INTERNATIONAL SYMPOSIUM ON FRONTIERS IN CATALYSIS IN THE 21ST CENTURY

SOUVENIR

January 19 - 20; 1999
DEHRADUN, INDIA

Organized by
CATALYSIS SOCIETY OF INDIA
(Northern Chapter)
&
INDIAN INSTITUTE OF PETROLEUM
DEHRADUN

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INTERNATIONAL SYMPOSIUM

ON

FRONTIERS IN CATALYSIS IN THE 21st CENTURY

(IN HONOUR OF Dr T S R PRASADA RAO)

January 19 - 20, 1999

Organised

By

INDIAN INSTITUTE OF PETROLEUM, DEHRADUN

&

CATALYSIS SOCIETY OF INDIA (Northern Chapter)

CREDITS

Cover Design : **Ms Sakshi Malhotra**
3rd Year, BFA
College of Arts, Chandigarh

The cover page shows the symposium highlighting the role of catalysis in keeping our earth safe and green in the 21st century

Souvenir Committee sincerely thanks all colleagues who have extended their help in bringing out the souvenir.

Published by Souvenir Committee on behalf of
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&
Catalysis Society of India (Northern Chapter)

अध्यक्ष लोक सभा
SPEAKER LOK SABHA

10 Dec 1998

Message

I am happy to learn that the International Symposium on Frontiers in Catalysis in the 21st Century is proposed to be held on 19th and 20th January 1999 and a beautiful commemorative Souvenir is proposed to be brought out to mark the occasion.

It is also heartening to learn that the International Symposium will be attended by more than 250 delegates, both from India and abroad. I am glad that a product exhibition will also be organised on this occasion for the benefit of delegates.

I wish the above International Symposium all success.

(G.M.C. Balayogi)

सत्यमेव जयते

वित्त सचिव

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वित्त मंत्रालय

आर्थिक कार्य विभाग

GOVERNMENT OF INDIA

MINISTRY OF FINANCE

Department of Economic Affairs

नई दिल्ली / New Delhi

Thursday, December 24, 1998

MEESSAGE

I am happy to learn that the IIP and the Catalysis Society of India are organising an International Symposium on the occasion of the 60th birthday of Dr. T.S.R. Prasada Rao.

In his career spanning over 30 years, Dr. Prasada Rao has made significant contributions to the scientific and technological process of catalysis in various industries.

It is fitting that his contribution is recognised through this symposium. My best wishes for its success.

(Vijay L. Kelkar)

एम. ए. पठान
अध्यक्ष

M. A. PATHAN
CHAIRMAN

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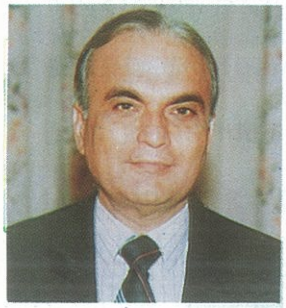

Message

I am very happy to know that Indian Institute of Petroleum and Catalysis Society of India jointly plan to bring out a Felicitation Souvenir in honour of Dr. T.S.R. Prasada Rao for release at the International Symposium on Frontiers in Catalysis in the 21st Century to be held at Dehra Dun during January 19-20,1999.

Dr. Prasada Rao is a catalysis scientist of international eminence and a leading light in the development and propagation of this branch of science in India in contemporary times. He is credited with the development and commercialisation of various catalytic processes and catalysts for Petro-chemicals and fertilisers.

Catalysis is the most critical factor in most of the industrial processes, more particularly in chemical industries including petroleum, petrochemicals, fertilisers, drugs and a host of others. The role of catalysts in chemical processing will become more and more critical in future not only to achieve higher product quality levels to meet customer expectations but also to conform to increasingly stringent environmental norms likely to come into effect.

The petroleum refining industry in India with an installed capacity of over 67 million tonnes per year is a large consumer of catalysts for fluid catalytic cracking process which are now being imported at a heavy cost. With expansion programmes in various refineries and new refineries planned, the existing capacity is slated to reach 129 million tonnes in the next-few years with catalyst requirements also going up proportionately. Therefore, it is high time for India to develop and manufacture indigenous catalysts to make our refining operations more competitive than at present. Hydrocracking process is yet another new addition to catalytic processes requiring focused attention of the scientists.

In his capacity as Director, Indian Institute of Petroleum and as Member of various technical committees, Dr. Prasada Rao has made very significant contributions to the growth, operational efficiency and safety in the oil industry. Indian Oil Corporation had the benefit of his advice on a number of technical and R&D related issues and I have very happy memories of constructive and stimulating interactions with him. I wish him more crowning achievements and the best of everything else in life.

(M.A. Pathan)

रिफाइनरी व
पाइपलाइन प्रभाग
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FELICITATION MESSAGE IN HONOUR OF DR T S R PRASADA RAO

The initiative of the Catalysis Society of India and the Indian Institute of Petroleum to organize the International Symposium on 'Frontiers in Catalysis in the 21st Century' at IIP, Dehradun in honour of Dr T S R Prasada Rao on his 60th birthday is indeed, the most befitting honour that one most eminent Catalysis Scientists of India so richly deserves. It is heartening and I feel proud to be associated in the programme. In my opinion, Dr Prasada Rao, Director, IIP during his tenure has taken this 'National Institute' to greater height in the International Scientific domain. It is Shri Rao who did not leave nay stone unturned to commercialise the technologies developed by the scientists of IIP and thereby brought fame to the Institute and name to the Scientists. I personally came to know Dr Rao only after he took over the helms of this premier Institute and then had many occasions of seeing him deliberating in Scientific Technology Forums, where he had gone out of way to project the image of the Institute and its Scientists. It is Dr Rao who has taken this prestigious institution to its glorious peak in the scientific world and brought the culture of team work amongst the Scientists/Technologists of IIP.

Dr Prasada Rao, a Catalysis Scientist himself has contributed immensely to indigenise business of catalysis in this country. His emphasis on technology development and commercialisation has provided a major fillip to globalisation and marketing of Indian technology and paved the way in establishing technology alliance with the world renowned technology establishments like IFP, UOP, SWEC, Mobil etc. This will go a long way in projecting the Indian technologies abroad.

His efforts in commercialisation of reforming catalyst, xylene isomerisation catalyst, NMP extraction process are few of the innumerable examples of his contribution in the field in the country. He took personal interest and saw that the commercialised technology succeeded in Indian Industries.

I take this opportunity to felicitate him and wish him all the best of life on his 60th birthday. I shall be looking forward to many more contribution from him for the development of science and technology for this nation in the days to come.

P K Biswas
Executive Director
Mathura Refinery

INTERNATIONAL SYMPOSIUM ON
FRONTIERS IN CATALYSIS IN THE 21st CENTURY
(In honour of Dr T S R Prasada Rao)

PROGRAM

ANUARY 19, 1999

INAUGURAL SESSION

9.30 – 11.00 hrs

nauguration by — **Professor C N R Rao, FRS**
President
Jawaharlal Nehru Centre for Advanced Scientific Research,
Bangalore, India

residing by — **Dr R A Mashelkar, FRS**
Director – General, CSIR & Secretary, DSIR, India

0.15 – 11.00 — Keynote Address by the Chief Guest
Professor C N R Rao, FRS
Jawaharlal Nehru Centre for Advanced Scientific Research,
Bangalore, India

11.00 – 11.30 hrs **Tea Break**

ESSION – II : INNOVATIVE APPROACHES IN CATALYSIS

11.30 – 13.00 hrs **INVITED LECTURES (2)**

.30 – 12.15 — How to Speed up the Development of Optimized Catalysts
Professor Michel Boudart
Department of Chemical Engineering
Stanford University and University of California at Berkeley, USA

.15 – 13.00 — Catalysis in Renewable and Non-traditional Energetics
Professor Valentin N Parmon
Boreskov Institute of Catalysis, Novosibirsk, Russia

13.00 – 14.00 hrs **Lunch Break (IIP Campus)**

JANUARY 19, 1999

SESSION – III : CATALYSIS AS AN INNOVATIVE TECHNOLOGICAL FRONTIER

14.00 – 15.30 hrs INVITED LECTURES (2)

14.00 – 14.45
Sustainable and Innovative Catalytic Technologies
Dr Ian E Maxwell
Shell Research & Technology Center, The Netherlands

14.45 – 15.30
New Scientific and Technological Frontiers in Diesel Fuel Formulation
Dr Henrik Topsoe
Haldor Topsoe A/S, Denmark

15.30 – 15.45 hrs Tea Break

SESSION – IV : CATALYSIS IN NATURAL GAS/SYNGAS CONVERSION

15.45 – 17.15 hrs INVITED LECTURES (2)

15.45 – 16.30
Feedstocks for Petroleum and Petrochemicals from Novel Methan
Natural gas Conversion Processes
Dr Vasant R Choudhary
National Chemical Laboratory, Pune, India

16.30 – 17.15
Modified F–T Synthesis for Selective Production of C_4 Hydrocarbons using Various Solid Acid Catalysts in Dual Reaction Systems
Professor A K Dalai
University of Saskatchewan, Canada

18.30 – 19.30 hrs
CULTURAL PROGRAM – AT IIP AUDITORIUM
KUCHIPUDI DANCE PERFORMANCE by
Padmasri Raja Reddy & Radha Reddy Couple

20.00 – 21.30 hrs Dinner (Hotel Madhuban)

JANUARY 20, 1999

FELICITATION FUNCTION

9.30 – 11.30 **Felicitation of Dr T S R Prasada Rao on his 60th birthday**

11.30 – 12.00 hrs Tea

SESSION – V : NEW DEVELOPMENTS IN CATALYST DESIGN

12.00 – 13.30 hrs INVITED LECTURES (2)

12.00 - 12.45
Latest Trends in MCM type Mesoporous Materials and their Novel Applications
Dr Girish K Chitnis
Mobil Technology Company, USA

12.45 – 13.30
Design and Development of Pore Size Regulated Zeolite Catalyst for Selective Synthesis of para–Dialkylbenzenes
Dr Anand B Halgeri
R & D Centre, Indian Petrochemicals Corp. Limited, India

13.30 – 14.30 hrs Lunch Break (IIP Campus)

SESSION – VI : RESEARCH IN OXIDATION CATALYSIS – PRESENT STATUS

14.30 – 16.00 hrs INVITED LECTURES (2)

14.30 -15.15
Mild Oxidation of Alkanes for Obtaining Valuable Chemicals : The Present Status of Research
Dr Jean - Claude Volta
CNRS, France

15.15 – 16.00
Activity and Selectivity of Promoted MgO and CaO Catalysts for Oxidative Coupling of Methane
Professor Dr Radmila Marinkovic - Neducin
University of Novi Sad, Yugoslavia

16.00 – 16.15 hrs Tea Break

JANUARY 20, 1999

SESSION – VII : APPLICATION OF HOMOGENEOUS CATALYSIS

16.15 – 16.30 hrs INVITED LECTURE (1)

16.15 – 16.30	Olefins Transformation by Homogeneous Catalysis – the IFP Experience **Dr Alaine Forestiere** Homogeneous Catalysis Division, IFP, France
16.30 – 17.00	Concluding Remarks & Vote of Thanks

19.30 – 21.30 hrs Dinner (Hotel Madhuban)

HOW TO SPEED UP THE DEVELOPMENT OF OPTIMIZED CATALYSTS

M. Boudart

Department of Chemical Engineering
Stanford University and University of California, Berkeley
USA

The first, largest and fastest development of a new catalyst was carried out at BASF in a crash program to synthesize ammonia. This program was started in 1909 by Mittasch, who defined and realized what is currently called combinatorial catalytic chemistry (CCC). The implementation of CCC relies on making and testing large collections of multicomponent catalysts. This is what the program of Mittasch did, but today that process is assisted by microfabrication techniques derived from the semiconductor industry.

Another promising methodology relies on a microkinetic analysis (MKA) of the catalytic process. It consists of repeated loops of catalyst synthesis, characterizating, and testing. At the end of each loop an attempt is made to analyze the results by means of a set of rate constants of presumed elementary steps. At the beginning of each new loop, a corrected catalyst composition is tested. A growing kinetic data bank is built up as the catalyst improves in the iterative process. Ideally, the CCC technique and the MKA technique can be combined to speed up catalyst development and optimization in a systematic and quantitative mode of assisted catalyst design. When this ultimate goal will be reached can only be speculated upon. As to the discovery of new catalyst reactions and new catalysts, this will be left to experts on the subject of creativity.

CATALYSIS IN RENEWABLE AND NONTRADITIONAL ENERGETICS

V.N. Parmon

Boreskov Institute of Catalysis
Novosibirsk 630090
RUSSIA

The real far future of our civilization depends mostly on our ability to resolve the expected energ problems. In case of absence some rigid limitations on the amount of energy in the mankind' disposal there will be no danger of a shortage of food, artificial motor fuel and chemicals, etc. even fo a 10 billion population of Earth [1].

There are two evident ways to overcome the future energy problems. First of all, one should increas the efficiency of usage of conventional energy carriers, that means simultaneously a necessity t diminish drastically the wastes or losses of energy. The second way is to enlarge utilization of non exhaustible sources of energy which still do not create the basis of the now-a-days energetics. principal role in all these movements belongs to catalytic technologies.

Traditional way in application of catalytic technologies energetics is their use for improvement incineration of conventional or available fuels in various large or small-scale power plants. This allow to increase the heat-producing efficiency of these plants as well as to diminish pollution of th environment by toxic products of the fuel combustion. However, there are also some not so evide applications of catalytic technologies which may appear to be of a principal interest for the future.

This presentation concerns the modern trends in application of catalytic technologies to (i) producin heat or high quality liquid fuels from renewable sources of carbon-containing raw materials (primaril biomass); (ii) utilizing nuclear and nontraditional sources of energy, (iii) producing the mechanical electrical energy from the energy of chemical energy carriers, and (iv) recovering middle or lo potential heat wastes or utilizing some unexpected heat-energy sources (see also [2]).

REFERENCES

1. V.N.Parmon, Chemistry for Sustainable Development, 1(1993) 59.
2. V.N.Parmon, Catalysis Today, 35 (1997) 153.

SUSTAINABLE AND INNOVATIVE CATALYTIC TECHNOLOGIES

Ian E. Maxwell

Shell Research and Technology Center
P.O. Box 38000, 1030 Amsterdam
The Netherlands

Catalysis plays an important role in the development of environmentally sustainable technologies which span across many important industries such as oil refining, petrochemicals, fine chemicals, transportation, power generation and natural gas conversion. In fact, recent studies sponsored by various governments have shown that catalytic technologies account for some 20-30% of national GDP for many countries where catalysis plays a key role in a wide variety of processes and products. In global terms this amounts to some US$ 5-7.5 trillion per annum in terms of economic importance. Some examples of recent innovations and developments in the field of catalytic technologies will be described where there is a strong link to environmental sustainability.

In oil refining the global trend towards "cleaner" fuels continues to result in governmental legislation relating to sulphur levels in gasoline and diesel fuels. In turn, this has stimulated research on improved hydrodesulphurization catalysts where there have been incremental improvements in performance over a number of years. In addition, new combinations of catalytic and reactor technologies, such as 2-stage, single stage counter current stacked bed reactor configurations and catalytic distillation technologies have been developed for more efficient and cost effective deep hydrogenation and HDS of diesel fuels. These new technologies also enable more powerful catalyst systems based on zeolites and noble metals to be deployed in combination with conventional mixed sulphide based catalysts.

Air pollution legislation related to NOx emissions is also becoming more stringent and is penetrating globally and thereby stimulating further improvement of selective catalytic reduction technologies. Some recent developments include the application of lateral flow reactor designs and alternative catalysts which can, in principle, achieve higher catalyst effectiveness factors and therefore reduced capital and operating costs compared to conventional monolith systems for certain applications. Other new developments include novel high temperature catalysts based on zeolites and more recently catalyst systems that employ hydrocarbons rather than ammonia as the reducing agent.

Catalytic exhaust emission control is gradually moving from first generation three-way catalysts towards second generation systems for both cold start applications, lean burn gasoline and diesel motor transportation vehicles. The reduction of NOx emissions under lean burn conditions has posed a major challenge. Some novel technologies involving a combination of adsorption and catalysis have been developed in Japan to solve this problem for application in lean burn gasoline engines.

The catalytic production of liquid products from natural gas (Gas to Liquid Technologies) is currently attracting considerable attention. This interest is driven by a number of factors such as increasing proven natural gas reserves, environmental concerns related to the flaring of associated gas at oil fields and various national governments desiring to exploit remote natural gas fields.

A number of companies and consortia such as Shell, Exxon, Sasol and Syntroleum have been developing improved GTL technologies to more cost effectively convert natural gas into more valuable chemical and fuel liquid products. All these technologies involve converting methane into synthesis gas and subsequent further conversion into liquid products by means of Fischer-Tropsch (F-T) catalysis. In fact, Shell has already had a plant operating at Bintulu in Malaysia for a number of years which deploys this type of technology and produces both chemicals and "clean" fuel products. Current research in this field is focused on reducing the capital cost of both the synthesis gas manufacturing and the catalytic F-T step by developing improved catalysts and reactor technologies.

In the chemicals industry catalytic technologies continue to contribute strongly to reduce undesired by-products and minimizing waste streams. Oxidation catalysis is important in this respect with new zeolite based catalyst systems emerging which employ aqueous hydrogen peroxide and nitrous oxide as oxidants. Some 90% of new chemical processes are now catalytic and the applications which have been traditionally wide spread in the bulk petrochemicals industry are now also gaining ground in the fine chemicals and even pharmaceuticals areas.

Finally, the emergence of some innovative enabling technologies for application in catalysis such as robotics synthesis and high speed screening techniques is also important and has the potential to significantly accelerate the innovation step in the search for new and improved catalyst systems.

NEW SCIENTIFIC AND TECHNOLOGICAL FRONTIERS IN DIESEL FUEL FORMULATION

Henrik Topsoe

Haldor Topsoe Research Laboratories
DK-2800 Lyngby, DENMARK

The renewed interest in hydrodesulfurization (HDS) of oil fractions is related to the increased demand to convert heavier and more sulfur-rich feed stocks and to the environmental pressures tc continuously reduce the sulfur content in the oil products. For example, in several places includin Europe, there are plans to lower the maximum sulfur content in diesel to the 50-100 ppm level Consequently, there is a need for introducing so-called deep HDS which will place demands on mor active catalysts and improved processing schemes. In order to aid the development of new HDS catalysts for deep HDS, it is desirable to establish fundamental relationships between the structure o the catalyst and the catalytic activity. In connection with deep HDS it is especially important t understand the reactivity and reaction pathways of the least reactive sulfur-containing molecules suc as the sterically hindered dibenzothiophenes. In recent years, several useful structure-activit relationships have been established for both transition metal sulfides and promoted Mo- or W-base catalysts. The talk will discuss the activity correlations and their relevance to the situation encountered during deep HDS. The talk will also discuss some very recent ab initio DFT calculation of both MoS_2, Co-Mo-S, Ni-Mo-S, and Fe-Mo-S structures. These results have provided evidence fc new structural features and surface reconstructions which must be taken into account when trying t understand deep HDS.

FEED STOCKS FOR PETROLEUM AND PETROCHEMICALS FROM NOVEL METHANE/NATURAL GAS CONVERSION PROCESSES

Vasant R. Choudhary

Chemical Engineering Division
National Chemical Laboratory, Pune – 411 008
INDIA

World reserves of natural gas are almost equivalent to that of oil, and more natural gas is being discovered than oil. Uncertain and/or short supply of conventional oil in the future has necessitated the use of natural gas as a source of feed stocks (viz. syngas, hydrogen, C_2-C_4 olefins, and aromatics) for petroleum and petrochemicals. Worldwide efforts are therefore being made for developing novel and/or energy efficient process for converting methane/natural gas into hydrogen, syngas, C_2-C_4 olefins, and aromatics by

- Oxidative conversion of methane to syngas
- Simultaneous exothermic oxidative conversion and endothermic steam and/or CO_2 reforming of methane to syngas
- Oxidative coupling of methane to C_2- hydrocarbons
- Oxidative pyrolysis of natural gas to ethylene and other lower olefins
- Oxycracking and oxidative dehydrogenation of ethane and propane to ethylene and propylene
- Two step conversion of methane and natural gas into aromatics or gasoline
- Direct aromatization of natural gas
- Aromatization of lower alkanes (C_2-C_4) and natural gas liquids (NGL).
- Pd-membrane assisted production of H_2 from methane/natural gas
- H_2 from decomposition of methane (by cyclic operation)

A brief account on the above, particularly with reference to our R&D activities in NCL, will be presented.

MODIFIED FISCHER-TROPSCH SYNTHESIS FOR THE SELECTIVE PRODUCTION OF C_4 HYDROCARBONS USING VARIOUS SOLID ACID CATALYSTS IN A DUAL REACTION SYSTEM

A.K. Dalai, S.P.R. Katikaneni, R.O. Idem, R. Sethuraman, R.V. Malyala, and N.N. Bakhshi

Catalysis and Chemical Reaction Engineering Laboratory
Department of Chemical Engineering
University of Saskatchewan, Saskatoon
SK, S7N5C9 CANADA

Branched C_4 hydrocarbons, namely, isobutane and isobutylene are used for many industria applications such as in the manufacture of reformulated gasoline and in alkylation processes Currently, these hydrocarbons are produced in petroleum sources. They may be also obtained using modified Fischer-Tropsch (FT) synthesis process. Our earlier studies have shown that C hydrocarbons can be selectively produced from syngas using a combination of Co-Ni/ZrO_2 (FT) an solid acid catalysts (SO_4^{2-}/ZrO_2, SO_4^{2-}/TiO_2 and Pt-HZSM5) in a single fixed-bed reactor.

This study attempts to improve the selectivity for C_4 hydrocarbons using the above mentione catalysts in two fixed-bed micro reactors in series. The first reactor contained Co-Ni/ZrO_2 catalys while the second reactor contained the solid acid modifier catalyst (SO_4^{2-}/ZrO_2, SO_4^{2-}/TiO_2 and Pt HZSM5). In all these tests, the FT catalyst was maintained at the same operating conditions (250°C, atm and 15 hr^{-1} WHSV) and the temperature of the second reactor was varied from 100° to 300°C. Th FT/solid acid catalyst mass ratios were 1:0.5, 1:1, 1:1.5, and 1:2. Since the solid acid catalysts do no require reduction the second reactor was bypassed during reduction. The performances of these thre solid acid catalysts were compared and explained on the characteristics of these catalysts.

Results reported earlier using Co-Ni/ZrO_2 FT catalyst alone in the reactor indicated an optimum C hydrocarbon selectivity of 13 wt % could be obtained at a reduction temperature of 400°C, reactio temperature of 250°C, reactor pressure 1 atm, and 15 hr^{-1} WHSV. This study showed that there was tremendous increase in the C_4 hydrocarbon selectivity when the SO_4^{2-}/ZrO_2 catalyst was incorporate in the second reactor. The maximum selectivity to C_4 hydrocarbons was increased to 31 wt %, at temperature of 150°C in the second reactor, 1 atm pressure and 15 hr^{-1} WHSV using a FT/solid ac catalyst mass ratio of 1:1. In the case of the SO_4^{2-}/TiO_2 catalyst, the maximum C_4 hydrocarbc selectivity obtained was 19 wt %, at a temperature of 200°C in the second reactor, 1 atm pressure, ar 15 hr^{-1} WHSV with FT/solid acid catalyst mass ratio of 1:1.5. On the other hand, the maximum hydrocarbons selectivity using Pt-HZSM5 was 28 wt %, at a temperature of 250°C in the secor reactor, 1 atm pressure and 15hr^{-1} WHSV using FT/solid acid mass ratio 1:1.

LATEST TRENDS IN MCM TYPE MESOPOROUS MATERIALS AND THEIR NOVEL APPLICATIONS

Girish K. Chitnis

Mobil Technology Company
USA

There has been an explosive growth in research in MCM type of mesoporous materials since their discovery by Mobil in 1991. The M41S family of materials allow tailoring of both structure and well defined pore sizes over a wide, 50-500Å range.

The discrete & well ordered mesopores and potential for custom functionalization of pore walls offer exciting opportunities to develop new applications. Several such applications are reviewed. In particular, the use of MCM-41 for toxic metals removal (mercury, arsenic, etc.) from drinking water as well as industrial waste water is illustrated.

DESIGN AND DEVELOPMENT OF PORE SIZE REGULATED ZEOLITE CATALYST FOR SELECTIVE SYNTHESIS OF PARA-DIALKYLBENZENES

A.B. Halgeri and J. Das

Research Centre
Indian Petrochemicals Corporation Limited
Baroda - 391 346
INDIA

In recent times the need to protect environment has induced chemical industry to develop new, highly selecti zeolite catalysts which yield purer products and avoid side reactions leading to the formation of undesired ar very often toxic byproducts. The present work aims in this direction.

Shape selective alkylation of alkylbenzenes over MFI Zeolites is of great industrial importance owing to t formation of very useful para substituted dialkylbenzenes like para-xylene, para-diethylbenzene, pa ethyltoluene and para-cymene. It has been reported earlier that only near equilibrium mixtures dialkylbenzenes with unmodified zeolites. However, the para-isomer can be enhanced beyond equilibriu compositions by modifying the structure of zeolite. One of the recently developed techniques to achieve high pa selectivity is to modify the zeolite by chemical vapour deposition of silica known as CVD technique. This invol blocking of non-selective external surface and pore mouth sites without altering the internal zeolite structure. report in this study various alkylation reactions of industrial importance including disproportionation of tolue and aromatisation of paraffins over pore size regulated zeolite catalyst to produce selectively para-dialkylbenzen The design of zeolite catalysts through pore size modification by silica deposition and its effect on shape selecti enhancement during mono alkylbenzene alkylation with C_1-C_3 alcohols have been studied. The alkylat reactions included in the study are toluene methylation, toluene ethylation, toluene isopropylation a ethylbenzene ethylation.

The MFI zeolite used in this work was synthesised as per the reported literature. It was characterised by XRD, SEM, MAS NMR and TPD of ammonia. The catalytic runs were carried out in a fixed bed, continuous down f integral reactor at atmospheric pressure. The chemical vapour deposition of silica was done in situ with t ethyl ortho silicate. The large crystal MFI zeolite above 5-7 mμ showed shape selectivity effects and was selec for further studies. The para selectivity of MFI zeolite was achieved by pore opening size regulation. This achieved by depositing vapour of bulky silicon compound whose molecular size is larger than zeolite pore open The internal structure of the zeolite remained unaffected, only the pore opening size was reduced.

On the pore size regulated MFI zeolite, during the alkylation reactions, the alkylbenzene conversion was mor ethylation than methylation. Para-dialkylbenzene selectivities were 100 %, 95 %, 93 % and 88 % respectivel para-cymene, para-diethylbenzene, para-ethyl toluene and para-xylene. This is in order of dialkylbenzenes w in turn is related to diffusivity difference between para- and other isomers. In addition to alkylation reacti selective disproportionation of toluene and aromatisation of paraffins over pore size regulated Ga_2O_3 incorpor zeolite were also studied to produce selectively para-xylenes. The results showed that the content of p-xy enhanced in the range of 80 to 90% in xylene fraction as against 24% over unmodified zeolites. The influen reaction parameters such as temperature, WHSV, mol ratio of mono alkylbenzene to alcohol on the p dialkylbenzene selectivity and stability have been discussed.

The above technique of enhancing para selectivity has been successfully employed to develop a comme process for manufacturing a value added chemical para-diethylbenzene from alkylation of ethylbenzene ethanol. The composite modified zeolite catalyst exhibited a steady state activity of 8-10 % ethyl ber conversion with 97-98% selectivity towards para-diethylbenzene across a single bed. The process is ecofrie does not involve any corrosive or pollutive chemicals. The pore size regulated zeolite catalyst has very stability and is regenerable. The process selectively produces p-DEB and a simple distillation is sufficie separate the desired product, thereby eliminating complicated separation process. The lecture highlights so the unique advantages of pore size regulated zeolites for the selective synthesis of para-dialkyl benzenes ove conventional acid catalyzed reactions.

MILD OXIDATION OF ALKANES FOR OBTAINING VALUABLE CHEMICALS : THE PRESENT STATE OF RESEARCH

Jean – Claude Volta

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The selective oxidation of alkanes is an important field of research for the further 20 years. This appears to be one of the conclusions of the workshop of the American Chemical Society (Washington, March 20-21, 1997). Indeed due to the low cost of raw material, there is a high potentiality for research in that field.

Very important industrial chemicals like acetic and acrylic acids, or moleic and phthalic anhydrides, may be obtained by direct oxidation of light alkanes such as ethane and propane, or n-butane and n-pentane at relatively low temperature (275-430°C). The difficulty for such a catalysis is due to the higher reactivity of the molecular olefinic or oxygenated intermediates which are more reactive than the starting alkanes molecules.

The strong development of research in alkane oxidation to be expected in the future will be a consequence of the results obtained with the study of the oxidation of n-butane to maleic anhydride on vanadium phosphorus oxides (VPO) catalysts. In the last five years, a large number of informations have been obtained on the VPO catalyst due to the development of new routes of preparation of the catalyst precursor and also to the possibility to approach the atomic structure of the materials when crossing complementary physicochemical techniques such as X-ray diffraction, XPS spectroscopy, Raman spectroscopy (in-situ), ^{31}P and ^{51}V solid NMR, High Resolution Electron Microscopy and Electron Conductivity. These techniques give informations on the volume and the surface of the VPO catalysts for which informations are necessary.

For n-butane oxidation at 380-400°C, the VPO catalyst is constituted of a $(VO)_2P_2O_7$ matrix highly developing the (100) crystal face with a suitable number of V^{5+} species in a special environment. The catalytic performances to maleic anhydride production are controlled by the dispersion of the V^{5+} species which depend on the preparation of the $VOHPO_4$, 0.5 H_2O precursor (different routes of preparation have been developed to control this aspect), but also by the conditions of activation of the catalyst which control the V^{5+}/V^{4+} ratio and the defects in the bulk material. A way to change the chemistry of the catalyst is to dope the VPO catalyst by different elements which modify both the redox and the acido-basic properties of the catalyst.

For n-propane oxidation to acrylic acid at 430-400°C, the $(VO)_2P_2O_7$ matrix has to be more oxidized to activate the propane molecule (higher V^{5+}/V^{4+} ratio), but water has to be added to the C_3/air flow in order to improve the acidity (both Brönsted and Lewis sites) to produce acrylic acid. The technical problems associated to acrylic acid (high facility of polymerisation) as compared to maleic anhydride (more stable) makes this research much more difficult.

For ethane oxidation to acetic acid at 275°C, the VPO catalyst has to be modified; it is necessary to disperse molybdenum and vanadium phosphates on a TiO_2 support at a low coverage (less than one monolayer). In reducing conditions, at low contact time and under pressure (7 bars), with addition of water in the flow, acetic acid is obtained at 2% conversion of ethane with a selectivity of 35%. A correlation has been established between the acidity of the surface (Brönsted sites) and the acetic acid yield which is increased by the influence, at short distance, of molybdenum on the vanadium sites.

For n-pentane oxidation to maleic and phthalic anhydrides, at 300-340°C, it is not yet understood what parameters influence the phthalic anhydride/maleic anhydride ratio.

ACTIVITY AND SELECTIVITY OF PROMOTED MgO AND CaO CATALYSTS FOR OXIDATIVE COUPLING OF METHANE

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Oxidative coupling of methane (OCM) is one in the category of promising processes in valorization o natural gas. Proven oil reserves are slowly eroding, while gas reserves continue to grow rapidly, whic contribute to increased global interest in new emerging technologies for efficient conversion of natura gas into higher value products. Development of direct processes as OCM and methane homologatio (MH), avoiding the stage of energy intensive synthesis gas production, are of especial economi interest.

Since the early work of Keller, Bhasin and Hinsen at the Beginning of eighties, the extensive work i the field of OCM precedes, based on thermodynamical and kinetical consideration of the reactio catalytic aspects concerning activity, selectivity and stability of different catalyst types, and als process aspects. Based on comprehensive consideration of the published results in these broad field the paper is especially concerned with catalytic properties of different oxide catalysts as one of th basic factor to move the process from laboratory closer to industrial level.

The results of activity, selectivity and stability of alkali earth metal oxide catalysts promoted by alka metals will be presented. Catalysts like MgO and CaO of different prehistory were doped by K various origin in order to enlighten both the critical factor influencing each of the catalytic properti and the mechanism of promoting effect. Generally observed promoting effect of K on activity ar selectivity is strongly influenced by the precursor, the type of introduced anion, especially towar selectivity. Prehistory of the catalyst determines its initial catalytic behaviour, but the leveling effect observed once the promoter is added, indicating the complex interactions in the system. The stabili of the catalyst in applied reaction conditions is suspected to be still the most critical for efficiency the process.

The preferences and obstacles of OCM process at the present stage of development are compared wi those of an other potential future process aimed to higher hydrocarbon production, i.e. metha homologation. Promoter effects in those different systems extended to different mechanis consideration in one and two-stage processes were focused. Comparisons were made based catalytic behaviour as well as on structural characteristics of different OCM and MH catalysts.

OLEFIN TRANSFORMATION BY HOMOGENEOUS CATALYSIS : THE IFP EXPERIENCE

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Iomogeneous catalysis probably dates to the 1930's with the discovery of the catalytic properties of netal carbonyl complexes. In 1938, Roelen discovered that cobalt complexes catalyzed the olefin ıydroformylation reactions, which is one of the most important processes involving homogeneous atalysis. Later, in 1953, Ziegler and Natta marked a new epoch when they demonstrated the fficiency of titanium complexes associated with alkyl-aluminium compounds for the promotion of thylene and propylene polymerization. Innovation in homogeneous catalysts entered a new era with he discovery of the excellent activities and selectivities afforded by tailor made metallocene complexes ssociated with alkylaluminumoxydes for polymerization reactions.

)uring the late 1950's, Total Petroleum discovered an industrial LPG and gasoline sweetening process ased on soluble cobalt phthalocyanine complexes. It was the first application of homogeneous atalysis inside a petroleum refinery. The IFP Dimersol™ process, developed and commercialized at he end of the 1970's, is another of the rare examples of a homogeneous process involved in the efining industry. Dimersol™ employs a soluble nickel complex and a chloroalkylaluminium ompound (a Ziegler type catalytic system) to oligomerize light olefins in the liquid phase.

oday, there are numerous industrial processes involving homogeneous catalysis. These systems find heir principal application in the production of large scale chemical intermediates and in fine hemistry. Homogeneous catalysis is generally poorly represented in the refining industry.

FP continues to be strongly active in this field, particularly in the development of processes involving lefin transformation. The chemistry, process description, industrial performance and economics of he commercially successful Dimersol™ family of processes, based on the use of nickel complexes, will e detailed, including :

- Dimersol-E, which produces gasoline from FCC ethylene and propylene,
- Dimersol-G which makes hexenes by propylene dimerization.
- Dimersol-X, a key process for the production of octenes for plasticizers by butenes dimerization.

P has also extended the application of our homogeneous catalysis knowledge into the field of etrochemicals. Twenty Alphabutol™ processes have been licensed to produce over 300,000 tons per ar of high purity 1-butene from the selective dimerization of ethylene catalyzed by a titanium based mplex. Our innovation in this field continues with the newly announced AlphaSelect™ process for e production of higher alpha-olefins by ethylene oligomerization. AlphaSelect™ enables an timization of the production of C_4 to C_{10} alpha-olefins from ethylene by employing a zirconium mplex. These alpha-olefins are key components for the production of special quality polyethylene.

e latest in the line of IFP homogeneous catalyst based process innovations is the Difasol™ process. conjunction with Dimersol-X, used as a finishing step Difasol™ ensures a significant boost in tenes yield with a reduction in catalyst consumption. The dimerization reaction is achieved thanks a nickel complex dissolved in an ionic medium which is a molten salt. Both the AlphaSelect™ and e Difasol™ processes will be discussed.

अभिनन्दन

गिरिवर हिमालय उत्तुंग शिखरों से भरा हो देश जो
उद्गम जहां गंगा सदृश, पावन नदी का वेश हो
तीर्थ के परिवेश की, व शिव उमा के देश की
भेंट, अभिनंदन हृदय की, द्रोण नगरी दून की

सरस्वती श्रीराम की, हुई सफल बहु साध
पूर्ण हुई मन कामना, पुत्र मिला प्रसाद

ज्ञान-बुद्धि का अग्रणी, कौशल नित्य प्रवीण
यश, वैभव का रच रहा, था इतिहास नवीन

आविडी भी गदगद हुई, पा यह शिशु अनमोल
पल-पल जग में गूंजते, मान-यशों के बोल

(मां) सरस्वती हर्षित हुई, पा हीरा अनमोल
समृद्ध धरा को कर रहा, वैज्ञानिक सा तोल

बाल्यकाल से ही रहा, धर्म-भक्ति का स्रोत
गुण से सबको रीझता, करता ओत-प्रोत

धन-धन धरती आविडी, धन-धन आन्ध्रा प्रांत
पाल-पोष विकसित किया, जिसने यह शिशु कांत

बने निदेशक, हृदय से, दिया निर्देशन, मान
विश्वमंच पर ला दिया, यह पेट्रो(लियम) संस्थान

केन्द्र बना विज्ञान का, फिर उत्तर प्रदेश
फैलाया विज्ञान को, भारत सहित विदेश

मर्मक्षेत्र विक्रमशिला, कर्मक्षेत्र गुजरात
लेकिन तप, यश से किया, ऊंचा भारत माथ

रहे अमर यह विश्व में, फले ज्ञान विज्ञान
नित निर्देशन यूँ मिले, अमर रहे संस्थान

यश वैभव बढ़ता रहे, दिन-दिन जीवन मान
पग-पग का परिचय रहे, पेट्रोलियम संस्थान

संस्थान करे यह कामना, हर्ष-हर्ष उत्कर्ष
तेरे नव-नव ज्ञान से, महके भारतवर्ष

निदेशक डॉ० टी एस आर प्रसादराव
को संस्थान की ओर से भेंट

रचयिता : डॉ० दिनेश चमोला, 1 जनवरी, 1999

Dr. T.S.R. PRASADA RAO – A PROFILE

Prof. Chunshan Song*

It gives me a special pleasure to write this article for the Felicitation Volume in honor of Dr. T. S. R. Prasada Rao on the occasion of his 60th birthday. I have had close interactions with Dr. Prasada Rao in the past several years. Personally, I have high respect for Indian catalysis community, and quite a few young researchers from India have worked with me in our laboratory. I first met Dr. Prasada Rao at the International Catalysis Congress in Baltimore in 1996 by the introduction of one of my coworkers, Dr. K. Madhusudan Reddy who completed his PhD research in National Chemical Laboratory in Pune under Dr. S. Sivasanker and Dr. Paul Ratanasamy. Dr. Prasada Rao kindly invited me to present an invited lecture at the Indian Catalysis Society National Meeting in Dehra Dun in 1997. I accepted the invitation, but due to the delay in receiving the invitation and the short time in making the travel arrangements within our busy schedule, we were not able to make the trip although I did contribute a review paper to the proceedings. He called me several times, which deeply moved me, and in a long phone conversation, he made me to promise that I will attend the next meeting in Madras in 1998. Later during his trip to US, he accepted our invitation to visit our laboratory at the Pennsylvania State University in March 1998, and gave an inspiring lecture on the development of catalytic processes. Most recently I visited India by kind invitation from Prof. V. Murugesan and Dr. Prasada Rao for giving a plenary lecture at the 14th Indian Catalysis Society National Meeting in Anna University in Madras during December 16-18, 1998. In this trip I also had opportunities to visit National Chemical Laboratory in Pune (hosted by Dr. Paul Ratanasamy and Dr. A. V. Ramaswamy), Indian Institute of Petroleum in Dehra Dun (hosted by Dr. T. S. R. Prasada Rao and Dr. Murali Dhar), and Research Center of Indian Oil Corporation (hosted by Dr. R. P. Verma and Dr. Sobhan Ghosh). I enjoyed the meeting and discussions during the catalysis symposium and during my visits to the laboratories of the leading researchers at the above-mentioned organizations. Through this trip I developed a deeper appreciation for Dr. Prasada Rao's leadership and I am proud to have known Dr. Prasada Rao as a professional colleague and a close friend.

A brief discussion is due here on leadership since I characterized him as a highly successful leader. In plain words, leadership determines what are the right things to do, and management skills concern how to do the things right. What distinguishes an effective leader in a research organization from an effective researcher? Having worked in industrial R&D center and in academia and interacted professional colleagues worldwide for sometime, I would like to share my own perspectives. Many scientists prefer to become an accomplished researcher in terms of quality and productivity of his or her own research or their research group, but this often more or less independent nature of research process could make the effective management of a large organization a little more difficult. In some cases where the mental environments are not so ideal, researchers and workers in different groups may not be very cooperative with each other. This can create a different mind set in people that could jeopardize the whole organization in long run. In my opinion, an effective and dynamic leader in a large research institute should possess first of all the right vision for the future, the clear mission for the organization, good interpersonal skills with sincere respect for the people, the ability to create new initiatives and to delegate responsibilities, the capacity to understand different views and concerns by the people at the working level, the skills to solve problems in a timely manner, the ability to shift the paradigm of thinking by the people in the organization to a cooperative and productive regime, and the capability to interact effectively with key personnel in government agencies, industries, national laboratories, universities and professional organizations. To be effective in understanding the concerns of the scientists and the key challenges in research and development, the leader should have extensive experience and track record as a successful researcher.

Dr. Prasada Rao has what it takes to be a highly successful and dynamic leader, and has proved his strong leadership in leading IIP to become a major institution with nation-wide and worldwide recognition. After my recent visit, I have no doubt that most people in Indian

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Institute of Petroleum would agree with me on this view. I myself have learnt a lot from discussions with him, particularly during our recent trip together from Delhi to Dehra Dun by car. He told me that he cared most about people and explained to me how he evaluated the situations when he first moved to IIP in 1990, how he interacted with people, what he did to change the work environment and to motivate the employees, how he built the cooperative relations with refining industries, and how he and his associates transformed IIP and what is he is continuing to do to make IIP into a global presence. Each of these was very challenging at the time, and he did all this with his associates and apparently he enjoys what he does. It was intellectually enriching to see his leadership, managerial skills, technical and the personal aspects that are all consistent with an underlying philosophy in life. At this point it is appropriate to mention his career development. He was born on January 20, 1939 in Southern India. He completed his educational training (Bachelor, Master and PhD) from the Andhra University in 1967 and then joined Projects and Development India Limited, Sindri, where he worked on temperature-shift fertilizer catalysts. In 1974 Dr. Prasada Rao moved to the Research and Development Center of India's first petrochemical company, the Indian Petrochemical Corporation Limited (IPCL) in Baroda. He worked on catalysis for petrochemical and refining technology at IPCL and was also responsible for the entry of IPCL into the global business of catalyst manufacture. At IPCL Dr. Prasada Rao is best known for developing the xylene isomerization catalyst "Encilite" in collaboration with researchers at the National Chemical Laboratory in Pune. Additionally, at IPCL, Dr. Prasada Rao was intimately associated with building and managing a first-class research facility in catalysis, adsorbents and polymers. In 1990 the Government of India persuaded Dr. Prasada Rao to move as Director of the Indian Institute of Petroleum (IIP) in Dehra Dun.

Several senior and junior researchers at IIP told me that this institute was not a well-recognized one in India and the Indian refining industries did not have much tie with it in the late 1980s. However, there have been dramatic changes after Dr. Prasada Rao was appointed to the Director of IIP in 1990. Since then, Dr. Prasada Rao and his associates have transformed IIP into India's premier refining technology center with a global presence. This is reflected by the facts that IIP has forged alliances with almost the entire Indian refining industry as well as Amoco, Mobil, UOP, Stone and Webster, Unitel Technologies, Dorf Ketal, HTI, ABB Lummus, and Praxair. At IIP he has been involved with initiating and monitoring new research and development initiatives at IIP including liquid phase oxidations, zeolite catalysis, separation processes and refining technology. What I was most impressed with was that under his leadership, mostly the same employees have made great strides in the same IIP in the past eight years. He remembers the names of the 600 employees in IIP as well as his family members. In addition to the institute-wide achievements, the notable scientific contributions by Dr. Prasada Rao's own research group at IIP include development of a single-step adipic acid synthesis process and the Naphtha to Gas and Gasoline (NTGG) process. I have seen from the display at IIP during my recent visit that IIP has won CSIR Technology Award 7 times under Dr. Prasada Rao's leadership with the most recent one awarded in 1998.

During my stay in Madras for the 14th Indian Catalysis Society National Symposium a Anna University, I heard several young researchers, who never worked at IIP nor directly associated with him, expressed their gratitude t Dr. Prasada Rao for help bringing financia support for their catalysis research. Late Dr. Prasada Rao told me that "all catalysi researchers in India are my friends". Whe introducing me for my lecture at IIP, he also tha "Professor Song is a friend of India" (partl because several young researchers and graduat students from India have worked with me in ou laboratory). In my opinion, it takes a great min to be able to make such statements naturall and he has certainly devoted his energy and tim to his country by his outstanding contributions i enhancing the research and development i Indian catalysis community.

The dedicated efforts and outstandin accomplishments of Dr. Prasada Rao have bee recognized by many prestigious awards, such a the Kuloor Memorial Award in 1992; FICCI Awar in 1993 by the then Prime Minister of Indi Mr. P.V. Narasimha Rao; Kamal Kumari Nation Science and Technology Award in 1995; KG Na

Gold Medal in 1996; Eminent Scientist Award by Catalysis Society of India in 1997; Om Prakash Bhasin Award in 1996; CHEMTECH Academic Award in 1998; and Fellowship of Science and Engineering Academies in India. As such, it should come as no surprise that Dr. Prasada Rao as a resource has been widely tapped by the government of India on India's highest bodies governing oil policy (Oil Industry Development Board), science policy (Society of the Council of Scientific and Industrial Research), education, and industry. In addition to his tireless efforts in leading IIP to become a global R&D organization, Dr. Prasada Rao has over 100 research papers, 25 patents and 3 books to his credit. He has served on the editorial board of Applied Catalysis journal, has represented India at the International Congress of Catalysis for the past 10 years and has served as President of the Catalysis Society of India.

Integral to Dr. Prasada Rao's achievements have been his wife, his son and his daughter. I happen to have had opportunities to know his son and his wife. Dr. Prasada Rao has always had a very busy schedule, traveled so much and worked in the train and in the car, but in the same time he has been a caring and loving father and husband. He cared about his family as well as the institute. I can see that from how his son, Uday Turaga (who currently works with me in our laboratory) admires his father.

Finally, I would like to congratulate Dr. Prasada Rao for his monumental achievements in research and development in Indian catalysis community and for his highly successful professional career and personal life, and I wish him continued success. I would also like to thank the Catalysis Society of India for the kind invitation to visit India and for the invitation to contribute this article.

अभिनन्दन

◆वीरेन्द्र सिंह सैनी
भारतीय पेट्रोलियम संस्थान, देहरादून

गिरिराज संदेश की शीतल समीर से महके ये क्षण ।
लिए अदभुत शान, गौरवशाली संस्थान का प्रत्येक कण।
विश्व का जन-जन, लिए पुलकित मन, विद्वता का कर रहा है नमन।
अभिनन्दन, अभिनन्दन, प्रसाद राव जी हार्दिक अभिनन्दन॥

अथक परिश्रम, उचित मार्गदर्शन से उठा यह संस्थान!
जिसकी उपलब्धियों से विश्व अब नही अनजान!
निरंतर औद्योगिकी शील्ड, विशिष्ट फिक्की सम्मान।
दर्शा रहा, उद्योग में आपका विशेष योगदान।

संयंत्रों के पीछे से उगती रवि की किरण, विद्वता का कर रही है नमन।
अभिनन्दन, अभिनन्दन, प्रसाद राव जी हार्दिक अभिनन्दन॥

अनुसंधान, शोध, कैसा भी प्रयोग, धनराशि अपार।
शोध से न उचटे मन, सुविधाओं में अपार विस्तार।
फोन घर-घर, गैस जब चाहे तब, वाहन तत्पर तैयार।
चिर संजोया, केन्द्रीय विद्यालय का किया सपना साकार।

परिसर की शान, बगीचे व उद्यान से आती पवन, विद्वता का कर रही है नमन।
अभिनन्दन, अभिनन्दन, प्रसाद राव जी हार्दिक अभिनन्दन॥

शक्ति सृजन, आपकी प्रेरणा, श्रीमती सुजाता, विशिष्ट व्यक्तित्त्व।
साक्षरता को समर्पित, निश्छल हृदय में भरा वात्सल्य मातृत्त्व।
हम करें प्रार्थना, मंगल कामना, गुरूद्वारा मंदिर मस्जिद व चर्च।
ऐसे प्रगति करो, आगे बढते रहो, ख्याति फैले धरा से नभ तक॥

रसायनों से जुडा हर उत्प्रेरण, विद्वता का कर रहा है नमन।
अभिनन्दन, अभिनन्दन, प्रसाद राव जी हार्दिक अभिनन्दन॥

THE CATALYSIS SOCIETY OF INDIA AND ITS ACTIVITIES TO FOSTER CATALYSIS RESEARCH

Dr. S. Sivasanker*

The catalysis society of India (CSI) was founded in March 1973 at Banaras with Prof. S.K. Bhattacharyya as the president and Prof. J.C. Kuriacose as the Secretary. The society has already completed 25 years of existence. The society has been growing continuously and has a membership (Life) of more than 500 at present. The main mandates of the CSI are to encourage catalysis research in India, to organize professional meetings between the researchers to enhance mutual interactions and to encourage cooperation between the industry and the academia. Excellent articles on the founding and achievements of the society have been written by Dr. K.K. Bhattacharyya and Dr. N.M. Gupta in the 'Souvenir' of the 13th national Symposium on Catalysis. There is really not much that can be added by me to the above articles within a year. I will make a general presentation of the catalysis research scenario in India and the role played by the CSI in promoting catalysis research.

Growth of Catalysis Research in India

The number of life members in the catalysis society is an indirect measure of the catalysis research activity in the country. As already mentioned, this number is now atleast 500 compared to the 75 in 1974. At the time of the founding of the CSI, the major centres of research in catalysis were just a handful, the IITs at Madras and Kharagpur, PDIL at Sindhri, IIP (Dehradun) and IPCL (Baroda). Catalysis research activity has spread to many more organizations during the past 25 years. The important research centres today are (based on the presence of atleast 10 life-members in CSI from the organization) are IIT (Madras), PDIL, IIP, IPCL, NCL (Pune), IICT (Hyderabad), CSMCRI (Bhavnagar), BARC (Mumbai), CFRI (Dhanbad) and RRL (Bhubaneshwar). The importance attached to catalysis research in these organizations is also evident from the fact that all of them have hosted either a catalysis symposium or a workshop during the last 25 years. Other important places of research in catalysis are RRL (Tiruvananthpuram) which conducted a workshop recently, IISC (Bangalore), IOC (R&D), MRL (R&D), ACC (Thane) and HLL (Mumbai).

During the last two decades, the catalysis community in India has made significant strides both in applied and fundamental research. Many catalysts and processes have been developed and commercialized, notably by IIP, IPCL, NCL and ACC in petroleum refining and petrochemicals manufacture and by PDIL in fertilizers production. In basic research also, members of the society have made important discoveries in catalysis resulting in publications in prestigeous journals such as Nature and Science. In catalysis education, whereas only the IITs and a few Universities were active during the seventies, today Ph.D. students can be found in nearly all the organizations mentioned. An interesting development in catalysis education is the introduction of a two year M.Tech. course in Industrial Catalysis at the Cochin University of Science and Technology recently.

An important activity of the CSI is the organization of national symposia and workshops on catalysis jointly with host organizations. In recent times, there have been so many foreigners participating in these meetings that they have virtually become international events. So far, the CSI and host organizations have jointly organized 14 National symposia and 6 workshops. These meetings have been enormous successes with about 300 to 500 participants. A large number of papers (at least 100) are presented and discussed with wide dissemination and exchange of ideas. Besides, meetings (short symposia) are also arranged by the local chapters of the society for various reasons, very often to honour a scientist at the time of his superannuation. All these meetings conducted under the auspices of the CSI have been important in the development of catalysis research in India.

Another important activity of the CSI is the publication of the 'Bulletin of the Catalysis Society of India' on a bimonthly basis. The bulletin has a readership of more than 550 persons in India (mostly Life and Corporate Members). Original research articles and reviews submitted by the CSI members are published along with news-briefs covering the activities of the individual members and zonal chapters and

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abstracts of recent publications by its members. The bulletin acts as a window to look at the activities of the various research groups in India and is also a source of information on the recent happenings in catalysis in India and abroad.

The CSI has also been encouraging catalysis research through its awards, the 'Eminent Scientist Award', the 'Young Scientist Award' and the 'L.M. Yeddanapalli Award'. Awards are statements of appreciation of the work done by the individual, and encourage the person to achieve more.

The future of catalysis research in India

One of the objectives of the CSI is to encourage industry - academia interactions for mutually beneficial collaborative research. Though these interactions have definitely increased since the inception of the society, the level of collaboration is still not very high. Contrary to the trend in developed nations where most catalysis research in academic institutions is supported by the industries, in India, most of the funds come from government agencies such as the CSIR and DST which are not the users or direct beneficiaries of the research. This results in a large amount of research not of much relevance to the industry. Even the petroleum and petrochemical industries, who are the major users of catalytic processes, do not carry out much R&D work (except IPCL and IOC). Their support to external research is also rather small, which could partly be due to the lack of suitable research proposals (of interest to the industry) from the academia.

The opening up of the Indian market for global business has resulted in many partnerships between Indian and foreign organization. For example, a good amount of catalysis research carried out at NCL is in collaboration with multinationals. It should also be possible for the academic institutions in India to enter into collaborative research with foreign industries. Again, with the opening up of the Indian market for global business, catalysis research aimed at indigenization of existing catalysts and processes has lost relevance. The focus of future research should be towards globally competitive catalysts and processes which can be exported to other countries.

A predominant amount of catalysi research in India is centred around th characterization of catalysts and laboratory leve catalytic reaction studies (of limited value). Les work is being done on the understanding of th preparation of catalysts. This has resulted i notably few novel Indian catalysts or catalyti materials (or even crystalline microporou materials which are being continually discovere outside India!).

In the area of catalyst/proces development and commercialization, or bottleneck is the limited availability engineering support by way of process an reactor design. Only a few organizations have th ability to carry out integrated research fro laboratory level studies to proces commercialization.

Worldwide, catalysis is now not on perceived as the route to economic benefits, bu also as a means of saving raw materials an prevention of ecological damage. Th development of green processes and pollutio abatement catalysts has acquired importance present.

Today, the most wasteful operations a carried out in the organic chemicals ar pharmaceuticals industries. Many of t synthesis and reaction steps used in the industries are based on discoveries made ma decades ago when environmental concerns we absent. The byproduct yields in many process are 5 to 100 times that of the desired product d to poor product selectivities and the many ste involved. This results in economic penalti waste of raw materials and environmen problems. It is believed that highly selective e friendly catalysis based organic transformatio will become important in the fine chemical a pharmaceutical industries in the near futu Again, catalysis in the synthesis of ch compounds is expected to grow rapidly. Ot areas of importance are the hetrogenization many homogeneous catalysts in indust practice, the immobilization of enzymes and synthesis of enzyme mimics. The last mentio area assumes importance as enzymes are by the most efficient catalysts known, nature hav taken millions of years to design them.

In the preceedings pages, I briefly recounted the activities of the CSI, its growth through a symbiotic relationship with the catalysis researchers in India and the future trends in catalysis research in India and elsewhere. The catalysis society will continue its role as a go-between the researchers and encourage research through its many activities. With the changing economic scenario in India, catalysis research activities in India will also undergo many changes in objectives, focus and partnerships. I believe that the members of the CSI will overcome the challenges and continue to contribute to the growth of our Nation. One of the reasons for the continued success of the society has been the excellent cooperation of the members which I am sure will continue in the future also. With such a large research activity in catalysis, it is time that we had a research journal in catalysis of international standard published in India. I hope that the catalysis bulletin will ultimately grow to be an international journal with the cooperation of the research workers. I also anticipate that the catalysis society's activities will become globalized by conducting international meetings and joint symposia with societies from other countries. The first step in this regard has already been taken; the present 'International Symposium on the Frontiers in Catalysis in the 21st Century' arranged by the Northern Chapter of the CSI in honour of Dr T S R Prasada Rao is probably the beginning.

संस्थान 'गीत'

स्वच्छ सुनिर्मित अनुपम छविमय
देश के गौरव की पहचान,
नमन करें इसको सब मिलकर
होता जिसमें अनुसंधान ॥०॥
उत्तम मानव संसाधनमय
गुणवत्ता नीति में श्रेष्ठ
गरिमामय मानस से अलंकृत
'सर्वो' है जिसका अभिषेक
उन्नत अपना कार्यक्षेत्र है, उन्नत अपना है विज्ञान
नमन करें इसको सब ------------ ॥1॥
तेल ग्रीस ईंधन परिशोधन
उत्प्रेरक इन्जिन विश्लेषण
पैट्रोलियम के इन क्षेत्रों में
होते जहाँ नये अन्वेषण
विकसित उत्पादों को मिलता, है पर्यावरणीय परिधान
नमन करें इसको सब--------------- ॥2॥
गर्व करें हम अपने केन्द्र पर
जिसको मिले कई सम्मान
प्रगति को जिसने अपनाया है
बनता जिससे देश महान
पूर्ण समर्पित हो कार्यों में, करते रहें यही गुणगान
नमन करें इसको सब ------------॥3॥

IIP : A PREMIER R&D ORGANISATION

*Dr. K.S. Jauhri**

A BRIEF HISTORY

The Indian Institute of Petroleum (IIP), one of the Constituent Laboratories of CSIR, was established in 1960 to provide R&D support to down stream sector of hydrocarbon industry. Located at Dehradun, in the picturesque Doon Valley, IIP received technical support from world famous Institut Francias du Petrole (IFP), France, in its formative years. R&D facilities received impetus from various organisations like UNDP, UNIDO, OIDB, World Bank, CHT, etc. from time to time.

IIP, right from its inception, is dedicated to the service of hydrocarbon industry in providing scientific and technical support, development and transfer of technologies & products and, training of technical personnel from industry. In its almost four decades of existence, it has developed 62 technologies, licensed 71 plants to industry, published over 2000 papers and filed 145 patents. The cumulative capacity of the plants so far licensed is about 28 million tonnes per annum.

IIP has been accredited with ISO 9001 certificate since March 1998.

IIP's QUALITY POLICY

Indian Institute of Petroleum is committed to develop into an internationally reputed R & D centre of excellence for providing globally competitive technologies and services for Hydrocarbon and related industries. This will be achieved through total quality management and by anticipating and exceeding the expectations of customers through innovation, team work and commitment.

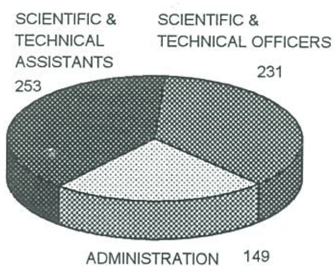
OBJECTIVES

- Develop innovative and frontier technologies and products.
- Maintain high level of scientific, technological, marketing and managerial competence.
- Excellence through team work, motivation and dedication.
- Provide customer satisfaction through meeting commitments on quality, cost and delivery schedule as per the contract.

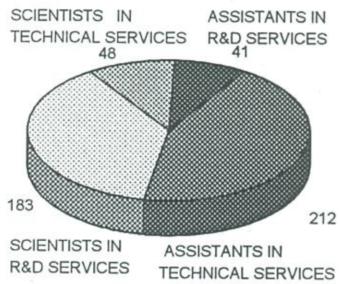
OUR RESOURCES

Human . IIP is particularly gifted with dedicated, highly experienced and well qualified staff. It has 230 R&D Scientists/Engineers and 253 skilled Technical personnel amongst its total staff of 635. Nearly 30% of its R&D scientists and engineers are doctorate degree holders. IIP is recognised by prestigious academic institutions of the country, to conduct research leading to Doctorate degrees. IIP has so far produced 70 Ph.D's in different disciplines relevant to R&D activities of the Institute. In its endeavor to constantly upgrade the scientific & technical capabilities of its staff, IIP sends them abroad as well as organises training/ reorientation programmes for them within the country.

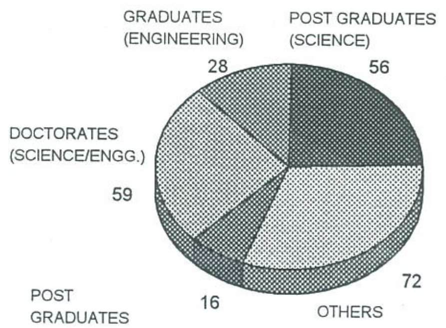
TOTAL STAFF



SCIENTIFIC & TECHNICAL STAFF



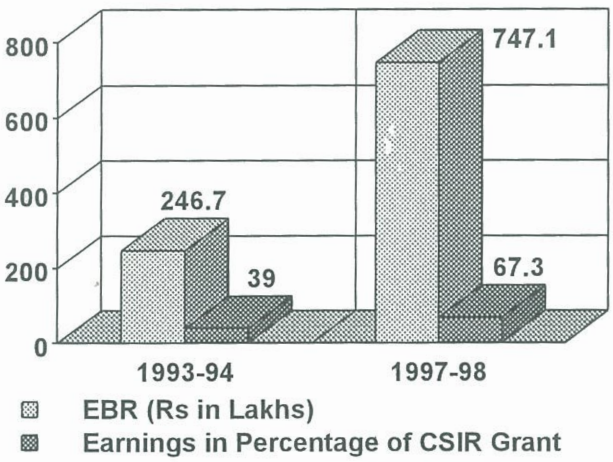
PROFILE OF SCIENTISTS & ENGINEERS



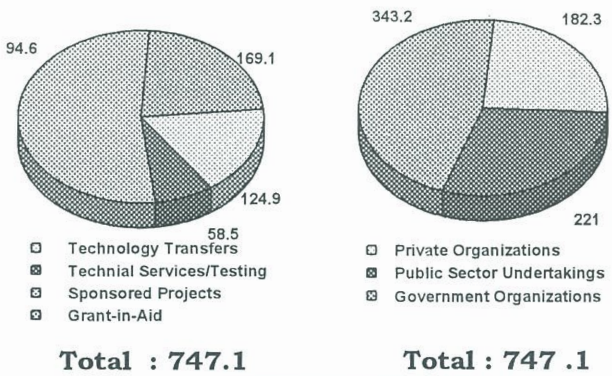
Library . With one of the best libraries in the field of petroleum processing and related areas in the country, IIP keeps its scientific brains updated on the latest developments in their fields. The current holdings of IIP library include 15,000 books, 15,000 bound volumes of journals and around 3000 miscellaneous publications. It regularly subscribes to nearly 140 periodicals, most of them being key publications in their areas.

* *Area Leader, Business Development, Technical Services Division, Indian Institute of Petroleum, Dehradun (INDIA)*

Finance . IIP receives annual grants from Government of India through CSIR, its parent body. Apart from this source of funds, IIP also earns money from other sources through sponsored R&D programmes, technical services, and technology marketing. Such earnings are called Extra Budgetary Resources (EBR). The surplus money from EBR is accumulated in a kitty called Lab Reserve Fund (LRF). IIP's earnings from EBR have been constantly on the rise during the last 8-9 years. Today IIP earns nearly 80% of its CSIR grants from such sources. Our endeavor is to become self-supporting non-profit organisation in near future.



MARKS OF GROWTH



EBR Break-up 1997-98 : (Rs. in Lakhs)

Infrastructure . IIP has a very strong infrastructural support for its R&D activity, which is essential for such developmental work. It has a very comprehensive, sophisticated and state of art facilities for analysis, evaluation and testing of petroleum crude oil, its products and chemicals. IIP has, in recent years, embarked upon major modernisation programmes to make its facilities most modern. State-of-art equipments worth Rs. 35 crores have been added within the last 3-4 years with the help of funds from OIDB, CHT, World Bank and our own internal resources. The Institute has well equipped workshops for design and fabrication of both metallic and glass equipments required for conducting its research work, and has its own captive power generation and water supply systems.

R&D AREAS AND ACHIEVEMENTS

The Institute is carrying out R&D work in the areas of Petroleum Refining, Catalysis, Chemicals & Petrochemicals, Application of Petroleum Products in IC Engines, Industrial and Domestic Combustion, Biotechnology and Analytical Sciences.

Petroleum Refining and Catalysis

IIP is engaged in R&D work in almost all major processes being used in a refinery, be these physical separations, catalytic conversions or thermal conversions.

Separation Technologies have been developed for separation of aromatics from various refinery streams like reformer and pyrolysis naphtha, raw cut hexane, kerosene and raw lube oils, using specific solvents. Our other solvent separation technologies include dewaxing, deoiling, deasphalting, and purification of ultrapure compounds through adsorptive separation processes. All these technologies have been licensed to industry.

Development of Catalytic Conversions Processes include : (i) Catalytic reforming to produce lead-free, high octane gasoline as well as aromatics like benzene, toluene and xylenes, (ii) Hydrodesulphurisation of various refinery streams like naphtha, diesel and vacuum gas oil, (iii) Hydrocracking, (iv) FCC, (v) Sweetening of LPG, naphtha and kerosene, and (vi) Residue upgradation. Proprietary catalysts for all these processes either have been developed or are being developed. A noble metal catalyst and wash coat technology for catalytic convertors have been developed. Latest developments include, conversions of light naphtha and NGL to LPG and aromatics.

Thermal Conversion Processes like visbreaking and delayed coking have been developed and are in use in Indian refineries. Almost all earlier oil visbreakers in the refineries have been revamped using our state-of-art soaker visbreaking technology.

Chemical Sciences

IIP is engaged in process development of bulk intermediates, additives and speciality chemicals. It also undertakes studies on electrochemistry and corrosion. Work is also being carried out on utilisation of renewable sources for energy and speciality chemicals.

Processes for **Bulk Intermediates** like adipic acid, isophthalic acid and purified terphthalic acid have been developed through novel ecofriendly synthesis routes. These technologies have evoked interests globally.

Processes for **Additives** like phenolic/amines types of antioxidants, wax crystal modifiers to improve cold flow properties of distillate fuels, multifunctional additives for lubricants, fuels and chemicals for enhanced oil recovery have been developed.

Processes for production of **Speciality Chemicals** like sulfolane and N-Methyl Pyrrolidinone (NMP) have been developed . An Indian company has become the third company in the world to produce sulfolane. Production of alcohols from n-paraffins is also in advance stage of development.

Basic engineering packages for all the above processes have been developed by the Institute. IIP also provides consultancy services for revamping of chemical plants.

Petroleum Products Application

IIP has one of the most comprehensive facilities in the country for applications of liquid and gaseous fuels and lubricants in IC engines. It has been rendering regular S & T support to the petroleum, automobile and related industries for evaluation and upgradation of their products.

Alternative Fuels . IIP has been carrying out extensive studies on partial replacement of gasoline and diesel by substitute fuels like alcohols (methanol and ethanol), natural gas, LPG and biogas in automotive vehicles. Extensive field trials have been conducted to establish the technical feasibility of use of such alternate fuels. IIP is the first organization in the country to successfully convert a three wheeler vehicle into a natural-gas-operated vehicle.

Engine Emissions are also biggest sources of atmospheric pollution. IIP is very much alive to this serious meanace. Extensive studies are being done in this area and S & T support is being given to industry. The laboratory is approved by the Ministry of Trasnport, Govt. of India for Type approval of vehicles and emission measurement equipment.

Tribology is the science of friction between moving surfaces. IIP is carrying out basic studies in this area and is also providing technical support to industry in the evaluation of their products and development of new products and techniques.

Regular assistance is being provided to Petroleum Conservation Research Association (PCRA) in evaluation of products for conservation of fuels and lubricants, and to Bureau of Indian Standards (BIS) in formulating standards for different petroleum products.

Industrial and Domestic Combustion

IIP has been highly successful in developing thermally efficient combustion appliances, both in industrial and domestic sectors, leading to significant conservation of fuels. Low air pressure (LAP) film burner developed by IIP, is being successfully commercially exploited and is in extensive use in various industries. Domestic appliances like LPG stoves, pressure and wick kerosene stoves developed by IIP have highest thermal efficiency among the products available in the Indian market. IIP also regularly provides its evaluation facilities in this area to industry. Design and development of a natural gas / LPG industrial burner is in its advance stage of completion. The Institute has provided technical support in the rural sector by improving performance of Gur making furnaces, which has resulted not only in a significant increase in the productivity but also reduced emission due to improved combustion of fuels in the furnace.

Biotechnology

The Institute has been engaged, since its inception in hydrocarbon transformations through biotechnology. The process for production of single cell proteins was developed upto pilot scale. Current researches in this area include microbial desludging of crude oil storage tank bottoms, production of microbial lipids and biodesulphurisation of diesel. Facilities for determination of biodegradability of lubricating oils have also been created to develop biodegradable lubes.

Analytical Sciences

IIP specializes in detailed analysis and evaluation of all kinds of crude oils, refinery products like fuels, waxes, lube oils, bitumens, asphalts, etc., feed stocks for secondary conversion proesses, petrochemicals, catalysts, greases, additives, clays, etc. IIP is well equipped with state-of-the-art analytical equipments for this purpose. It caters to the analytical requirements of industries also.

Market Surveys & TEFRS

IIP conducts market demand surveys and prepares techno-economic feasibility reports for various products and processes as and when desired by a client. Several of such jobs lead to serious business propositions based on the outcome of such reports.

Training

As per the mandate given at the time of its creation, IIP conducts specialized training programmes for technical personnel from refineries, petrochemical plants, automotive industry and power plants. These advance courses are designed as per specific requirements. Faculty is mostly drawn from the Institute itself but experts in specific areas from other organisations are also invited to give lectures. IIP has so far trained nearly 3000 personnel from various industries.

IIP also trains young students doing their engineering, graduation and post-graduation studies in specific areas from various academic institutions.

RECOGNITIONS

The Institute and its Scientists have received many prestigious awards in recognition of excellence in various fields. IIP has a rare distinction of bagging eight CSIR Best Technology Awards in the past nine years of institution of such awards by CSIR. Two of its Scientists have bagged Best Young Scientist Award of CSIR. IIP has also received FICCI, ICMA & NRDC awards many times for its technologies. Individual scientists have the honour of being bestowed with prestigious awards like Om Prakash Bhasin Award, Kamal Kumari Foundation Award, Hari Om Prerit Shanti Swaroop Bhatnagar Award, FICCI Award, Catalysis Society of India Award, etc.

IIP is recognized by prestigious academic institutions in the country to conduct researches leading to award of Doctorate degrees.

OUR ASSOCIATES IN PROGRESS

From its inception IIP has followed a consortium approach for development of its technologies and providing the total engineering packages to its clients. Most of the R & D projects have industrial partners in development. Technologies have been developed in collaboration with organizations like EIL, IOCL, HPCL, BPCL, MRL, CRL, IPCL, GAIL, PCRA, NRDC, etc. Although administratively linked with CSIR, the Institute has very close links with Ministry of Petroleum & Natural Gas (MOPNG) and its several outfits like Oil Industry Development Board (OIDB), Centre for High Technology (CHT), Oil Coordination Committee (OCC) and Petroleum Conservation Research Association (PCRA). Major R&D projects are also being undertaken with able guidance and support of Scientific Advisory Committee of MOPNG.

We also have support from Department of Scientific & Industrial Research under its PATSER Programme, ICICI under their SPREAD programme, Technology Development Board, Department of Science and Technology, Ministry of Non Conventional Energy Sources, Ministry of Surface Transport, Ministry of Environment & Forest etc.

Globalization

With liberalization of Indian economy to integrate with global economy, IIP too has moved towards globalization of its technologies. With major thrust in last four years in this direction, we have been able to forge alliances with prestigious international companies in USA like Stone & Webster Engg. Corpn., Mobil Corporation, UOP, AMOCO and ABB-Lummus, for global marketing of our technologies, contract R&D or joint ventures. IIP is a partner in a consortium of IOCL, GAIL & AMOCO for production and marketing of dimethyl ether as a substitute fuel for power plants, diesel vehicles and domestic combustion appliances.

Our business association with Institut Francaise du Petrol (IFP), France is almost four decades old. We co-licence certain IFP technologies like catalytic reforming (both SR & CCR types), hydrodesulphurisation of various refinery streams, hydrogenation of pyrolysis gasoline in India. Twenty five commercial plants have been licensed jointly in India with a cumulative licensed capacity of 19 million tonnes per annum.

We also provide our technical services to companies like Exxon, Mitsubishi, Suzuki, Enron etc.

THE CAMPUS

Around 8 km away from Dehradun City at Haridwar Road, IIP is situated amongst 260 acres of lush green tea gardens. Its southern boundary touches the dense forests of Shivalik Hills while the front has a beautiful view of Himalayas. Its R & D and infrastructure facilities are housed in seven major buildings spread over nearly half of the Estate, while the other half has residential complex for its staff. It has its own medical facilities, water supply system, a central school, LPG supply agency, a cooperative store for sale of essential food items and a fair price shop. The guest house has 40 single and 20 double room suits to house trainees and guests. A community centre provides facilities for indoor games and library of staff club. It is also used as venue for various social functions of the community.

IIP-IFP TECHNOLOGIES LICENSED TO INDUSTRY

TITLE OF TECHNOLOGY	UNIT	LICENSED CAPACITY TPA
1. CATALYTIC REFORMING (INCLUDING NAPHTHA PRETREATER)	IOC, HALDIA	196,000
	BRPL, BONGAIGAON	80,000
	IOC, (AOD), DIGBOI	90,000
	IOC, BARAUNI	300,000
	IOC, MATHURA(CCR)	500,000
	IOC, PANIPAT(CCR)	500,000
	ESSAR, JAMNAGAR (CCR)	900,000
2. KEROSENE HYDRODESULPHURISATION	IOC, HALDIA	577,600
3. GAS OIL HYDRODESULPHURISATION	MRL, CHENNAI	224,000
4. PYROLYSIS GASOLINE HYDROGENATION	IPCL, VADODARA	111,560
	HPL, HALDIA	230,000
	RIL, MUMBAI	474,160
	NOCIL, MUMBAI	264,000
5. NAPHTHA PRETREATER (HDS)	ZUARI AGRO, GOA	140,000
	SPIC, TUTICORIN	215,000
	IPCL, VADODARA	128,000
6. DIESEL HYDRODESULPHURISATION	MRL, CHENNAI	1,800,000
	HPCL, VIZAG	1,800,000
	CRL, COCHIN	2,000,000
	IOC, MATHURA	1,200,000
	IOC, PANIPAT	900,000
	ESSAR OIL, JAMNAGAR	3,300,000
	BHARAT-OMAN	1,600,000
7. DELAYED COKER NAPHTHA HYDROTREATER	ESSAR OIL, JAMNAGAR	300,000
8. DELAYED COKER GAS OIL HDS	ESSAR OIL, JAMNAGAR	1,230,000
		19,060,320

IIP TECHNOLOGIES LICENSED TO INDUSTRY

PROCESSES

TITLE OF TECHNOLOGY	UNIT	LICENSED CAPACITY TPA	
1. AROMATIC EXTRACTION FOR PRODUCTION OF BENZENE & TOLUENE (IIP-EIL)	BPCL, MUMBAI	97,000	(BENZENE)
		17,000	(TOLUENE)
	CRL, COCHIN	87,000	(BENZENE)
		20,000	(TOLUENE)
	NOCIL, MUMBAI	90,000	(BENZENE)
		10,000	(TOLUENE)
2. FOOD GRADE HEXANE (IIP-EIL)	BPCL, MUMBAI	25,000	
	MRL, CHENNAI	25,000	
	HPCL, MUMABI	50,000	
3. BIMETALLIC REFORMING CATALYST (IIP-IPCL)	MRL, CHENNAI	90,000	
		6.2	(Cat.)
	IPCL, VADODARA	110,000	
		6.8	(Cat.)
4. LOBS THROUGH NMP EXTN.(IIP-EIL)	IOC, BARAUNI	400,000	(Extrct.)
	IOC, HALDIA	350,000	(Base oil)
5. DELAYED COKING (IIP-EIL)	BRPL, BONGAIGAON	500,000	
	NRL, NUMALIGARH	306,000	
6. VISBREAKING OF PETROLEUM RESIDUAL FRACTIONS SOAKER MODE	IOC, GUJARAT (REVAMP)	1,600,000	
	IOC, MATHURA (REVAMP)	1,000,000	
	IOC, HALDIA (REVAMP)	1,000,000	
	MRL, CHENNAI (REVAMP)	550,000	
	CRL, COCHIN (REVAMP)	1,000,000	
	IOC, PANIPAT	450,000	
	HPCL, VIZAG	1,000,000	
7. DEWAXING / DEOILING (IIP-EIL), REVAMPING	IOC, HALDIA	27,000	
8. DI-TERTIARY BUTYL PARA CRESOL (IIP)	BALMER LAWRIE LTD., CHENNAI	150	
	TFCL, MUMBAI	500	

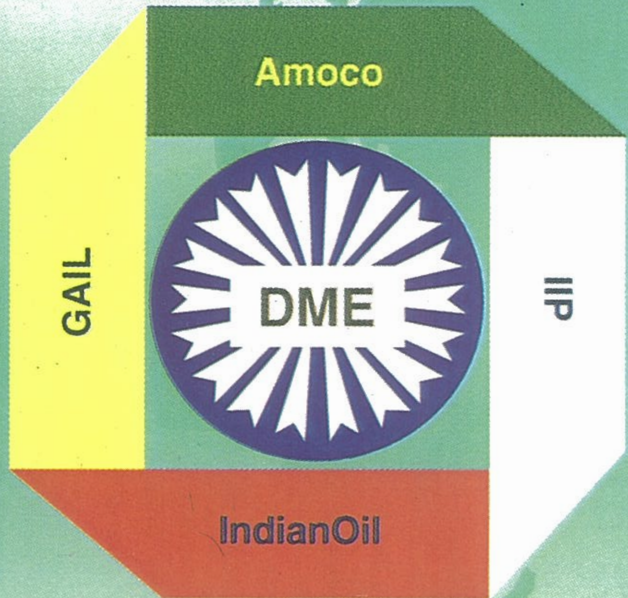
Contd...

TITLE OF TECHNOLOGY	UNIT	LICENSED CAPACITY TPA
9. PARA TERTIARY BUTYL PHENOL (IIP)	BALMER LAWRIE LTD, CHENNAI	300
	TFCL, MUMBAI	500
10. HIGH TEMP. ANTIOXIDANTS (IIP-AEC)	TFCL, MUMBAI	1,000
11. SODIUM SULPHONATE	NAL, HYDERABAD	500
12. CALCIUM SULPHONATE	NAL, HYDERABAD	500
13. E P ADDITIVE	NAL, HYDERABAD	100
14. MENTHA OIL TO MENTHOL	GDH, GHAZIABAD	50
15. SULFOLANE (IIP)	CADILA, AHMEDABAD	300
16. HOT ROLLING OIL (IIP)	LIL, MUMBAI	1,000
17. LUBE OIL REREFINING (IIP)	65 FIRMS	20,000
	Total	**8,828,900**

PRODUCTS

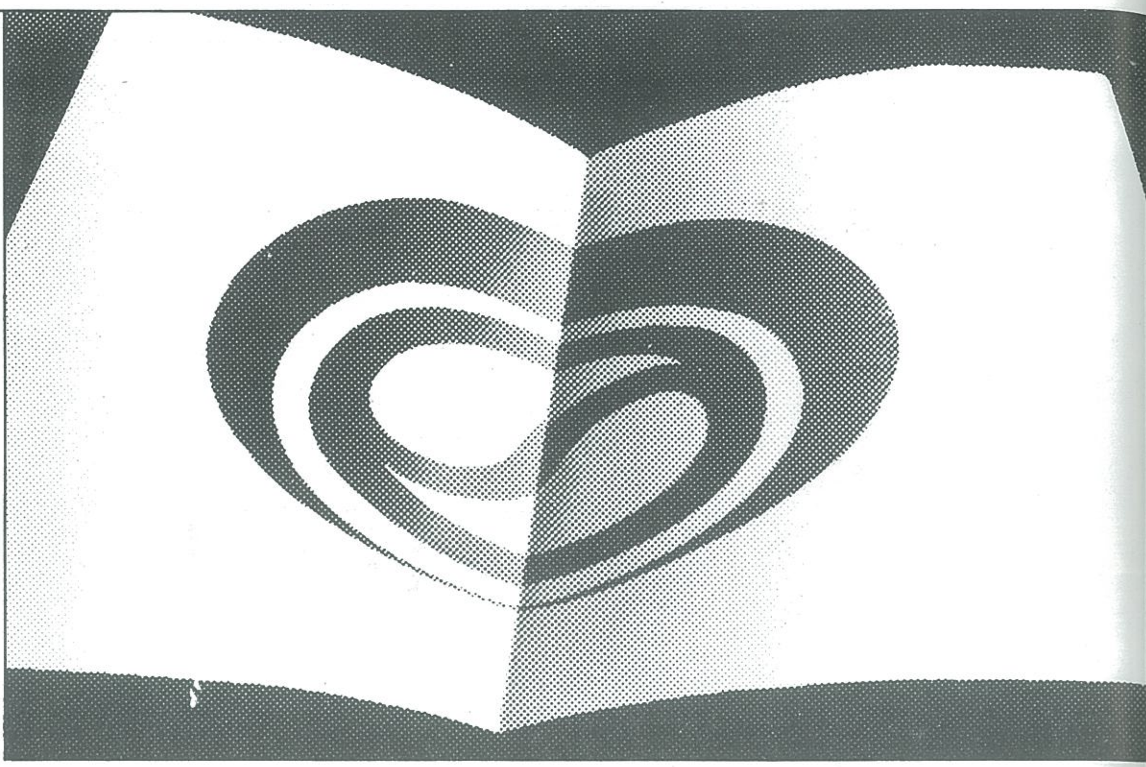
1. LAP BURNER (IIP)	SEVEN FIRMS	6,000 PIECES PA
2. WICK STOVES (IIP)	THIRTEEN FIRMS	1000,000 PIECES PA
3. LPG STOVE (IIP)	72 FIRMS	720,000 PIECES PA

Working Together

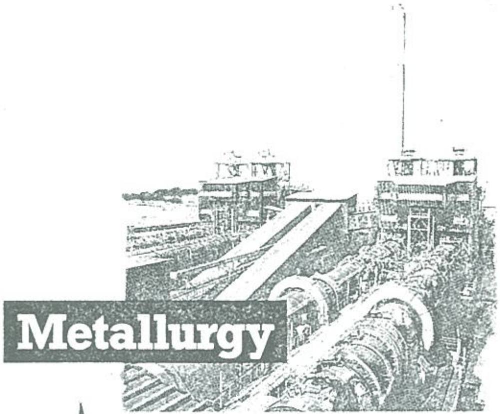


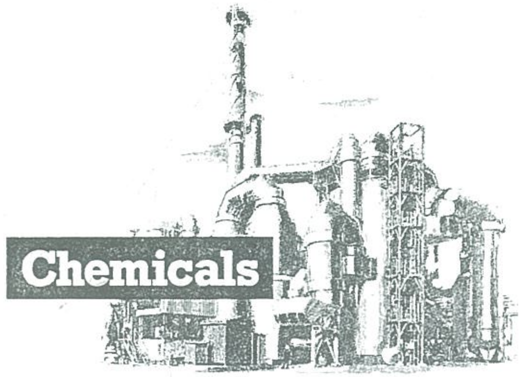
Energizing India's Future with DME:

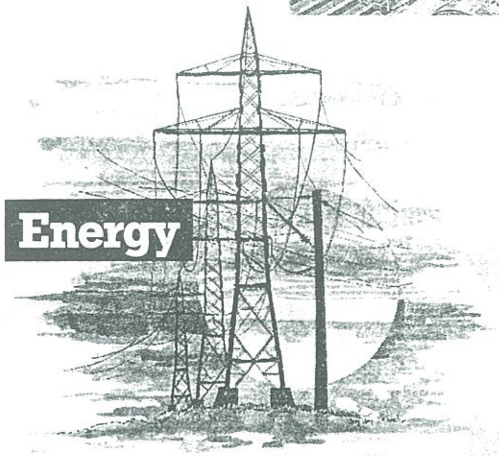
" A Clean Burning Fuel for the 21st Century "



Clean. Cost-effective. Lurgi process technology.

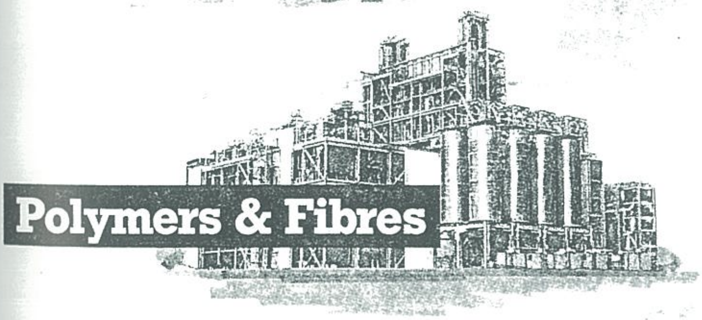






LURGI

Processes featuring integrated pollution control, optimum energy economy, recycling, reprocessing and safe disposal of waste streams.



...the plants are built by Lurgi

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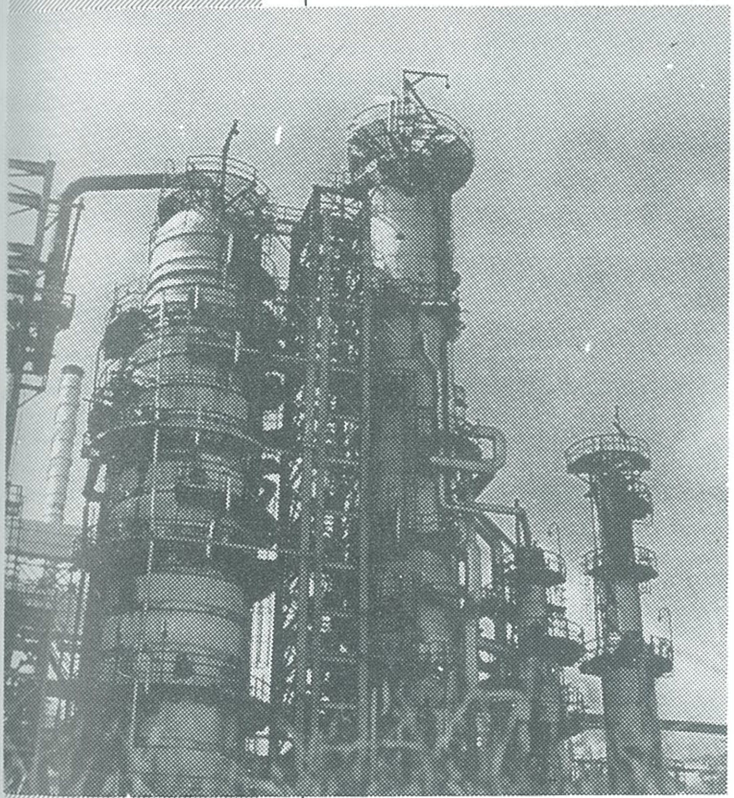
MRL – Poised for the change and challenges of time



Over the years ...

MRL has demonstrated its ability to change with the demands of the time.

From 2.5 MMTPA refining capacity to process 7.0 MMTPA of crude oil at 2 locations - Manali near Chennai and Panangudi near Nagapattinam, contributing to 12% of nation's refining capacity...

From refining just crude, to manufacturing a whole range of Petrochemical feedstocks, serving a host of downstream industries ...

An impressive performance

Thanks to the dedicated team of employees, MRL has excelled itself in its performance in 1997-98 with

- All-time high crude processing of 7.521 MMT
- All-time high turnover of Rs.2720 crores
- All-time high profit after tax of Rs.129 crores
- Highest ever dividend declared 27.5%.

The future is bright

MRL has on the anvil projects worth Rs.3,500 crores, which include a 3 MMTPA refinery expansion at Manali, a 500 MW Power Project in the joint venture at Manali, Jetty facilities to augment crude supply at Nagapattinam and also a mega-refining project in the joint venture. MRL is confident of funding these projects through significant internal accruals, and external borrowings.

The foray into the millennium is going to be dominated by a knowledge driven world, where knowledge and skills will be Power. MRL will focus on Technology Upgradation and Knowledge based training to properly equip its very young workforce to meet the challenges ahead.

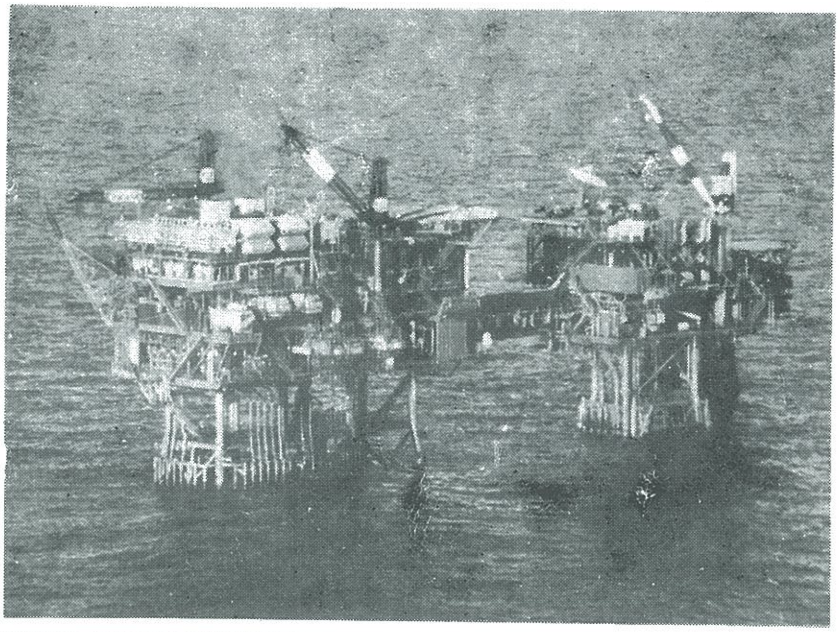
MRL

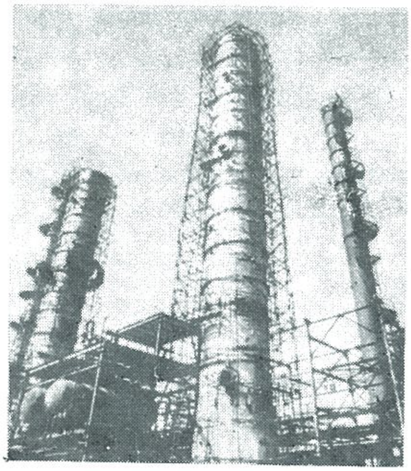
Madras Refineries Limited

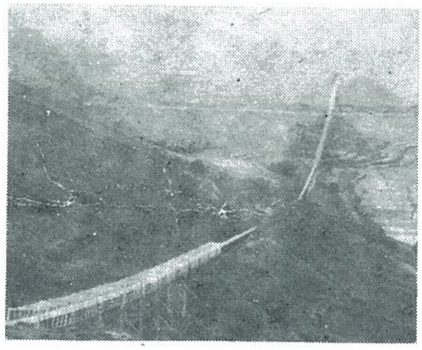
552, Anna Salai, Teynampet, Chennai 600 018.

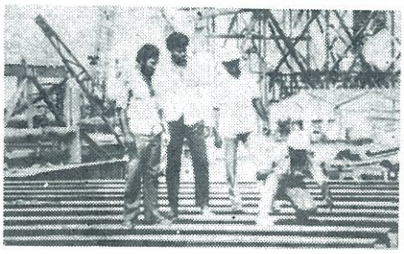
Moving into the next millennium with confidence

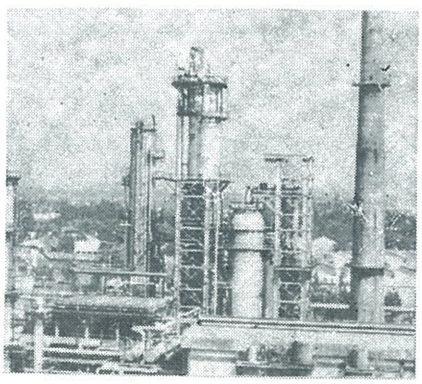
Sobhagya











IndianOil R&D Centre Adds Another Feather In Its Cap.

After the prestigious ISO-9001, it has now been accredited with prestigious ISO-14001 for its Environment Management System (EMS).

IndianOil's Research & Development Centre became the first R&D unit of the country's Petroleum Industry to get ISO-14001, when it was accredited with the prestigious certificate in February for its Environment Management System (EMS).

Established in 1972, the R&D Centre is committed to pollution control & environmental improvement. Working towards this goal, it has focussed its attention on developing environmentally safe products and processes. Besides, conservation of natural resources and effective waste management have been its other high-priority areas.

Research is a never-ending process especially in developing energy-efficient biodegradable lubricants and state-of-the-art refining processes at R&D Centre. This has largely contributed towards the development of globally competitive technologies. *SERVO* - IndianOil's world class lubricants reflect the capability of its R&D Centre to constantly innovate and upgrade products for any application.

Backed by its strong R&D Centre, IndianOil - the nation's only Fortune 'GLOBAL 500' company - continues to reach new heights of excellence and customer satisfaction.

इंडियनऑयल

IndianOil

Vision Beyond Tomorrow

NEWFIELDS

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, INDIA

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Activities of HUMAN RESOURCE DEVELOPMENT (HRD) GROUP

The HRD Group at CSIR has been contributing significantly to the development of highly qualified S&T manpower at the national level. It also provides financial assistance to promote research work in the emerging areas of science and technology. The activities of the Group comprise (a) selection of Junior Research Fellows (JRF) through National Eligibility Test (NET), (b) selection of Senior Research Fellows (SRF) and Research Associates (RA) and awarding the fellowship, (c) selection of Senior Research Associates (SRA), (d) funding the Extramural Research (EMR) schemes at the universities / R&D organisations, (e) granting of visiting associateship, symposium grants and travel grants, (f) award of Shanti Swarup Bhatnagar Prizes and Young Scientist Awards, and (g) conducting training programmes.

Research Fellowships/Associateships

NET examinations are held twice a year for selection and award of JRFs. Applications are invited, twice a year, for selection of SRF and RAs through personal interviews.

Senior Research Associateship (Under Scientists Pool Scheme)

The Scientists Pool Scheme was constituted in 1958 to support highly qualified Indian scientific & technical personnel trained in India or abroad for temporary placement.

Extramural Research Schemes and Special Support Programmes

CSIR provides research grants to scientists / faculty members in the Universities with the objective of improving the overall scientific and engineering research in the country.

CSIR laboratories are encouraged to foster collaboration with university departments for carrying out high level research. While the scientific investigations are taken up at the universities, the CSIR laboratories undertake applied and development part of the work and industries are co-opted to help in providing the total technologies developed and in their commercialisation.

Financial assistance are provided to superannuated outstanding scientists under the Emeritus Scientists (ES) scheme to enable them to pursue R&D and / or write books / monographs.

Visiting Associateship Scheme enables guest scientists from outside CSIR to make use of the advanced R&D facilities available in the CSIR set up.

Travel grant is provided to young researchers for presenting papers at the International Conferences held abroad. Grants are also given to scientific societies / institutes / departments for organising National / International Conferences / Symposia / Workshops, etc.

Shanti Swarup Bhatnagar Prizes

The Shanti Swarup Bhatnagar (SSB) Prizes for science and technology, instituted in 1957, are awarded annually to scientists, who are not more than 45 years of age, for outstanding research work done primarily in India during the last five years. The SSB Prize carries a cash award of Rs. 1.00 lakh, a citation and a plaque.

Young Scientist Awards

The CSIR Young Scientist (YS) Awards, instituted in 1987, given annually to scientists working in CSIR system to promote excellence in various fields of science and technology. These awards are presented to the recipients on 26 September, the CSIR Foundation Day. On this day, the CSIR Foundation Day Lecture is delivered by an eminent scientist.

Intramural Training Programmes

In order to enhance the managerial skills of the senior scientists, training programmes on 'Management of R&D' are arranged at the Administrative Staff College of India, Hyderabad.

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INDIAN INSTITUTE OF PETROLEUM
DEHRADUN 248 005 INDIA

ISO-9001 DNV REGISTERED R&D INSTITUTE

AIMS & OBJECTIVES:

The Indian Institute of Petroleum was established in September 1960 and started functioning at Dehradun from April 1963. The mandates of the institute are:

- Development of Processes for Petroleum Refining
- Assistance to Refineries in Absorption, Adoption , Selection of Technologies and Optimisation of Unit Operations
- Evaluation of Products for Market Development
- Technical Services including Crude Evaluation
- R&D work on Utilisation of Crude Petroleum, its Products, Natural Gas and Petrochemicals
- Impart Training to Personnel of Oil and Petrochemical Industry
- Assistance to Bureau of Indian Standards (BIS) in Formulating Standards for Petroleum Products
- Conduct Technoeconomic Feasibility Studies & Market Demand Surveys of Petroleum Products

PROCESSES AND PRODUCTS DEVELOPED

The following processes/products have been developed and licensed to the industry:

PROCESSES

- Computer data based of 30 indigenous & 140 imported crudes
- Various Speciality chemicals & Petrochemical Additives DBPC, PTBP, Sulpholane & high Temperature antioxidants
- NGL/Light Naphtha to LPG and aromatics
- Selective Hydrogenation of Pyrolysis gasoline (IIP-IFP)
- Lube base stocks with NMP extraction (IIP-EIL-MRL)
- Gas oil & naphtha hydrodesulphurisation (IIP-IFP)
- Petroleum based electrode pitches (IIP-GIL)
- Re-refining of used crankcase lubricating oil
- Food grade hexane production (IIP-EIL)
- Visbreaking & delayed coking (IIP-EIL)
- Bimetallic reforming catalyst (IIP-IPCL)
- Dearomatisation of naphtha (IIP-EIL)
- Hydrotreatment processes (IIP-EIL)
- Wax deoiling & dewaxing (IIP-EIL)
- Propane deasphalting (IIP-EIL)
- Aromatics extraction (IIP-EIL)

PRODUCTS

- Retrofit kit for dual-fuel operation
- Hot rolling oil, white oils, greases, 2 stroke engine oils
- Alcohol fuels and CNG utilisation in IC engines
- Indigenous smoke meter
- Improved wick stove, LPG stove, hurricane lantern
- Low air pressure film burner

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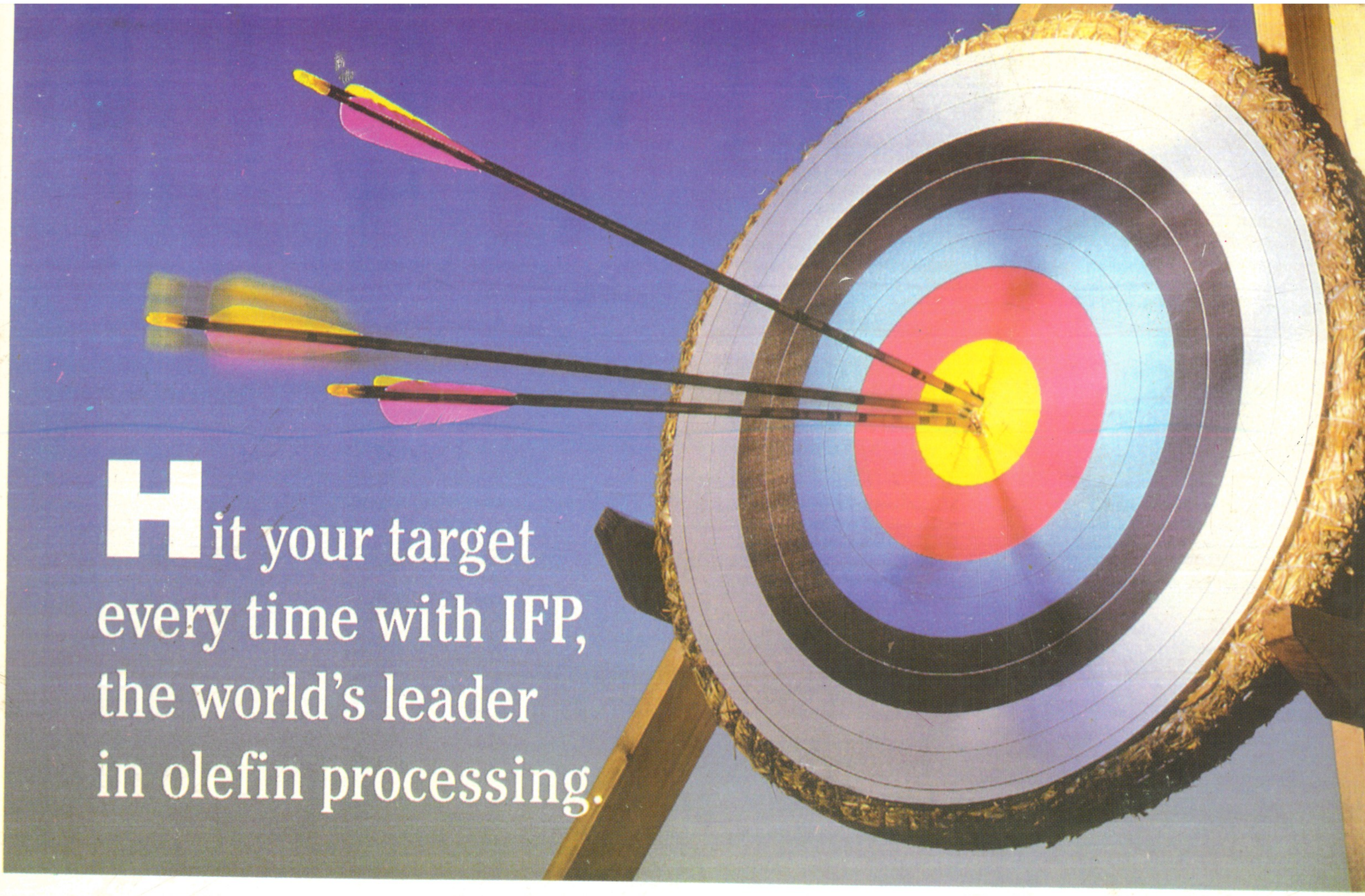

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Over 30 centuries of olefin processing.
That's experience !

Olefin Purification: Hydrogenation of cracked cuts for the production of unsaturated products, such as: propylene, butadiene, normal butenes, 1-butene, 2-butenes, pentenes, stabilized pygas, olefin and sulfur free aromatics, arsenic and COS free propylene. Selective hydrogenation of FCC cuts: butenes, isoamylene, FCC gasoline; *Arofining* reformate purification for aromatics production.

Olefin Transformation: *Alphabutol* 1-butene from ethylene, *Dimersol-E* gasoline from FCC ethylene and propylene, *Dimersol-G* hexenes by propylene dimerization, *Dimersol-X* octenes by butene dimerization, *Polyfining* C_4 raffinate-2 purification for 1-butene production, *Polynaphta* gasoline from C_4 olefin oligomerization, *Selectopol* isobutene removal from n-butenes.

And the innovation continues: *AlphaSelect* maximized production of C_4 to C_{10} alpha-olefins from ethylene, *Difasol* boosting octenes yield associated with *Dimersol-X*, *Isopure* high purity isobutene from isobutene containing C_4 cuts, *Meta-4* propylene production by metathesis.

IFP - THE olefins expert.

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