



### Arvind Varma: Educator, Researcher and Leader

It is a distinct pleasure for us to present this *Festschrift* to honor Professor Arvind Varma of Purdue University on the occasion of his 60th birthday.

Arvind Varma was born on October 13, 1947 in Firozabad, India. This city, near Agra where the Taj Mahal is located, is famous for its long-established glass industry, particularly glass bangles. He received his B.S. degree in Chemical Engineering from Panjab University in 1966 and his M.S. degree in Chemical Engineering from the University of New Brunswick, Canada in 1968. He then went to the University of Minnesota where, in 1972, he completed his Ph.D., under the mentorship of the legendary Professor Neal Amundson. While at Minnesota, he also developed a strong friendship with Professor Rutherford Aris, another pioneer in the field of chemical reactor theory. The influence of these two great men would have a profound effect on Professor Varma's stellar career.

He remained at the University of Minnesota for one year as an Assistant Professor, and was a Senior Research Engineer with Union Carbide Corporation in Tarrytown, NY for two years before joining the University of Notre Dame faculty in 1975 as an Assistant Professor of Chemical Engineering. He moved through the ranks rapidly, becoming Associate Professor in 1977, full Professor in 1980, and the inaugural Arthur J. Schmitt Professor in 1988. His academic leadership includes serving an effective six-year term as Department Chair at Notre Dame (1982–1988), which included the recruitment of several talented faculty as well as considerable growth in quality and stature of both the undergraduate and graduate programs. He was named founding Director of the Center for Molecularly Engineered Materials in the year 2000, and that center rapidly grew to include some 20 faculty researchers and significant extramural

funding. In January 2004, he moved to Purdue University as the R. Games Slayter Distinguished Professor and Head of the School of Chemical Engineering.

Professor Varma is a distinguished researcher in the field of chemical reaction engineering for more than 35 years. His contributions include original research publications, authorship of textbook and monographs, editorship of a book series, and professional activities. Through creative experimental and theoretical research, Arvind Varma has made pioneering contributions to the understanding, analysis and design of chemical and catalytic reacting systems, and synthesis of advanced materials, with desired composition and properties achieved by microstructural control. In these areas, he has authored or co-authored 258 archival journal articles, as well as three books and monographs, and he co-edited two books.

Professor Varma's early work dealt with the analysis of reactor steady-state multiplicity and stability, diffusion reaction in catalyst pellets, yield optimization in complex reaction networks, automotive exhaust catalysis, multiphase reactors, and the development of reactor models validated by experiments. Then, in a series of landmark publications, Professor Varma and his co-workers produced the definitive works on two subjects of central importance in chemical reaction engineering: (1) optimal distribution of catalyst in pellets, and (2) parametric sensitivity and runaway behavior. His group's work on the first topic, including both theory and experiments, is summarized in the monograph *Catalyst Design: Optimal Distribution of Catalyst in Pellets, Reactors and Membranes* (Cambridge University Press, 2001; 227 pp), and it has direct implications for rational catalyst design and manufacture. In the second area, he developed rigorous, powerful, and readily applicable criteria to identify regions of parametric sensitivity for various types of chemical and

catalytic reactors. This work, with extensions to include air pollution, combustion and metabolic systems, has also been summarized in a monograph, *Parametric Sensitivity in Chemical Systems* (Cambridge University Press, 1999; 342 pp).

Professor Varma has worked extensively in combustion synthesis. His work was instrumental in developing the understanding needed to tailor the composition and microstructure of several advanced materials such as aluminide-ceramic composites for aircraft turbines, cobalt-based alloys for orthopedic implants and nanoscale oxide powders for catalysts, fuel cell electrodes, and carbon sequestration applications.

Professor Varma is also a leader in inorganic membranes and membrane reactors, which is an emerging area of process technology, and he has focused his research in two directions. First, his group developed a novel technique for the synthesis of thin (a few micrometers thick) dense metal films, deposited on various porous substrates, that is based on the inventive use of osmotic pressure during electroless plating. With this method, his group has prepared palladium-composite membranes with significantly higher hydrogen permeability and enhanced thermal stability than can be achieved by conventional techniques. These membranes can be used in applications such as hydrogen separation from gas mixtures and, by simultaneous removal of hydrogen product, to enhance conversion in equilibrium-limited dehydrogenation reactions. Second, he has demonstrated elegantly, both by systematic experiments and theory, that conversion and yield in commercially important catalytic reactions, such as ethylene epoxidation and methanol oxidative dehydrogenation to formaldehyde, can be improved significantly using an inorganic membrane distributed feed reactor. This finding is significantly influencing industrial reactor designs.

His current research involves various aspects related to energy, with specific programs in hydrogen, fuel cells, conversion of biodiesel waste glycerol to valuable chemicals, and coal/biomass gasification and combustion.

In addition to the monographs mentioned above, Professor Varma has co-authored a major textbook entitled *Mathematical Methods in Chemical Engineering* (Oxford University Press, 1997; 690 pp) that, over the years, has been adopted as senior-graduate level text in more than 40 universities worldwide. He is also the founding editor of the *Cambridge Series in Chemical Engineering*, which is a series of books and monographs published by Cambridge University Press, established in 1996. With his vision and energy, the series has grown to include 18 books in print, several more signed under contract, and the first book published on chemical product design.

Dr. Varma regularly and actively participates in professional society meetings, where he has organized/chaired more than 50 technical sessions on various chemical engineering topics. Within AIChE, Dr. Varma was a member of long-standing (1978–1995) of the National Program Committee on Kinetics, Catalysis and Reaction Engineering (Area 1b), and was a founding Director of the Catalysis and Reaction Engineering Division (1996–1998), as well as a member of the AIChE Awards Committee (1994–1999). He has been a member of the ISCRE Board since 2001, and he served as Chair of ISCRE-18, held in 2004. For several years, he also served as an AIChE/ABET program evaluator for chemical engineering accreditation.

Professor Varma is also a gifted teacher with exemplary dedication and excellence in educating his students. His lectures are intellectually stimulating, characterized by careful preparation and energetic delivery. His painstaking teaching efforts are evident in the countless number of supplementary notes, most of which were handwritten, that he prepared for his classes. These notes form much of his textbooks and monographs.

Professor Varma has held many visiting faculty appointments at universities around the world: University of Wisconsin–Madison (Fall 1981); California Institute of Technology (Chevron Visiting Professor, Spring 1982); Indian Institute of Technology–Kanpur (Spring 1989); University of Cagliari, Italy (Visiting Chair Professor, Summer 1989, 1992); Princeton University (Spring 1996); University of Minnesota (Piercy Distinguished Visiting Professor, Fall 2001); and UICT–Mumbai (G.P. Kane Visiting Professor, January 2007; Golden Jubilee Visiting Fellow, March 2008).

Professor Varma has also delivered several named lectures at various institutions: Warren McCabe Lecture, North Carolina State University (1992); UOP Invitational Lecture (1994); G. C. A. Schuit Lecture, University of Delaware (1994); Robb Distinguished Lecture, Penn State University (1997); Kuloor Lecture, Indian Institute of Science–Bangalore (1999); Amundson Lectures, University of Guadalajara, Mexico (2001); Piercy Lecture, University of Minnesota (2001); Perkin-Elmer Chemcon Distinguished Lecture, Chennai, India (inaugural speaker, 2001); Paul C. Wilber Lecture, Rice University (2002); Research Highlight Series Lecture, NSF (2002); ConocoPhillips Lecture, Oklahoma State University (2003); Johansen-Crosby Lecture, Michigan State University (2004); G.P. Kane Lectures, UICT–Mumbai (2007); Golden Jubilee Lecture, UICT–Mumbai (2008); and the Distinguished Chemical Engineering Lecture, University of Utah (2009).

Professor Varma has received a variety of recognitions for his teaching and research. These include an Indo-American Fellowship, a Fulbright Scholar Award (1988–1989); the College of Engineering Outstanding Teacher of the Year Award (1991), a Special Presidential Award (1992), the Burns Graduate School Award (1997) and the Research Achievement Award (inaugural recipient, 2001) from the University of Notre Dame; the R. H. Wilhelm (1993) and Ernest W. Thiele (Chicago section, 1998) Awards of the American Institute of Chemical Engineers; the Dow Chemical Engineering Lectureship Award of the American Society for Engineering Education (2000); Honorary Fellow (inaugural batch) of the Indian Institute of Chemical Engineers (2001); and a Technology and Innovation Award from *IndustryWeek* (2005). Recently (in 2008), he was named a Distinguished Chemical Engineering Alumnus (inaugural batch) of his undergraduate alma mater Panjab University (India), also as is a Fellow of AIChE.

On the personal front, Arvind Varma met his wife Karen while they were students at the University of Minnesota, and married on August 7, 1971. They have two daughters, Anita and Sophia, both lawyers and married. Anita blessed her parents with a granddaughter, Genevieve, in July 2007, who has changed their lives.

Professor Varma's well-balanced contributions in teaching, research, and service are truly remarkable, and they make him the consummate professional and excellent role model that he is. The fact that several of his students (38 completed Ph.D. dissertations) and postdoctoral research associates have

gone on to assume successful careers in academia and in major companies is a testament to his excellent training and positive influence on his students.

We thank Professor Varma's many professional colleagues from various institutions around the world for contributing to this issue in his honor.

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