Biennial Report

2008
2010

भारतीय पेट्रोलियम संस्थान, देहरादून

Indian Institute of Petroleum, Dehradun

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Indian Institute of Petroleum, Dehradun

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Foreword

The achievements of this Institute during the period 2008-2010 will perhaps be written in glory in the history of IIP. From commercialization of technologies to path-breaking research expansion abroad along with several awards, a large number of conferences also had been the hallmark of this period.

A historic achievement has been in terms of licensing of our deoiling technology to the Numaligarh Refinery (BPCL) for setting up a 50,000 TPA, grass roots wax plant at an estimated cost of over 700 crores. We also carried out energy optimization, i.e., Pinch Analysis of the crude unit of the Guwahati Refinery of the Indian Oil Corporation Ltd.

The Institute continued aggressively in creating new markets abroad. We carried out a study on the sulpholane extraction unit of M/s SABIC, UK, which helped M/s SABIC, UK to process pyrolysis gasoline instead of reformate. A large study was carried out for M/s UNILUBE in the Kingdom of Saudi Arabia for re-refining of the used lube oil using solvent extraction. In India, we carried out the optimization of the NMP extraction unit for lubes at the HPCL, Mumbai as well as changing over solvent from sulfolane to NMP in the CPCL food-grade hexane unit.

On the instance of the Ministry of Petroleum & Natural Gas, a path-breaking study was carried out for estimating the stock losses of gasoline in retail outlets. In addition to others, one of the very important conclusions which emerged out of this study is that India should implement both Stage I and Stage II recovery systems not only to save precious gasoline but also to take care of the health of the workers in retail outlets.

A prestigious project was carried out on sponsorship of the NTPC and a unique technology was developed for CO_2 capture from power plant flue gases.

The Institute continued to maintain its leadership position in bagging prestigious awards. I am very proud to mention that we won the CSIR Technology Award-2009 for developing and commercializing an innovative technology for upgrading FCC Clarified Oil into premium refinery products. We also won the National Second Prize for our Hindi Magazine 'Vikalp' from H.E. the President of India.

April 2009 was the beginning of the celebrations of the Institute's Golden Jubilee Year 2009-2010. This was flagged off by no less a person than Prof M M Sharma, who laid the foundation stone of the Golden Jubilee Laboratory on 27th April, 2009. A series of National and International seminars was

organized during this period to showcase the Institute's knowledge and capability as well as to interact with the leading researchers to establish road-map for carrying out cutting-edge research in the future. The following are the seminars/conferences which were held :

- Workshop-cum-Training Programme on Advances in Processing of Heavy and Non-conventional Crude Oils
- Symposium on Fossil Economy to Bio-mass Economy : Opportunities & Challenges
- Seminar on Analytical Sciences in Energy and Environment
- Golden Jubilee Symposium on Bio-technology – A Road-Map Towards Sustainable Energy
- Second Indo-Norwegian Seminar on Advances in Separation Technologies
- Symposium on Solvent Extraction
- Indo-German Seminar on Future Mobility

The Institute continued to attract high officials and dignitaries, notably, Mr R S Pandey, Secretary, MoP&NG; Mr Anand Kumar, Director (R&D), Indian Oil Corporation Ltd.; Dr S Chandra, Joint Advisor, Fertilizers and Prof S C Saxena, Director, IIT, Roorkee.

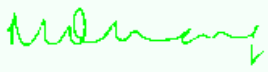
A highlight, of course, was the visit of the head of our family the Director General of CSIR and Secretary, DSIR, Prof Samir K Brahmachari, to the IIP. It is a matter of distinction that Prof Brahmachari visited our Institute within the first year of his taking over the leadership of the CSIR. He took a keen interest in the activities of the IIP.

The Institute published a very large number of research papers in high-impact journals during this period as well as filed several patents. We also added many state-of-the-art facilities such as FE-SEM, FTIR, GC-MASS, XRD, AAS and ICP-AES.

2009 was the beginning of recruitment of the first batch of M.Tech. Students inducted under the Post-Graduate Research Programme in Engineering. Four students started this programme on Advance Petroleum Science and Technology.

This period was the beginning of many initiatives that we have taken. This, I am sure, will take the Institute to greater heights. As always, we depend upon the support of one and all from both inside and outside the Institute.

I finally thank you for your confidence in us.



Dr M O Garg
Director

Contents

1

Contribution to Science & Technology

1.1 SEPARATION PROCESSES

Simulation and Modelling

Development of Adsorption Technology for the Removal of CO_2 from Power Plant Flue Gas

- A custom-designed three-column PSA/VSA unit has been set up in the laboratory. This unit has been designed to evaluate a wide variety of PSA/VSA cycles for CO_2 recovery
- A large variety of metal-exchanged zeolite adsorbents has been evaluated in this unit at low pressure and elevated temperature conditions, under which CO_2 recovery from power plant flue gas is required
- A novel three-column, eight-step VSA cycle has been developed for CO_2 recovery from power plant flue gas. This cycle uses a strong adsorptive rinse in a co-current depressurization step and is able to enrich the CO_2 from 12 vol% to > 90 vol% at elevated temperatures and low adsorption pressures with recovery of around 80%.
- Adsorbent testing has been carried out in the presence of 5 vol% moisture as typically present in flue gas and it was observed that with addition of a guard layer of commercial air drier adsorbent , the performance of the VSA system does not deteriorate and the system is able to consistently separate and recover CO_2 over repeated cycles.

Development of Low Carbon-emitting Technology for Production of Ultra-low Sulphur Diesel

- A large variety of metal-exchanged zeolite adsorbents has been evaluated in combinatorial equipment for sulphur removal from diesel-range hydrocarbons in liquid phase conditions
- Metal-impregnated mesoporous adsorbents have been synthesized and tested for sulphur removal from model mixtures and actual refinery diesel. Sulphur removal has been achieved from levels of 500 ppm in diesel to less than 30 ppm.
- New process conditions have been established for sulphur removal from diesel feeds. Under these conditions and using mesoporous adsorbents with specific metal impregnation, sulphur in diesel can be removed from 500 ppm to less than 30 ppm. The adsorbent can be regenerated thermally. Further studies are in progress to improve the capacity of the adsorbent and understand the mechanism of adsorption and regeneration.

Study on Optimization of 500N Process using NMP in SEU at HPCL, Mumbai

The objective of this work was the generation of optimum operating process parameters to meet specific product quality for maximizing feed in treater tower without changes in any hardware of the treater tower internals, solvent recovery section etc and also reduction in energy consumption and substantial reduction in utility consumption by effective pinch analysis on heat exchangers.

Sulphur Reduction in the Naphtha Product Obtained by Fluid Catalytic Cracking

A joint research project entitled *'Sulphur Reduction in the Naphtha Product Obtained by Fluidised Catalytic Cracking'* has been completed in collaboration with SINTEF Materials and Chemistry, Oslo with funding support under Indo-Norwegian Programme of Institutional Co-operation (INPIC) for development of an adsorption - based process for desulphurization of FCC gasoline. Combinatorial Chemistry equipment, which is a world- class facility proprietary to SINTEF, was used for rapid screening of adsorbents. The most promising adsorbents were tested at IIP in high-pressure and high-temperature, automated adsorption unit. Under optimum conditions, the best adsorbents were able to selectively remove the benzothiophene and alkylated benzothiophene from FCC naphtha. These are the specific “refractory” sulphur compounds which are not removed in the conventional FCC naphtha hydrodesulphurisation (HDS) processes in use in the refineries today. Based on these findings, a unique vapour-phase adsorption process has been developed which can be integrated

with the conventional naphtha hydro-desulphurization process to produce ultra-low sulphur gasoline. The process developed will reduce the sulphur levels to below 30 ppm with minimum octane loss. A basic engineering process package has been prepared based on an actual naphtha HDS unit operating in an Indian refinery. Commercialisation of this technology in the refining sector will have enormous benefits -- both economic as well as social, as it will make production of 'clean fuel' cheaper (the benefit of which will be passed on to the consumer) and it will be a step towards better environment management with respect to emissions control in refineries.

Feasibility of Producing High-specification Aromatics from Straight-run Naphtha using IIP's NMP Extraction Technology

SABIC UK Petrochemicals (erstwhile Huntsman petrochemicals), approached IIP for development of a technology for production of pure Benzene, Toluene and Xylene (BTX) from straight-run (SR) naphtha fractions. Compared to conventional high aromatics feed-stocks, e.g. reformate and pyrolysis gasoline (PG), the aromatics content of SR naphtha is very low (10 % against 60 to 80 wt. %) while the naphthene content is very high (about 25 % against 2 to 15 wt. %). Commercial specifications for pure BTX are very stringent with respect to non-aromatics content (< 500 ppm). Removal of naphthenes from aromatics is difficult since both are cyclic components and are very close boiling. Thus this work was very challenging. However, extensive experimental and simulation work by the IIP team led to the development of an innovative technology which was demonstrated on laboratory-scale. Based on the success of the first project, SABIC sponsored another project with a view to revamp their existing sulpholane unit for processing pure pyrolysis gasoline fraction as also its C6 heart cut. A test run on their unit was conducted under the guidance of IIP and stream data were provided to IIP for fine tuning aromatics extraction simulation model. IIP carried out detailed experimental and simulation studies for both the feedstocks and provided the material balance and the utility requirement for the design cases to M/S Foster Wheeler for equipment rating work.

Feasibility Study for Identifying Feedstock for Petrochemicals

The world is witnessing a gradual shift in the production and demand for petrochemicals from the West to East. This shift can, undoubtedly, be attributed to the rapidly developing economies of various Asian and Middle East nations. The two most dynamic Asian nations, China and India, have emerged as major contributors to the growth of the petrochemical industries due to their large-scale involvement in global markets and a gradual shift in their population demographics. The Middle East, having recognized the tremendous potential of their cheap and abundant raw material, has begun to invest substantial amounts of money into infrastructure development. This development would enable them to establish a nexus between the existing resources and market deliverability. The primary purpose of this project is to envisage a path which could be advantageous to India in acquiring its share of the global petrochemical pie. India's recent surge in refining capacities coupled with the abundance of manpower and cheap labour can propel it towards this goal. However, in proposing a plan of action for this industry, myriads of other factors, such as environmental considerations, target market, sustainability and feasibility of alternate feed-stock etc., need to be taken into account.

The *'Feasibility Study for Identifying Feedstock for Petrochemicals'* envisages the study of various options for identifying an alternative feedstock from refinery- as well as non-refinery sources and to convert them to value-added petrochemicals. IIP is entrusted to come out with a report considering this scenario. This report, through its various chapters, will analyze every possible option that India can espouse to advance in the petrochemical markets. The report begins with possibilities in the refinery-petrochemical integration field, leads into the analysis of alternative feed-stock, and ends with

global scenarios and advisable policy initiatives for the Government of India.

Energy Optimization Studies for IOCL, Guwahati Refinery

To Identify the Heat Integration Potential in the Preheat Trains for Crude Column & Delayed Coker

The preheat train for heating the feed to Crude column and DCU main fractionators was optimized with respect to heat integration using the pinch analysis tool. After extracting the data from the PFD and stream summary, data consistency check was carried out. Composite and grand composite curves were generated for the estimation of hot and cold utility required and to identify the heat saving potential. New heat exchanger network was prepared using the maximum energy recovery (MER) principles. The preheat train heat optimization study gives the opportunity to increase the capacity of the unit from 1.00 MMTPA to 1.30 MMTPA without any additional provision of heat duty. The heat saving potential of 0.59 MMKcal/hr or 472 SRFT/Yr is identified after the heat optimization of feed preheats train of DCU with minor modifications.

Optimization of Naphtha Stabilizer

Naphtha stabilizer and fractionation unit as well as various configurations were studied and analyzed for energy and product yield optimization. The best two configurations were proposed. Reduction in reboiler and condenser duties to the tune of ~ 45 % were estimated, thereby decreasing the utility demand for the unit.

Feasibility Studies for the Vacuum Residue (Bottoms) Up-gradation Options, BPCL Kochi & Mumbai Refineries

Two most frequent options i.e., delayed coker and solvent de-asphalting were studied for value addition to the vacuum residue available at the BPCL's Kochi and Mumbai Refineries. The yields of various products and their properties were estimated using the available and developed correlations. For economic feasibility and selection of better options between the two, the payout period was calculated for each option. It was concluded that delayed coker is a better choice due to its lower payout period against the solvent deasphalting option.

Feasibility Study for Change-over from Sulpholane to NMP in Food-grade Hexane (FGH) Unit, CPCL, Chennai

Presently, CPCL, Chennai is producing the food-grade hexane containing benzene content less than 500 ppm using IIP-EIL sulfolane solvent extraction technology. Now, they intend to replace the existing sulfolane solvent by NMP due to its high capacity and thermal stability. IIP conducted a feasibility study for this changeover based on its expertise in extraction technologies. Based on the feasibility study, adequacy checks were also carried out for critical equipments in the Unit.

Aromatics Extraction

Optimization of Food-grade Hexane (FGH) Unit at HPCL, Mumbai

The FGH Plant of HPCL, Mumbai, which was designed for sulpholane as well as solvent, was switched over to NMP+Water combination. Solvent recovery was experienced slightly under reduced pressure since its commissioning.

The IIP team visited this unit in November 2009 and established that it was facing several problems such as recycle solvent containing hydrocarbon carry-over (0.6 to 1 %), which would be mostly aromatic and would land up in the raffinate coming out from extractor top, thus deteriorating the product quality. Presence of HAN was also detected in the wash water going to raffinate wash column, making product quality poorer.

After solving the problems of the unit one by one, every column finally started functioning as expected i.e. solvent recovery at positive pressure, water content of solvent around 10% etc. and treated product, i.e., FGH containing 85 ppm benzene, which is, less than 100 ppm benzene and meets WHO grade FGH specifications.

A test report was prepared suggesting implementation of certain rectifications. The Mumbai plant of HPCL is running better after incorporation of rectifications.

Development of Process for Oxidative Desulphurization of Diesel

Among the alternative methods for desulphurization of diesel, the oxidative desulphurization approach has drawn worldwide attention due to its simple operation and being highly selective for removal of 4-MDBT and 4,6-DMDBT, thereby yielding ultra-low sulphur diesel with sulphur content below 10 ppm.

Innovative technology for oxidative desulphurization of diesel was developed at IIP. This process involves oxidation of sulphur compounds with an oxidizing solution consisting of carboxylic acid and active oxygen containing peroxide, to sulphones/ sulphoxides followed by their removal by extraction with NMP–antisolvent mixture and final finishing by passing them through a bed of silica/alumina to obtain ultra-low sulphur diesel.

Synthesis of Room-temperature Ionic Liquids and Study of their Application for Extraction of Sulphur, Nitrogen and Aromatic Compounds from Petroleum Feed-stocks

An ideal green solvent should have low volatility, be chemically and physically stable, easy to handle, recyclable and reusable. Room-temperature ionic liquids (RTIL) can be conceivably designed to provide a varied range of properties. Generally favorable properties include virtually no vapour pressure; low flammability; high conductivity and large electro-chemical window; low corrosion tendencies; good thermal stability and large density differences compared with other process fluids to hasten phase separation. Expertise have been developed to synthesize and characterize RTILs especially suitable for desulphurization, denitrogenation and dearomatisation. A few of the RTILs have been synthesized and detail characterization of the solvent is being investigated. Experiments of Batch LLE studies involving RTILs and oxidized diesel reveal that RTILs have a great potential to be an extraction solvent for sulphur and aromatic compounds from petroleum streams.

A complete know-how will be developed using a new class of ionic liquids for extraction of aromatics or sulphur-containing/nitrogen-containing species from petroleum fractions. It will be more environment-friendly, with almost nil environmental and human health concerns besides being cost-effective.

Wax Rheology

Development of Process for Conversion of Waste Plastics to Value-added Hydrocarbons

In today's world the use of plastics is increasing at a rapid rate which in turn is generating enormous amounts of waste. This waste being non-biodegradable is environmentally hazardous. IIP has carried out laboratory-scale studies to convert waste plastics, particularly polyethylene and polypropylene, into value-added products and has developed a simple catalytic process by which exclusively any one of the products –gasoline or diesel or aromatics along with LPG – can be produced in the same experimental set-up by simply altering the catalyst and process parameters.

The novelty of IIP process lies in the production of an exclusively single product whereas the other process produces a type of crude which needs to be processed further to get these products. The developed process is completely environment-friendly, produces fuel which meets most of the Euro-III specifications and

Laboratory-scale Unit

has the potential of solving the ever-increasing problem of disposal of waste plastics in an environment-friendly way as well as augment the supply of these petroleum products.

Studies on Cold Flow Behaviour of RJ Mangla Crude Oil

The transportation of crude oil through pipelines is the most economical & widely used method for crude oil transport. The deposition of wax during the pipeline flow of crude oil with the lowering of temperature is a major problem in petroleum industry as the deposited wax forms a gel like structure that hinders the flow of crude oil in a pipeline. Various methods like addition of polymeric additives and diluents are employed extensively to improve cold flow in pipelines.

The recently discovered RJ Mangla crude oil is a high-pour crude (42°C) and there is an apprehension of wax separation and gel formation when flown through a pipeline at the ambient temperature. IIP has carried out extensive flow-related studies with RJ Mangla crude and its blend with other low-pour crude oils and determined the safe blend ratio and operating temperature for flow assurance of blends of the RJ Mangla crude oil.

1.2 BIO-FUELS

Batch/Continuous Trans-esterification Process for Utilization of Coconut Oil for Bio-diesel Production

This Project was initiated on the request of coconut development Board, Kochi. According to the information from CDB, coconut oil is not competitive with other vegetable oils in terms of price and is sliding down from its role played in the past. To tide over this crisis, one of the options available is to increase the use of coconut oil in new sectors. Keeping in view, one of the options available is to use this oil as a substitute for diesel/bio-diesel. So far, no systematic information is available for use of coconut oil as bio-diesel.

Studies were carried out in a batch reactor for optimization of process parameters using homogeneous base catalyzed trans-esterification. The optimized conditions in batch reactions were fine-tuned for continuous trans-esterification. A study carried out on coconut oil in continuous trans-esterification process has resulted in product conversion of 98.83% as analyzed by HPLC. The bio-diesel from coconut oil meets the ASTM as well as BIS specifications.

The method developed has a good potential for continuous production of bio-diesel. However, issues like CFPP need to be addressed in detail; otherwise, the use of coconut oil bio-diesel will not be feasible as a transportation fuel or fuel additive in cold climates.

Bio-technology

To meet the bench-mark of 20% ethanol blend in fossil fuels in India, any non-molasses feed-stock is to be brought into reality. Moreover, the feed-stock should not compete with food demand. In order to achieve the need and to supply ethanol at a competitive price, a project was initiated on production of ethanol at high temperatures from lignocellulosic and starchy bio-mass whenever and wherever available in the country, extraction of most of the sugar from bio-mass and conversion of hexose as well as pentose sugar to ethanol, ethanol recovery from the fermented broth and, finally, value-addition to the by-products. So far, IIP has proposed an ethanol production from lignocellulosic bio-mass with thermophilic yeast at 50°C. We are able to recover 60% fermentable sugar (pentose and hexose mix) from sugarcane bagasse with acid hydrolysis. The acid is being recovered by ion exchange chromatography and 95% acid has been recovered for recycling. The total extracted fermentable sugar produced 21% ethanol (theoretical 35%). We found pentose sugar utilization for small amounts of ethanol production as well as production of xylitol as value-addition.

Bio-catalytic Desulphurization of Diesel

The Project was sponsored by CHT, OIDB, MoP & NG, Govt. of India and the project collaborators were IIP-Dehradun-Nodal agency, IIT-Delhi (Dept. of Biochem Engg. & Biotech.), and IOC (R&D), Faridabad.

The objective of the project was to develop a bio-catalyst and a bio-process for desulphurization treatment of hydro-treated diesel and cracked distillates for reduction of sulphur levels from 2500 ppm to 100 ppm in the finished product.

Scope of work and the targets achieved are :

- Screening and isolation of micro-organisms for sulphur-specific desulphurization (4S)
- Development of bio-catalyst by recombinant DNA technique to increase the specific activity and stability of the bio-catalyst.
- Development of bio-process and reactor configuration to achieve the target levels of sulphur in diesel at bench-scale using wild type strain *Rhodococcus* sp. IIPS7

Bio-prospecting for Novel Anti-microbials and Industrially Important Enzymes from Microbial Isolates in the Uttarakhand Himalayas

In the year 2007, a collaborative research work was initiated with the Sardar Bhagwan Singh Post Graduate Institute (SBSPGI), Balawala for Bio-prospecting of novel anti-microbials and industrially important enzymes from microbial isolates in the Uttarakhand Himalayas. The project was funded by the State DST (UCOST, Dehradun). The project was initially sanctioned for two years and was further extended for another six months to achieve the proposed and revised targets.

The salient achievements of this project are:

- Isolation of two potential protease-producing strains along with one esterase and one L-asparaginase producing strains.
- The LK-11 protease expressed by the *Bacillus* sp. LK-11 has been found to be novel by 16s molecular phylogeny and the strain has been submitted to Genbank (Accession Number: FJ913065).
- The LK-11 protease gives promising detergent action and has been purified to homogeneity.
- LK-11 protease is an alkaline cysteine protease and it has been characterized completely.
- The fermentation studies for up-streaming of enzyme production have been standardized.

Direct Production of Bio-diesel from Non-edible Seed Oils by Reactive-extraction

The aim of this project is to increase the efficiency of bio-diesel production by developing an integrated process combining the extraction of non-edible vegetable oils (such as *Jatropha* and *Pongamia*) from oilseeds with reaction of that oil to bio-diesel in a one-step 'reactive-extraction' process. This should facilitate distributed production of bio-diesel, principally by oilseed farmers, who would be able to produce bio-diesel on-site. The technology will be suitable for use in developing countries. The advantages of successful development of such a process are: reduction in capital cost, reduced waste and less environmental impact which means that this bio-diesel can be produced at a lower cost.

Studies have been carried out to optimize maximum yield of bio-diesel with variation in reaction parameters viz. seed size, seed/solvent ratio (w/w) and catalyst concentration. Under the optimized conditions, ~ 98% conversion to bio-diesel was observed and the product was analyzed by HPLC.

Bio-ethanol from Lignocellulosic Biomass Using Thermophilic Yeast

A process for production of bio-ethanol from lignocellulosic bio-mass in two stages has been developed. Bio-mass is converted to fermentable sugars by acid treatment and the sugars are fermented to ethanol and xylitol by thermophilic yeast, *Kluyveromyces* sp. IIE453 at 50°C. The adapted yeast strain showed high stability and ethanol yield at high temperatures.

Production of Bio-degradable Soluble Cutting Oil

The Institute has developed a vegetable oil-based fully bio-degradable metal-working fluid (soluble cutting oil) that offers the same or even better performance as petroleum oil-based products. This

metal-working fluid is less expensive in comparison to petroleum oils and offers significant benefits for environment and end-users. Soluble cutting oil is designed to cool the components, remove chips from the cutting zone, lubricate, and inhibit corrosion during a given machining. A bio-degradable soluble cutting oil plant has been designed for the capacity of 100 TPA. Basic engineering information has been provided to the customer (M/s Eco-care Bio-lubes India Private Limited, Coimbatore, Tamil Nadu) to build the plant. The technology is environment-friendly and economical as compared to the technology based on fossil fuels.

Development and Improvement of Heterogeneous Catalyst for Bio-fuels

Trans-esterification using a conventional alkali process gives high conversion levels of triglycerides to their corresponding methyl esters. The process has several drawbacks, e.g., it is energy-intensive, recovery of glycerine is difficult, the catalyst has to be removed from the product, the alkaline waste-water requires treatment and free fatty acids and water interfere with the reaction. In order to minimize the above process problems, development of heterogeneous catalyst for bio-diesel production was taken up.

Fatty acid methyl esters (FAME) were produced from different feed-stocks having heavy high FFA (*Jatropha* oil-20% FFA, PFAD-85% FFA, acid oil-55% FFA), using heterogeneous catalyst. The bio-diesel produced by this process meets ASTM/BIS specifications.

Important Chemical Intermediate from Glycerol

Bio-fuels are an important way of limiting green house gas (GHG) emissions, improving air quality & finding new energy resources. In the past years, the demand for bio-diesel created a glut of glycerol as a by-product of the trans-esterification reaction of vegetable oils. Finding an outlet to this glycerol is fundamental for the fatty acid methyl ester (FAME) network.

IIP has developed an improved process for converting glycerol to glycerol ethers using glycerol obtained from bio-diesel process and isobutylene in the presence of etherification catalyst to obtain a product containing 30-40% and 60-70 % of tri-tertiary butyl ether and di-tertiary butyl ether respectively. The product contains less than 1% mono-ether and glycerol. These tert-butyl ethers of glycerol with a high content of di-& tri-ethers are considered promising as oxygenated additives for diesel fuels (diesel, bio-diesel & their mixtures).

The product can improve cold-flow property of bio-diesel from any feed-stock and seems to be a potential oxygenate with high proportion of di- & tri-ethers of glycerol.

Addition of these ethers has a positive influence on the quality of final diesel fuel and it provides decrease in particulate emissions, carbon oxides & carbonyl compounds in exhaust gas emissions.

Process & Reaction Engineering: Bio-mass Conversion

Ultrasound can be very beneficial for the process of base-catalyzed trans-esterification that leads to formation of bio-diesel from vegetable oils, animal fats, etc. Cavitation can be effectively used for intensification of the synthesis of bio-diesel with over-all operation at ambient conditions of temperature and pressure as against the requirement of high pressure and reflux conditions for the conventional route of synthesis. It has been observed that the larger diameter of the probe dissipates more energy than its smaller diameter for the same power dissipation. The methyl ester conversion increases with increase in power dissipation rate as well as maximum conversion achieved at optimum time; beyond that, the conversion decreased. Optimization in terms of the operating molar ratio of methanol to oil (10:1 ratio is the optimum in the present case) and catalyst loading (1% by weight of KOH catalyst) results in more than 97% (mol%) conversion in 30 minutes of processing time. The power density (Power/volume) and irradiation time has strong correlation to get homogeneous mixing for speedy and maximum conversion of oil to methyl ester. Temperature variation (20 to 30°C) has very little effect on

conversion, and the trends of conversion are similar to different alcohol-to-oil molar ratios at different temperatures.

The use of cavitation has been demonstrated as an effective tool of process intensification and the approach to be used for optimization of the operating parameters with an aim of maximizing the extent of intensification.

Ultrasound flow cell can be also used for continuous production of bio-diesel.

Upgradation of the petroleum vacuum residue is done through ultrasound energy also. Conventional upgradation of residue is done through the catalytic and thermal cracking using very high temperature and pressure. The conventional high temperature upgradation process can be substituted by ultrasound assisted acoustic cavitations at ambient temperature and pressure.

The study revealed that the asphaltene content of the vacuum residue decreased from 13% to 6%. It has also been observed that the viscosity, density, and pour point of the vacuum residue reduced substantially.

Tribological Studies of Bio-lubricants and Bio-fuels

Non-edible vegetable oils e.g. *mahua*, *karanja* and rape-seed oil based-esters have high Viscosity Index, low freezing points and favourable viscosity-temperature characteristics. Chemical transformation of these vegetable oils to high-performance, long service life, environment-friendly lubricants is an attractive alternative to hydrocarbon-based and other synthetic lubricants.

Mahua, *Karanja* and rape-seed oil bio-esters have been developed, characterized and evaluated as bio-degradable lube-base stocks. The oxidation stability of these samples was also carried out with different anti-oxidant additive doses as per Loost & Rancimat methods. Loost method is found capable of differentiating the oxidation stability of vegetable oils. It has been successfully used to see the effect of anti-oxidant additives in improving the oxidation stability of vegetable oils. Rancimat method is found capable of differentiating the oxidation stability of vegetable oils and their esters. It has been successfully used to see the effect of anti-oxidant additives in improving the oxidation stability of vegetable oils and their esters. This method has been used for the first time for determining oxidation stability of bio-lubes.

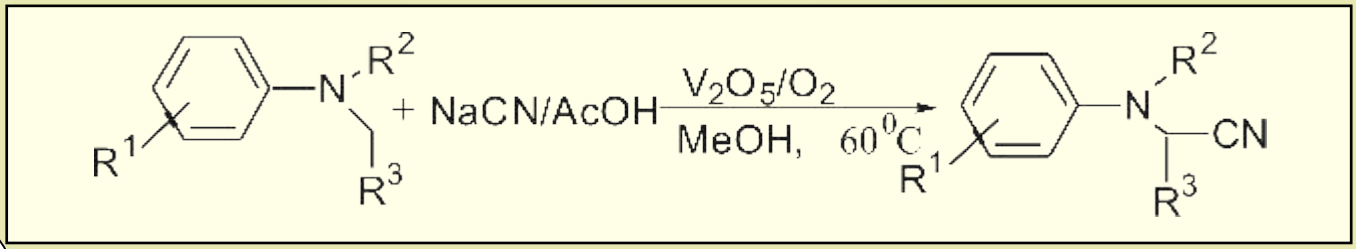
Some of the developed bio-esters are promising as bio-degradable lube base stocks for neat cutting oils. Other esters can be intended for application as hydraulic base fluids and formulations.

1.3 CHEMICAL SCIENCES

An Efficient Aerobic Oxidative Cyanation of Tertiary Amines with Sodium Cyanide Using Vanadium-Based Systems as Catalysts

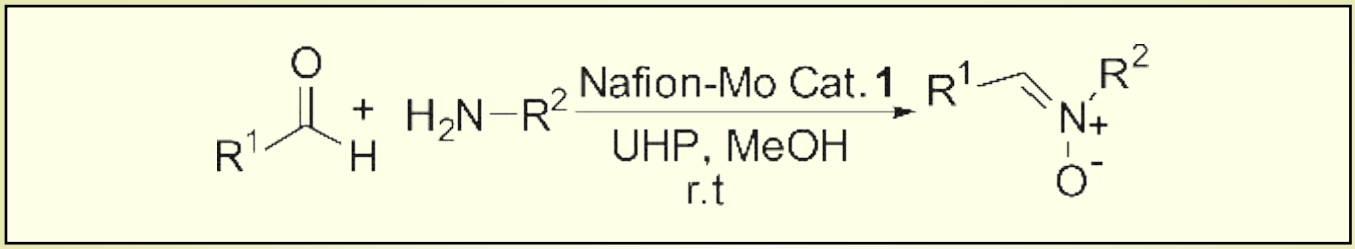
The use of vanadium-based catalysts for oxidative cyanation of tertiary amines with molecular oxygen in the presence of sodium cyanide and acetic acid to afford corresponding α-aminonitriles in good to excellent yields has been established.

Oxidative cyanation of tertiary amines is an important synthetic transformation as α-aminonitriles are extremely useful synthetic intermediates. The existing methods for their synthesis involve use of toxic, expensive metallic reagents, which generates huge amount of waste. The methodology developed in the present work represents a green approach for the synthesis of α-aminonitriles using molecular oxygen as environmentally benign oxidant under mild reaction conditions.



Direct Synthesis of Nitrones using Nafion-supported Molybdenum Oxychloride as a Recyclable Catalyst

Immobilization of molybdenum (VI) oxychloride to the surface of perfluorinated ion-exchange polymer 'Nafion' via ion exchange method was carried out for the first time. The prepared Nafion immobilized molybdenum (VI) oxychloride catalyst was used for the direct synthesis of nitrones via one-pot condensation/oxidation of primary amines with aldehydes using solid urea-hydrogen peroxide (UHP) as oxidant under very mild reaction conditions.



Nitrones are valuable synthones generally prepared either via condensation of carbonyl compounds with N-monosubstituted hydroxylamines or by the oxidation of secondary amines or hydroxylamines. However, both the methods have certain drawbacks such as, limited accessibility of the precursors (e.g. hydroxylamines), lower selectivity and poor product yields. A simple yet efficient catalytic methodology for the one-pot synthesis of nitrones via direct reaction of aldehydes with primary amines has been established. Further, we have reported the timed use of Nafion-NR-50 (commercially available) polymer resin as a soild support for immobilization of molybdenum oxychloride for the first time.

1.4 ANALYTICAL SCIENCES

VPO Catalysts

A series of novel meso-structured vanadium phosphate (VPO) phases has been synthesized and the mechanism for their transformation on ageing has been determined. A new way of dispersing VPO phases which are catalytically important for the selective oxidation of hydrocarbons has been developed involving exfoliation of the VPO phase followed by its dispersion on different supports. The $VOPO_4.2H_2O$ phase dispersed in this fashion has been found to be a very efficient catalyst for selective oxidation of cyclohexane to cyclohexanol. The activity has been found to vary significantly with the nature of the support. The vanadyl pyrophosphate phase has been found to be a very efficient catalyst for the one-step selective hydroxylation of benzene to phenol. Currently, phenol is commercially produced by the three-step cumene process.

Metrology in Chemistry (MiC)

IIP is the lead laboratory in MiC for petroleum-related areas under CSIR Network Project on *'Advances in Metrology'* in the 11th Five-Year Plan (Nodal Agency – NPL, New Delhi). The work has been initiated to develop a series of certified reference materials (CRM's) relevant to hydrocarbon and automobile industry. One lot of the reference materials (RM) for V, Na, Mg, Ca and Fe metals in hydrocarbon medium (fuel oil) and the second lot of RM for Ca, Mg, P, Zn and Na in virgin lubricating oil have been readied for conducting the Round Robin tests for their certification by the Nodal Agency. These CRM's are required for calibration of different analytical techniques for validation of analytical methods used in different sectors of science and technology like environment, health, agriculture and industries.

Basic research has been carried out regarding analytical methods for compositional analysis of bio-diesel and bio-diesel-in-diesel blends essential for preparing their CRM's.

Development of a Simplified Method for Quantification of Bio-mass Products

The products generated in the acidic and enzymatic hydrolysis of cellulose and hemicelluloses (into fermentable sugars using thermophilic micro-

organisms) were analyzed to determine different constituents namely glucose, xylose, maltose and ethanol along with their impurity. For this purpose, an isocratic HPLC method was developed using refractive index detector (RID) and the PL HI-PlexH column with water as mobile phase (0.001M H_2SO_4) in high-purity non-ionic water.

1.5 HEAVY OIL PROCESSING

Study on Motor Spirit (MS) Stock-losses at Retail Outlets/Company Owned-Company Operated Outlets (RO's /COCO's)

Investigations were initiated at the behest of the Ministry of Petroleum and Natural Gas (MoPNG) to establish MS stock losses at RO's/COCO's through study on various types of losses, mechanism, actual and historical loss data, notional loss due to variation in dispensing/delivery temperature, international norms etc., and to suggest measures to curtail losses/recovery of VOCs.

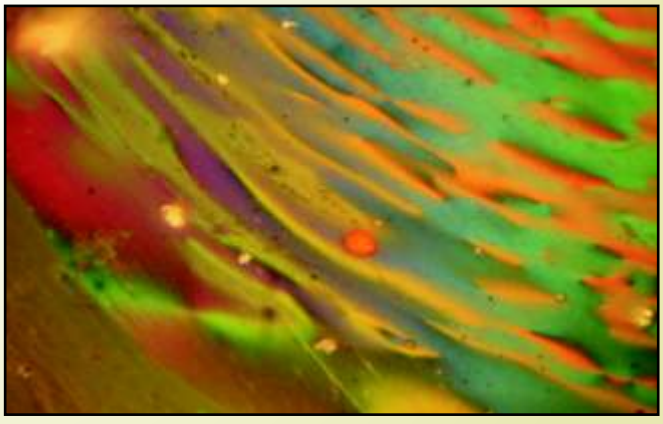
The volatile nature of gasoline is the prime reason for the various types of emissions in atmosphere at various stages of its retailing. The losses of MS are important not only from an economic point of view but they are also a potential health hazard. In view of this, the MoPNG assigned this study to IIP to establish the various losses of gasoline during refuelling operations and suggest ways & means to reduce the losses/recovery of the VOC emissions.

Ambient conditions data, dispensing temperature, underground storage tank temperature, tanker-lorry and UGS tank pre-decantation/post-decantation temperature and volume data were collected from a large number of RO's/COCO's spread across various cities in the country during the summer and winter seasons. Thorough analysis of the data was made, inferences drawn and the key observations and findings were submitted to the MoPNG. A road-map for implementing vapour recovery systems by oil marketing companies (OMC's) throughout the country has also been recommended. Valuable suggestions have also been received from oil marketing companies during joint discussions.

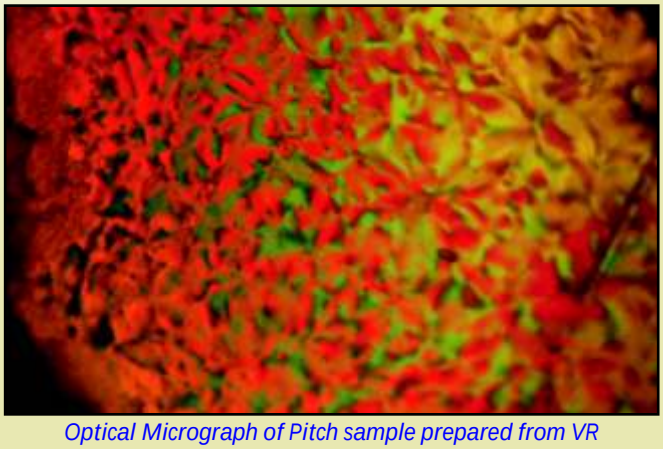
Studies on Formation of Mesophase During Conversion of Petroleum Refinery Streams Into Pitch for Needle Coke Production

The objective of this work was to examine the formation of 'mesophase' during conversion of refinery streams (vacuum residue and residual fuel oil) into pitch gation to ascertain the extent of mesophase formation and thereby establish suitability of the streams for 'Needle Coke' production. Currently, the demand for high-quality 'Needle Coke' required by graphite electrode industry in our country is met through imports.

The study shows that in formation of 'mesophase', an essential requirement for Needle Coke formation, Residual Fuel Oil (RFO) has the potential for formation of Needle Coke. The optical micrograph of pitch prepared from RFO showed lamellar alignment of bulk mesophase into needle-like structure of coke. On the other hand, vacuum residue (VR) doesn't have the



Optical Micrograph of Pitch sample prepared from RFO



Optical Micrograph of Pitch sample prepared from VR

potential for making Needle Coke as the optical micrograph of pitch prepared from VR showed 'mosaic texture' unlike 'lamellar texture' formed in pitch prepared from RFO. The mosaic texture is a poorly defined layered structure and does not produce 'needle-like' structure required for Needle Coke formation.

Studies on NMP Extraction for Improving Colour and Colour Stability of Wide-cut Used Oil and its Distillates

Studies were conducted to develop a process to improve colour and colour stability of Wide-cut Used Oil (WCO) and its distillates (LBO, MBO & HBO) using solvent extraction.

IIP successfully developed a solvent extraction-based technology to improve colour and colour stability of used oil distillates. The colour stability was found to be for more than 6 months. The novelty of this work was to design tailor-made solvent mixture and optimization of its dosage for refining of used oil distillates. This work has great environmental impact as it helps to conserve the best out of waste.

Used Oil Distillates

Solvent Extracted Distillates

Thermal Conversion Processes

Delayed Coking is the most widely used thermal conversion process for processing heavy residues. Over the last decade, delayed coking of petroleum residues has attained an important place in augmenting secondary conversion facilities in refineries as an effective way of treating heavy residual stocks, to meet the ever-growing demand of middle distillates as well as to produce petroleum coke. The quantity and quality of coke as well as liquid & gaseous products obtained from delayed coking process, depends mainly on feedstock characteristics and operating variables (coil outlet temperature, coke drum pressure & recycle ratio etc.). Recent advances in this area include the carrying out of delayed coking in the presence of a catalyst to increase distillate yield.

In view of the above, IIP carried out these sponsored studies :

Studies to Convert CSO & VR into Anode/ Needle Coke

To carry out Delayed Coking studies with the aim to convert its low value streams viz. CSO and VR into Anode/Needle Grade Coke, further studies were carried out on mixing of an additive with blended feed-stocks (CSO and VR) to assess the effectiveness of the additive in terms of improvement of quality and quantity of coker products. The study has been successfully completed.

Coking Studies

Delayed Coking of residue with and without catalyst was carried out to compare distillate yields and petroleum coke quality produced under varying operating conditions. The work was successfully completed.

Development of Polymer Modified Bituminous Binder

The project study has been successfully completed by following a new approach to meet the demand of high-performance bituminous material to construct flexible pavements using polymers and crumb rubber from waste tyres. Such types of bituminous materials have better performance than conventional bitumen, and provide an eco-friendly viable disposal of waste tyres. The performance of developed materials is supported by constructing 1 Km long test track on the state highway which has not shown any sign of distress under heavy traffic and even after experiencing three heavy rainy seasons.

Propane deasphalt (PDA), a Short Residue (SR) derived from indigenous refineries through down-streams can be used in value-addition after blending it with low-value flux components/feed-stocks/cutter stocks type materials to prepare tailor-made bitumen.

1.6 CATALYTIC CONVERSION PROCESSES

Development of a Catalyst and a Technology for Conversion of NGL/Naphtha into LPG & High-Octane Gasoline

The Indian Institute of Petroleum has been in the forefront of developing and commercializing innovative technologies to meet the present and future needs of the Indian hydrocarbon industry. Naphtha-To-Gas-Gasoline (NTGG) - an innovative technology to convert light naphtha/NGL to high-value LPG and high-octane gasoline is a major step in this direction by the IIP. Light naphtha/NGL is currently a surplus product in our hydrocarbon industry because of recent fuel speciation and also because of lack of off-take by other user industries such as petrochemicals and fertilizers. These feed-stocks contain considerable amounts of C_5-C_6 paraffins (40-60%) and are hardly converted to value-added products by the traditional reforming process. On the other hand, the demand for propane and butane (Liquefied Petroleum Gas) has been increasing at a growth rate of over 14% per year in the country and is expected to accelerate in the future as a result of increased use of LPG as a transport fuel. The conventional production of LPG from gas fields and refineries is not adequate to meet the deficit. Therefore, there is a need to study the country's need and develop specific technologies tailored to suit the Indian requirements.

In view of the above, a novel zeolite-based catalyst was developed at the IIP and it has been thoroughly evaluated on both pure model compounds and commercial light naphtha stocks. After successful demonstration of this process at bench scale, the IIP approached M/s Gas Authority of India Ltd. (GAIL) for their interest in using this technology at one of their LPG recovery sites. A unit of 8, 000 TPA, at a total cost of Rs 16.5 crores, has been installed at GAIL's LPG recovery unit at Vaghodia.

Novel Doped 3-D Nanoporous Oxides for Dye-Sensitized Solar Cells (DSSC)

Project aims to develop high-efficiency solar cells based on dye-sensitized 3-D nanoporous doped TiO_2 and other novel mesoporous wide band-gap oxide semiconductors. Major goal will be to develop very high surface area 3-D oxide matrix with tailored porosity as scaffold which can hold large numbers of the dye molecules resulting in improved efficiency. This research work is aimed to be the stepping-stone for making industrially viable, economical and environment friendly dye-sensitized solar cells for contributing to the energy demands of India. Specific objectives of the project are:

- To prepare wide band-gap nano-structured porous oxide semi-conductors (with 5-10 nm pore size) such as, doped mesoporous titania.

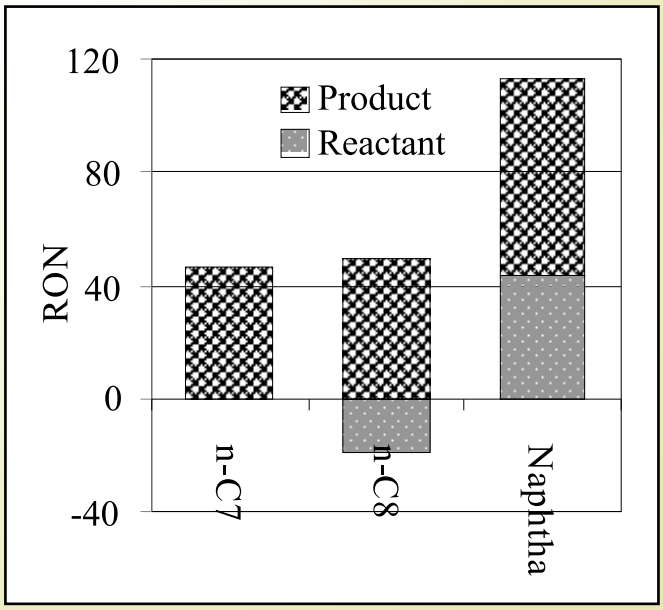
- Another goal would be to tailor the pore-size and improve the surface area of these mesoporous mixed oxides which would lead to better incorporation of the dye molecules in the mesopores. This would not only improve the efficiency but will also provide long-term stability.
- These nano-materials would be evaluated for their solar-cell efficiencies after incorporating suitable dyes.
- To develop lab-scale models followed by prototype.

The cell is constructed in two parts, the nano-porous TiO_2 is painted onto the back of a conducting glass (such as ITO) plate and dried, and then the dye is diffused into it simply by placing it in a dish of the dye or using a commercially available dye-colouration facility. The electrolyte is spread into a thin layer on the counter-electrode. The two parts are then assembled. The construction is simple and although they use a number of advanced materials, these are inexpensive compared to the silicon needed for normal cells as they require no expensive manufacturing steps. There are several important measures that are used to characterize solar cells. The most obvious is the total amount of electrical power produced for a given amount of solar power shining on the cell. Expressed as a percentage, this is known as the solar conversion efficiency. Electrical power is the product of current and voltage, so the maximum values for these measurements are important as well, Jsc and Voc respectively. The "quantum efficiency" is used to compare the chance that one photon (of a particular energy) will create one electron. A solar simulator lamp and standard I-V (current-voltage) measuring cell is used to measure the solar cell efficiencies.

Development of Catalyst for Ultra-deep Desulphurization of Gas Oil

The aim of the project sponsored by CHT (MoPNG) was to develop a catalyst for desulphurization of gas oil to get ultra-low sulphur diesel (30-50 ppm). Due to environmental concerns, developing countries are moving towards 30-50 ppm or even lower sulphur in diesel. India may also follow the same trend in future.

Cobalt or nickel-promoted molybdenum catalysts supported on gamma alumina, Siral-1, SBA-15 and MCM-41, were prepared by the incipient wetness impregnation and precipitation from homogeneous methods. These catalysts were characterized by surface area, pore size distribution and X-ray diffraction. Studies were made on the effect of molybdenum loading on oxygen chemisorption, variation of O/Mo, equivalent metal sulphide area and surface coverage, variation of HDS and hydrogenation activity, correlation of oxygen uptake with HDS and HYD rates. Several catalyst formulations based on different methods on different supports were prepared. Some of the formulations were found promising. Sulphur level of below 50 ppm was achieved with 1940 ppm feed (SR Gas Oil from Mathura Refinery) at 30 bars and 330^{0}C, tested in a micro-reactor.



The performance of HDS catalyst prepared by IIP is comparable to commercially available reference catalyst under identical process conditions.

Alkylation of Isobutane With Butylenes Over Solid Acid Catalysts

Several zeolite-based catalysts were prepared in the laboratory. The laboratory-made LaY samples

exhibited superior ion-exchange ability and alkylation performance when compared to the reported LaY catalysts. Detailed characterization studies indicated the superior exchange of La and the presence of strong Bronsted acid sites in the LaY prepared at IIP that are responsible for the increased alkylate yields. The laboratory-made catalyst also exhibited higher life-time when compared to the reference catalysts prepared at the Lercher's laboratory.

Isomerization of C_7+ Hydrocarbons in the Mid-Light Naphtha Cut

In an attempt to boost the octane number of the C_7+ hydrocarbon containing naphtha through aromatic-free isomerization route, a BEA zeolite based catalyst with tailored catalytic properties was developed and tested in the pilot plant for its performance towards 90-140°C cut of naphtha. The catalyst exhibited the isomer yield of 59 wt % with the Octane Number of 80.

Room Temperature Selective Oxidation of Styrene to Styrene Oxide over Mesoporous Ce-ZSM-5

The design of rational synthesis pathways for porous materials is significant due to their potential application as advanced catalysts, adsorbents, optical guides and sensors. In modern science, extensive research efforts have been devoted to the synthesis of porous inorganic materials with different structural coherency over a wide range of length scale. IIP has synthesized Ce-substituted mesoporous ZSM-5 using polymer template and it was found that the mesopore diameter was 30 nm. The mesoporous Ce-ZSM-5 was tested in the epoxidation of styrene and it was found that a conversion of 50% and epoxide selectivity of 99% was achieved with H_2O_2 as oxidant at room temperature.

Low Temperature Water-Gas-Shift Reaction over Cu-Nano-Clusters Supported on $CeO_2/ZnO/Al_2O_3$

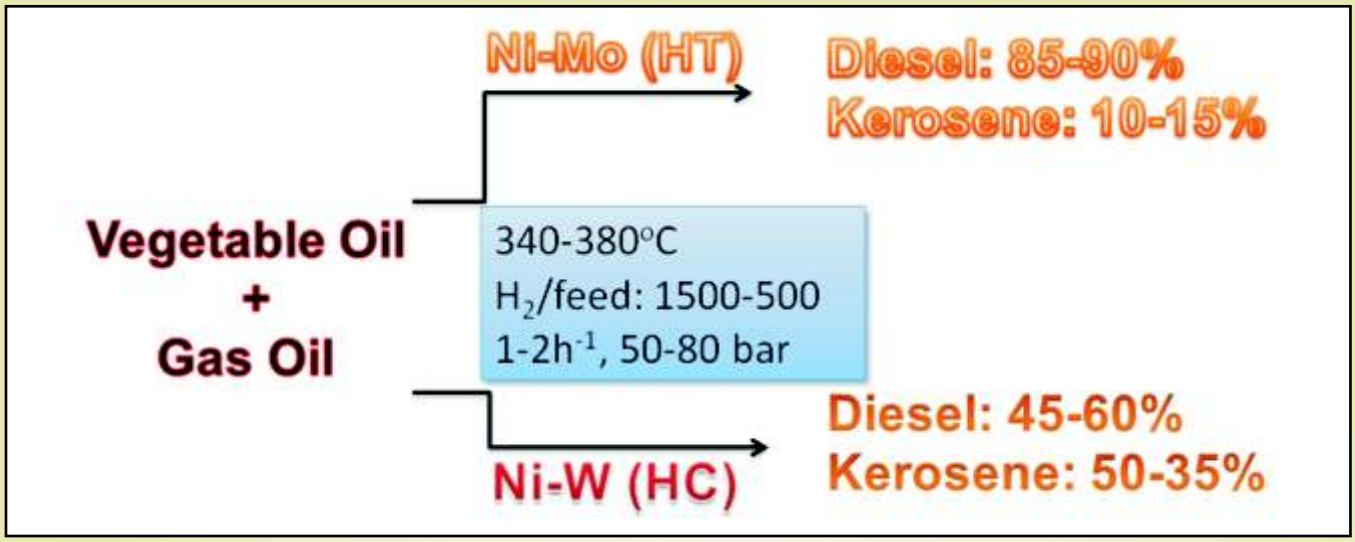
With the recent development and beginning of commercialization of polymer electrolyte membrane fuel cell (PEMFC) the demand of CO-free hydrogen has increased to a great extent. In fact, the development of a technology for production of pure hydrogen (with little or no CO) conventionally and at a low cost is one of the challenges posed to the hydrogen-economy sector. Conventionally, Water-Gas-Shift (WGS) Reaction, $CO + H_2O = CO_2 + H_2$, is applied in most hydrogen production facilities to decrease the concentration of CO and to increase simultaneously the production of H_2. The supported Cu-nano-clusters were prepared hydrothermally in the presence of the surfactant, cetyltrimethylammonium bromide. It has been observed that the small Cu-clusters supported on ZnO, Ceria and Al_2O_3 are active for the Water-Gas-Shift Reaction. It is interesting to note that when a small amount of Pt (0.5wt %) is added to these catalysts, the activity increases dramatically. Pt/Cu-Ce shows a CO conversion of 92.8% after 0.5 h reaction time at 423 K.

Aqueous Phase Reforming of Glycerol to 1,2-Propanediol over Pt-Hydrotalcite Catalyst

The use of renewable feedstock is becoming increasingly essential for sustainable development of society and, of late, much attention has been devoted to applying green catalytic processes to convert bio-renewable feedstocks to commodity chemicals and clean fuels. Research efforts to find new applications for glycerol as a low-cost feedstock for functional derivatives have led to the introduction of a number of selective processes for converting glycerol, a by-product from bio-diesel, into commercially-valued products. Aqueous phase reforming (APR) of glycerol was done over Pt-loaded hydrotalcite (HT) in a batch reactor at an initial N_2 pressure. A glycerol conversion of up to 95% with a selectivity of 65% for 1,2-propanediol was achieved, without the use of any external H_2.

Hydrotreating of Vegetable Oil for Green Diesel Production

Non-edible and used vegetable oils are renewable feedstocks for production of bio-fuel, contributing to decreased greenhouse gas emission, decreased dependence on fossil fuels, improvement in rural economics, and increased national security. Bio-diesel production by trans-esterification is currently



the primary route to bio-fuel from vegetable oils. However, this process produces the by-product glycerol, and new bio-diesel plants require a large capital investment. An attractive by-product-free route, that also offers engine compatibility and feedstock flexibility, using the existing petroleum refinery infrastructure, is the vegetable oil hydrotreatment, with petroleum-derived feed-stocks such as gas oil, to very high cetane diesel fuel. We have developed the process for hydrotreating gas oil and vegetable oil mixtures, to develop a process for diesel production in the same reactor within a petroleum refinery.

1.7 AUTOMOTIVE FUELS AND LUBRICANTS APPLICATIONS

Impact of the Selected Corridors on Fuel Economy

Fuel economy of vehicles needs to be seen in conjunction with both energy security and emission mitigation. Normally, the vehicular fuel economy and emission data are generated using standard equipment like chassis dynamometer, constant volume sampling system and following the standard driving cycle, ambient conditions etc. However, actual traffic, driving and road conditions pose high impact on the final fuel economy of the vehicle that one achieves due to the variables like driver's habits in terms of speed, acceleration, braking, corner handling, etc. on a particular traffic corridor.

In order to understand the effect of traffic system and actual driving conditions on various sectors of highways and cities in the country, a study was carried out on a gasoline-fuelled passenger car using on-board fuel flow-meter and global positioning system. The sectors covered were Dehradun-Delhi and Delhi-Jaipur Highways as well as the cities of Delhi, Jaipur and Dehradun.

The results of the study indicate a major difference in fuel economy which is as high as 20% from one Highway to another.

Use of Hydrogen and CNG Mixture in an Automotive Engine

In certain developing countries like India, the CNG-fuelled vehicles and the related infrastructure is available. So, it is feasible that some appropriate level of hydrogen may be mixed with natural gas with minimum modification cost and use of existing infrastructure to make it happen in a very short time. Investigations carried out so far conclude that the addition of hydrogen in natural gas can provide reduction of CO, HC and CO_2 emissions from the automotive engine exhaust. But NOx emissions generally increase. It is expected that the optimization of the ignition timing may reduce NOx emissions without sacrificing the performance in terms of power output and fuel economy.

Therefore, a study was carried out on an automotive

gasoline engine, converted to run on CNG fuel using different levels of hydrogen in CNG and the performance on engine dynamometer was measured at WOT, 75% and 50% of the full load at different speeds. Engine thermal efficiency and exhaust emissions were also analyzed during the experiments. The ignition timing was also altered for a specific blend to understand the effect of the ignition timing on NOx emissions.

Green House Gas Emission Inventory From Transport Sector: Natcom II

Transport sector is the major source of the GHG emissions in the country. In this project, emission factors of various categories of vehicles were established. To reduce the uncertainty in Green House Gas estimation, emissions were measured using laboratory equipments and the field data were also captured in select cities for refinement of emission factors.

Results show that real-time emission values depend upon traffic conditions like city or highway, and are higher as compared to laboratory evaluations.

1.8 INDUSTRIAL AND DOMESTIC COMBUSTION

Improved *Gur Bhatti* For Rural Areas

The *gur bhatti* owners will be benefitted by adopting the IIP's improved *gur bhatti* technology as, apart from reduction in chimney smoke, they can save bagasse which may be sold in market leading to extra profit. To encourage the *gur bhatti* owners, Petroleum Conservation Research Association (PCRA), New Delhi has announced financial subsidy if they set up improved *gur bhatti* as per IIP's design. A sum of Rs. 20,000/- is payable for full *gur bhatti* improvement which includes use of fire-bricks in furnace. Fire-bricks are costlier than the ordinary ones. So, a sum of Rs. 5,000/- is payable to a *gur bhatti* owner if he incorporates the rest of the improvements.

Gur and *khandsari* are among the major agro-processing industries found in the rural sectors of our country. Nearly 50% of the total sugar-cane produced in the country is used for manufacture of about 8 million tonnes of *gur,* known as the most nutritious agent among all the sweeteners.

Gur bhattis are generally small *bhattis* fabricated by local artisans and run by villagers in rural areas. The *bhatti* mainly consists of an underground furnace over which sugar-cane juice is boiled off in large boiling pans. Sugar-cane juice is produced after crushing sugar-cane in crushers and the left-over bagasse, after drying in sun, is used as fuel in the furnace. Exhaust gases are released into the atmosphere through a vertical chimney. This practice of *gur*-making has been followed for a long time by the villagers.

Conventional *Gur Bhatti*

The conventional *bhatti* is comprised of an underground horizontal furnace, made up of ordinary masonry bricks cemented with earth clay. No brick-work is used at the bottom. Generally, three numbers of sugar-cane juice boiling pans rest on top and along the length of the furnace. Bagasse is charged through a window located at one end of the furnace. No fire grates are used. The other end of the furnace opens into the base of a vertical chimney of rectangular cross-section. The cross-sectional area gradually reduces from bottom to top. This chimney is also made up of masonry bricks cemented with earth clay.

Since the furnace & chimney are not properly designed, a lot of heat is wasted and dense smoke is generally emitted from the chimney. As a result, bagasse consumption is very high. In case bagasse is used optimally, a significant quantity of it can be saved, which may be further put to other useful applications such as paper and pulp industry, mushroom growing, fuel for domestic and industrial use etc, thus leading to additional income. It is also seen that the small *gur* manufacturing units generally use vertical roller type sugarcane crushers which have poor juice extraction efficiency. As a result, a lot of juice remains un-extracted from bagasse and is wasted.

The IIP, Dehradun, realising its importance, undertook a project under the Council of Scientific and Industrial Research's Welfare Activity for Rural Masses. The project was undertaken with the aim of achieving following improvements over the conventional *gur bhattis* :

- Reduction in fuel (bagasse) consumption.
- Reduction in chimney smoke.
- Increase in furnace life.

Improved *Gur Bhatti*

After conducting long experimental trials on one of the conventional *bhattis*, an improved *bhattis* was set up. The improved *bhatti* is based on the popular design normally found in Dehradun and near-by U.P./Uttarakhand state areas. The improvement focusses mainly on a better design of furnace and chimney to improve the combustion performance of bagasse, resulting in about 10% reduction in bagasse consumption and lesser smoke through chimney. By using fire-bricks in the furnace, its life could be increased considerably. Besides, about 20% increase in *gur* production, of better quality, has been observed. With all these improvements, the profit of *gur bhatti* owner increases. Although the cost of the improved *bhatti* is higher, yet due to the additional profit, the *gur bhatti* owner can recover the extra cost incurred within 2 to 3 *gur*-production seasons.

Future Work Envisaged:

While working with the existing and improved *gur bhattis*, it has been experienced that there is still a scope of further improvement in the following parameters of the *bhatti:*

(i) Use of one additional sugar-cane juice boiling pan for pre-heating of sugar-cane juice.

(ii) Use of chimney waste heat for drying wet bagasse in cloudy weather.

(iii) Simple conveyor system for easy bagasse feeding.

(iv) Selection and use of efficient sugarcane juice extraction system for higher juice extraction efficiency.

IIP has done extensive work on the design improvement of *gur bhattis* for the sugar-cane belt areas. This technology offers reduction in fuel (baggasse) consumption, increase in *gur* production and reduction in chimney smoke. IIP is also making

Improved gur bhatti *(furnace and chimney)*

INSTALLED NEAR IIP, DEHRADUN

A Comparison Between the Conventional and the Improved *gur bhattis*

Conventional *gur bhatti*	Improved *gur bhatti*
Furnace made of ordinary bricks and cemented with clay.	Furnace made of fire-bricks and cemented with fire clay cement.
No brick-work used at the bottom of furnace	Brick-work also provided partially at the bottom of the furnace.
Short life of furnace.	Long life of furnace due to the use of fire-bricks.
No fire grates used in furnace.	Fire-grates used in furnace.
Charging of bagasse by the worker in standing mode, which is very tiresome.	Charging of bagasse by the worker in easy sitting posture, which is less tiresome.
Chimney of square cross section, height insufficient and no dampers used.	Chimney of circular cross section for smooth flow of exhaust gases, height increased suitably and dampers provided for controlling the draft.
Too much smoke from chimney.	Less smoke from chimney.
High bagasse consumption.	Less bagasse consumption.
Less *gur* production.	Increased *gur* production.

Gur bhatti *at Biharigarh (U.P.)*

IIP team with gur bhatti *owners*

continuous efforts to popularize the improved *gur bhatti* technology in different villages. On our motivation, about 10 new *gur bhatti* owners of U.P., Uttarakhand and Karnataka have shown interest in setting up their *gur bhattis* as per the IIP's design.

Development of Low-Capacity LAP Burner

An improved design of low-capacity LAP burner (5 to 15 lit/hr) suitable for ceramic/pottery industry has been developed. The field trials conducted in the pottery industry have shown an enhanced performance.

Trials at Khurja on LAP Burner

IIP LAP burner during operation on tunnel kiln

1.9 TRIBOLOGY

Study of Nano-Materials for their use in Engine Oil Formulations for Better Fuel Efficiency

The tribological pairs in an automotive engine are responsible for the loss of almost 40% of the total power produced in the engine in overcoming friction. Therefore, design and application of proper and efficient lubricant in engine can, to a great extent, participate in improving the fuel efficiency by reducing the friction and accompanied loss. The lubricant in an engine has to operate in a very dynamic environment of varying load, speed and temperature in dynamic lubrication regimes varying from fully flooded to mixed and/or boundary conditions. The contemporary commercial engine oils have, to a certain extent, limitations in overcoming friction in such dynamic tribological environments. Therefore, in the current project, the tribological performance of the engine oils is being enhanced by incorporating nano-sized solid lubricant particles viz. MoS_2, BN, WS_2 etc., to mention a few. The newly-formulated engine oils will possess benefits of both the liquid and the solid lubricants and will aid in satisfactory performance in a varied lubrication regime.

Tribological Studies of Bio-Lubricants and Fuels

The depleting petroleum reserves and increasing demand for the same necessitates the identification and use of cheaper and more environment-friendly lubricants. The research project in this perspective aims for the development of universal bio-degradable base-stocks that can replace the conventional base-oil in the new-generation lubricants. In this context, studies are being undertaken to identify and study the bio-lubricants for their tribological performance. Tribological performance behaviour of the *karanja* and rape-seed oil are being explored to utilize their lubricating capabilities as cutting oils, gear oils and hydraulic oils.

Studies on Energy-efficient Lubricants

Multi-grade oils are being used all around the globe to attain a consistent lubricant performance in all the climatic conditions. The VI improvers in multi-grade oils, which are basically polymeric compounds, are responsible for spontaneous variation in viscosity with temperature, thereby improving their low-temperature viscosity characteristics. Knowledge and understanding of tribological behaviour of these polymers is the key to making good lubricant formulations. It is, therefore, the tribological performance of the different polymeric molecules possessing different structure and weight in varying concentrations, that is being assessed by blending them with base-stocks, so as to use them in multi-grade lubricant formulations.

Development of Girth Gear Lubricating Grease

Lubricating greases are the semi-solid lubricants used extensively in girth gear applications where the lubricant has to withstand high-contact pressure and temperature. The mineral oil-based greases for the said application are very costly and possess environmental and health hazards. The quantity of the greases used is quite large and their disposal, too, is a big environmental issue. Keeping these shortcomings of mineral oil-based lubricating greases in mind, Eco-friendly Sprayable Girth Gear Lubricating Greases were developed for the cement plants. The developed products, when compared with the contemporary commercial products for their tribological performance, proved to be a better option in terms of energy savings, cost and environmental aspects.

Synthesis and Testing of Analogues of ZDDP

Zinc dialkyldithiophosphate (ZDDP), a well-acclaimed multi-functional additive is used widely to improve the anti-oxidant and anti-wear properties of the lubricating oils. Presence of Zn in ZDDP has always posed an environmental problem to its use in lubricants. However, the current project pertains to synthesis and testing of ZDDP and its analogues. The analogues of ZDDP were synthesized and tested either for their at-par or better tribological performance as compared to ZDDP and thereby eliminating Zinc. The analogue with Cu, Al, Ti, W and Ca were synthesized and characterized. The synthesized analogues were blended with base-stocks and tested for their tribological performance. Out of the five analogues, one showed remarkably better performance in respect of all parameters of friction, wear and seizure.

Design and Development of Novel-Type Maintenance-Free Bearings

Bearings are very critical machine elements and their failures result in a huge unwanted downtime and production loss. Therefore, there had been efforts to increase the MTBF for bearings by incorporating design changes in the existing ones. However, there are limitations to it in terms of static friction, stiffness, damping load bearing capacity etc. when one deals with either the fluid film bearings or the magnetic bearings. No single bearing design concept can provide the desired performance over the entire spectra of operating conditions as each of the bearings has one limitation or the other. It is in this context that a novel concept of hybridization of hydrodynamic bearings and the magnetic bearings is being carried out, in order to glean the benefits of both concepts of bearings. The research project involves the design and development of hybrid bearings which will have the advantages of magnetic levitation during the starting period, thereby minimizing static friction besides the advantage of hydrodynamic effect during running, thus reducing kinetic friction.

2

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Inclusion of Research Work in the form of Chapters in Books

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- A process for production of high-octane gasoline from straight-run light naphtha on Pt containing HZSM-5 molecular sieve catalyst, *P Vijayanand, S M Dhir, Lalji Dixit* and *S K Chopra*, Patent No. 232571, 18.03.2009
- An improved process for removal of phenols from industrial waste waters, *A N Goswami, A Nanoti, S K Ganguly, B S Rawat* and *S M Aswal*, Patent No. 232838, dt. 21.03.2009
- A Process for preparing olefin sulphonates, *Rakesh Yadav, A K Bhatnagar* and *A K Gupta*, Patent No. 232979, dt. 24.03.2009
- An improved process for preparing secondary alcohols, *A K Bhatnagar, A K Gupta, S C Joshi* and *H B Goyal*, Patent No 234666, dt. 16.06.2009
- An improved process for preparing secondary alcohols by liquid phase oxidation, *A K Bhatnagar, A K Gupta, S C Joshi* and *H B Goyal*, Patent No 238763, dt. 18.2.2010
- An improved process for preparing fatty acid for alkylesters for use as bio-diesel, *A K Gupta, A K Bhatnagar* and *Savita Kaul*, Patent No 239072, dt. 04.03.2010

2.4 PATENTS FILED

Patents Filed Abroad

- Process for preparing fatty acid alkyl esters suitable for use as biodiesel, *A K Gupta, A K Bhatnagar* and *Savita Kaul*
  - Australia, Application No. 2003290414, dt. 27.6.2006
  - Brazil, Application No. PI 0318651-2, dt. 29.6.2006
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- Canada, Application No. 25523713, dt. 30.6.2006
- Europe, Application No. 03782777, dt. 14.7.2006

- A process for direct hydroxylation of aromatic hydrocarbons, *Suman L Jain, Jomy Joseph, Sweety Sinhgal, Bir Sain, R Sivakumaran* and *Basant Kumar*, Application No 0115NF2007, dt 24.1.2008
- A composition and process for hydraulic fluids, *A K Singh, N K Pandey* and *A K Gupta*
  - Europe, Application No. 05850962.1, dt. 04.06.2008
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  - Japan, Application No., dt. 05.06.2008
  - China, Application No. 200580052250.9, dt. 06.06.2008
- A composition and process for insulating fluids, *A K Singh, N K Pandey* and *A K Gupta*
  - Japan, Application Filed, dt. 09.06.2008
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- A composition and process for lubricating oil for two-stroke gasoline engine, *A K Singh, N K Pandey and A K Gupta,* South Korea, Application No. 10-2008-7013824, dt. 09.06.2008
- Thermophilic ethanol producing yeast strain, D K *Adhikari, Sachin Kumar, C D Sharma* and *Deep Chand*, USA, Application No. 12/390851, dt. 23.02.2009
- A composition of bio-degradable gear oil, *A K Singh* and *Aruna Chamoli*, PCT, Application No. PCT/IN2009/000150, dt. 05.03.2009
- A novel process for conversion of paraffins, olefins and aromatics in mixed feed-stocks into iso-paraffins, *N Viswanadham, Raviraj Kamble, Amit Sharma, Jagdish Kumar, B S Negi, G Murali Dhar* and *M O Garg*, USA, Application No. 12/399717, dt. 06.03.2009
- A process for production of ethanol from starch, *D K Adhikari, Tsering Stobdan, R P Singh* and *A K Gupta*
  - USA, Application No 12/593920, dt. 30.09.2009
  - China, Application No. 200800/7851, dt. 27.11.2009
- A novel adsorption process for selective removal of oxidized sulphur compounds from oxidized hydrocarbon fuel, *Anshu Nanoti, Soumen Dasgupta, A N Goswami, B R Nautiyal, T V Rao, Bir Sain, Y K Sharma, S M Nanoti, M O Garg* and *Pushpa Gupta*, USA, Application No. 12/634312, dt. 09.12.2009
- A process for conversion of low-cost & high FFA oils to bio-diesel, *Savita Kaul, Neeraj Atrey* and *A K Bhatnagar*, PCT Application No PCT/IB2010/000592, 0063NF2008/WO, dt. 19-03-2010

Patents Filed in India

- A process for production of improved quality feedstocks from FCC bottoms for catalytic cracking and conversion into industrial carbon materials, *M O Garg, Manoj Srivastava, Manoj Kumar, Neeraj Atheya* and *K K Singh*, Application No. 606 Del 2009, dt. 27.03.2009
- *A process for conversion of low-cost & high-FFA oils to bio-diesel*, *Savita Kaul, Neeraj Atray* and *Ajay Bhatnagar*, Application No 1900 Del 2009, dt. 15.09.2009
- A novel process for exclusive production of gasoline, diesel or aromatics along with liquefied petroleum gas from waste polyolefins, *H U Khan, Sanat Kumar, Thallada Bhaskar, S M Nanoti, Jagdish Kumar, Sarvjeet Singh, C D Sharma* and *M O Garg*, Application No 0156NF2009, dt. 22.03.2010

2.5 D. PHIL./D. LITT. DEGREES AWARDED

D. PHIL. DEGREES

- Mr R K Chauhan, '*Plasma Spectroscopic Investigation of Trace Metals in Indian Crude* and *Selected Petroleum Products'*, H N B Garhwal University, Srinagar (Garhwal), April 2008. Supervisor: Dr Lalji Dixit
- Mr Jomy Joseph, '*Organic Transformations Using Metal-based and Metal-Free Catalytic Systems*,' IIT-Roorkee, October, 2009. Supervisors: Dr Bir Sain, Scientist, IIP & Prof A K Jain, IIT-Roorkee
- Mr R C Saxena, '*Laboratory Studies on Corrosion Control in the Petroleum Refinery Overhead Systems of Crude Distillation Unit*,' H N B Garhwal University, Srinagar (Garhwal), October 2009. Supervisors: Dr H B Goyal and Dr Jiya Nand
- Ms Shelu Garg, '*Novel Metal-incorporated Mesoporous SBA-15 as a Support for Hydrotreating Catalysis*,' H N B Garhwal University, Srinagar (Garhwal), October 2009. Supervisors: Dr G Murali Dhar and Dr J K Gupta
- Ms Sweety Singhal, 'Studies in Transition Metal-Catalyzed Organic Functional Group Transformations,' IIT-Roorkee, November 2009. Supervisors: Dr Bir Sain, Scientist, IIP and Prof A K Jain, IIT-Roorkee
- Mr Kapil Kumar Soni, 'Studies on Ordered Mesoporous Material-Supported Hydrotreating Catalysts,' H N B Garhwal University, Srinagar (Garhwal), January 2010. Supervisors: Dr G Murali Dhar and Dr J K Gupta

2.6 HONOURS, AWARDS & RECOGNITIONS

CSIR Technology Award-2009

The Institute bagged the CSIR Technology Award-2009 in the category of 'Physical Sciences including Engineering' on *Innovative Technology for Upgrading Fuel Oil Components into Premium Refinery Products*.

The process technology developed is based on an innovative concept of combining two distinct and unrelated disciplines i.e. 'solvent extraction' and 'catalytic cracking'. The process provides improved quality de-aromatized feed (raffinate) for Fluid Catalytic Cracking (FCC). This technology helps meet future carbon emission legislations for refineries. The process is easily adoptable by a refinery having conventional lube refining facility. Moreover, it does not require major additional investment for setting-up of any new units.

IIP Team (L-R: Mr Manoj Thapliyal, Dr Manoj Srivastava, Dr Neeraj Atheya & Mr U C Agrawal) receiving the CSIR Technology Award-2009 from Mr Prithviraj Chavan, Hon'ble Minister of State, Science & Technology and Earth Sciences at Vigyan Bhawan, New Delhi on CSIR Foundation Day. Prof Samir K Brahmachari, DG, CSIR is fourth from left

This technology has been commercialzed at M/s Hindustan Petroleum Corporation Limited (HPCL), Mumbai (Commercial Operations). This technology has resulted in an increase in the annual profit of the refinery to the tune of Rs. 87.6 crores (~ US $18 million)

Other Awards

- Dr M O Garg, Director, IIP, was elected a Fellow of the Indian National Academy of Engineering (INAE) in recognition of 'his distinguished contributions to Engineering.' The Academy as on 1 January, 2008 had 589 Fellows from India and 44 Foreign Fellows on its rolls divided into ten Engineering Sections.

- Dr M O Garg, Director was awarded with Alkyl Amines Professor B D Tilak Chemcon Distinguished Speaker Award 2008 by the Indian Institute of Chemical Engineers for 'his distinguished contributions as an academician in the field of Chemical Engineering.'
- Dr Arunabha Dutta, Scientist-G was appointed as Fellow under 'Professor B D Tilak Visiting Fellowship, 2009-2010'. This endowment fellowship was created by the Institute of Chemical Technology, Mumbai for inviting a distinguished person as a visiting fellow every year to interact with that institute's faculty and students.
- Mr Sandeep Saxena, Technician bagged the 'Young Scientist Award- 2009 (Material Science and Nano-Technology)' for oral presentation of the paper entitled '*Tailoring the textural properties of zeolite for octane up-gradation of fuels*' (authors: Sandeep K Saxena & N Viswanadham) at the *'4th Uttarakhand Science and Technology Congress'* held during November 10-12, 2009 at Govind Ballabh Pant University of Agriculture and Technology (GBPUAT), Pant Nagar.
- For an article authored by Mr Pritam Singh, Private Secretary, on the common theme *'Corruption in Public Organizations: Causes, Effects and Measures for Check'* for publication in the CSIR Foundation Day Souvenir, Mr Singh's article was adjudged second and awarded a cash prize of Rs 2000/-.
- The paper entitled *'Novel Process for Conversion of Waste Plastics into Fuels and Aromatic Hydrocarbons'* (authored by H U Khan, Sanat Kumar, T Bhaskar, Manisha Sahai, S M Nanoti & M O Garg) was adjudged the best paper in the poster session at the 'VII ISFL 2010', organized by the Indian Oil Corporation Ltd. at the India Habitat Centre, New Delhi, during March 9-12, 2010.

- इंडियन ऑयल कॉर्पोरेशन लिमिटेड, अनुसंधान एवं विकास केन्द्र, फरीदाबाद द्वारा 12 जनवरी 2010 को इंडिया हैबिटैट सेन्टर, लोदी रोड, नई दिल्ली में आयोजित राष्ट्रीय वैज्ञानिक संगोष्ठी में *'सड़कों के निर्माण में बिटुमेन की उपयोगिता'* विषयक शोध-पत्र *(लेखकगण: आनन्द सिंह, यू सी गुप्ता, कमल कुमार, यू सी अग्रवाल एवं एम् ओ गर्ग)* को सम्मानित किया गया।
- डॉ दिनेश चमोला, वरिष्ठ हिंदी अधिकारी द्वारा 8 जनवरी, 2010 को भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, क्षेत्रीय कार्यान्वयन कार्यालय (उत्तर) द्वारा आयोजित 'क्षेत्रीय राजभाषा सम्मेलन' में *'हिंदी में वैज्ञानिक लेखन'* विषय पर प्रस्तुत व्याख्यान हेतु प्रशंसित किया गया।
- संस्थान के वरिष्ठ हिंदी अधिकारी डॉ॰ दिनेश चमोला 'शैलेश' को हिंदी भाषा, साहित्य, संस्कृति एवं पत्रकारिता के क्षेत्र में किए गए उनके उल्लेखनीय योगदान के लिए दून द्रोण आदिम विकास समिति एवं साहित्य प्रभा, देहरादून द्वारा 'विद्याभूषण सम्मान-2008', अखिल भारतीय साहित्य कला मंच, मुरादाबाद द्वारा 'सारस्वत सम्मान-2008', चंद्र कुंवर बर्तवाल रुद्र कलश शिरोमणि सम्मान-2008', 'कबीर दीप सम्मान-2008', क्रिएटिव मल्टीमीडिया ग्रुप द्वारा 'हिमालय और हिंदुस्तान अवार्ड-2008', 'महावीर दयाल माथुर स्मृति सम्मान-2009, से सम्मानित किया गया।

राजभाषा

संस्थान 'नगर राजभाषा शील्ड' प्रथम से सम्मानित

- भारतीय पेट्रोलियम संस्थान, देहरादून को वर्ष 2007-08 में हिंदी के श्रेष्ठ कार्यान्वयन के लिए भारत सरकार के उपक्रमों में नगर राजभाषा कार्यान्वयन समिति, देहरादून द्वारा राजभाषा

श्री एम सी जोशी (बाएं) से राजभाषा शील्ड ग्रहण करते डॉ॰ दिनेश चमोला (दाएं)

शील्ड के रूप में प्रथम पुरस्कार से सम्मानित किया गया। यह सम्मान संस्थान की ओर से डॉ॰ दिनेश चमोला, वरिष्ठ हिंदी अधिकारी ने श्री एम सी जोशी, मुख्य आयकर आयुक्त एवं अध्यक्ष 'नराकास' से प्राप्त किया।

'विकल्प' को राष्ट्रीय पुरस्कार

- संस्थान की हिंदी पत्रिका 'विकल्प' को श्रेष्ठ संपादन एवं स्तरीय प्रकाशन की दृष्टि से गृह मंत्रालय, भारत सरकार के राजभाषा विभाग की ओर से वर्ष 2008–2009 हेतु केंद्र सरकार के उपक्रमों में अखिल भारतीय स्तर पर 'द्वितीय राष्ट्रीय पुरस्कार' प्राप्त हुआ। यह पुरस्कार संस्थान की ओर से डॉ॰ मधुकर ओंकारनाथ गर्ग, निदेशक, भापेसं ने विज्ञान भवन, नई दिल्ली में 14 सितंबर, 2009 को आयोजित समारोह में श्रीमती प्रतिभा देवी सिंह पाटिल, भारत की परमश्रेष्ठ राष्ट्रपति से प्राप्त किया।

राजभाषा विभाग, भारत सरकार द्वारा 14 सितंबर, 2009 को विज्ञान भवन, नई दिल्ली में आयोजित कार्यक्रम में 'विकल्प' पत्रिका हेतु भारत की परमश्रेष्ठ राष्ट्रपति श्रीमती प्रतिभा देवी सिंह पाटिल से पुरस्कार प्राप्त करते डॉ एम ओ गर्ग

स्मरणीय क्षण: विज्ञान भवन, नई दिल्ली में 'विकल्प' पत्रिका के पुरस्कार सहित डॉ एम ओ गर्ग (बाएं से तीसरे) एवं राजभाषा अनुभाग के सदस्य (बाएं से) श्री प्रताप सिंह चौहान, डॉ॰ दिनेश चमोला एवं श्री एम सी रतूड़ी

2.7 MoU's/MoC's/ AGREEMENTS SIGNED

Foreign Collaborations/Agreements

MoU with UK-India Education And Research Initiative (UKIERI)

- Under a contract signed between the British Council and the University of Newcastle-upon-Tyne, the project will be taken up by the University of New Castle-upon-Tyne and the Indian Institute of Petroleum on *'Direct Production of Bio-diesel from Non-edible Oilseeds by Reactive Extraction'.*
- MoU with the Erlangen Graduate School in Advanced Optical Technologies (SAOT), Friedrich-Alexander-University, Erlangen-Nuremberg, Germany and Lehrstuhl fur Technische Thermodynamik (LTT), Germany to *utilize mutual R&D facilities and expertise for scientific collaborative R&D work* besides *training of scientific manpower amongst researchers of CSIR/IIP, SAOT & LTT.*
- MoU entitled *'Application of Bio-fuels for Aviation'* under Indo-Canada Cooperation Programme signed under ISTP-GITA bringing together a consortium of institutes, universities, companies from India and Canada. From the Indian side, the Indian Institute of Petroleum, Dehradun (IIP), the Indian Institute of Technology, Kanpur (IITK) and the Indian Institute of Science, Bangalore (IISc), would be the institutional partners while M/s Infotech Enterprises P Ltd., Bangalore (Infotech), the Indian Oil Corporation Ltd (IOCL) and the Hindustan Petroleum Corporation Ltd (HPCL) are industrial partners. From the Canadian side the National Research Council (NRC), the Lavel University (LU), the McGill University (MU) and M/s Pratt and Whitney participated.
- MoU with M/s Super Refinery (Pvt.) Ltd., Bangladesh for *technical services*

Inland Collaborations/Agreements

- A non-declosure agreement was signed with M/s Cairn India Limited, Mumbai for *evaluation of technical data for processing of Rajasthan crude for its transportation through pipe lines, and its suitability of processing in various refineries.*
- A non-disclosure agreement was signed with Praj-Matrix, Pune for the study of *'Thermophillic yeast strain capable of fermenting sugars to ethanol'.*
- An MoU was signed with M/s Castrol India Limited for *synthesis, characterization and studies on tribological performance of analogues of ZDDP, a multi-functional additive.*
- An agreement was reached with M/s SAR Chandra Environ Solutions Private Limited, Kakinada, Andhra Pradesh on *developing the eco-friendly emulsion breaker for drill cutting waste, synthetic oil based mud (SOBM) waste for recovery of oil waste and solids.*
- Numaligarh Refinery Limited (NRL), Guwahati is collaborating for a joint study on *processing of MVGO and HVGO stocks for production of paraffin and microcrystalline wax at NRL (TS-024).*
- A non-disclosure agreement was signed with M/s Krishna Antioxidants Pvt. Ltd., Mumbai on *'Magnesium Alkyl Benzene Sulphonate'.*
- A non-disclosure agreement was signed with M/s Supercon Schweisstechnik India Ltd., New Delhi on *'Industrial Gear Oil (EP Type), Industrial Hydraulic Oil and Li-Based (EP) Greases.'*
- MoU with the ONGC, Delhi for *crude oil assay studies.*
- MoU with the Central Pulp and Paper Research Institute, Saharanpur for *'An Integrated Approach for Utilization of Bagasse Pith for Production of Bioethanol and Value-Added Lignin Products.'*
- MoU with the BITS, Pilani with the objective of *fostering academic and research interactions between the two institutions leading to scientific and technological advances, and to human resource development, in the thrust areas of IIP.*
- MoU with the GAIL, New Delhi for *scale-up studies for conversion of waste plastic and low polymer wax to value-added hydrocarbons.*
- Non-disclosure agreement with the Renewable Energy Development Pvt. Ltd., Gujarat for *'Bio-fuel from palm fatty acid distillate; fast pyrolysis of biomass; waste plastics to gasoline/ diesel; design of up-draft gasifier with loose biomass & design of burner.'*
- MoU with M/s Ecocare Biolube India Pvt. Ltd., Coimbatore, Tamil Nadu for *licensing of the know-how of bio-degradable soluble cutting oil.*
- A non-disclosure agreement signed with M/s Trivedi Industrial and Research Associates Pvt. Ltd. for *exchange of information on desulphurization from flue gas streams and conversion of pyrolyser tar from naphtha cracker to naphthene.*
- MoU signed with the Rajiv Gandhi Institute of Petroleum Technology, Rae Bareilly regarding *scope for academic interaction of that institute with the IIP.*
- A non-disclosure agreement signed with M/s KLJ Resources Ltd., New Delhi.
- MoU with the ONGC Petro Additions Limited (OPAL), Gujarat for information and studies related to technology selection and transfer, *technological problems, value-addition to streams and technical advice* in their working area.
- MoU with M/s Praj Matrix Ltd., Pune for *thermophilic yeast strain capable of fermenting sugars to ethanol*. The main objective is the *utilization of the yeast strain*

for use in the production of ethanol from conventional and cellulose-based feed-stock.

- MoU with M/s SINTEF, Norway under the Institutional Co-operation Project financed by the Norwegian Ministry of Foreign Affairs (MFA) for *development of adsorption technology for recovery of CO_2 from power plant flue gases.*
- Non-disclosure agreement with M/s Nagarjuna Fertilizers and Chemicals Ltd., Hyderabad for *technology development and commercialization in the area of catalysis and chemical engineering.*
- MoU with the Department of Energy, Tezpur, Assam *to establish close linkages and functional co-ordination for pursuing higher studies, research and need-based training programmes.*
- Non-disclosure agreement with M/s Sud Chemie India Ltd., New Delhi *for manufacture of modified ZSM-5 catalyst for NTGG process.*

2.8 EXTRA-BUDGETARY RESOURCES

IIP's earnings from ECF during the Financial Year 2008-2009 stood at Rs. 812.691 lakhs

Category	Govt.	Private Industry	Central PSEs	Foreign Companies	TDS Sponsors/Clients /Parties	Total
Sponsored R&D	30.329	54.818	79.499	158.780		323.426
Grant-in-Aid R&D	94.351					94.351
Collaborative/ Cooperative R&D		11.659	4.573			16.232
R&D Consultancy	49.036					49.036
Technical Services	16.950	34.502	219.358			270.810
Premier/Royalty		2.497		16.367		18.864
Total	**190.666**	**103.476**	**303.430**	**175.147**	**39.972**	**812.691**

IIP's earnings from ECF during the Financial Year 2009-2010 stood at Rs. 1006.773 lakhs

Category	Govt.	Private Industry	Central PSEs	Foreign Companies	Total
Sponsored R&D	216.098	77.794	146.345	52.706	492.943
Grant-in-Aid R&D	110.240	-	-	-	110.240
Collaborative/ Cooperative R&D	2.412	-	2.758	-	5.170
R&D Consultancy	133.540	-	-	-	133.540
Technical Services	5.785	24.210	225.634	-	255.629
Premier/Royalty	-	9.251	-	-	9.251
Total	**468.075**	**111.255**	**374.737**	**52.706**	**1006.773**

3

Human Resource Development

3.1 TRAINING THE OIL INDUSTRY PERSONNEL

Training the personnel from the oil industry & related fields like automobile industry, transport sector etc. is one of the most significant activities that the Institute engages in as per its mandate. Training programmes organized in this period are as follows:

Topics	Organization	Number of Participants	Number of Programme
Petroleum Refining Technology	IOCL, RIL, UOP, BPCL, HPCL, FDIPL, NRL, MRPL	303	13
Laboratory Practicals	NTPC	88	4
Vehicular Pollution	MSRTH	40	2
Operation and Maintenance of CFR Engines	Different Refineries	11	1
Overhauling of CFR Engines	IOCL	3	1
Deposit Rating of Automotive engine Components	BPCL, HERO HONDA, IOCL and BAJAJ	8	1
Advances in Processing of Heavy & Non-conventional Crude Oils	Different Refineries	16	1

Participants and Faculty at the 'Petroleum Refining Technology' programme, November 10, 2008 - January 2, 2009

Faculty and students: Training Programme on 'Laboratory Practicals', February 15-26, 2010

3.2 CONFERENCES / WORKSHOPS ORGANIZED

Workshop-cum-Training Programme on *'Advances in Processing of Heavy and Non-Conventional Crude Oils'*, May 20-22, 2009

As a part of the events of the Golden Jubilee Year (2009-10), this workshop-cum-training programme was organized in which twenty executives of different refineries and oil companies participated.

Symposium on *'Fossil Economy to Biomass Economy: Opportunities and Challenges (Energising a Sustainable Future)'*, August 19-21, 2009

With sustainability issues gaining importance day by

Participants and faculty of the workshop-cum-training programme, May 20-22, 2009

day, it has now become relevant to discover and switch over to renewable forms of energy. The symposium on *'Fossil Economy to Biomass Economy : Opportunities and Challenges (Engergising a Sustainable Future)'* organized by the Institute under its Golden Jubilee celebrations between 19th to 21st August, 2009, focussed on various environmental and ethical issues of biomass conversion processes to eco-friendly energy fuels (gaseous and transportation), lubricants, additives, value-added speciality products and economic and societal consideration *vis-à-vis* fossil-derived products.

(L-R) Dr Kuldeep Chandra, Former Executive Director (R&D), ONGC, inaugurating the symposium

Over 100 delegates from India participated in the symposium. The event featured papers by 30 distinguished speakers during the seven sessions covering the topics:

Energy Scenario, Biomass – Resources, Conversion Technologies to Gaseous and Liquid Fuels, Lubricants, Additives and Other Value-Added Products, Analytical Procedures & Compatibility for Engines.

Seminar on *'Analytical Sciences in Energy And Environment'*, November 19-20, 2009

Analytical sciences play a dominant role in addressing the environment and energy-related issues by way of effective monitoring of various parameters. With the aim of highlighting the significance and application of various analytical techniques in the areas of energy and environment, a two-day seminar with the theme *'Analytical Sciences in Energy & Environment'* was inaugurated in the Institute on November 19, 2009.

Release of souvenir at the seminar on analytical sciences. Dr Girijesh Pant is seen standing third from left

The seminar was jointly organized by the Delhi Chapter of the Indian Society of Analytical Scientists (ISAS) and the Institute under chairmanship of Dr M O Garg, Director, IIP. Dr Girijesh Pant, Vice Chancellor, Doon University, Derhadun, inaugurated the seminar.

Oral presentations and poster exhibition were made on the occasion by experts and students. The seminar was attended by around 400 participants.

Symposium on *'Bio-Technology: A Road-Map Towards Sustainable Energy,'* December 10-12, 2009

In order to bring together leading scientists, academics, stake-holders and students on a common platform to review and suggest the critical role of bio-catalytic processes in the energy sector, a two-day symposium on *'Bio-technology-A Road Map Towards Sustainable Energy'* was organized between December 10-12, 2009.

The symposium had plenary and invited lectures by

Dr D S Chauhan, Vice Chancellor, Uttarakhand Technical University, Dehradun, inaugurates the bio-technology symposium

reputed international and national experts in the field with technical sessions covering presentations and interactive discussions on topics like fossil fuels (upstream), fossil fuels (downstream), bio-mass derived green fuels, alternative fuels from solar energy and environmental clean-up.

Second Indo-Norwegian Seminar on *'Advances in Separation Technologies'*, January 7-8, 2010

The Second Indo-Norwegian Seminar on *'Advances in Separation Technologies'* was organized by the Institute jointly with SINTEF, the largest research organization in Scandinavia situated at Oslo, Norway. The seminar was inaugurated by Prof D N Saraf, University of Petroleum & Energy Studies, Dehradun.

Prof D N Saraf inaugurating the symposium

The seminar had five technical sessions on topics related to advanced materials for carbon-dioxide capture; technologies/processes development; innovations in separation technology and membranes & absorption. Application of metal organic framework for adsorption of carbon-dioxide and advances in distillation, membranes and extraction were also discussed. Among those who delivered lectures were eminent speakers from Indian and foreign organizations like SINTEF, Norway; Purdue University, USA; UMIST, UK; ICT, Mumbai; JNU, New Delhi and IIT, Roorkee.

Workshop on *'Solvent Extraction Revisited: Application in Process Industries'*, February 5-6, 2010

Solvent Extraction has a wide role in product development in various industries viz. refineries, petro-chemicals, nuclear, pharmaceuticals, food, metallurgy and chemicals etc. With a view to bring unified view of all such applications and to make the industry aware of the role of solvent extraction a workshop on *'Solvent Extraction Revisited: Application in Process Industries'*, was organized along with the Indian Institute of Chemical Engineers, Northern Regional Centre (IIChE-NRC) at New Delhi on February 5-6, 2010. More than 60 delegates from all spheres of industries, R&D organizations and academic Institutes participated.

Mr M K Joshi, Director (Technical), Engineers India Ltd., inaugurating the workshop

Indo-German Seminar on *'Future Mobility,'* February 26-27, 2010

World-wide, major R&D initiatives in the field of I.C. engines focus on design and development of fuel-efficient and environment-benign vehicles complying to Euro IV emission norms and beyond so that we can

Inaugural session of the 'Indo-German Seminar on Future Mobility' (L-R) : Dr M O Garg, Chairman, Prof Dr. Alfred Leipertz, Patron, Mr Anand Kumar, Patron and Guest of Honour, Mr L N Gupta, Chief Guest, Dr S K Singhal, Co-Chairman and Mr A K Jain, Organizing Secretary

preserve the environment and conserve fuel for our future generations. It was in this backdrop that the *'Indo-German Seminar on Future Mobility'* was organized by the Institute under the aegis of the German Academic Exchange Services-DAAD and in collaboration with Friedrich-Alexander University (FAU), Germany; Institute of Engineering Thermodynamics (LTT), Germany and Erlangen Graduate School in Advanced Optical Technologies (SAOT), Germany at New Delhi, India during February 26-27, 2010.

Mr Rajeev Narang addresses the symposium (L-R) Dr A Mukherjee, Mr M K Joshi, Prof V K Srivastava and Dr M O Garg

The seminar was inaugurated by Mr L N Gupta, IAS, Joint Secretary, Government of India, Ministry of Petroleum & Natural Gas.

A total of 18 technical presentations were made during the two-day event and around 120 delegates from automotive and petroleum industry, research institutes and Govt. agencies attended the seminar. Later, the Indian Institute of Petroleum, the CSIR and the Institute of Engineering Thermodynamics (LTT, FAU) signed an MoU for *future scientific collaboration.*

MoU Signing Ceremony between CSIR-IIP, CSIR and LTT, FAU

3.3 COLLOQUIA

- Dr Suman L Jain, Research Associate, IIP, *'Novel Approaches for the Synthesis of Polymer-Supported Catalysts'* , April 25, 2008
- Mr Deepak Parab, Vice President, Micro Devices Metrohm Ltd., New Delhi, *'Ion Chromatography Instrumentation and Application In Petro-chemical Research & Industry'*, June 11, 2008
- Dr Rajeev Tyagi, DM, Endocrinology, Dehradun, *'Diabetic Neuropathy Arrest Activity'*, June 11, 2008
- Dr Adarsh Kumar, *RMO, IIP, Dehradun, 'Introduction, Impact & Management of Osteoporosis,' July 6, 2006*
- Professor Mohan Joshi, Industrial Mathematics Group, IIT, Bombay, *'Industrial Mathematics Group and Its Study Group Activities*,' September 2, 2008
- Dr V N Kalevaru, Leibnitz-Institute for Catalysis, Berlin, Germany, *'Influence of Co-Components on the Activity, Selectivity and Long-Term Stability of Pd-Containing Acetoxylation Catalysts,'* November 7, 2008
- Dr A K Dalai, University of Saskatchewan, Canada, *'Status and New Trends of Bio-diesel Production in Canada and Efficient Utilization of Crude Glycerol,'* November 28, 2008
- L Robindro, Scientist, IIP, *'System Design and Integration of V-CPU (Vehicle Central Processing Unit) Required for On-line Vehicle Monitoring System and Vehicle Security & Safety (A Product Concept),'* December 1, 2008
- Prayag, COREL (BSNL), Dehradun, *'Features and Facilities On the Recently-installed BSNL Exchange at IIP,'* December 15, 2008
- Prabha Kiran Dasila, University of Petroleum & Energy Studies, Dehradun, '*Modelling of*

Fluid Catalytic Cracking Unit,' December 18, 2008

- Dr Vinod Arora, Eye Surgeon, Dehradun, '*Computer Vision Syndrome,'* December 24, 2008
- Dr Subrata Choudhary, Bruker – Biospin, Delhi, India, *'500 MHz NMR Spectrometer & Its Applications,'* March 20, 2009
- Dr Natarajan Hari, Sales & Applications Specialist, Varian Inc., India, *'500 MHz High Resolution NMR Spectrometer & its Applications'*, March 26, 2009
- Mr Anand Singh, Sci-Edge Information, STN/Sci Finder/ Chemical Abstracts Service, Pune, '*Uses and Benefits of Chemical Abstracts and Sci Finder'*, March 26, 2009
- Dr P V S R Rajshekhar, '*Scope of Microporous and Mesoporous Molecular Sieves in the Oxidation of Higher Alkanes with Ozone*,' April 21, 2009
- Dr Neeraj Atray, Scientist, IIP, '*Research Trends for Emerging Energy Fuel (Bio-fuel)*,' June 12, 2009
- Dr Purnendu Ghosh, Director, Birla Institute of Scientific Research, Jaipur, '*Biotechnology Industry Trends*,' July 8, 2009
- Dr Kuldeep Dutta, MD(Med), FICA, FICC, Dehradun, '*Swine Flu*,' August 27, 2009
- IMA Blood Bank Dehradun, *'Awareness for Blood Donation'* October 5, 2009
- Mr R C Saxena, Tehnical Officer, IIP, *'Leica DM IL Metallurgical Microscope'*, October 13, 2009
- Dr Kartick Mondal, Sabic Research & Technology Pvt. Ltd., Vadodara, Gujarat, '*Utilization of Green House Gases: Path to a Greener Future*,' January 11, 2010
- Mr L Robindro, Scientist, IIP, '*On-Road Vehicle Emission Characteristics of a Gasoline Car (Hyundai Accent) on Inter-city And Intra-City Roads of Dehradun, Delhi and Jaipur Cities,'* January 13, 2010
- Dr Masahiro Fujiwara, Nanotechnology Research Institute, AIST, Osaka, Japan, *'Advanced Applications of Micropores, Mesopores And Macropores of Porous Silica-Related Materials,'* January 22, 2010
- Professor A S K Sinha, Dept. of Chemical Engineering, Institute of Technology, BHU, Varanasi, '*Photo-catalytic Decomposition of Water for Hydrogen Production Using Solar Radiation,'* February 15, 2010
- Mr Krishna Rao, Forevision Instruments (I) Pvt. Ltd., Hyderabad, '*Cross-Talk Elimination (XE-) Technology in Atomic Force Microscopy, True – Non-contact Mode & its use in AFM,'* February 25, 2010

Invited Lectures

- Swami Nikhileswaranandaji, Secretary, Ramakrishna Mission, Vadodara, *'Holistic Approach on Management and Leadership'*, May 22, 2008

3.4 DEPUTATIONS ABROAD

- Dr Anshu Nanoti, Scientist, visited Norway for participation in the project review meeting of the new collaborative project between IIP and SINTEF entitled *'Development of Low Carbon-Emitting Adsorption Technology for Ultra-Low Sulphur Diesel Production'*, Supported by Norwegian MEA, Norway, April 27-30, 2008
- Dr N Viswanadham, Scientist, was deputed to South Korea under *'Brain Pool Programme'* of KOFST as an International Fellow at the Sustainable Chemical Technology Division of the Korean Research Institute of Chemical Technology (KRICT) on sabbatical leave, April 30, 2008 - April 29, 2009
- Dr Soumen Dasgupta, Scientist, visited SINTEF, Norway to participate in an experimental programme under a new collaborative project between IIP and SINTEF entitled *'Development of Low Carbon-Emitting Adsorption Technology for Ultra-Low*

Sulphur Diesel Production', May 30 - June 29, 2008

- Dr M O Garg, Director; Dr H B Goyal, and Dr Savita Kaul, Scientists, visited the School of Chemical Engineering and Advanced Materials (CEAM), UK, in connection with the joint project awarded by the British Council under UKIERI. They also visited the University of Southampton and University of Aston for discussions on a probable research project on *'Bio-fuel Production From Biomass'*, June 2-7, 2009
- Dr M O Garg, Director and Dr S K Singal, Scientist, visited Spain to attend the *'19th World Petroleum Congress'* at Madrid and to interact with top executives of leading oil companies to explore the possibility of commercialization of IIP's technologies abroad to develop strategic partnerships with various international organizations, June 29 - July 3, 2008
- Dr M O Garg, Director, Mr U C Agarwal, Scientist and Mr Manoj Kumar Thapliyal, Technical Officer, visited Saudi Arabia for presentation of results of the sponsored project on *Re-refining of Used Oil Through NMP Extraction*, Jun 26-27, 2008
- Dr A Datta, Scientist, visited Consiglio Nazionale delle Ricerche, Istituto dei Materiali Nanostrutturati- Sezione di Palermo (CNR-ISMN), Italy, Jul 26-Aug 7, 2008, under the DST-sponsored project entitled '*Preparation of Novel Mesoporous Vanadium Phosphate Phases as Potential Catalysts for Selective Oxidation'* under the aegis of Indo-Italian POC. The project was awarded jointly to Dr Datta and Dr Anna Maria Venezia, Director of Research, CNR-ISMN Italy
- Dr M O Garg, Director and Dr S M Nanoti, Scientist, visited M/S SABIC, UK during Jul 28-31, 2008 and Dr S M Nanoti, Scientist, again during Sep 3-6, 2008 for discussions on a project sponsored by them
- Dr A Datta, Scientist, visited Leibnitz Institute for Catalysis at the University of Rostock at Rostock, Germany, Sep 7-27, 2008, in connection with the DST-BMBF Indo-German project on '*Hydrogen Production by Catalytic Reforming of Glycerol in Aqueous Medium'*. He also attended *'DGMK International Conference'* at Berlin, Sep 29 - Oct 1, 2008
- Dr S K Singal and Mr Amar K Jain, Scientists, visited Austria to monitor the pre-acceptance test and to get training on Heavy-Duty Transient Test Bed Instrument at AVL, Graz, October 6-10, 2008. This instrument is procured by IIP under the OIDB sponsored project
- Mr G S Dang, Scientist, visited Singapore to deliver a presentation on *'Reviewing Coal/Petcoke Gasification'* at the Coal-to-Liquids Investment Forum, November 27-28, 2008
- Dr M O Garg, Director; Dr U C Agarwal and Mr Manoj Kumar, Scientists, visited UAE for presentation of results of the sponsored project on *'Re-refining of Used Oil Through NMP Extraction',* United Lube Oil Col. Ltd. (UNILUBE), Saudi Arabia, February, 4-5, 2009
- Mr L Robindro, Scientist, visited Japan for '*Pre-acceptance Test and Training at Horiba for On-board Emission Measurement System Model OBSO200 for Gasoline,'* February 10-15, 2009
- Dr Jasvinder Singh, Scientist, visited the University of Southampton to discuss further research collaborations with Prof Sai Gu, UK; February 15-22, 2009
- Dr Thallada Bhaskar, Scientist, visited Prof Yudi WADA, Tokyo Institute of Technology, under *'JSPS–DST Exploratory Exchange Programme,'* Japan, February, 20- March 19, 2009
- Dr M O Garg, Director, visited Russia as a

Member of the DST delegation for discussion with the Russian institutes in the area of *'Sustainable Energy with Focus on Energy from Bio-waste, Algae and Sun,'* May 17-19, 2009

- Dr M O Garg, Director, visited USA to attend the *'US-India Workshop on Metrology, Standards and Conformity Assessment and Their Use in Support of Technical Regulations [WS-45-2008-Metrology, Standards & Conformity Assessment]'* as a member of the Indian delegation led by the Director, NPL, June 1-4, 2009
- Mr M K Shukla & Mr Wittison Kamei, Scientists and Mr Yograj Singh and Mr Sethpal Singh, Technical Officers, visited Neuss, Germany for equipment training at M/s AVL Emission Test System on Emission Analyzer and CVS and FFP, June 2-10, 2009
- Dr Jasvinder Singh, Scientist, visited UK on a one-year visit to the University of Southampton, UK under the Royal Academy of Engineering Fellowship to work on a project entitled *'Development of Computational Models for fast Pyrolysis of Bio-mass,'* August 6, 2009 – July 30, 2010
- Mr R C Saxena, Technical Officer, visited Heirsburg, Switzerland to take part in a training on Leica DM IL Metallurgical Microscope, organized by M/s Leica Microsystems (Schweiz) AG, August 10-14, 2009
- Dr Anil K Sinha, Scientist, visited Erie, Pennsylvania, USA, for training on microprocessor-based high pressure Bench Top Reactor System (BTRS Unit) organized by M/s SNAP-TITE Inc, August 11-15, 2009
- Soumen Dasgupta, Scientist, visited SINTEF, Norway for participation in the experimental programme under a collaborative project between IIP and SINTEF entitled *'Development of Low Carbon-Emitting Adsorption Technology for Ultra-low Sulphur Diesel Production,'* September 1-30, 2009
- Dr Anil K Sinha, Scientist, visited Novosibirsk for attending the '*Indo-Russian Seminar on Catalysis and Environmental Engineering*', Institute of Catalysis, September 13-15 and also other Russian institutes, September 15-17, 2009
- Mrs Poonam Gupta, Scientist and Mr R K Chauhan, Technical Officer visited UK for training on SOLAAR M6 Dual Zeeman Atomic Absorption Spectrometer organized by M/s Thermo Fisher Scientific, Cambridge, September 28 – October 1, 2009
- Dr M O Garg, Director, visited the University of Newcastle and the University of Huddersfield, UK, under UKIERI project, December 3-8, 2009
- Dr Savita Kaul, Scientist, visited the University of Newcastle, UK, under UKIERI project, December 3-11, 2009
- Mr D P Bangwal, Technical Officer and Ms Jyoti Porwal, JTA, visited the University of Newcastle, UK, under UKIERI project, December 3-17, 2009
- Dr S K Singhal and Dr M R Tyagi, Scientist, visited the University of Huddersfield, UK, under UKIERI project, December 7-12, 2009
- Dr Thallada Bhaskar, Scientist, visited Chengdu, China to attend the scientific/ technical programme meeting for the forthcoming *'5th International Symposium on Feedstock Recycling of Polymeric Materials (5th ISFR 2009)',* October 11-14, 2009
- Dr A Datta, Head, ASD and Dr D K Adhikari, Scientist, visited Brazil under the *Indo-Brazil S&T Collaborative Programme*, January 17-31, 2010
- Mr S K Ganguly, Scientist, visited China to present a paper in the oral session at the '*4th Refining Meet-China,'* Beijing, China, March 24-26, 2010

4

Research Activities: On-Going & Completed

4.1 SPONSORED PROJECTS

Completed

- Evaluation of lubricating oils for their EP and wear properties
- Analysis of feed oil, light diesel oil and superior kerosene samples as per BIS specifications
- Physico-chemical characterization of industrial lubricating oil
- Compatibility of blending the so-called bio-diesel with the automotive diesel fuel
- Delayed coking studies on RIL feed-stocks for production of anode/needle-grade coke
- Studies on know-how for supercritical solvent recovery in PDA technology
- Pinch analysis of FCC units
- Bio-diesel from *jatropha curcas* oil and its study on vehicles including field trials
- Utilization of waste cooking oil/restaurant grease for production of bio-diesel
- Studies on re-refining of used oil through NMP extraction for production of group-II base oil
- Short evaluation studies on crude oil samples from Allora and Dholasan fields in Gujarat
- Air-blowing studies to make on-grade (Vg-10 & Vg-20) paving bitumen from HS crude SR (Basrah Light Crude) at IOCL, Baruni refinery
- Studies to establish the characteristics of CR modified bitumen
- Studies on analysis of engine oils from international tractors limited to the desired characteristics
- Studies on composition of gasoline and comparison with is 2796:2005 specification parameters from Central Excise Raibareily, India
- Sludge deposit rating study of four-stroke passenger car engine components
- To study the deposit characteristics and gear distress rating of four Bajaj pulsar engines
- Deposit rating study on four Tata Indica CNG passenger cars
- Development of catalyst and process for conversion of waste plastic & low-polymer wax into value-added hydrocarbons
- FCC catalyst/additive characterization and evaluation
- Short evaluation studies on crude oil samples for North Kathana of south Gujarat field
- Studies on quality of gasoline from Hyundai Motors India Ltd., Kancheepuram
- Studies on different models of two wheelers, cars, MUV's and LCV's for fuel efficiency
- Optimization studies of compatibility on blending of processed vegetable oil sample with the automotive diesel fuel (HSD) of Bharat Stage II
- Studies on the quality of motor spirit from Haldia petrochemicals ltd., Kolkata as per Euro IV specifications
- Evaluation of nickle passivator developed by Patchem Ltd., UAE
- Studies on NMP extraction of wide-cut used oil and its distillates (Stage-I : Basic Feasibility)
- Short evaluation adsorbent for Panipat refinery
- Studies for selection and development of technology for VOC recovery from chemical storage tank emissions (Phase-I)
- Studies on non-edible bio-oil (SVOS) as fuel for durability and fuel economy
- Development of mesoporous vanadium phosphates as potential catalysts for selective oxidation of hydrocarbons
- Optimization studies of HPCL NMP Lube extraction unit (Phase-I)
- Short evaluation studies on crude oil sample from main line of Nahorkatia from Oil India Ltd., Assam

- Short evaluation studies on Digboi crude oil sample from Oil India Ltd., Assam
- Evaluation of hydraulic fluid samples for : (i) fire-resistant characteristics, (ii) wear characteristics and (iii) air release
- Evaluation of BHEL's crude oil sample for : (i) physico-chemical analysis and (ii) preliminary combustion performance
- Modification of extractor operation by removing nitrogen padding
- Detailed evaluation studies on crude oil samples from M/s Oilex Ltd., Vadodara
- Analysis of kerosene samples from Mani Majra, Chandigarh as per BIS 7574-1975
- Development of petroleum-based mesophase pitch for making high-performance carbon fibres
- Studies on the propellant-grade kerosene sample from the LPSC, Tamil Nadu
- Characterization of gasoline from Yamaha motors
- Development of process for oxidative desulphurization of diesel
- Sludge deposit rating and emission study of passenger cars
- Sludge deposit rating study of passenger car engine component
- Delayed coking studies on RIL blended feedstocks for the production of anode/ needle grade coke
- Development of low-capacity LAP burners for ceramic/pottery industry at Khurja
- Study on performance improvement of the small *gur* making plant by improving the fuel-feeding platform, fuel gratings and chimney systems
- Studies on quality of gasoline from Haldia Petrochemicals Ltd., Kolkata
- Studies on ISO HV-68 & VG-32 oils
- Investigation of constraints to operation of sulpholane unit on a pure pyrolysis gasoline feed & study for comparison of extractor performance with solvent as continuous and dispersed phase
- Delayed coking studies for HPCL (M) refinery
- Assay of crude oils from M/s Reliance Industries Ltd.
- Study on MS stock losses at RO's/COCO's
- Utilization of glycerol to 1, 3/1, 2 propane diol
- Performance evaluation of IOC's kerosene lamps and lanterns (10 nos.)
- Synthesis and testing of analogues of ZDDP
- MAT testing of catalyst samples from HPCL, Vishakhapattanam
- Study of Butene-1 plant at IOCL, Gujarat refinery
- Evaluation of hydraulic oils for their EP and wear properties
- Evaluation of gear oils for their load-carrying capacity
- Development of new synthetic methodologies through immobilized and heterogenized homogeneous transition metal-based catalyst

On-going

- New absorption-based approaches for CO_2 recovery
- Optimization study on food-grade hexane production unit at HPCL, Mumbai
- Development of Pressure Swing Adsorption (PSA) technology for CO_2 capture
- Synthesis of room-temperature ionic liquids and study of their applications for extraction of sulphur, nitrogen & aromatic compounds from petroleum feed-stocks
- Development of low carbon-emitting adsorption technology for ultra-low sulphur diesel (ULSD) production

- Pinch analysis of Crude Distillation Unit (CDU) and Delayed Coking Unit (DCU)
- Feasibility study for identifying feed-stocks for petro-chemicals
- Feasibility study on the choice of process for bottom upgradation at BPCL-KR
- Column targeting studies for PRU revamp at HPCL, Vishakhapattanam refinery
- Feasibility study for change-over from sulpholane to NMP in hexane unit, CPCL, Chennai
- Scale-up studies for conversion of waste plastic & low-polymer wax to value-added hydrocarbons
- Lab-scale investigation on flow assurance for 10% RJ Mangla crude to RTF tanks through pipeline (Phase-I) & lab-scale investigation on flow assurance for 5% RJ Mangla crude to RTF tanks through pipeline (Phase-II)
- Development of adsorption technology for recovery of CO_2 from power plant flue gas
- Pre-flash column for SEU's
- Studies on chemical recycling of waste plastics to produce waxes, olefins & LOBS
- Feasibility study of changeover of solvent to NMP in hexane unit at CPCL, Manali (Part-II)
- Development of polymer modified bituminous binder
- Study for processing light vacuum gas oil from Mumbai High and Nile crude to produce paraffin wax at MRPL
- Studies on NMP extraction of wide-cut used oil and its distillates (Stage-II:Process optimization and generation of design data)
- Processing of light neutral distillate in NMP lube extraction unit at CPCL
- Study for processing of LVGO & HVGO stocks for production paraffin & micro-crystalline wax at NRL
- Studies on crud formation during NMP extraction of WCO and feed quality variation on NMP extraction of WCO
- Studies on formation of mesophase during conversion of petroleum refinery streams into pitch for needle coke production
- Development of solid acid catalyst for alkylation of isobutane with alkenes to form alkylates as gasoline blend
- Catalyst development for isomerization of C7+ hydrocarbons with industrial feed stocks
- Hierarchical nanoporous materials for petroleum, bio-diesel refining and future applications to energy and environmental problems
- Low-temperature water-gas shift reaction over Cu-nanoclusters supported on ZnO/Al_2O_3 for practical fuel cell application
- Development of new nano-structured mesoporous materials like SBA-15 for catalytic application in hydrotreatment
- Novel doped 3-D nano-porous oxides for dye-sensitized solar cells (dssc)
- Mat testing of catalyst samples from HPCL, Visakh
- Application of bio-fuels for aviation
- Utilization of CO_2 feed-stocks for production of value-added chemicals
- Batch/continuous trans-esterification process for utilization of coconut oil for bio-diesel production
- Direct production of bio-diesel from non-edible oil seeds by reactive extraction
- Eco-friendly emulsion breaker for drill cutting waste
- Bio-prospecting for novel anti-microbials and industrially important enzymes from microbial isolates in the Uttarakhand Himalayas
- An integrated approach for utilization of bagasse pith for production of bio-ethanol and value-added lignin production

- Study of nano-materials for their use in engine oil formulations for better fuel efficiency
- Setting up of modernized emission measurement facility at IIP, Dehradun (Phase-I)
- Study on the effect of driver behaviour on fuel economy
- To popularize "SONA ESVS" in *dhabas* in and around Dehradun
- Lab testing and field evaluation of 'Navagni' bio-mass stove sample
- Determination of GHG emission factors for different types of gasoline- and diesel-driven vehicles incorporating driving cycles and preparation of GHG emission inventory from this sector for the period 1995 to 2007
- Feasibility study of utilization of 10% pre-treated non-edible vegetables oils in stationary diesel engine
- Operation of Fuel Testing Laboratory at NOIDA
- Analysis of four samples for CO_2 capture
- Short evaluation studies of crude oil samples from ONGCL
- Detailed evaluation studies on crude oil samples from Cairn Energy India Pvt Ltd.
- Detailed evaluation studies on PSC crude oil sample from MoP&NG
- Feasibility study for development & production of T-6 fuel as per GOST 12308:89
- Studies on evaluation of the gas condensate of HOEC
- Preparation of novel mesoporous vanadium phosphate phases as potential catalysts from selective oxidation
- Hydrogen production by catalytic reforming of glycerol in aqueous medium
- Establishing collaborative research for the development of processes for second-generation bio-fuels

4.2 IN-HOUSE PROJECTS

Completed

- Development of eco-friendly additives and lubricants: (a) saccharide-based bio-degradable lubricants (b) additives for bio-degradable lubricants
- CFD studies on two-phase flow patterns in industrial flow contractors
- Development of environmental friendly extraction technology using room temperature ionic liquids
- Development of technology for production of pure benzene using extractive distillation route
- Development of water soluble catalyst for fixed-bed sweetening process
- Hydro-treating of vegetable oils for green diesel production
- Studies on the production of bio-diesel from non-conventional feed-stocks having high FFA like PFAD, fatty acids of refined oil, acid oil etc.
- Liquid fuels from bio-mass via fast pyrolysis
- Hydrogen production from bio-oil by thermo-catalytic conversion
- Studies on corrosion behaviour of bio-diesel on diesel engine parts
- Bio-technological approach for upgradation of petroleum crude oils
- Investigations in to the aspects of engine performance, emissions, durability & lubricant requirements of HCNG-fuelled passenger cars
- Investigating the effect of engine oil viscosity on fuel consumption and exhaust emission
- Lubricated wear of steel
- Design, development and integration of an electronic unit for FLOSCAN flow sensors
- Evaluation of grassroots innovative combustion appliances/accessories

- Trace metal analysis of petroleum products and related materials
- Characterization of refinery streams by gas chromatography
- Physico-chemical characterization of automotive and industrial lubricants
- Development of bottom-cracking additives for FCC process
- Development of a representative driving cycle specific to Dehradun city
- Development of HPLC methods for characterization of petroleum and related products; revised characterization of petroleum and related products by HPLC and customization of suitable method

On-going

- Study on the feasibility for removal of PCA from FGH for meeting PCA specifications in FGH
- An alternative to paraffin wax from waste polyolefins
- Development of carbon wool from petroleum pitches/residues
- Development of new fixed-bed sweetening catalyst and commercialization of LPG sweetening catalyst
- Exploratory studies of hydro-denitrogenation (HDN) catalyst for refinery streams
- Development of novel green catalytic methodologies for oxidation and acid base catalyzed reactions
- Development of new synthetic methodologies using heterogeneous and heterogenized homogeneous transition metal-based catalysts
- Screening of algae oil for bio-diesel production
- Studies on liquid phase heterogeneous reactions by means of ultrasonic energy
- Study on the use of bio-diesel (B20) in a Tata Indigo passenger car
- Development of a pneumatic engine for automotive application
- Studies on energy-efficient lubricants
- Development of girth-gear lubricating grease
- Conversion of Maruti-800 car into a solar electric hybrid vehicle
- Blending effect of bio-oil with conventional fuels and its performance
- Preparation, characterization and catalytic activity of new and metal-incorporated vanadium phosphates
- Setting up of the institutional repository of the Institute

4.3 CSIR NETWORK PROJECTS

Completed

- Upgradation of IS base units, national standards of measurement & apex calibration facilities and creation of high quality network of testing & calibration lab.
- Development of modified bitumen through molecular alteration in short residue (polymerization & condensation)

On-going

- Development of speciality inorganic materials for diverse applications
- Advancement in metrology
  - *Activity-1:* Metrology in chemistry (MiC) in petroleum-related areas : standardization of bio-diesel on an Indian level
  - *Activity-2:* Development of reference materials for lubricity, viscosity and trace metal analysis

4.4 'SUPRA-INSTITUTIONAL' PROJECT (SIP)

On-going Sub-Projects of SIP

- Development of know-how and technology for environmentally friendly conversion and utilization of bio-mass to fuels, lubricants and additives

- Development and improvement of heterogeneous catalsyts for bio-fuels
- Pilot plant, scale-up and commercialization of bio-diesel process
- Hydro-treating of vegetable oil for green diesel production
- Hydrogen production from glycerol
- Important chemical intermediates from glycerol
- Modified alkyd resin development for value-addition to glycerol
- Development of catalyst for production of ethers from glycerol
- Development of process know-how for bio-ethanol production from cellulosic and starchy bio-mass using thermophilic micro-organisms
- Process & technology for production of liquid and gaseous fuels by fast pyrolysis of bio-mass
- Upgradation of bio-oils to future fuels
- Gasification technology development for production of synthesis gas from carbonaceous feed-stocks for downstream utilization
- Development of eco-friendly additives and lubricants: (1) saccharide-based bio-degradable lubricants (2) additives for bio-degradable lubricants
- PSA process for CO_2 recovery from bio-mass pyrolysis/gasification of gas
- Development of absorption-based technologies for CO_2 capture from bio-mass gasification flue gases
- Development of life-cycle analysis model for bio-mass conversion to fuels and lubricants
- Development of methods for compositional analysis of bio-fuels, bio-lubricants & additives
- Engine performane studies on bio-fuels, bio-lubricants and additives
- Tribological studies of bio-lubricants and fuels
- Corrosion behaviour studies on bio-fuels, bio-lubricants and additives
- Additive development and oxidative stability studies on bio-fuels and bio-lubricants

5

Facilities Created / Updated

5.1 RELATED TO ANALYTICAL SCIENCES

Pressure Swing Adsorption Unit

A custom-designed three-bed computer-controlled unit having data logging facilities respect to flow temperature and pressure, and flexibility to operate with a range of PSA cycles for use in process studies for development of PSA technology for recovery of CO_2 from power plant flue gas.

Rancimat Unit for Enhancing Oxidation Stability of Bio-diesel

The unit is used to study the effectiveness of synthetic anti-oxidants for enhancement of oxidation stability of bio-diesel.

Rancimat Unit

Automatic Colorimeter

Automatic colorimeter is used to detect the coloring matter/oxidation/degraded product in fuel as per ASTM method.

Automatic Micro-Distillation Analyzer

Automatic Micro-Distillation Analyzer from ISL, France, is a high-quality design unit which provides a complete distillation run and test report in 12 minutes using only 10 ml of sample with the excellent repeatability and reproducibility. The user-friendly unit measures vapour & liquid temperature and pressure in the distillation flask as the sample gradually distills under atmospheric pressure. Distillation characteristics calculated from data are automatically corrected for barometric pressure and are stored in memory.

Automatic Micro-Distillation Analyzer

Automatic Pensky Martins Flash Point Tester as per ASTM D93

Having a temperature range of 1 to 370°C, of both gas and/or electric ignition, a system for automatically lighting the test flame and positioning the stirring mechanism, storing 20 test methods, 500 test results and providing statistical reports.

Automatic Pensky Martins Flash Point Tester

ED-XRF Sulphur Analyzer

The Polarized ED - XRF Bench Top Analyzer for detection of sulphur in petroleum products. Right from 2 ppm to 5 % wt. It is equipped with the polarized source of X-Ray using Pyrolytic Graphite Crystal (HOPG), a movable secondary target and a rugged gas-filled proportional counter detection system.

FTIR Spectroscopy

A unique state-of-the art facility for Fourier Transform Infrared (FTIR) spectroscopy consisting of a high-resolution Nicolet 8700 FTIR Spectrometer (spectral range 27000 to 375 cm^{-1} covering both mid and near IR regions) and its highly specialized accessories, namely

continuum microscope, horizontal ATR, fiber optic probes, cryogenic variable temperature cell, heated liquid cell, automatic polarizer, and an auxiliary experimental module. This is provided with the dual IR source, dual beam splitter & dual detector combination to cover the entire spectral range as well as an additional high sensitivity MCT TRS detector for time resolved spectroscopy at micro second scale. The system is operated using advanced OMNIC software package including 2D spectroscopy and multivariate analysis involving Beer's law, PLS, PCR & CLS methods.

X-Ray Diffractometer

A state-of-the-art facility, i.e., Bruker model D Advance powder X-ray Diffractometer was installed. It consists of special facilities for the following:

Automated multi-sample measurements using a nine-position sample stage at diffraction angles 2theta from 2 degree to 120 degree, at the ambient temperature.

Variable temperature measurements of XRD patterns (on single samples) from the ambient temperature to 1600°C.

Small-angle X-ray scattering measurements (on single samples) at the ambient temperature from 4 degree to 120 degree.

This system is operated with the help of the Commander software. The data processing and analysis are carried out using Eva and Topaz software.

Field Emission – Scanning Electron Microscope with EDS and EBSD System

Installation & commissioning of Field Emission – Scanning Electron Microscope with EDS and EBSD System; Model - Quanta 200 F (FEI, The Neitherland) with multiple Detectors done.

5.2 RELATED TO AUTOMOTIVE FUELS AND LUBRICANTS APPLICATIONS

On-Board Emissions Measurement System : A New Frontier in Emissions Measurement

Equipment Features:

This is a vehicle-mounted emissions measurement system in response to the increasing needs for exhaust measurement of vehicles being operated on actual roads. This is a compact equipment having low power consumption for analyzers. The system components have excellent vibration resistance.

On-board Emissions Measurement System

It continuously measures CO, CO_2, HC, NOx, A/F as concentrations but, by measuring the exhaust gas flow rate also, mass emissions and fuel consumption can be calculated. In addition to this, it provides the user with total information by giving a real-time data of the vehicle's operating environment factors such as global position and driving conditions also.

It allows one to measure actual exhaust emissions under real-world conditions as also to investigate the effects of vehicle, driver behaviour, traffic, road and weather conditions such as fuels, congestion, gradients and other unusual traffic conditions. With this flexibility, it can make a significant contribution to studies related to reducing pollution and improving energy efficiency. No longer is exhaust gas a specialized class of measurement.

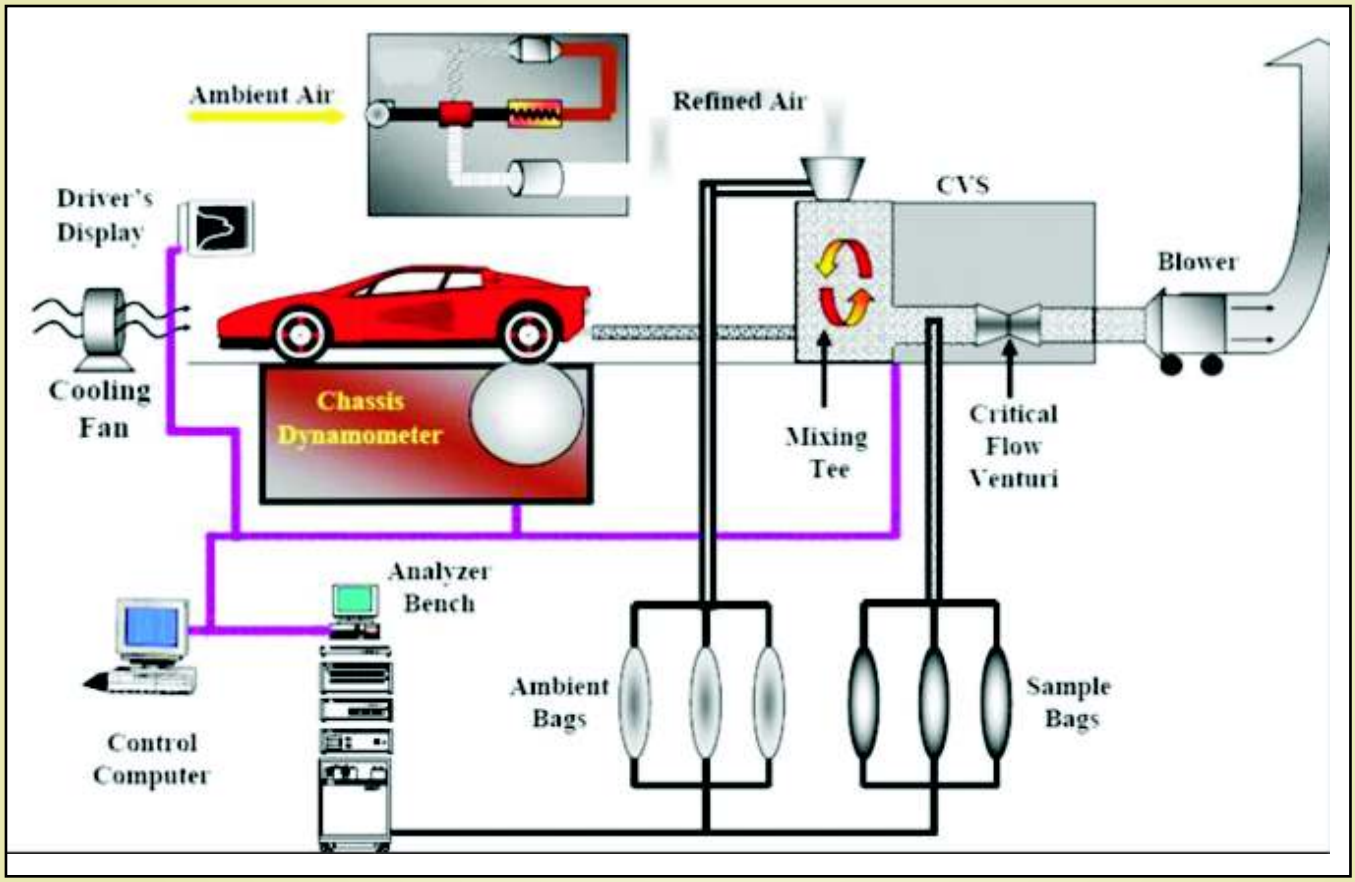
It may also be used for a diverse range of practical applications, e.g.:

- Investigation of the Effects of traffic or environmental conditions on exhaust emissions
- Analysis of the local pollution at specific spots, i.e. intersections or crowded roads
- Researching engine emissions for developing vehicles and catalysts
- Investigation of the composition change in in-use cars over the vehicle life time

4-Wheeler Test Cell: Mass Emissions Measuring Equipment

The set-up has the facility for Type Approval /COP/Development Tests on four-wheelers (Gasoline/CNG/LPG/Diesel) as per BS-II and BS-III, EURO and EPA norms and as per customer requirements with customized test cycles. The 150 kW AC machine chassis dynamometer having 48 inch dia. single roller with inertia simulation from 120 to 5443 kg is used for complete road-load simulation, measurement of vehicle emission, constant speed fuel consumption and vehicle performance. The latest-generation Dilute Diesel / Gasoline / CNG / LPG Exhaust Gas Analyzer, constant volume sampler and 12-inch dilution tunnel are suitable for measurement of all 4-wheeler passenger cars and light commercial vehicles.

A schematic layout of the test cell with vehicle is given in the figure below:



5.3 RELATED TO BIO-FUELS RESEARCH

Bio-photometer

One Bio-photometer (a single-beam spectrophotometer which can quantify any biological sample from a small volume like 50 µL) which is used to quantify Nucleic acids (ds and ss), proteins, carbohydrates, turbidity of cell etc. and one HPLC with RID and a sugar acid alcohol column which can detect sugars, acids and alcohols from fermentation broth, has been procured.

Ultrasound Reactor for Batch and Continuous Flow Modes for Reactants and for Vacuum Residue Upgradation

- Ultrasound waves can be produced through an ultrasound reactor. It has a frequency of 24 kHz and power input of 200W. High-intensity energy is released in terms of temperature (10000°K) and pressure (1000atm.), if the ultrasound waves pass through cavitating liquid. The ultrasound waves can be very

beneficial for the process of base-catalyzed trans-esterification that leads to formation of bio-diesel from vegetable oils, animal fats, etc. Manifold reduction of reaction times, improvement in production yields, drastic reduction of the excess alcohol reagent and catalyst, etc, can be achieved. The Ultrasound Reactor can be used for both batch as well as continuous modes.

- Two experimental units for pyrolysis (slow) have been constructed to study the process parameters and product yields using various bio-mass feed-stocks.

5.4 RELATED TO HEAVY OIL PROCESSING RESEARCH

Asphalt Rheometer and Other Instruments

The Bitumen Laboratory of the Heavy Oil Processing Division (HOPD) is fully equipped with all modern instruments to characterize both multi-grade (MG) and viscosity-grade (VG) bitumen; all tests under BIS 15462:2004, BIS 73:2006, and IRC 53:2004 specifications can be carried out including advanced facilities for testing high-performance grade bitumen under SHRP specification prevailing in US & Europe.

Asphalt Rheometer (AR 1500 ex) has been recently commissioned for assessment of high-performance bitumen.

Asphalt Rheometer (AR 1500 ex)

5.5 RELATED TO SEPARATION PROCESSES (ADSORPTION AND MEMBRANE) RESEARCH

A two-column automated Vacuum Swing Adsorption unit has been procured, installed and commissioned successfully for the recovery of CO_2 from bio-mass pyrolysis of gases. The unit is PC-PLC based and equipped with pneumatically actuated solenoid valves, pressure control value, electric furnace etc. It can operate at high temperatures and high pressures. The unit is highly flexible and different types of VSA sequences can be tested.

6

Down Memory Lane

6.1 ANNUAL EVENTS

IIP Foundation Day Celebrations, April 17, 2008

The Institute celebrated its Forty-eighth Foundation Day on April 17, 2008. In a glittering function Prof S C Saxena, Director, Indian Institute of Technology (IIT), Roorkee, delivered the Foundation Day Lecture *'Energy Scenario: Role of the Research Institutes'*.

IIP Foundation Day: Adorning the podium are Prof I M Mishra, Prof S C Saxena, Dr M O Garg and Mr V S Saini

Prof Saxena said that the creation of such modern temples by our visionaries basically aimed at meeting the challenges of food and energy security and national integrity. Cautioning on the energy security front he said that India has only 0.5% of global oil reserves and 0.55% of global gas reserves.

Prof I M Mishra, IIT, Roorkee, was the Guest of Honour on the occasion.

IIP Golden Jubilee Year 2009-2010 Celebrations (Curtain Raiser) Programme, April 27, 2009

The Institute held its 'Golden Jubilee Year Celebrations – Curtain Raiser' programme on April 27, 2009. The Chief Guest of the function was Prof. Man Mohan Sharma, Ex-Director of the University Institute of Chemical Technology, Mumbai, a recipient of Padma Bhushan, 1987 and Padma Vibhushan, 2001. Dr M O Garg, Director, IIP welcomed the distinguished guest and felicitated all the ex-employees of the Institute. A presentation, *'Down Memory Lane : Glorious Past Fifty years of IIP'* was given by an ex-employee, Dr K S Jauhri. An overview of the functions to be held by the Institute during the course of the next year was given by the Director, IIP, Dr M O Garg.

Prof M M Sharma (second from left) releasing the Golden Jubilee Logo of IIP. (L-R) Dr A Datta, Dr M O Garg & Dr K S Jauhri, Ex-Scientist, IIP join in

Prof M M Sharma (first from left) at the foundation stone-laying ceremony of the Golden Jubilee Laboratory. Dr M O Garg & others look on

Prof Sharma also released the IIP Golden Jubilee Logo on the occasion, and gave away prizes to the winners of the *IIP Golden Jubilee Logo Competition.*

During his visit, Prof Sharma interacted with the scientists of the Institute.

National Technology Day Celebrations, May 12, 2008

On this day, a unique workshop was organized in which new and innovative ideas were invited from the scientific and non-scientific staff of the Institute. The keynote lecture was delivered by Dr Lalji Dixit, Sr. Scientist, IIP on *'Nuclear Power for Peace'*. The following ideas were presented by the scientific & non-scientific staff : '*Wind Energy : Secondary Energy Source for Motor Vehicles, Reducing Friction Losses in Liner Piston Assembly*', *'Bio-mass to Hydrocarbons by Synthetic Biology'*, *'Conversion of Glycerol to Value-*

Added Products, Alternate Fuel for Flex Fuel Vehicles', *'A Heat Energy-Efficient Cooking Vessel'*, *'Utilization of Momentum of Vehicles'* and *'Checking the Menace of Dreaded Chemicals.'*

Creative Idea Workshop in progress

Earth Day Celebrations, April 22, 2009

Earth Day is celebrated to make people aware of the fact that we have only one earth to live and that we have to save it and its environment. For this cause, IIP held an on-the-spot painting competition for the children of various schools on April 21, 2009. To create awareness among the staff, a lecture was organized by the Chief Guest Dr Rai Avadhesh Kumar Srivastava, Ex-Chairman, Commission for Scientific and Technical Terminology, Ministry of Human Resource Development, Govt of India, New Delhi, on April 22, 2009. The topic of the talk was '*Jaroori Hai Prithvi Ko Bachane Ki Muhim*.' (It is necessary to have a movement to save the earth.)

Earth Day: (L-R) Dr Chamola, Dr Srivastava & Dr M O Garg

National Science Day Celebrations, 2009

National Science day was celebrated in the Institute in which Dr S Chandra, Joint Advisor (Fertilizer), Department of Chemical & Fertilizers, New Delhi, was the Chief Guest.

Dr Chandra delivered the National Science Day Lecture on *'Attitude of the Indian Society Towards Scientific Approach and International Comparison'*.

Dr S Chandra inaugurates the function as (L-R) Dr A Datta, Dr M O Garg and Ms Nalinee Pathak look on

Oil & Gas Conservation Fortnight (OGCF), January 15-31, 2010

The Fortnight is organized by the IOC, HPCL and BPCL along with Petroleum Conservation Research Association (PCRA) and IIP, Dehradun, every year in the second fortnight of January to spread the message of conservation of petroleum products. The Fortnight was formally inaugurated on January 20, 2010 at IIP by the Her Excellency the Governor of Uttarakhand, Mrs Margaret Alva. The Guest of Honour of the function was Mr Yashvir Gupta, DGM (RS), IOCL, Noida.

Her Excellency, Mrs Alva urged the youngsters to conserve energy and emphasized that proper use of petroleum products would help the country achieve

OGCF inauguration: dignitaries stand to attention as the National Anthem plays

savings upto 20-25 per cent of its current energy consumption.

The programme ended with a human chain formation by all present including students along with the dignitaries. Balloons with oil conservation messages were released by Her Excellency.

Spreading the message : 'SAVE OIL'

6.2 SPECIAL EVENTS

CSIR Programme on Youth for Leadership in Science (CPYLS), May 29-30, 2008

This CSIR programme, popularly known as CPYLS, aims to attract meritorious young school children towards science. The position holders of various High School Boards are invited to the Institute for a two-day programme every year.

Budding young scientists participating in the CPYLS Programme

The programme seeks to inspire in the students a spirit of adventure, excitement and future in science and research through individual assistance and support. The objectives of such schemes are:

- To motivate and attract the best young school students towards science through a unique hand-holding experience.
- To encourage young students to discover science as an exciting, rewarding and fulfilling career.
- Help build up a scientific mentality during teenage years itself.
- Awakening the students to the spirit of taking pride in the achievements of the Indian Science.

Students from the Uttarakhand State belonging to various School Boards like the CBSE, the ICSE and the Uttarakhand Board – some of them from remote hill areas – participated in the programme.

Visit of Prof Samir K Brahmachari, Director General, CSIR, December 2008

Yet another historical event was witnessed in the Institute when Prof Samir K Brahmachari, Director-General, Council of Scientific and Industrial Research (CSIR), visited its premises. Addressing all the members of IIP family, he dwelt upon the undeniable role of the CSIR in strengthening the scientific base of the country.

Talking about a renaissance in the Council, Prof

An eloquent Prof S K Brahmachari

Curious to know : Director General in Hydro-desulphurization Laboratory

Brahmachari said that affordable health and sustainable energy are the two major issues before the CSIR.

Visit of The National Commission for Scheduled Castes & Tribes (NCSCT), January 28, 2010

Representatives of the National Commission for Scheduled Castes & Tribes visited the Institute on January 28, 2010 to review the implementation of the rules of reservation and service safeguards being provided to the members of these communities (mandatory under the provisions of the Constitution of India). The representatives included Prof. N M Kamble, Vice Chairman; Mrs Satya Bahin; Mr Mahendra Bauddha and Mr Mrutyunjay Nayak.

NCSCT session in progress

6.3 विज्ञान: जन-जन की सेवा में/SCIENCE IN THE SERVICE OF THE PEOPLE

भारतीय पेट्रोलियम संस्थान, देहरादून के निदेशक डॉ॰ एम ओ गर्ग एवं पेट्रोलियम कंजर्वेशन रिसर्च एसोसिएशन (पीसीआरए), नई दिल्ली के संयुक्त निदेशक श्री सुधीश अग्रवाल ने बिहारीगढ़ एवं बुग्गावाला क्षेत्रों के उन्नत गुड़ भट्टी अपनाने वाले मालिकों की गुड़ भट्टियों का दौरा किया एवं उन्हें स्थल पर ही अनुदान राशि रु॰ 5000/- का चेक प्रदान किया। इस अवसर पर भारतीय पेट्रोलियम संस्थान के वैज्ञानिक गण श्री उमेश कुमार जायसवाल एवं डॉ॰ एस एन शर्मा, तकनीकी अधिकारी श्री सतीश कुमार एवं तकनीशियन श्री मोहकम सिंह भी उपस्थित थे। इस कार्य को संपन्न बनाने में बिहारीगढ़ की गुड़ भट्टियों के प्रधान श्री प्रवेश काम्बोज का विशेष सहयोग रहा।

संस्थान द्वारा विकसित उन्नत गुड़ भट्टी तकनीक अपनाने वालों के लिए भारत सरकार द्वारा घोषित अनुदान राशि का वितरण, 22 जनवरी, 2009

6.4 सामाजिक एवं सांस्कृतिक गतिविधियां/ SOCIAL & CULTURAL ACTIVITIES

Vishwakarma Pooja, September 17, 2009

This annual community function was organized in the Institute on September 17, 2009, wherein respect to tools was accorded in the form of a traditional *pooja*. Dr M O Garg led the *pooja* which was followed by a community dinner.

Dr M O Garg offers obeisances to Lord Vishwakarma, the Great Engineer of the Gods.

प्रश्न मंच का आयोजन, 23 सितंबर, 2008

वै औ अ प स्थापना दिवस के अवसर पर ज्ञान-विज्ञान के विषयों पर एक प्रश्न मंच का आयोजन किया गया, जिसमें विभिन्न नामों से गठित प्रतिभागियों के दलों के बीच स्पर्द्धा हुई। विजेताओं के नाम इस प्रकार से हैं :

प्रथम : श्री जी एम बहुगुणा, श्री मनोज तिवारी, श्री एम के पिल्ली एवं डॉ बी आर नौटियाल का दल।

द्वितीय : श्री देवेन्द्र सिंह, श्री सुनील पाठक, श्री पंकज कुमार एवं श्री मृत्युंजय कुमार शुक्ल का दल।

प्रश्न मंच की एक झलक

नाटक का मंचन, 23 सितंबर, 2008

वै औ अ प स्थापना दिवस के अवसर पर ही भापेसं स्टाफ क्लब के सदस्यों द्वारा एक गीत-संगीत भरे कार्यक्रम और एक नाटक *'गाँधी एलाइव'* की सराहनीय प्रस्तुति की गई।

6.5 HEALTH-CARE

In a series of activities being conducted by the Institute's Medical and Health Centre for the serving staff with a view to detection of diseases at an early stage, various Health-Care Camps were organized.

Diabetic Neuropathy Arrest Activity Camp, June 12, 2008

Free Diabetic Neuropathy Arrest Activity Camp, June 12, 2008.

Free Heart Check-up Camp, February 7-8, 2009

Under the auspices of the Escorts Heart Institute and Research Centre (EHIRC), New Delhi, this being a part of their Community Outreach Programme, the camp was held on February 7-8, 2009.

(L-R) Dr L Bakaya,Sr RMO, IIP, Mr A S Negi, DM, Dehradun, Dr A Datta, Sci-G, IIP and Dr H U Khan, Sci-F, IIP, at the Free Heart Check-up Camp

Free Eye Check-up Camp, May 23, 2009

The Institute and the Nav Jyoti Eye Hospital jointly organized a one-day Free Eye Check-up Camp within the IIP campus on May 23, 2009.

Blood Donation Camp-III, October 9, 2009

This camp was organized with the help of the IMA Blood Bank, Dehradun Chapter.

Mrs Alka Garg inaugurates the Blood Donation Camp-III as (L-R) Dr M O Garg, Mr V K Kaushika & Dr (Mrs) Lalita Bakaya look on

6.6 हमारा खेल-पक्ष/ON THE SPORTING SIDE

40वाँ शांति स्वरूप भटनागर स्मृति टूर्नामेंट (इंडोर)

- संस्थान के दल ने आइ एम टी, चंडीगढ़ में आयोजित 40वें एस एस बी एम टी इंडोर टूर्नामेंट में भाग लिया तथा फाइनल के लिए अर्हता प्राप्त कर संस्थान को गौरवान्वित किया।
- संस्थान के दल ने राष्ट्रीय भूभौतिकीय अनुसंधान संस्थान, हैदराबाद में 20-22 फरवरी, 2009 को आयोजित 40वें एस एस बी एम टी इंडोर टूर्नामेंट (फाइनल) में भाग लिया। प्रतियोगिता के फाइनल में श्री देवेन्द्र राय बैडमिंटन (व्यक्तिगत स्पर्द्धा) में तथा श्री एस सी भट्ट, श्री नरेन्द्र रावत एवं डॉ सोमेन दास गुप्ता टेबल टेनिस (दल स्पर्द्धा) में उपविजेता रहे।

भापेसं, देहरादून का विजेता दल

41वाँ शांति स्वरूप भटनागर स्मृति टूर्नामेंट (आउटडोर-ज़ोनल), भापेसं, देहरादून

- भापेसं, देहरादून में नवंबर 6-9, 2009 को आयोजित इस ट्र्नामेंट में सी एस आइ आर परिवार की 10 प्रयोगशालाओं से आये 190 खिलाड़ियों ने भाग लिया।

41वें शांति स्वरूप भटनागर स्मृति टूर्नामेंट का उद्घाटन-समारोह। (बाएँ से) श्री पी पी मणि, सचिव, आइ आइ पी स्टाफ क्लब (डा. ए दत्ता, कार्यकारी निदेशक, भापेसं तथा श्री ए के सूद (मुख्य अतिथि)

वॉलीबॉल प्रतियोगिता का शुभारम्भ करते हुए श्री विजय कुमार कौशिक, प्रशासन नियंत्रक

- इस टूर्नामेंट में क्रिकेट और वॉलीबॉल के खेल हुए। इस कार्यक्रम का उद्घाटन श्री ए के सूद, मैनेजर (एच एंड वेलफेयर) तथा इंचार्ज, वेलफेयर सेक्शन, ओ एन जी सी, तेल भवन, देहरादून ने किया।

41वाँ शांति स्वरूप भटनागर स्मृति टूर्नामेंट (आउटडोर-ज़ोनल), केंचअसं, चेन्नई

केन्द्रीय चर्म अनुसंधान संस्थान (CLRI), चेन्नई में नवंबर 30-दिसंबर 2, 2009 को आयोजित इस सम्मानित द्विवार्षिक परिषदीय क्रीड़ा समारोह में संस्थान के क्रिकेट तथा वॉलीबॉल दलों के निम्नलिखित सदस्यों ने भाग लिया:

क्रिकेट

सर्वश्री एन के रावत, राजेश कुमार, हेमंत तिवाड़ी, परवेज़ आलम, प्रदीप पंवार, राजीव शर्मा, मनमोहन सिंह, अरविंद खंडूड़ी, परवेश चन्द, धर्मेन्द्र पुण्डीर, हरजीत सिंह एवं हिम्मत सिंह पुण्डीर

वॉलीबॉल

सर्वश्री देवेन्द्र सिंह बुटोला, राजीव पंवार, राजेन्द्र बडोला, राकेश जोशी, शिव सिंह रावत, अब्बल सिंह रावत एवं सुदामा सिंह

41st Shanti Swaroop Bhatanagar Memorial Tournament (Outdoor), CSIO, Chandigarh

The Volley-ball & Cricket Teams of the Institute participated in the finals of this event organized at the CSIO, Chandigarh, during February 19-21, 2010. The Volley-ball Team comprising Mr Devender Butola, Mr Rajeev Panwar, Mr Rajender Badola, Mr Abbal Singh Rawat, Mr Shiv Singh Rawat, Mr Pushpraj Sharma, Mr Sudama Singh Bisht, Mr Vikram Singh Rawat & Mr Rakesh Joshi was Runner-up in the Tournament.

The Volley-ball Runner-up team members

7

Committees

7.1 RESEARCH COUNCIL (Reconstituted in January, 2009)

Chairman

Shri V Subramanian, IAS
12-E, HUDCO Place (Old)
Andrews Ganj
NEW DELHI- 110 049

Members

Dr M Ganapati
President – Corporate Planning
GMS, RTEC-D Block
C/o Reliance Petrochemicals
5 TTC Industrial Area
Thane-Belapur Road, Ghansoli
MUMBAI - 400 701

Shri B N Bankapur
Director, Refineries
Indian Oil Corporation Limited
Scope Complex, Core-2, Lodhi Road
NEW DELHI –110 003

Dr D M Kale
Executive Director (R&D)
Oil & Natural Gas Commission
Chief, Energy Centre, 5th to 15th Floor
South Tower, Scope Minar
Laxmi Nagar
DELHI- 110 092

Professor I M Mishra
Department of Chemical Engineering
Indian Institute of Technology
ROORKEE – 247 667

Dr K S Balraman
Executive Director
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5th Floor Core-6, Scope Complex
Lodhi Road, NEW DELHI – 110 003

Shri S N Sharma
Consultant
Human Resource Development Centre
Sector-19, Central Government Enclave
Kamla Nehru Nagar, P.B. No. 10
GHAZIABAD – 201 002

Dr A K Shukla
Director
Central Electro-chemical Research Institute
CECRI Nagar
KARAIKUDI – 623 006

Head or His representative
R&D Planning Division
CSIR, Rafi Marg
NEW DELHI – 110 001

Dr M O Garg
Director
Indian Institute of Petroleum
DEHRADUN – 248 005

Head, RPBD
Indian Institute of Petroleum
DEHRADUN – 248 005

Research Council Meeting, September 4, 2009

34th RC Meeting in progress. (L-R) Mrs N J Thomas, Dr B D Ghosh, Dr M Ganapati (partly seen), Mr B M Shukla, Mr V Subramanian, Dr M O Garg and Mr B N Bankapur

Research Council Meeting, March 26, 2010

35th RC Meeting in progress. (L-R) Mr B M Shukla, Mr S N Sharma, Dr D M Kale, Mr V Subramanian, Mr B D Ghosh, Prof I M Mishra and Dr M O Garg

7.2 MANAGEMENT COUNCIL

Chairman

Dr M O Garg
Director

Members

Dr A Datta
Scientist-G
Head, ASD/CCPD

Dr A N Goswami
Scientist-G

Dr Savita Kaul
Scientist E-I

Mr B M Shukla
Scientist-F
Head, RPBD

Dr Raja Ram Bal
Scientist-C

Mr V K Anand
Sr. CFA/CFA/F&AO

Sr. COA/COA/AO (Member-Secretary)

Mr Nishan Singh
Scientist-F
Head, ESD

Mr C R Srivastava
Engineer E-I

8

राजभाषा

8.1 'राजभाषा हिंदी विशिष्ट व्याख्यानमाला'

भारतीय पेट्रोलियम संस्थान, देहरादून में ***'राजभाषा हिंदी के साठ स्वर्णिम वर्ष- विशिष्ट व्याख्यानमाला'*** का आयोजन किया गया जिसके अर्न्तगत वरिष्ठ साहित्यकार एवं पत्रकार श्री हिमांशु जोशीघ्प्रो॰ रवि कुमार 'अनु', अध्यक्ष, हिंदी विभाग, पंजाबी विश्वविद्यालय, पटियालाघ् डॉ॰ गोविंद सिंह, प्रख्यात मीडिया विशेषज्ञ एवं पत्रकार, दिल्लीघ्डॉ॰ राष्ट्रबंधु, प्रख्यात साहित्यकार, कानपुर एवं प्रख्यात कवि पद्मश्री श्री लीलाधर जगूड़ी, देहरादून को आमंत्रित किया गया।

इन व्याख्यानमालाओं में राजभाषा हिंदी के साठ वर्षों की उपलब्धियों को रेखांकित किया गया। हिंदी की शक्ति तथा रोजगार के क्षेत्र में हिंदी के व्यापक विस्तारीकरण का प्रारूप तैयार किया गया तथा इसे संपर्क व सम्प्रेषण की भाषा बनाने पर बल दिया गया।

राजभाषा च्याख्यानमाला का उद्घाटन: (बाएं से) श्रीमती सुशीला सिंघल, श्री हिमांशु जोशी, डॉ॰ दिनेश चमोला एवं डॉ॰ अरुणाभा दत्ता

राजभाषा विशिष्ट व्याख्यान के विशिष्ट अतिथि (बाएं से) डॉ॰ राष्ट्रबंधु, पद्मश्री श्री लीलाधर जगूड़ी, डॉ॰ दिनेश चमोला, डॉ॰ एम ओ गर्ग एवं श्री विजय कुमार कौशिक

विशिष्ट व्याख्यान के अवसर पर दीप प्रज्वलित करते हुए प्रो॰ 'अनु'। मंच पर अन्य हैं (बाएं से दाएं): श्रीमती सुशीला सिंघल, प्रशासन अधिकारी, डॉ॰ एच बी गोयल, कार्यकारी निदेशक, भापेसं, एवं डॉ॰ दिनेश चमोला

8.2 समारोह

हिंदी को राजभाषा बनाये जाने के उपलक्ष में सितंबर माह में संस्थान में हिंदी के प्रचार के संबंध में कई कार्यक्रम आयोजित किये जाते हैं तथा माह का समापन 30 सितंबर को विख्यात वक्ता के द्वारा किया जाता है। इस कड़ी में 58वीं व 59वीं वर्षगांठ में प्रतिष्ठित साहित्यकार एवं समालोचक प्रो॰ सूर्य प्रसाद दीक्षित, प्रख्यात अनुवाद विशेषज्ञ डॉ॰ पूरण चन्द टंडन तथा डॉ॰ करुणा शंकर उपाध्याय, मुंबई विश्वविद्यालय ने व्याख्यान दिए।

दीप प्रज्वलन के क्षण: (बाएं से) डॉ॰ ए के भटनागर, डॉ॰ पी सी टंडन, डॉ॰ दिनेश चमोला, श्री ए के राज़दान, प्रो॰ सूर्य प्रसाद दीक्षित एवं सुश्री संध्या गर्ग

हिंदी माह समापन समारोह : (बाएं से) डॉ॰ राम सजन पांडेय, डॉ॰ करुणा शंकर उपाध्याय, डॉ॰ दिनेश चमोला एवं डॉ॰ अरुणाभा दत्ता

8.3 प्रशिक्षण

कंप्यूटर में यूनिकोड प्रणाली, 9 मई, 2008

वर्तमान में कंप्यूटर के बढ़ते उपयोग के कारण विश्व की भाषाओं की आपसी व्यवहार्यता को साकार करने के क्षेत्र में 'यूनिकोड' प्रणाली अत्यंत सफल सिद्ध हो रही है। राजभाषा हिंदी के अधिकाधिक और सर्वसुलभ प्रयोग में यह प्रणाली अत्यंत उपयोगी है। इस प्रणाली से सभी को सुपरिचित कराने के लिए इस कार्यशाला का आयोजन किया गया, जिसमें वक्ता थे श्री संजय गुप्ता, वैज्ञानिक, राष्ट्रीय सूचना विज्ञान केंद्र (एनआइसी), उत्तराखंड सचिवालय, देहरादून ।

8.4 अखिल भारतीय प्रतियोगिताएँ

केंद्रीय सचिवालय, हिंदी परिषद्, नई दिल्ली की ओर से राजभाषा अनुभाग द्वारा संस्थान में निम्नलिखित गतिविधियां आयोजित की गईं :

1. 40वीं हिंदी निबंध लेखन प्रतियोगिता: वर्ष 2008-09, 5 नवंबर, 2009
2. 40वीं अखिल भारतीय हिंदी टिप्पण एवं प्रारूपण प्रतियोगिता: वर्ष 2008-09, 11 नवंबर, 2009
3. 27वीं अखिल भारतीय विज्ञान तथा तकनीकी विषयों पर हिंदी लेख प्रतियोगिता: वर्ष 2008-09, 30 नवंबर, 2009

8.5 कार्यशालाएँ/संगोष्ठियाँ

8.5.1 'कंप्यूटर में यूनिकोड का प्रयोग' विषयक कार्यशाला का आयोजन, 10 मार्च, 2010

राजभाषा अनुभाग द्वारा आयोजित 'कंप्यूटर में यूनिकोड का प्रयोग' विषयक हिंदी कार्यशाला में ओएनजीसी के श्री दिनेश चंद्र थपलियाल, मुख्य प्रबंधक (राजभाषा) ने ऍप्लीकेशन सॉफ्टवेयर, फॉन्ट्स, फॉन्ट्स कोडिंग, यूनिकोड व नॉन यूनिकोड फॉन्ट्स, फॉन्ट कन्वर्टर्स आदि के साथ ही राजभाषा से संबंधित उपयोगी वेबसाइटों, कंप्यूटरों पर हिंदी का विकल्प लाने की विधि, मेल-मर्ज की विधि एवं यूनिकोड तथा हिंदी वर्ड प्रोसेसिंग के व्यावहारिक प्रयोग की जानकारी दी। कार्यशाला में संस्थान के प्रशासन, वित्त व लेखा तथा भंडार व क्रय अनुभागों के अधिकारियों/कर्मचारियों ने भाग लिया।

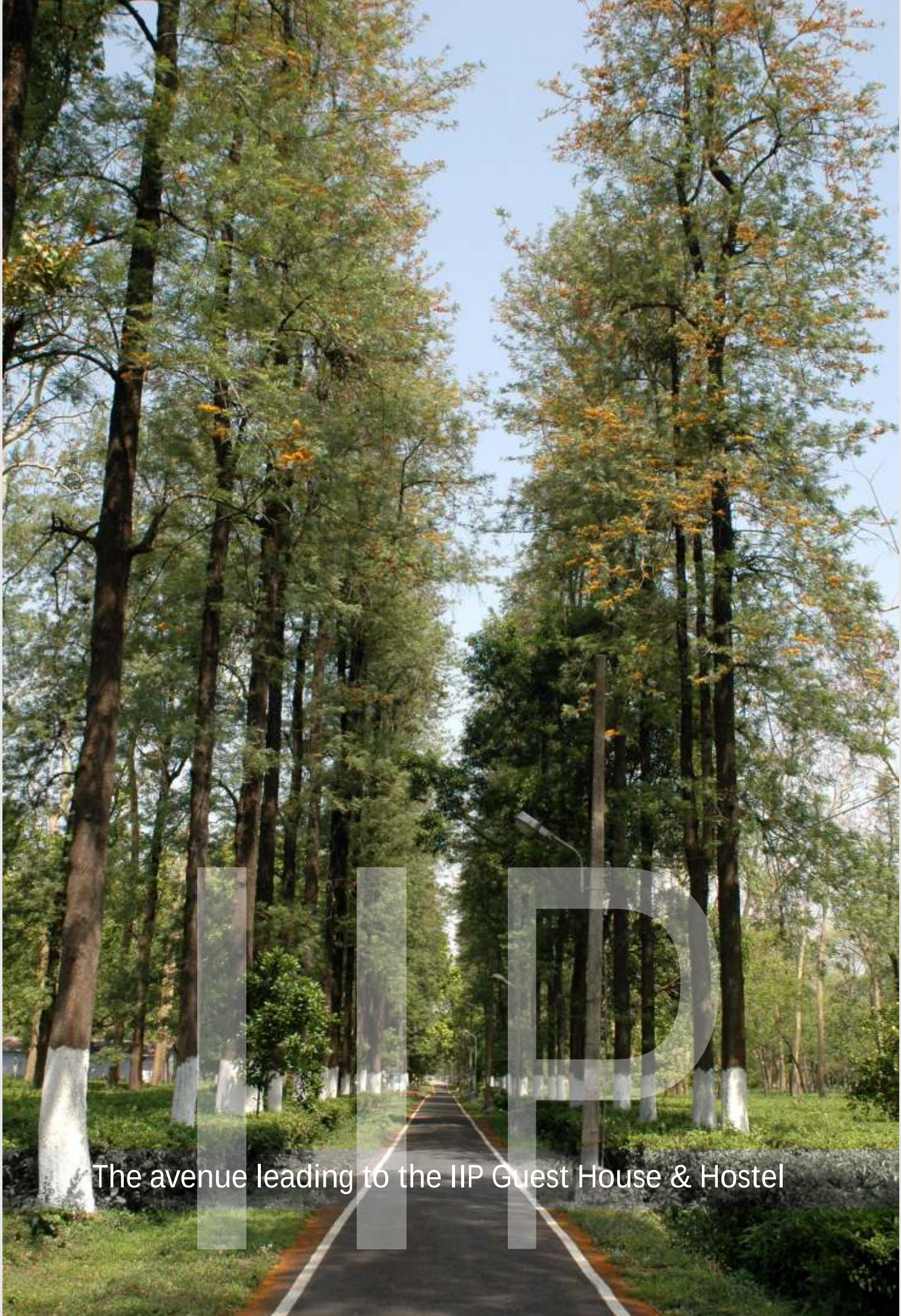
समारोह का संचालन वरिष्ठ हिंदी अधिकारी डॉ॰ दिनेश चमोला ने तथा समारोह के अतिथि का स्वागत प्रशासन नियंत्रक श्री विजय कुमार कौशिक ने किया।

8.5.2 आंतरिक हिंदी वैज्ञानिक संगोष्ठियाँ

राजभाषा अनुभाग द्वारा प्रत्येक तिमाही में एक आंतरिक हिंदी वैज्ञानिक संगोष्ठी का आयोजन किया जाता है। अत: वर्ष 2008-10 में आठ संगोष्ठियों आयोजन समय-समय पर किया गया जिनमें प्रस्तुत विषयों तथा लेखकों का विवरण निम्नवत् है :

नाम	विषय
डॉ॰ सविता कौल	*जैट्रोफा करकस*-अवशिष्ट तेल का स्नेहक ग्रीज़ के सूत्रण में उपयोग
श्री सुनील पाठक	विश्व-भर में यात्री वाहन ईंधन किफायत तथा जीएचजी उत्सर्जन मानकों की तुलना
सुश्री पूजा यादव	निष्कर्षण तकनीक द्वारा नैफ्था से विशुद्ध ऍरोमैटिक्स (बीटीएक्स) का उत्पादन
श्री प्रसेनजित मंडल	भारत में आर्सेनिक विषाक्तन स्वास्थ्य के लिए एक चेतावनीपूर्ण चुनौती
श्री वी एस सैनी	पर्यावरण संरक्षण में भारतीय पेट्रोलियम संस्थान, देहरादून का योगदान
श्रीमती पुष्पा गुप्ता	कार्बन प्रग्रहण तथा भंडारण
श्री स्वप्निल दिवेकर	वैश्विक तापन: कारण, प्रभाव तथा प्रशमन
सुश्री माफी खातून	आयनिक द्रवों द्वारा पेट्रोलियम पदार्थों से सल्फर तथा ऐरोमैटिक हाइड्रोकार्बन का निष्कर्षण
सुश्री मनीषा सहाय	वैश्विक तापन
श्री देवेंद्र सिंह	नव पीढ़ी वाहनों हेतु वायु-एक नव ईंधन
सारिका राणा	भारत के लिए प्रस्तावित स्थाई जैव ईंधन नीति
सुनील पाठक	ईंधन बचत (फ्यूल इकॉनॉमी): कुछ रोचक तथ्य
गरिमा शर्मा	ग्लिसरीन का मान-वर्द्धित उत्पादों में रूपांतरण
डॉ॰ एस एम नानोटी	प्रक्रम अभिकल्प का अनुसंधान से एकीकरण: प्रौद्योगिकी विकास का नया दृष्टिकोण
मृत्युंजय कुमार शुक्ल	गैसोलीन डायरेक्ट इंजक्शन (जीडीआइ) तकनीक: एक परिचय

नाम	विषय
सचिन कुमार	उच्च ताप पर जैविक पदार्थों से जैविक इथेनॉल का उत्पादन
कमल कुमार मौर्य	पेट्रोलियम पिच प्रतिदर्शों के मानयोग का समीक्षात्मक अध्ययन
पूजा यादव	खाद्य श्रेणी हेक्जेन में बेन्जीन तथा अन्य बहुचक्रीय ऍरोमैटिकों के पृथक्करण की आवश्यकता
सुनील पाठक	ईंधन बचत
डॉ॰ सविता कौल	ग्लिसरीन का तृतीय ब्यूटाइल ईथर में रूपांतरण
श्री अवनीश कुमार	आयनिक द्रवों के विभिन्न संभावित उपयोग
श्रीमती पुष्पा गुप्ता	अधिशोषण प्रक्रम द्वारा पॉलिमेरिक रेसिन की सहायता से फरफ्युरल को अपशिष्ट जल से अलग करना
सुश्री मनीषा सहाय	अनुपयोगी प्लास्टिक से उपयोगी पदार्थों का उत्पादन (भापेसं का प्रक्रम)
श्री ओ पी शर्मा	करंजा तेल के वसीय अम्ल एवं डेक्सट्रोज से बना एस्टर
डॉ॰ डी के अधिकारी	ऊर्जा हेतु जैव ईंधन बैटरी
श्री मनमीत कुमार	प्रत्यक्ष अंत:क्षेपण दाब ज्वलन इंजन में करंजा तथा राइस ब्रैन तेलों के निष्पादन तथा उत्सर्जन अभिलक्षण
श्रीमती निशा	वैश्विक तापन: एक समस्या
श्री यू सी गुप्ता	हम तथा हमारी सड़कें
श्री यू सी अग्रवाल	पेट्रोल पंपों व कंपनी संचालित पेट्रोल स्टेशनों पर पेट्रोल भंडार में क्षति
श्री यू सी गुप्ता	बढ़ती सड़क दुर्घटनाएं: कारण व निवारण
डॉ॰ मनोज श्रीवास्तव	गैर-उत्प्रेरकीय तथा उत्प्रेरकीय स्थितियों के अधीन पेट्रोलियम फीड स्टॉकों में मेसोफेज का निर्माण
श्री मनमीत कुमार	सूक्ष्म शैवाल से जैव-डीजल
डॉ॰ देवाशीष घोष	उत्तराखंड हिमालय से सूक्ष्म जैविक प्रोटिएज हेतु जैव-पूर्वेक्षण



The avenue leading to the IIP Guest House & Hostel

भारतीय पेट्रोलियम संस्थान,
देहरादून

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