



IMMT's Mission Terafil takes off

THE Institute of Minerals and Materials Technology (IMMT) (formerly RRL), Bhubaneswar, had developed the Terafil™ water filter to provide an affordable technology for safe drinking water in the rural and semi-urban areas of the country. Abundant availability of the raw materials used and low cost of production of Terafil™ has given the innovation a cottage industry status, thereby opening avenues for employment in the rural sector.

The Terafil™ filter candles (disc) are prepared from a mixture of pottery clay, river sand and wood saw dust and sintered in a low-cost kiln for mass production of desired shape and size. The discs could then be fitted into a variety of containers including earthen pots, and GI and plastic buckets. A Terafil™ disc of 100 mm diameter is capable of filtering 1 litre of turbid water of 200-300 NTU to less than 1 NTU in one hour. Additionally it removes about 90% iron and 94-99% microorganisms from the water.

IMMT has already licensed the technology for making and marketing Terafil™ discs to four parties in Orissa and has demonstrated the technology in various states including U.P., Jharkhand, Meghalaya, etc. Over 50,000 water filters have been distributed and sold through various government agencies and NGOs. The filter was extensively used by the people of Orissa during the super cyclone in the state in 1999, at a time when almost all sources of water were polluted in the coastal districts. IMMT has subsequently improved the technology for online filtration and community size filters.



Chief Minister of Orissa Shri Naveen Patnaik, Minister of Law, Industry & Rural Development Shri B.B. Harichandan, Minister of Woman & Child Development Mrs Pramila Mallik, several senior state government secretaries including Addl. Chief Secretary to the government Shri R.N. Bohidar, Director, scientists and some staff members of IMMT and CIPET, during the launching of Terafil water filter on 10 August 2007 at Bhubaneswar.



R & D Highlights

The Government of Orissa recently gave a boost to IMMT's impending desire for extensive propagation of the Terafil™ mechanism in the state to solve the drinking water problem in the rural areas. The state government has funded a mega project to develop over 75,000 sets of Terafil™ water filters of 30 litre capacity using food grade plastic containers. IMMT is collaborating with the Central Institute of Plastic Engineering and Technology (CIPET), Bhubaneswar, to manufacture the containers

designed by IMMT. The filters are being assembled and tested at IMMT for distribution to *Anganwadis*, schools, PHCs and *Gram Panchayat* offices, etc. through the state government departments concerned with Women and Child Development, Health, Education, etc. A few designated self help groups of the government will also be trained on the manufacturing techniques by IMMT and will be given license for large scale production of Terafil™ discs in different corners of Orissa shortly.

Hon'ble Chief Minister of Orissa Shri Naveen Patnaik inaugurated the launching of Terafil™ water filter on 10 August 2007 at Bhubaneswar. The Director, scientists and some staff members of IMMT and CIPET, Hon'ble Minister of Law, Industry & Rural Development Shri B.B. Harichandan, Hon'ble Minister of Woman & Child Development Mrs Pramila Mallik, and several senior state government secretaries including Addl. Chief Secretary to the government Shri R.N. Bohidar were present on the occasion.



Clockwise from left : Hon'ble Chief Minister of Orissa, Shri Naveen Patnaik launching the new Terafil™ water filter at Bhubaneswar; Shri B.K. Mishra, Director IMMT and Project Leader, Shri S. Khuntia discussing the performance of Terafil™ water filter with Hon'ble Chief Minister; Terafil™ water filters being tested at IMMT before packaging; and Terafil™ water filters ready for dispatch

CLRI's Biodiesel Technology Transfer to M/s Vel Biodiesel Energy Pvt. Ltd

THE Central Leather Research Institute (CLRI), Chennai, under the leadership of Dr T. Ramasami, former Director, CLRI and presently Secretary, Department of Science and Technology and Director General, CSIR, had signed an agreement with M/s Vel Biodiesel Energy Pvt. Ltd for the transfer of biodiesel technology on 28 November 2005. The demonstration of the biodiesel process was inaugurated by Dr S. Rajamani (former Director, CLRI) and Dr A.B. Mandal, Director Grade Scientist, on 28 June 2006.

Now, on 7 September 2007, Shri S.V. Balraj, Managing Director, M/s Vel Biodiesel Energy Pvt. Ltd, has paid 2nd and 3rd installments of Rs 89.888 lakh to Dr A.B. Mandal, Director, CLRI, for the biodiesel technology, in the presence of Shri S.P. Velayutham, Chairman, M/s Vel Biodiesel Energy Pvt. Ltd and the area leaders of CLRI.

The Director CLRI and all area leaders of CLRI congratulated the biodiesel process innovator Shri K.C. Velappan, Scientist, for the great achievement — technology transfer leading to External Cash Flow of rupees one crore.



Shri S.V. Balraj, Managing Director, M/s Vel Biodiesel Energy Pvt. Ltd, handing over the cheque to Dr A.B. Mandal, Director, CLRI

NEERI-DVC Agreement for developing Pollution Abatement Strategies for Damodar River System

A large number of industries have come up in the Bokaro-Dhanbad region of Jharkhand and Asansol-Durgapur region of West Bengal in the Damodar river watershed since 1960s. The river system alongwith four major dams receives grossly polluted wastewater from the industries and towns located in the watershed. Subsequent to a study carried out by several organizations including National Environmental Engineering Research Institute (NEERI), Nagpur, in 1994, Damodar Valley Corporation (DVC) desired NEERI to evolve pollution abatement strategies under the present circumstances through detailed water and wastewater analysis as well as appropriate wastewater treatment and catchment management practices.



Shri Ashutosh Chakravarty, Additional Secretary, DVC (*extreme left*) and Dr Apurba Gupta, Dy. Director, NEERI, signing the NEERI-DVC agreement. Seen in the centre is Shri S. Barari, CEO, EM&PC, DVC



In a joint meeting between DVC and NEERI, held in the recent past, Shri Asim K. Barman, Chairman, DVC, asked NEERI to prepare a detailed action plan indicating short and long term measures for protecting the river and reservoirs in the Damodar River System while developing Comprehensive Water Use Policy for the basin. DVC agreed to pay Rs 1.2 crore for this consultancy service to NEERI. This consultancy project is expected to be completed within sixteen months. NEERI will utilize the services of field laboratories at Durgapur, Dhanbad and Bokaro with the assistance of West Bengal and Jharkhand Pollution Control Boards in addition to the facilities available at NEERI headquarters in Nagpur and its Zonal Laboratory in Kolkata. Er. A.K. Biswas and Er. P.S. Kelkar of NEERI will lead the field survey pertaining to the project. The overall project will be led by Dr A. Gupta and assisted by Dr R.A. Sohony. Dr S. Devotta, Director, NEERI, will coordinate the project.

NEERI undertakes EIA study for Mumbai Sewage Disposal Project, Stage II, Priority Works

THE Municipal Corporation of Brihan Mumbai (MCBM) has undertaken Mumbai Sewage Disposal Project, Stage II, Priority Works, for improvement of environment in and around the Mumbai city. The priority works for implementation include sewage and treated effluent pumping stations at Versova and Malad along with the respective pumping mains, modifications of treatment plants at Versova, Malad, Colaba, Worli, Bhandup, Ghatkopar and Dharavi as well as the ocean outfall system at Erangal. Most of the installations are located in the Coastal Regulatory Zone (CRZ) and expected to create environment impact during construction and operational phases to the coastal environment including mangroves. MCBM has assigned to NEERI to carry out a

comprehensive Environmental Impact Analysis (EIA) for these installations and recommend appropriate Environmental Management Plan (EMP).

The impact assessment will include detailed water quality assessment in the coastal areas around Mumbai including the western coast and Thane creek. The study is also expected to recommend possible measures for further improvement of water quality in addition to the proposed wastewater treatment facilities for generating higher assimilative capacity of the heavily



The coastal survey team studying the ocean sampling sites (top), and Physico-chemical analysis (above left) and Biological analysis in progress (above right)

polluted creeks. MCBM has agreed to pay Rs 1.26 crore for this consultancy service.

NEERI will carry out extensive monitoring of coastal and creek waters, quantify and characterize treated and untreated wastewater discharges, monitor air, noise, land use, soil, groundwater, biological and socio-economic status around the installations. State of art water quality and hydrodynamic models will be used for predicting and evolving possible solutions for improvement of the environmental conditions. Dr Smt. S.S. Dhage, Er. P.S. Kelkar and Dr T.K. Ghosh will lead the various monitoring programmes. Dr A. Gupta, assisted by Er. Ritesh Vijay, will lead the overall activities including modelling. Dr S. Devotta, Director, NEERI, will coordinate the project.

NEIST: New Projects undertaken and Patents Filed/Granted

THE North - East Institute of Science and Technology (NEIST), Jorhat, has undertaken the following grants-in-aid project:

- Survey, isolation, identification and preliminary characterization of microflora (bacteria) from the Southern Corridor of Brahmaputra, undertaken on behalf of Department of Science & Technology, Government of India, New Delhi. (Total estimated cost Rs 7.07 lakh, Period- 3 yrs. PI - Dr B. G. Unni)

Patents

Filed in India

- An improved process for the production of substituted amino-benzophenones, Dipak Prajapati and Dhiren Barman
- A novel herbal antifungal formulation against dermal infection, Mantu Bhuyan, J.J. Mahanta, M. Chutia, P.R. Bhattacharyya, P.B. Kanjilal, P.K. Baruah, N.C. Baruah and P.G. Rao
- A versatile method for the oxidation of carbinols to carbonyls using hydrogen peroxide under triphase catalytic condition, Amrit Goswami, Mrs N. Bhati and Kuldip Sarmah

Granted in US

- 2-Methyl-epitylisonicotinate and process for production thereof, Gajendra Nath Bordoloi, Babita Kumari, Manabjyoti Bordoloi, M.K. Roy and Tarun Chandra Bora. Patent No.: US 6998411 B2

NEIST Process for Bacterial Bioformulation Released

THE North - East Institute of Science and Technology (NEIST), Jorhat, has developed a novel bacteria based bioformulation suitable for biomass improvement and yield enhancement in commercial crops. The formulation consists of two bacterial strains isolated from two different soil inhabiting bacterial strains which have the ability to improve the plant growth in addition to having the property of disease control and seed inoculation. The strains also have the ability to produce siderophore, an iron-chelating compound, and antibiotics like phenazine in culture medium. The formulation also contains various enzymes which trigger the enhancement of soil fertility and plant growth. The formulation is liquid based and useful in all major crops of NE region such as tea, rice and vegetables. Since the price of the technology has presently been maintained at a very affordable level of Rs 20,000, excluding the factory installation charges, it can be easily adopted as a cottage/rural technology. The technology has recently been released to two parties in Titabor and Golaghat districts of Assam and the parties have, in the meantime, started commercial production of this bioformulation.



Industrial Toxicology Research Centre

R&D Highlights

THE Industrial Toxicology Research Centre (ITRC), Lucknow, carries out its R&D activities in the following broad areas: Biology and Biotechnology, Ecology and Environment, Health Care and Drugs, Water Resources and Technology. During the last couple of years, in addition to contributing to 13 CSIR network projects and pursuing a host of sponsored/grant-in-aid/in-house projects, the laboratory has diversified its programmes with the addition of the following cutting edge toxicological research areas: Systems Toxicology and Risk Assessment; Environmental Toxicology; Toxicogenomics and Predictive Toxicology; Food, Drug and Chemical Toxicology, and Assessment, Mapping and Remediation of Ground Water Contamination.

Some of the significant R&D achievements are as follows:

- Indigenous protein and DNA based diagnostic tests have been developed for detection of GM-crops and food. These tests would be useful in detection of transgenes that are introduced in GM crops.
- Capability has been developed for the evaluation of allergenic potential of GM crops and foods (a Simulated Gastric Fluid Digestion Assay). Such an evaluation in GM crops will be useful for marketing the product for public consumption.
- SNPs in CYP1A1, 1A2, Aryl hydrocarbon receptor (Ahr) and aryl hydrocarbons nuclear translocator (Ahnt) genes have been identified. These are involved in the metabolic activation of pro-carcinogens and pro-mutagens in the Indian population. The information generated revealed that functionally important SNPs reported in Caucasian and Asian populations, which predispose individuals to the carcinogenic effects of environmental chemicals, are also found in the Indian population.
- Studies were carried out for the development of a scientifically validated health promoter, based on traditional knowledge. Three Positive Health Promoter (PHP) formulations are being developed under GMP norms, based on findings under a network project.
- *Zingiber officinale* is a widely used herbal drug in traditional system of medicine. The rhizome obtained from Southern region of India was found to have higher anti-oxidant, antimicrobial activities and bio-active constituents as compared to the samples procured from other ecological zones. The information is valuable for preparation of therapeutic formulations.
- An important constituent of ginger, 6-gingerol was found to have the potential to act as an effective chemopreventive and therapeutic agent for prostate cancer. Similarly, lupeol, a triterpene present in mango has been shown to possess cancer chemopreventive properties. The study showed that lupeol and mango pulp extract supplementation prevents enlargement of prostate and decreases levels of serum prostate specific antigen induced by testosterone as evident from an increase in apoptotic cell population in prostate cancer cells.
- Changes in the stability of antioxidant capacity with time

- and its relation to phenolic content was evaluated in popular herbal teas. Samples containing high phenolic content showed lesser decline in antioxidant capacity over a considerable storage time. The study indicates a need to provide information by the manufacturers regarding period of use without decline in beneficial effects of herbal teas.
- Black tea polyphenols that include catechins, thearubin and theaflavins were shown to inhibit mammary and esophageal tumors.
 - Of the 1400 plants used in Ayurveda, information on toxicology parameters, active constituents, and antidote potential of 700 plants has been compiled and is being validated. Digital documentation of this information is being carried out. Information of 340 plants has already been added to the database.
 - Role of STAT3 in murine airways was examined in response to IL-6, TNE, IL-13 which plays a major role during asthma pathogenesis. It was demonstrated that transfection of STAT2 SiRNA can regulate the expression of inflammation associated cytokines and may be of use in therapy.
 - Dopamine DA-D2 receptor binding in SHy-Sy-5y human neuroblastoma cell line was used as a model for the assessment of neurotoxicity of environmental chemicals. The results indicate that the receptors for DA-D2 are expressed and physiologically functional in this human neuroblastoma cell line and could be used as *in vitro* model for the assessment of neurotoxicity.
 - *Drosophila melanogaster* was used as an alternative animal *in vivo* model because of homology of genes present in this organism with that of mammals. To understand the mechanism of cellular stress, viz. hsp70 and oxidative stress-enzymes against environmental chemicals, studies using dichlorvos and chlorpyrifos as test chemicals, suggest that dichlorvos is more hazardous as compared to chlorpyrifos.
 - A study showed that the residues of the OCPs which constitute POP-pesticides group and were banned for last several years for manufacture and use in the country are still present in the alluvial ground water aquifers of Gangetic plains, which may pose health risk to the local population using these water resources.
 - Multi-drug resistant virulent environmental isolates of *Escherichia coli* and *Enterococci* were detected in surface waters of river *Ganga* at selected sites in Kanpur city.
 - Human monitoring studies for genotoxicity have shown significant gender and lifestyle related differences in the extent of DNA damage among Indian population. It was observed that basal level of DNA damage in males was higher than females generally in Indian population. Further, smoking, non-vegetarian diet and strenuous physical activity were found to enhance DNA damage in males.
 - The techniques for managing hazardous waste produced by refineries and industries were studied. Humus soil and hydroxyapatite have been used as immobilizing agents for *in-situ* remediation of hazardous waste that immobilizes heavy metals in contaminated soil and prevents their leaching into the ground water.
- During 2005-06, 88 papers were published in peer reviewed journals. The average Impact Factor was 1.545. In addition, eight book chapters were contributed.



R&D Facilities

Facilities for Smart Technologies at NAL

THE National Aerospace Laboratories (NAL), Bangalore, initiated research in smart technologies, although at a modest level, more than a decade back. Materials development has been an important aspect of this effort. Towards the goal of manufacturing indigenous materials leading to new devices, two facilities have been recently set up at NAL: a tape casting facility for the processing of piezoceramic materials and a vacuum arc melting facility for manufacturing of shape memory alloys. Dr V.K. Aatre, former SA to RM and currently Visiting Professor at ECE Department, Indian Institute of Science, inaugurated these facilities on 23 August 2007. The inauguration was followed by a Seminar on Smart Materials and Technologies held under the aegis of NAL and the Institute of Smart Structures and Systems (ISSS). It is only apt that Dr Aatre inaugurated this event as he has been championing the cause of this technology for more than a decade, and has been largely responsible for the government research programmes in this area. In his inaugural address he said that the programmes carried out so far have produced many successes. He

informed the audience that the second phase of NPSM, which is much larger in scale, is just an 'ink-signed copy' away from sanction.

The inaugural function was presided over by Dr A.R. Upadhyya, Director, NAL and President, ISSS. In his presidential address, Dr Upadhyya recalled how the foundation for this research at NAL was laid with the help of projects funded by agencies such as ARDB and DST. Thus, when the specific programmes such as DISMAS and NPSM were initiated, NAL was well placed to take up and execute the projects. He also highlighted the role of ISSS towards promoting these technologies. This is being done, he said, through its national and international conferences, training programmes for engineering faculty, industry meets, and its newsletter Sukshma.

Coordinated by Dr T.G. Ramesh, Head, Materials Division, the one-day seminar covered a wide spectrum of research and development. Nine lectures were spread out in two sessions chaired by Prof. Gopalakrishnan of IISc and Dr Vijayaraju of ADA. Four lectures were from scientists of the Materials Division covering the ongoing work

on development of piezoceramics (Dr P.K. Panda), piezopolymers (Dr Anjana Jain), shape memory alloys (Dr S.K. Bhaumik) and micro-electro-mechanical systems (Dr Soma Dutta). Two lectures by Ms Shashikala Prakash and Shri V. Shankar covered the work in the areas of vibration and aeroelastic control, smart structures modeling, and instrumentation development being carried out in the Structures Division. Technologies related to aerodynamic shape control and structural health monitoring being developed in the Advanced Composites Division were discussed by Shri G.N. Dayananda and Dr G.M. Kamath. Dr G.K. Ananthasuresh from the Mechanical Engineering Department, IISc, spoke on the devices being designed and fabricated by his group using the SMA developed at NAL.

The day's programme saw a good number of participants from NAL and outside. Speaking at the concluding session, Dr Aatre stressed the need to have more of these seminars, which he felt would help in bringing together scientists of different disciplines and creating more opportunities for cross-fertilization of ideas.

Revisiting Linnaean Thoughts for Plant Diversity and Phylogenetic Analysis Symposium at NBRI

THE National Botanical Research Institute (NBRI) and the Local INSA Chapter, Lucknow, jointly organized a two-day National Symposium on 'Revisiting Linnaean Thoughts for Plant Diversity and Phylogenetic Analysis' at NBRI, on 23-24 May 2007 to celebrate the 300th Birth Centenary of Prof. Carl. Linnaeus — the father of modern plant and animal classification. Prof. V.L. Chopra, Member Planning Commission, was the chief guest on this occasion and Prof. S.K. Jain, former Director, Botanical Survey of India, delivered the presidential address. Prof. S.S. Bir, Prof. Emeritus, Punjabi University, Patiala, gave the keynote address. Eminent taxonomists, scientists, research scholars and students attended the symposium.

Dr Rakesh Tuli, Director, NBRI, while welcoming the chief guest and participants, said that the work of Linnaeus has stood the test of time. The work carried out by Linnaeus helped establish and standardize the consistent binomial nomenclature for species which Linnaeus introduced on a world scale in 1753 and for animals in 1754, is being used even today, he remarked. He added that there is urgent need to revisit Linnaean works on taxonomic principles and to undertake a systematic analysis of phylogenetic relationship employing modern techniques available today so as to have a better understanding of the complexity of evolutionary patterns that exist in

the plant kingdom. In this context, Dr Tuli also elaborated on the biosystematic studies covering taxonomic revisions, evaluation of biodiversity, conservation biology, molecular taxonomy, bar-coding, etc being carried out at NBRI.

Prof. V.L. Chopra, in his inaugural address, said that it was important for us to look back at Linnaean thoughts as a baseline for refining our knowledge on biosystematics and for better understanding of the relationships that exist among various living organisms. With the availability of new tools and techniques, greater integration of all these is required in the biosystematic studies not with the intent of demolishing them but refining these further, he concluded.

Dr S.K. Jain in his presidential address, entitled, 'Legacy of Linnaeus will live till eternity', gave a brief background on the life history of Prof. Carl Linnaeus and the evolution of the binomial nomenclature of naming the living organisms. He informed that out of the 273 grass species available in India, 40 generic names and 160 species name were given by Linnaeus. Describing the status of Linnaean species that occur in India, he said that many of the species described by Linnaeus were type specimen today. He suggested to the taxonomists to visit the type locality for confirming the existence of the Linnaean plant species and stressed the need to create Linnaeus Garden. He further said that it was a challenge for Indian

taxonomists to analyze the number of endemic species described by Linnaeus, which would help us to understand the evolutionary changes that have occurred especially in those species found in the type locality. He added that a lot of genera and species names of plants are based on Sanskrit etymology (e.g. Jwarakush means that controls fever) and it would make an interesting study to analyze the number of such Linnaean species available in India.

Prof. S.S. Bir in his keynote address entitled, 'The Species Concept: Paradox of the Present Day Plant Taxonomy, Nomenclature and Phylogeny' described the genetic diversity that exists among the plant kingdom, especially in pteridophytes. Plant genetic diversity can be best understood by cytological and reproductive biology studies, he said. He urged the plant taxonomists of India to collaborate with scientists of various disciplines, if they have to make plant taxonomy a vibrant discipline of research. Floras are always in the state of evolution and if floras are to be made worthwhile, we should incorporate all types of information, like evolutionary status, cytotypes, survivability, etc, he remarked.

Dr R.K. Gupta proposed the vote of thanks.

The inaugural function was followed by two technical sessions which were held under the chairmanship of Prof. V.L. Chopra, Member Planning Commission and Prof. P.K. Gupta, Professor & INSA



Canna Linn.

*Some important
plant species
described by
Carl L.innaeus
and
available at
NBRI*



Cocos nucifera Linn



Quisqualis indica Linn.



Zamia pumila Linn



Ginkgo biloba L.



Plumeria rubra Linn

Senior Scientist, Department of Genetics & Plant Breeding, Ch. Charan Singh University, Meerut, in which presentations were made on: 'Species as morphometric terrains: Redefining the species boundaries' by Dr K.N. Ganeshaiyah; 'Taxonomy in the genomics era: Genetics of speciation, and Stability of names' by Prof. P.K. Gupta; 'FISH technology and phylogeny' by Dr S.N. Raina; 'From Linnaean invariability of species to the concept of Single Gene Pool and its impact on crop improvement' by Dr R.P. Sharma; 'Floral affinities and

biogeography of peninsular India: A need for phylogenetic approach' by Dr Praveen Karanth; 'Linnaean taxa in the flora of Northeast India: An analysis' by Prof. S.K. Borthakur; 'Influence of climate and growth form on genome size in plants' by Dr Deepak Ohri and on 'Forest ecosystem diversity in Northeast India' by Dr R.S. Tripathi

In the third session which was held under the chairmanship of Prof. S.S. Bir, following lectures were given by the scientists of NBRI: 'Present status of Linnaean names of Indian Cryptogams' by Dr D.K. Upreti; 'Reproductive

diversity and evolution in lower group of plants' by Dr P.B. Khare; 'Speciation: A case study in Linnaean genus *Pedicularis* (Scrophulariaceae)' by Dr Tariq Hussain; 'Reproductive isolation and speciation in flowering plants' by Dr (Smt.) Kanak Sahai and 'Development in Linnaean genus *Astragalus* (Leguminosae): Morphology to phylogeny' by Dr L.B. Chaudhary.

The symposium ended with the vote of thanks proposed by Dr P.B. Khare, Scientist, NBRI and Organising Secretary of the symposium.

Important plant species described by Carl Linnaeus and available at NBRI

Aspicilia calcarea (Linn.) Korb.

Cetraria islandica subsp. *islandica* (Linn.) Ach.

Ochrolechia pallescens (Linn.) A. Massal.

Pseudocyphellaria crocata (Linn.) Vain

Rhizocarpon geographicum (Linn.) DC.

Solarina crocea (Linn.) Ach.

Xanthoria parietina (Linn.) Th. Fr.

Bryophytes

Marchantia polymorpha Linn.

Riccia crystallina Linn.

Riccia fluitans Linn.

Targionia hypophylla Linn.

Pteridophytes

Adiantum capillus-veneris Linn.

Adiantum philippense Linn.

Equisetum arvense Linn.

Equisetum hymale Linn.

Marsilea quadrifolia Linn.

Ophioglossum reticulatum Linn.

Pteris biaurita Linn.

Pteris cretica Linn.

Pteris vittata Linn.

Gymnosperms

Cycas circinalis Linn.

Ginkgo biloba Linn.

Thuja orientalis Linn.

Zamia pumila Linn.

Angiosperms

Adansonia digitata Linn.

Amaryllis Linn.

Averrhoa carambola Linn.

Bauhinia purpurea Linn.

Bauhinia variegata Linn.

Bigonia Linn.

Bixa orellana Linn.

Bombax ceiba Linn.

Borassus falvellifer Linn.

Canna Linn.

Cannabis sativa Linn.

Caryota urens Linn.

Cestrum nocturnum Linn.

Chrysanthemum Linn.

Cissus quadrangularis Linn.

Clitoria ternatea Linn.

Cocoloba uvifera Linn.

Cocos nucifera Linn.

Crescentia cujute Linn.

Erythrina Linn.

Ficus benghalensis Linn.

Ficus religiosa Linn.

Gladiolus Linn.

Helianthus annuus Linn.

Heliconia Linn.

Hibiscus rosa-sinensis Linn.

Ixora coccinea Linn.

Lawsonia inermis Linn.

Mangifera indica Linn.

Melia azedarach Linn.

Mimosa pudica Linn.

Myrtus communis Linn.

Nyctanthus arbor-tristis Linn.

Phoenix dactylifera Linn.

Plumeria rubra Linn.

Polianthes tuberosa Linn.

Quisqualis indica Linn.

Trewia nudiflora Linn.

Vitex negundo Linn.

Zinnia Linn.



National Symposium and Indo-US Seminar on Catalysis at IIP

A National Symposium on Catalysis was held in the recent past at the Indian Institute of Petroleum (IIP), Dehra Dun. The symposium witnessed a detailed presentation, serious discussions and marathon brain storming by about four hundred scientists, engineers and researchers on the various issues related to catalysis, particularly on its application for

future fuels. The National Symposium and Indo-US Seminar on Catalysis are a three-day prestigious event of Catalysis Society of India (CSI), held once in two years. Jointly organized by IIP, the Indo-US Science & Technology Forum (IUSSTF) and petroleum industry, the present symposium was inaugurated by Shri M. B. Lal, Chairman Scientific Advisory

Committee, Government of India. Eminent scientists from USA, UK, Japan, Norway, Mexico and India put forward their views about the strategy that should be adopted to meet the challenges of the petroleum industry — poorer quality of crude oil available to the refining industry, the fast depleting reservoirs as reflected by the soaring and volatile prices of crude oil—



Seen during the 18th National Symposium & INDO-US Seminar on Catalysis (from left)

Top row: Dr M.O. Garg, Director, IIP welcoming the delegates; Dr G. Murali Dhar, Convener introducing the symposium; Dr S. Narayanan, President, CSI, delivering his address ;

Above row: Shri S. Sarpal, Secretary, Petro Tech Society of India, delivering his address; Mr Bipin Vora, UOP, LLC, USA; Dr Henrik Topsoe, Haldor Topsoe, Denmark and Dr S. Narayanan, President (CSI) at one of the technical sessions

calls for development of more efficient catalytic processes for refining of crude oil so as to maximize its utilization for production of desired fuels.

Catalytic Technologies: Retrospect and Prospects – The theme address by Shri M.B. Lal (abridged version)

The theme address dealt with the business environment for oil and oil refineries and how catalysts have sustained the development of the modern economy.

Tracing the history of oil and gas industry, Shri Lal said: It all started a small way when American industrialist George Bissell in 1859, hired Colonel Edwin Drake to find the source of oil seeps in Western Pennsylvania. Drake dug a well near oil creek in Pennsylvania and struck oil and thus laid the foundation for the oil and gas industry. Ever since the world has never been the same again and has never looked back. Today oil and gas are responsible for meeting 2/3rds of the global primary energy demand. It is this oil (and now increasingly gas), which because of its easy transportability, high energy density and convenient-to-use characteristics has completely revolutionized and perhaps irreversibly changed our lives in a short span of just hundred fifty years. Ever since the early 1900's, a symbiotic relationship between oil and the growth of the consumption in a country's economy emerged and oil started having a greater impact on geopolitics and international relations than even perhaps religion or race.

Today, the world consumes about 86 billion barrels of oil, 240

billion cuft. of natural gas, 14 mt of coal and 500,000 pounds of uranium every day. And this consumption rate is growing at the rate of about 1.4% for oil and more than 2% for gas annually. With supernormal growth in China, closely followed by India and increasing affluence and a rapidly growing vehicle population, the consumption of both gasoline and diesel is sharply on the increase here. This explosive growth, especially in oil consumption on an unprecedented scale, along with rapid urbanization, not unexpectedly, brought its own problems. It was not long before realization dawned that unless the emission from vehicles was dramatically curtailed, it would have serious and long lasting adverse impact on human health and well being and defeat the very purpose of development and growth. A coordinated approach between the automobile industry and the oil industry led to dramatically enhanced fuel quality specifications emerging through legislation. For instance sulfur levels have been reduced in gasoline from 1000 ppm in 1994 to less than 10 ppm by 2010. Similarly for diesel several quality parameters have been tightened.

As the demand for energy worldwide grows at a never before seen pace, supplies of light sweet crude are tightening, as this quality of crude is becoming increasingly difficult to find. This is reflected in the sustained high prices of crude for almost three years now. Aside from a handful of oil rich regions, today's oil fields are increasingly smaller in size. A new oil field containing a few hundred million barrels is big news today compared

to the elephant oil fields of yesteryears which contained billions of barrels of oil. Increasingly the world is being forced to look at processing heavier, higher sulfur crudes and of all the available crude oil in the world today, only 24% is sweet light crude. Refiners measure this changing trend in crude quality through the differential price of light and heavy variety of crudes and one can get a feel of the situation when one looks at the differential between Dubai Crude which is a medium sour marker crude and Maya which is a very heavy sour crude. Three years ago this differential used to be US\$2/bbl, but has now gone up to 11US\$/bbl and if you compare this with the average refy margin of 4US\$/bbl, you realize the significance of this differential. Also, as the oil reserves in the world are very unevenly distributed with many of the oil producing countries being politically unstable, there is increasing volatility and uncertainty about the long term availability of crude oil from any single region and flexibility has become a prime requirement for refineries and oil companies.

On the refining front, since globally the refining capacity is tight with little spare capacity, there is a rapid growth in this sector by way of Greenfield refineries, especially in Asia Pacific region including India and China. Catalytic processes in refineries represent about 83% of world crude distillation capacity distributed as 45% for hydrotreating, 17% FCC, 14% naphtha refining, 5% hydrocracking and 2% isomerisation. The main catalyst consumer is North America at 39% followed by Asia Pacific 20%



and Europe 8%.

Though the oil producers are benefited by the high prices of crude oil, in the refining and marketing side of the business it has become essential with high crude oil prices to contain costs and remain competitive. The challenges facing the oil industry can thus be summarized as

- Declining and uncertain source of crude availability,
- Poorer quality of crude oil,
- Demand for much higher quality of products,
- Declining demand for heavy products like fuel oil, increasing demand for transport fuels
- Stricter environmental regulations for refinery operations, and
- Need to contain costs, conserve energy, be efficient.

Refineries have responded to these challenges with plans for huge investments in new plants and technologies. Some of these like hydrotreating and reforming and isomerisation are already under execution or have been completed, since these relate to fuel quality upgradation to meet the new mandated standards. In addition, many refineries have projects for heavy ends upgrading and hydrotreating, or hydro cracking for improvements in product yields. In the FCC area there is an increasing trend to take in heavier feedstocks and many refineries have installed or are planning to install VGO Hydrotreaters upstream of the FCC. In many refineries, the FCC unit is being operated on maximum propylene mode to enhance the value addition from refineries. In refineries where full desulfurisation

capability is not there for producing low sulfur FCC naphtha, one has to resort to process expensive low sulfur crudes in greater proportion, thus severely denting the profitability. Many refineries have been able to deflect these challenges and in fact turn them into opportunities by intelligent selection of catalysts and additives and thereby avoiding or minimizing costly hardware changes.

Though catalysis is one of the most important technologies we have, outside the petroleum field, most people are unaware of its wide ranging significance. It plays a crucial role in many aspects of human progress in the efficient manufacture of many kinds of materials from fuels to plastics, in creating new energy sources and in protecting environment and even in developing effective safer medicines. In petroleum refining, over 80% of the processes involve catalysts and they are the key to the conversion and processing efficiency. The main refining processes using catalysts are hydrotreating, FCC, reforming, hydrocracking, alkylation and isomerisation.

Catalysis and the FCC processes have a long history together because the birth of modern catalysis coincided with the advent of first catalytic cracking process by Houdry in 1936. Since that time, there have been several major developments in FCC catalyst and with the evolution of FCC as a process, FCC catalyst has also undergone many changes. Before the second world war aluminium chloride or clay was used as a catalyst. After the war, the first commercial catalyst with clay was

formulated. With the introduction of zeolite catalysts in the 60's a whole new vista in catalyst technology got opened. The three dimensional shape selective nature ensures greater activity and selectivity towards the products. There is tremendous scope in modification of zeolite by incorporation of other metals in the lattice structure. In the 1980's a new range of FCC catalysts appeared in the market known as additives, which greatly enhanced the flexibility of FCC and refinery operations.

Catalysts and additives have played a key role in correcting the situation arising out of recent competitive and legislative challenges in refineries to a large extent through the use of Gasoline sulfur reduction additive, use of ZSM-5 for LPG enhancement and SO_x reduction additives all of which have helped the refineries to process heavier crudes and produce higher value products and thereby significantly enhance bottom line. Use of additives, which started in the 1980's through modification of the zeolites and incorporation of other metals in the lattice structure, give tremendous flexibility to refineries. The effects of additives are instantaneous in the unit and these can be started or stopped at will. Some of the additives available in the market are:

- ZSM 5 based additive for boosting octane number and yield of light olefins
- Alumina micro spheres with dispersed platinum for enhancement of CO burning in regenerator dense bed
- A specially formulated alumina micro sphere for upgradation of

- the heavier fractions of the feed
- SO_x additive for reduction of SO_x emission in flue gases
- Antimony or bismuth based liquid compound for passivation of the detrimental effects of nickel
- Vanadium trap for vanadium passivation
- Catalyst additive for gasoline sulfur reduction

Emerging specifications for diesel are going to make it increasingly difficult to incorporate the light cycle oil from FCC into diesel. One distinct possibility in the future is to treat LCO as a petrochemical feedstock and upgrade it to BTX instead of sending it to Fuel Oil.

Depending on the type of feedstock for FCC the catalyst attributes may need to be changed, such as, for Residue feed we need to consider coke selectivity, metals tolerance and bottoms upgrading capability. For VGO feed, activity retention, coke selectivity, metals tolerance and balanced hydrogen transfer is important. And for hydrotreated feed maximum activity, bottoms upgrading capability and optimum coke selectivity are important characteristics.

While continuous developments are taking place in FCC catalysts and additives, due to the dramatic changes in motor fuel specifications, hydrotreating and hydro cracking have also assumed tremendous significance in refineries. The removal of sulfur from the automotive fuels in the most efficient and cost effective way has become the prime requirement of a modern day refiner.

The major new areas for R&D work in the field of hydroheaters are new metallic catalysts for deep hydrogenation, new and tailor made catalyst supports and multi-bed reactors.

Hydrocracking is another process whose importance is growing in the refining industry, which is reflected in the 5% growth anticipated in the hydrocracking catalyst market. The important developments in hydrocracking catalysts are:

- Increased tolerance with respect to metals, CCR and nitrogen
- High active and selective catalysts so as to get desired flexibility in product slate and yields. The increasingly tolerant zeolitic catalyst and shape selectivity have helped in production of better quality middle distillates from a variety of feedstocks. Also, the technological developments in catalysts have paved the way for excellent quality Lube base stocks capable of meeting Group II specifications.
- Major effort in hydro cracking catalysts is towards the development of catalyst for increased middle distillate yield, lower hydrogen consumption and pressure and higher resistance to coke deactivation. The major R&D area is bi-functional metal acid catalyst system.
- A lot of R&D work has been done for reducing the emissions from automobiles by improvements in fuel quality, automobile design and using catalytic converter devices to

clear up the remaining emissions.

However, scientists and researchers feel that the ultimate answer could be hydrogen as a fuel in fuel cells. It is one of the solutions being cited to reduce our reliance on fossil fuels, although it may be a long journey before we can realize that dream. Reforming is and will remain the premier refining process for making high octane gasoline components. The new challenges in this area are new tri-metallic catalyst systems that increase yields, improve selectivity and stability at low pressures, and have increased lifetime.

For reducing emissions from automobiles catalytic converters in the tail pipes of automobiles play a significant role. The simplest car exhaust catalysts developed 20 or more years ago were based on Pt spread on an alumina honeycomb support to give a high surface area. They dealt with carbon monoxide and unburnt hydrocarbons, which react with oxygen to produce carbon dioxide and water. Today the modern 3-way catalyst — a combination of Pt, Pd and Rh — also removes NO_x by promoting the reaction of CO with NO to produce nitrogen and carbon dioxide. The 3 way catalyst has had an enormous impact on improving air quality, but regulations continue to tighten and developments will continue to take place.

In the case of diesel engines, a particular problem is particulates. Filters are quite effective though regenerating them is difficult. Research is on to develop a new combined catalyst system in which NO is first converted to NO_2 which



then oxidizes the soot particles in a trap.

Shri Lal also talked about biofuels, hydrogen, fuel cells, etc. as the future sources of energy. However, there is still much research to be done to ensure that the costs of producing and using hydrogen are competitive. This calls for inventing new catalysts.

In case of fuel cells, catalysts are at the heart of both electrodes to enable the critical reactions. The majority of catalysts are made primarily of platinum. Owing to the rarity of this metal, scientists are experimenting with doping platinum with metals like palladium or ruthenium and complexes of cobalt and nitrogen to help reduce the cost of production

Concerted efforts are being also directed towards the development of environmental catalysts and nano structured materials for the development of much more efficient catalysts, concluded Shri Lal.

Presentations by Eminent Scientists

The high cost intensive processes such as desulphurization need to be improved for making these economical and check the shriking margin of refineries. The presentations made in this regard ranged from the study of catalysts from atomic scale to large industrial scale involving thousands of tonnes of catalysts. Dr Henrik Topsoe, Halder Topsoe Denmark, gave an account of hydrotreating catalysts and Prof. Yasuhiro Iwasawa, University of Tokyo, detailed the advanced design and *in-situ* characterization of selective catalysts for green processes and future fuels. Dr A. B Halgeri, IPCL,

Vadodara, explained how the noble metal supported catalysts are finding more and more applications in fuel processing and petrochemical production. Prof. G. D. Yadav, UICT, Mumbai who was given Prof. S.K. Bhattacharya Eminent Scientist Award in the symposium presented the research activities in the field of catalysts used for the synthesis of a variety of industrial applications.

Owing to finite reserves of crude oil and its consumption, presently at a rate of 80 billion barrel a day and which is increasing at a rate of about 1.4%, has forced the policy makers to search for alternative fuels, preferably derived from renewable sources. The researchers agreed that more intensive R&D efforts are needed in the direction to make the future fuels, such as hydrogen, a reality. Conversion of gas-to-liquid fuel by Fischer Tropsch Synthesis is another option in the domain of alternate fuel. Again it is highly dependent on efficient catalysts. Dr Burton H. Davis, University of Kentucky, USA, compared different catalyst for such conversion. Shri Bipin Vora, Consultant, UOP, USA, described the various routes of conversion of methane to liquid fuels so as to facilitate its more efficient utilization. Methane, a component of natural gas (NG), is only a fraction of the proven reserves of NG (175 trillion cubic meters).

For sustainable clean energy development the research has been focussed on the development of fuel cells which are electrochemical devices to generate electricity. Fuel cell technology is highly efficient and being clean, meets the stringent

environmental standards. Catalytic processes are essential to make the hydrocarbon and alcohol fuels suitable for fuel cells. Prof. Chunshan Song, Pennsylvania State University, USA, dwelt upon the elaborate research being conducted in this area of catalysis while Dr Sai P. Katikaneni, R&D Centre, Saudi Aramco, USA, gave an overview of fuel cell technologies and discussed the challenges and potential opportunities.

In the field of alternative fuels attention has been drawn world over towards conversion of biomass to fuel. An alternative to Aviation Turbine Fuel (ATF), which have not attracted the much attention of environmentalists, also need to be developed. Dr Santosh K. Gangwal, RTI, USA, suggested FT Synthesis as a viable route and discussed its catalysts requirements. To reduce the green house emission, attention has been drawn to biodiesel and bioethanol. Dr Hiromichi Shimada, AIST, Japan, presented a futuristic look of such biofuels for transportation sector.

Dr Michael Stocker, SINTEFF, Norway, who due to his ill health could not attend the symposium, presented his paper on telephone from Norway while the slides synchronizing with his presentation were shown locally. He said that presently one-fourth of energy requirement is being met by biomass. Biodiesel, bioethanol, fast pyrolysis of biomass and conversion of biomass to liquid through FT route are possible and are being explored for commercial exploitation. He informed that by EU directive, 5.75% of the requirement of energy is to be met

through biomass by 2010, which shall require 13% of its total agriculture land. The consumption is to increase by 20% by 2020. He put forward the details of porous material as catalysts in such conversion. Biomass conversion to fuels idea would be turned into a reality with the establishment of bio refinery, the concept of which was put forward by him.

The research activities going in various organizations were presented in about 90 oral presentations made by experts as well as students. Development of catalysts for various refining operation, production of additives, chemical transformation, fundamental studies in catalysis and its mechanism, photocatalysis, catalysis by novel material, natural gas conversion and desulphurization were discussed in detail.

Dr S. Narayanan, President, Catalysts Society of India, spoke about the objective and diverse contributions of CSI.

Exhibition and poster presentations attracted the delegates in large number and had one-to-one interaction with the concerned authors and exhibitors.

Recommendations made in Panel discussion held at the end of Indo-US Seminar on the first day are being forwarded to IUSSTF.

In the valedictory function Dr M.O. Garg, Chairman, Organising Committee, summarized the proceeding and said that process packages along with the basic development in catalysis are paramount for the society to meet the energy challenges. The delegates appreciated the quality of science depicted through oral and

poster presentations. Dr G. Murli Dhar, Convener, proposed a vote of thanks.

Following awards were given in the valedictory function:

- A. Three Best Oral Presentation: C. M. Janet, IIT Madras; Nakka Lingaiah, IICT Hyderabad; and Mrs. Suman Lata Jain, IIP Dehra Dun
- B. Three Best Poster Presentations: Dayalan Subhashini, Anna University; Mrs. Anupama Sharma, DAV (PG) College, Dehra Dun; and Ms. Suman Sahoo, NCL Pune

Other Important Lectures at IIP

In fact, IIP during this year arranged a number of lectures by eminent personalities, on different occasions that were mainly addressed to attaining Energy Security for the country.

For example, **Dr Bipin Vora**, Consultant, UOP Fellow (retd), delivered this year's **IIP Foundation Day Lecture** in which he reviewed the current energy sources, trends for future development and also challenged faced by the chemical process industry.

Prof Rakesh Agrawal, Distinguished Professor, Department of Chemical Engineering, Purdue University, USA, delivered the **National Technology Day lecture** at IIP, on '**Environment-friendly Energy Solutions**'. In his lecture, Prof. Agrawal pointed out that with the present rate of production, the crude oil may last only for about 50 years and the oil production is definitely going to peak during the lifetime of a child born today. In

view of this it is important to find the new sources of energy. He said biomass alone would not be able to meet the energy requirement. He gave the example that even if all corn and soyabean produced by USA is converted to fuel, it will be able to meet only 12% of petrol and 6% requirement of diesel. Hydrogen is another option but it is only an energy carrier and has challenges of its storage and transportation. Regarding photo-voltaic cells, he said that the present efficiency of photo-voltaic cell is about 10% which makes the conversion of solar energy a costly proposition. He proposed that a partnership of biomass with carbon-free energy source is the right solution. He presented the technical details to convert this idea into reality, which includes generation of hydrogen using solar energy and its combination with biomass in a gasifier, and said that further research is needed in this direction.

Speaking on the occasion, Dr M. O. Garg, Director, IIP, said that Institutes of CSIR such as IIP have mandate to develop technologies and one of the essential requirements of technology is that it should be environment-friendly and acceptable to society. He pointed out that alongwith the technical issues the ethic issues involved in the technology development also need to be addressed.

Dr Lalji Dixit, Senior Scientist of the Institute, gave a presentation on the 'Splitting the atom for energy', advocating the use of atomic power to meet the energy demands. Shri V.S. Saini, Scientist, IIP, was the Chairman of NSD celebration committee.



Dr V. P. Dimri selected to deliver Lorenz Award Lecture



In recognition of his contributions to Nonlinear Geophysics, Dr V.P. Dimri, Director, National Geophysical Research Institute (NGRI), Hyderabad, has been selected to deliver Lorenz Award Lecture at the Fall Meeting of American Geophysical Union (AGU) to be held at San Francisco in December 2007.

AGU has a membership of more than 41,000 in the field of solid earth, ocean and atmospheric sciences. Dr Dimri is the first Indian geophysicist to receive this honour.

Prof. Edward Norton Lorenz was born in USA on 23 May 1917. He is a Meteorologist, made his boldest scientific achievement in discovering “deterministic chaos”, a principle which has profoundly influenced a wide range of basic sciences and brought about one of the most dramatic changes in mankind’s view of nature since Sir Issac Newton. This lecture series was instituted in the year 2001 by AGU, which provides an introduction to the role of nonlinearity, complexity and scaling in earth, ocean and atmospheric sciences. Prof. Benoit B. Mandelbrot, who is considered father of Fractals, was the first awardee of this lecture series.

Rajiv Gandhi Award for Dr Lalji Singh

Dr Lalji Singh, Director, Centre for Cellular and Molecular Biology (CCMB), Hyderabad, figures among the recipients of the Rajiv Gandhi Rashtriya Ekta Samman 2007. Instituted in the memory of former Prime Minister, the late Shri Rajiv Gandhi, these awards



were presented at the National Conference on Communal Harmony held in New Delhi on 19 August 2007. Dr Singh has been given this award for his outstanding achievements and contributions in Science and Technology and as an institute builder.

Receiving the award, Dr Singh said, “Given the reasons behind the Samman award, it is an honour and privilege for me to be a recipient.” Apart from his pioneering work on DNA fingerprinting, which has won many accolades, particularly in providing justice to people and culminated in setting up of another institute, the Centre for DNA Fingerprinting and Diagnostics (CDFD) in Hyderabad, Dr Singh is instrumental in setting up of a new facility, Laboratory for Conservation of Endangered Species (LaCONES), near the Nehru Zoological Park, Hyderabad, as CCMB Annex 1. LaCONES essentially deals with the issues related to the conservation of biodiversity amongst wildlife. Dr Singh is presently engaged in the process of setting up of world-class facilities to combat infectious diseases such as SARS, Japanese Encephalitis, Avian-Flu, etc. and in translational research that could bring scientists and clinicians to work together for the benefit of mankind.

The Rashtriya Ekta Samman awards have been instituted by the All India National Unity Conference, New Delhi, to promote national unity, integration, brotherhood and oneness.

Shri Kapil Sibal visits NBRI

SHRI Kapil Sibal, Minister for Science & Technology and Earth Sciences, and Vice President, CSIR, visited the National Botanical Research Institute (NBRI), Lucknow on 4 August 2007. During this visit, Shri Sibal inaugurated the Plant Genomic Facility and released a book, entitled, *Botanic Garden – A National Facility*. He also addressed the scientific community of the institute and held discussion with

the scientists and some of the industrialists who are pursuing R&D projects in partnership with NBRI and were invited on this occasion.

In his address, Shri Sibal pointed out that agriculture and health were two most important human enterprises of the country. Designating the scientists as 'Creators of Knowledge', he said that public had very high expectations from them. He emphasized the need to enhance investment on infrastructure and human resources for transforming institutes like NBRI into world-class institutes. Congratulating the NBRI scientists for their efforts in developing Bt-cotton technology and conservation of germplasm for sustainable utilization of biodiversity, Shri Sibal said that there was an urgent need to undertake mapping of the biodiversity of India. He underlined



Seen on the dais (from right) are: Shri Kapil Sibal, Hon'ble Minister for Science & Technology and Earth Sciences and Vice President, CSIR, and Dr Rakesh Tuli, Director, NBRI, Lucknow

that major areas of the north-east region of the country had still not been documented for their rich biodiversity. He stressed that India being an agriculture intensive country, it was important for scientists to reach out to farmers and provide them simpler technologies to enhance the yields of crops. With reference to several steps taken by the government, the minister said that interaction between scientists and industry was hardly known a decade back, but now it had become a reality. He said the government would like the Agribiotech industry to play a bigger role in enhancing yields and agreed with their difficulties regarding access to germplasm. Applauding the efforts of NBRI and its achievements, he expressed that there was a need to expand space and facilities at the institute since it had a major potential to make the country find solutions to the challenges of the

21st century. He appreciated the efforts of the scientists of NBRI and called upon them to remain relevant to S&T endeavours beneficial to industry and society at large.

Shri Sibal made the following remarks in the Visitor's Book, *"Footsteps into the future – for others to emulate. Well done, NBRI"*.

Earlier, Dr Rakesh Tuli, Director, NBRI, welcomed the Hon'ble Minister and informed him about the major achievements, recent developments, technology transfer and future plans



Shri Kapil Sibal, Minister for Science & Technology and Earth Science and Vice President, CSIR, addressing the gathering in NBRI auditorium



Shri Kapil Sibal inaugurating
the Plant Genomic Facility at NBRI

of the institute. He gave details of the state-of-art facilities being set up at NBRI for the documentation, conservation and utilization of plant diversity. In partnership with seed industry, NBRI had taken up projects in genomics for the improvement of fibre quality,



Shri Kapil Sibal releasing the book entitled,
Botanic Garden - A National Facility



Shri Kapil Sibal being apprised about the instruments installed in the Plant Genomic Facility at NBRI: Confocal microscope (left) and Affymatrix microarray (right)

drought tolerance and insect resistance in crop plants. In some of the major projects, the partner industries had contributed financially to the extent of 30 percent, he informed. Dr Tuli highlighted the plant-based products developed at NBRI and contributions of NBRI to the development of pharmacopoeia on indigenous drugs. He also described the projects taken up by NBRI in partnership with industry for economic utilization of marginal lands. Dr Tuli thanked the Minister and remarked that a Vice

President of CSIR had visited NBRI after more than twenty years.

On this occasion, Dr G.K. Garg, Director (Research), Krishi Dhan Seeds, Jalna; Dr P.C. Bhattacharya, Vice President, JK Agri Biotech, Hyderabad and Dr N. Brindavanam, Head, Agribiotech, Dabur Research Foundation informed about the research projects their companies had taken up in partnership with NBRI.