materials of construction.

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

Level 3 relates to turn-key offers through project engineers with financial guarantees of commercial plant, similar to any other turn-key offer.

3.2 Processes released / demonstratad during 1983–84 and 1984–85

Process	Licencee
1. Clonal multiplication of cardamom by plant tissue culture	Cardamom Board/Cardamom Research Institute Cochin
2. Clonal multiplication of cardamom by plant tissue culture	A. V. Thomas & Co., Madras
3. Dapsone	Chemicals Industrial & Pharmaceutical Labcratories Ltd. (CIPLA), Bombay
4. Dextropropoxyphene hydrochloride	Centaur Laboratories, Bombay
5. Ethephon	(i) Sudarshan Chemical Industries, Pune (ii) Hycount Agro, Quilon, Kerala
6. Ibuprofen	CIPLA, Bombay
7. Ketoprofen	Pharmaceuticals & Chemical Industries, Bombay
8. Nicotine Sulphate	Kraun Fine Chemicals Pvt. Ltd., Chikodi, Karnataka
9. Phenylglycylchloride hydrochloride	Sudarshan Chemicals Industries Ltd., Pune
10. Polysulphide liquid rubber	Transpeck Industries, Baroda
11. Polyurethane coating	Simple coatings, Bhopal
12. Vincristine & Vinblastine Sulphate	CIPLA, Bombay
13. Vitamin B_6	Lupin Laboratories, Bombay

In addition following processes have been released—demonstration yet to be given.

1. Acetyl alloisolongifolene (Necelone)	Camphor and Allied Products Ltd., Bombay
2. Butyltitanate	Monopal Chemicals, Bombay
3. Flematic oil	T. T. K. Pharma Pvt. Ltd., Madras
4. Polysulphide liquid rubber	Synthetic Resins and Adhesives Industries, Ahmedabad

4. CONSULTANCY

Assistance of NCL experts in various branches of chemistry is made available to the chemical industry through consultancy services offered by NCL. Public and private sector firms and small scale chemical industries have been benefitted by such consultancy. The services are made available not only to the firms that have purchased NCL know-how, but also to other established chemical companies. According to the guidelines of the CSIR, three types of consultancy are offered: (a) advisory (b) engineering and (c) general technical. Under these services, NCL scientists assist in solving chemical problems, detailed engineering designs, equipment, procurement, process and product improvement, plant modifications, commissioning, technology absorption, etc. Consultancy projects undertaken during the years 1983–84 and 1984–85 are :

1983–84

Title	Consultee
1. Technical advice for development of synthetic drugs and other natural products which can be used in medicine	CIPLA, Bombay
2. General technical consultancy	Dujodwala Industries, Bombay
3. General technical advice and assistance concerning polyester fibre plant	IOCL, Bombay
4. General technical consultancy	HOC, Rasayani
5. Advisory consultancy for developing new technologies for various intermediates for drugs and dyes.	Amar Dye Chem. Ltd., Bombay
6. Advisory consultancy for interpretation/evaluation of the results of testing carried out by NCL.	Peico Electronics & Electricals Ltd., Bombay
7. Advisory consultancy regarding setting up a plant for thiourea	Maharashtra Fine Chemicals, Pune
8. Advisory consultancy regarding development of catalyst for pilot plant operation to produce 1 kg. of aldehyde and characterisation of catalyst by XRD, TGA, DTA, etc.	Defence Research & Development Establishment, Gwalior
9. Advisory consultancy on polyester fibre project relating to (i) the setting-up of an in-house R & D centre (ii) R & D programmes (iii) process optimization/trouble shooting	M/s. Petrofils Co-operative Ltd., Baroda
10. General technical consultancy to Govt. of India	
11. Advisory consultancy on disproportionation and transalkylation C_7/C_9 aromatics	IPCL, Baroda

1984–85

Title	Consultee firm
1. Technical advice for development of synthetic drugs and other natural products which can be used in medicine.	CIPLA, Bombay
2. General technical consultancy	Dujodwala Resins & Terpenes Pvt. Ltd., Bombay
3. General technical advice and assistance concerning the polyester fibre manufacturing plant	Indian Organic Chemicals Ltd., Bombay
4. General technical consultancy for (i) Analysis of process in existing plants (ii) Identification of new projects (iii) Design, construction, and operation of plants	HOC, Rasayani
5. Advice on polymerization and spinning of polyester fibres with reference to process modification and improvements	Swadeshi Polytex Ltd., Gaziabad
6. Advisory consultancy	Amar Dye-chem Ltd., Bombay
7. Advisory consultancy on disporportionation and and transalkylation C_7/C_9 aromatics	IPCL, Baroda
8. Advisory consultancy on computer simulation for synthetic fibre	IOCL, Bombay
9. Development of piperazine and other chemicals	Diamines & Chemicals Ltd., Kalol
10. Technical advice and assistance relating to the in plant processing of chlorination	Abhi Chemicals and Pharmaceuticals Pvt. Ltd., Pune
11. Technical advice and assistance relating to the in plant R & D problems	Poona Pharmachem Industries, Pune
12. Modernization of process and plants of the Govt. Opium & Alkaloids Works at Neemuch & Ghazipur	Govt. of India Min. of Finance (Dept. of Revenue), New Delhi
13. Advisory conslutancy for development of catalysts	Standard Alkali, Bombay
14. Interpretation of data on physico chemical characteristics of catalysts	Alchemic Research Centre Pvt. Ltd., Thane
15. Adivsory consultancy for layout of R & D facilities	Sonnenflex Abrasives (P) Ltd., Pune
16. Advisory consultancy for production of polyurethane products	Nand Industries, Pune
17. General technical consultancy for development of suitable analytical methods for determination of Solasidine contents in crude material extracted from plant	Synthozyme Laboratories Pvt. Ltd., Jalgaon

	Title	Consultee firm
18.	Advisory consultancy on R & D work on multiplication of rubber by plant tissue culture	Rubber Board/ Rubber Research Institute, Kottayam
19.	Advisory consultancy services in entomological screening	Alchemie Research Centre Pvt. Ltd., Thane
20.	Cellulosic paper	Tasgaon Vaidnyanik Sheti Seva & Drakshkul Pvt. Ltd., Borgaon (Dist. Sangli)
21.	Advisory consultancy on computer modelling and simulation for IPCL plant	IPCL, Baroda
22.	Technical advise on hot moulded presets and potentiometers	Techmark Electronics Pvt. Ltd., Pune
23.	Downstream polymer products of Maharashtra Gas Cracker Complex	The Bureau of Industrial Costs & Prices, New Delhi
24.	Technical advice on polyester resins preparation	Unnati Corpn., Ahmedabad
25.	Advisory consultancy relating to new product development product improvement and diversfication of the existing production unit of the company	Pefco Foundry & Chemicals Ltd., Bombay
26.	Consultancy on modernization of pottasium permangenite plant of the company	Kurti Chemiclas Pvt. Ltd., Vasco-Dagama (GOA)
27.	Technical advice and assistance relating to characterization and identification of constituents of the complex mixture from petroleum origin by employing analytical methods and interpretation of the results	D. M. C. C. Ltd., Ambarnath
28.	Setting up of P. T. C. laboratory and for commercialization of NCL lab. scale technolcgy for cardamom	A. V. Thomas & Co. Ltd., Cochir
29.	General consultancy services for optimization and standardization for the purification of the drug intermediate	Hindustan Ciba Geigy, Bombay
30.	Technical advice for the synthesis of unsaturated polyester for moulding purposes	Polyester Moulding Company Pvt. Ltd., Dombivili

5. PREMIA AND ROYALTIES RECEIVED BY NRDC THROUGH NCL PROCESSES DURING 1983-84 AND 1984-85

5.1 Premia

	Process	Firm	Premium Received (Rs.)
1.	Quinapyramine sulphate and chloride	Chintamani Fine Chemicals, Pune	50,000.00

5.2 Royalties

	Process	Firm	Royalty Received (Rs.)	
			As on Dec. 83	As on Dec. 84
1.	Cation exchange resin (Polystyrene base)	Bharat Power & Mech. Engg. Ltd., Calcutta	—	2,609.00
2.	Can sealing composition based on nitrile rubber	Arya Chemical Works, Calcutta	2,284.79	4,430.54
3.	Dimethoate	Shaw Wallace and Co. Ltd., Calcutta	2,598.00	98,249.54
4.	Ethion	—do—	1,20,000.00	24,348.44
5.	Monoethylaniline	Atul Products Ltd., Atul	3,409.00	—
6.	Polyurethane coating	Cipy Chemicals, Pune	—	604.50
7.	Polyurethane printing rollers	Sree Saraswaty Press Ltd., Calcutta	16,696.30	26,393.70
8.	Quinapyramine sulphate and chloride	Chintamani Fine Chemicals, Pune	—	2,280.00
9.	Radiosonde thermistors	Bhagyanagar Lab., Hyderabad	—	26,838.75

6. LECTURES AND SEMINARS

6·1 The following visiting scientists delivered lectures in the laboratory

	Scientist	Subject
1.	Prof. E. W. Abel Department of Chemistry, University of Exeter, UK	Organometalic bases as synthetic intermediates in coordination chemistry
2.	Dr. Abid Ali Dost, V. G. Scientific, UK	Surface science of heterogeneous catalysis
3.	Prof. J. M. Ashworth, Vice Chancellor, University of Saford, UK	Reorganisation of British Technical Universities after the Government Cuts in 1981
4.	Dr. S. K. Bhatia, New Delhi	Kinetics of gas-solid reactions
5.	Prof. C. Brown, Noble Laurate, Department of Chemistry, Purdue University, USA	(i) Popular lecture-Adventures in research (ii) Asymetric synthesis (via) Chiralorganoboranes
6.	Prof. J. D. Bu' Lock, Chemistry Department, University of Manchester, UK	Development of biomass research 1984
7.	Prof. J. B. Chatopadhyaya, Department of Microbiology, Biomedical Centre, Sweden	Some aspects of chemicals synthesis of ribonucleic acids
8.	Dr. M. Chorgade, Harward University, USA	Bleomycin
9.	Dr. V. N. Demin, Institute of Organic Chemistry, Novosibirsk, USSR	The present state of liquid phase electroepitoxy
10.	Prof. D. D. Deshpande, Department of Chemistry, Indian Institute of Technology, Bombay	Transition in amorphous polymers
11.	Dr. V. R. Dhank, VG Scientific, UK	FIM Studies of transition metal layers

	Scientist	Subject
12.	Dr. Karl-Erik Erikson, Prof. & Head, Biochemistry and Microbial Research, Swedish Forest Products Research Laboratory, Sweden	Microbial delignification of lignocellulosic materials for ethanol production
13.	Prof. Ian Fleming, University of Chemical Laboratory, Cambridge, UK	Series of lectures on some uses of silicon compounds in organic synthesis
14.	Prof. Gassman, University of Minnesota, USA	(2–3)–Sigmatropic rearrangements in the synthesis of heterocyclic compounds
15.	Dr. A. B. Goel, Ashland Chemical Company, Ohio, USA	Current aspects of homogeneous catalysis and application in a new styrene process
16.	Dr. G. Goma, Department de Genie Biochimque, France	(i) Biotechnological production potencies and bottlenecks (ii) Alcohol fermentation some new aspects on inhibition and technological aspects
17.	Prof. J. B. Hendrickson, Bandeis University, USA	(i) Trifylactivation in organic synthesis (ii) Economy in synthesis
18.	Dr. R. S. Irwin, Senior Research Associate, Du-Pont Experimental Station, USA	Structure property relations in misophase polyesters fibres
19.	Dr. K. Jadhav, Purdue University, USA	Recent developments in assymmertric synthesis *via* chiralorganoboranes
20.	Dr. Thomas Jaffries, Forest Products Res-Lab., Wisconsin, USA	Physiological and genetic studies on xylose fermentions by yeasts.
21.	Prof. C. Kratochvil, Institute of Macromolecular chemistry, Czechoslovak Academy of Science, Czechoslovakia	(i) Heterogeneity in chemical composition of copolymers and its characterization (ii) Determination of size & shape of macromolecules by light scattering (iii) Block and graft copolymer micelles
22.	Dr. Krishnarajan, NRC, Canada	Application of high resolution transmission electron microscopy to materials problems.
23.	Dr. V. Kunze, Institute for Inorganic Chemistry, University of Tubingen, West Germany	Stannane dithio-carboxylates-Novel-OC-functicnal organotin ligands with unccmmon Tin-119 NMR shifts

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Scientist	Subject
24. Prof. R. W. Lenz, Massachussetts University, USA	Synthesis and properties of liquid crystalline thermotropic polyesters
25. Prof. Yu-Yen Linko, Helsinki University of Technolcgy, Finland	(i) Immobilized biocatalyst technology research at Helsinki University of Technology (ii) Current status of immoblized microbial cell technology for ethanol production
26. Prof. G. Lorve, Dyson Perrirs Laboratory Ltd., U. K.	Mechanistic studies on the utilisation of APT using Chiral (O^{16} O^{17} O^{18}) phosphate esters
27. Dr. K. P. Madhavan, Department of Chemical Engineering, Indian Institute of Technolcgy, Bombay.	Application of adaptive control principles to chemical Processes
28. Dr. Mary Mandeles, Head, Enzyme and Biochemical Engg. group US Army Natick R & D Lab., USA	(i) Production of trichoderm cellulase (ii) Saccharification of cellulose with trichoderma Cellulase
29. Dr. M. J. Modak, Sloane Kettering Cancer Centre, USA	(i) Mysterious DNA polymerase (ii) Reverse transcriptase
30. Dr. D. Mukherjee. Department of Physical Chemistry. IACS, Calcutta	Shape of molecules fact or fiction
31. Prof. R. Muthusasan, Drexel University, USA	New insights on acid hydrolysis of biomass in concentrated slurries.
32. Mr. N. B. S. Nageshwara Rao, College of Military Engg. Pune	X-ray photo electron spectroscopic studies and property measurements on electroless nickel and copper
33. Dr. R. G. Naik, Indian Institute of Science, Bangalore	Asymetric homogeneous hydrogenation
34. Dr. S. B. Padhye, Reader, University of Poona, Pune	Transition metal quinone complexes — A case of non-innocent ligands
35. Dr. G. G. Pai, Hindusthan Ciba Geigy, Bombay	Studies in borinanes and assymetric reduction
36. Dr. D. T. N. Pillay, University of Windsore, Canada	Mapping of chloroplast genanes

Scientist	Subject
37. Prof. S. Pokrny. Institute of Macromolecular Chemistry, Czechoslovakia	(i) Liquid chromatcgraphy a modern analytical too (ii) Analysis of polymers by steric exclusion chromatography
38. Prof. C. Quivoron, Scientific Counseller University of National Education, Paris	Organisation and present state of chemistry, research in France
39. Dr. T. S. Raghunathan, Indian Institute of Technology, Bombay	The hydrolysis of vegetable oils kinetic and equilibrium aspects
40. Prof. G. V. Reklaitis, Chemical and Metallurgical Engineering School of Chemical Engineering, Purdue University, Indiana	Computer aided design and analysis of batch processes
41. Prof. J. Riess, University of Nice, France	Examples of inter reactions between transition metals and phosphorus ligands
42. Dr. V. Sahasrabudhe, J. S. M. College, Alibag	EXAFS study of ferrites
43. Prof. M. Satyanarayana Indian Institute of Technology Madras	Parametric sensitivity of fixed bed reactions
44. Mrs. S. Sen, Texas University USA	Selection methods for drought tolexent pines
45. Dr. K. Seth, The Weizmann Institute of science, Israel	Thermostatic enzymes in organic synthesis
46. Dr. D. Shah University of Georgia USA	Multigene families in plants
47. Prof. J. S. Shah University of Bristol UK	Application of physical techniques in crystal related rheumatic diseases.
48. Prof. Y. T. Shah, Department of Chemical Engineering, University of Pittsburg, USA	(i) Kinetic of coal liquifaction (ii) Hydrodynamics and mass transfer in bubble columns
49. Dr. V. R. Shirhatti, National Institute of Health, USA	Drug induced action and toxicity : studies employing cultured myocuter and hepotocyter

Scientist	Subject
50. Dr. V. R. Srinivasan, Lousinia State University, USA	Closing of legnin degrading genes
51. Prof. E. J. Staba, Universjty of Minnesota, USA	Secondary metabolites in tissue culture
52. Prof. F. G. S. Stone, University of Bristol, U. K.	Metal-Carbon and metal-metal multiple bonds
53. Prof. J. Swithenbank, Sheffield University, UK	New development in mathematical modelling of two phase reacting systems
54. Mrs. N. Trolinder, Texas Technology University, USA	(i) Embryogenesis in cotton (ii) Studies in atriplex
55. Prof. W. A. Van Hook, University of Tennessee, Knoxville, USA	Condensed phase thermodynamic isotope effect Part I
56. Dr. V. V. Wadekar, AERE Harwell, Oxford shire, UK	Microprocessor based data aquisition systems
57. Dr. R. G. Walkar, R. K. Technologies, UK	Carbon fibre technologies
58. Prof. K. Walters, University College of Wales, UK	(i) Rheometry — including a discussion of practical needs, fundamental principles and two recent case histories (ii) Complex flow of elastic liquids and the possibility of its prediction - A research seminar with flow visualization data and numerical simulation
59. Prof. R. G. Weiss, Georgetown University, USA	The influence of liquid crystalline media on thermal and photochemical organic reactions
60. Prof. B. G. Williams, Cambridge University, UK	Application of compton scattering to solid state chemistry
61. Prof. J. J. Zukerman, University of Oklahama, USA	Where are the lone pairs in subvalent main group compounds

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

Scientist	Subject	Venue
1. Dr. B. B. Ghatge	(i) Modern instrumental chromatography (series of eleven lectures)	Shivaji University, Kolhapur
	(ii) Gas chromtography	Seminar on biogas application, Maharashtra Association of Cultivation of Science, Pune
2. Dr. S. Gundiah	Polyelectrolyte expansion in solutions	Vikram Sarabhai Space Research Centre, Trivandrum
3. Dr. T. N. Guru Row	Structure of two oxaza-phosphorin derivatives	International Union of Crystallography, Hamburg, West Germany
4. Dr. K. V. Krishnamurthy	Protoplast technology problems and perspectives	DST sponsored workshop on Plant tissue culture, NCL, Pune
5. Dr. P. S. Kulkarni	(i) Chemical ionization mass spectrometry (two lectures) (ii) Mass spectrometry culture (three lectures)	Post-Graduate Centre, Ahmednagar College, Ahmednagar Post-Graduate Centre, Yeshwant Maha vidyalaya, Nanded
6. Dr. A. F. Mascarenhas	(i) Recent trends in tissue culture	Molecular Biology Workshop, NCL, Pune
	(ii) Potential application of tissue culture	Poona University Teachers Workshop for plant tissue culture training
	(iii) Application of tissue culture for forest trees	DST sponsored Plant tissue culture Workshop at NCL, Pune
	(iv) Plant Tissue Culture application for forestry	Texas Tech. University. Lubbock, USA
7. Dr. A. A. Natu	(i) Recent advances in NMR spectroscopy	Yeshwant Mahavidyalaya, Nanded
	(ii) Applications of NMR in drugs and pharmacuticals	Workshop on NMR optical purty, HAl , Pune
8. Dr. V. S. Patwardhan	Process modelling and simulation in the NCL	RRL, Johrat
9. Dr. A. V. Rama Rao	(i) Synthesis of biologically active compounds with a difference	Alchemie Res. Centre, Thane
	(ii) Synthesis of active compounds	RRL, Hyderabad
10. Dr. A. S. Rao	Sterio chemistry (three lectures) and synthesis of natural products	Post Grduate Centre of University of Bombay, Goa
11. Dr. S. K. Rawal	Isoenzymes-an overview	DST sponsored Workshop on Plant tissue culture, NCL Pune
12. Dr. S. Sivasankar	(i) Petroleum processing	Maharashtra Institute of Technology, Pune
	(ii) Production of petrochemicals	Peico Electronics and Electricals Ltd Loni, Pune
	(iii) Surface area and particle size measurements	
13. Dr. K. V. Srinivasan	Disperse dyes and their structures	Seminar on Dyes for hydrofolic fibres organised as a part of Golden Jubilee Celebrations, BUDCT, Bombay
14. Dr. A. J. Varma	Applied organic chemistry (Series of 24 lectures)	Mahashtra Institute of Technology, Pune

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

1. The 49th Annual meeting of the Indian Academy of Sciences was held at NCL during November 7-9-1983. The meeting was well attended by fellows of the academy. The President of the academy addressed the gathering and mainly discussed various aspects of material science. Other major topics discussed during the meeting were organic synthesis and plant tissue culture studies. The highlights of the meeting was the talk given on the experiences by the members of Antartica Expendition aided by audio-visual and coloured slides.

2. The 52nd Annual meeting of Society of Biological Chemists (India) was held at NCL during November 26-28, 1983. The meeting was attended by about 800 scientists and students from all over the country. There were three symposia sessions on frontier thrust areas, Viz. Biotechnology, Plant biology at the molcular level and Structure and function of macromolecules. Three to four eminent scientists in the respective areas were invited to give the latest account of research developments. There were three poster sessions in all the biochemical areas and approximately 600 posters were presented. A round table conference on "Biochemical Education in India" was also arranged. About eight senior professors and scientists were invited to express their views on the present biochemical education and research in India.

3. A unique three day International Conference on Chemical Reaction Engineering was held at the NCL from January 9-11, 1984. It was the first conference of its kind to be held in India and it provided a rare opportunity for some of the top scientists working in the field in India and abroad to come together and discuss problems of mutual interest. Dr. Haldor Topose, who has been called the Grand Old Man of the catalyst industry, inaugurated the conference.

Over 160 delegates from abroad and from different parts of the country attended the conference, presented papers, gave plenary lectures and took part in the panel discussion. Eighty one original research papers were presented during the technical sessions.

4. A one-day Seminar on Heat Pump was held at the NCL in February 1984, towards the promotion of heat pump application in industry, to create an awareness about potential and its economic viability in the current context. This was subsequently followed by a two-day short course and workshop in January 1985. Both were widely attended by senior and middle manager from a variety of industries.

5. A 5 days Workshop in Plant molecular biology was held at NCL from January 21-25, 1985. This workshop was sponsored by Department of Atomic Energy, Government of India, Bombay. About 36 participants, selected from all over the country and 15 observers attended the workshop. Eminent scientists and professors were invited to deliver lectures in different frontier areas in the field of plant molecular biology.

6. A DST sponsored training course on Plant Tissue Culture was held at the NCL from March 4-7, 1985. Fifteen trainees representing different research laboratories, universities and institutions from all over the country attended the training course.

The participants were exposed to some of the latest highlights of the plant tissue culture work by lectures and intensive practical training course arranged during the workshop.

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7. STAFF STRENGTH

		(As on 31-3-84)	(As on 31-3-85)
1.	Scientific		
(i)	Director	1	1
(ii)	Scientist in Director's grade	2	2
(iii)	Dy. Director/ Scientist 'F'	6	6
(iv)	Scientist 'E-II'	2	14
(v)	Scientist 'E. I'	40	46
(vi)	Scientist 'C'	93	95
(vii)	Scientist 'B'	95	159
(viii)	Scientist 'A'	44	21
(ix)	S. S. A.	90	62
(x)	Scientific Assistant	61	52
(xi)	S. L. A.** Grade VII	75	10
	Total	509	468
2.	Technical	269	291
3.	Administrative	158	163
4.	Group D (Technical) (Including Trade-Apprentices)	180	178
5.	Group D (Non-Technical)	60	55
	Total (1-5)	1176	1155
6.	Research Fellows. Pool Officers, Guest Workers and Graduate Trainees		
(i)	JRFs, SRFs, and PDFs	64	60
(ii)	CSIR Pool Officers	8	4
(iii)	Guest Workers	12	7
(iv)	Reserch Associates	1	1
(v)	Post Doctoral Fellows	4	1
		89	73
7.	Scientific staff appointed for sponsored projects schemes	38	4

**Senior Laboratory Assistants (SLAs) are included in the scientific category since a majority of them have post graduate qualifications and are engaged in scientific work.

8. STAFF NEWS

8.1 Awards/Honours

1. ICMA Award to NCL

The Indian Chemical Manufacturers Association (ICMA) has recognized the contributions of National Chemical Laboratory (NCL), Pune, in conferring the Sir P.C. Ray Award for 'Development of Indigenous Technology' for 1983 on CIPLA, Bombay, as also the award for 'Forward Development Technology' on HICO Products Limited, Bombay.

The citation says: "National Chemical Laboratory Pune, have demonstrated in an imaginative way their expertise in dealing with complicated chemical engineering oriented technology for the manufacture of silicones by HICO Products Limited". "The Indian Chemical Manufacturers Association recognizes the NCL's contribution in the development and successful transfer of technology in a very demanding and challenging area and deeply appreciates this fruitful cooperation between a national laboratory and an industrial unit."

2. Dr. L. K. Doraiswamy, has been presented the prestigious "Distinguished Service Citation" by the University of Wisconsin-Madison, USA. The citation received by Dr. Doraiswamy is in recognition of his eminent professional services as chemical engineer and researcher "who through his technical expertise and commitment to excellence, has made contributions to chemical engineering science and to the chemical industry of India."
3. Dr. L. K. Doraiswamy, has been invited by the University of Bombay to be Dr. G. P. Kane visiting professor in chemical engineering for the year 1984-85.
4. Dr. T. N. Guru Row, has been selected as a Young Associate by the Indian Academy of Sciences, Bangalore, for his significant contributions in the field of X-ray crystallography.
5. Dr. M. G. Kulkarni, has been elected as a Young Associate by the Indian Academy of Sciences, Bangalore, for his significant contributions in the field of polymer science and engineering
6. Dr. A. F. Mascarenhas has been elected fellow of the Maharashtra Academy of Sciences, Pune, for his significant contributions to the area of plant tissue culture.

7. Dr. R. A. Mashelkar, has been elected as its fellow by the Indian Academy of Sciences, Bangalore in recognition of his outstanding contributions to chemical engineering sciences.

8. Dr. R. A. Mashelkar, has been elected as its fellow by the Indian National Science Academy, New Delhi, in recognition of his outstanding contributions to polymer engineering science.

9. Dr. R. A. Mashelkar, has been awarded the inaugural Prof. M. Santappa Silver Jubilee Award in recognition of his outstanding research in polymer science. The award has been given by the Society for Polymer Science, India and has been instituted by the Prof. M. Santappa Silver Jubilee Trust.

10. Dr. R. A. Mashelkar, has been awarded the prestigious 'Shanti Swarup Bhatnagar Prize' for the year 1982, for engineering sciences in recognition of outstanding research in polymer science and engineering.

11. Dr. R. A. Mashelkar, has been awarded Mrs. Chinnamaul Memorial prize for the best technical paper presented at the Annual Session of the Institute of Chemical Engineers (1983).

12. Dr. R. A. Mashelkar, has been felicited as one one of the ten outstanding citizens of Pune by Deccan and Saras Jaycees, Pune, 1983.

13. Dr. R. A. Mashelkar, has been invited to deliver Prof. K. H. Kabbur Memorial Lecture for the year, 1983 by University of Bombay.

14. Dr. R. A. Mshelkar has been awarded "Role of Honour-1984" by Giants International, Pune.

15. Mr. B. M. Pathan, has been awarded the third prize at the sixth safety poster competition-83 organised by the Council of Industrial Safety, Bombay.

16. Dr. S. D. Prasad, has been elected as a Young Associate by the Indian Academy of Sciences, Bangalore, for his significant contributions in the field of chemical engineering,

17. Dr. A. V. Rama Rao, has been invited to deliver two lectures under the Prof. A. B. Kulkarni, Lectureship Endowment, University of Bombay for the year 1983.

18. Dr. A. V. Rama Rao, has been elected as fellow by the Indian Academy of Sciences, Bangalore, for his outstanding contributions in the field of organic chemistry for the year 1984.

19. Dr. A. V. Rama Rao, has been awarded the K. G. Naik Gold Medal of M. S. University of Baroda for the year 1982 for his outstanding contributions to the field of organic chemistry.

20. Dr. P. K. Ranjekar, has been offered a National Biotechnology Board (NBTB) Overseas Junior Associateship for excellence in the area of biotechnology. This fellowship is given to outstanding scientists below 45 years.

21. Dr. A. V. Shenoy, has been selected for the Amar-Dye-Chem Award for "excellence in research and development" for the year 1984, by the Indian Institute of Chemical Engineers, Calcutta. The award is annually given to a young chemical engineer (below 35 years) for excellence in research.

22. Drs. S.P. Vernekar, B. B. Idage, P. P. Wadgaonkar, N. D. Ghatge and Mr. S. S. Mohite have been awarded the prestigious 'Dunlop Award (1985)' for their outstanding basic research in the field of rubber chemistry and technology.

23. Dr. J. S. Yadav, has been elected as a Young Associate by the Indian Academy of Sciences, Bangalore, for his significant contributions in the field of organic chemistry, for the year 1984.

8·2 Deputations/Visits abroad

1. Dr. L. K. Doraiswamy, visited Japan and USA to see the latest developments and discuss various aspects of Bioscience and engineering (Six weeks from April 1983).

2. Dr. S. S. Tavale, Mr. S. D. Bakare and Mr. P. D. Godbole were deputed for training on the operation and maintenance of the crystal automatic X-ray diffractometer at Enray Noxius Delft, Holland (Two weeks in April-May 1983),

3. Miss A. V. Joglekar was deputed to Australia to the school of Biotechnology University of South Wales and USA for training under UNDP Project on Bioscience and Engineering (Six months from April 1983).

4. Dr. R. N. Sharma was deputed to West Germany to attend the 2nd International Neem Conference at Geissen (One week from 25th May 1983).

5. Dr. (Mrs) H. Sivaraman was deputed to USA for training under the UNDP Project on Bioscience and Engineering.

6. Dr. R. A. Mashelkar visited USSR as a member of an Indian delegation which was specifically sent for exploring potential collaboration in the area of heat and mas transfer (Two weeks in June—July 1983).

7. Mr. M. G. Sane and Mr. M. G. Parande was deputed to UK for advance training in the field of heat energy recycling and heat pumps (One year from June, 1983).

8. Mr. V. V. Jogdand visited Switzerland for training prgoramme on fermentor operations at CHEMAP, A. G., Switzerland (Two weeks in July 1983).

9. Dr. L. K. Doraiswamy visited UK under Salford-NCL link (Three weeks from July, 1983).

10. Dr. A. P. B. Sinha visited G. D. R. (Germany) alongwith Vice-President, CSIR to visit industries and institutions to see facilities in the area of electronic grade silicon, micro electronics, characterisation of materials and equipment for microelectronic industry (One week in July 1983)

11. Dr. A. V. Rama Rao, visited USSR to attend the Indo-Russian Symposium on Chemistry of natural products. He also visited some scientific institutions at Moscow (September 1983).

12. Shri M. V. Deshpande was deputed to Sweden for training in the field of Microbial Chemistry under UNDP project on Bioscience and Engineering (Six months from May, 1983) and to USA for advanced training in the area of cellulose utilisation (Three months from November 1983).

13. Shri S. R. Modak was deputed to Bangkok & Manila to attend a Meeting of Curators of South East Asian Network of Culture Collections sponsored by ADAB (December 1983).

14. Dr. A. V. Rama Rao visited USA under CSIR-NSF Exchange Programme (One month from March 1984).

15. Dr. A. H. Lachke visited USA under UNDP Project on Bioscience and Engineering for training at Forest Product Laboratory, Wisconsin. The U. S. Department of Agriculture awarded him a Certificate of appreciation in recognition of his contribution towards the understandings of the biochemistry of D-xylose fermentation yeasts (Six months from April 1984).

16. Miss R. Seeta was deputed to USA under UNDP Project on Bioscience and Engineering (Eight months from April, 1984).

17. Mr. B. Seetarama Rao was deputed to Australia for training in the field of immobilised systems of microbial whole cells (Six months from April 1984).

18. Mr. V. V. Jogdand was deputed to USA for training in the field of applied microbiology with particular refrence to bioconversion of cellulose to glucose (Six months from April 1984).

19. Dr. L. K. Doraiswamy visited various companies and R and D Centres and University of Pennsylvania, in UK and USA (Three weeks from May 1984).

20. Dr. M. C. Srinivasan, was deputed to attend UNI-IRRI workshop on biological nitrogen fixation in Rice Rhizosphere Las Barros, Manila (May 1984).

21. Dr. Paul Ratnasamy was deputed to USSR to participate in the first Indo-Soviet Seminar on Catalysis being held under Indo-USSR Programme on S & T Co-operation. He also visited various institutions in the area of catalysis at West Berlin, Denmark and U. K. (Three weeks from June 1984).

22. Dr. R. V. Chaudhari was deputed to USSR to attend First Indo-Soviet Seminar on Catalysis at Novosibrisk, USSR (Ten days in June, 1984).

23. Mr. S. T. Dhume was deputed to Switzelrand, Sweden, Finland, USA and Japan under UNDP project on Biosciences & Engineering (Three months from July, 1984).

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24. Dr. A. P. B. Sinha visited USSR to attend and give a seminar as a member of delegation constituted by INSA (Ten days in August, 1984).

25. Dr. (Mrs.) Vidya S. Gupta was deputed to Tokyo, Japan to present a paper at IIIrd International Congress on Cell Biology (Six days in August, 1984).

26. Dr. R. A. Mashelkar visited Salford University, UK under Heat Pump–Heat Energy Recovery Programme (Three weeks in September 1984).

27. Dr. A. B. Sahasrabudhe was deputed to Poland under CSIR-PAS Exchange Programme to study the latest techniques in isolation of compounds with biological activity and the use of phase transfer catalysis (Three months from September 1984).

28. Dr. V. S. Patwardhan visited Salford University, UK under Heat Pump–Heat Energy Recovery Programme (Three weeks in September October 1984).

29. Dr. L. K. Doraiswamy visited USA to receive award from University of Wisconsin, Madison College of Enginneering, USA (Nine days in October, 1984).

30. Mr. M. V. Gokhale was deputed to West Germany under CSIR-DAAD Exchange Programme (Two months from October 1984).

31. Dr. G. R. Venkitakrishnan and Mr. S. P. Mukherjee visited USA, W. Germanty and France as a member delegation constituted by the Ministry of Finance (Dept. of Revenue) for the purchase of equipment for updating the existing technology of the Govt. of Opium and Alkaloid Works Undertaking at Neemuch (M. P.) and for installing a new plant at Ghazipur (UP) (Four weeks in October-November, 1984).

32. Dr. (Mrs) J. P. Jog was deputed to USA for training on Dynamic Spectrometer (Three weeks in November, 1984).

33. Dr. M. C. Srinivasan was deputed to Bangkok to participate in the Fifth International Congress of Culture-Collections. (One week in November, 1984).

34. Dr. A. F. Mascarenhas was deputed to USA under Indo-US-SSP Programme on Biomass Project (Two weeks in December, 1984).

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

Seminars/Symposium/Conference	Scientists
1. First annual session of the Young Chemists Association of India, Delhi	Dr. J. S. Yadav Dr. (Mrs.) Bhanu Chanda Dr. V. H. Deshpande
2. Workshop on stirling cycle liquid nitrogen plants—principles and maintenance, TIFR, Bombay	Mr. K. Y. Shinde
3. Course in electrical circuits in machine tools, Pune	Mr. B. R. Kulkarni
4. Course on safety aspects in the research applications of ionsing radiations, BARC, Bombay	Dr. (Mrs.) Vidya Gupta
5. Course on welding, L & T Ltd., Bombay	Mr. S. B. Jadhav
6. International conference on natural projects as regulators of insect reproduction, RRL, Jammu	Dr. R. N. Sharma Dr. A. S. Gupta
7. Seminar on surface coating and printing inks, Bombay	Dr. Sobhan Ghosh Dr. S. G. Joshi
8. Pension course conducted by NISTADS, NGRI, Hyderabad	Mr. S. M. Bhambure Mrs. M. John
9. Course on the conservation and preservation of documents in libraries, Lucknow	Mr. N. B. Dahibhate
10. International workshop on pesticides formulations, New Delhi	Mr. N. Rajgopalan
11. Training course for senior engineers, L & T Ltd, Bombay	Mr. B. D. Pradhan
12. National symposium on surfactants emulsions and biocolloids, Calcutta	Dr. S. C. Sethi Dr. S. S. Katti
13. The II Indo-French workshop on genetic engineering, IIT, New Delhi	Mr. P. M. Dalal
14. National symposium on applied biotechnology of medicinal aromatic and tuber yielding plants, Calcutta	Dr. P. K. Gupta
15. Genetic manipulation course, IICB, Calcutta	Mr. H. Balakrishnan
16. 52nd annual meeting of the Society of Biological Chemists, NCL, Pune	Dr. P. K. Ranjekar Dr. S. G. Patil Mr. R. H. Hendre Dr. U. N. Dwivedi Mrs. S. S. Keskar Miss S. Subramanian Mr. I. I. Sutar Mrs. A. K. Vyas Mrs. U. S. Puntambekar Dr. G. T. Panse
17. National Seminar on recent developments in polymer science, AC College of Tech., Madras	Dr. N. D. Ghatge Mr. P. P. Wadgaonkar
18. 1st national symposium on recent trends in the development of composite materials, College of Engg., Pune	Dr. B. M. Shinde
19. 2nd national workshop on catalysis in pertochemical industry, IIT, Madras	Mr. K. P. Srinivasan Mr. S. G. Pataskar Mr. V. P. Shiralkar Dr. (Mrs.) A. J. Chandwadkar
20. 4th national symposium on thermal analysis IISc, Banglore	Mr. V. G. Gunjikar Mr. A. N. Kotasthane
21. 35th Indian Pharmaceutical Congress, Hyderabad	Dr. T. Ravindranathan Dr. S. V. Hiremath Dr. M. K. Gurjar Dr. A. R. Mehendale

Seminars/Symposium/Conference	Scientists
22. 36th annual session of IIChE, Pune	Dr. S. M. Abhyankar Dr. V. R. Chaudhary Dr. R. V. Chaudhari Dr. P. H. Brahme Mr. K. S. Balaraman Mr. A. K. Srivastava Dr. Sobhan Ghosh
23. Seminar on on new-trends in information technology, CDRI, Lucknow	Mr. M. D. Panse
24. Seminar on industry carbo-hydrates, ATIRA, Ahmedabad	Dr. P. H. Brahme
25. 3rd Oriental entomology symposium, Trivandrum University, Kerala	Dr. R. N. Sharma Mr. S. N. Mukherjee Mrs. V. S. Tare Mr. P. H Vartak Mrs. G. D. Hebbalkar Mr. S. G. Deshpande
26. 3rd national conference on water desalination, CSMCRI, Bhavnagar	Mr. M. B. Sabne Dr. M. G. Kulkarni Dr. H. G. Vartak
27. Symposium on plastics in defence, Maratha Chamber of Commerce, Pune	Dr. R. A. Mashelkar
28. International chemical reaction engineering conference, NCL, Pune	Dr. L. K. Doraiswamy Dr. R. A. Mashelkar Dr. B. D. Kulkarni Dr. V. S. Patwardhan Dr. R. V. Chaudhari Dr. K. S. Balaraman Dr. S. D. Prasad and C. E. staff
29. VIIth International biotechnology symposium, IIT, New Delhi	Dr. N. G. Karanth Dr. M. C. Srinivasan Dr. (Mrs) Chitra Misra Dr. A. H. Lachke Dr. P. K. Gupta Mr. S. K. Chatterjee
30. All India conferences on transformers, Bombay	Mr. K. M. Inamdar
31. Plant tissue culture conference, Coimbatore	Dr. A. F. Mascarenhas Dr. K. V. Krishnamurthy Dr. S. V. Paranjape Mr. R. R. Hendre Miss Rama Iyer
32. International symposium on genome org. & expression in devellopment differentiation of neoplasia, Pune	Dr. P. K. Ranjekar Dr. D. N. Deobagkar Dr. (Miss) Vidya S. Gupta

Seminars/Symposium/Conference	Scientists
33. NBTB course on technique in molecular biology, BARC, Bombay	Dr. P. K. Ranjekar Dr. D. N. Deobagkar
34. Symposium on developmental biology, Allahabad	Dr. R. N. Sharma
35. XVth international congress of genetics, New Delhi	Dr. A. F. Mascarenhas Dr. P. K. Ranjekar Dr. K. V. Krishnamurthy Dr. D. N. Deobagkar Dr. S. S. Khuspe
36. Ist international congress meeting on advances chromo. some genetics & self incompatibility, Chandigarh	Dr. P. K. Ranjekar
37. Training programme on patents, Calcutta	Mr. P. K. Deshpande
38. XIth International conference on magnetic resonance in biological systems, Goa	Dr. P. M. Nair
39. One day seminar on design & fabrication of chemical process equipment, Bombay	Mr. D. D. Ravetkar
40. Seminar on behavioural & physiological approaches in management of crop-pests, Coimbatore	Dr. R. N. Sharma Dr. A. S. Gupta Dr. B. A. Nagsampagi Dr. (Mrs.) S. A. Patwardhan
41. Symposium on photovoltaic materials & devices, NPL, New Delhi	Dr. V. J. Rao
42. All India symposium on environmental entomology, Pune	Dr. R. N. Sharma Mr. D. S. Hebbalkar Mrs. V. S. Tare Mr. S. N. Mukherjee Mr. J. V. Rao Mr. S. G. Deshpande Miss P. D. Gund
43. Workshop on computer applications in information sciences, NML, Jamshedpur	Mr. M. B. Patil
44. Role on computers & communications in the 3rd world Tata Inst. of Management Centre, Pune	Dr. G. P. Das Dr. A. Bhattacharya
45. Winter school on biological applications on mangetic resonance, Bangalore	Dr. S. D. Patil Dr. T. P. Mohandas
46. 53rd Annual meeting of the society of biological chemists, New Delhi	Mr. J. M. Khire Mr. A. M. Bodhe Mr. M. V. Deshpande Mr. U. M. Dwivedi
47. First national conference on micrographic, New Delhi	Mr. R. S. Singh
48. Papers presented at National Seminar on energy conservatien (NSEC), Bhopal	Dr. S. T. Kshirsagar Mr. H. S. Potdar
49. Seminar on contribution of personal protective equipments in promotion of industries safety, Bombay	Mr. N. Mohandas
50. 6th symposium on plantation crops (Plascrosym VI) RRI, Kottayam	Mr. D. D. Kulakrni

Seminars/Symposium/Conference	Scientists
51. Symposium on recent developments in co-ordination chemistry and catalysis, B. H. U. Varanasi	Dr. C. Gopinathan
52. 21st annual convention of chemists, Jadhavpur University, Calcutta	Dr. G. H. Kulkarni
53. Seminar-cum-workshop on high energy materials and advanced workshop, ERDL, Pune	Mr. P. P. Wadgaonkar
54. Symposium on recent trends in organic chemistry, IISc. Bangalore	Dr. A. V. Rama Rao Dr. J. S. Yadav Dr. H. R. Sonawane Dr. A. B. Sahasrabudhe Dr. (Mrs) H. V. Kamath Dr. V. Ravindranathan Dr. K. T. Srinivasan Dr. R. J. Lathoti Dr. (Miss) Z. Muljiani
55. Workshop on Bombay high crude, IIP, Dehradun	Dr. S. Sivasankar
56. Seminar on target 1990-challenges of bulk drug production	Dr. V. N. Gogte Dr. A. S. Rao Dr. A. A. Natu Dr. S. C. Sethi
57. New trends in management of libraries, University of Poona, Pune.	Mr. R. S. Singh Mr. M. B. Patil Mr. N. B. Dahibhate
58. Annual meeting of AMI, Pant Nagar	Mr. S. G. Patil Mr. D. V. Gokhale Mr. K. B. Bastawade Mrs. A. K. Vyas Mrs. V. S. Puntambekar Mrs. N. A. Sahasrabudhe
59. Seminar on scientific glass blowing in R & D institution and industries, BARC, Bombay	Mr. H. P. Chakraborty Mr. M. B. Kakade Mr. S. S. Yelwande Mr. P. S. Darawade Mr. M. B. Pardeshi
60. Workshop-cum-seminar on enzyme engineering, Jadhavpur University, Calcutta	Dr. (Mrs.) H. Siva Raman
61. 37th annual session of Indian Instt. of Chemical Engineers., IIT, New Delhi	Dr. R. A. Mashelkar
62. Conference organised by CHEMTECH, Bombay	Dr. A. V. Shenoy Dr. M. G. Kulkarni
63. Fourth national seminar on PSD, Jaipur	Dr. C. E. Deshpande
64. Western regional workshop / seminar on research in library and information centres, Bombay	Mr. M. D. Panse

Seminars / Symposium / Conference	Scientists
65. Seminar on rubber processing organised by AIRIA, Bombay	Mr. S. R. Srinivasan
66. 10th plant tissue culture conference, Jaipur	Dr. A. F. Mascarenhas Dr. K. V. Krishnamurthy Dr. S. V. Paranjpe Dr. U. N. Dwivedi Dr. (Mrs) R. Thengane Dr. (Miss) S. Nair
67. 7th national symposium on advances in catalysis, IPCL, Baroda	Dr. S. G. Patskar Dr. A. P. Singh Miss. Maya Devi Mr. A. A. Kelkar Dr. S. Sivshankar Dr. S. G. Hegde
68. Administrative management course, NIO, Goa	Mr. S. R. Srinivasan
69. Workshop on plant molecular biology sponsored by DAE, NCL, Pune	Dr. P. K. Ranjekar

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

Scientist		Subject
1. Dr. S. K. Date	(i)	Invited talk on physics and chemistry of unstable 3rd monoxides, Dept. of Physics, Nagpur University, Nagpur (January, 1985)
	(ii)	Invited lecture on structure property relationship in ferricyanides, Chemical Society meeting of the Institute of Science, Nagpur (January, 1985)
2. Dr. L. K. Doraiswamy	(i)	Invited talk on chemical engineering research in India —Challenges and opportunities at Seminar on Chemistry and industrial development challenges and opportunities at Indian Chemical Society, Bombay (January, 1985)
	(ii)	Chaired one session of the one day seminar on the design of multiphase reactors, BUDCT, Bombay as part of Golden Jubilee Celebrations
	(iii)	Chaired the plenary lecture of Prof. Delmon at the 7th National Symposium on advances in catalysis science and technology and gave his concluding remark at the valedictory function at IPCL, Baroda (February, 1985)
	(iv)	Presided over the seminar organised by the Tamil Nadu Chemical Manufacturers' Association and Rotary Club of Madras South on Safety in chemical industry. His presidential address was on Re-emphasis on industrial safety and its implications, (February, 1985)

Scientist		Subject
3. Dr. T. N. Guru Row	(i)	Invited lecture on Molecular interactions (via) data base, 1st workshop of NICRYS, at University of Madras, Madras (November, 1983)
	(ii)	Invited lecture on Electron density and chemical bonding, Department of Chemistry, IIT, Madras (November, 1983)
	(iii)	Invited lecture on Structure, conformation and charge density studies by X-ray diffraction, Golden Jubilee Lecture of the Indian Academy of Sciences, Bangalore (February, 1985)
	(iv)	Invited lecture on Electron density distribution in transition metal omplexes, Dept. of Physical and Inorganic Chemistry, IISc. Bangalore (February, 1985)
4. Dr. R. A. Mashelkar	(i)	Chairman, Technical Sessions Committee, Indian Institute of Chemical Engineers Annual Session (1983)
	(ii)	Chairman, Seminar on new trends in polymer synthesis, University of Madras Madras (April, 1983)
	(iii)	Chairman, Seminar on By-products utilization in sugar industry, Deccan Sugar Institute, Pune (June 1983)
	(iv)	Chairman, Seminar on inter disciplinary approach in R & D, Indian Institute of Chemical Engineers (Pune Regional Centre) (July, 1983)
	(v)	Chairman, technical session in International catalysis symposium, Indian catalysis society, Pune (February, 1983)
	(vi)	Chairman, a technical session in materials in high energy applications, ERDL, Pune (November, 1984)
	(vii)	Invited lecture in diffusion and mixing effects in macromolecular reactions in the workshop on Micromixing and selectivity of the chemical reactions, IIT, Kanpur (April, 1983)
	(viii)	Invited lecture — world of polymers academic forum, University of Poona (March, 1985)
	(ix)	Chairman, Seminar on plastics in defence, Plastics and Rubber Institute, Bombay (February, 1984)
5. Dr. U. R. Nayak		Invited talk on Alloisolongifolene, a totally new face of longifolene in 1983, at National Symposium on the chemistry of natural products at NCL, Pune (September, 1983)
6. Dr. V. S. Patwardhan		Invited lecture at the Seminar on applications of computer aided simulation and modelling in chemistry and industry at RRL, Jorhat (April, 1984)
7. Dr. A. V. Rama Rao	(i)	Prof. A. B. Kulkarni endowment lecture studies directed towards the total synthesis of antitumour anthracyclinones
	(ii)	Methods and methodology for the synthesis of macrolides, Bombay University, Bombay (February, 1984)
	(iii)	Invited lecture on contributions of national laboratories to drug industry - prospects and retrospects, 60th birthday celebrations of Dr. Nitya Nand, CDRI, Lucknow (January, 1985)
	(iv)	Prof. N. V. Subba Rao's memorial lecture-New approaches to the total synthesis of some biologically active antibiotics, Osmania University (February, 1985)
	(v)	Invited lecture on Natural products chemistry and the present directive, 61st birthday felicitation of Dr. Sukhdev at NCL, Pune

Scientist		Subject
8. Dr. R. N. Sharma	(i)	Chaired one of the sessions at the National seminar on behavioural and physiological approaches in the management of crop pests and presented two papers at the Tamil Nadu Agricultural University, Coimbatore
	(ii)	Chaired one of the sessions of the III oriental entomology symposium at University of Kerala (February, 1984)

8.5 Membership of Committees

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

Scientist	Capacity	Committee
1. Dr. S. M. Abhyankar	Member	Board of Studies in Chemical Engineering, Small Scale Industries Services Institute, Bombay
2. Dr N. R. Ayyangar	Alternate Member	ISI-Chemical Division Council
	Member	Working group on capacity utilization of alcohol, Ministry of Chemicals and Fertilizers, Govt. of India
3. Dr. L. K. Doraiswamy	Member	Sub-group on R & D in Petrochemicals appointed by the Planning Commission
	Member	Steering Committee on Fuels from Biomass-DST
	Member	Hindustan Lever Research Foundation, Bombay (Industrial Chemicals Panel)
	Member	ISI-Chemical Division Council
	Member	R & D Advisory Committee-Fertilizer Association of India
	Member	Award Committee — K. G. Naik Gold Medal, M. S. University of Baroda
	Member	International Reviewer, Panel of Applied Mechanics Reviews (S. E. Res. Inst., Texas, USA)
	Member	National Organizing Committee (INSA) of the 7th International Fermentation Symposium (1984)
	Member	Editorial Advisory Board of Advances in Transport Phenomena (Wiley Group)
	Member	CSIR-Chemical Engineering Research Committee
	Member	DST-Science Engineering Research Council
	Member	Sub-group on Conversion and Utilisation of Bicmass-DST Chairman Sub-group of Steering Committee on Fuels from Biomass-DST
	Member	R & D group, Hindustan Antibiotics Ltd., Pimpri, Pune
	Member	CSIR Polytechnology Transfer Centre (Bombay) — Advisory Council
	Member	Technical Advisory Committee for Chemical Industry –Kerala State Industrial Develcpment Corpn. Ltd.
	Member	Development Council for Inorganic Chemical Industries, Ministry of Industry, Govt. of India

Scientist	Capacity	Committee
3. Dr. L. K. Doraiswamy (Contd.)	Member	Scientific Advisory Board — Nimbkar Agricultural Research Institute, Phaltan
	Member	Scientific Advisory Committee, Dept. of Petroleum, Ministry of Petroleum, Chemicals and Fertilizers, Govt. of India
	Part-time Director	Indian Petrochemicals Corpn. Ltd., Baroda
	Part-time Director	Hindustan Organic Chemicals Ltd., Rasayani
	Chairman	CSIR Advisory Committee on Engineering (JRF/SRF)
	Chairman	Technical Manpower Committee, Govt. of Maharashtra
	Member	Council of Indian National Science Academy, New Delhi (1983 to 1985)
	Member	Governing Council and Academic Council, IAT, Pune
	Member	ICMA Awards Selection Committee (1983)
	Member	University of Poona Senate
	Member	A Committee on new technology and innovation set up by the Association of Indian Engineering Industry
	Member	Academic Committees of National Defence Academy, Pune and Army Cadet College, Dehra Dun
	Chairman	CSIR Review Committee to review the functioning of Field/Regional Centres of National Laboratories / Institutes and Polytechnology Transfer Centres, etc.
	Member	CSIR Standing Committee for Emeritus Scientists
	Member	Development of Western Ghat Committee
	Chairman	Programme advisory Committee for Chemical Engineering Sciences Programme (constituted by the DST for 3 years from 16-8-1984)
	Chairman	Coordination Council, Chemical Sciences Group (1-10-84 to 30-9-1986)
	Member	Governing Body and the Society of CSIR (1-10-84 to 30-9-1986)
	Chairman	Committee appointed by the DGSIR for working out a training programme in the use and applications of computers
	Member	Working group for DST for preparing the 7th Five Year Plan (1985-90)
	Member	Scientific Advisory Committee for the Dept. of Petroleum, Ministry of Energy, (two years from May 1983)
4. Dr. S. Gundiah	Member	Governing Council of Indian Rubber Manufacturers' Research Association, Bombay
	Member	Maharashtra Council on Science and Technology Study group of chemical industry
5. Dr. T. N. Guru Row	Member	National Information Centre for Crystallography (NICRYS)
6. Dr. B. D. Kulkarni	Member	Research Advisory Committee of the IPCL R & D programme

Scientist	Capacity	Committee
7. Dr. A. F. Mascarenhas	Member	Research Advisory Committee of ICAR on Biotechnology
	Member	Research Advisory Committee of Poona University on Biotechnology
	Member	Indo-US Panel on Biomass
	Secretary	Plant Tissue Culture Association of India.
8. Dr. R. A. Mashelkar	Editor (India)	Chemical Engineering Communications, Gordon Breach (USA)
	Editor (India)	Rheological Acta, Dr. Dietrich Steinkopff Verlag (Germany)
	Editor (India)	J. Non-Newtonian Fluid Mechanics, Elsevier (Holland)
	Editor	Advances in Transport Processes, Wiley Eastern/Wiley Halsted
	Member	Editorial Board Indian Journal of Technology
	Member	Publications Committee Indian Chemical Engineer
	Member	Editorial Advisory Board, Polymer Materials, Oxford and IBH Publishing Company
	Member	Reviewers' Board, Applied Mechanics Review, USA
	Member	Abstractors' Board, Rheology Abstracts, British Society of Rheology, UK
	Member	Chemical Engineering and Material Science Research Committee of CSIR
	Member	Industrial Chemistry and Chemical Technology Research Committee of CSIR
	Member	Project Advisory Committee on Resins and Composites Department of Science and Technology (1983-84)
	Secretary	International Chemical Reaction Engineering Conference (1983-84)
	Member	Board of Studies in Chemical Engineering and Technology, Banaras Hindu University (1983)
	Member	Board of Studies in Polymer Science, University of Madras (1983)
	Member	Selection Committee for Dunlop Award given on a national basis (1983)
	Member	Evaluation Committee, Maharashtra Gas Cracker Complex and Salimpur Complex, Ministry of Petroleum (1982-85)
	Chairman	Committee to evaluate CIPET (Madras) as a post-graduate education centre (1983)
	Member	Expert Committee to evaluate SASMIRA's fibre pilot plant, Ministry of Industry (1983)
	Member	National Co-ordination for Polymer Science and Engineering R & D plan for the seventh five year plan of CSIR (1984)
	Member	Research Advisory Committee, IPCL, (Baroda) 1984)
	Member	Research Consultative Committee, HAL, Pune (1984)
	President	Society for Polymer Science in India (1984-85)

Scientist	Capacity	Committee
9. Dr. R. B. Mitra	Member	Development Council for Organic Chemicals constituted by the Ministry of Petroleum and Chemicals, New Delhi,
	Member	Central Insecticides Board, Faridabad
	Member	Research Advisory Council, RRL, Jorhat
10. Dr. V. M. Nadkarni	Member	Technology Selection Team for Maharashtra Gas Cracker complex, Oil Industry Development Board, Ministry of Petroleum
	Member	ISI Committee on (i) Plastic Pipes Sub-Committee and (ii) Chemical Engineering Selection Committee
	Member	Metallurgical and Chemical Engineering Research Sub-Committee, Central Board of Railway Research, Ministry of Railways
11. Dr. U. R. Nayak,	Member	Sub-Committee of the Development Committee for Oleoresins, Gums and Essential Oils.
	Member	Sub-Committee on Synthetic Perfumery Materials—PCDC
12. Dr. P. K. Ranjekar	Member	Executive Committee of Society of Biological Chemisls of India
	Member	Executive Committee of Indian Society of Cell Biology
13. Dr. A. V. Rama Rao	Member	Maharashtra Board of Research in Ayurveda
	Member	Editorial Board of Indian Journal of Chemistry
	Member	Organic Chemicals Sub-Committee (ICMA)
	Member	Advisory Committee for the Regional Sophisticated Instrumental Centre
	Member	Board of Studies in Applied Chemistry, University of Cochin
	Member/ Group Leader	Sub-Committee for Forest Product Research, Dept. of Science and Technology — Science Advisory Committee to the Cabinet (SACC)
14. Dr. V. J. Rao	Member	National Advisory Committee of the International conrence on the physics and technology of compensated semi-conductor held at IIT, Madras
15. Dr. P. Ratnasamy	Member	Editorial Board of the Fuel Science and Technology Journal brought out by CFRI, Dhanbad
16. Dr. S. C. Sethi	Member	Natural and Synthetic Perfumery Materials Sectional Committee, PCDC 18, ISI, New Delhi
17. Dr. M. S. Setty	Member	Screen Printing Association of India, Bombay
	Member	Ad-hoc Committee on International Society for Hybrid Microelectronics Grade, Inst. of Engineers India, Calcutta (Bangalore Chapter)
18. Dr. A. P. B. Sinha	Member	Materials Research Committee, Dept. of Atomic Energy
19. Dr. M. C. Srinivasan	Nominated Member	World Federation of culture collections specialist committee on Endangered culture collections
20. Dr. R. Tewari	Member	Regional Computer Centre Users Committee, NCL nominee

8.6 Post-Graduate degrees received by NCL Staff members and research fellows/guest workers

Sr. No.	Name	Degree	University	Subject of thesis	Guide
1	2	3	4	5	6
1.	Mr. K. R. Acharya	Ph. D.	Bangalore	Crystal structure analysis of antibiotics organic compounds by X-ray methods	*Dr. D. S. Bakegowda Bangalore
2.	Mr. K. S. Balaraman	Ph. D. (Chem. Eng.)	IIT Bombay	Studies in polymerization reactors	Dr. R. A. Mashelkar & *Prof. K. P. Madhavan, IIT Bombay
3.	Mr. R. B. Bambal	Ph. D.	Bombay	Reactions of organic azides	Dr. N. R. Ayyangar
4	Mr. A. Basu	Ph. D.	Poona	Studies on structure-function relationships of K. aerogenes citrate lyase	Dr. C. Siva Raman
5	Mr. K. S. Bhat	Ph. D.	Poona	Studies on (1) biologically active compounds and their analogues	Dr. A. S. Rao
6	Mrs. V. S. Bhat	Ph. D.	Poona	Studies in natural products	Dr. D. D. Nanavati
7.	Mrs. Mrinal Bhave	Ph. D.	Poona	Genome organization in plants with special reference to four cucurbitaceae species	Dr. P. K. Ranjekar
8.	Mr. R. B. Borade	Ph. D.	Poona	Synthesis and characterization of ZSM-5 type zeolites	Dr. (Miss) S. B. Kulkarni
9.	Miss K. H. Chandavar	Ph. D.	Poona	Alkylation reactions of aromatic hydrocarbons over ZSM-5	Dr. (Miss) S. B. Kulkarni
10.	Mr. S. Chidambaram	M. Sc.	Poona	Confirmational transitions in polymethacrylic acid	Dr. S. Gundiah
11.	Mr. V. R. Chumbhale	M. Sc.	Poona	Physico-chemical characterization of ZSM-5 type Zeolities	Dr. (Miss) S. B. Kulkarni
12.	Mrs. V. S. Dalvi	M. Lib. I. Sc.	Poona	Information seeking habits of the scientists at NCL	*Prof. M. R. Riswadkar
13.	Miss M. D. Deo	M. Sc.	Poona	Studies in chromatrography	Dr. N. R. Ayyangar
14.	Mr. A. R. A. S. Deshmukh	Ph. D.	Poona	Transformations of (+) -3-carene synthesis of pyrethroids	Dr. R. B. Mitra

1	2	3	4	5	6
15.	Mr. M. D. Deshpande	M. Sc.	Poona	Studies in polyurethane elastomers	Dr. N. D. Ghatge
16.	Mr. S. Devotta	M. Sc.	Salford	Heat pumps and their applications	*Prof. F. A. Holland
17.	Mr. G. S. Grover	Ph. D.	Poona	Studies in transition metal complex catalyzed reactions: oxidation of olefins	Dr. R. V. Chaudhari
18.	Mr. P. K. Gupta	Ph. D.	Poona	Biochemical studies on plant tissue culture	Dr. A. F. Mascarenhas
19.	Mr. R. J. Hegde	Ph. D.	Poona	ESCA study on dilute tin alloys	Dr. A. P. B. Sinha
20.	Mr. B. B. Idage	Ph. D.	Poona	Studies in hydroxyl terminated polybutadienes	Dr. N. D. Ghatge
21.	Miss Rama Iyer	M. Sc.	Poona	Growth of plant cells	Dr. A. F. Mascarenhas
22.	Mr. J. Y. Jadhav	Ph. D.	Poona	Studies in synthesis of (i) Organosilicon diisocyanate Polyimides and polymides, (2) Polyurethane polymers	Dr. N. D. Ghatge
23.	Mr. P. B. Jadkar	M. Sc.	Shivaji	Studies of some design parameters for butenediol process	Dr. R. V. Chaudhari
24.	Mr. S. M. Jagadale**	Ph. D.	Poona	Studies in polymerization of acrylamide, modified acrylamides and polymeric therefrom	Dr. N. D. Ghatge
25.	Mr. S. G. Joshi	Ph. D.	Poona	Studies in chlorocarboxlation of polythylene	*Dr. R. M. Joshi
26.	Mr. S. V. Joshi	Ph. D.	Bombay	Studies in disperse dyes	Dr. N. R. Ayyangar
27.	Mr. S. V. Kamath	Ph .D.	Karnataka	Synthetic studies in drugs and their intermediates	Dr. S. N. Kulkarni
28.	Mr. R. G. Kelkar	Ph. D,	Poona	Reactions of hydroxyl radicals with olefins	Dr. H. R. Sonawane
29.	Mr. B. M. Khan	M. Phil	Aligarh	Studies on nitrate metabolizing enzymes	Dr. J. C. Sadana
30.	Mr. D. D. Kulkarni	M. Sc.	Poona	Studies on plant tissue culture	Dr. A. F. Mascarenhas
31.	Mr. V. M. Kulkarni	M. Sc.	Poona	Studies on plant tissue culture	Dr. A. F. Mascarenhas

1	2	3	4	5	6
32.	Mr. V. S. Kulkarni	Ph. D.	Poona	Studies on some mixed monomolecular film properties of n-long chain alcohols, n-alcoxy ethanols and propanols	Dr. S. S. Katti
33.	Mrs. V. A. Kumar	Ph. D.	Poona	Optical induction	Dr. V. N. Gogte
34.	Mr. J. B. Lamture	Ph. D.	Poona	Studies in phytochemistry sesquiterpenes of *Pinus longifolia*	Dr. U. R. Nayak
35.	Mr. N. R. Meshram	Ph. D.	Poona	Toluene disproportionation and transalkylation with C9 aromatics over ZSM-5 zeolites	Dr.(Miss) S.B. Kulkarn
36.	Mr. Jaweed Mukarram	Ph. D.	Poona	Total synthesis of (±) 4-demethoxy-daunomycinone	Dr. A. V. Rama Rao
37.	Mrs. R. S. Nadgauda	Ph. D.	Poona	Biochemical studies on plant tissue culture	Dr. A. F. Mascarenhas
38.	Miss S. Nair	Ph. D.	Poona	Studies on plant tissue culture	Dr. A. F. Mascarenhas
39.	Mr. A. D. Natu**	Ph. D.	Poona	Autoxidation of cyclo-alkenes	Dr. S. C. Sethi
40.	Mr. V. S. Nayak	Ph. D.	Poona	Studies in synthetic zeolites	Dr. V. R. Chaudhary
41.	Mr. Sourav Pal	Ph. D.	Calcutta	Studies on some aspects of coupled cluster method in quantum chemistry	*Dr. D. Mukherjee
42.	Mr. D. G. Panse	Ph. D.	Poona	Application of synthetic stationery substrates in Gas-liquid chromatography	Dr. B. B. Ghatge
43.	Mr. M. D. Panse	M. Sc.	Poona	Photo chemistry of some organic compounds	Dr. H. R. Sonawane
44.	Mr. M. G. Parande	M. Sc. (Chem. Engg.)	Salford UK	Studies of heat pumps assistance distillation	*Prof. F. A. Holland
		Ph. D.	Poona	Reaction engineering studies in a slurry reactor	Dr. P. H. Brahme
45.	Mr. S. G. Pataskar	Ph. D.	Poona	Studies on thermal decomposition of solids in catalyst preparation	Dr. V. R. Chaudhary

1	2	3	4	5	6
46.	Mr. A. S. Patil	M. Sc.	Shivaji	Studies in vinyl polymerization using glycidyl methacrylate (Blemmer-G)	Dr. N. D. Ghatge
47.	Mr. G. Prakash Babu	Ph. D.	Poona	Reactions of aromatic hydrocarbons over ZSM-5 zeolites	Dr. (Miss) S. B. Kulkarni
48.	Mrs. V. G. Puranik**	Ph. D.	Bangalore	X-ray analysis of some crystal structure	*Dr. (Mrs.) K. Vijayan
49.	Mr. P. C. Purohit	Ph. D.	Poona	Photochemistry of some organic molecules	Dr. H. R. Sonawane
50.	Mr. M. V. Rangaishenvi	Ph. D.	Poona	Synthetic studies in terpenes	Dr. S. N. Kulkarni
51.	Mr. J. V. Rao	Ph. D.	Osmania	Studies on some toxicological parameters of certain pesticides on Albino rat	*Dr. S. H. Qadri
52.	Mr. K. Ravichandran	Ph. D.	Bombay	Synthesis of some biologically active compounds	Dr. A. V. Rama Rao
53.	Mr. K. Bal Reddy	Ph. D.	Poona	Studies directed towards the total synthesis of anthracyclines	Dr. A. V. Rama Rao
54.	Mr. N. Laxma Reddy	Ph. D.	Poona	Studies directed towards the total synthesis of anthracyclines	Dr. A. V. Rama Rao
55.	Mr. D. Rajagopala Reddy	Ph. D.	Poona	Studies directed towards the total synthesis of anthracyclines	Dr. A. V. Rama Rao
56.	Mr. M. B. Sabne	Ph. D.	Poona	Studies in cellulose: Modification of cellulose ester for use in desalination	Dr. N. D. Ghatge
57.	Mr. M. G. Sane	M. Sc.	Salford	Study of absorption systems for coating, heating and simultaneous coating and heating	*Prof. F. Holland
58.	Mr. K. M. Sathaye	Ph. D.	Poona	Isolation and synthesis of some biologically active compounds	Dr. A. V. Rama Rao

1	2	3	4	5	6
59.	Mr. M. S. Setty	Ph. D.	Poona	Study of electrical, structural and optical properties of thick films of $Cd_2 SnO_4$	Dr. A. P. B. Sinha
60.	Mr. G. V. Madhava Sharma	Ph. D.	Poona	Macrolides	Dr. A. V. Rama Rao
61.	Miss H. R. Shitole	Ph. D.	Poona	Studies in isoprenoids newer aspects of longifolene	Dr. U. R. Nayak
62.	Mr. P. G. Shukla	M. Sc.	Poona	Encapsulation of carbofuran using starch matrix	Dr. N. D. Ghatge
63.	Mrs. B. Sinha	Ph. D.	Poona	Studies in carbohydrates and lipid associates of leguminaceae	Dr. D. D. Nanavati
64.	Miss Laxmi Sivaraman	Ph. D.	Poona	Genome characterization in plants with special reference to four millet species	Dr. P. K. Ranjekar
65.	Mr. K. R. Srinivasan	Ph. D.	Poona	Some applications of gas chromatographic techniques in catalysis	Dr. V. R. Choudhary
66.	Mr. K. V. Sirnivasan	Ph. D. (Tech.)	Bombay	Novel organic intermediates and reaction-an analytical approach	Dr. N. R. Ayyangar
67.	Miss S. Subramanian	Ph. D.	Poona	Microbial enzymes-studies on citrate lyase from K. aerogenes and E. Coli	Dr. C. Siva Raman
68.	Mrs. V. S. Tare	M. Sc.	Poona	Pest control potential of the oils from mohwa. neem, etc.	Dr. R. N. Sharma
69.	Mr. P. P. Wadgaonkar	Ph. D.	Poona	Studies in (i) telechelic diene polymers, (i) Silicon containing polyimides	Dr. N. D. Ghatge
70.	Mr. P. Yadagiri	Ph. D.	Poona	Synthesis of some biologically active componds	Dr. A. V. Rama Rao

* Guide not from NCL ** Guest Worker

8·7 NCL Scientists recognised by different universities as research guides

1.	Dr. Ayyangar, N. R.	Bombay, Poona
2.	Dr. Brahme, P. H.	Poona
3.	Dr. Chaudhari, R. V.	Poona, Shivaji
4.	Dr. Chaudhary, V. R.	Poona, Shivaji
5.	Dr. Damodaran, V.	Poona, Shri Venkateswara
6.	Dr. Date, S. K.	Poona
7.	Dr. Deshpande V. H.	Poona
8.	Dr. Doraiswamy, L. K.	Banaras, Bombay, Calcutta, Jadhavpur, Nagpur, Poona Salford (UK)
9.	Dr. Ghatge, B. B.	Poona, Shivaji
10.	Dr. Gogte, V. N.	Poona, Shivaji
11.	Dr. Gokarn, A. N.	Poona
12.	Dr. Gopinathan, C.	Marathwada, Poona
13.	Dr. Gundiah, S.	Karnataka, Poona
14.	Dr. Harish Narain	Shivaji
15.	Dr. Jose, C. I.	Poona
16.	Dr. Katti, S. S.	Bombay, Poona
17.	Dr. Krishnamurthy, K. V.	Poona, Shri Venkateswara,
18.	Dr. Kulkarni, B. D.	Poona
19.	Dr. Kulkarni, G. H.	Nagpur, Poona
20.	Dr. Kulkarni, S. N.	Bombay, Karnataka, Poona, Shivaji
21.	Dr. Mascarenhas, A. F.	Poona
22.	Dr. Mashelkar, R. A.	Banaras, Bombay, Nagpur, Poona, Salford (UK)
23.	Dr. Mitra, R. B.	Bombay, Poona
24.	Dr. Nagasampagi, B. A.	Poona
25.	*Dr. Nair, P. M.	Andhra, Poona, Shivaji
26.	Dr. Nayak, U. R.	Poona, Shivaji
27.	Dr. Pansare, V. S.	Poona

28.	Dr. Panse, G. T.	Poona, Shivaji
29.	Dr. Pant, L. M.	Poona
30.	Dr. Patwardhan, V. S.	Poona, Shivaji
31.	Dr. Rama Rao, A. V.	Bombay, Kakatia, Poona, Shivaji, Vankateswara
32.	Dr. Ranjekar, P. K.	Poona, Shivaji
33.	Dr. Rao, A. S.	Bombay, Poona, Shivaji
34.	Dr. Ravindranathan, T	Bombay, Marathwada, Shivaji, Poona
35.	Dr. Roy-Chowdhury, P.	Marathwada, Poona, Shivaji
36.	*Dr. Sadana, J. C.	Aligarh, Poona
37.	Dr Sethi, S. C.	Poona
38.	Dr. Sharma, R. N.	Poona Shivaji
39.	Dr. Sinha, A. P. B.	Banaras, Bombay, Poona. Shivaji
40.	*Dr. Siva Raman, C.	Poona
41.	Dr. Sonawane, H. R.	Marathwada, Poona
42.	Dr. Srinivasan, M. C.	Poona, Shivaji
43.	Dr. Tewari, R.	Poona,
44.	Dr. Umapathy, P.	Poona
45.	Dr. Varma, A. J.	Poona
46.	Dr. Vartak, H. G.	Poona, Shivaji
47.	Dr. Vernekar, S. P.	Poona, Shivaji
48.	Dr. Yadav, J. S.	Poona, Shivaji

* Retired/Emeritus Scientists.

□ □

9. PAPERS PRESENTED AT SYMPOSIA, SEMINARS, ETC.

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Synthesis and characterization of isocyanate-terminated polybutadiene prepolymers,
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90. Ghatge, N. D., Sabne, M. B., Gujar, K. B. and Mahajan, S. S.,
Modification of cellulose acetate by aliphatic isocyanates,
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91. Gopichand, S. and Patwardhan V. S.
Heat pumps for energy saving in ethanol distillation,
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PATENTS IN FORCE AS ON 31-3-1984

Indian patents sealed

1. 148132
   A process for the preparation of new yellow naphthoquino-quinazoline dione disperse dyes for polyester fibres.
   Ayyanagr, N. R., Deshpande, R. J. and Wagle, D. R.

2. 149249
   An improved apparatus for the simultaneous determination of carbon, hydrogen, and halogen or sulphur in organic matter, coke and coal, steel and like materials.
   Malvankar, R. B., Ramdasi, S. S. and Pansare, V. S.

3. 150165 (750/DEL/78)
   A process for the preparation of new violet naphthostyril cationic dyes for application to polyacrylonitrile fibres.
   Ayyangar, N. R., Lahoti, R. J. and Wagle, D. R.

4. 150166
   A process for the preparation of new violet naphthostyril disperse dyes for polyester fibres.
   Ayyangar , N. R. , Lahoti, R. J. and Wagle, D. R.

5. 150391 (761/DEL/78)
   Synthesis of a new insecticide belonging to the synthetic pyrethroids group.
   Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D., Khanra, A. S., Choudhari, P. N. and Bhawal, B. M.

6. 150470 (958/DEL/78)
   A new process for the preparation of *cis*-caronic acid from 4-∝-acetyl-cer-2-ene.
   Mitra, R. B., Kulkarni, G. H., Gore, K. G., Khanna, P. N., Joshi, G. D. and Khanra, A. S.

7. 150474 (793 / DEL / 78)
   Improvements in or relating to the preparation and sintering of manganous zinc ferrous ferrite,
   Murthy, M. N. S., Deshpande, C. E., Bakare, P. P. and Shrotri, (Mrs.) J. J.

8. 151660 (347/DEL/79)
   A novel process for recovery of D (+) camphor-sulphonic acid during the resolution of DL-phenylglycine.
   Mitra, R. B., Joshi, B. N., Hinge, V. K. and Natekar (Miss), M. V.

Indian patent applications accepted

1. 152306 (411/DEL/79)
   Process for the preparation of 3-phenoxybenzyl 1R-cis-2, 2-dimethyl-3 –(2-cyanoprop-1-enyl) cyclopropane carboxylate,
   Mitra, R. B., Kulkarni G. H., Muljiani, (Miss) Z. and Khanna, P. N.

2. 153336 (717/DEL/79)
   A new process for the preparation of 1R-cis-2, 2-dimethyl-3- (2-oxopropyl) cyclopropane carboxylic acid, an important intermediate in the synthesis of insecticides of the synthetic pyrethroids group by oxidation of 3,6,6, trimethyl, 4-formyl (3, 1, 0)-bicyclo-hex-3-ene, using suitable oxidising agents,
   Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani, (Miss) Z., Khanna, P. N., Joshi, G. D. and Bhawal, B. M.

Indian patent applications filed

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

2. 702/DEL/79
   A process for the reactive dyeing of cellulosic fibres by the application of 6-cyano-7-methyl-oxazolo (3, 2-a) pyrid-5 (4H)-one followed by treatment with diazonium salts.
   Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

3. 703 / DEL / 79
   A process for the preparation of new yellow to blue azopyrid-2-ene pendant cationic dyes for acrylic fibres.
   Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

4. 704 / DEL / 79
   A process for the preparation of new yellow to red azoarylimidazopyridone disperse dyes for synthetic fibres.
   Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

5. 798/DEL/79
   Process for the preparation of ∝-cyano-3 ∝-phenoxybenzyl 1-R-cis 2, 2-dimethyl-3 (2-chloroprop-1-enyl) cyclopropane carboxylate, a new insecticide belonging to the synthetic pyrethroids group.
   Mitra, R. B., Kulkarni, G. H., Gore, K. G. Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D. and Bhawal, B. N.

6. 869/DEL/79
   A process for the isolation of a fraction from neem extract enriched with active principle exhibiting oviposition deterrent and anti-feedant activity against potato tuber moth.
   Nagasampagi, B. A., Sharma, R. N., Kulkarni, (Miss) M. M., Bhosale, A. S. and Tungikar, V. B.,

7. 922/DEL/79
   A process for the preparation of new yellow to violet azo disperse dyes derived from moreholinonanphthalenes for appliation to synthetic fibres.
   Ayyangar. N. R., Moghe, P. P. and Tilak, B. D.

8. 942/DEL/79
   Process for the preparation of a novel controlled release mosquito larvicide.
   Das, K. G., Mirajkar, S. P. and Tungikar, V. B.

9. 949/DEL/79
   A process for the preparation of new blue azo-disperse dyes from 3-chloro-1, 2, 3, 4-tetra-hydro-7, 8-benzoquilione and the iscmeric 2-(chloromethyl) - berze (g) indoline for the application of synthetic fibres.
   Ayyanagar, N. R., Moghe, P. P. and Tilak, B. D.

10. 950/DEL/79
    A process for the preparation of blue naphtho-styril cationic dyes.
    Ayyangar, N. R., Moghe, P. P. and Tilak B. D.

11. 91/DEL/80
    An improved chemical process for the manufacture of high alpha cellulose pulp from naturally occurring cellulosic materials.
    Bendale, D. S., Mahajan, M. B. and Karnik, R. S.

12. 208/DEL/80
    A new process for the preparation of 2, 2-dimethyl-3- (2 oxopropyl)- cyclopropane acetic acid, an important intermediate in the synthesis of chrysanthemic acid and synthetic pyrethroid insecticides.
    Mitra, R. B., Hinge, V. K. and Khanra, A. S.

13. 378/DEL/80
    A process for the selective isolation of vinblastine sulphate from the leaves of *Vinca* rosea (*Catharanthus roseus* G. Don).
    Rama Rao, A. V., Venkatswamy, G., Sathaye, K. M. and Yadagiri P.

14. 425/DEL/80
    An improved method for the preparation of 1R-*cis*-2, 2-dimethyl-3-(2-hydroxy-2-carboxypropyl) cyclopropane carboxylic acid from car-4-ene-3-ol.
    Mitra, R. B., Kulkarni, G. H., Muljiani, (Miss) Z. Naik, V. G. and Deshmukh, A. R. A. S.

15. 426/DEL/80
    A method for the preparation of Y-lactone of 1R-*cis*-2, 2-dimethyl-3-hydroxymethyl cyclopropane carboxylic acid from methyl 1R-*cis*-2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylate.
    Mitra, R. B., Kulkarni, G. H., Khanna, P. N. and Joshi, G. D.

16. 444/DEL/80
    A process for the manufacture of sodium hydrosulphate via ferrous hydrosulphite.
    Gopinathan, C., Gopinathan, (Mrs.) S., Unny, I. R., Awasarkar, P. A., Pandit, S. K., Pardhy, (Mrs.) S. A., Chatterjee, A. K. and Sonsale, A. Y.

17. 453/DEL/80
    A new process for the preparation of 1R-*cis*-2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides,
    Mitra, R. B., Joshi, G. D. and Khanra, A. S.

18. 512/DEL/80
    A new route for the preparation of 1R, *cis*-2 2-dimethyl-3-(2-oxopropyl) cyclopropanecarboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides.
    Mitra, R. B. and Khanra, A. S.

19. 581/DEL/80
    Catalyst and process for the conversion of alcohol to hydrocarbons.
    Kulkarni (Miss), S. B. Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.). A. J. and Kotasthane, A. N.

20. 599/DEL/80
A process for the preparation of new yellow naphthoquinoquinazolinedione disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

21. 663/DEL/80
A process for the isolation of active principles from the plant *Lavendula gibsoni* (*L. perottetii* Benth; family Lamiaceae) exhibiting antigonadial, antifeedant oviposition deterrent, repellent and ovicidal activities against insect pests,
Gupta, A.S., Sharma, R.N., Patwardhan, (Mrs.) S.A., Bhosale, A.S., Zadu (Miss), G.V., Nadkar, R.Y. and Nanda, B.

22. 669/DEL/80
Catalyst and process for the selective conversion of ethylene into aromatic hydrocarbons containing 6 to 8 carbon atoms.
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

23. 732/DEL/80
Catalyst and process for the alkylation of benzene to ethylbenzene.
Ratnasamy, A., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

24. 843/DEL/80
A process for the preparation of catalyst.
Kulkarni (Miss), S. B., Ratnasamy, P., Kotasthane A. N., Chandwadkar, (Mrs.), A. J., Babu, G. P. and Chandavar, K. H.

25. 900/DEL/80]
Improved process for the conversion of toluene to xylenes.
Kulkarni (Miss), S. B. Ratnasamy, P., Kotasthane, A. N., Chandwadkar, (Mrs.), A. J. Babu, G. P. and Chandavar, K. H.

26. 290/DEL/81
Process for the catalytic conversion of alkylaromatic hydrocarbons into paraxylenes,
Ratnasamy, P., Kulkarni (Miss), S. B., Rao, B.S., Kotasthane, A. N., Chandwadkar, (Mrs.), A. J. Kulkarni, S. J. and Hegde, S. G.

27. 291/DEL/81
Process for the preparation of a catalytic composite material.
Kulkarni (Miss), S. B. Ratnasamy, P., Shiralkar, V. P., Balakrishnan, I. and Kavedia, C. V.

28. 630/DEL/81
Improved process for the disproportionation of toluene to benzene and xylene.
Ratnasamy, P., Kulkarni (Miss), S. B. Babu, G. P., Chandavar, K. H., Balakrishnan, I. and Shiralkar, V. P.

29. 668/DEL/81
A process for the preparation of polyamides,
Ghatge, N. D. and Mullick, U. P.

30. 702/DEL/81
A process for the preparation of improved cellulose acetate.
Ghatge, N. D., Sabne, M. B. and Gujar, K. B.

31. 703/DEL/81
Improved process for the preparation of ethyl -α-(carbethoxy)-β-(substituted anilino) acrylates.
Ayyangar, N. R., Jinaraj, V. K., Lahoti, R. J. and Danial, T.

32. 707/DEL/81
An improved process for the preparation of aromatic hydrocarbons from ethyl alcohol in a single step conversion.
Kulkarni, (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar, (Mrs.) A. J. and Kotasthane, A. N.

33. 804/DEL/81
Process for the synthesis of new 3, 6-diaryl-3-4 dihydro 1, 3, 2-oxazaphosphorin-2-oxides.
Tilak, B. D., Gogte, V. N. and Modak, A. S.

34. 21/DEL/82
Process for the preparation of improved composite catalyst material.
Kulkarni, (Miss) S. B. Ratnasamy, P., Balakrishnan, I., Kulkarni, S. J. and Borade, R. B.

35. 44/DEL/82
An improved process for the catalytic alkylation of benzene to ethylbenzene.
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P. Babu, G. P. and Chandavar, K. H.

36. 78/DEL/82
An improved process for the preparation of substituted aromatic diamines.
Ghatge, N. D. and Maldar, N. N.

37. 96/DEL/82
A novel device for solar thermal conversion in which fluid is used as an absorbing medium.
Sathaye, S. D., Potdar, H. S., Soni, H. S. and Sinha, A. P. B.

38. 476/DEL/82
An improved process for the preparation of N-Alkyldiisopropanolamines.
Nerlekar, P. G. and Moghe, P. P.

39. 478/DEL/82
A process for the preparation of stable manganous oxide (MnO).
Murthy, M. N. S., Deshpande, C. E., Bakare, P. P. and Shrotri, (Mrs) J. J.

40. 66 /DEL/82
A process for the synthesis of (+) 4-demethoxy-7-deoxydaunomycinone - A key intermediate for the manufacture of 4-demethoxydaunomycin, an anttiumor compound.
Rama Rao, A. V., Chanda, B. and Borate, H. B.

41. 670/DEL/82
An improved process for the preparation of thermoplastic polyurethane polymers.
Ghatge, N. D. and Jadhav, J. Y.

42. 57/DEL/83
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reactions.
SivaRaman, H., Rao, B. S., Shanker, V., Pundle, A. V. and SivaRaman, C.

43. 58/DEL/83
A catalytic process for the conversion of methanol to olefins.
Kulkarni, (Miss) S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Shiralkar, V. P., Hegde, S. G. and Kotasthane, A. N.

44. 60/DEL/83
An improved process for the production of pyridoxine hydrochloride (Vitamin B_6)
Rama Rao, A. V., Joshi, C. G., Rao., M. N. and Sathe, V. M.

45. 115/DEL/83
A process for the preparation of composite catalyst material.
Kulkarni, (Miss) S. B., Ratnasamy, P., Balakrishnan, I., Shiralkar, V. P., Kotasthane, A. N., Rao, B. S. and Borade, R. B.

46. 140/DEL/83
A process for the preparation of car-4-ene-3-ol an intermediate for use in the synthesis of pyrethroid insecticides.
Mitra, R. B., Muljiani, (Miss), Z and Deshmukh, A. R. A. S.

47. 275/DEL/83*
Process for the preparation of crystalline catalyst composite material designated encilite.
Ratnasamy. P., Borade, R. B., Kulkarni, (Miss) S. B. and Hegade, S. G.

48. 296/DEL/83*
A process for the preparation of homogeneous metal chiral ligands catalysts using natural alkaloids.
Gogate, V. N., Natu, A. A. and Ahuja, R. R.

49. 370/DEL/83*
Process for the catalytic conversion of methanol to hydrocarbons mainly olefins.
Ratnasamy, P., Kulkarni, (Miss) S. B., Balakrishnan, I., Rao., B. S., Shiralkar, V. P., Hegde, S. G. and Borade, R. B.

50. 437/DEL/83*
A process for the conversion of alkanols to hydrocarbons.
Ratnasamy, P., Balakrishnan, I. and Rao, B. S.

51. 539/DEL/83*
A novel process for the preparation of isocyanate terminated Telechelic) diene prepolymers by free radical polymerization technique.
Ghatge, N. D., Vernekar, S. P. and Vadgaonkar, P. P.

52. 585/DEL/83*
An improved process for the preparation of 4-amino-3-nitrobenzophenone with or without alkyl substituents.
Ayyangar, N. R., Lahoti, R. J. and Thomas, D.

53. 628/DEL/83*
A process for the manufacture of benezene and xylenes admixtures from alkyl aromatic hydrocarbons.
Ratnasamy, P., Kulkarni, (Miss) S. B., Meshram N. R. and Hegde, S. G.

54. 115/DEL/84* .
A process for the preparation of 2, 2-dimethyl -3- (n-propyl) cyclopropane acetic acid by reaction of hydrazine hydrate with 2, 2-dimethyl-3- (2-oxopropyl) cyclopropane acetic acid.
Mitra, R. B., Joshi, B. N., Natekar, (Miss) M. V., Arable, A. A. and Shinde, D. D.

55. 116/DEL/84*
A process for the preparation of substituted alkyl, cyclohexyl, cyclohexylalkyl, aralkyl, aryloxyalkyl esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid by trans-esterification.
Mitra, R. B., Joshi, B. N., Natekar, (Miss) M. V., Arable, A. A. and Shinde, D. D.

56. 191/DEL/84*
Preparation of substituted alkyl cyclohexyl, cyclohexyalkyl/aryl, arakyl, esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid and 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid derived from (+) 3-carene as potential miticides by the reaction with thionyl chloride.

*** These applications were newly filed during the year.**

Foreign patent application sealed

1. U. K. Patent Application No. 7935813
New pyrethroid (corresponds to the Indian Patent Application No. 761/DEL/78-Synthesis of a new insecticide belonging to the synthetic pyrethroids group).
Mitra, R. B., Kulkarni.. G. G., Gore, K. G., Muljiani, (Miss) Z., Khanna, P. N., Joshi, G. D., Khanra, A. S. and Bhawal B. M.

Foreign patent application filed

1. Netherland Patent Application No. 79.07332 Werkwijze on insecticiden uit de pyrethoide-group to bereiden (corresponds to the Indian Patent Application No. 761/DEL/78-Synthesis of a new insecticide belonging to the synthetic pyrethroids group).
Mitra. R. B., Kulkarni, G. H., Gore, K. G., Muljiani, (Miss) Z., Khanna, P. N., Joshi, G. D., Khanra, A. S. and Bhawal, B. M.

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

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

Indian patent applications accepted

1. 153415 (869/DEL/79)
A process for the isolation of a fraction from neem extract enriched with active principle exhibiting ovipositon deterrent and anti-fedant activity against potato tuber moth.
Nagasampagi, B. A., Sharma, R. N., Kulkanri (Miss), M. M., Bhosale, A. S. and Tungikar, V. B.

2. 153460 (798/DEL/79)
Process for the preparation of ∝-cyano-3-phenoxy-benzyl 1-R-cis-2, 2-dimethyl-3-(2-chloroprop-1-enyl) cyclopropane carboxylate, a new insecticide belonging to the synthetic pyrethroids group.
Mitra, R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D. and Bhawal, B. M.

3. 153587 (942/DEL/79)
Process for the preparation of a novel controlled release mosquito larvicide.
Das, K. G., Mirajkar, S. P. and Tungikar, V. B.

4. 153634 (91/DEL/80)
An improved chemical process for the manufacture of high alpha cellulose pulp from naturally occurring cellulosic materials.
Bendale, D. S. Mahajan, M. B. and Karnik, R S.

5. 153878 (208/DEL/80)
A new process for the preparation of 2, 2-dimethyl-3-(2-oxopropyl)-cyclopropane acetic acid, an important intermediate in the synthesis of chrysanthemic acid and synthetic pyrethroid insecticides.
Mitra, R. B. Hinge, V. K. and Khanra, A. S.

6. 154233 (950/DEL/79)
A process for the preparation of blue naptho-styril cationic dyes.
Ayyangar, N. R., Moghe, P. P. and Tilak, B. D.

7. 154331 (378/DEL/80)
A process for the selective isolation of vinblastine sulphate from the leaves of *Vinca rosea* (*Catharanthus roseus* G. Don.)
Rama Rao, A. V., Venkatswamy, G., Sathaye, K. M. and Yadagiri, P.

8. 154394 (453/DEL/80)
A new process for the preparation of 1R-cis-2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides.
Mitra, R. B., Joshi, G. D. and Khanra, A. S.,

9. 154396 (512/DEL/80)
A new route for the preparation of 1R, *cis*-2-2-dimethyl-3-(2-oxopropyl) cyclopropanecarboxylic acid, an important intermediate for the synthesis of pyrethroid insecticides.
Mitra, R. B. and Khanra, A. S.

10. 154460 (318/DEL/78)
A process for the preparation of new yellow to violet azo-N-substituted homophthalimide disperse dyes for synthetic fibres.
Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

11. 154665 (425/DEL/80)
An improved method for the preparation of 1R-*cis*-2, 2-dimethyl-3-(2-hydroxy-2-carboxypropyl) cyclopropane carboxylic acid from car-4-ene-3-ol.
Mitra, R. B., Kulkarni, G. H., Muljiani (Miss), Z., Naik, V. G. and Deshmukh, A. R. A. S.

12. 15466 (426/DEL/80)
A method for the preparation of Y-lactone of 1R--*cis*-2, 2-dimethyl-3-hydroxymethyl cyclopropane carboxylic acid from methyl 1R-*cis*-2, 2-dimethyl-3-(2-oxopropyl) cyclopropane carboxylate.
Mitra, R. B., Kulkarni G. H., Khanna, P. N. and Joshi, G. D.

13. 154667 (444/DEL/80)
A process for the manufacture of sodium hydrosulphate via ferrous hydrosulphite.
Gopinathan, C., Gopinathan (Mrs.) S., Unny, I. R., Awasarkar, P. A., Pandit, S. K., Pardhy, (Mrs.), S. A., Chatterjee, A.K. and Sonsale, A. Y.

14. 154669 (581/DEL/80)
Catalyst and process for the conversion of alcohol to hydrocarbons.
Kulkarni(Miss), S.B., Ratnasamy, P., Balakrishnan I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

15. 154702 (900/DEL/80)
Improved process for the conversion of toluene to xylenes.
Kulkarni (Miss), S. B., Ratnasamy, P., Kotasthane, A. N., Chandwadkar (Mrs), A. J., Babu, G. P. and Chandavar K. H.

16. 155205 (843/DEL/80)
A process for the preparation of catalyst.
Kulkarni (Miss), S.B., Ratnasamy, P., Kotasthane, A. N., Chandwadkar (Mrs.), A. J., Babu, G. P. and Chandavar, K. H.

Indian patent applications filed

1. 702/DEL/79
A process for the reactive dyeing of cellulosic fibres by the application of 6-cyano-7-methyl-oxazolo (3, 2-a) pyrid-5 (4H)-one followed by treatment with diazonium salts.
Ayyanagar, N. R., Rao, U. S. and Tilak, B. D.

2. 703/DEL/79
A process for the preparation of new yellow to blue azopyride-2-one pendant cationic dyes for acrylic fibres.
Ayyangar, N. R., Rao, U. S. and Tilak, B. D.

3. 922/DEL/89
A process for the preparation of new yellow to violet azo disperse dyes derived from morpholinonaphthalenes for application to synthetic fibres.
Ayynagar, N. R., Moghe, P. P. and Tilak, B. D.

4. 949/DEL/79
A process for the preparation of new blue azo disperse dyes from 3-chloro 1, 2, 3, 4-tetra-hydro-7, 8-benzoquinoline and the iscmeric 2-(chloromethyl)-benz-(g)-indoline for the application of synthetic fibres.
Ayyangar, N. R., Moghe, P. P. and Tilak, B. D.

5. 599/DEL/80
A process for the preparation of new yellow naphtho-quinoquinezolinedicne disperse dyes for polyester fibres.
Ayyangar, N. R., Deshpande, R. J. and Wagle, D. R.

6. 663/DEL/80
A process for the isolation of active principles from the plant *Lavendula gibsoni* (*L. Perottetii* Benth; family Lamiaceae) exhibiting anti-gonadial, antifedant, oviposition deterent, repellent and ovicidal activities against insect pests.
Gupta, A. S., Sharma, R. N., Patwardhan (Mrs.), S. A., Bhosale, A. S., Zadu (Miss), G. V., Nadkar, R. Y. and Nanda, B.

7. 669/DEL/80
Catalyst and process for the selective conversion of ethylene into aromatic hydrocarbons containing 6 to 8 carbon atoms.
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

8. 732/DEL/80
Catalyst and process for the alkylation of benezene to ethylbenzene.
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

9. 290/DEL/81
Process for the catalytic conversion of alkylaromatic hydrocarbons into paraxylenes.
Ratnasamy, P., Kulkarni (Miss), S. B., Rao, B. S., Kotasthane, A. Chandwadkar (Mrs), A. J., Kulkarni, S. J. and Hegde, S. G.

10. 291/DEL/81
Process for the preparation of a catalytic composite material.
Kulkarni (Miss), S. B., Ratnasamy, P., Shiralkar, V. P., Balakrishnan, I. and Kavedia, C. V.

11. 630/DEL/81
Improved process for the disproportionation of toluene to benzene and zylene.
Ratnasamy, P., Kulkarni (Miss), S. B. Babu, G. P., Chandavar, K. H., Balakrishnan, I. and Shiralkar, V. P.

12. 668/DEL/81
A process for the preparation of polyamides.
Ghatge, N. D. and Mullick, U. P.

13. 702/DEL/81
A process for the preparation of improved cellulose acetate.
Ghatge, N. D., Sabne, M. B. and Gujar, K. B.

14. 703/DEL/81
Improved process for the preparation of ethyl-α-(carbethoxy)-β (substituted anilino) acrylates.
Ayyangar, N. R., Jinaraj, V. K., Lahoti, R. J. and Danial, T.

15. 707/DEL/81
An improved process for the preparation of aromatic hydrocarbons from ethyl alcohol in a single step conversion.
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Chandwadkar (Mrs.), A. J. and Kotasthane, A. N.

16. 804/DEL/81
Process for the synthesis of new 3, 6-diaryl-3-4 dihydro 1, 3, 2-oxazaphosphorin-2-oxides.
Tilak, B. D., Gogte, V. N. and Modak, A. S.

17. 21/DEL/82
Process for the preparation of improved composite catalyst material.
Kulkarni (Miss), S. B., Ratnasamy P., Balakrishnan, I., Kulkarni, S. J. and Borade, R. B.

18. 44/DEL/82
An improved process for the catalytic alkylation of benzene to ethylbenzene.
Ratnasamy, P., Kulkarni (Miss), S. B., Shiralkar, V. P., Babu, G. P. and Chandavar, K. H.

19. 78/DEL/82
An improved process for the preparation of substituted aromatic diamines.
Ghatge, N. D. and Maldar, N. N.

20. 96/DEL/82
A novel device for solar thermal conversion in which fluid is used as an absorbing medium.
Sathaye, S. D., Potdar, H. S., Soni, H. S. and Sinha, A. P. B.

21. 476/DEL/82
An improved process for the preparation of N-alkyldiso-propanolamine.
Nerlekar, P. G. and Moghe, P. P.

22. 478/DEL/82
A process for the preparation of stable manganous oxide (MnO).
Murthy, M. B. S., Deshpande, C. E., Bakare, P. P. and Shrotri (Mrs.), J. J.

23. 668/DEL/82
A process for the synthesis of (+) 4-demethoxy-7-deoxydaunomycinone-A key intermadiate for the manufacture of 4-demethoxy-daunomycin, an antitumor compound.
Rama Rao, A. V., Chanda (Mrs.), B. and Borate, H. B.

24. 670/DEL/82
An improved process for the preparation of thermoplastic polyurethane polymers.
Ghatge, N. D. and Jadhav, J. Y.

25. 57/DEL/83
Process for the preparation of open pore polymer gel beads with desired entrapped whole cells for use in fermentation reasctions.
Siva Raman (Mrs.), H., Rao, B. S., Shankar, V., Pundle, A. V. and Siva Raman, C.

26. 58/DEL/83
A catalytic process for the conversion of methanol to olefins.
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Rao, B. S., Shirlkar, V. P., Hegde, S. G. and Kotasthane, A. N.

27. 60/DEL/83
An improved process for the production of pyridoxine hydrochloride (vitamin B_6).
Rama Rao, A. V., Joshi, C. G., Rao, M. N. and Sathe, V. M.

28. 115/DEL/83
A process for the preparation of composite catalyst material.
Kulkarni (Miss), S. B., Ratnasamy, P., Balakrishnan, I., Shiralkar, V. P., Kotasthane, A. N., Rao, B. S. and Borade, R. B.

29. 140/DEL/83
A process for the preparation of car-4-ene-3-01 an intermediate for use in the synthesis of pyrethroid insecticides.
Mitra, R. B., Muljiani (Miss), Z. and Deshmukh, A. R. A. S.

30. 275/DEL/83*
Process for the preparation of crystalline catalyst composite material designated Encilite.
Ratnasamy, P., Borade, R. B., Kulkarni (Miss), S. B. and Hegde, S. G.

31. 296/DEL/83*
A process for the preparation of homogeneous metal chiral ligands catalysts using natural, alkaloids.
Gogte, V. N., Natu, A. A. and Ahuja (Miss.), R. R.

32. 370/DEL/83*
Process for the catalytic conversion of methanol to hydrocarbons mainly olefins.
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S., Shiralkar, V. P., Hegde, S. G. and Borade, R. B.

33. 437/DEL/83*
A process for the conversion of alkanols to hydrocarbons.
Ratnasamy, P., Balakrishnan, I. and Rao, B. S.

34. 539/DEL/83*
A novel process for the preparation of isocyanate terminated (Telechelic) diene prepolymers by free radical polymerization technique.
Ghatge, N. D., Vernekar, S. P. and Vadgaonkar, P. P.

35. 628/DEL/83*
A process for the manuafcture of benzene and xylenes admixtures from alkyl aromatic hydrocarbons.
Ratnasamy, P., Kulkarni (Miss), S. B., Meshram, N. R. and Hegde, S. G.

36. 585/DEL/83*
An improved process for the preparation of 4-amino-3-nitrobenzophenone with or without alkyl substituents.
Ayyangar, N. R., Lahoti, R. J. and Thomas, D.

37. 115/DEL/84*
A process for the preparation of 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid by reaction of hydrazine hydrate with 2, 2-dimethly-3- (2-oxopropyl) cyclopropane acetic acid.
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde, D. D.

38. 116/DEL/84*
A process for the preparation of substituted alkyl, cyclohexyl, cyclohexylalkyl, aralkyl, aryloxyalkyl esters of 2, 2-dimethyl-3-(2-oxopropyl) cyclopropane acetic acid by trans-esterification.
Mitra, R. B., Joshi, B. N., Natekar (Miss), M. C., Arabale, A. A. and Shinde, D. D.

39. 191/DEL/84*
Preparations of substituted alkyl, cyclohexyl, cyclohexylalkyl aryl, aralkyl, esters of 2, 2-dimethyl-3-(2-oxoprophyl) cyclopropane acetic acid and 2, 2-dimethyl-3-(n-propyl) cyclopropane acetic acid derived form (+) 3-carene as potential miticides by the reaction with thionyl chloride.
Mitra, R. B. Joshi, B. N., Natekar (Miss), M. V., Arabale, A. A. and Shinde. D. D.

40. 506/DEL/84*
A process for synthesis of 22, 23-dihydroxy-24S-ethyl-3 ∝ 5 cyclo-5∝-cholestan-6-ones from phytosterols of sugarcane wax.
Mitra. R. B., Kapoor (Miss), V. M. and Hazra, B. G.

41. 507/DEL/84*
An improved process for the preparation of monoalkyl esters, of azelaic acid.
Mitra, R. B., Joshi, R. S. and Lunkad, K. F.

42. 537/DEL/84*
An improved process for the preparation of *SYM* N, N' disubstituted diarylurea compounds.
Ayyangar, N. R. and Choudhary, A. R.

43. 587/DEL/84*
A novel process for the manufacture of 2, 4-dichloro-5-pentadecylphenoxy acetic acid.
Amarnath, N., Ghatge, N. D. and Moghe, P. P.

44. 664/DEL/84*
Improvements in or relating to the preparation of 3-methyl-but-2-ene-YL acetate,
Mitra, R. B., Kulkarni, G. H., Joshi, R. S., Khanna P. N., Lunkad, K. F. and Shaha, S. C.

45. 837/DEL/84*
A process for separation of stigmasterol derived products from phytosterols of sugarcane wax.
Mitra, R B., Kapoor (Miss), V. M. and Hazra, B. G.

46. 60/DEL/85*
Process for the preparation of new catalyst composite material useful for conversion of alkanols to hydrocarbons.
Ratnasamy, P., Kulkarni, (Miss) S. B., Kotasthane A. N. and Shiralkar, V. P.

47. 61/DEL/850
Process for the preparation of a catalyst useful for selective conversion of ethylene into aromatic hydrocarbon containing 6-8 carbon atoms.
Ratnasamy, P., Kulkarni (Miss), S. B., Balakrishnan, I., Rao, B. S. and Shiralkar, V. P.

48. 224/DEL/85*
Improvements in or relating to the process for the isolation of useful sterols from sugarcane wax.
Mitra, R. B., and Kapadia, V. H.

49. 251/DEL/85*
A process for preparing base polymer for ion-exchange membranes.
Saini, R., Nadkarni, V. M., Dutta, A., Ghosh, S., Kshirsagar, S. N. and Mashelkar, R. A.

50. 267/DEL/850
A device for obtaining NMR spectra in undeuterated solvents on FT (fourier transform) instruments.
Deshpande K. G.

51. 279/DEL/85*
Process for conversion of methanol to olefins.
Ratnasamy, P., Balakrishnan, I., Rajiv Kumar and S. G. Hegde.

Foreign patent application sealed

U. K. Patent Application No. 7935813
New pyrethroid (corresponds to the Indian Patent Application No. 761/DEL/78-Synthesis of a new insecticide belonging to the synthetic pyrethroids group)
Mitra. R. B., Kulkarni, G. H., Gore, K. G., Muljiani (Miss), Z., Khanna, P. N., Joshi, G. D., Khanra A. S. and Bhawal, B. M.

Foreign Patent applications filed

1. Netherland Patent Application No. 7907332 Werkwijze on insecticiden uit de pyrethoide group to bereiden (corresponds to the Indian Patent Application No. 761/DEL/78-Synthesis of a new insecticide belonging to the synthetic pyrethroids group.
Mitra, R. B. Kulkarni, G., H. Gore, K. G., Muljiani (Miss), Z. Khanna, P. N., Joshi, G. D., Khanra, A. S. and Bhawal, B. M.
2. Algerian patent application no. 7124184**
3. Australian patent application no. 30020/84**
4. Canadian patent application no. 457311**
5. Canadian patent application no. 457310**
6. Canadian patent application no. 45709**
7. East German patent application no. 7036**
8. Egyptian patent application no. 763/84**
9. European patent application no. 84302893**
10. Indonetian patent application no. 10173**
11. Thailand patent application no. 2565**
12. Pakistan patent application no. 251/84**
13. USA patent application no. 06/608172**
14. USA patent application no. 06/608173**
15. USA patent application no. 06/609912**
16. USSR patent application no. 3770903.04**

** These foreign patent applications corresponding to Indian patent applications nos. 275/DEL/83 and 437/DEL/83 were newly filed during the year.

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RESEARCH UTILISATION

TABLE 1: PRODUCTS MANUFACTURED ON THE BASIS OF NCL KNOW-HOW

(T—Metric tons)

Sl. No.	Name of the process/product	Field of utilisation	Name of the manufacturer (Year of commencement of Production)	Production			Capacity installed Nature of release and remarks
				Qty. value Rs. in lakhs		Upto March' 85 Qty. / value Rs. in lakhs	
				1983-84	1984-85		
1	2	3	4	5	6	7	8
1.	Acetanilide	Intermediate	Hindustan Organic Chemicals Ltd., P. O. Rasayani 410 207 (through project engineers R. L. Dalal & Co., Bombay 400 018) (1969)	2097.00 T 554.01	2417.00 T 638.55	25482.49 T 4168.80	2000 T Non-exclusive
2.*	Acrylic acid/ acrylates from acrylonitrile	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., P. O. Petrochemicals, Dist. Baroda-391 346 (1984)	976.00 T 355.00	1677.00 T 609.00	2653.00 T 964.00	
3.	Antipriming compositions	Antipriming in locomotives	Research Designs and Standards Organization M & C Wing, Lucknow 226 011 (1964)	4.00 T 0.48	5.00 T 0.60	169.58 T 16.45	26 T Non-exclusive
4.	Tert-Butyl catechol	Synthetic rubber	Percynic Chemicals, Bombay Silk Mills Bldg., Industrial Estate, Lalbaug, Bombay 400 012 (1972)	7.54 T 9.04	6.15 T 7.37	81.51 T 90.88	50 T Non-exclusive

1	2	3	4	5	6	7	8
5.	Butyl titanate	Varnishes, enamels	Synthochem, 33 A, Laxmibainagar Industrial Estate, Indore 452 006 (1973)	22.96 T 13.78	32.32 T 19.40	266.72 T 138.95	36 T Non-exclusive
6.	Calcium hypophosphite	Pharmaceuticals	Hypophosphite & Co., 79-F, Princess Street, Bombay 400 002 (1967)	—	—	190.00 T 144.30	24 T (Including hypophosphites) Sponsored
7.	Can lining composition	Metal can industry	Arya Chemical Works, 141/2 A, Lenin Sarani, Calcutta 700 013 (1974)	—	—	6.34 T 2.10	500 Kg / day Non-exclusive
8.	Can sealing composition	Metal can industry	—do— (1962)	—	—	587.41 T 44.92	500 kg / day Non-exclusive
9.	Catechol	Pharmaceuticals	Percynic Chemicals, Bombay (1972)	7.80 T 4.68	9.13 T 5.47	81.08 T 48.97	50 T Non-exclusive
10.	Cation exchange resin-styrene DVB base	Demineralization of liquids	Bharat Process & Mechanical Engineers Ltd., Dakhindari, Calcutta 700 048 (1968-69)	—	—	28662.18 Cft 98.39	10000 Cft Non-exclusive
11.	Cationic dyes for acrylic fibres	Dyes for synthetic fibres	Sahydri Dyestuffs & Chemicals, 177 Parvati-Vithalwadi Road, Poona 411 030 (1976)	—	—	123.47 T 140.59	120 T Sponsored
12.	Chlorobenzenes	Industrial chemicals	Hindustan Organic Chemicals Ltd., P. O. Rasayani (1976)	4118.00 T 512.69	5095.00 T 634.33	34173.41 T 3036.34	4500 T Sponsored
13.	Chloromethanes	Industrial chemicals	Standard Alkali Chemicals Divn., The Standard Mills Co. Ltd., Mafatlal Centre, Nariman Point, Bombay 400 021 (1974)	—	—	4020.12 T 171.44	3000 T —

1	2	3	4	5	6	7	8
14.	Diethyl-m-aminophenol	Dye Intermediate	Sahydari Dyestuffs & Chemicals, Pune (1970)	36.50 T 47.45	62.50 T 93.75	709.03 T 798.25	150 T Sponsored
15.	DihydroisoJasmone and peach aldehyde	Perfumery chemicals	S. H. Kelkar & Co. Ltd., Lal Bahadur Shastri Marg, Mulund, Bombay 400 080 (1965)	—	—	61.62 T 21.07	2 T Non-exclusive
16.	Dimethoate	Pesticides	(i) Mico Farm Chemicals Ltd., Lotus Court 165, Thambu Chetty Street, Madras 600 001 (1979)	9.36 T 7.02	14.99 T 11.24	52.99 T 37.73	100 T Non-exclusive
			(ii) Shaw Wallace & Co. Ltd., 4, Bankshall Street, Calcutta 700 001 (1979)	—	—	40.95 T 32.62	15 T (Pilot plant) Non-exclusive
17.	Dimethylaniline (Continuous process)	Industrial chemicals	Sahyadri Dyestuffs & Chemicals, Division of Deepak Nitrate Ltd., Pune (1976)	—	—	2450.18 T 761.86	3000 T Sponsored
18.	Endosulfan	Pesticides	Bharat Pulverising Mills Pvt. Ltd., Shriniketan, 14 Queens Road, Bombay 400 020 (1980)	—	—	24.16 T 20.54	600 T Non-exclusive
19.	Ethion	Pesticides	Shaw Wallace & Co. Ltd., Calcutta 1979)	—	—	33.06 T 26.24	15 T (Pilot Plant) Non-exclusive
20.	Ethylenediamine	Bulk organic chemicals	Diamines & Chemicals Ltd., The Bharat Vijay Mills Ltd. Premises, Kalol 382 721 (1982)	—	—	78.00 T 31.00	2000 T of (Ethylenediamine and) polyamines
21.	Ethylene oxide condensates	Surface active agents	Hico Products Ltd., 771, Mogal Lane, Mahim, Bombay 400 016 (1965)	2198.00 T 703.36	2365.00 T 804.10	20449.14 T 4886.21	2500 T Sponsored

1	2	3	4	5	6	7	8
22.	Ferrites-Hard	Electronics	Dr. Shet Magnetics Pvt. Ltd. 1069, V Block, 1st floor, Rajajinagar, Bangalore 560 010 (1978)	N. A. 0.67	N. A. 1.00	4.00 T 3.98	20 T Non-exclusive
23.	Foundry core binder (Sinol core binder)	Core binder steel foundries for high dimensional accuracy	Card Chem. Industries, B-12, Co-op. Industrial Estate, Balanagar, Hyderabad 500 037 (1980)	—	—	9919 ltrs 0.61	Not available Non-exclusive
24.	Hydroxycoumarin	Pharmaceuticals	Unichem Laboratories Ltd., Unichem Bhavan, S. V. Road, Bombay 400 060 (1974)	—	—	273.69 Kg 1.06 (including warfarin)	540 Kg Non-exclusive
25.*	Ibuprofen	Drug	The Chemical Industrial & Pharmaceutical Laboratories Ltd. (CIPLA), Bombay 400 008 (1983)	Reported to be in production Data not available			
26.*	Immobilized enzyme	Pharmaceutical	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1984)	—	940 Kg N. A.	940 Kg N. A.	—
27.	β-ionone	Perfumery, intermediate for vitamin A	S. H. Kelkar & Co. Ltd., Bombay (1975)	0.13 T 0.49	0.302 T 1.31	1.66 T 6.62	4.4 T Non-exclusive
28.	Maleic hydrazide	Agrcohemical	Micro Chemicals (India), Scheme No. 1, Road No. 3, Nai Abadi, Mandsaur 458 001 (1978)	— —	— —	2.22 T 1.24	1 T Non-exclusive
29.	p-Menthane hydroperoxid	Synthetic rubber	Camphor & Allied Products Limited, P. O. Clutterbuckganj 243 502, Dist. Bareilly (1976)	23.02 T 12.20	12.67 T 6.72	165.03 T 71.07	60 T Exclusive

1	2	3	4	5	6	7	8
30.*	Methyl Chlorosilane	Intermediate	Hico Products Ltd., Bombay	255.00 T 102.00	284.00 T 110.00	539.00 T 212.00	Collaborative Non-exclusive
31.	Monochloro acetic acid	Intermediate for weedicides, carboxymethyl cellulose, etc.	Hico Products Ltd., Bombay (1975)	436.00 T 71.93	335.00 T 66.98	2616.37 T 379.60	720 T Non-exclusive
32.	Monoethylaniline	Intermediate for explosives	The Atul Products Ltd., Atul 396 020, Dist. Valsad (1975)	61.12 T 23.84	72.57 T 28.31	731.52 T 254.25	100 T Non-exclusive
33.	1-Naphthyl-acetic acid	Agro chemicals, Plant growth regulator	Micro Chemicals (India), Mandsaur (1975)	— —	— —	5.10 T 5.10	1.5 T Sponsored
34.	Nicotine Sulphate from tobacco and tobacco waste	Insecticides	Urvakunj Nicotine Industries, Petlad-Cambay Road, Dharmaj 388 430, Dist. Kaira (1963)	178.20 T 83.86	215.61 T 130.00	1347.80 T 426.64	150 T Non-exclusive
35.	Nitrile Rubber	Oil resistant rubber formulations, adhesives	Syntheties and Chemicals Ltd., 7, Jamshedji Tata Road, Bombay 400 020 (1974)	718.60 T 101.00	389.91 T 57.48	4833.51 T 819.58	2000 T
36.	p-Nitrophenol	Intermediate	Hindustan Organic Chemicals Ltd., P. O. Rasayani (1978)	—	—	4.00 T 1.16	900 T Non-exclusive
37.	Nonyl phenol	Surface active agent	Aniline Dyestuffs and Pharmaceuticals Pvt. Ltd., Mahalaxmi Chambers, 22, Bhulabhai Desai Road, Bombay 400 026 (1974)	—	—	178.73 T 25.31	1000 T Sponsored

1	2	3	4	5	6	7	8
38.	Opium alkaloids	Pharmaceuticals	Govt. Opium & Alkaloid Works Undertaking, Neemuch 458 441 (1975)	4.57 T 149.74	2.69 T 132.02	47.63 T 1443.90	16.66 T of various alkaloids (morphine codeine, narcotine, papavarine and thebaine) Exclusive.
39.	Perfumery products based on longifolene (capinone)	Perfumery	Comphor & Allied Products Ltd., Dist. Bareilly (1968)	13.83 T 27.17	13.46 T 26.45	178.58 T 245.03	50 T (for both capinone and meracene) Sponsored.
40.	Perfumery products based on Δ^3 - carene (meracene)	Perfumery	—do—	7.75 T 5.66	10.21 T 7.45	111.22 T 58.59	—do—
41.	β-Phenethyl alcohol	Perfumery	Sunanda Aromatic Industries, Mysore—K. R. S. Road, Mettagalli P. O. Mysore 571 106 (1970)	—	—	1072.83 T 603.13	270 T Sponsored
42.	Phenthoate	Insecticides	Bharat Pulverising Mills Pvt. Ltd., Bombay (1975)	—	—	27.10 T 17.55	600 T Sponsored
43.	Phthalate-butyl octyl	Plasticizers	Herdillia Chemicals Ltd., Air India Bldg., Nariman Point, Bombay 400 021 (1979)	8.00 T 1.52	—	309.43 T 58.25	5000 T (including other phthalates) Non-exclusive
44.	Phthalates-diethyl and dimethyl	Plasticizers	The Mysore Acetate and Chemicals Co. Ltd., A-19 Acetate Town, Mandya 571 404 (1970)	287.10 T 51.66	376.82 T 67.83	2474.79 T 427.28	600 T Non-exclusive
45.	Phthalates-dioctyl and dibutyl	Plasticizers	Amines and Plasticizers Ltd., 'D' Bldg., Shiv Sagar Estate, Dr. Annie Besant Road, Worli, Bombay 400 018 (1971)	3270.00 T 600.00	4017.00 T 864.00	42546.18 T 6700.55	5000 T Non-exclusive

1	2	3	4	5	6	7	8
46.	Polyurethane coating	Coatings	Cipy Chemicals, 229, Rasta Peth, Pune 411 011 (1977)	1086.00 Ltrs 0.55	1556.00 Ltrs 0.82	10304.00 Ltrs. 3.88	30 T Non-exclusive
47.	Polyurethane printing rollers	Printing	Sree Saraswathy Press Ltd., 32, Acharya, P. C. Ray Rd., Calcutta 700 009 (1965)	—	—	662 Nos 14.25	3000 Nos Non-exclusive
48.	Quinapyramine Sulphate/Chloride	Veterinary drugs	Chintamani Fine Chemicals, S. No. 64/5, Bhide Baug, P. O. Vadgaon Budruk, Sinhagad Road, Pune 411 041 (1982)	—	70.00 Kg 5.6	79.00 kg 6.45	N. A. Non-exclusive
49.	Radiosonde therimistors	Meteorology	The Bhagyanagar Laboratories, 11-1523/8, Golkonda Cross Rd., Hyderabad (1974)	—	—	215000 Nos 38.79	N. A. Non-exclusive
50.	D. C. Recording polarograph including potentiometric strip chart recorder for captive consumption	Polarographic analysis	(i) Elico Pvt. Ltd., Sanatnagar Indl. Estate, Hyderabad 500 018 (1974)		—	195 + 3 Units 30.46	50 Units Non-exclusive
			(ii) Chromatography & Instruments Co., 121/122, Makarpura Ind. Estate, Baroda 390 010 (1974)	—	—	84 Units 13.45	100 Units Non-exclusive
51.	Silica gel	Humidity control	Minco Products, 17, Thirwottyur High Road, Madras 600 081 (1963)	12.50 T 1.80	13.00 T 2.00	4962.70 T 19.52	18 T Sponsored
52.	70% Sorbitol from dextrose monohydrate	Pharma-ceuticals, Vitamin C synthesis	(i) Maize Products, Divn. of Sayaji Mills Ltd., P. O. Kathawada, Maize Products, Ahmedabad 382 430 (1976)	1439.00 T 143.90	1977.00 T 237.24	9225.20 T 911.81	2000 T Non-exclusive
			(ii) The Anil Starch Products Ltd., P. B. No. 10009, Anil Rd., Ahmedabad 380 025 (1976)	495.00 T 52.60	823.00 T 87.05	3693.40 401.51	1000 T Non-exclusive

1	2	3	4	5	6	7	8
53.	Direct Reading spectro-photometer/ calorimeter	Biochemical research, spectroscopic analysis in visible range	Scientific Instruments Co. Ltd., Tej Bahadur Sapru Rd., Allahabad 211 001 (1974)	12 Nos 0.95	18 Nos 1.42	212 Unit 14.27	100 Unit Non-exclusive
54.	Staple pin adhesive	Adhesive for staple pins	Esdee Paints, Near Power House, Kolshet Rd., Thane 400 607 (1979)	1212.00 Ltrs 0.58	1472.00 Ltrs 0.70	5637.00 Ltrs 3.98	N. A. Non-exclusive
55.	Terpineol	Perfumery	Dujodwala Industries, Tulsiani Chambers, 8th Floor, 814, Nariman Point, Bombay 400 021 (1976)	—		400.00 T 112.50	200 T Non-exclusive
56.	P-Toluidine from p-nitrotoluene by vapour phase reduction	Organic intermediate	Sudarshan Chemical Industries, 162, Wallesley Road, Sangam Bridge, Pune 411 001 (1977)	121.0 T 46.20	84.00 T 45.65	615.00 T 236.26	300 T Sponsored
57.	Trichloro-benzene	Intermediate	Mycol International Agencies, Lotus Court, 165, Thambu Chetty St., Madras 600 001 (1978)	—	—	2.30 T 0.16	100 Kg/batch Non-exclusive
58.*	Vinblastin Sulphate B. P. and Vincristine Sulphate B. P.	Pharma-ceuticals	The Chemical & Pharma-ceutical Laboratories Ltd., Bombay (1984)	Reported to be in production Data not available			NA Non-exclusive
59.	Vitamin C	Pharma-ceuticals	Hindustan Antibiotics Ltd., Pimpri, Pune 411 018 (1975)	—	—	5.83 T 7.82 (Estimated)	125 T Non-exclusive
60.	Warfarin	Rodenticide	Unichem Laboratories Ltd., Bombay (1974)	—	—	384.29 Kg	840 Kg Non-exclusive

* During the period under review production has been newly reported on these items (5).

Note : The following processes had appeared in Table I of the previous reports. As and when the production is reported on these items they will be included in Table I (i) Calcium silicate (ii) Carbimazole (iii) Oxalic acid from bark of Ain tree

VALUE OF PRODUCTION BASED ON NCL TECHNOLOGIES

Year	No. of items manufactured	Value of production (Rs. in lakhs)
1980-81	61	3056.60
1981-82	62	2928.62
1982-83	58	3019.11
1983-84	58	3685.16
1984-85	60	4703.84
		17393.33

SECTORWISE VALUE OF PRODUCTION OF NCL TECHNOLOGIES (1984-85)

Type of industry	No. of processes in production	Value of production during 1984-85 (Rs. in lakhs)
1. Public sector	8	2014.50
2. Large scale private sector	25	2539.16
3. Medium and small scale sector	27	150.18
	60	4703.84

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TABLE II : PROCESSES RELEASED AND AWAITING PRODUCTION

Sr. No.	Name of the process	Field of utilisation	Name of the party (Year of release)	Nature of release	Remarks
1	2	3	4	5	6
1.	Adhesive for renewable resources	Adhesive	Carborundum Universal Ltd., 28, Rajaji Road, Madras 600 001 (1985)	Sponsored	Recently released
2.	Aniline	Organic intermediates	Hindustan Organic Chemicals Ltd., Rasayani (1973)	Non-exclusive	—
3.	Anisidine by liquid phase hydrogenation of nitroanisoles	Intermediate for dyestuffs	Amar Dye-Chem Ltd., Rang Udyan, Sitladevi Temple Rd., Mahim, Bombay 400 016 (1974)	Sponsored	—
4.	Antioxidant TEDQ (2, 2, 4-trimethyl-6-ethoxy-1, 2-dihydroquinoline)	Rubber antioxidant	– do— (1976)	Non-exclusive	—
5.	Atrazine	Herbicide	—do— (1978)	—do—	—
6.	Butenediol	Pesticides, polymers	Hindustan Organic Chemicals Ltd., Rasayani (1980)	Collaborative work	—
7.	1, 3-Butylene glycol	Petrochemicals, bulk organic chemicals	Indian Petrochemicals Corpn. Ltd., Dist. Baroda (1976)	Sponsored	—
8.	Butyl titanate	Varnishes, enamels	Monopol Chemicals Pvt. Ltd., 901, Rahaja Chambers, Nariman point, Bombay 400 021 (1984-85)	Non-exclusive	Recently released
9.	Camphene from pinene	Pharmaceuticals, perfumery	Resin & Terpene Industries 812/813, Tulsiani Chambers, 212, Nariman Point, Bombay 400 021 (1978)	Sponsored	—

1	2	3	4	5	6
10.	Carboxin	Pesticides	(i) Bharat Pulverising Mill P. Ltd., Bombay (1978)	Non-exclusive	Under implementation
			(ii) Laxmi Traders, 2 India Exchange Place, Calcutta 700 001 (1980)	—do—	—do—
11.	Conversion of crotonaldehyde to maleic anhydride	—	Deccan Sugar Institute, Manjari, Pune 412 307 (1983-84)	Sponsored	—do—
12.	Carboxylation of ethanol to propionic acid		Deccan Sugar Institute, Manjari, Pune (1983-84)	Sponsored	Recently released
13.	Catalytic vapour phase oxidation of toluene to benzaldehyde	Intermediates for pharmaceuticals, perfumeries, etc.	Indian Organic Chemicals Ltd., Khopoli 410 203 Dist. Raigad (1981)	Sponsored	—
14.	Citrate plasticizers-tributyl/acetyl tributyl citrate	Plasticizers	Sturdia Chemicals Ltd., Neville House, J. N., Hardia Marg, Ballard Estate, Bombay 400 038 (1980)	Sponsored	—
15.	Clonal multiplication of cardamom by tissue culture	Agriculture	(i) A. V. Thomas & Co., 22, Marshalls Rd., Egmore, Madras 600 008 (1984-85)	Non-exclusive	Recently released
			(ii) Cardamom Research Institute, Cardamom Board, Banarji Road, Cochin 682 018 (1984)	—do—	—do—
16.	Dapson	Drug	CIPLA, Bombay (1984)	Sponsored	—do—
17.	Dextropropoxyphene hydrochloride	Drug	Centaur Laboratories, Kumar Engineering Works Compound, Kalina, Santacruz (East), Bombay 400 029 (1983–84)	Sponsored	—do—
18.	Diazepam	Anti-anxiety drug	Orion Chemicals, Mulchand Mansion, Princess St., Bombay 400 002 (1975)	Non-exclusive	—
19.	Dibutyl tin oxide	PVC stabilizers	Dura Chemical Corpn. Ltd., Wakefield House, 11, Sprott Road, Ballard Estate, Bombay 400 038 (1977)	Non-exclusive	Under implementation

1	2	3	4	5	6
20.	Dichloropropionic acid (Dalapon)	Pesticides	(i) Hico Products Ltd., Bombay (1975)	Non-exclusive	—
			(ii) Jaydee Agrochemicals P. Ltd., Majwaji Ka Bagh, Moti Dugri Road, Jaipur 302 004 (1975)	—do—	—
			(iii) IDL Agrochemicals Ltd., 11th floor, Hindustan Times House, 18-30 Kasturba Gandhi Marg, New Delhi 11000	—do—	—
21*.	Dimethoate	Pesticides	PNM Company, Thindal, Perundurai, Main Road, Erode 638 009 (1978)	—do—	In trial production
22.	DVO acid chloride	Intermediate	National Organic Chemical Industries Ltd., Mafatlal Centre, Nariman point, Bombay 400021	—do—	—
23*.	Endosulfan	Pesticides	Hindustan Insecticides Ltd., Hans Bhavan, Wing I, Bahadur Shah Zafar Marg, New Delhi 110 002 (1976)	—do—	Turn-key plant offered through project engineers; In trial production
24.	Ethephon	Pesticides	(i) Varson Chemicals P. Ltd., 9th Mile, Hosur Rd., PO : Singasanda, Bangalore 560 068 (1978)	Non-exclusive	—do—
			(ii) Sudarshan Chemical Industries P. Ltd., Pune (1984-85)	—do—	
			(iii) Hycount Agro, Sherry Land, Quilon 691 005 (1984-85)	—do—	
25.	Flematic skin oil	Veterinary drugs	TTK Pharma P. Ltd., Old Trunk Road, Madras 600 043 (1984)		
26.	Flexible magnets	Refrigeration gaskets, toys, educational kits	Dr. Shet Magnetics P. Ltd., Bangalore (1976)	Non-exclusive	—
27.	Fumed silica	Bulk inorganic chemicals	Century Rayon, PB No. 22, Murbad Rd., Shahad 421103 Thane (1976)	Sponsored	—

1	2	3	4	5	6
28.	Hexachlorocyclopentadiene (HCCP)	Pesticides	Hindustan Organic Chemicals Ltd., Rasayani (1981)	Collaborative work	—
29.	Items having short shelf life	Sealants, adhesives	Hindustan Aeronautics Ltd., (Nasik Division) Ozar Township PO, Nasik 422 007 (1980)	Sponsored	—
30.	Ketoprofen	Drug	CIPLA, Bombay (1983-84)	Sponsored	Recently released
31.	1-Menthol from Δ^3-carene	Perfumery	Bhavana Chemicals Ltd., Laxmi Insurance Bldg., Sir PM Rd., Bombay 400 001 (1978)	Sponsored	Under implementation
32.	Morpholine	Intermediate for rubber chemicals	(i) Bombay Wire Ropes Ltd., Kavesar Village, Ghodbunder Road, Thane (1975)	Non-exclusive	—
			(ii) Catalyst (India) P. Ltd., Embassy Centre, 10th floor, 207, Backbay Reclamation, Nariman Point, Bombay 400 021 (1975)	—do—	—
33.	Multiplication of Napier grass by tissue culture	Agriculture	National Organic Chemical Industries Ltd., Mafatlal Centre, Bombay 400 021	Sponsored	
34.	Multiplication of teak by tissue culture	Forestry	Forest Development Corpn. of Maharashtra Ltd., 6-A, Nawab Layout, Tilak Nagar, Nagpur (1981)	Sponsored Under field trials	—
35.	Nacelon	Perfumery	Comphor & Allied Products Ltd., 133, M. G. Road, Jehangir Bldg., Bombay 400 023 (1984-85)	Non-exclusive	Recently released
36.*	Nicotine sulphate	Insecticides	Kraun Fine Chemicals P. Ltd., Chikodi, Karnataka (1983-84)		—
37.	Nitrofen	Weedicide	Amar Dye-Chem. Ltd., Bombay (1978)	Non-exclusive	—
38.	p-Nitrophenol	Intermediate	Catalyst (India) P. Ltd., Bombay (1975)	—do—	—
39.	Phenylglycyl chloride	Drug intermediate	Sudarshan Chemical Industries Ltd., Pune (1983-84)	Sponsored	Recently released

1	2	3	4	5	6
40.	Polycrystalline silicon-ultrapure	Electronics	Grindwell Norton Ltd., Devenhalli Rd., Old Madras Road, Bangalore 560 049 (1982)	Sponsored	Recently released
41.	Polysulphide liquid rubber	Adhesives, sealants	(i) Rathi Rubber Products, 27, Shankarshet Rd., Pune 411 009 (1981)	Non-exclusive	—
			(ii) Mundoz Corporation, 3, Moghe Bhuwan, Gokhale Rd., Dadar, Bombay 400 028 (1981)	—do—	—
			(iii) Transpeck Industry Ltd., Vadodara (1983-84)	—do—	Recently released
42.	Polysulphide sealant compound (Sp. by HAL, Nasik)	Sealants	Rathi Rubber Products, Pune (1981)	Non-exclusive	—
43.*	Polyurethane coating	Coating	Simple Coatings, Fahmeeda Manzil, Bhoipura Bhopal (1984-85)	Non-exclusive	Recently relased
44.	Propylene oxide from propylene (extension to propylene glycol)	Petrochemicals	Indian Petrochemicals Corpn., Ltd., Dist. Baroda (1978)	Sponsored	—
45.	Silver paste for mica capacitor electrodes	Electronics	(i) Jyoti Refinery, 216, Lakad Ganj, Nagpur (1978)	Non-exclusive	In trial production
			(ii) Ramans (India) 9882/6, Ambala City, (1978)	—do—	—
			(iii) Luxmi Traders, Calcutta (1981)	—do—	—
46.	Simazine	Hebricide	Amar Dye-Chem Ltd., Bombay (1978)	—do—	—
47.	Sodium sulphide	Varios industries	—do— (1976)	Technical aid)	
48.	Sorbitol from glucose (continuous process)	Pharmaceuticals	The Anil Starch Products Ltd., Ahmedabad (1976)	Sponsored	—
49.	Staple pin adhesive	Adhesive for staple pins	Duro Meto Chem P. Ltd., Nirlon House, 254-B, Dr. A. B. Road, Worli, Bombay 400 025 (1976)	Non-exclusive	—
50.	Substitute for side seam cement	Adhesive	Nand Industries, 324, Shaniwar Peth, Pune 411 030 (1978)	Sponsored	—

1	2	3	4	5	6
51.	Sulphur monochloride	industrial chemical	Phosphate Co. Ltd., 14, Netaji Subhash Road, Calcutta 700 001 (1976)	Non-exclusive (Technical aid)	—
52.	Synthesis of basic drugs and intermediate	Drug intermediate	Dexo Laboratories P. Ltd., 6-3-348 Dwarkapuri colony, Hyderabad 500004 (1984-85)	Sponsored	Recently released
53.	Theophylline, aminophylline and caffeine	Pharmaceuticals	(i) Pefco Foundry & Chemicals Ltd., Plot No. 10, Off Dr. Moses Road, Worli, Bombay 400 018 (1978)	Non-exclusive	In trial production
			(ii) Nufarm Chemicals, Faridabad (1984-85)	Non-exclusive	Recently released
54.	Thionyl chloride	Various industries	Dharamsi Morarji Chemical Co. Ltd., Prospect Chambers, 317/21, Dr. D. N. Road, Bombay 400 001 (1977)	Collaborative work	—
55.	N-Tridecyldiisopropanolamine	Intermediate	BASF (India) Ltd. Sudam Kalu Ahire Marg, PB No. 19108, Bombay 400 025 (1981)	Sponsored	—
56.	Vitamine B_6	Drugs	(i) Lupin Laboratories, 159, CST Road Kaline, Santacruz (E) Bombay 400098 (1983-84)	Non-exclusive	Recently released
			(ii) Themis Chemicals, Plot No. 69, GIDC Vapi (Dist. Valsad) Gujarat		

*These process have also appeared in Table I along with other licensees.

In ddition to the proceses listed above the following sponsored processes were also completed during 1983-84 and 1984-85: and due to the nature and objective of these schemes no production was envisaged. (i) Aromatic polymers/polyamides, (ii) Enzyme reagents, (iii) Physics and chemistry of oxide surfaces, (iv) Studies on fluidization with reference to acrylonitrile reactor and (v) Solar grade polysilicon.

The process on clofibrate which was included in Table II of the Annual Report 1982-83 has now been dropped as the party is not likely to implement the know-how on techno-economic reasons.

LIST OF PROCESSES AVAILABLE

(As in March 1986)

Sl. No.	Name of the process/ product	Field of utilisation	Major raw materials	Range of total capital requirement	Remarks
1	2	3	4	5	6
1.	Acetanilide	Drug and dye intermediate	Aniline and acetic acid	C	Released, in production, turn-key plant available through project engineers
2.	Aniline	Organic intermediate	Nitrobenzene, hydrogen and catalyst	C	Released
3.	Atrazine	Herbicide	Cyanuric chloride, ethylamine and monoisopropylamine	C	Released
4.	*tert*-Butyl catechol	Stabilizer and polymerization inhibitor for synthetic rubber	Catechol, *tert*-butyl alcohol and catalyst	A	Released, in production
5.	Butyl titanate	Insulating varnish, special paints, catalyst	Butanol and titanium tetrachloride	B	Released, in production
6.	Can lining composition (based on nitrile rubber latex)	Lining cans for storing mineral oils, greases, food	Synthetic rubber latex, synthetic resins and rubber chemicals	A	Released, in production
7.	Can sealing composition (based on natural rubber)	Metal can industry	Natural rubber latex and rubber chemicals	A	Released, in production
8.	Carboxin	Pesticide	Acetoacetanilide, sulphuryl chloride, benzene and 2-mercaptoethanol	C	Released
9.	2-Chloroethyltrimethyl ammonium chloride	Plant growth regulator	Trimethylamine and ethylene	A	—
10.	Diazepam	Anti-anxiety drug	p-Nitrochlorobenzene, benzyl cyanide, dimethyl sulphate, iron powder and chloroacetyl chloride	A	Released
11.	Dichloropropionic acid (Dalapon)	Weedicide	Propionic acid, chlorine and soda ash	C	Released

A— Capital requirement less than Rs. 10 lakhs
B— Capital requirement between Rs. 10 lakhs and Rs. 20 lakhs
C— Capital requirement above Rs. 20 lakhs

These figures are tentative and purely indicative, and are subject to revision from time to time.