ChE department

Chemical engineering offices and laboratories are located in Perlstein Hall.

ILLINOIS INSTITUTE OF TECHNOLOGY

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THE DEPARTMENT OF Chemical Engineering at the Illinois Institute of Technology (IIT), formally established in 1904, is one of the oldest chemical engineering departments in the nation. The development of the department in the pre-1971 period was previously described in this journal [1]. Dramatic changes have occurred in the department since that time in terms of faculty, undergraduate and graduate programs, and research. All current chemical engineering faculty, with the exception of one member, were added after 1974. Since then, there has been a significant expansion in research activities and research areas pursued, with the current faculty having expertise in traditional as well as emerging areas in chemical engineering. This is also reflected in the undergraduate and graduate curricula, which have changed significantly to meet the changing needs of the profession.

IIT's main campus, internationally recognized as an architectural landmark and located three miles south of Chicago's downtown area and a mile west of Lake Michigan, was designed in the 1940s by Ludwig Mies van der Rohe, one of this century's most influential architects. The current university population on the main campus includes about 6500 undergraduate and graduate students and about 500 faculty. The other campuses of IIT are located in downtown Chicago and in the western suburbs of Chicago in DuPage County. Chicago, one of the largest cities in the world and a national and international center of business and industry, offers students an exceptionally wide variety of professional and cultural resources. The close proximity of several chemical, food, and allied industry research centers and production

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plants provides for the IIT community an invaluable source of close interaction with industry.

THE DEPARTMENT

The chemical engineering offices and laboratories are located in Perlstein Hall. Presently, about 150 full-time undergraduate students and 60 full-time graduate students are enrolled in the department. In addition, there are about 40 part-time undergraduate students and 50 part-time graduate students. Three graduate degrees are offered by the Chemical Engineering Department: Master of Science (MS), Master of Chemical Engineering (MChE), and Doctor of Philosophy (PhD). The department annually awards nearly 40 Bachelor of Science, 10 MS, 10 MChE, and 8 PhD degrees.

Over the years, the department has graduated many competent engineers, a number of whom have obtained significant national prominence in their professional careers. Several of our alumni have held national office in the American Institute of Chemical Engineers. Although a majority of our alumni have pursued professional careers in industry, we are proud that, over the years, a significant number have joined chemical engineering faculties at major institutions.

RESEARCH

The research areas pursued in the pre-1971 period were chemical reaction engineering, separation processes, thermodynamics, and transport and interfacial phenomena [1]. In recent years, many additional areas of research have been initiated and strengthened. They include biochemical engineering, biomedical engineering, combustion, energy technology, enhanced gas and oil recovery, and process dynamics and control. Interdisciplinary research has been a strong tradition at IIT and several joint initiatives with other departments have evolved to address problems in the critical emerging areas. Some of the faculty have cooperative research activities with the Institute of Gas Technology, IIT Research Institute, and Argonne National Laboratory. All such interactions provide an intellectually stimulating environment for the graduate students. The development of IIT's very strong research and educational center in food technology at the Moffett Technical Center (located in the Chicago area) will be completed this summer. Some of the chemical engineering faculty will be closely associated with this center.

It is interesting to look at the current faculty in chronological order of joining the chemical engineering department at IIT in order to trace the growth of our program in recent years.

Darsh Wasan, currently acting Dean of the Armour College of Engineering, is the oldest faculty member in terms of service, having joined IIT in 1964. He served as department chairman from 1971 to 1987. His research deals with interfacial and colloidal phenomena, enhanced oil recovery, and separation processes. Darsh and his research team are developing experimental techniques to accurately measure surface and interfacial rheological properties. This research has significant utility in control of a variety of dispersed phase systems and in study of the mechanisms of oil bank formation and propagation in chemical flooding processes involving surfactants and alkaline agents, foams, emulsions, and polymers for mobility control. Research in separations is concentrated on separation of fine particles from non-aqueous media based on electrokinetic phenomena, emulsification/demulsification processes and thin liquid film phenomena. Darsh is a recipient of the Western Electric Fund Award of the ASEE, the Hausner Award of the Fine Particle Society, and the Special Creativity Award of the National Science Foundation.

The mid-1970s saw the addition of two of the current faculty members, Rob Selman and Dimitri Gidaspow. **Rob Selman,** currently acting chairman of the department, joined the faculty in 1975. His research interests are electrochemistry and electrochemical engineering with a special emphasis on high-temperature processes. Rob and his students are currently investigating the formation, growth, and corrosion of dendritic metal deposits, a problem common in the charging of zinc-based aqueous batteries which are being developed for electric vehicles and load leveling. Other current research projects deal with fundamental aspects of molten carbonate fuel cells and development of porous-electrode models for these fuel cells. The characterization of micro-emulsions by AC impedance is being investigated to assess the effectiveness of electrochemical oxidation as a means of breaking micro-emulsions. Other research projects under Rob's direction deal with molten salt processes involving

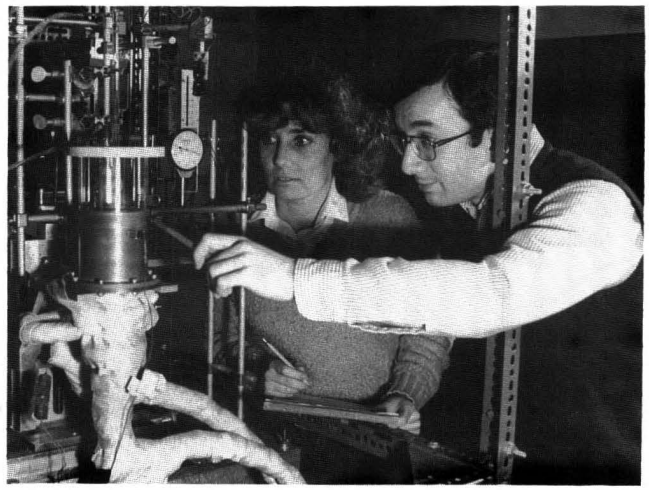
carbon cathodes and amorphous metal deposition from molten salts.

Dimitri Gidaspow joined the faculty in 1977. Dimitri's research interests are in the areas of mathematical modeling and analysis of various energy conversion processes. His current research involves studies of the hydrodynamic theories of fluidization and gas-solids transport. Generalizations of Navier-Stokes' equations are being solved using supercomputers to predict phenomena such as cluster formations in risers and bubble motion in fluidized beds. In collaboration with Darsh Wasan, he also conducts research in the areas of separation of colloidal particles and electrostatic desulfurization of coal. Dimitri has been recognized for his research through the Donald Q. Kern Award of the AIChE and the Special Creativity Award of the National Science Foundation.

The bulk of the present faculty members arrived on the scene in the 1980s. **Richard Beissinger** joined the chemical engineering department in 1981.

Taha Alkhamis and Richard Beissinger working with a Weissenberg rheogoniometer for blood viscosity measurement.

Richard's research is concerned with transport phenomena in biological systems. His current research activities are in blood-artificial surface interactions, biorheology, and development of artificial red blood cells. He also conducts research in the development of implantable drug infusion systems and in pharmacokinetics. Some of his current research projects are: augmented mass transport in sheared suspensions; macromolecular adsorption to solid surfaces; liposome-encapsulated hemoglobin and hemoglobin-in-oil-in-water multiple emulsion droplets as red blood substitutes; and the effects of red blood cells on platelet adhesion and aggregation in laminar shear



Jill Weldon and Selim Senkan discussing experiments with a flat flame burner in the combustion research laboratory.

flow. Rich is also directing development of the interdisciplinary Polymer Science and Engineering program.

Ali Cinar, who arrived in 1982, conducts research in process control and dynamics. Control strategies for multivariable chemical processes are being developed and tested using experimental systems and real-time microcomputers. One of his research projects deals with developing methods for selecting robust operating configurations and improved control strategies using a pilot plant consisting of two catalytic tubular reactor beds with internal heat exchange and a feed-effluent heat exchanger. Ali and some of his graduate students are also investigating forced periodic operation of chemical reactors using the vibrational control approach. Their work is focused on stabilization of exothermic continuous stirred tank reactors and tubular packed bed reactors as well as on improvement in selectivity and yield of complex reactions. Another of Ali's research projects deals with development of expert systems for fault-tolerant computer control of complex processes, such as multibed autothermal reactors.

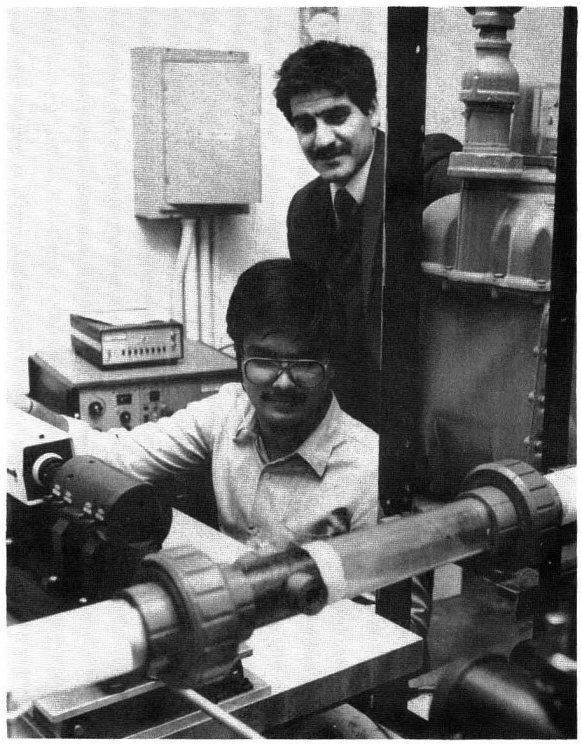
Selim Senkan joined IIT in 1982. His research is in the areas of combustion and high-temperature chemical reaction engineering as applied to problems in energy conversion, propulsion, and environmental protection. One of his research projects deals with experimental and theoretical investigation of oxidation and pyrolysis of chlorinated hydrocarbons (CHCs) using model compounds. In the experimental program, stationary flames of selected CHCs are probed for the determination of species and species profiles

using supersonic jet sampling coupled with on-line molecular beam mass spectroscopy (MBMS). An outcome of this research is the recently patented, economic process for conversion of methane into acetylene and ethylene. Because of low NO_x pollutant emissions, catalytic combustion is an attractive alternative to flame combustion when very high temperatures are not required. Selim and his group are also involved in the study of the impact of halogens on catalyst development, reaction rates, and selectivity in catalytic combustion processes.

William Weigand joined the IIT faculty in 1983. His research interests are biochemical engineering and process control. Bill and his research group are involved in kinetic modeling of cell growth and product formation for microorganisms which produce primary and secondary metabolites. The optimal operating procedures are then derived and examined with the aid of computer simulations and experiments carried out with highly-instrumented, computer-coupled fermentors. Bill is also interested in development of new sensors and the use of estimation techniques which permit optimal operation in the absence of complete variable measurement. In the area of process control, techniques for control in the presence of modeling error, for changing system dynamics, and for nonlinear interacting systems are being developed.

Hamid Arastoopour and Satish Parulekar joined the department in the fall of 1985. **Hamid Arastoopour** has research interests in the areas of multiphase flow, flow in porous media and unconventional gas reserves, and fossil fuel conversion processes. Current research projects being investigated by Hamid and his graduate students are hydrodynamic analysis of pneumatic conveying of solids, numerical analysis of single and multiphase flow in unconventional reserves, analysis and measurement of the agglomeration of sticky particles and heat transfer in fluidized beds, and analysis and measurement of transient gas and condensate flow in gas transmission and distribution systems.

Satish Parulekar conducts research in biochemical engineering and chemical reaction engineering. His research in biochemical engineering deals with production of extracellular and intracellular enzymes/proteins by recombinant and wild-type microorganisms and production of biochemicals using immobilized cell reactors. The research with recombinant organisms is aimed at gaining a fundamental understanding of host-plasmid interactions in these species and the effect of these interactions on plasmid stability, cell growth and product gene expression. The research with wild-type microorganisms is directed towards understanding the mechanism of synthesis of extracellular enzymes such as amylases and proteases. The research dealing with immobilized cell reactors is focused on study of alteration in cellular metabolism due to immobilization and implications of such alteration in design of these reactors. His research in chemical reaction engineering is concerned with identification of optimal reactor structures for complex reaction networks and experimental and theoretical investigation of forced periodic operation of continuous flow (CSTR and tubular) reactors.



Prasad Davuluri and Hamid Arastoopour studying transient gas transport with a Laser Doppler velocimeter.

Henry Linden joined the faculty in the spring of 1987 as the F. W. Gunsaulus Distinguished Professor of Chemical Engineering. Henry has had an exceptionally illustrious career in research in fuel technology at both the Institute of Gas Technology and the Gas Research Institute and was president of each of these institutions for several years. His distinguished career has led to membership in the National Academy of Engineering, as well as to numerous honors and awards such as the Distinguished Service Award from the American Gas Association. Having Henry on board will give us the benefit of his wide-ranging experience and insight in energy-related research.

UNDERGRADUATE PROGRAM

The mission of the undergraduate program in chemical engineering at IIT is to prepare our students for their professional careers and to enable them to develop the technology of the future. There is enough flexibility in the program for each student to tailor an individualized curriculum to satisfy his or her particular scientific or technical interests. The first two years are devoted to the fundamental sciences, mathematics, and engineering sciences and are particularly concerned with the development of professional skills. In addition to developing engineering competence, the program examines the economic and societal implications of chemical engineering. The required courses are material and energy balances, and unit operations-I in the sophomore year; thermodynamics, transport phenomena, unit operations-II, and chemical engineering laboratory-I in the junior year; and chemical reaction engineering, process control, chemical process design (two semesters), and chemical engineering laboratory-II in the senior year.

In addition, there are elective courses in bioengineering, computer applications in chemical engineering, colloidal and interfacial phenomena, electrochemistry, energy technology, food technology, microelectronics fabrication, and polymer processing. Students interested in gaining professional specialization may include some of these courses in their curriculum to earn a specialized minor in one of the following areas: biotechnology, computers in chemical engineering, energy technology, food technology, and polymer engineering.

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GRADUATE PROGRAM

The coursework for MS and MChE degrees must include at least four of the following six core courses: chemical reaction engineering, fluid mechanics, heat transfer, mass transfer, process control, and thermodynamics. For a PhD degree, coursework in all six areas is required so that the students will be equipped to apply advanced principles from the entire spectrum of chemical engineering irrespective of their research specialization. A student pursuing an MS must complete eight credit hours in research and thesis work. The MChE is a professionally-oriented degree program which permits a concentration in engineering practice. The requirements are the same as those for the MS degree, except that additional courses and/or a project replace the eight credit hours of thesis. Every prospective PhD candidate must take a qualifying examination to determine fitness and aptitude for further graduate study. Research qualities are judged during the oral comprehensive examination over the student's dissertation proposal, taken some time after admission to candidacy. After successfully clearing this examination, the candidate pursues the selected research program in consultation with the research adviser and advisory committee.

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In addition to the core courses, IIT offers a wide variety of elective graduate courses which in the past three years have included biochemical engineering, catalysis, computational techniques, electrochemical engineering, polymer processing, reservoir engineering, separation processes and transport phenomena in living systems. Many of the graduate courses, particularly the core courses, are televised through the IIT/V network. Remote centers for reception of these telecasts are located near several of the industrial centers within a fifty-mile radius from the IIT campus for the benefit of part-time students.

THE FUTURE

As the chemical engineering profession changes and adapts to the technology needs of the next decade and the next century, so must chemical engineering education. In the coming years, the curriculum content will be modified to accommodate new technology areas in chemical engineering. At IIT, we are developing courses to integrate these emerging areas into our curricula while, at the same time, leaving the emphasis on science and engineering fundamentals unchanged. As in the past, thorough training of the undergraduate as well as graduate students will continue to receive the highest priority.

REFERENCES

1. Kintner, R. C., D. T. Wasan, *Chem Eng. Ed.*, **5**, 108 (1971). □