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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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FLUID CATALYTIC CRACKING: CATALYST EVALUATION & TECHNOLOGY

UC/IND/86/106/11-02

INDIA

Final Report*

Prepared for the Government of the Republic of India
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. H. J. Lovink
Expert in running and maitenance of automatic pilot plants

Backstopping officer: M. Derrough, Industrial Operations Technology Division

United Nations Industrial Development Organization
Vienna

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H. J. Lovink
Aletta Jacobslaan 17
3818 LP Amersfoort
Tel. 033-622517

A. Summary

The main objective was to teach the technical staff of IOC the intricate details of some generally known FCC Catalyst synthesis methods for the lab pilot plant and (later) commercial plants.

Much of the work was "hands-on" with the staff of Dr. Sobhan Ghosh in Faridabad, but I also gave some 10 lectures on several connected subjects (see list). The preparational work was very successful, particularly in view of the short time, although some critical control methods were still lacking.

Activity test methods are very good at IOC, upto or better than of many international Oil Companies! Good activity catalysts have been made but due to the above missing analysis methods progress was sometimes erratic. Improvements in catalysts for the typical Indian conditions is the purpose of the programme; an extensive further programme was set up and occasional visits to India may serve to continue these contacts.

Recommendations:

- Line-up of an X-ray to determine the crystallinity of zeolites and catalysts. A "standard" apparatus is good enough.
- FCC catalysts need special zeolites and special exchange procedures; study of both is recommended.
- India has some unique raw materials for making ultralow cost FCC catalysts. Dr. Sobhan Ghosh knows all the details.
- Continue to use commercial raw materials and procedures of catalyst manufacturers. Otherwise, products without a future may be made.
- Organize regular exchange meetings with all other groups that work in FCC catalysts funded by oil companies and national laboratories incl. also on the cracking technology e.g. 2 or 3 times per year.

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B. Other Companies/Institutes visited and consulted:

1. IPCL-Baroda where I gave a plenary lecture to the annual meeting of the IIChEngineers, Sunday December 18, last.

2. IPCL labs., Dr. Prasada Rao, consult on several details of his catalyst related work in catalytic reforming, oxychlorination, zeolites and adsorbents, December 19 and 20, last.

3. CATAD in Thane, production of aluminas adsorbents and catalysts, December 22, last.

4. NCL, Dr. Ratnasamy, December 23 and 24, last.
   Several items as a follow up of my consultancy in Pune in January 1988.

5. University of Delhi Chem.Eng. Dept., Prof. Subharaman, general lectures on conversion of petroleum: December 27, last.

6. Centre of High Technology, January 9, last.
   An afternoon's meeting with Dr. A. Kumar and his staff on general trends in petroleum refining processes.

7. With Dr. Sobhan Ghosh to Trivandrum:

   - English Indian Clay Co. for selection of kaolin.
   - Regional Research Laboratory of Trivandrum for information of:

     • Rare Earths Chloride for catalyst
     • Clay raw material for FCC catalyst

C Diary - Consultancy Indian Oil Co.
Faridabad

Contract No. UC/IND/86/106/11-02/ of 13424
H. J. LOVINK

Arrival Dec. 06 1988 Delhi
06.25

Morning:UNDP Office Lodi Estate
Afternoon: IOC, discussion of the programme in Faridabad with Dr. Sobhan Ghosh
Preparation of a general lecture on FCC catalysts.

Wednesday December 7:

Morning - final arrangements at UNDP Office
Afternoon- Indian Oil Company, Faridabad
Lecture and discussion on "Developments in Fluid Catcracking".

Thursday December 8:

Morning - Lecture on "FCC Catalyst Composition"
Afternoon - Discussion on the same subject.

Friday December 9:

Morning - "Manufacturing schemes of FCC catalysts by the major manufacturers".

Afternoon - Discussion of the current experimental programme.

Saturday December 10:

Tour through the laboratories and check of equipment with Dr. Sobhan Ghosh

Monday December 12:

Lecture on "Zeolites, their properties and preparation for FCC catalysts"

Afternoon : Start of a new experimental programme for making FCC catalysts in the Laboratory using a new "Sol technique".

Tuesday December 13:

Continuation of the lab. experiments with the IOC technicians in order to get the Sol technique under control.
This is a very essential technique, using raw materials available in India and currently in use at 5 FCC catalysts manufacturer in the world.
Lecture on "alumina as matrix materials for FCC catalysts".

Wednesday December 14:

Further experiments and procedure-adjustments to local equipment; first full success in the laboratory!

Thursday December 15:

First experiments in zeolite exchange of Na versus NH_4 and Lanthanum. Zeolite exchange control has to be arranged for analytically, which was not directly available.

Discussions with Sobhan Ghosh of some test results of refinery catalysts used at Mathura and Gujarat refineries.

Friday December 16:

Study of procedures for making catalysts in the library, drawing up of instructions to the laboratory staff.

Saturday December 17:

First successful catalyst made by the new "Sol technique" was tested' although the La-content was not sufficiently high the result was still very encouraging! In the meantime the sol technique on lab. scale was better under control and lower viscosity gel was produced.
Evening:transfer to Baroda.

Sunday December 18:

Plenary lecture at the annual meeting of the Indian Institute of Chemical Engineers in Baroda (appr. 200 attendees) on.
"The hydrocarbon chemistry of FCC naphtha formation".
The rest of the day of I attended the other meetings of this Congress.

Monday December 19:

Meetings at IPCL-Baroda with Dr. Prasada Rao and his staff on several matters regarding catalyst testing and preparation such as:

- Catalytic reforming
- FCC catalysts
- CATAD's products. adsorbents

Tuesday December 20:

Continued discussions at IPCL Baroda with Dr. Prasada Rao and staff; some microscopic observations on two different adsorbents of IPCL that showed different performances in commercial use; advise on pentasils production at CATAD Transfer to Bombay.

Wednesday December 21:

Visit to CATAD (IPCL) in Thane near Bombay.
Extensive discussions with Dr. Lohokare Managing Director of CATAD, Dr. Rao and others on all matters regarding zeolites, FCC catalysts, a possible manufacture of FCC and reforming catalysts, visit to the plant and advice on many aspects of CATAD's operations, rationalisation of production, increasing the marketing force, R&D and product control.

Thursday Dec. 22 +
Friday Dec. 23:

Visit to NCL in Puna, with Dr. Ratnasamy.

A great number of subjects were discussed e.g.
- Help for IOC in analysing samples. I took a number of them with me, as IOC badly needs X-ray equipment, available at NCL.

- The FCC catalyst project and the way to implement the forthcoming results.
- New developments in hydrocarbon chemistry in the western world in '90-95' and the prospects of catalysts.

- Progress in development and implementation of the pentasil zeolites invented by Ratnasamy, the market development needs and the good prospects.
- Cooperation with international companies in developing inventions.
- Ferrisilicates; new routes required to fully benefit from their potential.

Monday Dec. 26: back in Faridabad

Discussing of detailed results of the experimental programme, review of new procedures and planning of further experiments. Hands on work.

Tuesday Dec. 27:

Preparation of lectures, review of testing procedures: Afternoon: Lecture for the Delhi section of the Institute of Engineers and the Delhi University section Chemical Engineering.
(organised by Dr. Rihani of Engineers of India) ; some 30 attendees.

Wednesday December 28:

Review of raw materials for FCC catalysts manufacture to come to "all indian" catalysts with modern constituents. Trip to kaolin and Rare Earth manufacturers appears necessary for collecting more information.

Thursday Dec. 29:

Discussions with Dr. Mukhopadhyay and Dr. Verma on their planned service and testing of hydrocracking operations in Faridabad.
How to set up the laboratory, which type of reactors, their size, the lay out of the lab. AKZO Chemicals can possibly be of help to IOC (and I will do my best to arrange this).
Safety aspects of this laboratory, additional analytical and preparatory equipment needed.
Engine modification of scooters, contacts where to get information on these engines made in the West (I wil check).
Impact of low lead/no lead in gasoline.
Merits of various reforming processes and their possible future development.
Hydrotreatment of coker naphthas.

Monday January 2:

The first pilot plant batches of the new sol technique have been made. The material shows high bonding strength as expected but the small dryer of IOC gives very fine products.
Further discussions with Dr. Mukhopadhyay on the above, the programme FCC catalysts.

Friday January 6:

Review of the analytical results, proposals for further work and the next tests,

January 4:

Review of the laboratory work, discussions with all the staff on the progress and the problems arisen in the work January 3/4/5.

Extensive discussions over lunch with Mukhopadhyay on matters related to the complete gamma of petroleum refining in India, the best processes for catalytic reforming, the most economical ones, hydrocracking auto exhaust measures etc.

Saturday; January 7:

Review of the experimental work in Faridabad done January 3,4 and 5

- Spray dryer operation.

Although the density of Sol/Kaolin mixtures spray dried look good, the Sol formation itself is not proceding as desirable: too much gel formation. We watched a batch being made concluding that more permanent, better controllable equipment is needed

- Exchange with NH_4 sulfate solution is not always leading to good Na removal.

Review-on-the-spot of way the technicians operate:

- NaY zeolites of world reknown companies have been successful exchanged with LaCl3 solution, a good result!

Monday January 9:

Further review of the pilot plant equipment:

a) The nozzle configuration of the spray drier may be slightly modified giving a wider spray angle.

b) The batch tank design with a permanently present stirrer.

- Technical discussions with the Commission of High Technology, under chairmanship of Dr. A Kumar of the ministry of oil refining; Subjects:

a) Catcracking in general and particular aspects of so called resid catcracking
b) Hydrocracking/FCC combination
c) Hydrodewaxing

Tuesday January 10:

Morning: Transfer to Trivandrum with Indian Airlines (!), with Dr. Sobhan Ghosh of ICC

Afternoon/evening: Discussions with India's major kaolin manufacturer there.

Indian English China Clay

Kaolin is an important raw material for FCC catalyst manufacturing as the usual catalysts contain 50-70% of kaolin straightly mixed in!

The grades available, their chemical and physical properties, prices and future outlook were extensively discussed. We also paid a visit to the production facilities.

As the Kerala deposits are all of the sedimentary type, and reach upto 70%, very fine and well suitable material can be made.

For the FCC catalyst "[illegible]" [illegible]. The production is almost [illegible] t/month, price [illegible]. A slightly cheaper grade, not bleached [illegible].

Wednesday January 11:

Visit to the Regional Research Laboratory Trivandrum

Purpose: Discussion of the Rare Earth oxydes/chlorides availability and properties and analysis.
Received by Dr. A D Damodaran and his staff (A detailed report will be made by Dr. S Ghosh IOC)

FCC catalysts are containing 0.5-2.5% rare earth oxydes which are deposited on the zeolite by ion exchange against the Na of NaY zeolite

The Indian Rare Earth Company in Kerala produces several types of Rare Earth from so called Monazilte sand. This Institute (RRL in Trivandrum) has much experience in the analysis of rare earth, a key factor of importance to us.

The Director, Dr. Damodaran, was very helpful and it was quickly agreed that one of his specialists will come to Faridabad to help IOC in the analysis of these materials. He will also provide IOC with a bigger sample of rare earth chlorides.

We also talked briefly with Dr. Lalith Kamba on the various clays and kaolin that are commercially exploited in Kerala. Further contacts will be directed towards finding even better materials than we found (of good quality) so far.

January 12, 13, 14, 15 holidays and travel back to Delhi (also report writing !)

January 16: Two lectures for the FCC group in IOC

"A micro simulation test for FCC catalyst" and "Ni and Vanadium in FCC catalysts"

Discussions of the good results found January 12-5 in IOC on the catalysts made so far.

Tuesday January 17: Conclusion planned with a "Question and Answer" session for all staff of IOC Faridabad on FCC catalysts.

H J Lovink

D. Presentation/Lectures in Faridabad

	Topic	Date
1.	General trend in FCC Catalysts	7 December 1988
2.	FCC catalyst composition	8 December 1988
3.	General Manufacturing Schemes	9 December 1988
4.	FCC Zeolites	12 December 1988
5.	Matrix properties and Composition	13 December 1988
6.	Additives for FCC catalysts	16 December 1988
7.	Metal resistance of FCC catalysts	16 January 1989
8.	MicroSimulation tests for FCC catalysts	16 January 1989
9.	Questions and Answer Session	17 January 1989

Departure: January 18 for Holland