APPLICATIONS OF HETEROGENEOUS CATALYSIS

DAN LUSS and JAMES T. RICHARDSON
University of Houston
Houston, Texas 77004

Chemical Engineering Departments provide a useful service to the industrial community by offering short courses on topics of current interest. Many universities have found this to be so profitable a utilization of faculty and facilities that available courses proliferate during the summer months. The most valuable courses are those which are tailor-made to suit the needs of potential attendees and not the predilections of the available faculty.

The Chemical Engineering Department of the University of Houston organized two short course on the applications of heterogeneous catalysis during the summers of 1971 and 1972. The program was so successful that essentially the same course is being repeated this year. Other short courses in catalysis have been presented before at Rice University, Lehigh, Berkeley and Delaware. However, our program is sufficiently different from these others so that it is worthwhile to outline the philosophy, organization and logistics of the course.

There are two types of practitioners in catalysis—the researchers and the users. A short course should be organized from the beginning with one or the other of these groups in mind. This course was aimed at the wide audience of users. These individuals have usually a considerable practical experience in a relatively narrow area but do not have a systematic and comprehensive coverage of the theory of catalysis and catalytic reactor design. Moreover they usually have little knowledge of the principles and techniques used by others.

We decided upon a "how to" theme—how to select, prepare, characterize, test and use a catalyst. The program was built around these five points with emphasis on practical implications and applications of current theory and know how and not on building an in-depth understanding of the latest research developments.

In order to present a comprehensive coverage of the subject and to expose the students to a variety of viewpoints we selected as instructors two industrial and three academic experts. Each lecturer was instructed on the material to be included in his section in order to avoid gaps in the coverage and to prevent repetitious discussions of certain material. A comprehensive set of notes for classroom use was collected from each. These were reproduced, bound and distributed to each attendee before the start of the course. The class schedule for 1972 is shown in Table 1.

Table 1 - COURSE OUTLINE AND LECTURERS
(Summer 1972)

1. **Catalyst Selection** (0.5 day) J. T. Richardson
   - A. Introduction to catalysis
   - B. Theories of catalysis
   - C. Prediction of catalytic properties
   - D. Catalytic process development
2. **Catalyst Preparation and applications** (1 day) C. L. Thomas - Sun Oil Company (retired)
   - A. General principles
   - B. Preparation and use of non-supported catalysts
   - C. Preparation of catalyst supports
   - D. Preparation of supported catalysts
   - E. Proven catalysts and catalytic processes
3. **Catalyst Characterization** (0.5 day) J. T. Richardson
   - A. Common mechanical properties
   - B. Measurements of surface area, pore size distribution, acidity, metal surface area, effective diffusivity and dispersion
   - C. Survey of instrumental techniques
4. **Kinetics, Mechanisms and Experimental Reactors** (0.5 day) J. W. Hightower - Rice University
   - A. Theory of adsorption
   - B. Langmuir Hinshelwood kinetics
   - C. Discussion of some examples
   - D. Comparisons of various experimental reactors
   - E. Practical suggestions
5. **Diffusional Effects** (0.5 day) D. Luss
   - A. Isothermal inter and intra-particle diffusional disguise of activity and kinetics
   - B. Effect of external and internal temperature gradients
   - C. Diffusional disguise of selectivity
   - D. Experimental methods of determining these effects
6. **Poisoning of Catalysts** (0.5 day) J. T. Richardson and D. Luss
   - A. Mechanisms of sintering, poisoning, and fouling
   - B. Determination of mechanisms by single pellet studies

James T. Richardson received his PhD ('56) degree in solid state physics from Rice University. Following a year of postdoctoral research in low temperature physics, he joined Humble Oil and Refining Company (later Esso Research and Engineering) at Baytown Texas. During the next thirteen years, his research activities included all phases of fundamental and applied heterogeneous catalysis, with emphasis on correlation between catalyst properties and kinetics. In 1969 he joined the ChE Department of the University of Houston. Dr. Richardson is one of the organizers and a past chairman of the Southwest Catalyst Society. (left photo)

Dan Luss received his BS and MS from the Technion-Israel and his PhD from the University of Minnesota. His areas of specialization are analysis and control of chemical reactors and heat and mass diffusional intrusion in catalytic reactor behavior. He received the Allan P. Colburn award of the AIChE in 1972.

C. Effects of diffusion on poisoning and regeneration
D. Shell progressive non-catalytic gas solid reactions

7. **Catalytic Emission Control Devices for Automobiles** (0.5 day) J. W. Hightower - Rice University
   A. Federal standards and testing procedures
   B. Engine parametric effects on emissions
   C. Chemistry of control systems
   D. Choice of possible catalysts
   E. Cold start up, poisoning and melting problems
8. **Aspects of Catalytic Reactor Engineering** (0.5 day) D. Luss
   A. Effect of poisoning on operation of catalytic reactors
   B. Regeneration of cokes packed reactors
   C. Design aspects of exothermic reactors
   D. Sensitivity and stability
9. **Industrial Applications** (0.5 day) V. W. Weekman, Jr. Mobil Research and Development Company
   A. Modelling techniques of complex processes
   B. Modelling of catalytic cracking kinetics
   C. Modelling of a regenerator for catalytic cracking processes
   D. Modelling of catalytic mufflers

An important part of organizing such a course is to attract a sufficient number of attendees. The publicity for our course consisted primarily of a brochure, outlining the aims and details of the course, which was mailed to local members of the ACS and AIChE, and to members of the Catalysis Society of North America. This was followed by individual letters to various industrial research organizations, catalyst manufacturers, etc. This procedure was found to be very effective and in 1972 we had to reject 21 applicants due to restrictions on the maximal size of the class (40 students).

The students, representatives of a wide range of industries, responded most favorably to this format. Classes were informal with valuable contributions being made by many of the group. Using suggestions of the 1971 participants, we expanded in 1972 the discussions of proven catalysts and methods of catalyst preparation as well as of problems related to the design of catalytic mufflers for automobiles.

Short courses similar to this may, no doubt, be organized in many other fields of chemical engineering. The needs of industry for further education are continually changing. Courses of this nature help to fill the gap between formal university curricula and the demands of our profession. In addition, exposure to groups such as this is a rewarding and revitalizing experience for any faculty member. □

HUNTER: (Continued from page 15)

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Acknowledgements

I would like to acknowledge the work and suggestions of the other twelve senior assistants during the past three years; Don Hedden, Craig Farmer, Bob Powell, John McMartin, Jim Roberts, Craig Miller, Ed Heubach, Bill Barker, Chris Harris, Craig Runyan, John Hayes and Steve Hammill. □