

Global Overview of Catalysis

India

1. History

The major research activities in independent India during the 50's and 60's were in the agriculture and power sectors. Since fertilizers were important for increasing agricultural yields, serious research into both basic and applied catalysis related to fertilizers was initiated during the above period by Projects and Development India, Ltd. (PDIL), the R&D wing of the government-owned Fertilizer Corporation of India. Since advanced education and fundamental research were also considered important, a number of government-supported educational institutions such as the Indian Institute of Technologies (IITs) and research laboratories belonging to the Council of Scientific and Industrial Research (CSIR) came into existence. A limited amount of research (mostly basic) in catalysis was initiated in these organizations; notably the IITs at Kharagpur and Madras, the CSIR laboratories at Hyderabad, Dehradun and Pune and the Jesuit-owned Loyola College, Madras. During the 70's, with industrialization picking up and the consumption of petrochemicals and petroleum products increasing, the need for applied research in catalysis was felt. By the early 80's many organizations were actively involved in both basic and applied research activities in catalysis.

2. Technical trends in catalysis research

An important object of catalysis research during the 80's was the development of catalysts and processes for the value addition of indigenous raw materials and for the upgradation of the waxy indigenous petroleum feedstocks. This research resulted in the development of a novel process (ALBENE) for the direct conversion of ethanol (from agricultural sources) and benzene to ethyl benzene in one step and catalyst/process for the upgrading of waxy heavy oils fractions into lube base stocks.

Another aim of catalysis research in India during the above period was the replacement of imported catalysts by indigenous ones, mainly to reduce dependence on others. Although the above objective was met to a limited extent, the recent opening up

of the economy (since 1991) has changed the focus towards original and competitive catalysts and technologies. As a result of this approach, a few Indian catalysts in niche areas were developed.

Although the per capita consumption of petroleum and petrochemicals in India is probably an order of magnitude lower than that of western countries, the demand is increasing rapidly. Hence, the major research activities in catalysis are now centered around petroleum refining and petrochemical production.

The important areas of research in catalysis in India at present can be summarized as follows:

- 1. Petroleum refining**
Advanced reforming catalysts, FCC catalysts suitable for the waxy Indian feeds, hydrocracking catalysts, catalysts for improvement of product quality such as dewaxing and deep hydrotreating catalysts.
- 2. Petrochemicals**
Alkylation catalysts aimed at replacing $\text{HF}/\text{AlCl}_3/\text{H}_2\text{SO}_4$, transalkylation of heavy alkyl aromatics.
- 3. Fine chemicals**
Selective oxidation processes using metallosilicate molecular sieves.
- 4. Environmental catalysts**
Exhaust emission abatement by both noble and non-noble metal catalysts.
- 5. New materials**
Novel molecular sieves, zeolites, mesoporous materials
- 6. Catalysts related to nitrogenous fertilizer production**
- 7. Reaction engineering and reactor design; modeling of zeolites and catalysts**

The list of research centers in catalysis research, their activities, and the catalysts/processes developed by them are presented in Table 1. Besides, the organizations listed, catalysis research is carried out at a low-key at a number of other institutions.

Some of the research centers have their own catalyst production facilities and many of the catalysts developed by them are commercially available. Some of them, like United Catalysts (I) Ltd. (UCIL), Hindustan Lever Ltd. (HLL) and International Catalysts Ltd. (ICL), are subsidiaries of Western companies. NCL has established its own catalyst production (pilot plant) facility for the preparation of catalysts (up to 10–20 tons) for its own catalysis research activities. NCL's facilities are also available for other organizations interested in producing catalysts in moderate volumes.

Table 1
Catalysis research activity in India

Organization	Areas	Commercial Catalysts	Commercial Processes
Indian Institute of Technologies (IITs) at Madras, Bombay & Kharagpur	Wide variety of topics (Mostly fundamental)		
Indian Institute of Technology (IICT) Hyderabad	Supported metals and oxides, hydrogenation catalysts, fluorochloro hydrocarbons	Benzene hydrogenation	
Indian Institute of Petroleum (IIP) Dehradun	HDS, reforming, hydrocracking, FCC, aromatization, exhaust catalysts.	Bimetallic reforming catalyst Auto	
National Chemical Laboratory (NCL) Pune	Reforming, dewaxing, FCC, isomerization, alkylation, zeolites, C1 chemistry, auto exhaust catalysts, carbonylation, modeling of zeolites and catalysts, reactor design and modeling	Monometallic reforming Xylene isomerization Ethylbenzene Formaldehyde Dewaxing p-diethyl benzene Linear alkyl benzene (semi-commercial)	(Novel process) (Novel process) (Novel process)
National Environmental Engineering Research Institute (NEERI) Nagpur	Auto exhaust catalyst		
Central Fuel Research Institute (CFRI) Dhanbad	Liquid fuel from coal		
Indian Petrochemical Corp., Ltd. (IPCL) Vadodara	Reforming, isomerization, dehydrogenation, alkylation, transvinylation, zeolites, oxides	Xylene isomerization, Mono and bimetallic reforming catalysts Dehydrogenation of linear alkanes p-diethyl benzene	(Novel process)
Associated Cement Co. (ACC) Thane	Isomerization, alkylation, auto exhaust, oxides, zeolites	Reforming catalyst Bisphenol-A	
Hindustan Lever Ltd. (HLL) Bombay	Hydrogenation of oils, zeolites, FCC	Hydrogenation of oils FCC catalysts	

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Table 1 (continued)

Organization	Areas	Commercial Catalysts	Commercial Processes
Bhabha Atomic Research Centre (BARC), Bombay	Broad area Fundamental aspects		
Indian Oil Corp. (Res. and Dev.) (IOC R and D) Faridabad	FCD, hydrocracking, zeolites, auto exhaust		
Projects and Development Indian Ltd. (PDIL) Sindri	Fertilizer and related catalysts	Almost all catalysts - used in fertilizer industry	
United Catalysts (I) Ltd. (UCIL) Bombay		General catalysts Fertilizer catalysts Zeolites	
International Catalysts Ltd. (ICL) Pune		Formaldehyde Dehydrogenation catalysts	

3. Who pays for research in catalysis in India?

The exact amount spent on catalysis research in India is not readily available as no organization funds catalysis research separately. The catalyst manufacturers (some like PDIL, IPCL and HLL are also user organizations) have their own budgets for catalysis research. Among the non-users, the CSIR laboratories probably spend about 3 million US dollars on catalysis research (including salaries) per year, the major portion of the funding coming from government agencies such as the CSIR, the Ministry of Petroleum, the Department of Science and Technology, the Center for High Technology and the Department of Environment. The above governmental organizations also sponsor research activities in IITs and universities, although funding to these organizations may be a small fraction of the above amount. Some funding is also available from industries in the petroleum and petro-chemical sectors, but their contribution is small.

4. The Catalysis Society of India

The Catalysis Society of India, founded in 1976, has about 500 members mostly from the educational institutions, corporate laboratories and government/CSIR research laboratories. The society has its headquarters at IIT, Madras and is run by an executive committee, whose members are elected (by ballot) every two years from different parts

of India by the members of the Society. The current President of the Society is Dr. N.M. Gupta from Bhabha Atomic Research Center (BARC), Bombay.

5. Meetings

The Catalysis Society of India conducts a National Symposium and a Workshop on Catalysis every two years such that the two meetings are held on alternate years. The next meeting of the Society is the 13th National Symposium on Catalysis to be held at the Indian Institute of Petroleum (IIP) Dehradun, in February 1997. The proceedings of the Annual Symposium are published, although those of the workshops may not always be published. However, a book of abstracts is made available. The symposia and the workshop lasting 3-4 days consist of plenary and invited lectures and contributed papers (both oral and posters).

6. Publications

The Catalysis Society of India (CSI) publishes a bulletin every two months. The bulletin carries mostly review articles in catalysis and related subjects submitted by its members, although the publication of original research articles is encouraged. It is also a vehicle for the dissemination of information regarding the activities of the Society and its members. In addition, the Indian Journal of Technology published by the CSIR has a section devoted to catalysis. Another journal in which one finds articles in catalysis is the Indian Journal of Chemistry.

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