वार्षिक प्रतिवेदन
Annual Report

2011-12

सीएसआइआर – भारतीय पेट्रोलियम संस्थान, देहरादून
CSIR-Indian Institute of Petroleum, Dehradun

भापेसं
Creating future fuels

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सीएसआइआर-भारतीय पेट्रोलियम संस्थान, देहरादून

CSIR-Indian Institute of Petroleum, Dehradun

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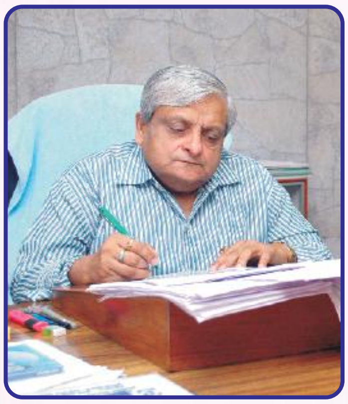
Acknowledgements to
All Heads of Divisions/Cells/Sections for providing inputs for the report

Published by
Dr M O Garg
Director
CSIR-Indian Institute of Petroleum
Dehradun

Designed and Printed by
M/s Saraswati Press
2, Green Park, Niranjanpur
Sabzi Mandi, Dehradun
Tel.: 0135-2726694, 9359211333



प्राक्कथन

2011-12

यह मेरे लिए गौरव और सम्मान का विषय है कि मैं वर्ष 2011–12 की अवधि के दौरान अपनी मुख्य गतिविधियों और उपलब्धियों को आपके सामने रख रहा हूँ। भारतीय पेट्रोलियम संस्थान के इतिहास में इस वर्ष को ऐसी अवधि के रूप में याद किया जाएगा, जब कि हमें ''यू.एस्.-कोटि की गैसोलीन बनाने के लिए एफ् सी सी हार्ट-कट से शुद्ध बेंजीन की पुन: प्राप्ति'' हेतु रिलाइएंस से एक परियोजना प्रायोजित किए जाने की महत्वपूर्ण उपलब्धि हुई। यदि हमारी प्रौद्योगिकी रिलाइएंस द्वारा स्वीकार कर ली जाती है, तो यह विश्व में अपने प्रकार की पहली इकाई होगी, और साथ ही वैऔअप की वैश्विक स्तर की प्रथम प्रौद्योगिकी होगी।

मैं अपने मा० विज्ञान एवं प्रौद्योगिकी मंत्री, भारत सरकार तथा उपाध्यक्ष, वैऔअप, श्री विलासराव देशमुख के लिए अपना आभार और प्रशंसा व्यक्त करूँगा कि उन्होंने संस्थान का दौरा किया और 1 नवंबर, 2011 को हमारे वैऔअप स्थापना दिवस का मुख्य अतिथित्व स्वीकार किया। इसके अतिरिक्त प्रो० राकेश अग्रवाल, 'विन्थ्रॉप ई. स्टोन डिस्टिंग्विश्ड प्रॉफेसर ऑव् केमिकल इंजीनियरिंग,' पर्ड्यू यूनिवर्सिटी का दौरा भी एक स्मरणीय घटना थी चूँकि उन्हें हाल ही में अमेरिकी राष्ट्रपति श्री ओबामा द्वारा 'नैशनल मेडल ऑव् टेक्नॉलॉजी ऍण्ड इनोवेशन 2011' पुरस्कार से भी सम्मानित किया जा चुका है।

CO_2 प्रग्रहण पर एक उल्लेखनीय संगोष्ठी का भी आयोजन 'इंडिया हैबिटैट सेंटर' में किया गया। इसका उद्घाटन डॉ० आर० चिदम्बरम्, भारत सरकार के प्रधान वैज्ञानिक सलाहकार द्वारा परमश्रेष्ठ राजदूत, नॉर्वे, सुश्री ऍन् ऑलेस्टाड के साथ किया गया।

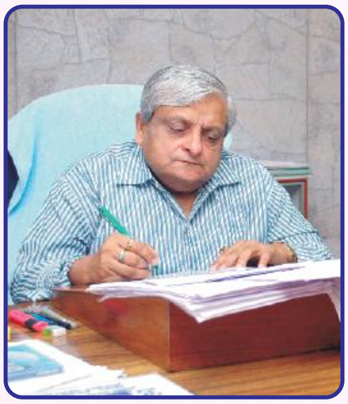
वाणिज्यिक अनुसंधान के अपने प्रयत्नों को जारी रखते हुए हमने हल्के उदासीन फ़ीड-स्टॉक के प्रक्रमण के लिए सीपीसीएल्-एन्एम्पी ल्यूब निष्कर्षण इकाई के प्रचालन का सफलतापूर्वक निदर्शन किया। 55 T/H तक का संवेश-प्रवाह (थ्रूपुट) प्राप्त किया गया। इसके साथ ही, एक अन्य उल्लेखनीय उपलब्धि थी, सीपीसीएल् खाद्य-श्रेणी हेक्जेन इकाई को एन्एम्पी में रूपांतरित करने के लिए हमारी एन्एम्पी निष्कर्षण प्रौद्योगिकी का अनुज्ञापन। इसके परिणाम स्वरूप, खाद्य-श्रेणी हेक्जेन की उच्चतर लब्धियों व बेहतर गुणता के रूप में उल्लेखनीय लाभ हुए हैं।

अपने मानव संसाधन को विस्तार देने तथा युवा श्रमशक्ति को शामिल करने के अपने प्रयत्नों के रूप में हमने पुनश्च नवीन ढंग से साक्षात्कार आयोजित किए हैं और उच्च क्षमता वाले वैज्ञानिकों का चयन किया है जो आने वाले कुछ महीनों में संस्थान में कार्यग्रहण कर लेंगे।

हमारे वैज्ञानिकों एवं अधिकारियों के अथक प्रयासों से और आपके सहयोग से हमने फिर से कई पुरस्कार जीते हैं : हमारी हिंदी पत्रिका 'विकल्प' के लिए प्रथम पुरस्कार तथा वैऔअप से प्रतिष्ठित व्यवसाय विकास विपणन पुरस्कार 2011। इसके अतिरिक्त, संस्थान को अनुसंधान एवं विकास में उत्कृष्टता हेतु प्रतिष्ठित 'ओशनटेक्स अवॉर्ड' से भी सम्मानित किया गया।

अंतत:, आपके आशीष और सहयोग से हमने इस वर्ष रु० 11 करोड़ की ईसीएफ् प्राप्त की है। मैं अनुरोध करता हूँ कि आप अपना सहयोग और प्रोत्साहन सतत बनाए रखेंगे ताकि हम उच्चतर उपलब्धियाँ प्राप्त कर सकें।

(डॉ० मधुकर ओंकारनाथ गर्ग)
निदेशक



Foreword 2011-12

It is my honour and privilege to present to you our major highlights and achievements during the period 2011-12. This year would be remembered in the history of IIP for making a major breakthrough with Reliance awarding us a project for "Recovery of Pure Benzene from FCC Heart-Cut to Make US–Grade Gasoline". If our technology is accepted by Reliance this will be the first unit of its kind in the world and also the first CSIR technology of global standards.

I would like to record my thanks and appreciation to our Hon'ble Minister for Science & Technology, Govt. of India and Vice President, CSIR, Shri Vilasrao Deshmukh, for visiting the Institute and accepting to be the Chief Guest on our CSIR Foundation Day Ceremony on 1st November, 2011. Also, the visit of Prof Rakesh Agrawal, Winthrop E Stone Distinguished Professor of Chemical Engineering, Purdue University was a memorable event as he has been recently awarded with the National Medal of Technology and Innovation 2011 by US President Mr Obama.

A landmark seminar was organized at the India Habitat Centre on CO_2 Capture. This was inaugurated by Dr R Chidambaram, Principal Scientific Advisor to the Govt of India alongwith Her Excellency, the Ambassador of Norway Ms Ann Ollestad.

Continuing our efforts towards commercial research we successfully demonstrated the operation of CPCL NMP Lube Extraction Unit to process light neutral feedstock. Throughput up to 55 T/H was achieved. Also, a significant achievement was the licensing of our NMP Extraction Technology for Converting the CPCL Food Grade Hexane Unit to NMP. This has resulted in substantial benefits in terms of higher yields and better quality of Food Grade Hexane.

In our attempt to expand our human resource and to induct young manpower we have carried out a fresh round of interviews and selected high calibre scientists who will join us in the next few months.

With the untiring effort of our scientists and officers and with your kind support we have yet again won several awards : First Prize for our Hindi Magazine "Vikalp" and the prestigious Business Development Marketing Award 2011 from the CSIR. In addition to this, the Institute was bestowed with the prestigious OceanTEX Award for Excellence in Research and Development.

Lastly, with your blessings and support we have achieved an ECF of Rs 11 crore during this year. I request you to continue to provide your kind support and encouragement so that we can achieve greater heights.

(Dr Madhukar Onkarnath Garg)
Director

Contents

Page No.

1. **CONTRIBUTIONS TO SCIENCE & TECHNOLOGY**
   - 1.1 Separation Processes 3
   - 1.2 Bio-fuels 10
   - 1.3 Chemical Sciences 17
   - 1.4 Analytical Sciences 24
   - 1.5 Catalytic Conversion Processes 25
   - 1.6 Heavy Oil Processing 34
   - 1.7 Automotive Fuel and Lubricants Application 35
   - 1.8 Industrial & Domestic Combustion 38
   - 1.9 Tribology 39
2. **ACHIEVEMENTS**
   - 2.1 Papers Published in Journals 45
   - 2.2 Chapter(s)/Paper(s) Published in Book(s) 47
   - 2.3 Papers Presented in Conferences/Seminars 47
   - 2.4 Patents Sealed 50
   - 2.5 Patents Filed 50
   - 2.6 D.Litt./D.Phil. Degrees Awarded 51
   - 2.7 Honours, Awards & Recognitions 51
   - 2.8 MoU's/MoC's Agreements Signed 53
   - 2.9 Extra-Budgetary Resources 54
3. **HUMAN RESOURCE DEVELOPMENT**
   - 3.1 Training the Personnel from the Oil Industry and Related Fields 57
   - 3.2 HRD Programmes for the Employees 58
   - 3.3 Colloquia 58
   - 3.4 Deputations Abroad 59
4. **RESEARCH ACTIVITIES: ON-GOING, INITIATED & COMPLETED**
   - 4.1 On-going Projects 63
   - 4.2 Projects Initiated 65
   - 4.3 Projects Completed 66
5. **ENHANCING R&D INFRASTRUCTURE**
   - 5.1 New Facilities Created 69
6. **IMPORTANT EVENTS**
   - 6.1 Foundation Days 75
   - 6.2 National Days 75
   - 6.3 Knowledge Exchange Events 77
   - 6.4 State-wide Missions 78
   - 6.5 Exposure Events 78
   - 6.6 Research Management Events 80
   - 6.7 Fostering the Scientific Spirit 80
   - 6.8 हमारा क्रीड़ा पक्ष 81
   - 6.9 Technology Outreach 81
   - 6.10 Employee Awareness Drives 82
   - 6.11 Socio-cultural Activities 82
   - 6.12 Community Health Drives 82
   - 6.13 Activities of the Scheduled Castes/Tribes Employees/Welfare Association 83
7. **COMMITTEES**
   - 7.1 Research Council 87
   - 7.2 Management Council 88
8. **राजभाषा**
   - 8.1 राजभाषा हिंदी विशिष्ट व्याख्यानमाला 91
   - 8.2 हिंदी समारोह 92
   - 8.3 संगोष्ठियाँ/कार्यशालाएँ 92
9. **THE INSTITUTE AS AN ACADEMIC INSTITUTION**
   - 9.1 CSIR-PGRPE Programme at the CSIR-IIP 97
10. **THE CSIR-IIP FAMILY**
    - 10.1 Scientists Group-IV 101
    - 10.2 Technical Staff Group III 102
    - 10.3 Technician Staff Group II 102
    - 10.4 Laboratory Staff Group I 103
    - 10.5 Administrative Staff 104

1

Contributions to Science & Technology

1.1 SEPARATION PROCESSES

1.1.1 Aromatic Extraction

1.1.1.1 Synthesis of Room-temperature Ionic Liquids (RTIL's) and Study of their Application for Extraction of Sulphur, Nitrogen and Aromatic compounds from Petroleum Feed Stocks

Activity coefficients at infinite dilution of various hydrocarbon solutes in the synthesized ionic liquids were determined using the method of selective adsorption on static ionic liquid phase in a gas chromatograph. The coefficients were measured at different carrier gas temperatures based on the knowledge of critical properties of the solutes along with the determination of retention time in the GC (with inbuilt software for direct estimation). The selectivities of various solutes were compared with respect to a particular aromatic compound for all the ionic liquids synthesized as well as procured, and the results were compared with those obtained for sulfolane as the solvent.

Process flow sheet was simulated and the stream results generated using process flow simulator representing a liquid-liquid extraction unit by the use of an ionic liquid as the extracting agent. The model feedstock comprised of a mixture of an aliphatic and an aromatic. The aliphatic recovered was 99 % pure and the aromatic recovered was above 98% in purity. The energy and mass balance report data sheet has been presented for the process.

The work carried out during the year 2011-12 along with the earlier work was compiled in the form of a draft report and submitted to the CHT, New Delhi. A brief summary of the earlier work included in the report is as follows:

Dearomatization Studies: Some selected ionic liquids like N–Butyl–4–Methyl Pyridinium Tetrafluoroborate, N–Butyl–3–Methyl Imidazolium Tetrafluoroborate, N–Butyl–3–Methyl Imidazolium bis(trifluoromethyl sulphonyl)imide were synthesized in the laboratory and liquid–liquid extraction for dearomatization was carried out using them as solvents and model hydrocarbon feedstocks comprising of a mixture of toluene and heptane.

Extractive Desulphurization studies: Using model feedstock of (Toluene + Decane + DBT / 4,6 – DMDBT + IL's) was carried out with some ionic liquids having varying cations and anions, in order to study the effectiveness of extraction with respect to structural changes in the solvent. Batch processes were conducted with various reaction times and S/F ratios to study the extent of extraction of sulphur compounds.

Extractive Catalytic Oxidative Desulphurization (ECODS): Experimental studies were performed by using model oil (Dibenzothiophene (DBT) + Toluene + n-Decane), oxidant (H_2O_2), catalyst (formic acid) & employing various IL's. N-hexyl 3-methylpyridinium bis{trifluromethyl sulphonyl} imide showed the highest rate of sulphur removal up to 95.7 %.

Denitrogenation: It was also studied through extraction using IL's. In coker diesel, a moderate level of denitrogenation was observed while in oxidized diesel, desulphurization and denitrogenation were carried out simultaneously and it was found that in oxidized diesel there is quantitative denitrogenation by some of the IL's indicating the presence of oxidized nitrogen compounds. Percentage removal was achieved up to the order of 80.

Following are recommended RTIL's as solvents for different applications:

	Process	Recommended RTIL
	Dearomatization Studies	N-Me butyl pyridnium tetrafluoroborate
	Extractive catalytic oxidative desulphurization (ECODS)	N-hexyl 3-methylpyridinium Bis bis{trifluoromethylsulphonyl}imide
	Denitrogenation through extraction using IL's	Butyl-Me imidizolium tetrafluoroborate

1.1.1.2 Extraction of Bio-butanol from Fermentation Broth

The need for alternate and renewable fuels is widely recognized due to depleting supplies of fossil fuels and contribution of these fuels to greenhouse gases leading to global warming. Bio-butanol presents an enormous potential in this respect. It has the advantage of being bio-degradable, renewable, non-toxic, and have low pollutant emissions compared to the conventional diesel. Conventional production of bio-butanol from fermentation broth involves three main processing steps: generation of butanol in fermentation broth, extraction of butanol from fermentation broth and enrichment of butanol from extract phase by distillation argeting butanol of at least 99% purity.

In the laboratory, more than 93% recovery of 1-butanol from synthetic mixture of acetone, butanol and ethanol representing actual fermentation broth was achieved. Recovery of butanol from actual fermentation broth containing 0.7% butanol was also studied with more than 90% recovery.

1.1.1.3 Upgradation of Residual Fuel Oil using Non-HDS Routes, such as, Oxidation/ Solvent Extraction

Residual fuel oils (RFO's) are the products produced by blending residues obtained from various processes of a refinery, such as, mixture of vacuum-flashed VB residue, atmospheric VB gas oil, vacuum residue from high sulphur crude, PDA pitch, heavy extracts etc. Hence RFO's may contain significant quantities of impurities such as asphaltenes (3-10%), nitrogen (0.25-0.6%) and sulphur (3-5.5%) along with some metals. The high level of impurities in residual fuel is a hindrance to catalytic reactions as these impurities poison the catalyst and are responsible for coke production. Fuel oils have a broad range of volatility and viscosity. Hence the processing of residual fuels to meet the required specifications by hydrodesulphurization will pose problems. Since fuel oil is also used aboard ships to generate power for the engines, it is also known as 'bunker fuel'. Disposal of this product as such will pose a problem to environment in the future.

Considering future sulphur specifications (<1.0%) of residual fuel oils (RFO's) & the limitations of the HDS process, there is an urgent need for development of an innovative process based on non-HDS route. This will also help save enormous amounts of hydrogen and subsequently reduce green house gases. In view of this, an in-house project was initiated at the Institute and under this project, the following feasibility studies were initiated:

- Extensive literature survey and patent search;
- Batch mixer settler facility of SS material with sufficient thickness to withstand the pressure up to 10 kg/cm^2 got fabricated.
- Experimental runs at 70°C in a glass mixer settler reactor with feed-heavy oils containing ~ 6% total sulphur and different aqueous solutions of solvents e.g. acetonitrile, acetone, NMP etc.
- Characterization of samples was done for total sulphur content and viscosity at different temperatures

1.1.2 Modelling and Simulation

1.1.2.1 Revamping of Sour Water Stripper Unit at the CPCL, Chennai (Phase-I: Adequacy Study; Phase II: Basic Engineering Design Package)

M/s. Chennai Petroleum Corporation Limited (CPCL), Chennai had put up a crude unit of 2.8 MMTPA capacity in 1984. This unit was revamped to 3.7 MMTPA in 1993. Plans for another revamping of the crude unit to increase the capacity to 4.3 MMTPA have been scheduled for 2012. The Sour Water Stripper (SWS) unit is excluded in the current revamp. The SWS unit catering to this unit is having a design capacity of 35 m^3/hr. This unit is designed to treat the combined sour water stream from crude & FCCU units. The existing SWS unit was found to be overloaded and operating with certain limitations. The proposed revamping of the crude unit would increase feed rate to the SWS unit up to 45 m^3/hr compared to the design feed rate of 35 m^3/hr.

Revamping of SWS Unit at the CPCL, Chennai

The CSIR-IIP was approached to take up the adequacy study of the sour water stripper unit in Phase I, while the basic engineering design package needed to be prepared for the work in Phase II for the revamping of the SWS unit to meet the desired objectives. Report on adequacy study had already been submitted to them.

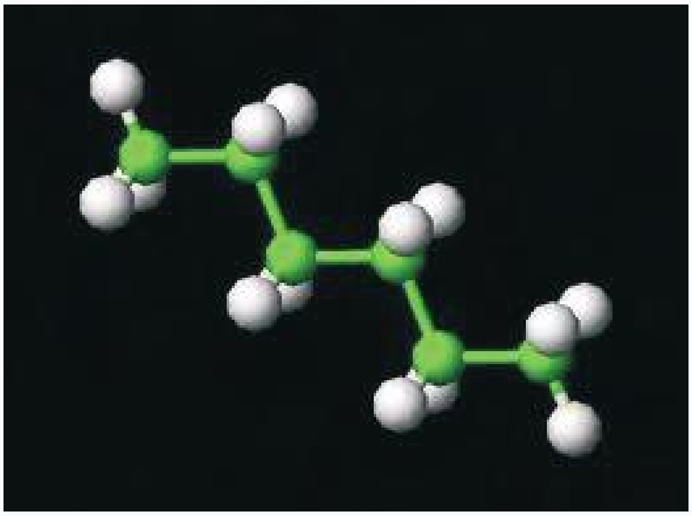
The CSIR-IIP simulation model was used to simulate the base case data provided, by the CPCL. A rigorous testing of the simulation model was carried out to represent the CPCL design data and also to match the literature data.

In order to meet the CPCL process objectives based on the information provided, a solution was recommended involving change of internals alone (higher efficiency tray). The adequacy of the pumps and the heat exchangers involved in the SWS unit was checked for revamp case. The provision for caustic addition for enhanced removal of fixed ammonia was also recommended. The revamps suggested adhered to the objectives of the CPCL, i.e., they could meet the target specifications of stripper bottoms.

1.1.2.2 Changeover of Solvent in Food Grade Hexane (FGH) Unit at CPCL, Chennai from Sulpholane to NMP

The CPCL refinery had been producing Food Grade Hexane (FGH) by dearomatization of 63 – 69 °C naphtha fraction, using sulpholane technology developed by the CSIR – IIP and EIL, since May 1992. To meet the revised specifications for FGH with respect to benzene content (<500 ppm (w/w)), deep extraction of naphtha fraction is necessary for which NMP is a better solvent than sulpholane due to better capacity.

FGH Unit at CPCL, Chennai



The CPCL & the CSIR–IIP put forth a road map for changeover in the form of a work plan. Accordingly, the work was carried out in two phases as described below:

Phase-I: Feasibility Study

The feasibility study aimed at the changeover of solvent in the hexane unit along with adequacy check for the equipments. After extensive experimental studies at the laboratory, simulation of FGH plant data using actual plant operating conditions were carried out and data was re-simulated using NMP solvent. A detailed feasibility study report was submitted.

Phase-II: Commissioning of Solvent Changeover

After the recent shutdown, the CSIR–IIP provided guidance for the changeover of solvent from sulpholane to NMP along with CPCL, and established a very stable operation within 24 hrs after getting stabilised raw hexane fraction from naphtha splitter, with better FGH product quality (<100 ppm benzene and <5 ppm sulphur).

Benefits of Changeover

With column and process operating parameters provided by the CSIR–IIP and plant operation expertise from the CPCL, the commissioning was successfully performed with the FGH (<100 ppm benzene and <5 ppm sulphur) meeting product specifications along with steady-state operation of the plant. The major benefits are listed below:

- Lower solvent: feed ratio leading to a lower solvent circulation
- SRC operation at positive pressure
- Reduction in reboiler steam (400kg/hr) and elimination of steam ejectors (250kg/hr) in SRC – savings of ~ 95 lakh per annum
- Reduced solvent consumption –saving of about 14 lakh per annum
- Better product quality with respect to sulphur and benzene content in product

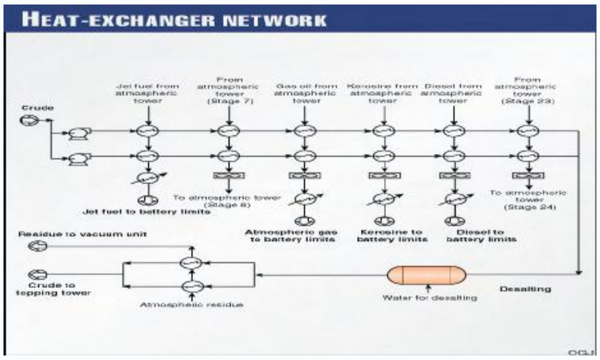
1.1.2.3 Pinch Analysis Study of Crude Distillation Unit (CDU) and the Delayed Coker Unit (DCU) to Achieve the Maximum Attainable Preheat Temperature at the IOCL Refinery, Digboi

The CSIR-IIP has got immense expertise in e pinch analysis and has already carried out many projects in this area for oil refining industries. The pinch analysis of AVU preheat train to maximize the preheat temperature was carried out for the Digboi Refinery. Executive summary of the study for AVU pinch analysis carried out at the CSIR-IIP is given below:

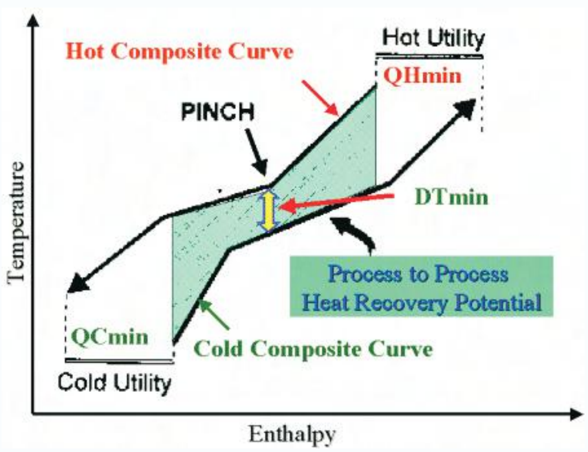
- The main objective of the study was to increase preheat temperature
- Current operational data were collected from different sources at the plant
- Plant data were made consistent for the energy-and-material balance using simulator and after discussions with the officials of the refinery
- Stream data required for pinch analysis were tabulated along with target (run-down)

temperature for products and return temperature for PA which were also finalized after discussion between the CSIR-IIP and the refinery officials.

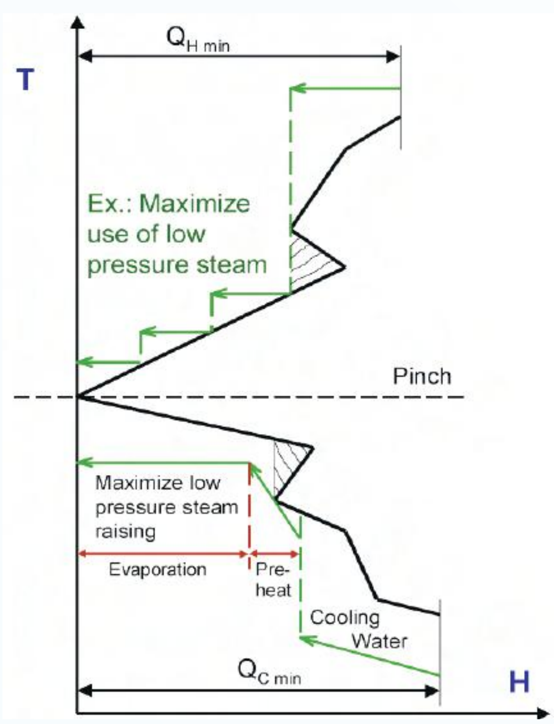
❖ The composite curve and grand composite curve were generated for the extracted stream data.



Heat Exchanger Network



Hot Composite Curve



Grand Composite Curve

❖ Benefits of the proposed heat exchanger network

- Crude preheat increased by 10 °C
- 5104 MMkcal/annum energy saving and reduction of the emission of CO_2 into the environment to the tune of 1276 tonnes per annum, while achieving 100 % furnace efficiency.
- 6805 MMkcal/annum energy saving and reduction of the emission of CO_2 into the environment to the tune of and 1701 tonnes per annum, while achieving 75 % furnace efficiency.
- The annual savings at 100 % and 75 % furnace efficiency are ~48 and ~64 lakh rupees respectively, based on the natural gas price @ 5.25$/MMBTU which 8000 operational hours per annum.

1.1.2.4 Comparative Study of Diesel Reforming Processes (SDR, POX and ATR) Using Process Simulator

Hydrogen has a long tradition as an energy carrier as well as an important feedstock in the chemical industries and refineries. It has a very high energy density. Hydrogen based PAFC fuel cell application in submarine needs a suitable onboard reformer. The possibility of reducing the sulphur content of diesel below 10 ppm drives its application as a reforming feedstock preferably in submarine. In principle, there are three types of reforming processes used for hydrogen production:

➢ Steam Reforming

➢ Partial Oxidation

Diesel Reforming

- (Non-Catalytic) Partial Oxidation (POX)
- Catalytic Partial Oxidation (CPO)

➢ Auto thermal Reforming

During the visit of the NMRL (Naval Material Research Laboratory) team to the CSIR-IIP, detailed discussions were held on all of these reforming processes. The CSIR-IIP proposed to the NMRL that there is a need of simulation-based comparative study of all these reforming processes prior to identifying the best process for taking up the experimental study. The major points to justify the simulation study are as follows:

- Naphtha and NG reforming processes are well established; however, not much information is available in open literature on diesel reforming.
- More constraints would be associated with reforming in submarine conditions such as oxygen availability and flue gas disposal.
- The necessity to screen the reforming processes to select the optimum reforming process prior to actual experimental study. The key parameters for screening will be the quantity and the quality of hydrogen produced, oxygen consumption, energy required besides flue gas amount and composition. Moreover, the process should be self-energy-sufficient.
- Identification of operating challenges associated with reforming in submarine conditions for conceptualization of a flow scheme which may be different from the conventional reforming process.

Finally, NMRL awarded the project to the CSIR-IIP to carry out simulation based comparative study of diesel reforming processes such as Steam Diesel Reforming (SDR), Partial Oxidation Diesel Reforming (POXDR) and Auto Thermal Diesel Reforming (ATDR) for key parameters such as hydrogen produced and oxygen consumption.

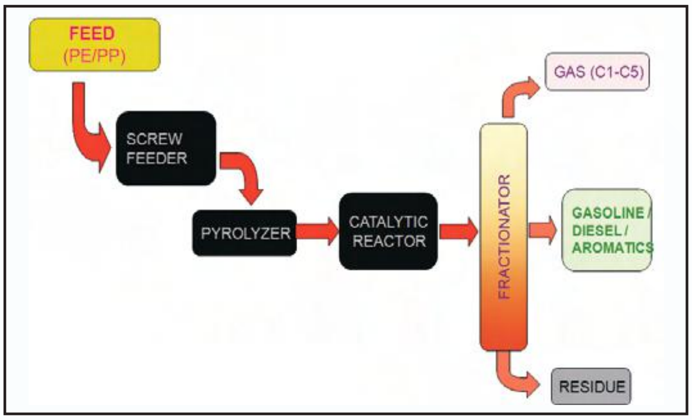
An exhaustive simulation study was carried out beginning with the validation of simulation model for each process using the relevant literature data. Finally, key parameters were compared.

From the study results it is clear that SDR produces maximum hydrogen at the cost of maximum oxygen consumption; POXDR and ATDR provide almost the same H_2 production and O_2 consumption. Moreover, in POXDR and ATDR processes tail gas utilization from PSA needs to be identified.

1.1.3 Wax Rheology

1.1.3.1 Scale up Studies for Conversion of Waste Plastics to Value-Added Hydrocarbons

CSIR-IIP has developed a novel process for converting waste plastics, particularly polyolefins, to value-added products like automotive graded fuel and petrochemical feedstocks. The novelty of the process lies in the exclusive production of either gasoline or diesel or aromatics along with simultaneous production of LPG. The lab-scale batch process has been scaled up to bench-scale and modified to make it continuous (feed rate 0.5-3.0 Kg/hr) by incorporating a continuous feeding system. Experiments have been carried out to obtain the reaction conditions as well as yield pattern and properties of the products. The detailed material and energy balance has been obtained and simulation studies have been carried out to obtain the design parameters. Cost-benefit analysis has also been carried out for various capacity plants which indicates that minimum capacity required for commercial viability (payback period < 3 years) is 50 TPD. Discussions are in progress with a number of entrepreneurs who are interested in putting up the commercial plant based on this technology.



Process flow sheet of waste plastics conversion process

1.1.3.2 Studies on Rheology of Crude Oil Obtained from Oil Wells of the ONGC and Analysis of Pipeline Deposits

CSIR-IIP took up the project for rheological analysis of crude oils from IC complexes. The study involved dehydration of crude oils, rheological analysis and determination of wax appearance and wax deposition temperature, measurement of apparent dynamic viscosity of crude oils in Newtonian and non-Newtonian range and rate of wax deposition under different oil temperature conditions using cold finger apparatus. The viscosity inversion point was determined by preparing different water/oil emulsions and measuring their apparent viscosities. The pipeline deposit was investigated for its solubility behaviour and the best solvent system was recommended.

Determination of rate of wax deposition from crude oils by cold finger set-up

1.1.4 Sweetening

1.1.4.1 Development and Commercialization of New Ammonical Water-Soluble Fixed-Bed Sweetening Catalyst

It was planned that initial screening of catalyst is to be done on the basis of its solubility in ammonical water. Our target is that the catalyst should have solubility in ammonical water slightly more than that of the commercial catalyst. About nine batches of catalyst at different conditions were prepared in the laboratory and subsequently their solubilities were measured. We have almost reached the target solubility. However, we have yet to carry out the synthesis of a few more batches to achieve the full target solubility.

1.1.4.2 Commercialization of Catalyst Thoxcat ES for Sweetening of LPG

The CSIR-IIP proposed to M/s RIL to make a plan for the short trial run with the catalyst modified by adding anti-foaming additive (AFA). M/s RIL agreed to this and intimated that 40 kg (active ingredient) catalyst has to be supplied free-of-cost for the trial run. Accordingly, on the request of the CSIR-IIP, M/s Lona Industries prepared 40kgs to the catalyst Thoxcat ES and sent the sample to the CSIR-IIP.

Thereafter the sample of the above batch of 40 kg catalyst was evaluated rigorously. It was observed that its activity and foaming characteristics were the same as that of the reference catalyst. Subsequently, M/s Lona Industries sent 40 kgs of the catalyst to M/s RIL, Jamnagar.

Main reactor in catalyst production unit at M/s Lona Industries Ltd., Mumbai

M/s RIL started the trial run in their Unsat LPG Merox unit on 13th September, 11. Analyzing the data sent by M/s RIL, it was observed that the consumption rate of our catalyst Thoxcat ES was much less than that of the other commercial catalyst being used earlier in the same unit. In spite the of the large variation in mercaptan content in the feed, Thoxcat ES is able to maintain the total product sulphur within 15 ppm. These studies confirm that Thoxcat ES is performing better than the commercial catalyst used earlier.

M/s MRPL, Mangalore; M/s HPCL, M/s Mittal Energy, Bhatinda, and M/s IOCL, Digboi procured this catalyst for their new units.

1.1.5 Gas Absorption

1.1.5.1 Techno-Economic Feasibility of the Open Loop Thermo-chemical S – I cycle of the H_2S Split for Carbon-Free Hydrogen Production in a Petroleum Refinery

The objective was to prepare a techno-economic feasibility report involving extensive literature review on the components of the Open Loop Sulphur – Iodine Process with the sole purpose of concretizing the laboratory studies in Phase II.

An extensive literature review was carried out to concretize the techno-economic feasibility of the Open Loop Sulphur – Iodine-Process of H_2S splitting.

A report was submitted to the sponsors. The report describes the work accomplished by the CSIR–IIP in a four-month project entrusted by the sponsors as Phase-I on the Open-Loop Thermo-chemical H_2S Splitting. The report gives an insight into all the composite components of the laboratory studies to be proposed in Phase II. These components include incineration of H_2S to produce sulphur dioxide, the Bunsen reaction and the HI_x decomposition by reactive distillation and the related simulation studies.

The aim of this work is to develop an efficient, cost effective, carbon-free and large-scale production of hydrogen in the future. The benefits of this technology include the generation of hydrogen in a refinery from a continuous source of hydrogen sulphur in a highly efficient method sans any greenhouse gas emissions.

Based on this preliminary experience, a joint proposal with the sponsors on 'Carbon-Free Hydrogen Production Using H_2S in Petroleum Refinery' was submitted to the Centre for High Technology (CHT). The objective of this project is carbon-free hydrogen production from H_2S in the refineries and to arrive at optimized conditions for achieving a better economics in the process. This project was proposed to the SAC (Scientific Advisory Committee).

1.1.5.2 Development of Clean Coal Technologies

Development of advanced solvents and blended formulations for CO_2 capture, with lower regeneration energy requirement being the objective, CO_2 absorption/regeneration studies were carried out with different solvents. Apart from solvent screening, effects of various process parameters on CO_2 loading were investigated. Figure 1 shows the different solvent effects on CO_2 loading during CO_2 absorption. The absorption temperature has been maintained at 40°C with solvent concentration of 30 wt%. The CO_2 absorption rate is the highest for 2-amino-2 methyl-1 propanol (AMP), whereas it is the lowest for N-methyldiethanolamine (MDEA) among the studied solvents. It is well known that MDEA is a tertiary amine and AMP is a primary hindered amine.

Figure 2 shows the CO_2 loading variation with reference to different solvent concentrations. CO_2 loading in amine solutions decreases when the amine concentration increases. The variation of CO_2 loading might be due to the decrease of the diffusivity of ions, resulting from a rise of the viscosity in the AMP solution (due to increase in concentration).

The heat-and-mass-balance across the absorber and the regenerator was carried out using the simulation software. The typical flue gas composition has been used for heat-and-mass balance. Figures below show the % absorption and regeneration with reference to different solvent and blended solvent formulations.

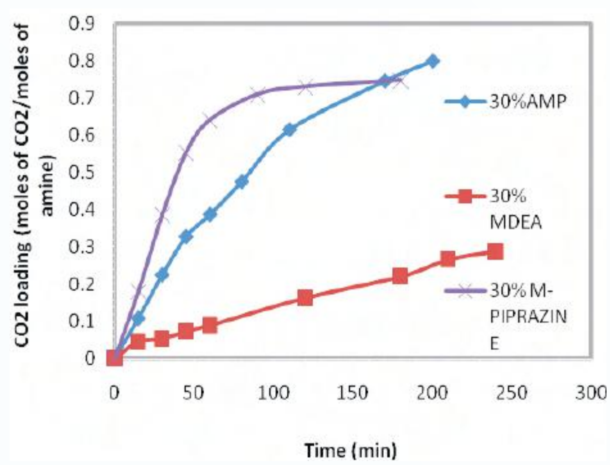


Figure 1 : Effect of different solvents on CO_2 loading

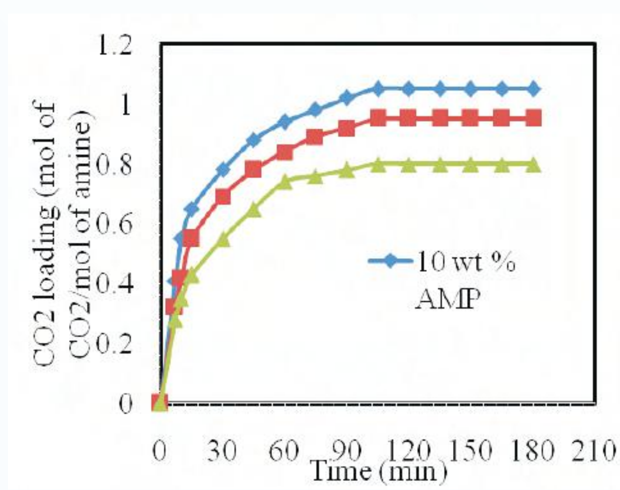


Figure 2: Effect of solvent concentration on CO_2 loading

1.1.5.3 Supportive Laboratory Data Generation on CSIR-IIP–EIL-NRL SO_2 Recovery Process to Prepare BDEP for Numaligarh Refinery Limited

This project is based on a previuos study entitled 'Development of regenerative process for removal of sulphur dioxide from lean gas streams', carried out by the CSIR-IIP in collaboration with the Engineers India Limited (EIL). The objectives of this project were:

- Development of novel solvent formulations for removal of sulphur dioxide at laboratory scale, and,
- Testing of newly-developed solvents at pilot plant scale.

The process was taken up for commercialization at the NRL which later became a joint partner with the CSIR-IIP and the EIL.

CSIR-IIP had the onus of providing supportive data to the EIL for generation of BDEP for the SO_2 recovery unit at the NRL. In this regard, the present study aimed at laboratory scale experimentation for supportive data generation on absorption of SO_2 in the CSIR-IIP formulated solvents.

1.1.5.4 Technologies offered for commercialization

Biogas Desulphurization

This technology was developed during the currency of a project entitled 'Development of a catalyst formulation and a process for desulphurization of flue gas streams' carried out by the CSIR-IIP during 1990-1997. The performance of the catalyst was studied in a continuous bench-scale unit for removal of H_2S from petroleum refinery off-gas. This technology was offered to a merchant customer for biogas desulphurization.

CDR Unit Using CSIR-IIP/EIL CO_2 Removal Process

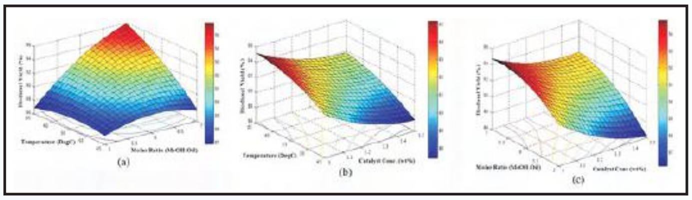
This technology was developed under a project entitled 'Development of absorption-base process for recovery of carbon dioxide from flue gas streams' carried out by the CSIR-IIP during 2005-2010. A solvent formulation had been developed which was at par as far as absorption rate and capacity for CO_2 were concerned, with nearly 99% CO_2 regeneration. The solvent developed is suited for CO_2 recovery at urea plants as well as at coal-fired power plants. This technology has been offered to a merchant customer.

1.2 BIOFUELS

1.2.1 Chemical Conversion (CAPS)

1.2.1.1 Direct Production of Biodiesel from Non-edible Oil Seed by Reactive Extraction

The need for alternate and renewable fuels is widely recognized due to depleting supplies of fossil fuels and contribution of these fuels to greenhouse gases leading to global warming. Biodiesel presents an enormous potential in this aspect. It has the advantage of being biodegradable, renewable, non-toxic, and has low pollutant emissions compared to the conventional diesel. Conventional production of biodiesel from seeds involves two main processing steps; extraction of oil and esterification/ transesterification to fatty acid methyl esters (FAME), commonly known as biodiesel. Contrarily, reactive extraction is a single-step in-situ transesterification process involving extraction and reaction in a single step. The reactive extraction is a feasible technology for the production of biodiesel that can cut the processing cost. In the reactive extraction process, the oil bearing material i.e. seeds contact directly with the extraction and reaction solvent (alcohol in this case). In other words, alcohol acts as extraction solvent as well as transesterification reagent during reactive extraction, and, therefore, a higher amount of alcohol is required. However, reactive extraction eliminates the requirement of two separate processes, the costly hexane oil extraction process and the transesterification reaction process, thus reducing processing time, cost and amount of solvent required thereby intensifying the biodiesel production process. An integrated process for biodiesel production was developed using non-edible oil seeds such as Jatropha and Pongamia by reactive extraction. This should facilitate distributed production of biodiesel, principally by oilseed farmers, who would be able to produce biodiesel on-site. The technology will be suitable for use in developing countries. Different parameters such as seed size, methanol-to-oil ratio, catalyst concentration, reaction temperature, etc. were optimised. The conversion of >95% was achieved.



Three-dimensional response surface plots showing the effect of process variables on biodiesel

1.2.1.2 Metrology in Chemistry

7 CRMs and their protocol procedures were prepared and submitted to the nodal laboratory for Round Robin Tests. The developed CRMs are as follows:

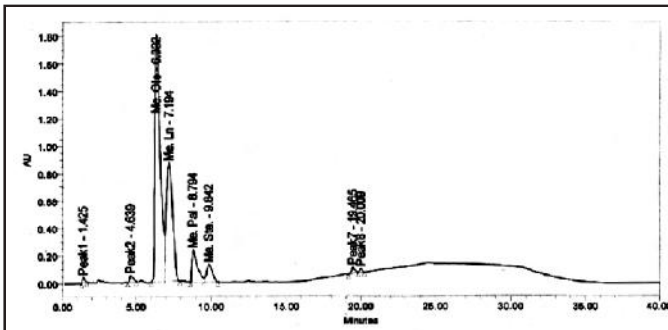
1. Viscosity oils -two
2. Lubricity oils -two
3. Metals in hydrocarbon oil
   (a) Fresh lube oil (b) used lube oil
4. Biodiesel CRM

1.2.1.3 Development and Improvement of Heterogeneous Catalyst for Biofuels

CSIR-IIP has long been actively engaged in the process development of biodiesel from various feed-stocks such as non-edible oils e.g., Jatropha curcas, Karanja, Salvadora, Madhuca Indica and several other oils. Besides this, CSIR-IIP has also utilized other cheaper raw materials e.g. waste cooking oil, restaurant grease, soya DEO distillate, palm free fatty acid etc.

In this project, we have developed few catalysts for transesterification of low-cost feed-stocks (PFAD, acid oil etc.) to biodiesel and conversion up to > 95 % in batch mode pilot plant for biodiesel production in continuous mode using novel reactor was installed this year. Optimizations of parameter were carried out for Jatropha oil having high free fatty acid, using heterogeneous catalyst in this plant. Conversion up to > 60 (single pass) was observed and further studies with this plant are continuing.

Continuous Pilot plant for Biodiesel Production using CFR



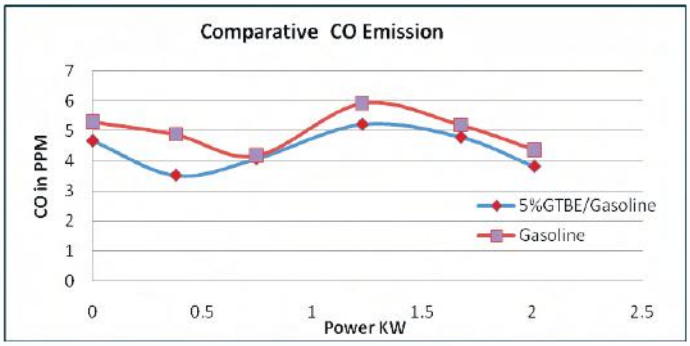
	Peak Name	RT	Area	% Area	Height
1	Peak1	1.425	335257	0.42	38256
2	Peak2	4.639	732149	0.91	48169
3	Me. Ole	6.332	43580568	54.33	1799530
4	Me. Ln	7.194	25257214	31.49	863192
5	Me. Pal	8.794	5954289	7.42	235851
6	Me. Sta.	9.842	3408974	4.25	127948
7	Peak7	19.465	651156	0.81	46854
8	Peak8	20.009	295858	0.37	28332

HPLC separation of components of Jatropha *Bio-diesel*

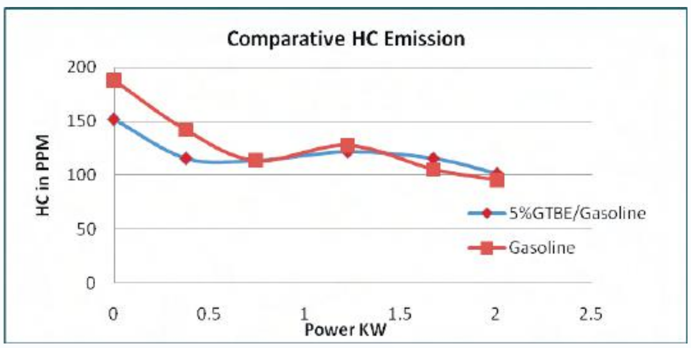
1.2.1.4 Chemical Intermediates from Glycerol

Glycerol is the inevitable by-product of transesterification process. Research efforts to find new applications of glycerol as a low-cost feedstock for functional derivatives have led to the introduction of a number of selective processes for converting glycerol into commercially valued products. In the present project, the conversion of glycerol to 1,2 and 1,3 propane diols (PDO) and glycerol tertiary butyl ether (GTBE) was studied. 1,2 and 1,3 –PDO are major commodity chemicals, with typical uses in unsaturated polyester resins, antifreeze, deicing and heat transfer fluids, pharmaceuticals, foods, cosmetics, detergents, paints, etc. Several catalysts were experimentally tested and operating conditions were optimized for hydrogenolysis of glycerol. Under optimized condition >85% conversion to propane diols has been achieved with a commercial catalyst for hydrogenolysis using pure glycerol. The product has >90% purity while using pure glycerol and 80% purity while using glycerol from the biodiesel process. Copper-metal supported catalysts were found to be the most potential catalysts for hydrogenolysis of glycerol.

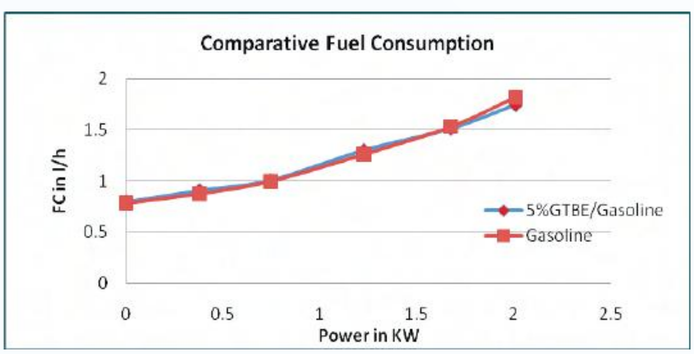
Glycerol cannot be added directly to fuel, because at high temperatures, it polymerizes—and thereby clogs the engine and it is partly oxidized to toxic acrolein. On the other hand, oxygenated molecules such as methyl tertiary butyl ether (MTBE) are used as valuable additives as a result of their antidetonant and octane-improving properties. In this respect, GTBE is an excellent additive with a large potential for diesel and biodiesel reformulation. The 99% conversion of glycerol with 95% selectivity to di- and tri-ethers was obtained. The engine testing was conducted to measure the amount of emissions on mixing GTBE with gasoline and diesel. The CO and hydrocarbon emissions reduced on mixing 5% GTBE with gasoline. Particulate matter emissions reduced on mixing 10% GTBE with diesel.



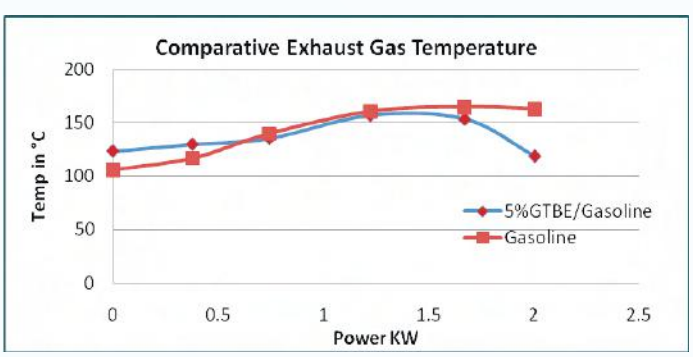
Comparison of CO Emissions from Neat Gasoline and GTBE-blended Gasoline



Comparison of HC Emissions from Neat Gasoline and GTBE-blended Gasoline



Comparison of CO Emissions from Neat Gasoline and GTBE-blended Gasoline

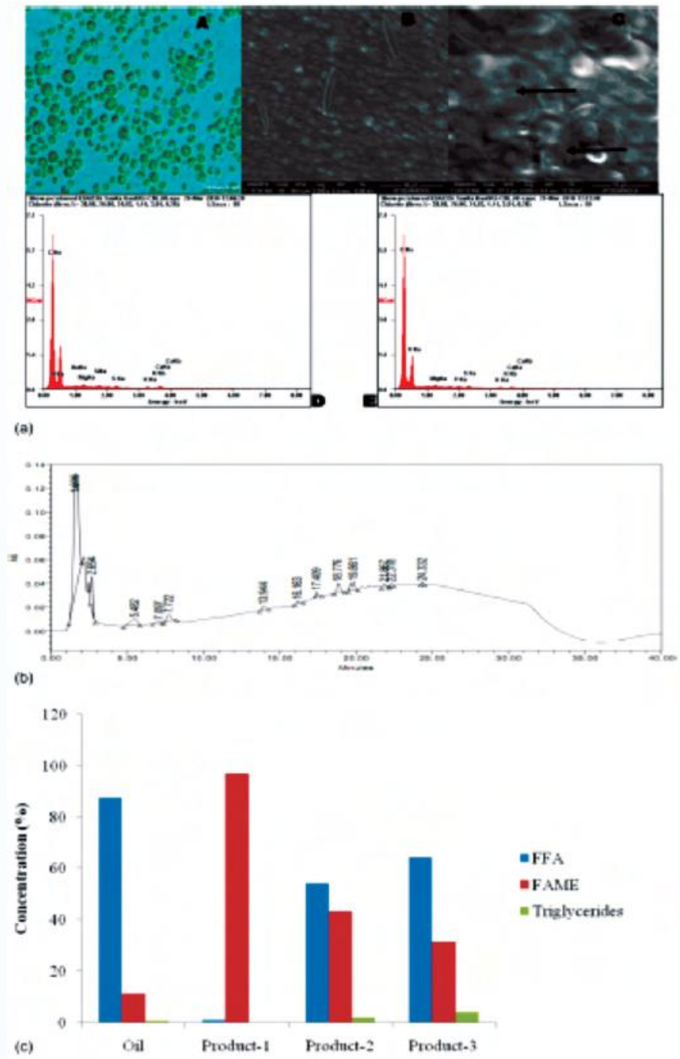


Comparison of Exhaust Gas Temperature from Neat Gasoline and GTBE-blended Gasoline

1.2.1.5 Screening of Algae for Biodiesel Production

The work was nitiated by screening the samples of algae oil received from outside of the CSIR-IIP in which potential extraction methdos were developed.

The objective of the project was to focus on the screening of natural grown-microalgae, extraction of oil from dry algae biomass and its conversion to biodiesel.



(a) B and C are the SEM images compared with A, image of Chlorella Minutissima species of algae, D and E are the EDAX of the places, which are mentioned by the arrows in C. (b) HPLC analysis of hexane extractal oil in cold (c) Comparative HPLC analysis of transesterified oil from micro algae

1.2.1.6 Tribological Studies of Bio-lubricants and Bio-fuels

The chemical transformation of non-edible vegetable oils to high-performance long- service-life environment-friendly lubricants is an attractive alternative to conventional base oils and other synthetic lubricants. Products based on non-edible vegetable oil esters (Mahua and Karanja) have a good potential as biodegradable lube base stocks. Products find application either alone or as formulations like

- Cutting oils
- Industrial gear oils

1.2.1.7 Production of Biodiesel from Low-Cost Feed Stocks using Heterogeneous Catalyst

The objectives of this project are:

- Establishing the potential of heterogeneous catalyst for biodiesel production from low-cost feed-stocks
- Process development for biodiesel production using a modified reactor
- Development of an eco-friendly process for biodiesel production with zero effluent

1.2.1.8 Valorization of Glycerol for Biodiesel for Biodegradable Base Fluids and New Biofuel Formulations

The project aims at value-addition of glycerol for:

- Biodegradable base fluid(s)/formulation & target applications
- A new biofuel formulation and the potential of reformulated fuel(s) in terms of pollutant emissions

1.2.2 Biotechnology Conversion

1.2.2.1 2nd Generation Bio-Ethanol Production and Valorisation of Process Intermediates: an end-to-end Process

Rising prices of crude oil coupled with the increasing demand for transportation fuels is a major constraint for the economic development of many nations. The scarcity of fossil fuels has led to the use of ethanol-blended gasoline (20–90%) in Brazil and the USA. India imports 75% the of total consumed crude oil and this burden has forced the oil sector to start blending 5% ethanol in gasoline. The supply of ethanol to meet this rising demand requires evidently a non-molasses feedstock which directs the R&D focus towards lignocellulosic biomass. CSIR-IIP started venture into 2nd generation bioethanol programme with an aim of developing an end-to-end process by complete utilization of sugarcane bagasse for ethanol production and further value addition. Lignocellulosic ethanol so far surpassed huge economic barriers where each threshold point leads to new research avenues. The ultimate aim of lignocellulosic ethanol business is to reduce the process and product cost which ethanol as a single product cannot resolve. Hence an array of value-added products have been targeted to bring down the ethanol cost. Moreover, if the plant can be established along with a sugar mill or paper mill in line with biorefining concept transportation and supply, the feed cost would be zero. With this background, our lignocellulosic ethanol programme was integrated with a project with The Central Pulp & Paper Research Institute (CPPRI), Saharanpur, UP where sugarcane bagasse pith (a waste generated by sugarcane bagass-based paper mills) was taken as feedstock. The work was carried out with the following objectives:

(i) Pretreatment and saccharification of lignocellulosic biomass

(ii) Yeast biomass generation and further fermentation of biomass hydrolysate at high temperatures

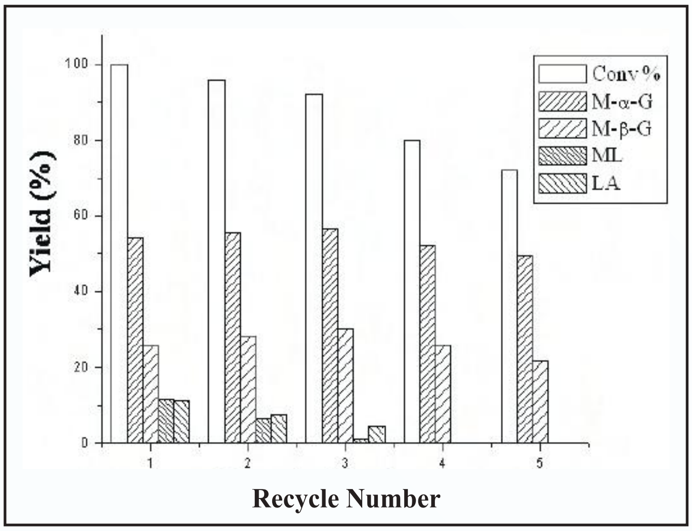
(iii) Value-addition to the process intermediates

- **Pretreatment and saccharification of lignocellulosic biomass**

Lignocellulosic biomass (Sugarcane bagasse from the local sugar industry and sugarcane bagasse pith from a local paper mill) was subjected to steam and mild sulphuric acid pretreatment for recovery of xylose-rich fraction and, further, enzymatic saccharification (market-available cellulase enzyme) was optimized to recover hexose rich broth. Optimized pretreatment process has yielded 90% recovery of the pentosans from raw biomass. Leftover biomass was saccharified with cellulase cocktail procured from market to recover 75% hexosans from pretreated biomass.

- **Yeast biomass generation and further fermentation of biomass hydrolysate at high temperatures**

The CSIR-IIP bioethanol process has been established with our own proprietary microorganism Kluyveromyces sp. IIPE453 (MTCC 5314), a thermotolerant yeast, which grows and ferments at high temperatures (50°C) and, unlike Saccharomyces cereviecae, can utilize pentose for cell biomass generation. High temperature growth and fermentation minimize the cost required for the cooling of

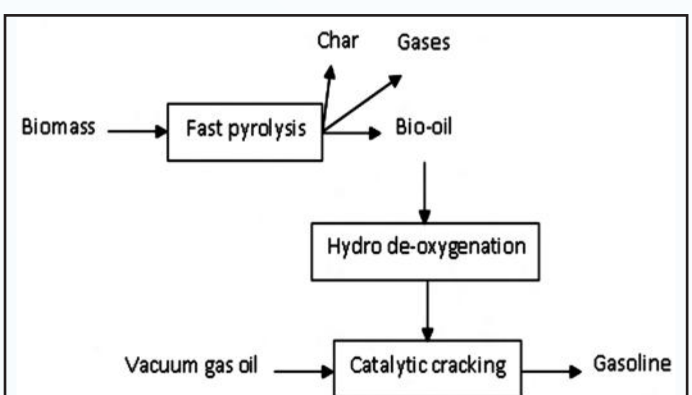


Recyclability of carbon catalyst
(M-α-G, M-β-G, ML and LA denotes methyl-α-glucopyranoside, mehyl-β-glucopyranoside, methyl levulinate and levulinic acid respectively)

1.2.3.2 Co-processing Studies of Biomass-Derived Fast Pyrolysis Bio-oil with Vacuum Gas Oil in FCC Unit

Feasibility of the approach of co-processing of bio-oil in a refinery

The biomass-derived fast pyrolysis bio-oil can't be directly used as a fuel in any type of engines. Hence, the work was initiated to study the feasibility of co-processing of upgraded bio-oil with petroleum-derived vacuum gas oil using refinery infrastructure. Co-processing of vacuum gas oil with feedstocks from renewable resources using existing refining catalysts, processes, and technologies offers advantages from both technological and economical points of view. Using the existing refining infrastructure and configuration, minute additional capital investment is required. However, technical challenges of maintaining or even enhancing process efficiency, retaining catalyst activity and stability, and improving product quality still remain.



Process scheme: The approach to bio-oil processing in a refinery unit

1.2.3.3 Hydropyrolysis of Lignocellulosic Biomass to Value-Added Hydrocarbons

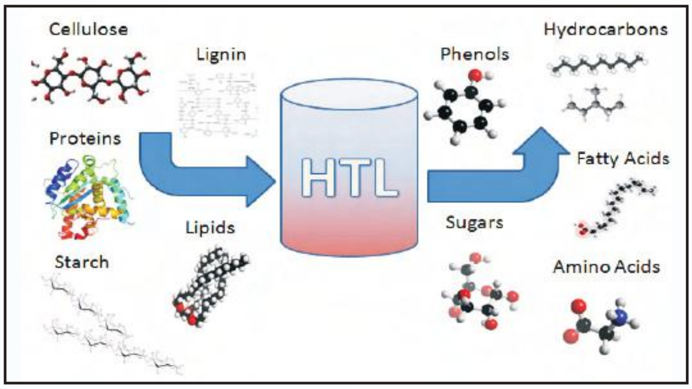
A know-how process for one-step conversion of biomass to hydrocarbons

It is highly desirable to produce liquid bio-fuel in a sustainable manner for the transportation sector in order to overcome the rising concerns of energy security, oil peaking, high crude oil prices and global warming. The only sustainable environment-friendly source of carbon for liquid fuel production is biomass which is fixed by plants using atmospheric CO_2. Therefore, biomass can be a sustainable source for liquid fuel production. However, a major challenge for biomass-based routes is to economically produce the enormous quantities of liquid fuels chemicals needed by the liquid hydrocarbon fuels/chemical sector.

Bio-oil can be produced from various thermo-chemical methods of conversion like fast pyrolysis, BTL, gasification followed by Fischer-Tropsch synthesis and hydrothermal treatment. There have been many studies on the pyrolysis of lignocellulosic biomass using various catalysts for production of liquid hydrocarbons. The fast pyrolysis oil possesses many undesirable properties, and its inherent low-energy density makes it (pyrolysis oil) expensive to transport. Besides this, the high TAN makes it metallurgically incompatible with conventional transport vessels and refinery hydroconversion equipment. With this scenario, the development of novel catalysts and integrated hydropyrolysis is of immense importance to convert lignocellulosic biomass into value-added hydrocarbons in a single step.

Hydrothermal Liquefaction

Hydrothermal upgradation (HTU) is also a promising process as it can be used for conversion of a broad range of biomass feedstocks (aquatic, agro, forest and other). The process is especially best suited for wet materials; the drying of the feedstock is not necessary. HTU has the potential of producing liquid hydrocarbons with much higher calorific values and a range of valuable/functional chemicals from a wide range of feedstocks. CSIR-IIP has performed hydrothermal upgradation (non-catalytic and catalytic) of various biomass feedstocks (forest, agro and aquatic biomass) and biomass components to understand the mechanistic pathways.



Macromolecule breakdown

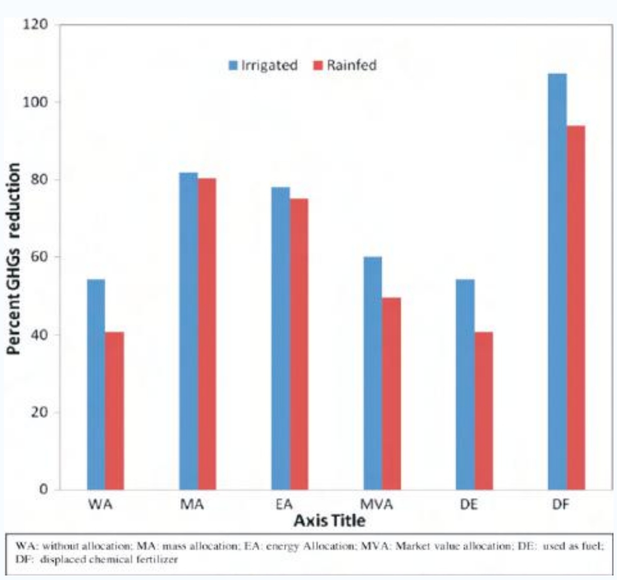
1.2.4 Biofuel Modelling

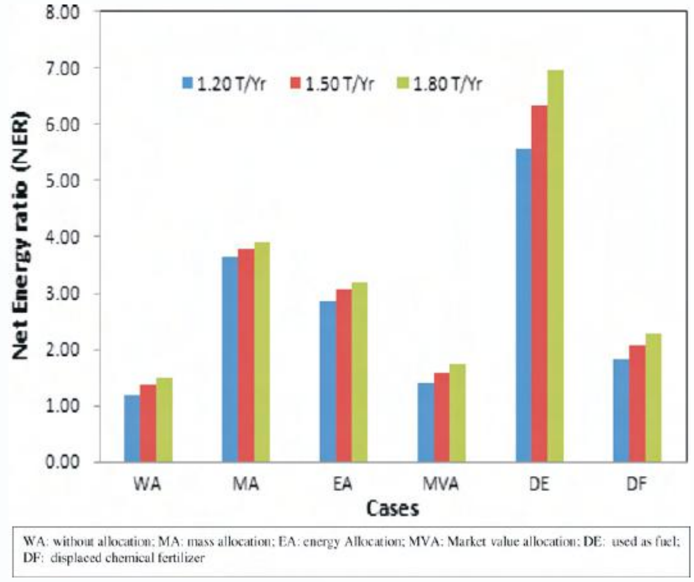
In biofuel modelling, the focus is on computational modelling of conversion routes of biomass to biofuels and chemicals, techno-economic evaluation of various bioconversion routes as well as their life cycle assessment, and exploring the possibilities of transforming the lab scale studies to an integrated bio-refinery concept. Various activities of this area are as follows.

Life Cycle Assessment (LCA) studies on biomass conversion to fuels

Life cycle assessment is a unique way to assess the scope and feasibility of a process in terms of environmental impact as well as commercialization. When deciding between two or more alternatives, LCA can help decision-makers compare all major environmental impacts caused by products, processes, or services.

At IIP spread sheet based LCA model have been developed for Jatropha biodiesel, Bio-ethanol from sugarcane molasses, Bio-ethanol from sugarcane bagasse etc. LCA models green diesel and Soybean biodiesel are also being developed. A paper on LCA of Jatropha biodiesel has been published in "Bioresource Technology" journal (Impact factor: 4.98).





1.3 CHEMICAL SCIENCES

In the area of chemical sciences we mainly work in areas related to applied and basic chemistry research. The main objective of the research is to develop cost-effective technologies widely used in petrochemicals, additives for lubricating oils and fine chemicals. Another objective is to develop new approaches for utilization of carbon dioxide for production of value-added chemicals. Photocatalysis including photoassisted reduction of carbon dioxide to hydrocarbon fuels is another prime objective of this area.

1.3.1 Speciality Products

Research is being conducted on the development of various lubes and additives which support lubricant industries. Current research focus in on development of bio-degradable lube oils using non-edible vegetable oils and various additives targetting anti-corrosion, anti-foaming, anti-oxidant, friction modifiers and anti-wear characteristics. Cellulose based bio-mass has been studied for lube development. Recently, various advanced materials such as layered structural nanoparticles, ionic liquids and metal oxide nanoparticles have been studied to explore their potential for lubricant additive development. Various product packages such as soluble cutting oil transformer oil, gear oil, lithium grease and hydraulic oil have been developed. Most of these products are bio-degradable in nature. Recently, soluble cutting technology was commercialized for its industrial scale production. Support is also provided to various industries for lube and fuel analysis.

1.3.1.1 Development of Eco-friendly Additives and Lubricants

Work is being done on developing saccharides-based biodegradable lubricants and additives, compatible with biodegradable lubricants. Preliminary span trioleate was selected for use as biodegradable/ eco-friendly lube oil base stock (LOBS) and a few products such as neat cutting oil, soluble cutting oil, and grease were formulated. Carboxymethyl cellulose (CMC), an important industrial polymer with a wide range of applications in flocculation, drag reduction, detergents, textiles, paper, food, drugs, and oil-well drilling operation, was developed using waste biomass. Various additives have been optimized such as lubricity improver for fuels, anti-foaming agent for mix vegetable oil and acetylated castor oil, anti-corrosive additive for transformer oil etc. We have also formulated additive packages targetting lubricity, detergent dispersant, oxidation stability and anti-foaming characteristics of SAE-40 and n-butylpalmitate/stearate. Further activities on development of sugar- and polyol-based lube base stocks using various catalytic systems are in progress. The biodegradable soluble cutting oil developed under this section has been commercialized to merchant customer.

1.3.1.2 Chemically-Derived Graphene Nanosheets as New-Generation Lubricant Additives

Graphene, a two-dimensional honeycomb lattice of sp^2 bonded carbon atoms, possesses remarkable electrical, mechanical, and thermal characteristics along with very high specific surface area, which promises its potential in many applications including its function as a friction and wear modifier. The weak Van der Waals interaction between individual 2D graphene sheets eases the shearing, resulting in excellent lubricity characteristics. However, for utilization of such excellent lubricity characteristics, graphene nanosheets need to be effectually dispersed in lube base stocks without compromising its characteristics. Such challenge is at the root of preparation of alkylated graphene nanosheets which can be dispersed in various organic solvents including non-polar hydrocarbons. The alkylated graphene nanosheets with variable alkyl chains (C_n = 8, 12, 18) were prepared and characterized by various techniques such as FTIR, UV-Visible, and TGA analysis. It was found that dispersibility of alkylated graphene nanosheets in non-polar hydrocarbon solvents increases with the increase in the chain length of (a) non-polar hydrocarbon solvents used for dispersion and (b) alkyl groups attached to the graphene nanosheets. The octadecylamine functionalized graphene nanosheets dispersion in hexadecane exhibited long-term stability owing to their high degree of cohesive interaction. This work has a new direction now, that of developing chemically-modified graphene nanosheets for non-polar organic solvents in order to exploit their utilization in various lube applications.

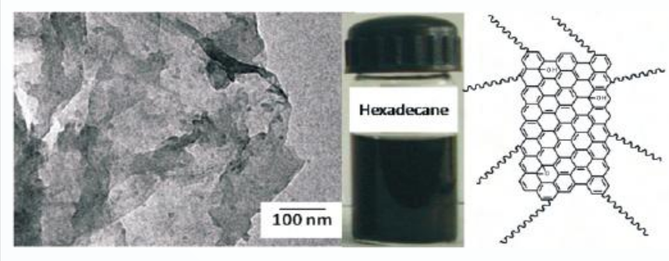


Figure: TEM image of alkylated graphene along with its dispersion in hexadecane

1.3.1.3 Boundary Lubrication Capabilities of Ionic Liquids and their Futuristic Applications to Lubricant Development

Ionic liquids known as green solvents possess remarkable physico-chemical characteristics such as negligible volatility, excellent conductivity, high viscosity and non-flammability, which are identical characteristics with an excellent lubricant. An inherent polar nature of ionic liquids facilitates their interaction with sliding surfaces, resulting in lube thin film formation, which protects metal-to-metal contact and provides low friction. Under this section, a new family of ionic liquids-based on bis(salicylato) borate [BSB] anion and ammonium cations with variation in alkyl chains has been synthesized. The synthesized ionic liquids were examined using NMR and FTIR as characterization tools. It was observed that the melting point of these ionic liquids increases with the increase in the symmetric nature of ammonium cations. TGA studies reveal very good thermal stability for these ionic liquids. Tribo-evaluation of these ionic liquids was performed using four-ball test machine. It was noted that the presence of these ionic liquids significantly increased the lubricity by reducing friction and wear. Such reduction in friction increases with the increase in the chain length of alkyl groups in ammonium cations.

1.3.1.4 Synthesis, Characterization and Tribo-evaluation of Cellulose Fatty Esters for Bio-lubricant Applications

The aim of this activity is to identify a sustainable source of cellulose and then prepare the cellulose esters using various fatty acids for their utilization as bio-lubricants. For this exercise, corn-cobic agro waste has been targetted for preparing some cellulose derivatives like methylcellulose as viscosity modifiers and thickeners. The cellulose DDSA ester and fatty esters have been synthesized for their tribo-characterization.

1.3.2 Speciality and Applied Chemistry

1.3.2.1 Development of an Indigenous Process for Synthesis of N-methyl-2-pyrrolidone (NMP)

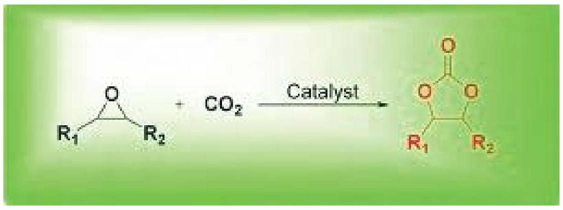
N-Methyl-2-pyrrolidone is one of the most important industrial solvents based on fossil resources. Due to its high chemical and thermal stability, it is suitable for a range of applications including the petrochemical industry, the micro-electronics fabrication industry and the manufacture of various compounds, including pigments, cosmetics, drugs, insecticides, herbicides, fungicides, pharmaceuticals, agrochemicals etc. The increasing use of NMP is as a substitute for chlorinated hydrocarbons. The global annual production of NMP is estimated to be 100-150 k tonnes per annum. Extraction of vacuum distillates and deasphalted oil for production of lube oil base-stocks with solvents like furfural and N methyl -2- pyrrolidone (NMP) is carried out in many Indian refineries. As there is no commercial plant for synthesis of NMP in India, therefore it was intended to develop an indigenous process for the same. The prime objective was to develop a cost-effective process for its synthesis. Some of the significant achievements are:

- A lab-scale batch type process for preparation of NMP from readily-available gamma butyrolactone and methylamine.
- A one-step synthesis of gamma-butyrolactone (GBL) by oxidation of tetrahydrofuran by using selenium oxide and hydrogen peroxide system. The maximum yield of the GBL was found to be 75 % with 100 % selectivity for the desired product.
- A one-step process for synthesis of NMP from aqueous ammonia, gamma-butyrolactone followed by methylation with DMC in the presence of catalyst. The developed process shows better conversion and was found to be advantageous from the economical viewpoint as well.

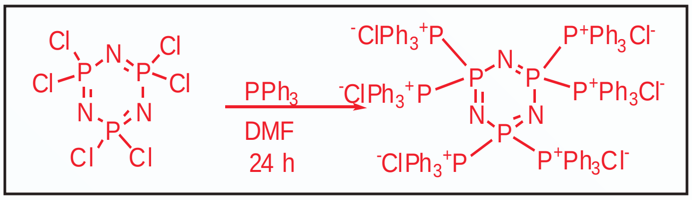
1.3.2.2 Utilization of CO_2 for Production of Fuels and Chemicals

Utilization of CO_2 as a source of carbon for synthesis of fine or bulk chemicals is gaining interest in recent years and a variety of synthetic processes have been developed. Although a few of them have been developed on industrial scale, the main obstacle for establishing industrial processes based on CO_2 as a raw material is its low energy level. The chemical transformation of carbon dioxide to useful products is a desirable goal from both economical and environmental points of view.

The main objective of this project is to develop efficient methodologies for producing high-value chemicals from carbon dioxide. Significant achievements of this project are as follows:



- A novel organocatalyst i.e chlorotriphosphazenyl-anchored triphenylphosphene containing multiple reactive sites has been developed for the synthesis of cyclic carbonates via coupling of CO_2 with epoxides. The developed catalyst was prepared by reaction of hexachlorotriphosphazene ($N_3P_3Cl_6$) and triphenylphosphene as shown in Scheme 1.

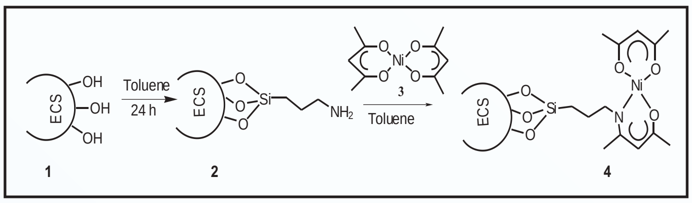


Scheme 1: Synthesis of triphosphazene supported organocatalyst

The prepared catalyst showed higher catalytic activity due to the presence of multiple reactive sites and provided excellent product yield without adding any co-catalyst or additive under milder reaction conditions.

- A simple and convenient base catalyzed synthesis of asymmetrical carbonates from primary alcohols with dimethylcarbonate (DMC) has been developed. The method is advantageous in many ways in that (i) it gives selective synthesis of unsymmetrical carbonates in high-to-excellent yields, (ii) uses an environmentally-benign and non-toxic reagent, e.g. dimethylcarbonate in place of toxic chemicals such as phosgene, carbon monoxide and (iii) requires simple basic conditions under comparatively lower reaction temperature.
- A new heterogeneous catalyst by using chemically-modified expended starch as support and Ni-acetylacetonate as grafting moiety has been developed, since starch is renewable, biodegradable and relatively inexpensive material and has been used for the grafting of Nickel (II) acetylacetonate by covalent linkage. The morphology of the prepared catalyst was studied using the SEM. The surface of ECS-Ni(acac)$_2$ was

found to be a fine, homogeneous powder with clear appearance of catalyst loading (Fig. 1). The prepared material in combination with tetrabutyl ammonium bromide was found to be a very active, selective and recyclable catalytic system for cyclo-addition of CO_2 and epoxides without co-solvent under relatively mild reaction conditions. The hydroxyl groups of the starch surface showed a promoting effect on the catalytic activity of $Ni(acac)_2$. Importantly, the starch-grafted nickel catalyst and TBAB was easily recovered after the reaction and was reused many times without any loss in catalytic activity (Scheme 2).



Scheme 2: Grafting of Ni-acetylacetonate to chemically-modified ECS- support

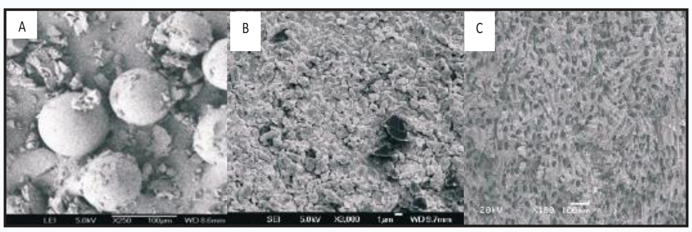


Figure 1: SEM image: a) Corn starch; b) ECS; c) ECS-Ni(acac)$_2$

- A new methodology for synthesis of cyclic carbonates by reaction of oxiranes and carbon dioxide in the presence of the catalytic amount of tetrabutylammonium bromide in dimethyl carbonate without any metal catalyst has been developed. Significant rate acceleration in the reaction was observed in dimethylcarbonate as compared to other solvents. Under the reaction conditions of 100°C and 2.1 MPa in dimethylcarbonate, maximum conversion and selectivity was achieved. Dimethylcarbonate-containing tetrabutylammonium bromide catalyst can be easily recovered and reused for at least six recycles with the same selectivity.

1.3.2.3 Development of a New-generation Metal, Phosphorous-Free Lubricant Additive as a Substitute for ZDDP

Zinc di-alkyl di-thiophosphate (ZDDP) has been used for a long time as a multifunctional additive including anti-wear agent in engine oil and its use is considered to be essential at present area. However, it contains a metal component, a phosphorus component and a sulphur component, which adversely affect the performance of engine oil and other devices. Similarly, future generations of passenger car motor oils and heavy duty diesel engine oils require lower levels of phosphorus and sulphur in order to protect pollution control devices, since phosphorus- and sulphur-containing additives may poison or reduce the effectiveness of the pollution control devices. Thus, the development of an alternative metal-, phosphorus- and sulphur-free additive for lubricating oils as a substitute for ZDDP was essentially required.

- Synthesis of amino acids-derived ionic liquids having tetrabutylphosphonium as cation was carried out.

- Aspartic acid and glutamic acid-derived ionic liquids containing tetrabutylammonium cation were developed as high-performance anti-wear and friction-reducing additives for base oil. The tribological performance evaluation of the lubricant blends, prepared as 1000 ppm and 2250 ppm of C, H and N into the base oil, was carried out on Four-Ball Tribo-Tester. Concentrations of carbon, hydrogen and nitrogen influenced the tribological performance of the synthesized additives. The synthesized ionic liquids exhibited excellent anti-friction and anti-wear characteristics. The anti-friction behaviour was more prominent with a reduction in coefficient of friction to the order of 70% in comparison to reduction in wear. Comparative anti-wear and friction-reducing behaviour of the synthesized ionic liquids is shown in Fig. 2 & 3.

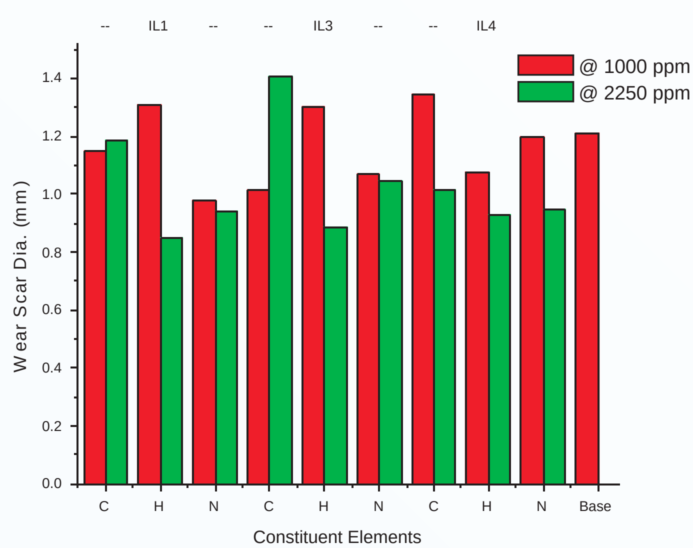


Fig. 2 Comparative assessment of anti-wear behaviour of ionic liquid blends.

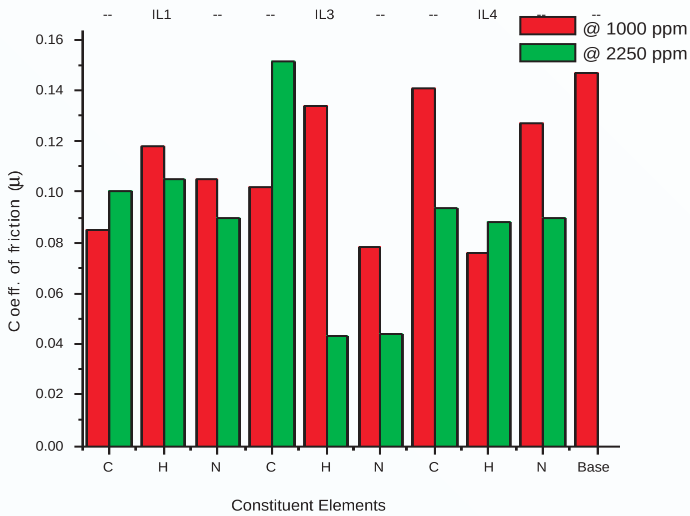


Fig. 3 Comparative assessment of anti-friction behaviour of ionic liquid blends

1.3.2.4 Photoassisted Reduction of Carbon Dioxide to Hydrocarbon Fuels

The increasing demand for global energy has drawn much attention to the field of energy development. It has been predicted that the annual amount of energy requirement will double in the next fifty years from 13.5 TW/year in 2001 to 27 TW/year in 2050. At present, the main energy output comes from hydrocarbon fuels, and only 20% comes from other energy sources such as tidal power, nuclear energy, biomass, photovoltaic, etc. Hydrocarbon fuels have many advantages over the other types of fuels, including easy storage and transportation, availability and a high volumetric energy density (33 GJ/m^3). The total amount of global hydrocarbon fuel available is limited and the large amounts of CO_2 emitted from burning hydrocarbon fuels are a significant drawback against their application. Conversion of the Green House Gas CO_2 into useful carbon sources such as CO, HCOOH, HCHO, CH_3OH, and CH_4 is a potential-method of solving both energy and environmental problems. Photo-catalytic conversion of CO_2 is attractive from the viewpoint of sustainable energy production and Green House Gas reduction. The prime objective of the project is to develop new catalytic materials and approaches for the photo-reduction of CO_2 to hydrocarbons and they will further be used to develop more value-added products.

1.3.2.5 Development of Process for Normal Dodecane Fraction from Straight-Run Kerosene Obtained from Petroleum Refinery

n-Dodecane is a liquid alkane hydrocarbon with the chemical formula $CH_3(CH_2)_{10}CH_3$ (or $C_{12}H_{26}$), an oily liquid of the paraffin series which is used in several applications, e.g.,

- as a solvent,
- distillation chaser,
- scintillator component,
- diluent for TBP for plant-reprocessing,
- Ferro-fluid for production of nano-crystalline magnetite powders--the only magnetic materials accepted for medical applications and,
- detergent manufacture (constitutes > 40%),

At present, there is no indigenous process for production of normal dodecane fraction and the current demand is met by import only.

n-Dodecane is found in the straight-run kerosene (boiling range 140-250°C) and there is an enormous potential for production of such a valuable component from the mentioned hydrocarbon stream as there is surplus production of kerosene in India. The objective of the project was to develop an indigenous process for production of normal dodecane fraction from such straight-run kerosene.

Urea molecules are known to form reasonably stable crystalline hexagonal structure, wrapping inside linear (straight-chain) paraffins containing six carbon atoms or above in the form of adducts at room temperature. This property of urea in the presence of an activator followed by decomposition of the adduct was studied with a suitable fraction of kerosene for development of the process for production of normal dodecane fraction.

Following are the conclusions of this work:

- The desired kerosene cut was obtained by distillation from straight-run kerosene after detailed study of distribution of normal dodecane component in different fractions.
- Separation of straight-chain paraffins from the C_{12}-rich fraction was studied extensively by the dry process of urea adduction methodology for optimization of both the yield and the quality.
- A lab-scale batch process has been developed based on the quality of the normal dodecane fraction required, in which all the used reagent can be recycled almost completely.

1.3.2.6 Development of a Process for Detergent-grade Alpha-olefin (AO) Sulphonates by Using Linear Alpha-olefins (C_{14}-C_{18} range) from the Coker Distillate of an Indian Refinery

Alpha-olefins are highly valuable components which find a wide spectrum of applications in various fields based on the carbon range.

Alpha-olefin (carbon range)	Utilization
C_4-C_8	Co-monomers, LLDPE, HDPE, plasticizers, Viscosity Index improvers
C_8-C_{10}	Synthetic lubes
C_{10}-C_{18}	Surfactants
C_{20}-C_{24}	Speciality chemicals

Currently, such alpha-olefins (except for linear alkyl benzene sulphonates surfactant) are not produced in India. Companies like Shell, Chevron, Ethyl, Mitsubishi and Idemitsu are the major producers of AOs in the world, the first two being the world's largest producers. The primary technology suppliers are Shell, Chevron and Ethyl Corporation, while in India, major R&D was being carried out by M/s Godrej Soaps Ltd., who patented and then also commercialized their process on alpha-olefins. But the process based on dehydration of fatty alcohols was found to be uneconomical due to feed vs. product cost issue. Currently, there is no indigenous production of the detergent-grade alpha olefins (C_{14}-C_{18} range) and all of the demand is being met through import from China.

Such alpha-olefins of immense commercial value have been found to exist substantially in thermally-cracked petroleum streams e.g., coker streams in state-of-the-art refineries. Coker streams generally have poor storage stability and are, therefore, hydrotreated in order to blend them with the straight-run fuels. Being an untapped source of linear alpha-olefins and paraffins, coker streams from a refinery could provide a ready source of such a valuable component.

Alpha olefins in the carbon range C_{14}-C_{18} are extremely useful in the form of sulphonates intermediate in detergent applications and are much more eco-friendly in comparison to the commonly-used linear alkyl benzene sulphonate-based detergents. The beneficial attributes of alpha olefin sulphonates include, good cleaning and foaming properties--both in soft and hard water, mildness in the skin and rapid biodegradability. The household applications of alpha-olefin sulphonates include laundry and dish detergents and personal-care applications including shampoos and liquid hand soaps.

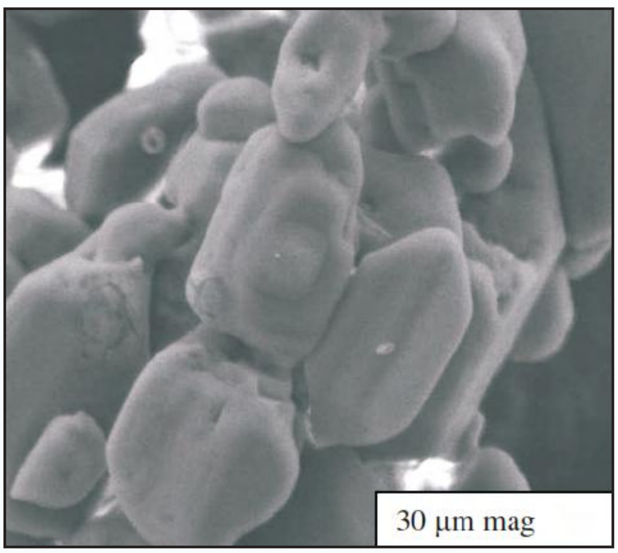
A suitable fraction of coker gas oil in the carbon range of C_{14}-C_{18} constitutes about 30-40 % by weight of olefins more than 95 % of which are those of alpha-olefin type.

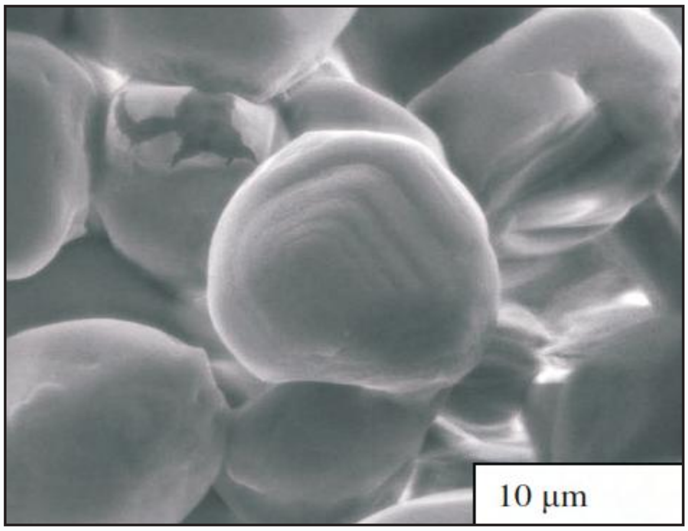
Prior to literature art, there was no such commercial process available on value addition to coker streams through separation and utilization of alpha-olefins.

After Bengen's discovery in 1940, it came to be known that urea forms stable needle-shape hexagonal clathrate/inclusion compound with straight-chain hydrocarbons of carbon number 6 or above at room temperature. Such compounds can be further decomposed thermally and, therefore, they enable the separation of straight-chain molecules from complex mixture of hydrocarbons. Owing to the presence of double bond at the terminal position alpha olefins of certain carbon range also participate in the formation of such inclusion complex along with straight-chain paraffins with urea. CSIR-IIP Dehradun carried out extensive research work in the separation of alpha olefins of C_{10}-C_{18} range of detergent grade from low-sulphur coker distillates by aqueous urea adduction methodology but the process lacks in the recycling of urea as the complex undergoes decomposition in the presence of water.

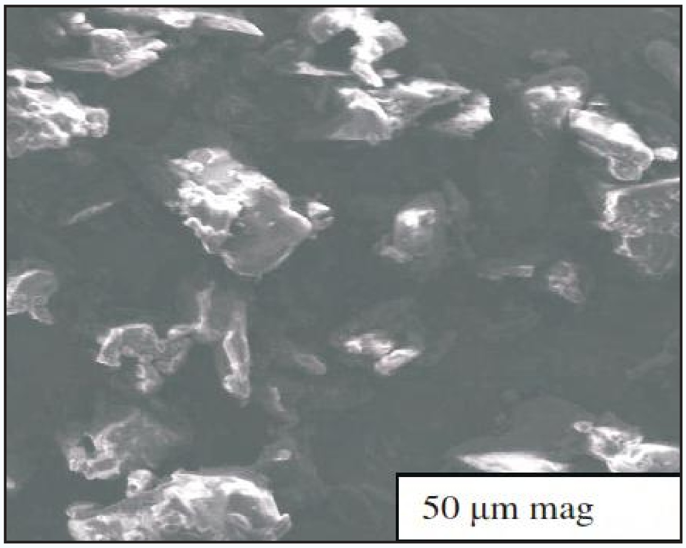
The prime objective of the work mainly concentrated towards development of process for separation of linear alpha olefins and paraffins mixture from a suitable fraction of coker gas oil by employing dry urea adduction methodology process in batch mode followed by sulphonation of the mixture to produce detergent-grade alpha olefin sulphonates (C_{14}-C_{18} range). Significant achievements of this work were as follows:

1. Detailed compositional studies of coker gas oil.
2. Fractionation under vacuum of coker gas oil for studying the carbon-range distribution in order to prepare feedstock for the selective range of linear alpha-olefins and paraffins (C_{14}-C_{18}).
3. Characterization and condition optimization of the formation and decomposition of urea-olefin-paraffin adduct in the presence of a suitable solvent instead of using water.
4. Formation and decomposition of hexagonal adducts were characterized by SEM images.

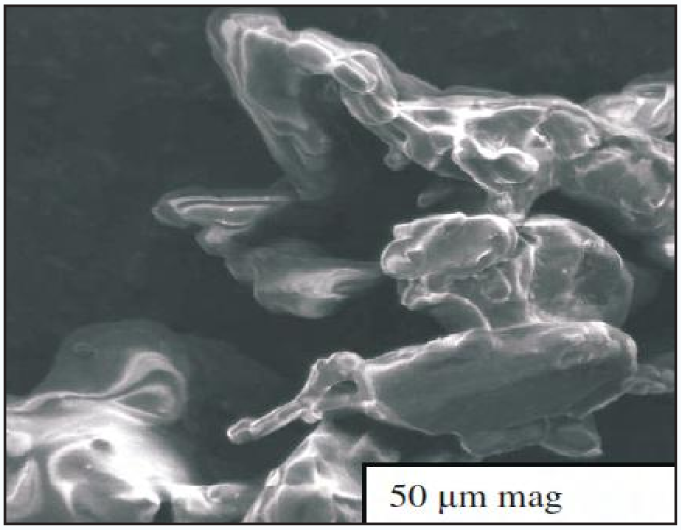




The hexagonal adducts were found to be consisting of contours which represent layered structure, a finding further confirmed by XRD.



Thermally-decomposed urea



Fresh Urea

The absence of contours in the decomposed urea adduct shows similarity with the fresh tetragonal urea (confirmed by XRD pattern).

The process was developed and standardized at the laboratory scale and further scaling up is in progress.

1.3.3 Applied Corrosion Science

The phenomenon of corrosion is as old as the extraction of a metal from its ore. Although corrosion is only nature's method of recycling, or of returning a metal to its lowest energy form, it is also an insidious enemy destroying the domestic belongings to turnkey engineering structures. In an industrialized country, corrosion causes losses amounting to almost 4% in gross national product (GNP). Corrosion can occur in various attack forms like uniform, crevice, pitting, inter-granular, selective leaching, erosion, hydrogen damage and stress corrosion. Various environmental variables viz. dissolved oxygen, oxidizing power (potential), pH, temperature, fluid velocity, processing constituents (sulphur compounds, organic acids, carbon dioxide etc.) and biological micro-organisms play a dominating role during corrosion.

Corrosion studies at the Institute relate to hydrocarbon sector and futuristic biofuels. Research activities focus on internal corrosion and its control due to hydrocarbons containing inherited impurities and severe operating conditions during production, processing, transportation and storage. Recent activities encompass corrosion behaviour of various new-generation renewable fuels such as biodiesels synthesized from different non-edible seed oils of Indian origin. Various commercial corrosion inhibitors were also evaluated for their inhibiting effect in the hydrocarbon environment.

Looking Ahead

In order to ascertain effective corrosion monitoring in hydrocarbons and bio-fuel systems, Thin Layer Activation (TLA) technique will be developed as a sensitive, non-destructive and quicker corrosion monitoring technique.

Facilties present at the Institute incoude the following

- Metallurgical Microscope
- NACE TM 0172
- ASTM G31

1.4 ANALYTICAL SCIENCES

1.4.1 Crude Evaluation

1.4.1.1 Evaluation Studies on Crude Oils from a Merchant Client

A merchant client sponsored a project for evaluation of 20 crude oils from different fields of India being explored by them. The evaluation study was aimed at determining the bench-mark pricing of crude oil samples.

1.4.1.2 Detailed Evaluation Studies on a Crude Oil

One of our client refineries has exploratory rights for hydrocarbon prospecting on onshore block CB-ONN-2003/1 (CB10 Part A &B). As a part of the exploratory campaign, it has certain wells to ascertain the hydrocarbon reserves. The block CB-ONN-2003/1 is located in the Anand district in the Cambay basin, Gujarat state, India.

The present detailed evaluation study was aimed at determining the potential of value-addition to the straight-run cuts of crude oil (CB-10AA, Khambat) of the client refinery. Such information on a particular variety of crude oil is expected to give an idea of its intrinsic value for its marketability. This will also help assess the feasibility of producing value-added products aimed at increasing the profit margins of the refinery in processing the crude oil.

1.4.1.3 Effect of Blending Bio-oil with Conventional Fuel

This study was aimed at producing bio-fuel. A success was achieved in this study in exploring the blending of bio-oil and its fractions by various methods with the conventional fuels. As a result, bio-oil could be converted into bio-fuel.

1.4.1.4 Investigation of Oil Blackening of AI-20 Aero Engine

Detailed physico-chemical and spectroscopic characterization of fresh and the corresponding used blackened oils of AI-20 Aero engine was carried out to find out the probable reasons for the blackening. A detailed report was submitted to the sponsors.

1.4.1.5 Development of a Method for Compositional Analysis of Bio-fuels, Bio-lubricants & Additives

A detailed report on characterization and compositional aspects of bio-fuels, bio-lubricants & additives by newer methods was prepared.

1.4.2 Analytical Research

1.4.2.1 Trace Metal /SEM/XRD Analysis

- **Trace metal analysis of petroleum and related materials using ICP-AES/AAS and morphological studies by Scanning Electron Microscope**

In the area of trace metal analysis, we are is engaged in providing quantitative inputs in respect of metal contents to various sponsored/in-house projects of the Institute and outside parties. A large number of samples like metal extracted from Co-Mo, de-oiled cake, bagasse, crudes oils from a client oil company,, Mangala crude oil from another client refinery, vegetable oils, catalysts, bio-oil, bio-mass, fresh & used oils from the defence sector, coker distillates, petroleum/coal tar, channa straw, graphene, microbial lipid, zeolites, sugar mill bearing oils, RFO feed, bio-lubricants, fresh & used lubricating oils from Lubrizol India Pvt. Ltd. etc have been estimated quantitatively at ppm/ppb level for various metals such as Na, Mg, P, Co, V, Zn, Fe, Ti, Ca, Mn, Ni, Cu, Al, Cr, Ba, Mo, Pb, Sn, Ag, Pt & K.

Similarly, a large number of samples like catalysts, solar cells, petroleum cokes, metal balls from tribology and micro organisms of algae have been analyzed by SEM for morphological studies, images, elemental analysis and mapping for different sponsored/in-house projects of the Institute.

- **XRD/TGA**

More than 400 samples have been analyzed for diffraction pattern along with 2 and D-values, planes(hkl values), crystallite size, relative crystallinity, intensity & relative intensity by XRD.

Percent weight loss with respect to temperature has been studied by TGA for various in-house/sponsored projects during 2011-2012.

1.4.2.2 Mass Spectrometry (MS)

We have provided analytical support through mass spectrometry (MS) to a large number of ongoing projects of the Institute. Samples were largely analyzed by gas chromatograph coupled with mass spectrometer (GC-MS) for structure elucidation, molecular weight informations and/or monitoring of chemical reactions. Presence of distinct amounts of reactants as well as products along with other chemical species formed as a result of side reactions were estimated qualitatively in most of the cases. However, in a few cases, wherever required, semi-quantitative and quantitative determinations were also carried out.

1.4.2.3 UV-Vis-NIR & NMR

- **Study of the effect of ionizing radiations on biomass for its conversion to ethanol**

The project is a grant-in-aid project, in which another agency is participating. Data compilation and report have been under preparation.

- **Synthesis, development, characterization and evaluation of graphene TiO_2 hybrid material for enhancement of photovoltaic efficiency**
- **Development of graphene-metal oxide nano-composites as potential candidates for photovoltaic applications**

1.4.2.4 Chromatography

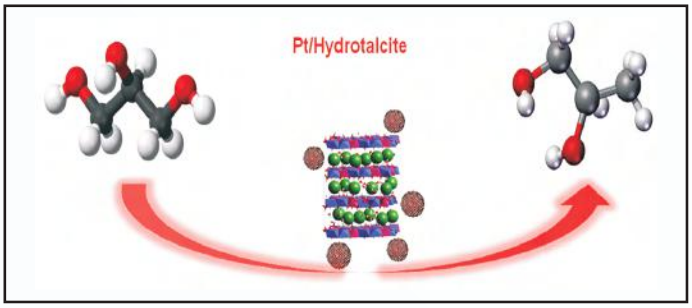
Through chromatography, we have provided gas chromatographic (GC), high performance liquid chromatographic (HPLC) and supercritical fluid chromatographic (SFC) research inputs to various sponsored/in-house projects of the Institute.

1.5 CATALYTIC CONVERSION PROCESSES

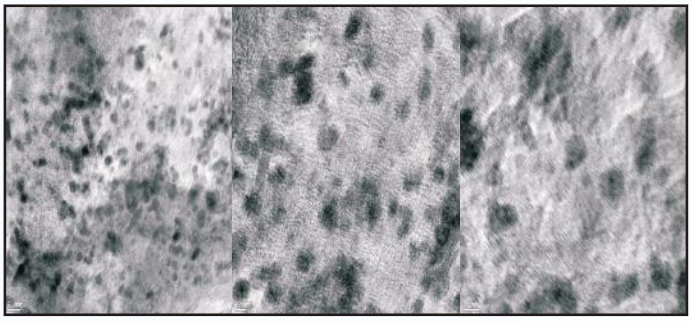
1.5.1 Nano-Catalysis

The Institute has many strong and expanding activities in nano-catalysis for energy, petrochemicals and environmental applications providing efficient, sustainable and economical ways to convert raw materials into valuable chemicals and advanced future fuels. Besides this, we also investigate the fundamental physics and chemistry of surfaces by using advance characterization techniques. This has led us to a molecular-level insight between nanoparticle properties and catalytic performances.

1.5.1.1 Aqueous Phase Reforming of Glycerol to 1, 2-propanediol Over Pt/Hydrotalcite Catalyst

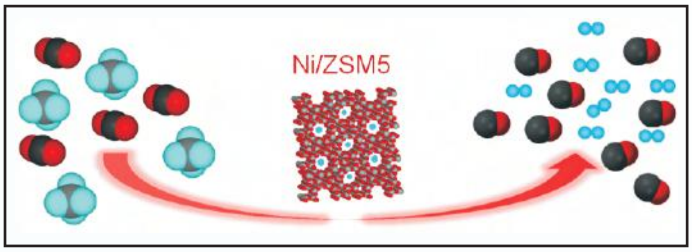


The use of renewable feedstocks is becoming increasingly essential for sustainable development of society, and, of late, much attention has been devoted to applying green catalytic processes to convert bio-renewable feedstock to commodity chemicals and clean fuels. Glycerol is the by-product during the production of biodiesel by transesterification of seed oil with methanol. 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 into commercially-valued products. Here we report the aqueous phase reforming (APR) of glycerol over Pt-loaded hydrotalcite (HT) in a batch reactor at an initial N_2 pressure. A glycerol conversion of upto 95% with a selectivity of 65% for 1,2-propanediol was achieved, without the use of any external H_2. Recently, we have also found that addition of small amounts of alkali (NaOH), the product, form only gas and it contains almost 75% of H_2 and the rest is mostly CO_2.



TEM pictures of Pt/Hydrotalcite

1.5.1.2. Development of Speciality Inorganic Materials for Diverse Applications

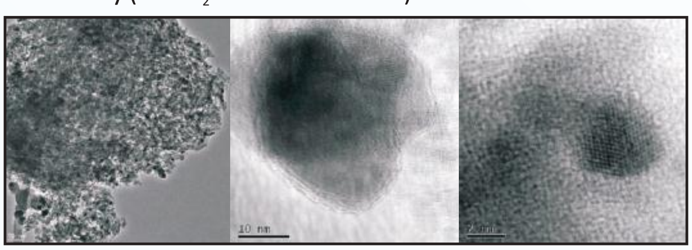


Dry reforming of methane over Ni-nanoparticles supported on mesoporous ZSM-5

Pollution has become a major concern on global scale and various factors, viz., byproducts in fossil fuels combustion, chemical combustion and synthetic fuel manufacturing, etc., contribute to the emission of Green House Gases into the atmosphere. The perturbation in climate caused by the Green House Gases (mainly methane and carbon dioxide), acid rain etc. have come up as major fundamental issues before mankind. Aganist this background, natural gas appears to be a clean and ecological source of energy and is now viewed as a very competitive product in improving the performance of major oil companies. One of the processes commonly used in recent years is the dry reforming of methane. Indeed, this process is of particular interest as it uses two Green House Gasses via this reaction:

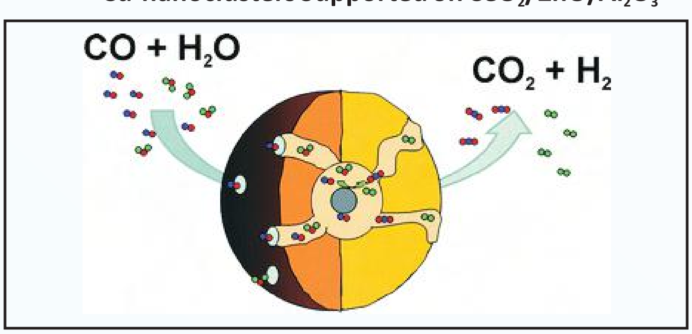
$$CH_4 + CO_2 \rightarrow 2CO + 2H_2$$

We have found that Ni-nanoparticles supported on mesoporous ZSM-5 show very good activity and selectivity. A conversion of 92.8 % with ~ 100% CO selectivity (CO: H_2 molar ratio = 1:1) was achieved at 1073K.



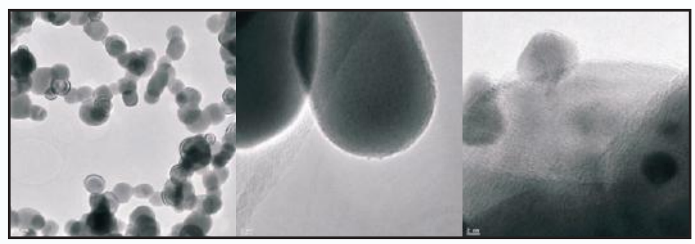
TEM pictures of Ni/ZSM-5

1.5.1.3 Low-temperature Water-gas-shift Reaction over Cu-nanoclusters Supported on $CeO_2/ZnO/Al_2O_3$



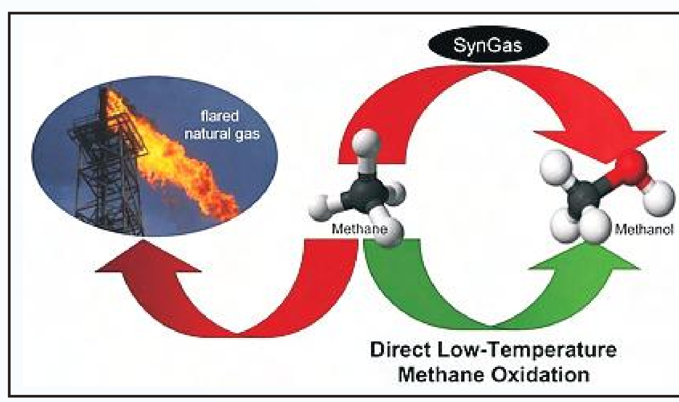
Water gas shift reaction

With the recent development and beginning of commercialization of polymer electrolyte membrane fuel cell (PEMFC), the demand for CO-free hydrogen has increased manifold. In fact, the development of a technology for production of pure hydrogen (with little or no CO) conventionally and at 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-nanoclusters 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 water gas shift reaction. It is very interesting to note that upon addition of a small amount of Pt (0.5wt %) 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.

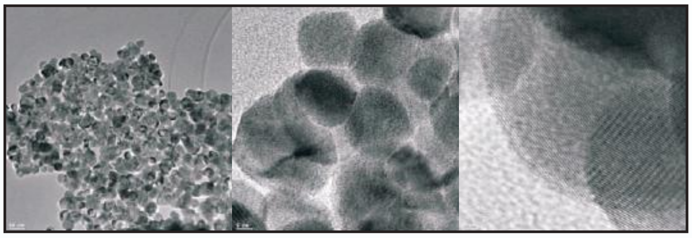


TEM pictures of $Cu/CeO_2/ZnO/Al_2O_3$

1.5.1.4 Selective Oxidation of Methane to Methanol over Supported Nanocluster

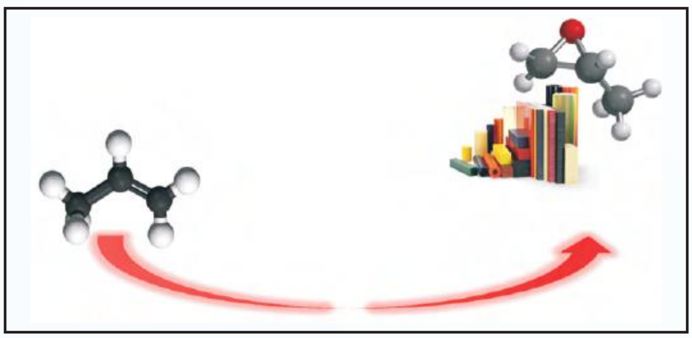


Preparation of nanoclusters where the particle size is below 1 nm poses the greaterst challenge to research in terms of preparation, characterization and potential enhancement of reactivity. Development of such novel material is the fundamental focal point of chemical research; and this interest is mandated by advancement in all areas of industry and technology. Methane is the most abundant and the least reactive of the hydrocarbon family; thus the selective oxidation of methane to methanol is one of the most challenging chemical problems, in addition to being of great practical importance.



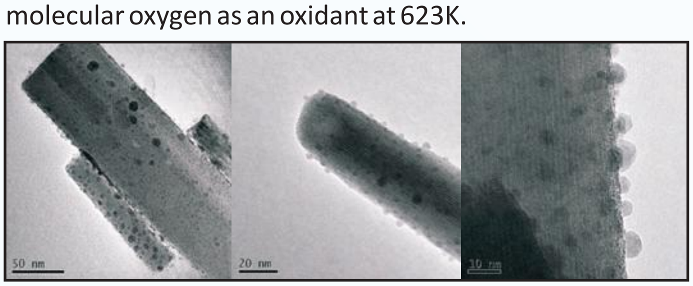
TEM pictures of the prepared catalyst

1.5.1.5 Selective Oxidation of Propylene to Propylene Oxide with Molecular Oxygen over Ag-W-Oxide Catalysts



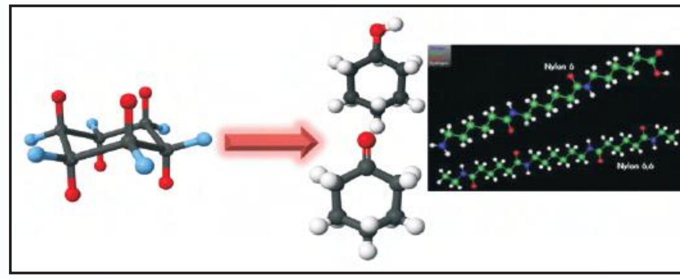
Propylene oxide (PO) is a versatile chemical intermediate used in a wide range of industrial and commercial products including polyether polyols, propylene glycols and propylene glycol ethers

By volume, it is amongst the top 50 chemicals produced in the world with an annual production of about 5 million tonnes. The industrial production of propylene oxide is mainly from co-oxidation of propylene with other chemicalss but these technologies create additional side products. The major conventional manufacturing methods of PO are the chlorohydrins process and the Halcon process. The chlorohydrin process is being phased out because of environmental pollution, while the latter has the limitation of producing by-product. So a new, environmentally-benign technology has to be developed for production of propylene oxide. We have found that nanocrystalline catalysts show a propylene conversion of ~46% with ~100% propylene oxide selectivity using molecular oxygen as an oxidant at 623K.

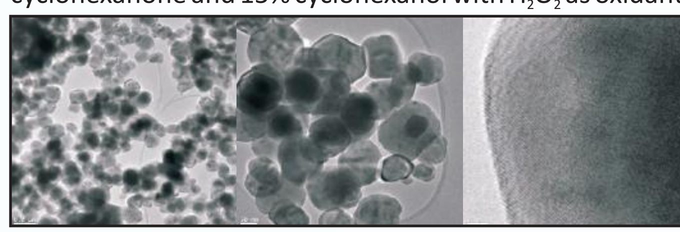


TEM pictures of the prepared catalyst

1.5.1.6 Room-temperature Selective Oxidation of Cyclohexane with H_2O_2 Over Cu-Cr_2O_3 Catalysts

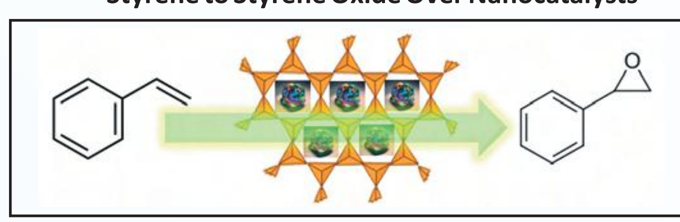


The oxidation of cyclohexane due to the large demand for cyclohexanone and cyclohexanol, important raw materials for production of adipic acid and caprolactam, is finally used in the manufacture of nylon-66 and nylon-6 polymers. However, the oxidation of cyclohexane turns out to be the least efficient of all major industrial processes. The present industrial process for cyclohexane oxidation is carried out worldwide at 423 K and 1-2 MPa pressure, employing metal cobalt salt or metal-boric acid as homogeneous catalyst. There is no heterogeneous catalyst reported to date which can be used in the industry. We have found that Cu-supported on Cr_2O_3 prepared by hydrothermal method shows 100% cyclohexane conversion at room temperature with a selectivity of 85% cyclohexanone and 15% cyclohexanol with H_2O_2 as oxidant.

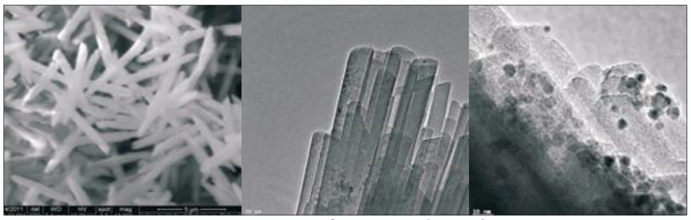


TEM pictures of Cu/Cr_2O_3

1.5.1.7 Room-temperature Selective Oxidation of Styrene to Styrene Oxide Over Nanocatalysts



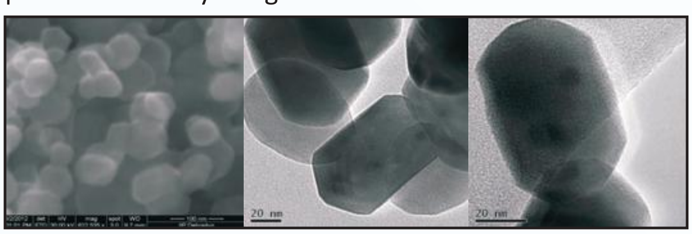
The design of rational synthesis pathways for nanocrystalline materials is significant due to their potential application as advanced catalysts, adsorbants, optical guides and sensors. In modern science, extensive research efforts have been devoted to the synthesis of porous inorganic materials with different structural coherencies over a wide range of length scale. We have successfully synthesized nanoparticles supported on different materials. The catalyst is highly active for selective oxidation of styrene to styrene epoxide.



TEM pictures of prepared catalyst

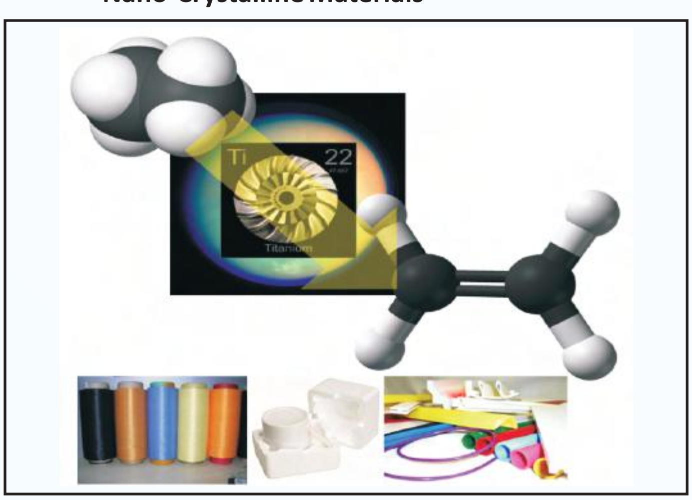
1.5.1.8 Selective Oxidation of Benzene to Phenol with Molecular Oxygen Over Cu-Cr-Oxide Catalysts

Phenol is one of the most important chemicals in industries, the global production exceeding 7.2 megatonnes per year. Phenol has been produced industrially from benzene by the three-step cumene process, which is not only energy-consuming but is also less efficient, showing very low phenol yield (~ 5 %, based on the amount of benzene inlitially used) and producing lots of by-products such as acetone and –methylstyrene. Direct phenol synthesis from benzene is an alternative way to overcome these problems. We have found that CuCr catalysts show a benzene conversion of ~30% with ~98% phenol selectivity using air as an oxidant at 623K.

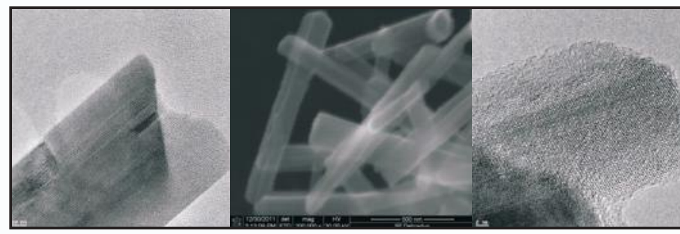


SEM & TEM pictures of Cu/Cr_2O_3

1.5.1.9 Dehydrogenation of Ethane to Ethylene over Nano-Crystalline Materials



Ethylene is a very important chemical, which does not occur in nature but still represents the organic chemicals consumed in great quantities worldwide. It is the main raw material for the large number of industrial products, such as polyethylene, polyvinyl chloride, polystyrene, polyester, etc. Despite the economic uncertainty around the petrochemical industry, ethylene production and consumption scenario are expected to grow continuously. The global demand of ethylene is over 140 million tonnes per year with the future growth rate of 3.5% per year. We have successfully developed a nanocatalyst which shows ethane conversion of ~92% with ~85% ethylene selectivity at 973K.



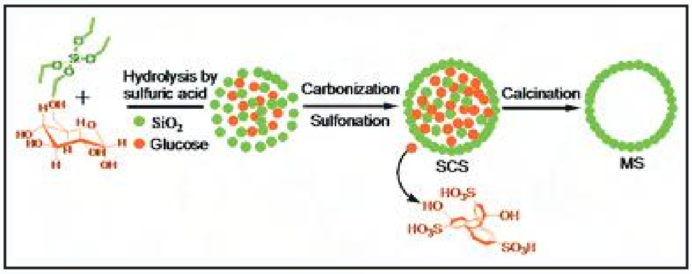
TEM pictures of nano-crystalline materials

1.5.2 Catalytic Reforming: Advanced Materials For Hydrocarbon Conversion

Synthesis of functionalized materials is gaining importance in catalysis as it provides opportunity to design active sites in desired environment in order to provide enhanced accessibility to reactant molecules, enough space for formation of bulky intermediates and facile diffusion of product molecules. Nano particles with a combination of micro-meso, meso-macro and micro-meso-macro pores are the highly desired catalyst systems for improving product quality. The work is in pre-mature stage and a very limited literature is available on this subject, where expensive and laborious preparation methods are reported for the sythesis of composite materials. We, at the CSIR-IIP, have been involved in the synthesis of novel materials using cheaper and common ingredients such as glucose. Several nano materials of different morphologies viz. nano tubes and nano plates are synthesized and explored for catalytic applications. Emphasis is also given for value-addition of bio-mass derived by-products such as glycerol, ethanol and acetone.

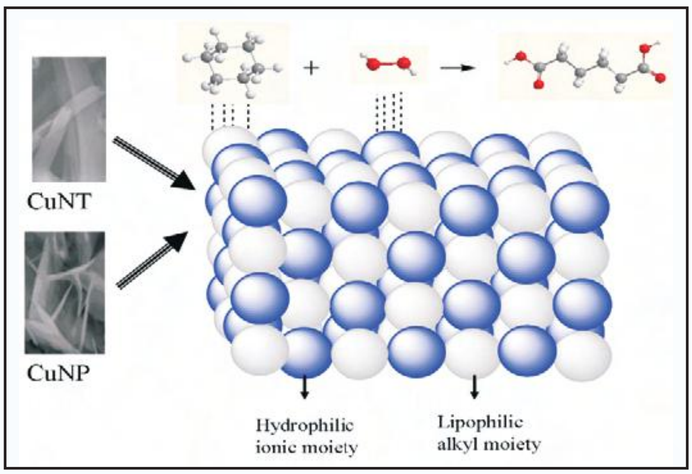
1.5.2.1 Novel, Economic and Efficient Routes for Synthesis of Advanced Materials for Catalytic Applications

A novel and simple method has been developed for preparing a sulphonated carbon–silica-meso composite showing high acidity and porosity useful for transformation of bulky molecules, where glucose was used as a carbon source as well as a non-surfactant templating precursor. The resultant composite (upon calcination) yielded the mesoporous silica.



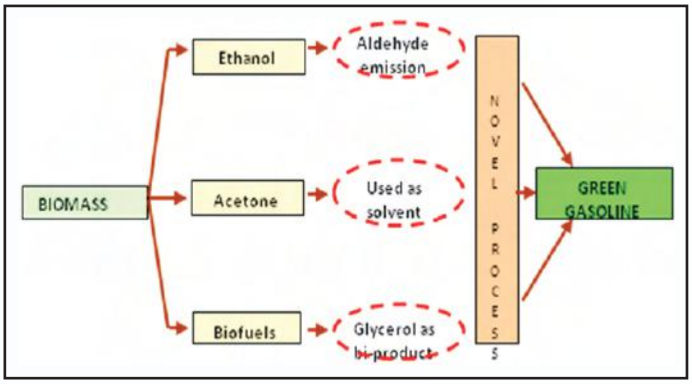
1.5.2.2 Synthesis of Magnetically Recoverable Copper-alkyl Amine Nano-Tubes (CuNT) and Nano-Plates (CuNP)

The present work illustrates a simple method for the synthesis of alkyl amine interacted $Cu_2(OH)PO_4$ nano structures, viz., nano-plates (CuNP) and nano-tubes (CuNT) exhibiting interesting surfactant and magnetic properties suitable for solvent-free catalytic reactions and adsorption applications.



1.5.2.3 Value-Addition of Biomass-Derived Low-Value By-Products such as Glycerol, Scetone and Ethanol Through their Effective Conversion into Gasoline

About 9 wt% of glycerol is produced as a bi-product from trans-esterficaiton reaction of biomass that needs to be converted into valuable products. Etherification of glycerol with bio-alcohols gives ethers that are useful as effective oxygenates for fuel blending applications. Though the Amberlyst based catalysts are utilizesed for this pupose, the catalysts have the drawbacks of high-temperature instability and swelling property. The present study is focussed on exploiting the virtues of zeolites for achieving di-ether rich product from glycerol. Gycerol etherification with TBA is successfully conducted in the laboratory using BEA zeolite based catalyst. The catalyst exhibited >90% conversion of glycerol with the major product being di- and tri-ether (~95% selectivity). The catalyst works at >100° C and hence overcomes the equilibrium limitations caused by the bi-product, viz., water. Bio-ethanol and acetone are also sucessfully converted into gasoline range hydrocarbons along with olefins over zeolite-based catalyst.



1.5.2.4 Catalyst development for Conversion of Light Naphtha to Diesel

The abundant availability of naphtha and the overwhelming demand for diesel instead of gasoline envisions the need of converting naphtha into diesel-range products. A recent paper (David Gibbons, PTQ Q3 2011) addresses the issues and challenges in catalyst development for such conversions. While no research groups have so far attempted catalytic conversion of naphtha into diesel, the research group at the CSIR-IIP initiated the work and a series of solid acid catalysts with dehydrogenation and oligomerization functionalities were prepared and tested in the laboratory. The exploratory studies conducted on catalytic conversion of n-paraffins/ naphtha into diesel gave encouraging results. A solid acid catalyst developed in the laboratory gives about 23 wt% diesel, which is indeed the first of its kind in obtaining the catalytic conversion of naphtha to diesel. Detailed studies are under way for optimising catalyst and process parameters for increasing the diesel yield.

1.5.3 Fluidized Catalytic Cracking (FCC)

FCC is the most widely used secondary conversion process in the refining industry for producing gasoline, olefin & middle distillates from heavier petroleum fractions. Expertise has been generated in evaluation of various FCC catalysts/ additives prepared at the CSIR-IIP as well as that of the commercial FCC Catalyst and in guiding the refineries to choose most promising FCC catalysts/

additives from the vendors, in terms of the high yield of liquid product, low coke , dry gas & high propylene yield.

Following are the R&D highlishts of this area in the year:

- Development of new-generation FCC catalysts in collaboration with a client refinery.
- Development of DCC (DEEP CATALYTIC CRACKING) Catalyst.
- Studies on upgradation of biomass constituents for energy applications.
- Upgradation of FCC recycles through solvent extraction.
- Maximization of middle distillates through the use of de-asphalted oil (DAO) as incremental feed in vacuum gas oil.
- Process & technology for production of liquid and gaseous fuel by fast pyrolysis of biomass.
- Evaluation of FCC Ccatalysts / additives received from a merchant oil company.
- Utilization of biofeed (glycerol) in the FCCU for fuels and chemicals.

1.5.4 Adsorption and Membrane Separation Area

1.5.4.1 Technology Development on Renewable Energy from Biogas *(Research Project under Australia–India Strategic Research Fund in collaboration with the Melbourne University, Australia)*

Biogas produced by anaerobic fermentation of biomass contains about 40-60% CH_4, the balance being CO_2 along with trace amounts of H_2S (ppm level). As such, the calorific value of biogas is low (~21.5 MJ/m^3) due to the presence of a considerable amount of inert CO_2. Such raw biogas, however, is commonly used as a low-quality fuel for domestic cooking in rural areas of many developing countries. If biogas is to be considered as a renewable source of methane for power generation and vehicular fuel it has to be upgraded to methane with specifications matching that of pipeline -quality natural gas (CH_4 > 98%, calorific value ~35.8 MJ/m^3).

We have developed a pressure vacuum swing adsorption process (PVSA) using simple cycle to produce pipeline-quality methane from biogas. The process consists of a four-step two-column PVSA cycle based on a low-cost and regenerable CO_2 selective adsorbent.

A binary gas mixture consisting of 44% CO_2 and 56% CH_4 was used as a representative bio gas feed during PVSA experiments. Each VSA experiment was studied over many cycles and flow and CO_2 and CH_4 concentration in different product streams were measured at different cycles in order to determine the establishment of the column steady-state. The adsorption temperature during all the VSA experiments was fixed at 30°C.

Temperature	Pressure	Feed Concetration	Feed Flow Rate
30 °C	1.5 bar absolute	56% CH_4 balance CO_2	1.5 NLPM

Cycle Steps	Column 1	Column 2
1.	Adsorption	Counter-current Evacuation
2.	Co-current Depressurization	Pressure Equalization
3.	Counter-current Evacuation	Adsorption
4.	Pressure Equalization	Co-current Depressurization

Table 1: Process Parameters and Description

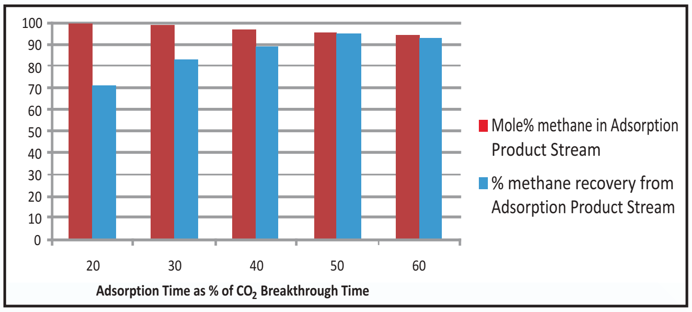


Figure 1: Performance of CSIR-IIP developed PVSA process for methane enrichment and recovery from biogas feed using Monash-1 adsorbent

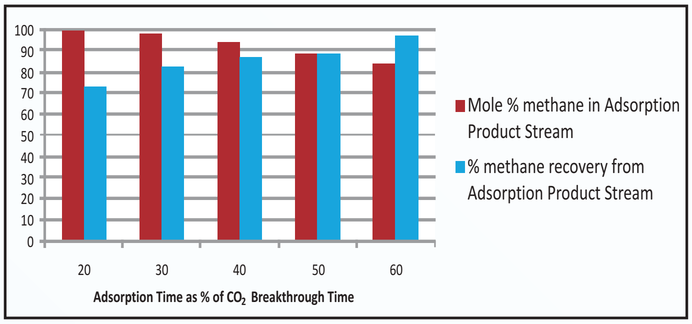


Figure 2: Performance of CSIR-IIP PVSA process for methane enrichment and recovery from biogas feed using IIP-1 adsorbent

It is evident from Figure 1 and Figure 2 that by using a simple four-step PVSA process, methane can be enriched to > 90% level from biogas at a recovery of > 90%. It is even possible to achieve pipeline quality methane (>98%), though at a slightly lower recovery of 75-80%.

Another important feature of the CSIR-IIP process is that CO_2 can also be enriched to >90% level (Figures 3 & 4) which is sequestration grade CO_2 at a high recovery of 85-90 %.

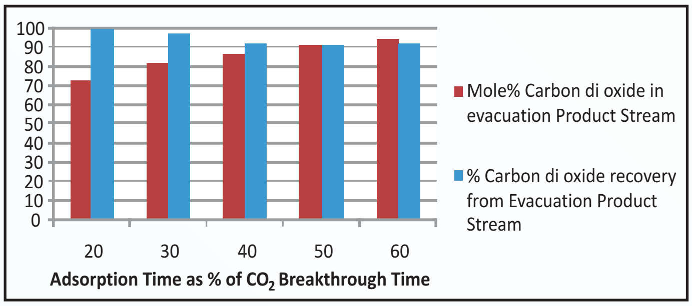


Figure 3: Performance of CSIR-IIP PVSA process for CO_2 enrichment and recovery from biogas feed using Monash-1 adsorbent

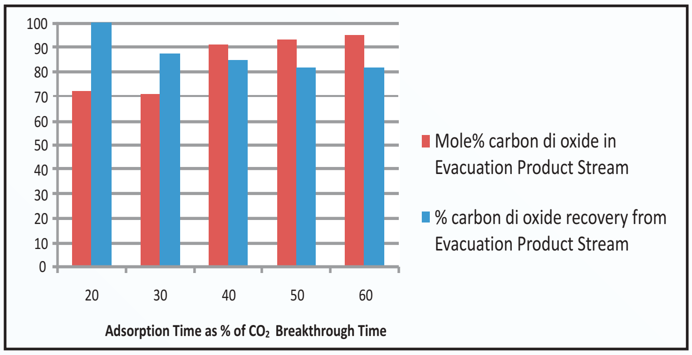


Figure 4: Performance of CSIR-IIP PVSA process for CO_2 enrichment and recovery from biogas feed using IIP-1 adsorbent

1.5.4.2 Single-Column VSA Studies for CO_2 Recovery using Metal Organic Framework Adsorbent *(Indo-Norwegian Collaborative Research Project in collaboration with SINTEF Materials and Chemistry, Norway, sponsored by the Norwegian Ministry of Foreign Affairs)*

Metal Organic Frameworks (MOF) are a new class of adsorbents attracting interest for selective CO_2 separation. These are materials in which metal ions or clusters are connected via organic linkers to form highly porous network structures. Several MOF's have been proposed as adsorbents for CO_2 recovery. However, studies reported on CO_2 adsorption on MOF's have been limited mostly to equilibrium isotherm and diffusion measurements with pure components.

CSIR-IIP is developing the PVSA process for separation of CO_2 from mixtures with nitrogen simulating flue gas. Two MOF adsorbents namely UiO-66 ($Zr_6O_4(OH)_4$(1,4-dicarboxybenzene)) synthesized by SINTEF and CuBTC [Copper(II) benzene 1,3,5 tri carboxylate] have been tested in a custom-designed vacuum swing adsorber operating with a heavy reflux or rinse cycle typically used for recovery of the strong adsorptive component (in this case, CO_2) from gas mixtures. Evaluation of another MOF, namely, CPO-27Ni (synthesized at SINTEF, Norway) is under progress. UiO-66 and CPO-27Ni can be formulated easily in suitable forms for column operation. The results are compared with performance data generated with commercial Zeolite 13X (Z-10-04 from Zeochem) under comparable operating conditions.

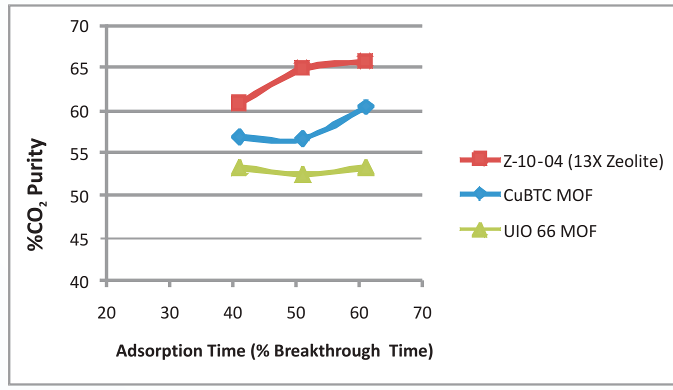


Figure 5: Performance comparison in terms of CO_2 enrichment from flue gas of MOF adsorbents with zeolite in single column PVSA

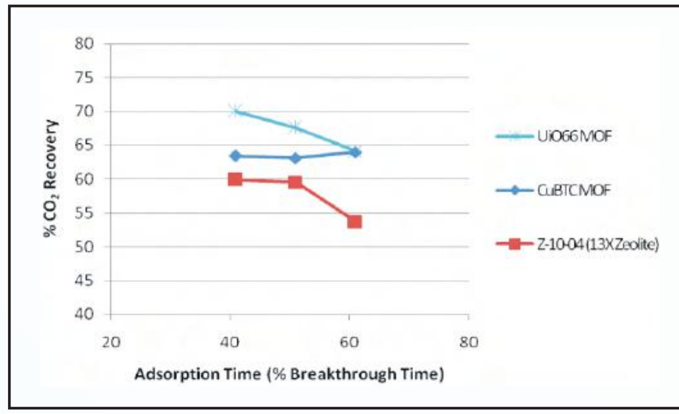


Figure 6: Performance comparison in terms of CO_2 recovery from flue gas of MOF adsorbents with zeolite in single column PVSA

The study shows that MOFs perform satisfactorily under PVSA process conditions and there was no performance deterioration noted under long-duration column operation. CO_2 recoveries are higher than observed with the zeolite while CO_2 purities are lower.

1.5.4.3 PSA Process for CO_2 Recovery from Biomass Pyrolysis/ Gasification off-Gas *(Under CSIR-Supra Institutional Project)*

Three types of Vacuum Swing Adsorption cycles viz. VSA-1, VSA-2 and VSA-3 were designed and tested for their efficiency in CO_2 removal from a ternary feed mixture simulating biomass pyrolysis/ gasification off-gas with composition 63 mole% CO_2, 17 mole% CH_4 and balance N_2. The details of cycle configuration are described in Tables 2-4 below. The adsorption step in the cycling process was carried out at 1.5 bar absolute pressure and at ambient temperature (32 °C). The Adsorption time was varied in the range of 30-60% w.r.t. the CO_2 Breakthrough Time. Effect of adsorption time and VSA cycle type was studied on two key parameters i.e product purity and recovery. The results are illustrated in Figures 7-12

Step No.	Column 1	Column 2	Step Timings
1	Feed Pressurization	Blow Down	20 Seconds
2	Adsorption	Countercurrent Evacuation	92% of Total Adsorption Time
3	Adsorption	Countercurrent Evacuation with Adsorption Product Purge	8% of Total Adsorption Time
4	Depressurization	Pressure Equalization	10 Seconds
5	Blow Down	Feed pressurization	20 Seconds
6	Countercurrent Evacuation	Adsorption	92% of Total Adsorption Time
7	Countercurrent Evacuation with Adsorption Product Purge	Adsorption	8% of Total Adsorption Time
8	Pressure Equalization	Depressurization	10 Seconds
Base Case for Illustration	Feed: 20 mole% N_2; 63 mole% CO_2; 17 mole% CH_4 Ads. Temp.: 32 °C Ads. Press.: 1.5 bar absolute Feed flow: 1.5 LPM CO_2 Breakthrough Time: 497 sec.	Adsorption: 60% of CO_2 BT ≡ 298 seconds Evacuation: 92% of Adsorption Time ≡ 275 Seconds Evacuation with Purge: 8% of Adsorption Time ≡ 23 Seconds	

Table 2: Two-column, eight-step Vacuum Swing Adsorption Cycle VSA-1

Step No.	Column 1	Column 2	Step Timings
1	Feed Pressurization	Blow Down	20 seconds
2	Adsorption	Countercurrent Evacuation	30% of CO_2 BT
3	Depressurization	Pressure Equalization	10 seconds
4	Blow Down	Feed Pressurization	20 seconds
5	Countercurrent Evacuation	Adsorption	30% of CO_2 BT
6	Pressure Equalization	Depressurization	10 seconds

Table 3: Two-column, six-step Vacuum Swing Adsorption Cycle VSA-2

Step No.	Column 1	Column 2	Step Timings
1	Adsorption	Counter current Evacuation	34% of CO_2 BT
2	Depressurization	Pressure Equalization	10 seconds
3	Countercurrent Evacuation	Adsorption	34% of CO_2 BT
4	Pressure Equalization	Depressurization	10 seconds

Table 4: Two-column, four-step Vacuum Swing Adsorption Cycle VSA-3

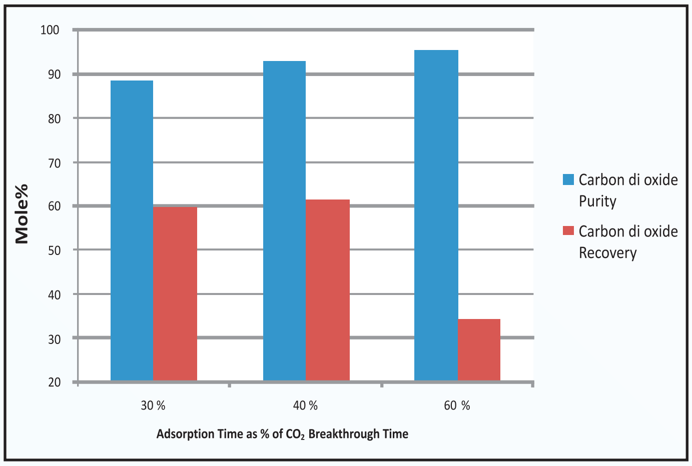


Figure 7: Effect of Adsorption Time on Evacuation Product Purity

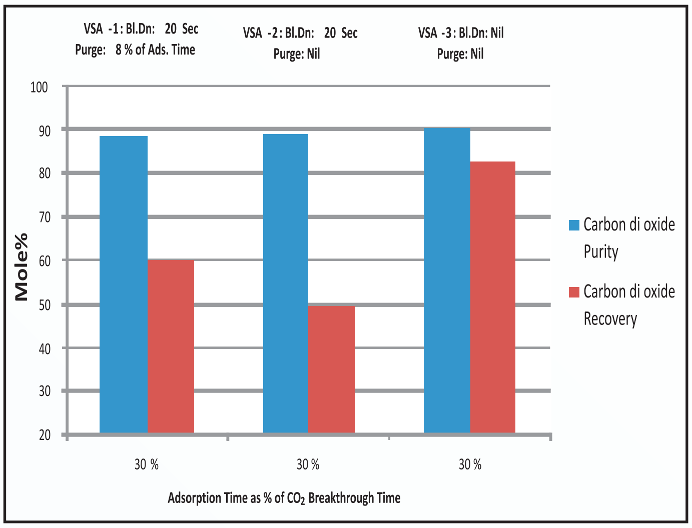


Figure 8: Comparison of VSA-1, VSA-2 and VSA-3 on Evacuation Product Purity and Recovery

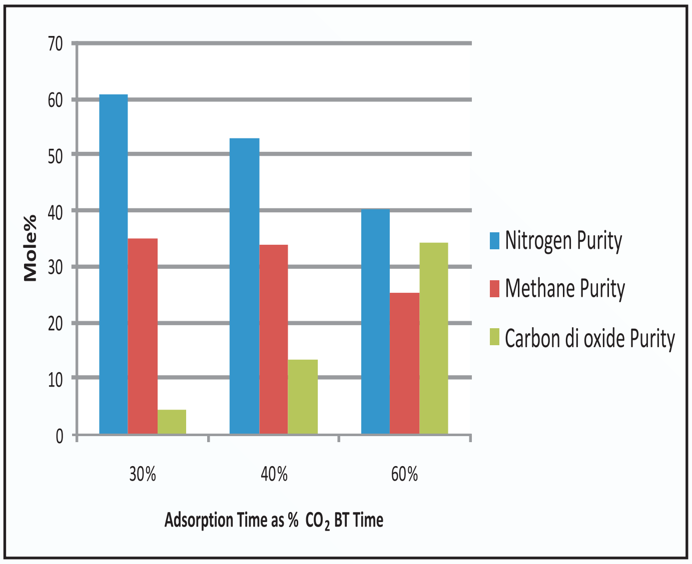


Figure 9: Effect of Adsorption Time on Adsorption Product Composition

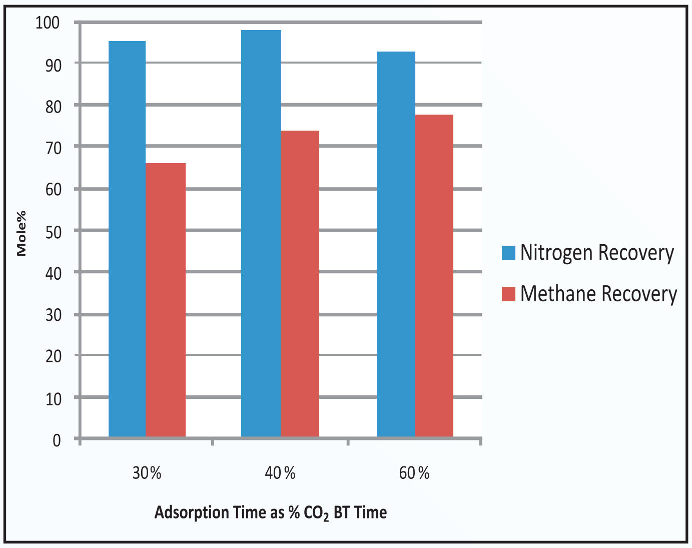


Figure 10: Effect of Adsorption Time on Adsorption Product Recovery

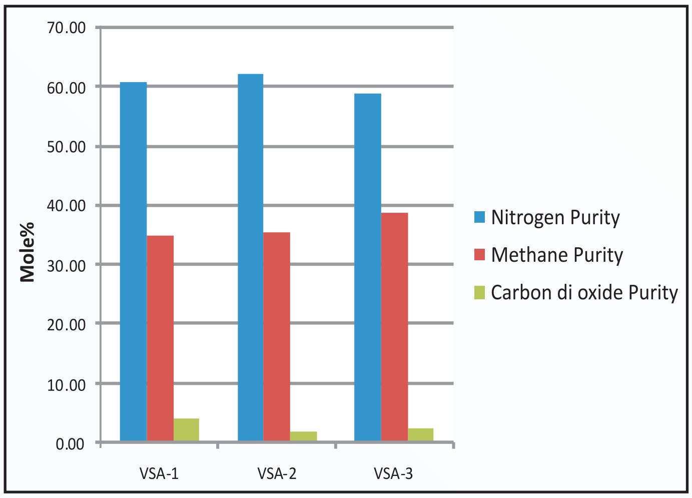


Figure 11: Comparison of different VSA cycles viz. VSA-1, VSA-2 and VSA-3 on Adsorption Product Purity

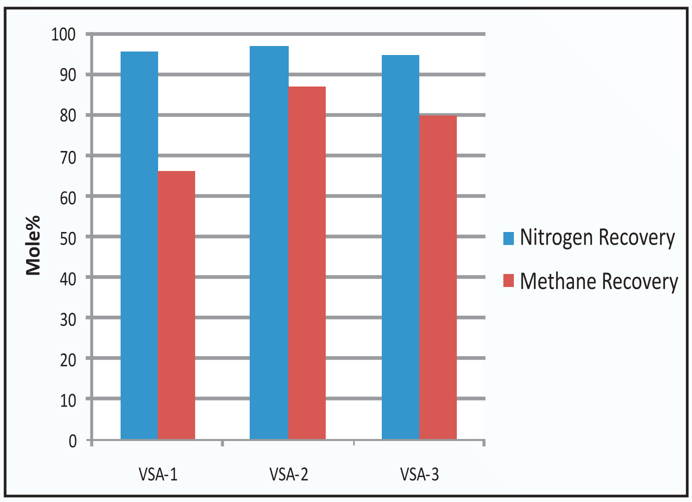


Figure 12: Comparison of different VSA cycles viz. VSA-1, VSA-2 and VSA-3 on Adsorption Product Recovery

Above results indicate that by using vacuum swing adsorption cycles designed at our laboratory (VSA-3), we can achieve CO_2 enrichment in the evacuation product to the level of ~90 mole% at a recovery of ~ 80 mole% from a biomass pyrolysis off-gas feed containing ~ 60 mole% CO_2. The CO_2 content in the adsorption product stream can be decreased down to 2% level which is highly desirable in improving the net calorific value of the stream.

1.5.4.4 Adsorption Technology Development for High-Temperature Acid Gas Removal in Coal Gasification *(Under CSIR Network Project, Nodal Laboratory: CSIR-NCL, Pune)*

Acid gas clean-up in coal gasification operations is required to prevent corrosion, erosion of system components, prevent deactivation or poisoning of processing agents (catalysts) and to prevent environmental pollution. The hot gas from a coal gasifier exits at a temperature ranging from 400 to >1200 °C depending on the type of gasifier. In the two main gasification technologies that exist for hydrogen and power production, sulphur compounds are removed prior to the shift reaction (sweet gas shift reaction) or after the Shift reaction (sour-gas shift reaction). When CO_2 capture is also to be implemented in IGCC, this is typically carried out after the Shift reaction. Gas cleanup technologies presently available for removal of sulphur and CO_2 contaminants in syngas are based on chemical or physical absorption and operate at ambient/sub ambient temperatures. Implementation of these technologies in the gasification train leads to high thermal efficiency losses both in the case of Sweet Water gas shift as well as Sour Water gas shift due to the requirement of cooling and re heating of syngas. There are advantages of increased energy efficiency in effecting this clean-up in hot gas conditions and considerable research and development efforts are being made towards this end. However, hot gas cleanup has not been demonstrated successfully so far and the trend is now more towards moderate temperature clean up at temperatures in the range of 400 to 600°C.

At the CSIR-IIP we are developing a PTSA process based on hydrotalcite based sorbents for high temperature capture of both CO_2 and H_2S under sour water gas shift reactor conditions (Temperature: 300-400°C; Pressure: 20 bars). The CO_2 capacity of CSIR-IIP sorbents is comparable to the best reported values for a similar class of high-temperature sorbents.

Highest CO_2 uptake occurs in the temperature range of 350-400°C and adsorbents are regenerable under inert purge with or without evacuation at ~450°C which indicates requirement of a small temperature swing of 50-100°C for adsorbent regeneration. Also no appreciable loss was observed in breakthrough capacity over multiple cycles of adsorption-regeneration.

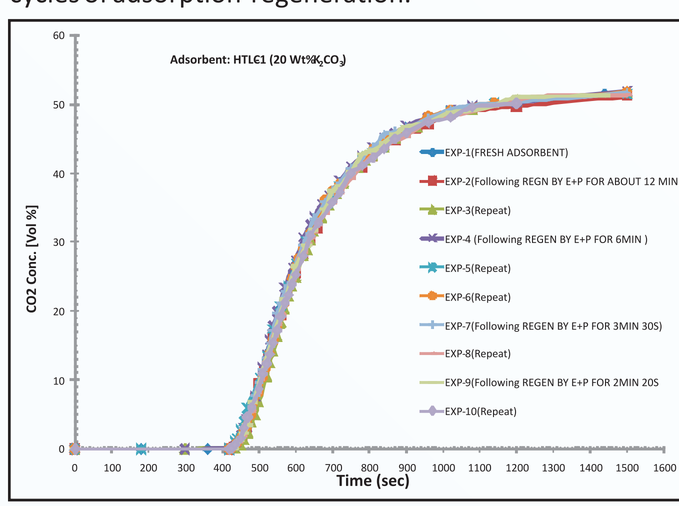


Figure 13: Successive CO_2 breakthrough runs at 400 °C and 12 bar pressure using a feed consisting of 53% CO_2 balance nitrogen

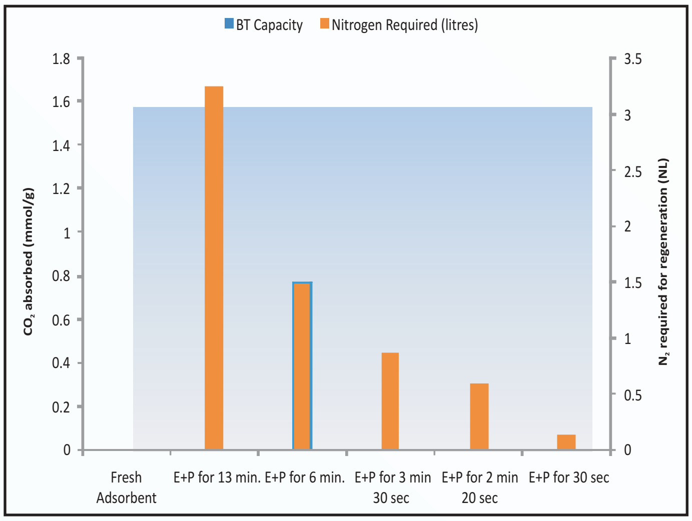


Figure 14: Effect of nitrogen purge duration during CO_2 loaded hydrotalcite regeneration on subsequent adsorption breakthrough capacity

1.6 HEAVY OIL PROCESSING

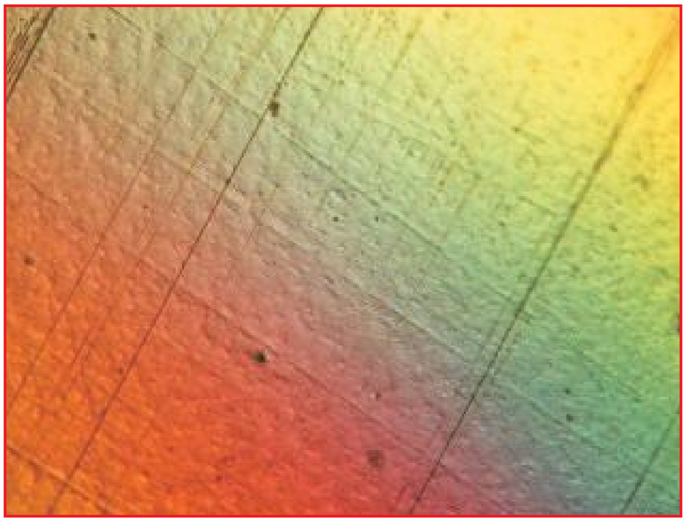
(Comprising Lube, Wax, Bitumen and Thermal Conversion Processes)

1.6.1 Analysis of Petroleum/Coal Tar-Based Feed Stocks to Examine their Suitability for Producing Carbon Black

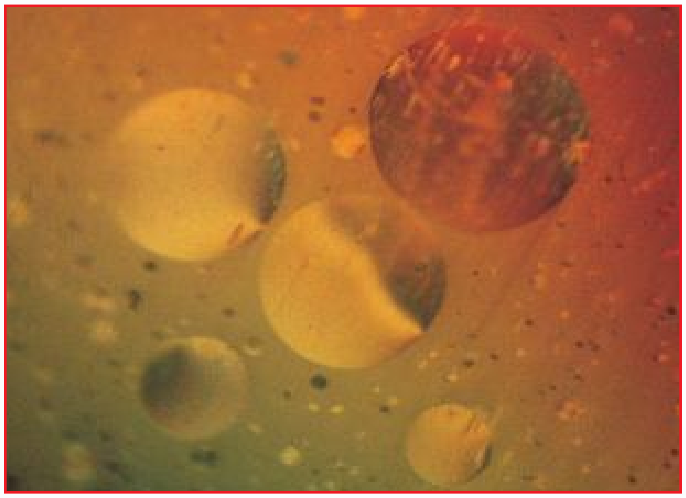
Detailed analysis of petroleum and coal tar-based feed stocks was carried out for their suitability for making carbon black. A new method was also developed for the screening of petroleum/coal tar-based carbon black feed stocks. It is based on combining three approaches viz., physico-chemical properties, instrumental analysis and experimental lab data on carbon black soot formation. This method is more effective in predicting the quality of carbon black feed stocks (CBFS) than any one of the other individual techniques and even than the conventionally used 'BMCI' method as well.

1.6.2 Study on Clarified Slurry Oil (CSO) and its Conversion into Petroleum Pitch - Precursor for Advanced Carbon Materials

The R&D work carried out in CSIR-IIP successfully established that it is feasible to produce 'isotropic' and 'mesophase' pitches from clarified slurry oil (CSO). In this study, optimization of process conditions (thermal treatment, temperature and time) was done by using optical microscopic imaging of surface morphology/ texture of isotropic and mesophase pitches. These pitches are the starting material for making many industrial and advanced carbon materials.



Impregnating Pitch



Mesophase Pitch

1.6.3 Feasibility Studies to Make Improved Performance Bituminous Binder using Glycerol

The main objective of this study was to use glycerol – a by-product of biodiesel - as an additive to improve the properties of bituminous binder with improved performance.

1.6.4 Process Design of Soaker Drum Internals for Revamp of Visbreaker at the Vishakhapattanam Refinery of the HPCL

The project was aimed to carry out process design & to recommend suitable internals in the existing hollow soaker drum of the visbreaking unit (VBU) at the HPCL(V) refinery. The project also envisaged carrying out economic analysis to establish the benefits of incorporation of internals in the hollow soaker on the basis of yield and quality improvements. The final design package was prepared jointly by the CSIR-IIP & the EIL and submitted to M/s HPCL

(V). Benefits obtained after incorporation of internals in the existing hollow soaker at HPCL (V) were:

- Enhancement of quantity and quality of products,
- Energy saving in terms of reduction in temperature and
- Improvement of stability of produced fuel oil

Overall, it is a low-cost revamp as no major hardware change is required with the payback period being less than six months.

1.6.5 Feasibility Study for Producing Needle Coke From Residual Fuel Oil Ex-Numaligarh Refinery (NRL), Numaligarh

Delayed coking studies were conducted at the CSIR-IIP Coker plant using NRL-RFO as feed stock. The studies were taken up with an aim to examine the feasibility of making premium-grade needle coke from NRL-RFO as well as to optimize the process parameters required to produce needle coke having low Coefficient of thermal Expansion (CTE). During the entire studies different operating conditions, mainly temperature and pressure, were optimized with and without recycle feed. The gas and liquid products produced during each set of operating conditions with and without recycle feed were characterized to assess the effect of variation in operating parameters on the quantity and quality of the products. The raw petroleum coke (RPC) produced from recycle runs at each set of experimental conditions was analyzed by optical microscopic analysis to confirm the mesophase formation during the process.

The RPC samples produced with the recycle runs in four sets of operating conditions were calcined and got characterized in detail by an outside agency, i.e., HEGL, Bhopal. It was observed that the calcined petroleum coke (CPC) obtained from the recycle runs meets all needle coke specifications except the CTE.

1.6.6 Process Engineering Design Package for Solvent De-oiling Unit at the NRL

Additional data were generated on de-oiling studies required for the designing of the solvent de-oiling unit. Crystallization curves were generated. Compilation of data was done and the vendor drawing reviewed.

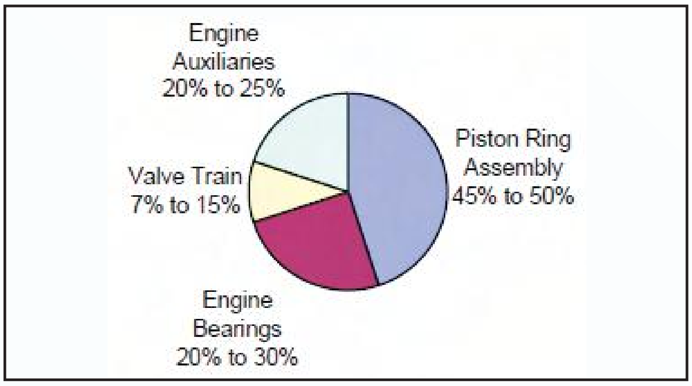
1.6.7 Studies on the use of e-Waste for Improving the Properties of Paving-Grade Bitumen

The main objective of this project was to utilize e-waste (non-metallic part) in the modification of bitumen in terms of value-addition. Several experiments were carried out after segregation and pulverization of e-waste material manually. Since the use of e-waste as such causes inhomogeneous mixing, therefore, the slurry approach was tried.

1.7 AUTOMOTIVE FUELS AND LUBRICANTS APPLICATIONS

1.7.1 Effect of Engine Operating Variables and Lubricant Viscosity on Engine Friction - A Design of Experiment (DOE) Approach

Distribution of the total mechanical losses of a diesel engine is represented in the figure below. It can be seen from the pie chart that piston ring assembly and bearings contribute to approximately 75% of mechanical losses. It is a well-accepted fact that the piston ring assembly and bearings operate predominantly in the hydrodynamic lubrication regime and that the valve train system operates under boundary conditions, hence the variables affecting these both types of friction are different.

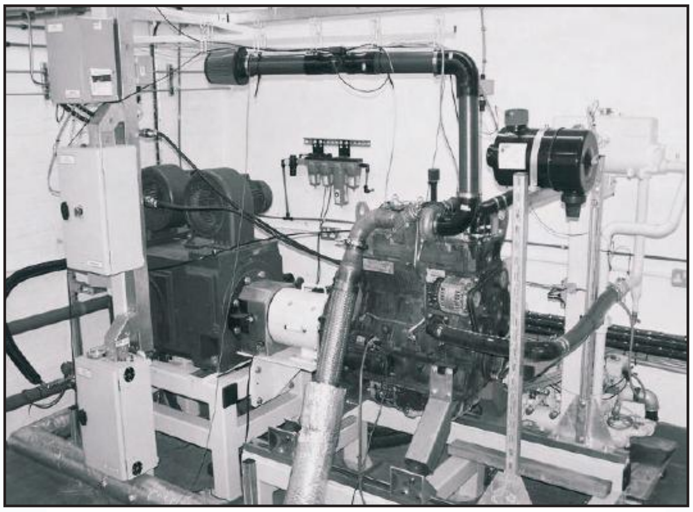


Distribution of the total mechanical losses of a diesel engine

To understand the effect of various operating parameters and other factors (varying simultaneously) on engine friction characteristics, a simple full factorial experimental DOE, with three factors (speed, load and engine oil viscosity) each having two levels (low and high), was used for investigating the most dominant among the three factors that influences engine friction significantly with 95% confidence level. The number of replicates was chosen as two, and a total of 16 experiments were performed. Details of factors and setting of factor levels are given in the table below:

Factors		Low Setting	High Setting
Speed (A)		1000 rpm	2000rpm
Load (B)		50 Nm	350 Nm
Oil type (C)		SAE 10W-30	SAE 15W-40

Factors with its levels of experiment

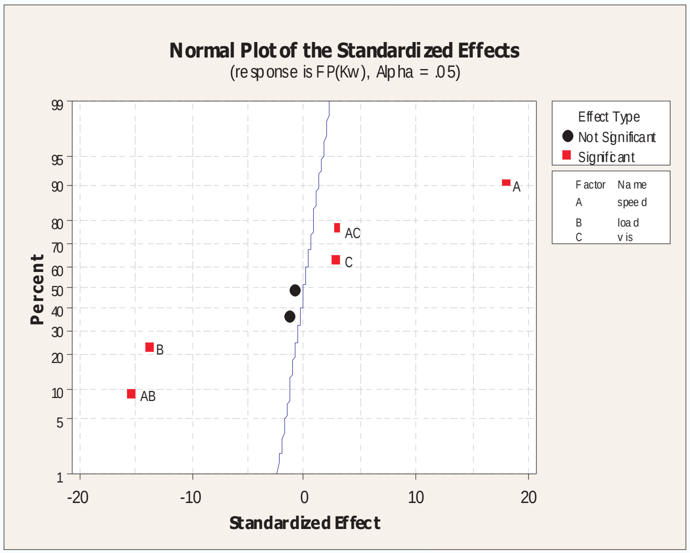


Engine Dynamometer & Engine

Operating Conditions	Values
Speed (rpm)	1000 and 2000
Torque (Nm)	50 & 350
Temperature Oil (°C)	90 ± 5
Temperature Coolant (°C)	85-90

Test operating conditions for Steady-State-Test

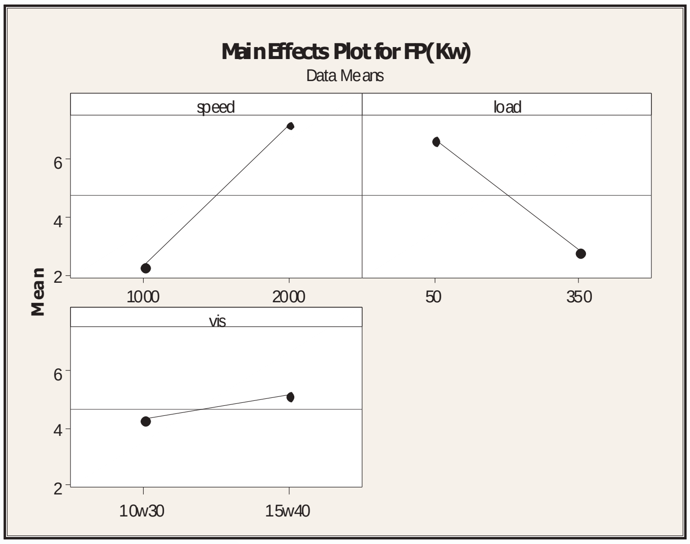
In order to determine the dominant factor among the above three factors, influencing the engine friction power, a full factorial method was adopted using the Minitab software for analyzing the results.



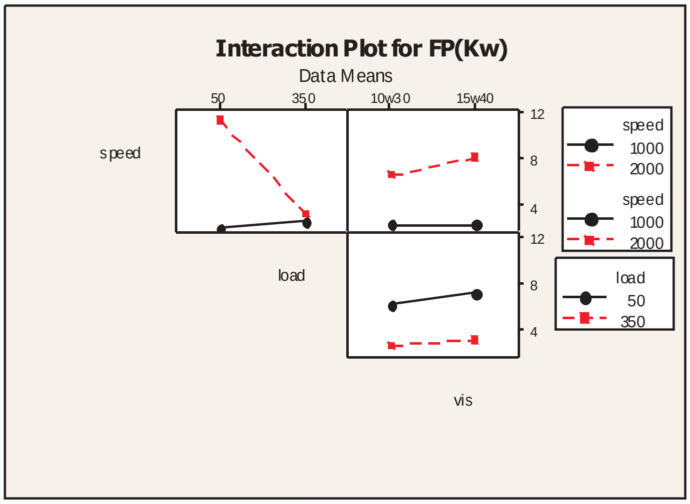
Normal plot of all factors (effects) influencing the Response Friction Power

Friction Power (FP) = 4.733+2.508A–1.938B+ 0.397C - 2.153 A*B + 0.417 A*C

After screening out the unimportant effects, a final factorial fit comprising all important effects was designed. In order to visualize the effects, a main effects plot and an interaction plot were generated from the significant factors.



Main factors (effects) : plot speed, load and lubricant viscosity for the Response Friction Power



Interaction Plot of speed-load, speed-viscosity, load-viscosity for the Response Friction Power

From the interaction plot of speed and engine lubricant type (viscosity) it has been observed that friction power is less for low viscosity grade oil when the engine is running at high speed (2000 rpm) whereas, at low speed for both load points, the change in friction power with oil viscosity is marginal, which complies with the theoretical prediction that boundary lubrication is not a function of engine lubricant viscosity.

The experimental study investigates some of the important facts about friction power dependence on the engine operating variables and engine lubricant viscosity. The following points may be concluded from the experimental study:

- Engine friction power is significantly affected by the engine speed, load and lubricant viscosity. DOE analysis revealed that operating variables play a dominant role in influencing the friction power.

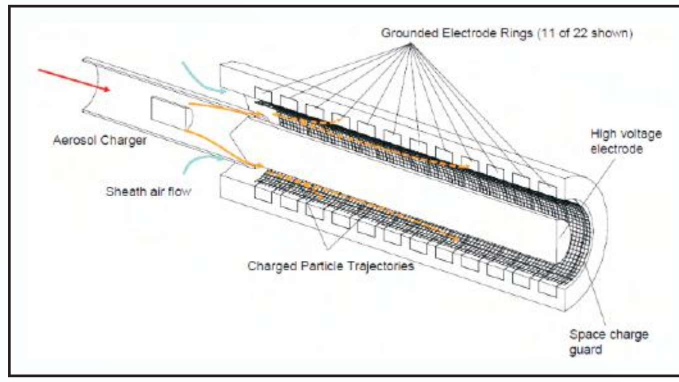
- At high speeds, engine lubricant viscosity is a vital factor which influences the friction power. Experiments and DOE results indicate that lower viscosity grade engine lubricant reduces the friction power significantly for high speed at both low and high loads.
- Factorial fit developed can be used to predict the friction power of a fired engine at 95% confidence level for the range of parameters considered in this investigation.

1.7.2 In-Use Particulate Emission Comparison of Diesel and Natural Gas Vehicles for Indian Road Conditions

Pollution from road vehicles is a serious concern in rapidly developing countries such as India. One approach to reduce harmful emissions is to use vehicles which operate on alternative fuels. In India, compressed natural gas (CNG) has been a success story, with conversions and dedicated CNG vehicles displacing a significant number of conventional fuel vehicles. In Delhi, the total commercial fleet is being converted to run on CNG, with about 1 million vehicles using the fuel. Natural gas availability is increasing in the country, so the government plans to cover more cities with gas distribution systems, further increasing the number of CNG-fuelled vehicles. The rapid increase in CNG vehicles comes parallel to the tightening emission standards for diesel vehicles, raising the question of what magnitude of air quality improvement can be expected with CNG. To find out an answer to the above questions, a collaborative study was planned with the University of Alberta, Canada. The objectives were as given below:

1. How do ultra-fine particle emissions from CNG conversion vehicles compare to those of baseline diesel or gasoline vehicles?
2. How do ultra-fine particle emissions from CNG Euro IV vehicles compare to those of comparable advanced technology diesel vehicles with particulate filters?
3. How are the emissions, especially ultra-fine particles, affected by typical driving conditions and are they predictable based on standard certification testing?

Distribution Management System (DMS) is the only available equipment which can be used for on-road particle size distribution measurement



Distribution Management System

Different driving cycles were used including Indian modified driving cycle, Japanese driving cycle, US FTP72 driving cycle, ECE 15 driving cycle, Mumbai driving cycle, Driving cycle for 2 & 3-wheeler vehicles besides constant speed test.

Driving cycles for passenger cars

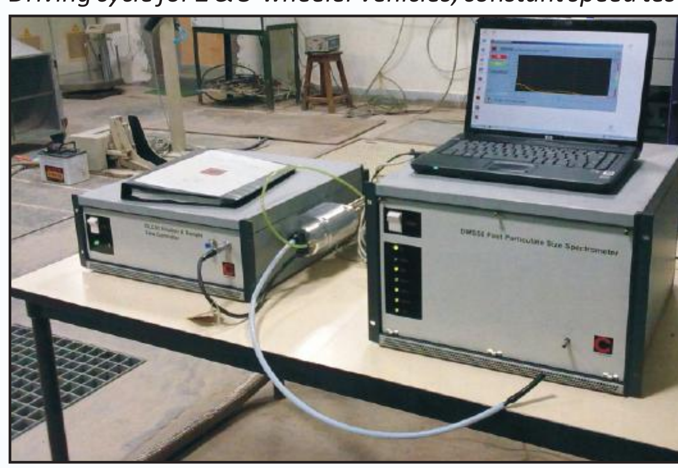
Indian modified driving cycle, Japanese driving cycle, US FTP72 driving cycle, constant speed test

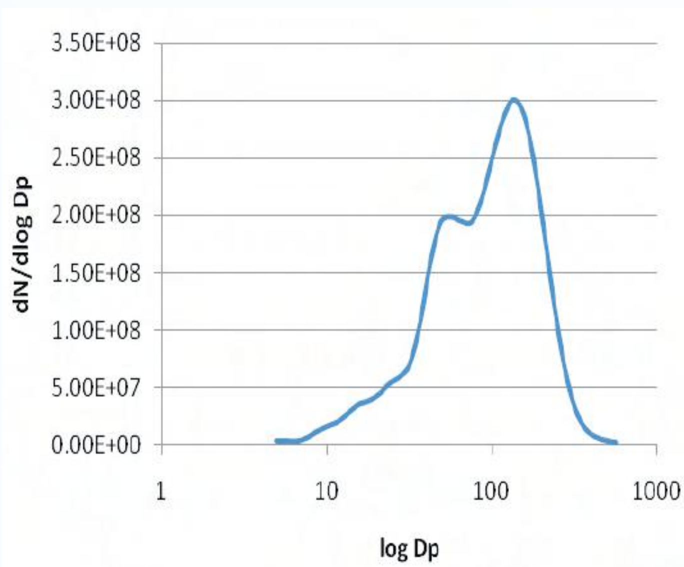
Driving cycles for trucks

ECE 15 driving cycle, Mumbai driving cycle, constant speed test

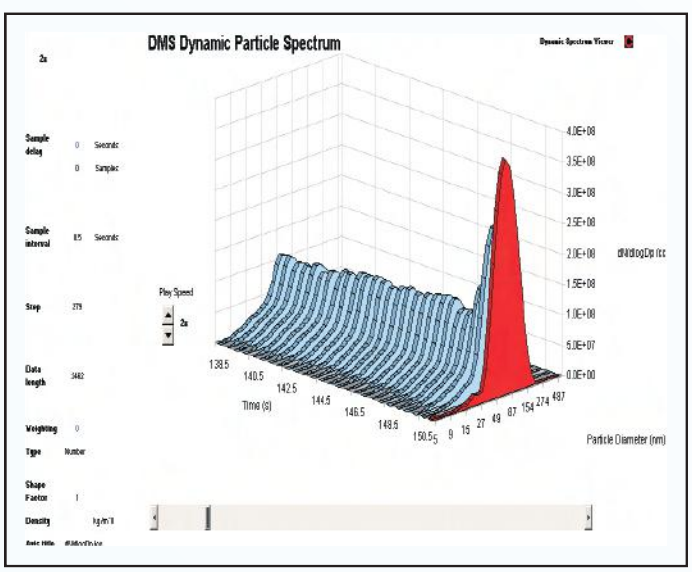
Driving cycles for motorcycles

Driving cycle for 2 & 3-wheeler vehicles, constant speed test





Particle size distribution in diesel passenger cars



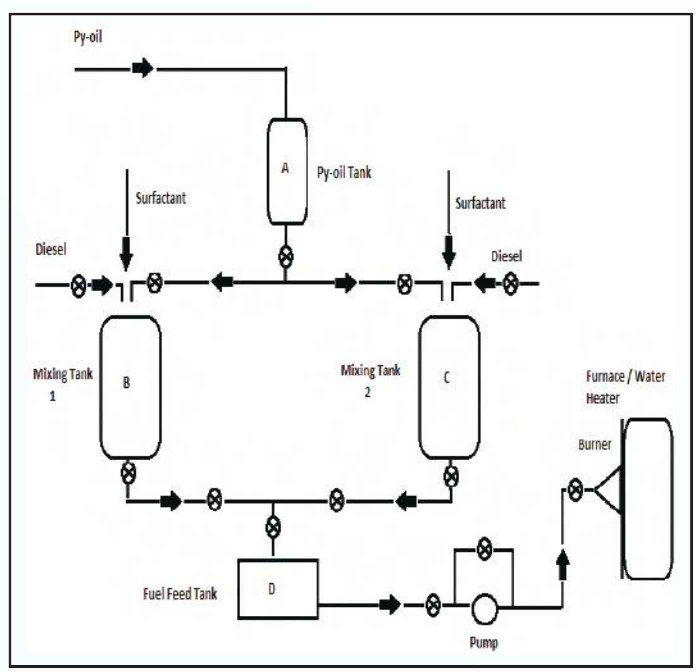
DMS Dynamic Particle Spectrum

1.8 INDUSTRIAL AND DOMESTIC COMBUSTION

1.8.1 Designing and Fabrication of Fuel Mixture Preparation Unit for Combustion Performance Studies of "Py-oil" (fast pyrolysis oil) and Fuel Oil Additives

The S&T personnel at the Industrial and Domestic Combustion Laboratory (IDCL) of the institute worked successfully on a sponsored project from the UOP, Honeywell Pvt. Ltd. The project work included overall application exploration of fast pyrolisys oil ("Py-oil") for industrial and domestic heating applications.

The S&T team worked extensively regarding the application perspective of Py-oil, and finally conducted exploratory combustion trials of mixture of Py-oil with diesel in the ratio of 50: 48.5:1.5 (Py-oil : diesel : surfactant) on experimental water heater and furnace. A Fuel Mixture Preparation Unit was designed and fabricated for making mixtures of Py-oil with diesel and the surfactant. The study indicates the scope of utilizing Py-oil for industrial heating applications. However, it was not found suitable for domestic heating and lighting applications. This unit can also be used for making mixtures with various fuel oil additives, fuel mixtures and blends of different conventional and non-conventional fuel oils.



Schematic diagram of Fuel Mixture Preparation Unit

Fuel Mixture Preparation Unit for Py – oil

Dr Anjan Ray, Business Development Director, UOP, Honeywell Pvt. Ltd., with IDCL team, on the occasion of inaugural combustion trial of Py-oil mixture on experimental water heater

1.9 TRIBOLOGY

The research and technical activities in the field of tribology touched the domains of macro-to nano-tribology, mineral to bio-based lubricants, low-temperature greases to high-temperature hydraulic fluids etc. The research encompassed the whole range of basic research in the science of tribology to applied research in the development of lubricants and their performance evaluation for specialty applications. Theoretical/ mathematical modelling of the tribo-phenomena in different lubrication regimes and their experimental validation aided in understanding and defining hidden insights of tribology.

1.9.1 Boundary Lubrication Capabilities of Ionic Liquids and their Futuristic Applications to Lubricant Development

With growing demand for environment-friendly lubricants and additives, lubricant manufacturers are forced to develop environment-friendly substitutes of harmful mineral-based lubes and additives. In this context ionic liquids show good potential as lubricant additives due to their extraordinary physico-chemical characteristics. The imidazolium based ionic liquids are being synthesized and their role in reducing friction and wear is being understood.

1.9.2 FZG Gear Scuffing Performance Evaluation of Lubricating Oils

The concentrated gear contacts are prone to scuffing and scoring during their operating span. Lubricants used in these contacts have a significant role to play in predicting the useful life of the gears. In this context the gear oils developed by a merchant customer are being studied for their scuffing performance on the FZG gear test rig.

1.9.3 Evaluation of Servofyress HFDU 68 ES for FZG Test

The maximum load sustained by the lubricated contact is dependent on the characteristic load-bearing capability of the lubricant. The lubricant under the applied load is pressurized resulting in the separation of the surfaces in contact. However, this property of the lubes differs from product to product, and to a significant extent, is dependent on the additive chemistry of the lubricant. It is in this regard that the Servofyress HFDU 68 ES lubricant from Ma merchant customer is being studied for its load bearing capacity on the FZG gear test rig.

1.9.4 µ – EHL and Failure Investigations in Line Contacts

Micro-Elastohydrodynamic lubrication is the most common lubrication phenomenon prevailing within the concentrated industrial contacts, the condition wherein the asperity heights are higher in magnitude than the thickness of the lubricant film. Under such conditions, the components are susceptible to failures; thereby reducing the machine reliability. The project strives to investigate the lubrication mechanism in the micro EHL domain and develop models to theoretically study the failure phenomena within them. In this scenario an iso-thermal EHL model for the smooth surface utilizing Newtonian lubricant has been developed and experimentally validated. The model is further being enhanced by incorporating the surface roughness aspect of the contacting bodies.

1.9.5 Design & Development of Novel-type Maintenance-free Bearings

The CSIR EMR-II funded project on the development of

Novel Maintenance-Free Bearings is in participation with a premier scientific institute in India. Hydrodynamic bearings in industrial applications are subjected to frequent start-up and stop-down operations which results in the wear of the bearing surfaces. The worn-out bearing surfaces have a deteriorating effect on the bearing performance. However, the journal bearings have the advantage of higher load-carrying and damping capacity due to which it is very hard to find any replacement for them. On the contrary the magnetic bearings operating on the principle of magnetic levitation have the capability of separating the journal and the bearing even in the static condition. However, these bearings have poor load-bearing and damping capacity. Hence, when the concept of magnetic levitation is merged with the hydrodynamics, a hybrid bearing possessing combined advantages of both the individual bearings can be attained. The project aiming towards the development of novel maintenance-free bearings is based on the merger of the principles of magnetic levitation and hydrodynamics.

The research activities under the project include a detailed experimental and theoretical study of hydrodynamic bearings, study of the influence of lubricant type, bearing clearance and operating parameters, etc. on the friction and wear behaviour of the bearings. Theoretical models for the hydrodynamic bearings capable of studying the effect of non-Newtonian lubricants with the combination of rough surfaces, too, have been developed. Modelling of the magnetic bearings along with the fabrication of hybrid bearings is in progress.

1.9.6 Chemically-Derived Graphene Nano-sheets as a New-Generation Lubricant Additive

One-dimensional graphene nano-sheets are being looked upto as the promising candidates for use in lubricant development. The hexagonal layered structure offers lubricating capabilities that can be harnessed in order to develop new-generation lubricants and additives.

The research project envisages the development/ synthesis of grapheme nano-sheets, besides characterizing and using them in the blending of the lubricants. It is in this regard that graphene is being synthesized through various chemical routes and the desired chemical properties are being incorporated into them through functionalization. Various chemical routes have been used and graphene nano-sheets with varying degrees of lubrication capabilities have been developed. The lubrication capabilities of synthesized material are evaluated on tribo-testers.

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

Use of nano-particles in engine oil formulations to improve fuel efficiency is a novel concept. The addition of nano-particles (solid lubricants) enhances anti-wear and anti-friction properties of the lubricant, resulting in the desired fuel economy of an automotive. However, the targeted goal is highly challenging and dependent on the following:

i) Synthesis of nano-particles of desired particle size to act as a lubrication agent rather than as an abrasive, and,

ii) Homogeneous dispersion the solid-state nano-particles into the liquid-state lubricant for the required shelf life. This Indo-foreign funded project, viz., 'Study of nano-particles for their use in engine oil formulations for better fuel efficiency', aimed at providing solutions to the problems of synthesis and dispersion of the nano-particles and to obtain an engine oil formulation for energy efficiency.

The research project targetted the activities pertaining to the

i) synthesis, characterization and dispersion of the nano-particles into the lubricants,

ii) tribo-performance evaluation of the lubricant blends, and,

iii) performance evaluation on engine test benches.

Nano-particles of boron nitride (Hex. BN) and MoS_2 were selected for the study. Hex. BN nano-particles were procured from the market and MoS_2 synthesized in the laboratory. MoS_2 nano-particles were synthesized using nine different chemical routes and were functionalized. The synthesized MoS_2 nano-particles were chemically characterized using XRD & SEM and their tribological performance assessed.

The Hex. BN nano-particles were functionalized with amine and then dispersed in varying concentrations in commercial oils. This reported a quality dispersion. The functionalized Hex. BN nano-particles were tested under very severe conditions of 3.4 GPa contact pressure. The concentration of functionalized Hex. BN nano-particles was optimized in commercial oils for minimum friction and wear. The 0.05% concentration of the functionalized Hex. BN in CO-01 reported $\approx$25% reduction in friction and $\approx$18% reduction in wear. These functionalized Hex. BN nano-particles were sent to our foreign-based merchant customer for engine testing.

The studies provided significant insights into the reduction of friction and wear with the use of nano-particles in the engine oil. This study, if further scaled up, can yield the desired fuel efficiency in actual automotives.

1.9.8 Tribo-Performance Evaluation of Stabutherm GH 461 Grease

The project envisaged the performance evaluation and characterization of lubricating greases to assess their suitability for the steel and the railway industries. The comparative assessment undertaken for the greases included their consistency, shear stability, high-temperature performance etc.

1.9.9 Evaluation of Low-temperature Torque of Grease

Lubricating greases when used in Cryogenic (sub-zero) environments are susceptible to higher operating torque. The higher operating torque results into higher operating friction and power consumption. At extreme conditions it may even lead to the failure of the machinery. Higher torque is obtained due to the solidification of the hydrocarbon present in the base oil at lower temperatures. Hence, if the greases are to be used in cryogenic environment, the operating torque has to be as low as possible. It is in this context the greases from a merchant customer were assessed for their low-temperature torque behaviour.

1.9.10 Performance Evaluation of Mono- & Multi-grade Gear Oils

The mono- and multi-grade gear oils of GL-IV, GL-V grades are frequently used in the heavy earth moving machinery. These lubricants are subjected to very severe operating conditions which make the design and selection of these lubricants a highly challenging task. Hence, the performance of mono- and multi-grade gear oils were undertaken for their load-bearing capability under shock loading conditions.

1.9.11 Tribological Studies of Bio-Lubricants and Fuels (A 'Supra' Project)

Vegetable oils have been historically used as lubricants since time immemorial but their popularity as lubricants declined with the advent of petroleum-based lubricants. The major reason has been the lower cost of the hydrocarbon-based lubricants and their thermo-oxidative stability despite having relatively poor lubricity and inferior viscosity–temperature characteristics.

The use of vegetable oils is increasing worldwide due to their origin from renewable sources and favourable eco-toxic characteristics. Their properties are dependent on fatty acid structure. Therefore, these oils have to be subjected to chemical transformation to obtain base fluids with satisfactory performance characteristics. Rapeseed, castor and sunflower oils have the biodegradability of over 80% offering a promising base-stock for formulation of specialized lubricants.

The use of vegetable oils and their esters has continued as lubricants in applications like rolling, cutting, drawing and quenching operations either above or in combination with mineral oils because of their superior lubricity and higher specific heat. Modified vegetable oil-based esters are used in engine oils and gear oils besides their already increasing use as lubricants in hydraulic fluids, machine tool lubricants and metal-working lubricants.

Vegetable oil-based lubricants are gaining increasing importance due to safety of health, besides economic and environmental issues. The main focus is on the use of non-edible vegetable oils e.g. *Karanja* (Pongamia), *Mahua* and Rapeseed oils for development of lubricants and formulations.

The selected non-edible oils were chemically modified and characterized for their chemical and physical properties. The chemically modified oils were tested for their solubility into the mineral-based oils. These oils in the bulk form were then selected and tested to be used as neat cutting oils in various manufacturing operations. The findings of the project include:

- The non-edible oils possess high lubricity property and can be used in bulk form and as lubricity enhancing additives with the base oils,
- The oils are highly soluble with the mineral-base oils and the extent of solubility is stable even at higher temperatures, and,
- The esters of non-edible oils can be used as neat cutting oils,

2

Achievements

2.1 PAPERS PUBLISHED IN JOURNALS

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- Bio-degradable glycerol ester base stock for neat cutting oil, P Nagendramma and Savita Kaul
- Potential oxygenates from glycerol, Savita Kaul, D P Bangwal and M O Garg

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- Bio-degradability and toxicity studies of synthesized polyol ester lubes and lube base stocks, Ponnekanti Nagendramma, Savita Kaul and D K Adhikari
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- Catalytic conversion of bio-ethanol to transportation fuels, Sandeep K Saxena, Peta Srinivasulu, Devaki Nandan, Sarabjeet Singh and N Viswanadham
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2.6 D.LIT./D.PHIL. DEGREES AWARDED

Mr Raviraj S Kamble for his thesis entitled 'Synthesis, Characterization and Activity of some Solid Acid Catalysts for Light Alkane Conversions' by the H N B Garhwal University, Srinagar (Garhwal), in May 2010, under the supervision of Dr N Viswanadham, Scientist, CSIR-IIP

2.7 HONOURS, AWARDS & RECOGNITIONS

2.7.1 Institutional/Group Awards

- **देश की हिंदी गृह–पत्रिकाओं में 'विकल्प' प्रथम पुरस्कार (वैज्ञानिक तथा तकनीकी क्षेत्र) से सम्मानित**

सीएसआइआर–भारतीय पेट्रोलियम संस्थान, देहरादून की हिंदी गृह– पत्रिका 'विकल्प' को राजभाषा विभाग, गृह मंत्रालय, भारत सरकार ने वैज्ञानिक एवं तकनीकी क्षेत्र के कार्यालयों की कोटि में वर्ष 2011 हेतु हिंदी गृह–पत्रिकाओं का 'प्रथम पुरस्कार' प्रदान किया। हिंदी दिवस, 14 सितबंर, 2011 के दिन यह पुरस्कार विज्ञान भवन, नई दिल्ली में आयोजित एक भव्य समारोह में भारत की परमश्रेष्ठ राष्ट्रपति श्रीमती प्रतिभा देवी सिंह पाटिल के हाथों संस्थान के निदेशक डॉ० एम ओ गर्ग ने ग्रहण किया। समारोह में पत्रिका के संपादक सहित राजभाषा अनुभाग के श्री मुकेश चंद्र रतूड़ी, हिंदी अधिकारी एवं श्री प्रताप सिंह चौहान, वरिष्ठ आशुलिपिक ने भी भाग लिया।

भारत की परमश्रेष्ठ राष्ट्रपति श्रीमती प्रतिभा देवी सिंह पाटिल से गृह–पत्रिका पुरस्कार ग्रहण करते डॉ० एम ओ गर्ग

राजभाषा अनुभाग के प्रभारी डॉ० दिनेश चंद्र चमोला, वरिष्ठ हिंदी अधिकारी के संपादन में प्रकाशित इस पत्रिका को देश में उत्कृष्ट संपादन के लिए कई अन्य पुरस्कार भी प्राप्त हो चुके हैं। अभी तक 'राजभाषा', 'अनुवाद', 'स्वर्ण जयंती', 'हिंदी विज्ञान पत्रकारिता', 'पुराण–विज्ञान', 'सूचना–प्रौद्योगिकी', 'पेट्रोलियम–पर्यावरण', 'प्रयोजनमूलक हिंदी', 'जैव– प्रौद्योगिकी', 'जनसंचार', 'विश्व में हिंदी', 'वैश्विक तापन' तथा 'विज्ञान संचार' जैसे विषयों पर इस पत्रिका के कई महत्वपूर्ण विशेषांक प्रकाशित किए गए हैं।

- **Business Development & Technology Marketing Award 2011**

The Institute bagged the CSIR Technology Award for Business Development and Technology Marketing 2011 for "Significantly enhancing the business through commercialization of its technologies against stiff global competition and marketing of its knowledgebase".

The Institute has played a vital role in the nation's quest towards scientific and technological leadership, providing globally competitive, sustainable and energy-efficient eco-friendly technologies, products and scientific solutions to energy and allied sectors, particularly petroleum (upstream, refineries, petrochemicals) and other industries including the Strategic and/or Defence sectors.

The Institute has adopted several new initiatives for establishing national and international linkages with prospective industrial, academic and research clients to continually enhance collaboration, co-operation and external cash flow, reach out to new customers, share knowledgebase, and offer consultancy and S&T service to meet the growing needs of the industrial sector and enhance the valuation of intangible assets. Over the last three years the Institute's earnings from the industry have increased significantly.

The award was presented on the occasion of the CSIR Foundation Day on September 26, 2011, at a grand function held at the Vigyan Bhawan, New Delhi. Dr M O Garg, Director and Mr B M Shukla, Head, RPBD, received the award on behalf of the Institute from Mr Vilasrao Deshmukh, Hon'ble Minister of Science & Technology and Earth Sciences.

The CSIR award being received by Dr M O Garg (second from left) and Mr B M Shukla (second from right) from Mr Vilasrao Deshmukh. Others present include (L-R) : Prof S K Brahamachari, Mr Ashwani Kumar & Dr R A Mashelkar

The other dignitaries present on the occasion included Prof S K Brahamachari, Secretary, DSIR & DG-CSIR, Mr Ashwani Kumar, Hon'ble Minister of State, Ministries of Planning, Science & Technology and Earth Sciences and Dr R A Mashelkar, FRS, CSIR Bhatnagar Fellow, Ex-DG, CSIR.

- **'Best Stall' Award in the Uttarakhand Science Expo-2011**

CSIR-IIP's stall was adjudged the best among all other stalls in the Uttarakhand Science Expo-2011, organized at a local hotel on September 21, 2011.

Dr Mahendra Pal (left) receiving the award from Prof Girijesh Pant, VC, Doon University (right).

- **OceanTEX Award 2012**

The CSIR-Indian Institute of Petroleum, Dehradun won the prestigious OceanTEX 2012 Leadership & Excellence Award under the category 'Outstanding Achievement in Research & Development' for excellence in research & development in multi-disciplinary areas for the downstream sector of hydrocarbons & related industry.

The Award was bestowed on the Institute by Mr S Vasudeva, Chairman & Managing Director, ONGC, on February 8, 2012 at a gala function held in the Hotel Grand Hyatt, Mumbai. Dr M O Garg, Director, CSIR-IIP, received it on Institute's behalf.

- **Best Paper Award**

A research paper entitled 'Catalytic Conversion of Bio-ethanol into Transportation Fuels', authored by Sandeep K Saxena, Peta Srinivasulu, Devaki Nandan, Sarabjeet Singh & N Viswanadham, and presented in the '9th International Symposium on Fuels and Lubricants' (ISFL-IX) at New Delhi, was awarded the 'Best Paper' prize during the ISFL-IX, event on March 5-7, 2012.

Mr Sandeep K Saxena receives the Best Paper Award

2.7.2 Individual Awards

- **डॉ दिनेश चमोला को 'डॉ. गोविंद चातक सम्मान'**

माह अप्रैल, 2011 के दौरान उत्तराखंड के तत्कालीन मुख्यमंत्री डॉ० रमेश पोखरियाल 'निशंक' ने उत्तराखंड भाषा संस्थान की ओर से, संस्थान के राजभाषा अनुभाग के प्रभारी, डॉ० दिनेश चंद्र चमोला को 'डॉ. गोविंद चातक सम्मान' से समादृत किया। यह सम्मान डॉ० चमोला को उनके हिंदी साहित्य के क्षेत्र में दिए गए विलक्षण एवं वृहत् साहित्यिक अवदान के लिए प्रदान किया गया।

डॉ० रमेश पोखरियाल 'निशंक', माननीय मुख्यमंत्री, उत्तराखंड से 'डॉ० गोविंद चातक सम्मान' प्राप्त करते हुए डॉ० दिनेश चमोला।

2.8 MoU's MoC's / Agreements Signed

2.8.1 With Indian Concerns

- With the Banasthali University, Rajasthan, for enhancing the availability of highly qualified manpower within the country in the area of chemical engineering.
- With the Oil & Natural Gas Corporation, Mumbai, for Study of Crude Oil Analysis of IC Complexes.
- With the Delhi Technological University, Delhi, for academic collaboration.
- With the Reliance Industries Limited, Mumbai, for Study on Clarified Slurry Oil (CSO) and its conversion into petroleum pitch precursor for advanced carbon materials.
- With the Reliance Industries Ltd., Mumbai, to provide research services relating to the research and development of new processes and materials.
- With the Quanta Process Solutions Private Limited (QPSPL), Gujarat, to provide services to the hydrocarbon and chemical industries globally and to develop new marketing material or organize industry events from time-to-time for business development purposes.
- A five-year Strategic Alliance Agreement with the Utttarakhand Technical University (UTU), Dehradun, to encourage interaction among the scientists, research fellows, research scholars, faculty members and students of both the organizations by arrangements such as exchange of personnel for a limited period as mutually agreed upon; holding of joint conferences and seminars; practical training of the UTU students at the CSIR-IIP; joint guidance of student projects/ theses and joint PhD Programmes as per mutually agreed terms.

Dr M O Garg and Prof D S Chauhan, VC, UTU, signing the agreement

- With the Yew Petroproducts Pvt. Ltd., West Bengal for feasibility study on reprocessing of pyrolysis gasoline.
- With the Centre of High Technology (CHT), New Delhi and the Chennai Petroleum Corporation Ltd.(CPCL), Chennai, for desulphurization of fuel oil using solvent extraction route.
- With the S V National Institute of Technology, Surat, for academic collaboration and availability of highly qualified manpower in the area of chemical engineering.

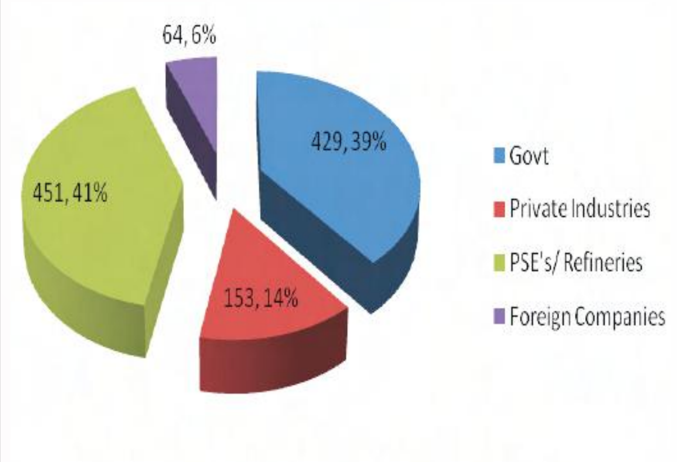
2.8.2 With Foreign Concerns

- With the University of Alberta, Canada to pursue collaborative R&D work on "In-use particulate emission comparison of diesel and natural gas vehicles for Indian road conditions" with the objective to make CNG usage in automotive sector more environment-friendly.
- A non-disclosure agreement with the Saudi Basic Industries Corporation, Kingdom of Saudi Arabia (KSA) for engaging in commercial and technical discussions, and, if appropriate, any future collaboration in relation to Butadiene Extraction Process.
- With the Illinois Sustainable Technology Centre (ISTC) of the University of Illinois Centre (UIUC), Illinois, USA, for utilization of mutual R&D facilities and expertise for scientific, collaborative, R&D work and training of scientific manpower amongst researchers of the CSIR-IIP and the ISTC-UIUC in the area of renewable energy and bio-fuels.

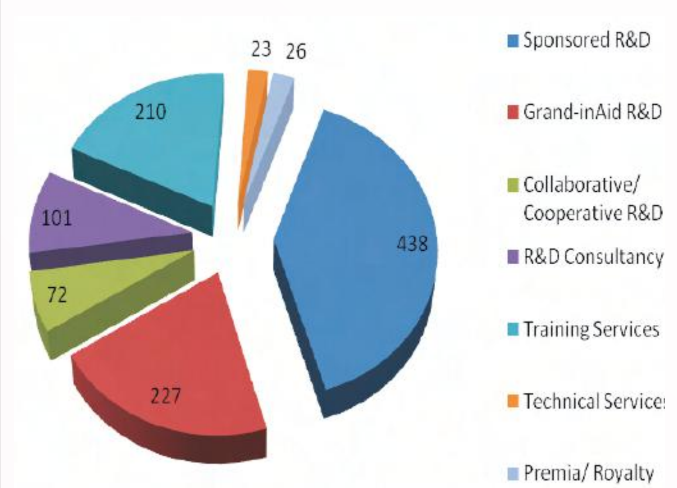
2.9 EXTRA-BUDGETARY RESOURCES (EBR)/ EXTERNAL CAST FLOW (ECF)

The CSIR-IIP's earnings from ECF during Financial year 2011-2012 stood at Rs 1097 lakhs. The table below shows a detailed break-up of the ECF:

ECF during the Financial Year 20112012 (Rs in Lakhs)					
Category	Govt	Private Industries	PSE's/ Refineries	Foreign Companies	Total
Sponsored R&D	99	89	214	36	438
Grant-in-Aid R&D	223	4	-	-	227
Collaborative/ Cooperative R&D	-	-	44	28	72
R&D Consultancy	101	-	-	-	101
Training Services	-	46	164	-	210
Technical Services	6	12	5	-	23
Premia/Royalty	-	2	24	-	26
Total	429	153	451	64	1097



ECF from different sectors during 2011-2012



ECF from various resources during 2011-2012
(In Lakh rupees)

3

Human Resource Development

3.1 TRAINING THE PERSONNEL FROM THE OIL INDUSTRY & RELATED FIELDS

The CSIR-IIP imparts, as a part of its mandate, training to the personnel from the oil industry & related fields like the automobile industry and the transport sector etc.

3.1.1 Programmes on 'Petroleum Refining Technology'

A. For the Indian Oil Corporation Ltd. (IOCL)

- Programme for 27 Chemical Engineers, August 8 – September 23, 2011
- Programme for the Chemical Engineers, October 31- December 16, 2011
- Programme for the Chemical Engineers, January 9 – February 24, 2012
- Programme for the Chemical Engineers, New Delhi, March 19 – May 4, 2012

Faculty and participants of the training programme during Aug. 8 – Sept. 23, 2011

Faculty and participants of the training programme during Oct. 31 – Dec. 16, 2011

B. For other refineires

- Advanced Programme for the Chemical Engineers of the Essar Oil Limited, Jamnagar, April 11-15, 2011 & May 2-6, 2011
- Programme for the Non-Chemical Engineers of different refineries, July 4-15, 2011
- Programme for the Chemical Engineers of Essar-KRPL, October 31 – November 18, 2011

Faculty & students of the training programme during April 11-15, 2011

3.1.2 Other Training Programmes

- Programme on 'Analysis of Petroleum and Petroleum Products' for Essar Oil Limited, Jamnagar, April 18-29, 2011 and May 9-20, 2011
- Programme on 'Operation & Maintenance of CFR Engines' for laboratory personnel of different refineries, September 26 – October 7, 2011
- Programme on 'Get More out of Your Solvent Extraction Units' for Engineers of Refineries/ Hydrocarbon Industry, October 17-21, 2011
- Programme on 'Laboratory Practicals' for Assistant Chemists of the NTPC, NOIDA, December 26, 2011 – January 6, 2012
- Programme on 'Laboratory Practicals' for Assistant Chemists of NTPC, NOIDA, January 9-20, 2012
- Programme on 'Automotive Lubricants' for engineers and professionals of different oil companies and refineries, e.g., IOCL-Faridabad, Nandan Petrochem Ltd., Mumbai, Sah Petroleum Ltd., Mumbai, Raj Petro Specialties Pvt. Ltd., Mumbai and Balmer Lawrie Co. Ltd., Kolkata etc., February 27-29, 2012

Faculty & students of the training programme, April 18-29, 2011

3.2 HRD PROGRAMMES FOR THE EMPLOYEES

3.2.1 Programmes Organized by the HRDC (CSIR), Ghaziabad

- Mr Prasoon Kumar, Section Officer and Ms Neha Nautiyal, Assistant, 'Induction Training Programme on Behavioural Aspects & Transformation Project for SO's and Executive Assistants', April 11-29, 2011
- Mr Satish Chand, Assistant (S&P), '3-week Orientation Training Programme for Section Officers and Assistants', April 11–29, 2011
- Mr V K Kaushika, CoA, 'Workshop for Transparency Officers/Appellate Authorities and PIO's in the CSIR System', May 10-12, 2011
- Mr D P Bangwal and Mr Anand Singh, Technical Officers, 'Training Programme on Competency Development for Technical Officers', June 20-24, 2011
- Mr A K Jain, Chief Scientist, 'Training Programme on Research Methodology: Multivariate Methods of Analysis', July 4-8, 2011.
- Mr A K Saxena, Principal Scientist, 'Training Programme on Emotional Intelligence for Managerial Efficiency', July 18-20, 2011
- Mr Suresh Pant, SPO and Mr C S Bisht, Section Officer (F&A), 'Training Programme on Management Development Programme for Officers of Administration, Finance & Purchase', July 25-29, 2011
- Mr Sunil Kumar, Scientist, 'Training Programme on Research Methodology and Statistical Methods : Designing for Breakthrough', August 16-20, 2011
- Dr Thallada Bhaskar, Senior Scientist, 'Training Programme on Crafting Effective S&T Communication', August 24-26, 2011
- Mr Suresh Pant, Stores & Purchase Officer; Mr Pramod Joshi and Mr Himmat Singh, Assistants (Stores & Purchase); and Mr Anil Kumar, Technician, 'Training Programme on Material Management Module (ISEP Portal RFP-5/TCS)', October 18-20, 2011
- Mr M S Mehra, F&AO, 'Training Programme for FAOs on Hindi as Rajbhasha', February 1-3, 2012
- Mr Suresh Pant, SPO, 'Training programme for CoSP & SPO on Hindi as Rajbhasha', March 1-3, 2012
- Dr Rashmi and Dr Raj Kumar Singh, Junior Scientists, '24th Induction Training Programme for Newly Recruited Scientists', March 18-27, 2012

3.2.2 Participation in Programmes Organized by Different Organizations/ Institutions etc.

- Ms Richa Singhal, Ms Padma Latha Patnam, Mr Sandeep Saxena and Mr P K Khatri, Technical Assistants, '6th Summer School on Petroleum Refining & Petrochemicals', organized by the PETROTECH Society, IIPM, Gurgaon, June 6-10, 2011
- Mr Suryadev Kumar, Scientist, 'Workshop-cum-Training on Advanced Web Application Security', organized by the Department of Information Technology, Govt. of India, New Delhi, June 17, 2011
- Mr Nilesh Gode and Mr Bipul Sarkar, Junior Research Fellows, short-term course on 'Advances in Chemical and Bio-technical Processes for Utilization of Natural Resources Towards Sustainable Development', IIT-Roorkee, organized jointly by IIT-Roorkee and the Institution of Engineers, October 19-21, 2011
- Mr Anand Singh, Sr Technical Officer and Mr Kamal Kumar Maurya, Technical Assistant, 'NGT 2012: National Get-Together on Road Research and its Utilization', CSIR-CRRI, New Delhi, March 1-2, 2012

3.3 COLLOQUIA

- Mr Bhawan Singh, SRF, CSIR-IIP, 'Immobilization of Homogenous Catalysts on Mesoporous Silica', May 9, 2011
- Dr Lars Halldahl, K-Analys AB, Sweden, 'Studies on Thermal Measurements & Hot Disk', May 11, 2011
- Mr Jitendra Kumar Satyarthi, CSIR-NCL, Pune, 'Catalytic Conversion of Vegetable Oils to Bio-fuels and Chemicals', May 20, 2011
- Dr Anurag Garg, Centre for Environment Science & Engineering (CESE), Indian Institute of Technology, Bombay, 'Options for Material Recycling and Energy Recovery from Municipal Solid Waste in India', June 6, 2011

- Mr Deepak Verma, JRF, CSIR-IIP, 'Hydrogen Storage Materials', June 10, 2011
- Dr Ataullah Khan, University of Regina, Canada, 'Catalyst for Feedstock : Flexible and Process-Flexible Hydrogen Production', August 4, 2011
- Dr Joji Sonoda, Manager of International Sales, BEL Inc., Japan, 'Recent Advances in Adsorption Technique', July 18, 2011
- Mr Bipul Sarkar, JRF, CSIR-IIP, 'Methane Dry Reforming', July 20, 2011
- Mr Shankha Shubhra Acharaya, JRF, CSIR-IIP, 'Selective oxidation of Benzene to Phenol', September 8, 2011
- Dr Tohru Kamo, National Institute of Advanced Industrial Science and Technology (EMTech), Japan, 'Recovery of Useful Resource from E-waste by Using Liquefaction in Bio-Mass-Derived Tar or by Steam Gasification in The Presence of Eutectic Carbonates', February 13, 2012
- Dr Suman Lata Jain, Senior Scientist, Dr T V Rao, Senior Scientist, Mr Dinesh Bangwal, Sr Technical Officer, attended 'Proceedings of the Indo-US Workshop on Green Chemistry for Environment and Sustainable Development' (held at Dehradun during March 11-13, 2012), March 22, 2012
- Dr Neeraj Atray, Senior Scientist and Dr Raj Kumar Singh, Junior Scientist, attended 'Proceedings of the Indo-US Workshop on Green Chemistry for Environment and Sustainable Development' (held at Dehradun during March 11-13, 2012), March 29, 2012

3.4 DEPUTATIONS ABROAD

- Dr M O Garg, Director and Dr A K Sinha, Scientist, visited Canada under DST-ISTP joint Indo-Canadian research project entitled 'Applications of Bio-fuels for Aviation', June 13-17, 2011
- Mr Devendra Singh, Scientist, visited the University of Huddersfield, UK under the DST-UKIERI project entitled 'Study of Nano Materials for their use in Engine Oil Formulations for Better Fuel Efficiency', July 2- August 26, 2011
- Mr Sudip K Ganguly, Principal Scientist and Dr Anil K Sinha, Senior Scientist, visited Singapore to present a research paper at the International Refining & Petrochemicals Conference–Asia at Suntec, Singapore, July 19-21, 2011
- Dr O P Khatri, Scientist, visited ETH, Zurich, Switzerland, in order to pursue research work entitled 'Study on Tribo-chemical Events of Ionic Liquids', August 28 – September 27, 2011. (This work has been approved under the umbrella of the Indo-Swiss Joint Research Programme (ISJRP) for Joint Utilization of Advanced Facilities)
- Dr Thallada Bhaskar, Scientist and L N Shiva Kumar Konthala, Technical Assistant, visited Spain to deliver an invited lecture in the 6th International Symposium on Feedstock Recycling of Polymeric Materials (ISFR 2011), during 5-7 October 2011 and were invited to visit VTT Technology Research Centre, Finland to have discussions with Dr Y Solantausta, Chief Research Scientists, VTT Technology Research Centre, Finland
- Dr R K Chauhan, Technical Officer and L N Shiva Kumar Konthala, Technical Assistant Instrumental Training on Field Emission Scanning Electron Microscope (Fe-SEM), FEI Trading Co Ltd, Shanghai, China, October 10-15, 2011
- Dr Savita Kaul, Principal Scientist, Dr Neeraj Atray, Senior Scientist, Mr Dinesh Bangwal, Technical Officer and Ms Jyoti Porwal, Technical Assistant, to visit the University of Newcastle under the on-going United Kingdom-India Education and Research Initiative (UKIERI) project, UK, October 31 – November 12, 2011
- Dr Rajaram Bal, Scientist, visited the University of Newcastle, UK under the on-going United Kingdom-India Education and Research Initiative (UKIERI) project, UK, November 6-12, 2011.
- Dr M O Garg, Director, visited the Stiftelsen for Industriell og Teknisk Forskning (SINTEF) or Foundation for Scientific and Industrial Research under the 'Indo-Norway Project on CO_2 Recovery from Power Plants', sponsored by the Ministry of Foreign Affairs (MFA), Norway and also visited the University of Newcastle, UK under the United Kingdom-India Education and Research Initiative (UKIERI), project, UK, November 7-12, 2011
- Dr A N Goswami, Chief Scientist and Dr Anshu Nanoti, Senior Principal Scientist, visited the Stiftelsen for Industriell og Teknisk Forskning (SINTEF) or Foundation for Scientific and Industrial

Research under the 'Indo-Norway Project on CO_2 Recovery from Power Plants', sponsored by the Ministry of Foreign Affairs (MFA), Norway, November 7-9, 2011

- Dr M O Garg, Director and Dr S M Nanoti, Chief Scientist, visited Qatar to attend the '20th World Petroleum Congress', December 4-8, 2011
- Mr Kalyan Singh, Sr Technical Officer, visited the USA for inspection of the Cooperative Fuel Research Committee (CFR) engine, December 12-16, 2011
- Dr Rajaram Bal, Scientist, visited the Consiglio Nazionale delle Ricerche-Istituto per lo Studio dei Materiali Nanostrutturati (CNR-ISMN) or 'National Research Council – Institute for the Study of Nanostructure Materials', Italy under the 'Indo-Italian Research Project' under the aegis of CSIR-CNR programme of Co-operation, December 12-26, 2011
- Mr Praveen K Khatri, Technical Assistant, visited Pukyong National University, South Korea for discussions and to carry out experimental work on a joint research project entitled 'Utilization of CO_2 for Production of Fuels and Chemicals' under the Department of Science & Technology, Govt. of India (DST)-Ministry of Education, Science & Technology (MEST), Republic of Korea Point of Contact (POC), February 15 -March 14, 2012

4

Research Activities: On-going, Initiated & Completed

4.1 ON-GOING PROJECTS

4.1.1 Sponsored

- Setting up of the Modernized Emission Measurement Facility at IIP-Dehradun (Phase-I)
- Synthesis of Room-temperature Ionic Liquids and study of their applications for extraction of sulphur, nitrogen & aromatic compounds from petroleum feedstocks
- Direct production of biodiesel from non-edible oil seeds by Reactive Extraction
- Study for processing light vacuum gas oil from Mumbai high and Nile crude to produce paraffin wax at the MRPL
- Eco-friendly emulsion breaker for drill-cutting waste
- Development of new nano-structured mesoporous materials like SBA-15 for catalytic applications in hydrotreatment
- Processing of light neutral distillate in NMP Lube Extraction Unit at the CPCL
- Study on processing of LVGO & HVGO stocks for production of paraffin & microcrystalline wax at the NRL
- Novel doped 3-d nanoporous oxides for dye-sensitized solar cells (DSSC)
- Short evaluation studies of crude oil samples from the ONGCL
- An integrated approach for utilization of bagasse pith for production of bioethanol and value-added lignin production
- Scale-up studies for conversion of waste plastic & low polymer wax to value-added hydrocarbons
- Utilization of CO_2 feedstocks for production of value-added chemicals
- Development of adsorption technology for recovery of CO_2 from power plant flue gas
- Development of RAM Rocket T-6 fuel from the DRDL, Hyderabad
- Application of bio-fuels for aviation : green jet fuel from *Jatropha* oil (biojet) and bioethanol
- Boundary lubrication capabilities of ionic liquids and their futuristic applications to lubricant development
- Study of the effect of ionizing radiation on biomass for its conversion to ethanol
- Renewable energy from biomass: technology development
- Nanostructured porous inorganic oxide materials with tailored pore size and their coatings for application to catalysis, environment and for inclusion of biomolecules
- Pinch technology study at the AVU and the DCU of the Digboi Refinery
- Preliminary evaluation of 'Py-oil' of the UOP
- Process design of soaker drum internals for revamping of visbreaker at the HPCL's Vishakhapattanam Refinery
- Process engineering design package for Solvent Deoiling Unit at NRL
- MAT testing of catalyst samples from the HPCL's Vishakhapattanam Refinery
- Upgradation of Clarified Slurry Oil (CSO) ex-RIL by converting into petroleum ptiches (isotropic and mesophase) -- precursors for advanced carbon materials
- FZG gear scuffing performance evaluation of lubricating oils
- Evaluation of Servofyres HFDU 68 ES for GZG test

4.1.2 In-house

- Conversion of the Maruti-800 car into a solar-electric hybrid vehicle
- Development of new fixed-bed sweetening catalyst (revised)
- Screening of algae oil for biodiesel production
- Exploratory studies on hydrodenitrogenation (HDN) catalyst for refinery streams
- Design and development of novel-type maintenance-free bearings
- Blending effect of bio-oil with conventional fuels and its performance
- Development of novel green catalytic methodologies for oxidation and acid base catalyzed reactions
- Studies on the flow behaviour of diesel matrix at different temperatures : wax-additive interaction in relation to composition and properties of waxes
- Catalyst development for conversion of light naphtha to diesel
- Development of carbon wool from petroleum pitches/residues
- Molecular modelling and simulation application for development of adsorbents for methane storage

- Conversion of lignocellulosic biomass to middle distillate hydrocarbons (C12-C18) and solvents (butanol) through biotechnology route
- Synthesis, development, characterization and evaluation of graphene-TiO_2 hybrid material for enhancement of photovoltaic cell efficiency
- Feasibility study on upgradation of residual fuel oil (RFO) using non-HDS route
- Feasibility study on recovery of butanol from fermentation broths
- Development of a process for detergent-grade alpha-olefin sulphonates by using linear alpha olefins (C_{14}-C_{18} range) from the coker distillate of an Indian refinery
- Chemically-derived graphene nanosheets as a new-generation lubricant additive
- Single-step catalytic process to bio-jet fuels from triglycerides ('CSIR-Empower' Project-1)
- Selective oxidation of methane to methanol with molecular oxygen over supported nanoclusters ('CSIR-Empower' Project-2)
- Systematic studies on kinetics of CO_2 absorption in chemical and / or physical solvents and blends
- Development of new-generation metal-phosphorus-free lubricant additives as substitutes for ZDDP
- Investigation of oxidation stability of a biolubricant for IC engine applications
- Degradation / depolymerisation of commingled plastics to produce value-added products
- A novel solvent for CO_2 capture
- Biocatalytic upgradation of crude oil
- Studies on use of e-waste for improving the properties of paving-grade bitumen
- Study on the effect of fuel sensitivity on performance and emissions of modern spark-ignition engines

4.1.3 CSIR Network Projects

- Development of speciality inorganic materials for diverse applications
- Development of clean coal technology
- Advancement in metrology

  Activity - 1 : Standardization of biodiesel on an Indian level

  Activity - 2 : Development of reference materials for lubricity, viscosity and trace metal analysis

- Technologies and products for solar energy utilization through networks (TAPSUN) : novel approaches for solar energy conversion

4.1.4 'Supra-Institutional' Project (SIP)

Development of know-how and technology for environment-friendly conversion and utilization of biomass to fuels, lubricants and additives

Sub-activities

- Development and improvement of hetero-geneous catalysts for biofuels
- Pilot plant scale up and commercialization of biodiesel process
- Hydrotreating 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 biomass using thermophilic microorganisms
- Process & technology for production of liquid and gaseous fuels by fast pyrolysis of biomass
- Upgradation of bio-oils to future fuels
- Gasification technology development for production of synthesis gas from carbonaceous feedstocks for downstream utilization
- Development of eco-friendly additives and lubricants i.e., (1) saccharide-based bio-degradable lubricants (2) additives for bio-degradable lubricants
- PSA process for CO_2 recovery from biomass pyrolysis / gasification off-gas
- Development of absorption-based technologies for CO_2 capture from biomass-gasification flue gases
- Development of life-cycle analysis model for bio-mass conversion to fuels and lubricants
- Development of methods for compositional analysis of biofuels, biolubricants & additives
- Engine performance 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 biofuels and biolubricants

4.2 PROJECTS INITIATED (TAKEN UP/ NEW)

4.2.1 Sponsored

- Operation of Fuel Testing Laboratory at NOIDA (2010-2011)
- Feasibility study for producing needle coke from residual fuel oil ex-Numaligarh Refinery
- Analysis of petroleum / coal tar-based feedstocks to examine their suitability for producing carbon black
- Study of crude oil analysis of IC complex
- To study ISO HV-68 and VG 32 oils for physic-chemical characteristics
- Study of condensate and gas from GAIL
- Development of process for normal dodecane fraction from straight-run kerosene obtained from a petroleum refinery
- Utilization of carbon dioxide for production of fuels and chemicals
- Study on tribo-chemical events of ionic liquids
- Evaluation of fire-resistant hydraulic fluid samples
- Upgradation of clarified slurry oil (CSO) ex-RIL by converting it into petroleum pitches (isotropic and mesophase)-- precursors for advanced carbon materials
- Feasibility study for production of ultra-low sulphur diesel for on-board reforming using adsorptive desulphurization
- Development of graphene-metal oxide nano-composites as a potential candidate for photovoltaic applications
- Valorization of glycerol for biodegradable base fluids and new biofuel formulations
- Dye-sensitized solar cell (DSSC)/ Quantum dot-dye sensitized solar cell (QDDSSC)
- Production of second-and third-generation biofuels (biomass-to-liquid)
- Techno-economic feasibility of open loop thermo-chemical S-I cycle of H_2S split for carbon-free hydrogen production in petroleum refinery
- FZG gear scuffing performance evaluation of lubricating oils
- Hydropyrolysis of lignocellulosic biomass to value-added hydrocarbons
- Comparative study of diesel reforming processes (SDR, POX and ATR) using process simulator
- Evaluation of Servofyress HFDU 68 ES for GZG test
- Field trials on four-stroke motorcycles for performance evaluation of engine oils
- Overhauling of CFR octane engines at the Reliance Industries Limited (RIL), Jamnagar, Gujarat
- Evaluation of crude oil samples from the Mangala oil field of Rajasthan; Flash Point and BS&W of crude oil from Viramgaon and AGI 33 terminals
- Commercial development of the reprocessing of pyrolysis gasoline
- Production of biodiesel from low-cost feedstocks using heterogeneous catalyst
- Basic design engineering package (BDEP) for solvent refining of base oil
- Licensing of CSIR-IIP BTX model to SABIC, UK

4.2.2 In-house

- Procurement of two 90 KVA UPS systems
- Replenishment of store-chemicals, glassware etc.
- Purchase/procurement of IT equipments (computers, printers, scanners, Network components etc.), AMC of PC's, printers etc. and payment of Internet leased line
- Data entry operator salary
- Obtaining & maintaining ISO-9001:2008 Certificate for the Institute
- Development of test method for evaluation of fuel oil additives for combustion performance
- Optimization of domestic gas stove burner design (LPG/NG) for enhanced performance by mathematical modelling and experimental methods
- In-use particulate emission comparison of diesel and natural gas vehicles for Indian road conditions
- Transformation of CO_2 to Syngas ($CO+H_2$) over supported nano-structured mixed metal catalytic systems
- Molecular modelling and simulation application for development of adsorbents for methane storage
- Feasibility study for production of pure benzene from light FCC gasoline

- Hydroprocessing of biomass-derived oil : Fractional Distillation and detailed studies on fractions
- Combustion study of CI and SI engines
- Screening of thermophilic butanologen
- Selective oxidation of propylene to propylene oxide with molecular oxygen over nanocatalysts
- Co-processing studies of biomass-derived fast pyrolysis bio-oil with vacuum gas oil in Fluid Catalytic Cracking (FCC) unit
- Improvement / value-addition to grass-roots innovations : Kero gas stove with lighting fixture
- Improvement / value-addition to grass-roots innovations : *dosa* burner
- Improvement / value-addition to grass-roots innovations : wood-fired stove
- Improvement / value-addition to grass-roots innovations : jute match-stick
- Improvement / value-addition to grass-roots innovations : modified auto engine for increasing mileage
- Synthesis, characterization and tribo-evaluation of cellulose fatty esters for biolubricant applications
- Making the Xytel unit functional for catalyst evaluation
- µ-EHL & failure investigation in line contacts
- Development of an indigenous process for synthesis of *N*-Methyl-2-Pyrrolidone (NMP)

4.3 PROJECTS COMPLETED

4.3.1 Sponsored

- Popularization 'SONA ESVs' in *dhabas* in and around Dehradun
- Designing of pre-flash column in the NMP lube extraction unit of the HPCL, Mumbai
- Delayed coking studies on RIL blended feedstock
- Studies on the assay of gas condensate to improve its monetary value
- Study of the deposit characteristics on two motor cycle engine components
- Studies on two rocket propellant fuels coded as T-6B and R-T6C from INS Kalinga
- New absorption-based approaches for CO_2 recovery
- Low-temperature water-gas shift (WGS) reaction over Cu-nanoclusters supported on ZnO/Al_2O_3 for practical fuel cell application
- Development of low carbon-emitting adsorption technology for ultra-low sulphur diesel (ULSD) production
- Feasibility study on utilization of 10% pre-treated non-edible vegetable oils in stationary diesel engines
- Feasibility study on identifying feedstocks for petrochemicals
- Studies on evaluation of the gas condensate from the Reliance Industries Ltd
- Tribo-performance evaluation of Stabutherm GH 461 grease
- Feasibility study an changeover of solvent to NMP in the hexane unit at the CPCL, Manali (Part-II : adequacy check for changover from sulpholane to NMP in hexane unit)
- Study on the effect of driver behaviour on fuel economy
- Evaluation of hydraulic fluid samples for : (1) fire-resistant characteristics; (2) air release properties; (3) four-ball wear test
- Evaluation of domestic LPG stoves for thermal effiency (as per IS 4246)
- Study of nano-materials for their use in engine oil formulations for better fuel efficiency

4.3.2 In-house

- Study on the feasibility of removal of PCA from FGH for meeting PCA specifications in FGH
- Studies on energy-efficient lubricants
- Study on the use of biodiesel (B20) in a Tata Indigo passenger car
- Development of a pneumatic engine for automotive applications
- An alternate to paraffin wax from waste polyolefins
- Feasibility studies on making improved percormance bituminous binders using glycerol
- Studies on liquid-phase heterogeneous reactions by means of ultrasonic energy.

5

Enhancing R&D Infrastructure

5.1 New Facilities Created

5.1.1 AMA i60 Exhaust Measurement System

This Automotive Exhaust Measurement System is a high-end emission bench for emission testing, focussing on both certification and R&D for all fuel types. Integrated pumps draw in the measurement gas from the sample point, which can be located at a distance of up to 20 m. The analysis of the gas is done by means of conventional analyzers – FID for THC and CH_4, CLD for NO/NO_X, IRD for CO, CO_2 and N_2O as well as PMD for O_2. This facility is capable of mass emission measurement from automotive vehicles fuelled with conventional and alternative fuels including alcohols, bio-diesel and gaseous fuels like CNG,

Exhaust Measurement System

hydrogen, DME and their mixtures like CNG-hydrogen mixture and LPG-hydrogen mixture, as per Bharat Stage III/IV and European emission norms upto Euro-V. This facility consists of Constant Volume Sampler (CVS) for flow rates between 1 to15 m^3/min and Emission Analyzer for diluted exhaust gas sampling and measurement. The Emission Analyzer is shared with two existing chassis dynamometers in the laboratory. The Emission Analyzer along with the CVS has automated calibration, exhaust gas sampling, bag filling and measurement of exhaust gas.

5.1.2 New HPLC System

A New HPLC system installed with the following detection devices:

- Evaporative Light Seattering Detector (ELSD),
- Fluorescence Detector (FLD) and
- Diode Array Detector (DAD)

5.1.3 High-Pressure Fixed Reactor (HPFR)

Pilot plant/HPFR installed at the Hydroprocessing Laboratory for bio-jet fuel production from vegetable oils with the following specifications:

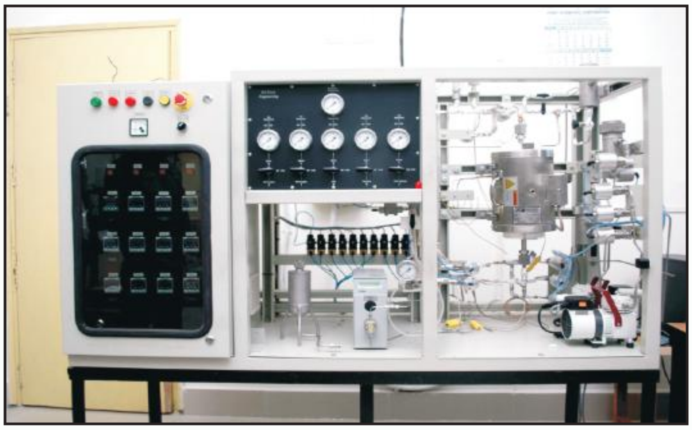
High-Pressure Fixed Reactor

Catalyst Loading Capacity	0.5-3 Kg
Liquid Feed Processing Range	0.25-15 litres/hr
Gas Feed Processing Range	50-6000 litres/hr
Bio-jet Fuel Production Rate	6 litres / day (average)
Other Provisions	Hydrogen recycling and regeneration of the catalyst
Approximate Plant Cost	₹ 99 lakhs

5.1.4 Single-Column Microadsorber

A fully-automated custom-designed micro-adsorber unit was installed. The unit is capable of performing breakthrough experiments and multi-step pressure/ vacuum swing adsorption (P/VSA) cycle studies. The unit is designed up to 20 bar pressure and 500°C temperature.

The unit is suitable for screening small amounts of adsorbents by breakthrough and single-column P/VSA studies.



Single-Column Microadsorber

5.1.5 High-Temperature and High-Pressure Gravimetric Microbalance

High-temperature and high-pressure gravimetric microbalance (IGA-001 from Hiden Isochema, UK) has been installed at the CSIR-IIP. The fully automated unit is capable of measuring adsorption/desorption isotherm of gases from vacuum to 20 bar pressure and up to 500 °C temperature. It is also possible to carry out gas adsorption kinetic studies and adsorbent stability tests with adsorbents in milligram scale. There is a provision of in-situ thermal activation/regeneration of adsorbents under high vacuum prior to equilibrium adsorption experiments.

HT-HP Gravimetric Microbalance

5.1.6 CFR

Combo Octane Engine With XCP- Digital Octane Panel

The XCP Digital Octane Panel incorporates many easy-to-use features including increased function, automated functions and enhanced documentation capabilities. The XCP digital octane panel is user-friendly, intuitive and accommodates users of all levels. Faster throughout, increased productivity and shorter training periods can incorporate a highly-automated fuel testing option.

CFR COE

The main features are as follows:

- Easy-to-use panel interface:

  The combination of a Windows-based touch-screen user interface and rugged industrial keyboard has produced a digitally enhanced control panel with many easy-to-use features. Operators can quickly become proficient and comfortable using the XCP Digital Octane Panel.

- More consistent results: user-friendly software
- Automated data recording
- Automated digital knock meter
- Electronic barometer
- Laser cylinder height sensor
- Equipment protection system

- Retrofit capability
- Faster testing time and less variability

5.1.7 Continuous bench-scale unit for waste plastics conversion process

5.1.8 Cold finger set-up for wax deposition studies

5.1.9 Metallurgical Microscope

5.1.10 NACE TM 0172

5.1.11 ASTM G 31

5.1.12 Installation of pilot plant unit for biodiesel production in continuous mode.

5.1.13 High resolution GC-MS (HRGCMS), (MSI Pvt. Ltd. U.K.)

The instrument is a double-focussing magnetic analyzer with 80,000 resolving power. The instrument is equipped

HRGCMS

with all-glass heated inlet sample introduction system (AGHIS) for characterizing hydrocarbon types in petroleum components. It is also coupled with HRGC, direct insertion probe (DIP) and high-temperature probe for organic compound analysis. The instrument utilizes various ionization techniques such as electron ionization (EI), chemical ionization (CI) and field ionization/field desorption (FI/FD). The functioning and all performance specifications of the instrument were demonstrated during the commissioning activity.

The instrument is capable of analyzing petroleum samples viz. gasoline, middle distillates and lubricants. The information is revealed in the form of hydrocarbon classes in that sample.

5.1.14 Advanced cracking evaluation Unit. (ACE-R)

Advanced Cracking Evaluation Unit

6

Important Events

6.1 FOUNDATION DAYS

6.1.1 CSIR Foundation Day, November 1, 2011

The CSIR Foundation Day was celebrated at the Institute on November 1, 2011. Chief Guest on the occasion was Mr Vilasrao Deshmukh, Hon'ble Minister of Science and Technology, Govt. of India, who urged the scientists to develop innovative technologies for making larger quantities of petrol and diesel from one barrel of crude oil which can help reduce the price of these fuels.

He said that in order for India to become the second largest economy in the world, it is essential not only to improve the productivity but also to improve the net energy usage which is at 400 kw per capita at present, much below that of world average. Mr Deshmukh said that India is an energy-deficient nation in terms of its resources and has to import almost 80 per cent of its crude oil requirement by spending considerable foreign exchange. Another problem is the concern for environment because the level of pollution is likely to grow with increase in energy consumption. This increases the importance of innovative methods to resolve these two conflicting issues. The Minister also stressed on the need for innovative methods for exploring and exploiting alternative energy resources like bio-mass, wind and solar energy.

Mr Deshmukh inaugurates the Foundation Day celebrations as (L-R) Dr S K Sharma, Mr V K Kaushika & Dr M O Garg look on; Ms Neelima Shah assists

"The CSIR-IIP is very well positioned to make a significant impact on efficient use of biomass to make transportation fuels which can be either petrol substitutes like bioethanol or diesel substitutes such as biodiesel," he said.

The retired employees of the Institute and those having put in 25 years of service were honoured on the occasion by the Chief Guest.

Mr Deshmukh delivering the Foundation Day Lecture

6.2 NATIONAL DAYS

6.2.1 Ambedkar Jayanti, April 14, 2011

The 120th birthday of Bharat Ratna Dr B R Ambedkar was celebrated in the Institute with great joy. The function was presided over by Mr Vijay Kumar Kataria, President, SC/ST Employees' Welfare Association and the Chair of the Chief Guest was graced by Mr U C Agrawal, Acting Director, while Dr M M Swamy, Deputy Commissioner (Retd.), Kendriya Vidyalaya Sangathan, New Delhi, was the Guest Speaker. Mr Vijay Kumar Kaushika, Controller of Administration, senior scientists of the Institute, trainees and all the office-bearers of the SC/ST Employees' Welfare Association were present.

Dr M M Swamy offering his respects to Dr Ambedkar

Mr U C Agrawal, Acting Director, while remembering Baba Sahib, appealed to all for inculcating the ideals of this Architect of the Constitution for the betterment of the lives of economically & socially down-trodden people.

6.2.2 National Technology Day, May 11, 2011

National Technology Day was celebrated on May 11, 2011 in the Institute. Professor Satyendra Prasad Mishra, Vice Chancellor, Uttarakhand Ayurveda University, Dehradun, presided over the function. Speaking on the occasion, the Chief Guest said that May 11 is termed as the day of honour for India, as on this day the second successful nuclear test was conducted by its scientists at Pokharan, Rajasthan, in 1998.

Prof S P Mishra lights the lamp on National Technology Day as Mr U C Agrawal watches; Ms Madhavi Gera assists

Quoting the CSIR mandate, Prof Mishra said that technology development should serve mankind. Technological progress is a must in all the fields and is specifically required in the field of Ayurveda. India has been practising this science for the last 3,000 years but we have not been able to reap its full benefits. The principle of Ayurveda is to provide protection to health sans any ill-effect. He opined that the science of Ayurveda science, if developed further through technological inputs, has the potential to become even more popular than the Western medical science.

Prof Mishra addressing the gathering

Dr S K Sharma, Chairman, Celebrations Committee, said that this day provides us an opportunity to seek inspiration & strength from past achievements, so that we can review our present status and decide upon the ways to be adopted in future for development of the latest technologies.

6.2.3 National Science Day, February 28, 2012

The National Science Day is observed on February 28th every year in the country, to commemorate Sir Chandrashekhara Venkata Raman's discovery of the radiation effect involving the inelastic scattering of light

Dr Garg speaks on National Science Day

later known as 'Raman Effect'. Raman was awarded the Noble Prize on December 11, 1930 for this discovery. He was the first Asian Nobel Laureate in any discipline of science. His discovery is now a powerful technique in physical and chemical research, particularly for characterization of materials.

The function was inaugurated by Dr M O Garg, Director, CSIR-IIP. While addressing gathering he said that the in order to be a good scientist, one ought to have passion and

School-children being shown around one of the laboratories. Dr Sanat Kuamr, Senior Scientist, explains some fine points a deep love for science. He talked about the 'Development of Technology for Simultaneous Production of US Grade Gasoline and Pure Benzene from FCC Naphtha'. On this occasion, Dr S S Ray, Sr Principal Scientist, CSIR-IIP, delivered a lecture entitled 'Raman Spectroscopy'.

In the forenoon, as a part of the 'Open Day,' school-children visited the laboratories and saw the activities therein (especially on petroleum and petrochemicals). They were excited to learn about the recently-developed technology on transforming waste plastics to fuels and aromatics.

6.3 KNOWLEDGE EXCHANGE EVENTS

6.3.1 'The 3rd Indo-Norwegian Seminar on CO_2 Capture : Leading High Science to Innovative Technologies,' organized jointly by the CSIR-IIP & SINTEF, Norway

The Third Indo-Norwegian Seminar on 'CO_2 Capture: Leading High Science to Innovative Technologies' was jointly organized by the CSIR-IIP and the SINTEF Materials & Chemistry, Oslo, Norway at the India Habitat Centre in New Delhi.

Industries world-wide are reducing their carbon foot-print by deploying inherently low-carbon and more efficient technologies and/or by carbon capture. Carbon-di-oxide Capture and Storage (CCS) technologies are an essential part of the strategy to combat climate change. The success in large-scale development and deployment of CCS depends critically on efficient and economic separation techniques.

Inauguration of the Indo-Norwegian Seminar

The Chief Guest of the inaugural function was Dr R Chidamabaram, Principal Scientific Advisor, Govt. of India and the Guest of Honour was Ms Ann Ollestad, HE the Ambassador, Royal Norwegian Embassy, New Delhi.

Dr Chidambaram in his inaugural address expressed concern over the alarming rise of atmospheric CO_2 concentrations and its impact upon climate change and global warming. He stressed upon the need for developing cost-effective technologies especially in developing

Dr Garg speaking at the Seminar

countries like India where increase in electricity cost arising from implementation of power intensive technologies will not be affordable. He noted the various R&D programmes on Carbon-di-oxide Capture and Storage (CCS) development in India and urged scientists, engineers and technologists to develop novel processes and materials by applying high science for CO_2 mitigation.

Ms Ann Ollestad, HE the Ambassador, Royal Norwegian Embassy, New Delhi, mentioned the initiatives taken by the Norwegian Government to combat climate change and also talked about the current Indo-Norwegian co-operation project between CSIR-IIP and SINTEF Materials & Chemistry, Norway on developing advanced materials for CO_2 capture.

The seminar was in the form of invited lectures from eminent scientists and engineers from Norway and India. The focus of the seminar was advanced material synthesis for CO_2 capture, atom-scale modelling of adsorbent materials, amine absorption processes, CO_2 recovery by vacuum swing adsorption and dual PSA, chemical looping. There was a large participation in the seminar from academia as well as the industry.

CSIR-IIP has had very fruitful ongoing collaboration with SINTEF, Norway for joint development of novel adsorption technologies in several areas including ultra-low sulphur gasoline/diesel production and CO_2 recovery from flue gas. The seminar was also an occasion to commemorate the decade-long relationship built up between the two organizations.

6.4 STATE-WIDE MISSIONS

6.4.1 Oil & Gas Conservation Fortnight Inaugural, January 18, 2012

The 'Oil & Gas Conservation Fortnight' (OGCF 2012) was formally inaugurated at the Institute on January 18, 2012. It was launched at the Institute in collaboration with these oil companies, viz., IOC, HPCL, BPCL and the Petroleum

Inauguration of OGCF-2012

Conversation Research Association (PCRA). It is observed every year from January 15 to January 31. The programme was inaugurated by Mr Subardhan, IAS, Secretary, Food and Civil Supplies, Uttarakhand.

The Chief Guest opined that 'Energy Conservation' is a misnomer. It should instead be called 'Reduction of Energy Usage' as no energy means no life. For development,

Giving out the message 'Save Oil'

energy is a must. Misuse of energy is a matter of concern. We must devise ways and means to conserve energy to reduce our dependence on other countries for natural resources which are limited and in short supply.

Mr Ashwani Dua called for more efficient use of fuels which will also conserve the environment. He called for taking small measures like car pooling, avoidance of idling, proper tuning of vehicles and turning off lights when not in use.

The vote of thanks was proposed by Mr Pawan Sehgal. Lauding the role of the media, he said that they are the most important means of propagating the message of Oil and Gas Conservation.

A human chain was formed to take the pledge that together we would spread the message 'Save Oil and Gas'. The staff of the CSIR-IIP and the students of Kendriya Vidyalaya, IIP, took part in forming the chain.

6.5 EXPOSURE EVENTS

6.5.1 Seventh Framework Programme for Research & Development (FP7) Info Day on Green Energy, organized by the EUINEC & the CSIR, November 25, 2011

The objective of the event was to inform potential researchers about 'The Seventh Framework Programme for Research & Development (FP7)' of the European Union & India Enhanced Co-operation (EUINEC) Framework for Improved Bilateral Dialogue in the Fields of Science & Technology and Open Calls for Research Proposals under the FP7 Co-operation Programme.

Dr M O Garg speaks on FP7 Info Day

The aim of the EUINEC is to create a scientific and technology co-operation community that will further enhance the EU-India co-operation by bringing together key players in an environment that will build stronger relations and stimulate the identification of new areas of co-operation. The EUINEC will furthermore allow for exchange of experience and provide integrated training opportunities on proposal development and project management to encourage co-operation between stakeholders in the respective regions.

Mr Anoj Kumar Chadar, Scientist, PPD-CSIR, describes FP7 to the dignitaries of the CSIR-IIP

More than 70 scientists, technologists and experts from the Indian R&D organizations, e.g., CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur; Wadia Institute of Himalayan Geology; ONGC; University of Petroleum & Energy Studies; Uttarakhand Technical University; Doon University; Shivalik University; Uttarakhand Renewable Energy Development Agency, Dehradun; CSIR-Central Building Research Institute, Roorkee and IIT, Roorkee participated in this one-day programme.

6.5.2 CSIR-IIP in the Industrial Green Chemistry World Symposium & Exhibition (IGCW) EXPO-2011, December, 4-6, 2011

The IGCW-2011 Symposium & Expo is primarily designed to bring forth GC&E initiatives by various chemical companies. This year, the Symposium & Expo were organized during 4-6 December, 2011 at the Regal Intercontinental The LaLiT Hotel, Mumbai. The event was divided into two parts: (1) the IGCW Symposium, and (2) the IGCW-2011 Exhibition. Apart from this, the IGCW also organized 180° Seminars on 'Inter- & Intra-Green Entrepreneurship', 'Green Chemical Processes', 'Green Solvents', 'Green Catalysts,' Green Measurements & Matrices' and 'Green Engineering' during this period.

Dr Mahendra Pal explains the technologies of CSIR-IIP to a visitor

Prof. Nitesh Mehta, Founder, Green Chemis Tree Foundation inaugurated the symposium on December 4, 2011. Delegates from India and abroad, hailing from 50 organizations/companies participated in the event.

In the CSIR pavilion, 7 Chemical Cluster Laboratories of the CSIR, namely, CSIR-IIP, CSIR-IICT, CSIR-NEERI, CSIR-CLRI, CSIR-CSMCRI, CSIR-CIMFR and CSIR-NCL participated and displayed about 30 posters on products, processes & technologies.

The CSIR-IIP displayed four of its technologies, viz., (1) Waste Plastics-to-Fuel & Aromatics, (2) Bio-jet Fuel, (3) CO_2 Mitigation and (4) Ionic Liquids as Lubes / Additives, in which delegates and students of the Mumbai-based institutions visiting the IGCW-2011 exhibited a keen interest and interacted with Dr Mahendra Pal, Chief Scientist, CSIR-IIP, who apprised the delegates/visitors of the CSIR-IIP technologies and recent innovations.

6.5.3 CSIR-IIP's Participation in the 99th Indian Science Congress (ISC-2012), January 3-7, 2012

CSIR-IIP participated in the 99th Indian Science Congress ISC-2012 held at the Kalinga Institute of Industrial Technology (KIIT), Bhubaneshwar. The theme of the event was 'Science & Technology for Inclusive Innovation-Rôle of Women'.

The programme was inaugurated by Dr Man Mohan Singh, Hon'ble Prime Minister of India.

The CSIR put up the pavilion entitled 'CSIR-800' in which 22 CSIR laboratories displayed their technologies/ products/ processes. The CSIR-IIP displayed its two recent technology posters titled (i) 'Waste Plastics-to-Fuels & Aromatics' and (ii) 'Gur Bhatti'.

The CSIR also put up a CSIR Experience Centre Exhibition at the Kalinga Institute of Social Sciences (KISS), Bhubaneshwar, which was inaugurated by Dr S K Brahmachari, DG, CSIR on January 3, 2012.

The CSIR-800 pavilion was awarded the 'Most Innovative Pavilion' in the 'Pride of India' Exhibition.

6.5.4 India-Africa S&T Ministers' Conference & Expo, Vigyan Bhawan, New Delhi, March 1-2, 2012

The Institute participated in The India-Africa S&T Ministers' Conference & Expo at the Vigyan Bhawan, New Delhi, organized by the Confederation of Indian Industry (CII). A total of 31 the CSIR laboratories showcased their technologies in the Expo. The event was inaugurated by Mr Vilasrao Deshmukh, Hon'ble Minister of Science & Technology, Govt. of India.

The participating delegates visited the CSIR Pavilion and evinced interest in these technologies of the CSIR-IIP: (1) Fast Pyrolysis of Bio-mass, (2) Bio-jet Fuels and (3) Bio-degradable Lubricants. They were apprised of the R&D facilities and training programmes at the CSIR-IIP.

6.5.5 India-Africa Technology Partnership Programme, New Delhi, March 18-20, 2012

The Institute participated in The India-Africa Technology Partnership Programme at the Hotel Taj Place, New Delhi, during March 18-20, 2012. The event was inaugurated by Mr Anand Sharma, Hon'ble Minster of Commerce, Industry & Textiles, Government of India. He spoke on 'India-Africa : The Growing Partnership'. Mrs Joice Mujuru, HE the Vice President, Zimbabwe & Shri B Muthuram, President, CII also spoke on the occasion.

The exhibition which included exhibits from the CSIR and the Indian Council of Agricultural Research (ICAR), was inaugurated by Mrs J Mujuru. She visited the CSIR-IIP stall and interacted and showed interest in Jatropha-based technology of bio-jet fuels. The programme consisted of presentations on various subjects spread over two days.

6.6 RESEARCH MANAGEMENT EVENTS

6.6.1 CSIR-IIP Research Council Meeting, September 6, 2011

The 37th meeting of the the CSIR-IIP's Research Council was held at the Institute on September 6, 2011. Prof Devang V Khakhar, IIT-Bombay, Chairman, presided. Dr M O Garg, Director, CSIR-IIP, was present along with other Memebrs,

Prof Devang V Khakhar, Chairman, RC, CSIR-IIP, flanked by Dr M O Garg & Mr B M Shukla

viz., Prof I M Mishra, IIT-Roorkee; Dr D M Kale, ONGC; Mr P Padmanabhan, BPCL; Dr Amalendu Sinha, Director, CSIR-CIMFR, Dhanbad; Mr Anand Kumar, Ex-IOCL and Dr B D Kulkarni, CSIR-NCL, Pune.

6.7 FOSTERING THE SCIENTIFIC SPIRIT

6.7.1 Dr M O Garg Inaugurates the Uttarakhand Science Expo-2011

Dr M O Garg, Director, CSIR-IIP, inaugurated the three-day 'Uttarakhand Science Expo-2011', organized by an NGO, Sansa Foundation, at a local hotel on September 21, 2011. While inaugurating the Expo, Dr Garg expressed the hope that the Science Expo would attract the youth and others to the different aspects of science displayed in this three-day exhibition.

Dr M O Garg (far right) inaugurating the Science Expo. Others in the picture include (L-R) Mr Sadhuram, Ex-Minister, Govt. of Uttarakhand, Mr Ravi Prakash, AC, Dept. of Agri. & Co-op, Dr Mahendra Pal, Chief Sc., CSIR-IIP & Ms Meenu Vashishtha, Sansa Foundation

CSIR-IIP's stall was adjudged the best. Dr Mahendra Pal, Chief Scientist, CSIR-IIP, accepted the award for the Institute from Prof Girijesh Pant, VC, Doon University, Dehradun.

6.8 हमारा क्रीड़ा पक्ष

6.8.1 43वीं शांति स्वरूप भटनागर स्मृति खेल-प्रतियोगिता (मैदान-खेल—आंचलिक)

सीएसआइआर-केंद्रीय सड़क अनुसंधान संस्थान, नई दिल्ली में सीएसआइआर-क्रीड़ा संवर्द्धन मंडल के तत्वावधान में आयोजित '43वीं शांति स्वरूप भटनागर स्मृति (मैदान खेल-आंचलिक) खेल-प्रतियोगिता (XLIII - SSBMT) में संस्थान के निम्नलिखित खिलाड़ियों ने क्रिकेट एवं वॉलीबॉल प्रतियोगिताओं में भाग लिया:

क्रिकेट

सर्वश्री परवेज आलम, एन के रावत, देवेंद्र राय, प्रदीप पंवार, विक्रम सिंह रावत, हेमन्त तिवाड़ी, बी बी डिमरी, हिम्मत सिंह, धर्मेन्द्र पुण्डीर, मनमोहन सिंह, शिवराम एवं आशीष रतूड़ी।

वॉलीबॉल

सर्वश्री देवेन्द्र बटोला, राजीव पंवार, राजेंद्र सिंह बडोला, राकेश कुमार जोशी, शिव सिंह रावत, अब्बल सिंह रावत एवं पुष्पराज शर्मा।

प्रतियोगिता में सम्मिलित संस्थान के दोनों दलों ने अपने-अपने समूह में उत्कृष्ट खेल का प्रदर्शन करते हुए सीएसआइआर -केंद्रीय इलेक्ट्रॉनिकी अभियांत्रिकी संस्थान (CSIR-CEERI), पिलानी में मार्च, 2012 में आयोज्य अंतिम स्तर की प्रतिस्पर्द्धाओं हेतु अर्हता प्राप्त की।

6.8.2 जिला-स्तर की दो-दिवसीय कैरम प्रतियोगिता का आयोजन

सीएसआइआर-भापेसं स्टाफ क्लब द्वारा आयोजित जिला-स्तर की दो-दिवसीय कैरम प्रतियोगिता का उद्घाटन 24 सितंबर, 2011 को सीएसआइआर-भापेसं समुदाय केंद्र में श्री त्रिवेंद्र सिंह रावत, काबीना

कैरम प्रतियोगिता का उद्घाटन करते हुए श्री त्रिवेंद्र सिंह रावत (बाएं, बोर्ड पर)। डॉ एम ओ गर्ग (दाएं, बोर्ड पर) अवलोकन कर रहे हैं

मंत्री, उत्तराखंड सरकार द्वारा किया गया। उद्घाटन समारोह के अवसर पर विशिष्ट अतिथि के रूप में निदेशक डॉ० एम ओ गर्ग तथा साथ ही नरेंद्र नगर के विधायक श्री ओम गोपाल रावत व नैशनल पैनल अम्पायर-कैरम श्री अरूण सक्सेना के साथ-साथ अन्य गणमान्य व्यक्ति भी उपस्थित थे।

उक्त प्रतियोगिता में केंद्र तथा राज्य सरकार के प्रतिष्ठानों जैसे- आइआरडीई (डील) बार एसोसिएशन, देहरादून (ओएनजीसी) बीएचईएल (एफआरआइ) पीएण्डटी (एजी) भापेसं एवं सीक्यूए (आइ) ने मुख्य रूप से भाग लिया। प्रतियोगिता में एकल तथा युगल स्पर्द्धा में लगभग 50 टीमें शामिल हुई।

एकल प्रतियोगिता में विजेता श्री अश्विनी, वन अनुसंधान संस्थान, देहरादून तथा उप-विजेता श्री हरि ओम गुप्ता, बीएचईएल, हरिद्वार रहे, जबकि युगल प्रतियोगिता में श्री एन के बलोदी व श्री रवीन्द्र पंवार, डील, देहरादून विजेता और श्री टी एस नेगी, ओएनजीसी, देहरादून व श्री अनिल बैसने, आइआरडीई, देहरादून, उप-विजेता घोषित किए गए।

सीएसआइआर-भापेसं स्टाफ क्लब द्वारा आयोजित इस प्रतियोगिता के प्रबंधन व संचालन में सचिव श्री नवीन कुमार मौर्य सहित क्लब के सभी पदाधिकारियों व कार्यकर्ताओं ने सक्रिय रूप से भाग लिया।

6.8.3 43वीं शांति स्वरूप भटनागर स्मृति खेल-प्रतियोगिता (मैदान-खेल—अंतिम), 22-24 मार्च, 2012

सीएसआइआर-केन्द्रीय इलैक्ट्रॉनिकी अभियांत्रिकी अनुसंधान संस्थान, पिलानी में सीएसआइआर-क्रीड़ा संवर्द्धन मंडल के तत्वावधान में आयोजित '43वीं शांति स्वरूप भटनागर स्मृति (मैदान खेल-आंचलिक) खेल-प्रतियोगिता (XLIII-SSBMT) में संस्थान के निम्नलिखित खिलाड़ियों ने क्रिकेट एवं वॉलीबॉल प्रतियोगिताओं में भाग लिया:

- **क्रिकेट**

सर्वश्री परवेज आलम, एन के रावत, देवेंद्र राय, प्रदीप पंवार, राजेश कुमार, हेमन्त तिवाड़ी, हिम्मत सिंह, धर्मेन्द्र पुण्डीर, मनमोहन सिंह, शिवराम, सतीश चंद, सुभाष एवं आशीष रतूड़ी।

- **वॉलीबॉल**

सर्वश्री देवेन्द्र बटोला, राजीव पंवार, राजेंद्र सिंह बडोला, राकेश कुमार जोशी, शिव सिंह रावत, अब्बल सिंह रावत, पुष्पराज शर्मा एवं सुदामा सिंह बिष्ट।

प्रतियोगिता में सम्मिलित संस्थान के दोनों दलों ने अपने-अपने समूह में उत्कृष्ट खेल का प्रदर्शन किया।

6.9 TECHNOLOGY OUTREACH

6.9.1 ग्राम-केंद्रित प्रौद्योगिकियों का विकास

सीएसआइआर-भापेसं द्वारा विकसित उन्नत गुड़ भट्टी तकनीक अपनाने वालों के लिए भारत सरकार द्वारा घोषित अनुदान राशि का वितरण

संस्थान ने उत्तराखंड एवं उत्तर प्रदेश में प्रचलित पारंपरिक गुड़ भट्टियों के डिज़ाइन में सुधार कर इसे अधिक ईंधन-दक्ष एवं पर्यावरण-स्नेही बनाया

श्री बी एम शुक्ल, प्रमुख ए आर पी बी डी, एक गुड़ भट्टी मालिक को अनुदान राशि का चेक प्रदान करते हुए

है। संस्थान के वैज्ञानिक निरंतर गुड़ भट्टी क्षेत्रों का दौरा कर गुड़ भट्टी मालिकों को अपनी भट्टियों में सुधार करने हेतु प्रेरित करते रहते हैं। भारत सरकार की नई दिल्ली-स्थित पेट्रोलियम कंजर्वेशन रिसर्च एसोसिएशन (पीसीआरए) ने संस्थान के इस कार्य के महत्व को समझते हुए उन्नत गुड़ भट्टी अपनाने वाले मालिकों को ₹ 5000/- प्रति व्यक्ति की अनुदान राशि देने की योजना बनाई है। इसके तहत 35 गुड़ भट्टी मालिकों ने अपनी भट्टियों में सुधार कार्य पूरा कर लिया है। सीएसआइआर-भारतीय पेट्रोलियम संस्थान, देहरादून ने बिहारीगढ़ एवं बुग्गावाला क्षेत्रों के उन्नत गुड़ भट्टी अपनाने वाले 13 मालिकों को ₹ 5000/- प्रति की अनुदान राशि के चेक प्रदान किए।

6.10 EMPLOYEE AWARENESS DRIVES

6.10.1 Vigilance Awareness Week, October 31-November 7, 2011

Adhering to the instructions of the Chief Vigilance Commission, Government of India, the, Vigilance Awareness Week for the year 2011 in CSIR-IIP commenced with a pledge on October 31, 2011, followed by many other awareness programmes throughout the week.

6.11 SOCIO - CULTURAL ACTIVITIES

6.11.1 Inauguration of the Community Library & Reading Room

Dr M O Garg, Director, CSIR-IIP, inaugurated the Library & Reading Room in the IIP Community Centre January 26, 2012, refurbished and revived the aim is to create and maintain a reading habit in the members of the CSIR-IIP community.

Dr Garg inaugurates the Library & the Reading Room

6.11.2 विश्वकर्मा पूजा

17 सितंबर का दिन प्रतिवर्ष संस्थान में एक सामुदायिक गतिविधि का साक्षी बनता है। संस्थान में सामूहिक रूप से मनाई जाने वाली यही एकमात्र पूजा है। इस दिन सनातन मान्यताओं के अनुसार देवताओं के वास्तुशास्त्री

विश्वकर्मा पूजा के अवसर पर सामुदायिक भोज का दृश्य

अथवा इंजीनियर माने जाने वाले विश्वकर्मा जी के स्मरण के माध्यम से संस्थान के जीवन में विभिन्न कल-पुर्जों-मशीनों-यंत्रों-साधनों का महत्व मानते हुए उन्हें सम्मान दिया जाता है और संस्थान के परिसर में ही पूर्वाहन में पूजा के पश्चात् एक सामूहिक दोपहर-भोज का आयोजन किया जाता है। इसमें समस्त संस्थान-परिवार सोत्साह भागीदारी करता है।

6.12 COMMUNITY HEALTH DRIVES

With a view to ensure better health for the CSIR-IIP community, various free health-camps were organized by the CSIR-IIP Medical & Health Care Centre.

6.12.1 Breathing & Respiratory Camp-III, April 6, 2011

The Third Breathing & Respiratory Camp was held on April 6, 2011 with a view to provide the IIP community with an opportunity not only to be examined for respiratory problems but also to be educated about the origin, causes, effects and treatment of such diseases.

6.12.2 Free Heart Check-up and Orthopaedic Camp, May 7, 2011

The Heart Check-up Camp was organized in association with the Escorts Heart Institute and Research Centre (EHIRC), New Delhi, on May 7, 2011 under their Community Outreach Prgoramme (COP). Dr Sanjiv Gera, Sr Cardiologist, EHIRC, led the 14-member team. More than 200 persons from the CSIR-IIP community including retired persons attended the camp. Dr M O Garg, while speaking on the occasion, reiterated that the CSIR-IIP is committed to better health for its employees and every effort in this regard is welcome.

The camp was organized by Dr Lalita Bakaya, Sr. RMO and Dr Adarsh Kumar, RMO while the logistic support was given by Controller of Administration, Mr V K Kaushika.

At the Heart Camp (L-R) : Dr S K Sharma, Dr Lalita Bakaya, Dr M O Garg, Dr S Gera & Dr Adarsh Kumar

6.12.3 Free Eye Check-up Camp

A Free Eye Check-up Camp was organized at the CSIR-IIP Medical & Health Care Centre conducted by Dr Vinod Arora, Eye Surgeon, Dehradun, August 10, 2011

6.12.4 Voluntary Blood Donation Camp, August 25, 2011

The Fourth Voluntary Blood Donation Camp was organized in the Institute in Association with the IMA Blood Bank of

Dr M O Garg initiating voluntary blood donation

Dehradun on August 25, 2011, in which 70 people donated blood. Dr M O Garg, Director, inaugurated the camp and dwelt upon the importance of blood donation.

6.12.5 Typhoid Vaccination Drive

Vaccination against typhoid was organized on January 27, 2012.

6.12.6 Hepatitis 'B' Vaccination Drive

Vaccination against hepatitis 'B' was organized on March 27, 2012.

6.13 ACTIVITIES OF THE SCHEDULED CASTES/TRIBES EMPLOYEES' WELFARE ASSOCIATION

Birthday of Bharat Ratna Dr. Baba Saheb Bhimrao Ambedker was celebrated on April 14, 2011 in the Institute. Sh U C Agrawal, Acting Director, Sh V K Kauhika, CoA, Dr S K Sharma, Sr Principal Scientist, Sh Vijay Kumar Katariya, President of SCST-EWA and Sh Jagdish Kumar, Secretary SCST-EWA garlanded the photo of Bab Sahib.

General body meeting of the SCST-EWA was conducted on April 29, 2011 to conduct elect a new Executive Body ion of the Association under the Chairmanship of Sh Babulal, Senior Technical Officer completion of the tenure of two years by upon the existing committee.

The new Executive Body of the SC/ST Employees Welfare Association for the year 2012-2014 was also constituted.

7

Committees

7.1 RESEARCH COUNCIL

Chairman
Prof Devang V Khakhar
Director
Indian Institute of Technology, Bombay
P.O.-IIT, Powai, Mumbai – 400 076

External Members

Mr P K Kapil
Executive Director
Reliance Industries Ltd.
Village Meghpar/Padana, Taluka-Lapur
Dist Jamnagar – 361280

Mr K Murali
Director
Hindustan Petroleum Corporation Ltd.
17, Jamshedij Tata Road, Church Gate
Mumbai – 400020

Dr D M Kale
Advisor & Ex-DG
Chief Engineer Centre
Oil and Natural Gas Commission
5th to 15th Floor, South Tower,
Scope Minar, Laxmi Nagar
New Delhi – 110092

Mr K Balachandran
Managing Director
Chennai Petroleum Corporation Limited
536, Anna Salai, Teynampet,
Chennai – 600018

Mr P Padmanabhan
General Manager (Technical)
Bharat Petroleum Corporation Ltd.
Refinery, Mahul
Mumbai – 400074

Mr A S Basu
Executive Director
Indian Oil Corporation Ltd.
Scope Complex, Core – 2
7, Institutional Area, Lodhi Road
New Delhi – 110003

Dr Balu Sarma
President & Chief Technology Officer
PRAJ MATRIX-The Innovative Center
(A Division of Praj Industries Ltd.)
Gate No. 1098, 402 & 403, Urawade
Taluka-Mulshi
Pune- 411042
Prof I M Mishra
Professor
Deptt of Chemical Engineering
Indian Institute of Technology, Roorkee
Saharanpur Campus, Paper Mill Road
Saharanpur – 247001

Mr Anand Kumar
Former Director (R&D)
Indian Oil Corporationn Ltd &
Director, Petrotech-India
602, Tolstoy Bhavan, Tolstoy Marg
Connaught Place
New Delhi – 110001

Mr S K Srivastava
Director-General
Directorate-General of Hydrocarbons
C-139, Sector -63
NOIDA – 201301

D-G's Nominee
Dr B D Kulkarni
Dy Director & Head
Chemical Engineering &
Process Development Division
National Chemical Laboratory
Pashan Road, Pune – 411008

Dr Amalendu Sinha
Director
Central Institute of Mining & Fuel Research
Barwa Road
Dhanbad – 826015

Cluster Director
Dr S Sivaram
CSIR Bhatnagar Fellow
A 201, Polymers & Advanced
Materials Laboratory
National Chemical Laboratory
Dr. Homi Bhabha Raod
Pune – 411008

Director
Dr M O Garg
Director
Indian Institute of Petroleum
PO-IIP, Mohkampur
Dehradun – 248005

Permanent Invitee
Head or His Nominee
Planning & Performance Division
Council of Scientific & Industrial Research
Anusandhan Bhawan, 2-Rafi Marg,
New Delhi – 110001

Secretary
Mr B M Shukla
Head, RPBD
Indian Institute of Petroleum
PO-IIP Mohkampur,
Dehradun – 248005

7.2 MANAGEMENT COUNCIL

Chairman
Dr M O Garg
Director

Internal Members
Dr S S Ray
Senior Principal Scientist

Mr S K Ganguly
Principal Scientist

Dr Suman Lata Jain
Senior Scientist

Dr O P Khatri
Senior Scientist

Dr Lalita Bakaya
Principal Technical Officer (3)

Mr B M Shukla
Chief Scientist
Head, RPBD

Mr M S Mehra
F&AO

Mr V K Kaushika
CoA (Secretary)

External Member
Prof S K Bhattacharya
Director
CBRI, Roorkee

8

राजभाषा

8.1 राजभाषा हिंदी विशिष्ट व्याख्यानमाला

8.1.1 9वाँ पुष्प, 10 जून, 2011

'राजभाषा हिंदी विशिष्ट व्याख्यानमाला' के '9वें व्याख्यान' में 'कार्यालयीन अनुवाद: समस्याएं एवं समाधान' विषय पर बोलते हुए प्रो० पी सी टंडन, निदेशक, भारतीय अनुवाद परिषद एवं मूर्धन्य साहित्यकार (दिल्ली) ने कहा कि भारत की आजादी के समय हमने भाषा की अपेक्षा विकास को चुना और हिंदी के साथ-साथ अंग्रेजी को सरकारी काम-काज की भाषा के रूप में रखा, इसलिए हिंदी में हम आत्म-निर्भर नहीं हो सके हैं और कार्यालयीन हिंदी अनुवादाश्रित और अंग्रेजी की देन-भर रह गई है। अनुवादजन्य हिंदी पर अंग्रेजी की छाया स्पष्ट दिखाई देती है। उन्होंने अच्छे अनुवाद के लिए स्रोत व लक्ष्य दोनों भाषाओं में पर्याप्त ज्ञान की आवश्यकता पर बल दिया और कहा कि हिंदी की शब्द-संपदा अथाह है और संस्कृत की धातुओं में अपना मूल होने के कारण हिंदी के पास प्रजनन शक्ति भी है।

प्रो० पी सी टंडन व्याख्यान देते हुए। अन्य (बाएँ से दाएँ): डॉ दिनेश चंद्र चमोला, डॉ श्रीकांत एम० नानोटी एवं श्री विजय कुमार कौशिक

इससे पूर्व निदेशक, भापेसं की ओर से डॉ० श्रीकांत एम नानोटी, वरिष्ठ वैज्ञानिक ने मुख्य अतिथि का स्वागत करते हुए कहा कि संस्थान द्वारा समय-समय पर आयोजित कार्यक्रमों के माध्यम से हिंदी में काम-काज करने का एक स्वस्थ परिवेश निर्मित हुआ है, जिसमें ऐसे मनीषी विद्वानों के अभिभाषणों का महत्वपूर्ण योगदान है।

अंतत: श्री विजय कुमार कौशिक, प्रशासन नियंत्रक ने धन्यवाद ज्ञापित किया और कहा कि इस प्रकार के विद्वानों के व्याख्यान आगे बढ़ने का सूत्र प्रदान करते हैं।

8.1.2 10वाँ पुष्प, 26 अगस्त, 2011

'राजभाषा हिंदी विशिष्ट व्याख्यानमाला' के '10वें व्याख्यान' के अवसर पर 'हिंदी-अंग्रेजी की वाक्य संरचनाओं में अनुवाद की समस्याएं' विषय

'राजभाषा हिंदी विशिष्ट व्याख्यानमाला' के 10वें वक्ता प्रो० रवि प्रकाश गुप्त

पर बोलते हुए प्रो० रवि प्रकाश गुप्त, भाषा वैज्ञानिक एवं क्षेत्रीय निदेशक, केंद्रीय हिंदी संस्थान, दिल्ली ने कहा कि अनुवाद में किसी भाषा की शब्दावली और भाषा संरचना पर अधिकार के अतिरिक्त उस भाषा की सांस्कृतिक पृष्ठ-भूमि या सांस्कृतिक संदर्भों की समझ होना अत्यंत आवश्यक है। इसके अतिरिक्त किसी भाषा के संदर्भ में भौतिक सत्य और भाषिक सत्य के अंतर को समझना भी आवश्यक है। इसकी अपूर्ण समझ से ही अनुवाद में भूल होती है। वस्तु को देखने की दृष्टि हर समाज में अलग-अलग होती है। भाषा का उद्देश्य संप्रेषण है और इस उद्देश्य के पूरा न होने पर अनुवाद अर्थहीन हो जाता है। प्रो० गुप्त ने भाषा के प्रयोजनमूलक स्वरूप की चर्चा करते हुए बताया कि विशिष्ट क्षेत्रों में प्रयोग की जाने वाली भाषा, प्रयुक्तियों पर आधारित होती है। भारत में विज्ञापन एवं पत्रकारिता की भाषा को छोड़कर अन्य सभी प्रयुक्तियां अनुवाद के माध्यम से आई हैं, इसलिए वे सहज नहीं हैं। प्रो० गुप्त ने हिंदी के शुद्ध रूप पर क्षेत्रीय भाषिक प्रयोगों के प्रभाव से होने वाली भाषा-संबंधी विकृति की भी चर्चा की।

इससे पूर्व श्री यू सी अग्रवाल, वरिष्ठतम वैज्ञानिक ने निदेशक, भापेसं की ओर से मुख्य अतिथि का स्वागत करते हुए कहा कि ये प्रयत्न किए जा रहे हैं कि हिंदी विज्ञान की भी भाषा हो जाय ताकि आम आदमी को भी विज्ञान का लाभ प्राप्त हो।

संस्थान के वरिष्ठ हिंदी अधिकारी एवं समारोह के संयोजक डॉ० दिनेश चंद्र चमोला ने कहा कि शब्द अनुभूतियों की यात्रा को अभिव्यक्ति के गंतव्य तक पहुंचाता है। अनुवाद ज्ञान के आदान-प्रदान की एक मजबूत आधारशिला है। किंतु अच्छे अनुवाद के लिए भाषा की बारीकियां समझना आवश्यक है।

8.1.3 11वां पुष्प, 21 नवंबर, 2011

'राजभाषा हिंदी विशिष्ट व्याख्यानमाला' के '11वें व्याख्यान' में 'वर्तमान परिप्रेक्ष्य में अनुवाद की चुनौतियां' विषय पर मुख्य अतिथि डॉ० मुक्ता, प्रख्यात हिंदी सेवी एवं निदेशक, हरियाणा ग्रंथ अकादमी, पंचकुला ने

अनुवाद की आवश्यकता, प्रक्रिया, स्वरूप, प्रकार, प्रकृति, इतिहास और वर्तमान समय में इसके विभिन्न पक्षों पर एक विषद् वक्तव्य दिया। अनुवाद के व्यावहारिक पक्ष को लेते हुए डॉ० मुक्ता ने कहा कि ज्ञान के असीमित भंडार से परिचित होने का माध्यम अनुवाद ही है। अनुवाद के माध्यम से हमारा दूसरी जाति, देश, संस्कृति की वास्तविकताओं से परिचय होता है।

इससे पूर्व डॉ० एस एम नानोटी, मुख्य वैज्ञानिक ने निदेशक, भापेसं की ओर से मुख्य अतिथि का स्वागत करते हुए कहा कि हमें हिंदी और अनुवाद के काम को समस्या की अपेक्षा चुनौती के रूप में स्वीकार करना चाहिए।

समारोह के संयोजक एवं संस्थान के वरिष्ठ हिंदी अधिकारी, डॉ० दिनेश चंद्र चमोला ने कहा कि अनुवाद आज के युग की मांग है। अनुवाद दो संस्कृतियों, व्यक्तियों व समाजों को आपस में जोड़ने का एक महत्वपूर्ण सेतु है।

अंत में श्री विजय कुमार कौशिक, प्रशासन नियंत्रक ने सभी उपस्थितों तथा समारोह को सफल बनाने वाले सदस्यों का धन्यवाद करते हुए कहा कि ऐसे विद्वानों का आगमन हमारे लिए ज्ञान में वृद्धि का एक अनूठा अवसर है।

8.2 हिंदी समारोह

8.2.1 हिंदी माह समारोह, 30 सितंबर, 2011

सीएसआइआर-भारतीय पेट्रोलियम संस्थान, देहरादून में माह-भर की हिंदी संबंधी गतिविधियों के समापन के अवसर पर आयोजित समारोह में मुख्य अतिथि के रूप में बोलते हुए डॉ० कृष्ण कुमार रत्तू, प्रख्यात मीडिया विशेषज्ञ एवं साहित्यकार, पटियाला ने शब्द की शक्ति को रेखांकित करते हुए कहा कि भाषा का संवाद आदमी को आदमी के साथ जोड़ता है। हिंदी प्रेम हमारी रूह, विरासत, पुरखों और गंगा-जमुनी संस्कृति की भाषा है। यह देश के दूरस्थ क्षेत्रों के वासियों की आवाज़ औरों तक और सरकार तक पहुंचाती है।

हिंदी माह समापन समारोह का उद्घाटन करते हुए मुख्य अतिथि डॉ० कृष्ण कुमार रत्तू। मंच पर अन्य (बाएँ से) श्री विजय कुमार कौशिक, डॉ श्रीकांत नानोटी, डॉ दिनेश चमोला एवं सुश्री कुशल त्यागी

डॉ० रत्तू ने मीडिया में प्रयुक्त हिंदी की चर्चा करते हुए समाचार चैनलों में 'ब्रेकिंग न्यूज़' के चलन और मीडिया के द्वारा समाज के आचार, विचार और भाषा पर किए जा रहे अतिक्रमण पर चिंता व्यक्त की और कहा कि मीडिया ने इन वस्तुओं पर नियंत्रण कर लिया है। यह आवश्यक है कि भाषा को अब नई पीढ़ी तक वैज्ञानिक तरीके से पहुंचाया जाए, नहीं तो संवाद बंद हो जाएगा।

संस्थान के कार्यकारी निदेशक डॉ० एस एम नानोटी ने मुख्य अतिथि का स्वागत करते हुए संस्थान में किए जा रहे हिंदी संबंधी प्रयासों का स्मरण किया और कहा कि संस्थान में हम लगभग हिंदीमय हो चुके हैं। डॉ० नानोटी ने 'संस्थान-गीत' के लिए संस्थान के भीतर ही किए गए सफल प्रयासों को याद किया और बताया कि हम शीघ्र ही अपने वैज्ञानिक क्षेत्र से संबंधित कार्यों पर एक हिंदी की पुस्तक भी प्रकाशित करने वाले हैं। डॉ० नानोटी ने यह भी उद्धृत किया:-

> ''भाषा की समस्या का अंत चाहते हैं,
> हिंदी के उपवन में वसंत चाहते हैं'''

इस अवसर पर मुख्य अतिथि ने विभिन्न प्रतियोगिताओं (यथा: टिप्पण/प्रारूपण, अनुवाद एवं शब्दावली, सुलेख, निबंध, हस्ताक्षर, स्वरचित कविता-पाठ एवं आशु-भाषण) के विजेताओं को पुरस्कार वितरित किए। धन्यवाद प्रस्ताव ज्ञापित करते हुए संस्थान के प्रशासन नियंत्रक श्री विजय कुमार कौशिक ने कहा कि डॉ० रत्तू का व्याख्यान हिंदी के पोषण हेतु हमारे भीतर छिपी शक्ति के लिए चिंगारी का कार्य करेगा। श्री कौशिक ने हिंदी के क्षेत्र में संस्थान की सफलताओं (यथा हाल ही में हिंदी दिवस, 2011 के अवसर पर भारत की परमश्रेष्ठ राष्ट्रपति द्वारा संस्थान की पत्रिका 'विकल्प' को प्रदत्त प्रथम पुरस्कार) के प्रकाश में लोगों से आग्रह किया कि वे और भी अधिक ऊर्जा से कार्य करें।

8.3 संगोष्ठियाँ/कार्यशालाएँ

8.3.1 आंतरिक हिंदी वैज्ञानिक संगोष्ठियाँ

- **33वीं आंतरिक हिंदी वैज्ञानिक संगोष्ठी, 15 जून, 2011**

'33वीं आंतरिक हिंदी वैज्ञानिक संगोष्ठी' में डॉ० देवाशीष घोष ने 'उत्तराखंड हिमालय से एक सूक्ष्मजीवीय एस्टरेज़: शुद्धिकरण तथा अभिलक्षण', श्री राकेश कुमार ने 'जैव ईधन: ड्रॉप-इन वैकल्पिक विमानन ईधन', सुश्री मनीषा सहाय ने 'टार सैंड', सुश्री नीलिमा शाह ने 'सौर सेल रचना में प्रोटीन का योगदान' तथा डॉ० एच यू खान ने 'घरेलू इलेक्ट्रॉनिक उपकरणों की अत्यधिक खपत: वरदान या अभिशाप' विषयों पर प्रस्तुतियां दीं।

प्रशासन नियंत्रक श्री विजय कुमार कौशिक ने कहा कि इस प्रयास से विज्ञान लेखन में रुचि पैदा हो सकती है। इसमें वरिष्ठ वैज्ञानिकों, तकनीकी कर्मचारियों एवं विभिन्न प्रतिष्ठानों से आए प्रशिक्षणार्थियों, परियोजना सहायकों एवं शोधार्थियों/विद्यार्थियों आदि ने भी भाग लिया।

- **34वीं आंतरिक हिंदी वैज्ञानिक संगोष्ठी, 19 अगस्त, 2011**

इस संगोष्ठी में श्री आनंद सिंह ने 'मान वर्धन तकनीक' (सुश्री ऋचा सिंघल ने 'शैवाल ऊर्जा' (श्री सुंदराम शर्मा ने 'मध्य आसुतों तथा उनकी अंतर्निर्भरता के वाष्पशील अभिलक्षणों पर अध्ययन' (श्री सुनील पाठक ने 'वाहनों से नैनो कणों का उत्सर्जन' (श्री एम के एस अलूपवान ने 'सिलिका वाले कच्चे तेल में आयरन, कॉपर, निकिल वैनेडियम, जिंक का आइ सी पी तकनीक द्वारा निर्धारण करना' तथा श्री सिया राम ने 'पराबैंगनी दृश्य स्पेक्ट्रममिति द्वारा पेट्रोलियम उत्पादकों में ऐरोमैटिकों की प्रतिशतता तथा गुणवत्ता का आकलन' विषयों पर प्रस्तुतियां दी।

- **35वीं आंतरिक हिंदी वैज्ञानिक संगोष्ठी, 16 दिसंबर, 2011**

इस संगोष्ठी में श्री मृत्युंजय कुमार शुक्ल एवं श्री ई. किसन ने 'एल्कोहॉल ईधनों के प्रयोग से ध्वनि प्रदूषण का अध्ययन', श्री हर्षल पी. मुंगसे ने 'ग्रैफ़ीन ऑक्साइड में ऍल्किल ऍमीन का संनिवेशन', डॉ० सुमन लता जैन ने 'संधारणीय कार्बनिक संश्लेषण के विकास हेतु उत्प्रेरक तथा हरित रसायन', श्री पीयूष गुप्ता, ने 'उत्प्रेरकीय पुन:संभावन', डॉ० एच यू खान ने 'प्रवाहिकी के मूल तत्व: एक परिचर्चा' तथा श्री ए के जैन एवं श्री सुनील पाठक ने 'वाहन उत्सर्जनों तथा ईधन बचत पर सड़क गुणवत्ता, यात्रा प्रबंधन तथा चालक प्रशिक्षण का प्रभाव-भारतीय सड़कों पर एक प्रयोगात्मक अध्ययन' विषयों पर प्रस्तुतियां दीं।

- **36वीं आंतरिक हिंदी वैज्ञानिक संगोष्ठी, 21 मार्च, 2012**

इस संगोष्ठी में डॉ० गौतम दास ने 'गुरुतर पेट्रोलियम प्रभाजों के मधुरण हेतु कोबाल्ट थैलोसायानाइन डाइक्लोराइड उत्प्रेरक का विकास' (श्री पंकज कुमार आर्य ने 'प्रयोगात्मक जल तापक में काष्ठ-आधारित ताप अपघटन तेल का दहन' (डॉ० सनत कुमार ने 'पी पी डी की दक्षता को बाधित करने वाले अणुओं को ज्ञात करने का योजनाबद्ध अवलोकन: केस अध्ययन : उच्च रंध्र तथा उच्च ऍस्फॉल्टिक कच्चा तेल' (श्री एस एन यादव ने 'भारतीय परिवेश में नीड्ल् कोक के उत्पादन की संभावनाएं' तथा श्री गजेंद्र मोहन बहुगुणा ने 'अंतरिक्ष की खोज में स्पेक्ट्रोस्कोपी का अनुप्रयोग' विषयों पर प्रस्तुतियां दीं।

9

The Institute as an Academic Institution

9.1 CSIR-PGRPE PROGRAMME AT CSIR-IIP

M.Tech (Provisional) Degree for PGRPE Students

The first (2009-2011) batch of the students of the CSIR-initiated 2-year Post-Graduate Research Programme in Engineering (PGRPE) graduated on 15th September, 2011. The CSIR-IIP, as the nodal laboratory for 'Advanced Petroleum Science & Technology' (APST), launched this programme (PGRPE-APST) in 2009 in which four B.Tech. degree holders were enrolled. The programme was formally inaugurated on September 8, 2009, by Prof. S K Brahmachari, DG-CSIR.

The M.Tech. (Provisional) Degree was awarded at a ceremony held on September 15, 2011 in the Shanti Swarup Bhatnagar Hall of the CSIR Headquarters at the Anusandhan Bhavan, New Delhi. The function was presided over by Prof S K Brahmachari. The Convocation Lecture was delivered by Mr Sam Pitroda, Advisor to the Prime Minister of India. A total of 51 PGRPE students graduated this year, including Ms Bhavya B., Mr Anand Mohit, Mr Diptarka Dasgupta and Mr Indrajit Ghosh from the CSIR-IIP. The function was co-ordinated by Prof. Gautam Biswas, Acting Director, AcSIR and Dr Nagesh Iyer, Acting Associate Director, AcSIR, and attended by the Directors of the CSIR Laboratories/Institutes concerned, Deans & Associate Deans of the AcSIR and the PGRPE Co-ordinators.

Group photo of all graduating PGRPE students of the 2009-2011 batch

10

The CSIR-IIP Family

Staff List as on 31st March, 2012

10.1 SCIENTISTS GROUP-IV

Name of employee	Designation
Dr M O Garg	Director
Dr A N Goswami	Chief Scientist
Mr U C Agarwal	Chief Scientist
Dr S M Nanoti	Chief Scientist
Mr B M Shukla	Chief Scientist
Dr S K Singhal	Chief Scientist
Dr D K Adhikari	Chief Scientist
Mr Nishan Singh	Chief Scientist
Mr A K Jain	Chief Scientist
Dr A K Chatterjee	Chief Scientist
Dr Mahendra Pal	Chief Scientist
Mr A K Aigal	Sr Principal Scientist
Dr Y K Sharma	Sr Principal Scientist
Dr S K Sharma	Sr Principal Scientist
Dr Gautam Dass	Sr Principal Scientist
Mr U K Jaiswal	Sr Principal Scientist
Mr N K Pandey	Sr Principal Scientist
Mr Sudhanshu Gupta	Sr Principal Scientist
Dr S S Ray	Sr Principal Scientist
Dr (Mrs) Anshu Nanoti	Sr Principal Scientist
Dr Neeraj Athaiya	Sr Principal Scientist
Mr S K Ganguli	Principal Scientist
Mrs Poonam Gupta	Principal Scientist
Dr (Mrs) Savita Kaul	Principal Scientist
Mr A K Saxena	Principal Scientist
Dr N Vishwanadham	Principal Scientist
Mr Rajesh Kumar	Principal Scientist
Mr P Vijayanand	Principal Scientist
Dr Manoj Srivastava	Principal Scientist
Dr Samir Kumar Maiti	Principal Scientist
Mr V S Dangwal	Senior Scientist
Mr P C Joshi	Senior Scientist
Dr V V D N Prasad	Senior Scientist
Dr T Venkateshwar Rao	Senior Scientist
Dr P S Verma	Senior Scientist
Dr Anil Kumar Sinha	Senior Scientist
Dr Anil Kumar Jain	Senior Scientist
Dr Thallada Bhaskar	Senior Scientist

Mr Sunil Pathak	Senior Scientist
Dr Sanat Kumar	Senior Scientist
Dr Neeraj Atrey	Senior Scientist
Dr Suman Lata Jain	Senior Scientist
Dr O P Khatri	Senior Scientist
Dr Shailendra Tripathi	Scientist
Mr L Robindro	Scientist
Mr Devender Singh	Scientist
Mr Suryadev Kumar	Scientist
Mr Wittison Kamei	Scientist
Dr Soumen Dasgupta	Scientist
Dr Rajaram Bal	Scientist
Dr Atul Ranjan	Scientist
Mr G D Thakre	Scientist
Mr Arakshita Mazhi	Scientist
Mr D V Naik	Scientist
Dr Ajay Kumar	Scientist
Mr Mritunjay Kumar Shukla	Scientist
Mr Sunil Kumar	Scientist
Mr Prasenjit Ghosh	Scientist
Mr Salim Akhtar Faruqi	Scientist
Ms Richa Singhal	Scientist
Ms Aarti	Scientist
Dr Babita Behera	Scientist
Dr Debashish Ghosh	Scientist
Mr Pankaj Kumar Kannaujia	Scientist
Mr Deeptarka Dasgupta	Scientist
Ms Bhavya B	Scientist
Ms Deepti Agarwal	Scientist
Mr Anand Mohit	Scientist
Mr Sunil Kumar Suman	Scientist
Mr Indrajeet Kumar Ghosh	Scientist
Dr Subham Paul	Scietnist
Dr Umesh Kumar	Scientist
Mr Swapnil Divekar	Jr. Scientist
Mr Sandip Kumar Biswas	Jr. Scientist
Mr Pankaj Kumar Arya	Jr. Scientist
Dr Rashmi	Jr. Scientist
Dr Raj Kumar Singh	Jr. Scientist

10.2 TECHNICAL STAFF GROUP III

Mr Sunil Pathak	Senior Scientist
Dr (Mrs) Lalita Bakaya	Principal Technical Officer (RMO)
Mr Babu Lal	Sr Technical Officer (3)
Dr D C Pandey	Sr Technical Officer (3)
Dr R K Chauhan	Sr Technical Officer (3)
Mr Anand Singh	Sr Technical Officer (3)
Mr D P Bangwal	Sr Technical Officer (3)
Dr Jasvinder Singh	Sr Technical Officer (3)
Dr Ajay Kumar Gupta	Sr Technical Officer (3)
Dr K S Rawat	Sr Technical Officer (3)
Mr M L Sharma II	Sr Technical Officer (3)
Mr Manoj Kumar	Sr Technical Officer (3)
Mr Laxmi Narayan	Sr Technical Officer (3)
Mr C R Srivastava	Sr Technical Officer (3)
Dr B R Nautiyal	Sr Technical Officer (3)
Mr R C Saxena	Sr Technical Officer (3)
Mr Servjeet Singh	Sr Technical Officer (3)
Mr Mahipal	Sr Technical Officer (3)
Mr Hakim Singh	Sr Technical Officer (3)
Mrs Pushpa Gupta	Sr Technical Officer (3)
Mr K K Singh	Sr Technical Officer (3)
Mr Girender Singh	Sr Technical Officer (3)
Mr Siya Ram	Sr Technical Officer (3)
Mr G M Bahuguna	Sr Technical Officer (2)
Mr Yog Raj	Sr Technical Officer (2)
Mr V S Kukreti	Sr Technical Officer (2)
Mr S Uppadhyay	Sr Technical Officer (2)
Mr K P Bhatt	Sr Technical Officer (2)
Mr Ravi Khanna	Sr Technical Officer (2)
Mr Man Mohan Kumar	Sr Technical Officer (2)
Mr Yograj Singh	Sr Technical Officer (2)
Mr Kalyan Singh	Sr Technical Officer (2)
Mr Deependra Kumar Pandey	Sr Technical Officer (1)
Mr M K S Aloopwan	Sr Technical Officer (1)
Mr Hari Chand Singh	Sr Technical Officer (1)
Mr C D Sharma	Sr Technical Officer (1)
Mr Sath Pal Singh	Sr Technical Officer (1)
Mr Sunil Kumar	Sr Technical Officer (1)
Mr Rakesh Kumar	Sr Technical Officer (1)
Mr Mukesh Sharma	Sr Technical Officer (1)
Mr Sandeep Saran	Sr Technical Officer (1)
Mr Satish Kumar	Sr Technical Officer (1)
Mr Jagdish Kumar	Sr Technical Officer (1)
Mr Manoj Kumar	Sr Technical Officer (1)
Mr Rakesh Kumar Joshi	Technical Officer
Mr Vineet Sood	Technical Officer
Mr Satya Niketan Yadav	Technical Officer
Mr Rajendra Badola	Technical Officer
Mr Sarvanad Tiwari	Technical Assistant
Mr Amit Sharma	Technical Assistant
Mr Om Prakash Sharma	Technical Assistant
Mrs Nisha	Technical Assistant
Ms Rekha Chanuhan	Technical Assistant
Mr Sund Ram Sharma	Technical Assistant
Ms Smita Darmora	Technical Assistant
Mr Kamal Kumar	Technical Assistant
Ms Pooja Yadav	Technical Assistant
Ms Jyoti Porwal	Technical Assistant
Mrs Sandhya Jain	Technical Assistant
Mr Yashveer Singh Meena	Technical Assistant
Mr Chandrashekar Pendem	Technical Assistant
Mr Praveen Kumar Khatri	Technical Assistant
Mrs Kamla Yadav	Technical Assistant
Ms Manisha Sahai	Technical Assistant
Mr K L N Konthala	Technical Assistant
Mr Srinivas Halavath	Technical Assistant
Mr Piyush Gupta,	Technical Assistant
Mr Rohit Kumar	Technical Assistant
Ms Rashmi	Technical Assistant
Mr Pradeep Kumar	Technical Assistant
Mr Raguvir Singh	Technical Assistant
Mr Deependra Tripathi	Technical Assistant
Mr V Bhanu Prasad	Technical Assistant
Ms P Padma Latha	Technical Assistant
Mr Mukesh Kumar Poddar	Technical Assistant

10.3 TECHNICIAN STAFF GROUP II

Mr P B Pant	Sr Technician (2)
Mr P S Lal	Sr Technician (2)
Mr Triloki Prasad	Sr Technician (2)
Mr R D Singh	Sr Technician (2)

Mr Mohkam Singh	Sr Technician (2)
Mr Ram Pal Singh	Sr Technician (2)
Mr Paramjeet Singh I	Sr Technician (2)
Mr G C Bahuguna	Sr Technician (2)
Mr V P Mamgain	Sr Technician (1)
Mr Madan Gopal	Sr Technician (1)
Mr T C Sharma	Sr Technician (1)
Mr N N Bahuguna	Sr Technician (1)
Mr Deep Chand	Sr Technician (1)
Mr Harbhajan Singh	Sr Technician (1)
Mr H K Sahi	Sr Technician (1)
Mr Paramjeet Singh II	Sr. Technician (1)
Mr Rajeev Sharma	Technician (2)
Mr Rajnish Bhatnagar	Technician (2)
Mrs Anjali Bhatnagar	Technician (2)
Mr Anil Kumar	Technician (2)
Mr Rajpal Singh	Technician (2)
Mr N K Rawat	Technician (2)
Mr Prem Chand Verma	Technician (2)
Mr Sanjeev Kumar	Technician (1)
Mr Mayank Mishra	Technician (1)
Mr Pradeep Singh Negi	Technician (1)
Mr Devender Singh Batola	Technician (1)
Mr Binod Kumar	Technician (1)
Mr Puran Singh Aswal	Technician (1)
Mr Pradeep Singh Panwar	Technician (1)
Mr Rituraj Negi	Technician (1)
Mr Parvej Alam	Technician (1)
Mr Vivek Kumar Sharma	Technician (1)
Mr Rajendra Kumar	Technician (1)
Mr Naseem Ahmed	Technician (1)
Mr Ashok Kumar Thakur	Technician (1)
Mr Gembbir Singh	Technician (1)
Mr Ashok Kumar	Technician (1)
Mr Mahendra Singh Negi	Technician (1)
Mr Shiv Prasad Nautiyal	Technician (1)
Mr Manmohan S. Gosain	Technician (1)
Mr Daniel Shah	Technician (1)
Mr Rajeev Panwar	Technician (1)
Mr Indu Shekhar	Technician (1)
Mr Sandeep Kumar Saxena	Technician (1)
Dr (Mrs) Aruna Kukreti	Technician (1)
Mr Satish Mani	Technician (1)
Mr Khem Singh	Technician (1)
Mr Abbal Singh	Technician (1)
Mr Girish Chand Tiwari	Technician (1)
Mr Rajesh Sharma	Technician (1)
Mr Naveen Kr. Maurya	Technician (1)
Mr Pushp Raj Sharma	Technician (1)
Dr (Mrs) P Nagendramma	Technician (1)
Mr Tasleem Khan	Technician (1)
Mrs Ritu Mourya	Nursing Sister (ANM) Non-Tech
Mr Hari Prakash	Pharmacist (Non-FCS)

10.4 LABORATORY STAFF GROUP I

Mr Vijay Singh	Laboratory Attendant
Mr Ranjeet Singh	Laboratory Assistant
Mr Budh Singh	Laboratory Assistant
Mr D B Shukla	Laboratory Assistant
Mr Jagdish Singh	Laboratory Assistant
Mr Hari Kishan	Laboratory Assistant
Mr Sukhbir	Laboratory Assistant
Mr Kaman Singh	Laboratory Assistant
Mr Ashok Kumar	Laboratory Assistant
Mrs Maya Gusain	Laboratory Assistant
Mr Balbir Singh II (GB)	Laboratory Assistant
Mr Raj Kumar	Laboratory Assistant
Mr S P Mani	Laboratory Assistant
Mr Balbir Singh I	Laboratory Assistant
Mr Mohd Parvej	Laboratory Assistant
Mr Shyam Singh	Laboratory Attendant (2)
Mr Surat Ram	Laboratory Attendant (2)
Mr Mahesh Pal	Laboratory Attendant (2)
Mr Ranbir Singh	Laboratory Attendant (2)
Mrs Shyam Lata	Laboratory Attendant (2)
Mr Sanjay Kumar	Laboratory Attendant (2)
Mrs Ganga Devi	Laboratory Attendant (2)
Mr Jai Prakash	Laboratory Attendant (2)
Mr Bharat Singh	Laboratory Attendant (2)
Mr S K Verma	Laboratory Attendant (2)
Mrs Kanta Devi	Laboratory Attendant (2)
Mr Dinesh Chandra	Laboratory Attendant (1)
Mr Sunil Kumar	Laboratory Attendant (1)

Mr Naveen Bhatt	Laboratory Attendant (1)
Mr Burhanudeen	Laboratory Attendant (1)
Mr Hari Singh	Laboratory Attendant (1)
Mr Narendra Singh Negi	Laboratory Attendant (1)
Mr Harold Gladwyn	Laboratory Attendant (1)
Mr Mohan Singh	Laboratory Attendant (1)
Mr Jyoti Prasad	Laboratory Attendant (1)
Mr Sanjay Kumar	Laboratory Attendant (1)
Mr Shivram Singh	Laboratory Attendant (1)
Mr Rakesh Kumar	Laboratory Attendant (1)
Mr Pradeep Singh Pundir	Laboratory Attendant (1)
Mr Ram Kishore Maurya	Laboratory Attendant (1)

10.5 ADMINISTRATIVE STAFF

10.5.1 COMMON CADRE OFFICERS

Mr V K Kaushika	Controller of Administration
Mr Suresh Pant	Stores & Purchase Officer
Mr M S Mehra	Finance & Accounts Officer
Mr Parvesh Chand	Section Officer (General)
Mr Pankaj Kumar	Section Officer (General)
Mr Rajeev Kumar Verma	Section Officer (General))
Mr Prasoon Kumar	Section Officer (General)
Mr Mukesh Kumar Gairola	Section Officer (General)
Mr Shivraj Singh Kushwaha	Section Officer(Stores & Purchase)
Mr C S Bisht	Section Officer(Finance & Accounts)
Mr R K Kapoor	Private Secretary

10.5.2 ASSISTANTS GRADE I

Mr Ramesh Kumar Joshi	Assistant (General) Grade-I
Mr D S Negi	Assistant (General) Grade-I
Mr R S Chauhan	Assistant (General) Grade-I
Mr Manbar Singh Negi	Assistant (General) Grade-I
Mr Vijay Kumar Kataria	Assistant (General) Grade-I
Mrs Vineeta Walia	Assistant (General) Grade-I
Mr Manoj Tiwari	Assistant (General) Grade-I
Mr Arvind Arora	Assistant (General) Grade-I
Mrs Kanak Kuchhal	Assistant (General) Grade-I
Mohd Javed	Assistant (General) Grade-I
Mrs Abha Dhyani	Assistant (General) Grade-I
Ms Neha Nautiyal	Assistant (General) Grade-I
Mr B B Dimri	Assistant (General) Grade-I
Mr Vishvendra K Dogra	Jr. Steno
Mrs Shobha Panwar	Assistant (Finance & Accounts) Grade-I
Mr Satish Chand	Assistant (Finance & Accounts) Grade-I
Mr L R Kaushik	Assistant (Stores & Purchase) Grade-I
Mr V K Kapoor	Assistant (Stores & Purchase) Grade-I
Ms Meena Kumari	Assistant (Stores & Purchase) Grade-I
Mr R N Sharma	Assistant (Stores & Purchase) Grade-I
Mr R K Bhattacharya	Assistant (Stores & Purchase) Grade-I
Mr Pramod Joshi	Assistant (Stores & Purchase) Grade-I

10.5.3 ASSISTANTS GRADE II

Mr Adesh Seth	Assistant (General) Grade-II)
Ms Pratima Bagga	Assistant (General) Grade-II)
Mr Jassu Kumar Sharma	Assistant (General) Grade-II)
Mrs Anju Sharma	Assistant (General) Grade-II)
Mr Rakesh Pant	Assistant (General) Grade-II)
Mrs Kiran Lata	Assistant (General) Grade-II)
Mrs Anita Devi	Assistant (General) Grade-II)
Mr Sanjay Pokhriyal	Assistant (General) Grade-II)
Mr Harjeet Singh	Assistant (General) Grade-II)
Mr Kulwant Singh	Assistant (General) Grade-II)
Mrs Harvinder Kaur	Assistant (General) Grade-II)
Mr Shiv Prasad Saklani	Assistant (Finance & Accounts) Grade-II
Mrs Seema Sharma	Assistant (Finance & Accounts) Grade-II
Mr Jitendra Singh Negi	Assistant (Finance & Accounts) Grade-II
Mr Pankaj Mourya	Assistant (Finance & Accounts) Grade-II
Mr Mahesh Kumar Jatav	Assistant (Finance & Accounts) Grade-II
Mr M.P.S. Arora	Assistant (Stores & Purchase) Grade-II
Mr Vikram Singh	Assistant (Stores & Purchase) Grade-II
Mr Dinesh Chandra	Assistant (Stores & Purchase) Grade-II
Ms Asha Joshi	Assistant (Stores & Purchase) Grade-II
Mr Himmat Singh	Assistant (Stores & Purchase) Grade-II

10.5.4 ASSISTANTS GRADE III

Mr Vishvendra K Dogra	Jr. Steno
Mr Ashish Raturi	Assistant(Finance & Accounts) Grade-III
Mr Jitendra Singh Rawat	Assistant (General) Grade-III
Mrs Kiran Bala	Assistant (General) Grade-III
Mr Sunil Rawat	Assistant (Stores & Purchase) Grade-III
Mohd. Furkan Saifi	Assistant(Finance & Accounts) Grade-III

10.5.5 STENOGRAPHIC GADRE

Mr G S Sharma	Sr Stenographer(Assured Career Progression)
Mrs Geeta Chhetri	Sr Stenographer(Assured Career Progression)
Mr Suresh Kothari	Sr Stenographer(Assured Career Progression)
Mr S C Bhatt	Sr Stenographer
Mr G P Sharma	Sr Stenographer
Mr P S Chauhan	Sr Stenographer
Mrs Saroj Kushwaha	Sr Stenographer
Mr Devendra Rai	Sr Stenographer
Ms Reena Sharma	Sr Stenographer
Ms Kusum	Sr Stenographer
Mrs Bhawana Rawat	Jr Stenographer
Mrs Pratima Rana	Jr Stenographer
Mr Rajendra Kumar	Jr Stenographer
Mrs Shaloo Vinodhia	Jr Stenographer
Mr Navneet Singh Rana	Jr Stenographer

10.5.6 ISOLATED POSTS

Dr D C Chamola	Sr Hindi Officer
Mr M C Ratori	Hindi Officer
Capt R J Simon	Sr Security Officer
Mr Mohar Singh Nirala	Driver
Mr Tajender Singh	Driver
Mr G S Mehta	Driver
Mr Rajender Prasad	Driver
Mr Mukesh Kumar	Driver
Mr G S Rawat	Driver

10.5.7 CANTEEN STAFF

Mr Bharat Singh Bisht	Assistant Halwai-cum-Cook
Mr Lok Bahadur	Tea/Coffee Maker(Assured Career Progression)
Mr Gopal Singh	Bearer (Assured Career Progression)
Mr Sudama Singh	Bearer (Assured Career Progression)
Mr Matbar Singh I	Bearer (Assured Career Progression)
Mr Matbar Singh II	Bearer (Assured Career Progression)
Mr Asha Ram	Bearer (Assured Career Progression)
Mr Munish Kumar	Safai Karmachari (Assured Career Progression)

10.5.8 GROUP C STAFF (NON-TECHNICAL)

Mr Mandev Singh	Junior Security Guard(Assured Career Progression)
Mr Deepak Kumar	Group C(Assured Career Progression)
Mr Raja Ram	Junior Security Guard (Assured Career Progression)
Mr K N Sharma	Junior Security Guard(Assured Career Progression)
Mr B B Ekka	Junior Security Guard(Assured Career Progression)
Mr Gopal Singh	Junior Security Guard
Mr Ghanshyam	Group C
Mr Mukesh Kumar	Group C
Mr Ram Pal	Group C
Mr Chandra Sekhar	Group C
Mr Rajesh Kumar	Group C
Mr Dalip Kumar	Safai Karamachari
Mr Naresh Kumar	Group C
Mr Surjeet Thapa	Group C
Mr Kamal Kumar	Group C
Mr Satish Kumar	Group C
Mr Ajay Pal	Group C
Mr D S Adhikari	Group C
Mrs Bharti Payal	Group C
Mr H K Tiwari	Group C
Mr B S Bisht	Group C
Mr Sudama Singh	Group C
Mr L S Rawat	Group C
Mr Rajbeer Singh	Group C
Mr Amit Upadhyay	Group C
Mr Ramesh Chandra	Group C
Mr Shiv Singh Rawat	Group C
Mr Ajay Paul	Group C
Mr Pankaj Bhaskar	Group C
Mr Murlidhar Chandna	Group C
Mr Tika Ram Bhatt	Group C
Mr V S Kandari	Group C
Mr Vishwas Kumar	Group C
Mr Rajesh Kumar	Group C
Mr Manoj Kumar	Group C
Mr Sanjay Kumar	Group C
Mrs Yashoda	Group C
Mr Rajendra Prasad	Group C
Mr Kalu Ram	Group C
Mr R P Dabral	Group C
Mr Mannu Ram	Group C
Mr Irshad Khan	Group C
Mr Suresh Kumar	Farash
Mr Kedar Dutt Pandey	Group C
Mr Gokul Prasad	Group C

Mr Vivek Singh	Group C
Mr Harish Kumar	Group C
Mr Bijendra Dutt	Group C
Mr Ghanshyam	Group C
Mr Rajesh	Farash
Mr Tanveer Ahmad	Group C
Mr Vijay Kumar Verma	Group C
Mr Sanjay	Group C
Mr Tilak Kumar	Farash
Ms Sarveshvari Devi	Group-C (Non-Technical)
Mr Kamal Singh	Group-C (Non-Technical)
Smt Shyamkali	Group-C (Non-Technical)
Mr Mukesh Kumar	Group-C (Non-Technical)

Mr Chander Singh	Group-C (Non-Technical)
Mr Kishore Kumar	Group-C (Non-Technical)
Mr Surender Kumar	Group-C (Non-Technical)
Mr Rajesh Kumar	Group-C (Non-Technical)
Mr Arvind Khandoori	Group-C (Non-Technical)
Mrs Sureshi Rawat	Chair Caner (Non-Technical)
Mr Ramchander	Group C (Non-Technical)
Mr Suresh Chand	Group-C (Non-Technical)
Mr G B Khatri	Group-C ((Non-Technical))
Mr Mukul Sharma	Group-C (Non-Technical)
Mr D S Pundir	Group-C (Non-Technical)
Mrs Urmila Sundriyal	Record Keeper Group-C (Non-Technical)
Mrs Uma Devi	Trainee

सीएसआइआर – भारतीय पेट्रोलियम संस्थान, देहरादून

CSIR-Indian Institute of Petroleum, Dehradun

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