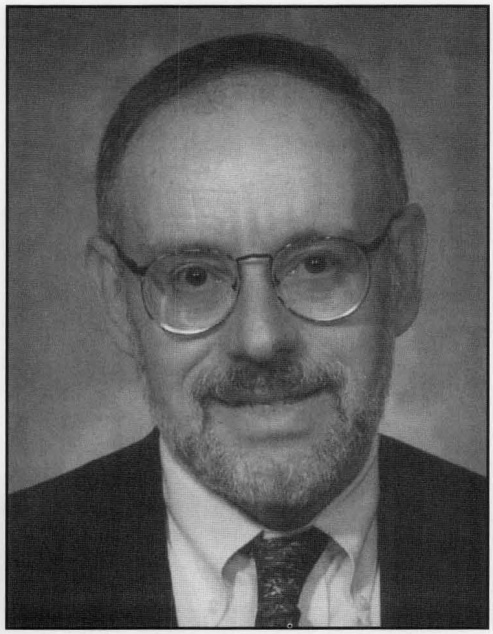
ChE educator

STAN SANDLER

of the University of Delaware

By His Colleagues and Friends at
University of Delaware • Newark, DE 19716



Stan then (circa 1941) and now.

Stanley I. Sandler, a native of New York City, earned his BS at the City College of New York and his PhD at the University of Minnesota, both in chemical engineering. After a year as an NSF Postdoctoral Fellow at the Institute for Molecular Physics at the University of Maryland, he joined Delaware's chemical engineering faculty in 1967. At various times since then he has been the department chair and interim dean of the College of Engineering at Delaware, in addition to being a visiting professor at universities in England, Germany, Australia, and Argentina. He is currently the H.B. du Pont Professor of Chemical Engineering and Professor of Chemistry at the University of Delaware, and Director of its Center for Molecular and Engineering Thermodynamics.

Stan's areas of research include thermodynamics, statistical mechanics, separations processes, and phase behavior. He is the author of *Chemical and Engineering Thermodynamics* and approximately 190 refereed papers, and is the editor of seven books on thermodynamics and chemical engineering education. Among the awards he has received are the Professional Progress Award from the American Institute of Chemical Engineers, the 3M Lectureship Award from the American Society for Engineering Education, and the Distinguished U.S. Senior Scientist Award from the Alexander von Humboldt Foundation (Germany).

STAN'S PREPARATION FOR DELAWARE

1962. What a year! Stan graduated from the City College of New York, got married (the same week he graduated), and went to Minnesota for graduate school shortly thereafter. One of his senior design partners at CCNY was Richard Felder, now at NCSU.

In those days new graduate students at Minnesota had to take written exams before classes started. That was part of the qualifying process—indeed the only written qualifying exams. There were a total of five exams, and Stan passed all but the thermodynamics exam! (We've hitherto kept this secret from his thermo classes!) During that first summer at Minnesota he had a job at General Mills and spent considerable time studying thermodynamics. He subsequently developed a structure for understanding thermodynamics which enabled him to pass the qualifying exam and, about fifteen years later, it became the basis for his widely used textbook *Chemical and Engineering Thermodynamics.* Clearly, the exam process had many unanticipated benefits.

Stan's graduate student colleagues at Minnesota who have since gone into academia include Bruce Finlayson, Dan Luss, Ramkrishna, Mort Denn, Harmon Ray, George Gavalas, Ben McCoy, and others. During the last year of his graduate work, his thesis advisor, John Dahler, took a sabbatical leave at the University of California, Berkeley, and brought Ben McCoy and Stan with him. John was in the physics department, while Ben and Stan were housed in a "temporary" building built during the first or second world war that was still being used as graduate student offices in 1965.

Notable events while Stan was at Berkeley included the

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birth of his first child (Cathy, now Assistant Vice President at MBNA), and discovering the West Coast, the Sierra Mountains, and the desert. It should be noted that Stan grew up in midtown Manhattan and that his parents never had a car. Their philosophy was that anyplace you could not get to via the New York City subway system was not worth going to! Consequently, going to Minnesota, and still further to California, were great adventures for Stan. His wife Judy claims he travels so much because he has this unending urge to discover what lies beyond the New York City subway system.

Stan and Judy during a recent summer bicycling vacation in Europe.

During Stan's time in California, he also interviewed for jobs for the first time, and his first interview trip, to the Los Alamos and Sandia Laboratories, was memorable. Not only was he amazed by the beauty of the Southwest, but it was also his first experience in flying. He arranged to fly from the Oakland airport to Los Alamos by way of San Francisco and Albuquerque. The flight from Oakland to San Francisco was by Hoovercraft, then to Albuquerque by jet prop, to Los Alamos by a twin-engine, eight-seater plane, to Albuquerque by a single-engine, four-seater plane, and from San Francisco to Oakland by helicopter. Consequently, on his first airplane trip he experienced virtually every type of air transportation then available.

Stan finished his thesis at Berkeley, and then, to defend, "dropped in" at Minnesota on his way as a National Science postdoc to the (then) Institute for Molecular Physics at the University of Maryland, working with Ed Mason. His postdoc work combined a continuation of things he had done at Minnesota with some more applications of kinetic theory. One application was on the kinetic theory of ionized gases, which resulted in consulting (in 1970) for Martin Marietta to help design the heat shield for a Project Galileo probe to Jupiter that is only now on its way to that planet.

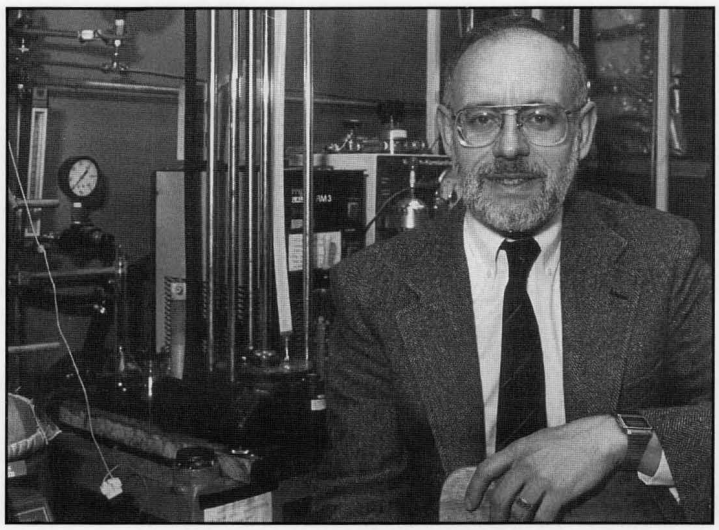
During the time Stan was a postdoc, Mort Denn invited him to give a seminar at Delaware, and this visit subsequently led to an offer of a faculty position. Having grown up in New York and living in Minneapolis, the San Francisco Bay area, and the Washington, DC area, his wife and he could not imagine living in the small town of Newark. They decided to try it for three years, however—and twenty-seven years later they are still there. They found Newark to be a delightful town, close to Philadelphia, Baltimore, Washington, and New York.

Stan was welcomed to the department by excellent, friendly, and extremely helpful colleagues. They quickly recognized Stan's talents, and he was promoted to associate professor three years after he arrived! His promotion to full professor came six years after his arrival and several weeks before his 33rd birthday. Clearly, Stan was ready for a brilliant career at Delaware.

STAN'S ROLE AS EDUCATOR

Stan's versatility was on display during his early years at Delaware, when he taught a large variety of courses. In those days, classes were held Monday through Saturday noon, and during his first two or three years he was regularly assigned to teach classes at 8 and 9 a.m. on Tuesdays, Thursdays, and Saturdays. Since he has been at Delaware, he has taught virtually the entire curriculum at one time or another, including (of course) several "flavors" of thermodynamics.

His transition to applied thermodynamics was catalyzed by his organizing an Engineering Foundation conference of both academic and industrial engineering thermodynamicists. This conference, "Phase Equilibria and Fluid Properties in the Chemical Industry," was held in January of 1977 and probably marked his entry into, and acceptance by, the applied thermodynamics community. The meeting was a great success, helping to revitalize thermodynamics (including sessions at AIChE meeting). It also resulted in several long-term consulting contracts for him that have further helped Stan develop the field. He co-organized the second conference, held in Berlin in 1980, with Helmut Knapp of the Technical University of Berlin. The conference now continues, being held every three years and alternating be-



Stan in one of his laboratories.

The Sandler family at home: Joel and Michael (first row), Catherine, Stan, and Judith.

tween North American and Europe.

Another conference he started (in 1982) is the so-called "Mid-Atlantic Thermodynamics Conference." This meeting rotates among the core schools of Delaware, Penn, Princeton, and Johns Hopkins, and now also includes Rutgers, Virginia, and Penn State, with occasional visitors from farther afield. One characteristic of these symposia is that only graduate students are allowed to make presentations. It is meant to be an event during which graduate students working in the broadly defined area of thermodynamics can meet and interact with their colleagues at other (relatively) nearby schools.

The thermodynamics conferences in California and Berlin led to Stan's close association and friendship with Helmut Knapp of the Technical University of Berlin. As a result, he spent one sabbatical leave in 1981 (taking only his middle child Joel with him since Judy was working at the time) and part of another 1988-89 sabbatical leave at the Technical University of Berlin. Both were supported by the Alexander von Humboldt Foundation (Bonn, Germany). As a result of this Berlin connection, approximately a dozen students from Berlin, and also two from the University of Karlsruhe, have done their *studienarbeit* or *diplomarbeit* in Stan's laboratories at Delaware, and five Delaware students have spent varying amounts of time at T.U. Berlin. Another especially delightful part of Stan's Berlin sabbatical was the development of a friendship with John and Susie Prausnitz, who were also there.

Stan was also co-chairman of the ASEE Chemical Engineering Faculty Summer School held in Santa Barbara, California, in 1982, and organizer and chairman of the 1983 National Science Foundation workshop "Thermodynamic Needs for the Decade Ahead: Theory and Experiment." He has also served on the organizing committees for many other meetings, including the two "Beijing Symposia on Thermodynamics in Chemical Engineering and Industry," as well as meetings conducted by the National Bureau of Standards (now NIST) and the ASME. In addition, he has served as meeting session chairman, on various committees, subcommittees and panels of the National Science Foundation and the AIChE, on the National Research Council/National Academy of Sciences Evaluation Panel for the Center for Chemical Engineering of the National Bureau of Standards, as a member of the Board of Trustees of the CACHE corporation, and on editorial boards of *Industrial and Engineering Chemistry Fundamentals,* the *AIChE Journal,* and the University of Delaware Press. At present he is Thermodynamics Area Editor for *Chemical Engineering Education,* and is on the editorial advisory boards of the *IEC Research,* the *Journal of Chemical Engineering Data, Engineering Science and Technology* (Malaysia), *Indian Chemical Engineer* (Calcutta), and the John Wiley & Sons Series in Chemical Engineering. He is also on the external advisory board of the Department of Chemical Engineering at Carnegie-Mellon University, having previously served in a similar role at LSU.

Another of Stan's activities had a major impact of chemical engineering education in this country. Recognizing the need to bring examples from new technologies and nontraditional areas into chemical engineering courses, he organized and chaired a 1988 Engineering Foundation Conference titled "Chemical Engineering Education in a Changing Environment." One goal of the conference was to discuss, in the context of examples and case studies, the use of fundamental chemical engineering principles in such new technology areas as solid state processing and electronics, biochemical and biomedical engineering, hazardous waste management

and disposal, food processing, etc. Another goal was to produce a proceedings volume of examples and case studies, with sufficient data and detail that they could easily be included into traditional chemical engineering courses. This made it possible to rapidly bring new technology areas into the chemical engineering educational program and classroom without the need for major curricula revision or the introduction of new courses. Stan and Bruce Finlayson edited these conference Proceedings, which were published by the Engineering Foundation and distributed by the AIChE in the fall of 1988. Stan and colleague Kenneth Bischoff, recognizing a need to introduce safety and environmental considerations and risk and hazard analysis in an already crowded chemical engineering curriculum, have been teaching a very popular one-semester elective course titled "Risks, Safety, Hazards, and the Environment." Perhaps Stan's next book will arise from that course.

Stan's textbook, *Chemical and Engineering Thermodynamics,* has made a major contribution to chemical engineering education and went through thirteen printings. It was a featured selection of the McGraw-Hill Book Club, has been translated into Spanish and Chinese, and is reprinted in Taiwan, Korea, and India. The second edition of the book is the first chemical engineering textbook to contain, as an integral part, a disk of calculational personal computer programs to be used for thermodynamic and phase equilibrium calculations. These programs have also been used by students in the stagewise operations and capstone design courses to estimate phase equilibria easily and realistically. This new edition has been well received, with numerous adoptions and sales in excess of 9,000 copies in the U.S. and an additional large number of paperback copies in Europe and Asia since its introduction in 1989. It has already been translated into Korean.

Stan has been a strong advocate of the use of computers in chemical engineering courses. He introduced process simulation into the senior design course, was instrumental in establishing a microcomputer laboratory, and acquired a VAX 785 computer for the department (in the early 1980s!). Nationally, he has advocated chemical engineering computation as a member of the CACHE Corporation Board of Trustees. He was also one of the first chemical engineers to develop computer-assisted instructional materials for the PLATO system and for the IBM-PC.

A WORLD-CLASS THERMODYNAMICS PROGRAM

Stan's research program has grown from a very fundamental base to include applications-oriented components. For a number of years after coming to Delaware, he continued to do research in statistical mechanics, though moving away from the kinetic theory of dilute, structured gases to various aspects of equilibrium properties of liquids. Recognizing that a lack of knowledge of the interactions between molecules was a difficulty in his work, Stan initiated research directed toward obtaining such information for nonspherical molecules. Here he pioneered the method of comparing the results of statistical mechanical theory and computer simulations with X-ray diffraction data taken by his research group in collaboration with scientists at the Oak Ridge National Laboratory to obtain information on intermolecular forces and order. This work was a major step in using theory, rather than geometric models, to interpret molecular diffraction data.

A significant accomplishment during this period of his career was the development of a statistical mechanical perturbation theory based on the use of a nonspherical reference potential. Before his work, statistical mechanical perturbation theories had been based on the use of spherical molecules (generally hard spheres) as the reference fluid. While such perturbation theories were of some use for long-range forces, such as polar and multipolar forces, they were poorly convergent for the addition of shape and overlap forces. Stan's work showed how these latter effects could be accounted for accurately in perturbation theory.

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Stan then moved into an extremely productive phase of research in which he applied the lessons learned from his statistical mechanical research to the area of applied thermodynamics, which is of more immediate need to chemical engineers. First, with Professor Amyn Teja (Georgia Institute of Technology), he developed a highly accurate corresponding states principle using two reference fluids. Next he initiated a successful and continuing research program on the measurement of vapor-liquid equilibrium of systems that are chemically reactive, associate, or are difficult systems in other ways, to provide data for his theoretical research and that of others, especially in the area of group contribution methods. A part of this work has been an international cooperative effort involving researchers at the Technical University of Berlin and the University of Paris.

Coincidental with this work has been a continuing theoretical research program which has included the development of a rigorous thermodynamics of continuous, but bounded, mixtures, which was immediately adopted by the Chevron Oil Field Research Company in its reservoir simulations and crude characterizations and is being used by others in designing crude oil distillation columns. Stan is also using this work for the description of polymer solution phase equilibrium and biochemical separations.

Other aspects of Stan's research have also had important

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industrial applications. For example, his research on calculational methods and equations of state has been used in the design many commercial processes and to achieve major reductions in computation time in reservoir simulation calculations.

Another important research effort has been his work on the generalized van der Waals theory. This work has led to a new understanding of the theoretical bases and assumptions that underlie the equations of state and activity coefficient models currently in use, as well as the development of completely new, theoretically based models. Perhaps the most significant product of his recent research has been a new, theoretically correct mixing rule that allows equations of state and activity coefficient models to be combined in such a way that equations of state can now be used to predict the behavior of highly nonideal mixtures over wide ranges of temperature and pressure. The manuscript describing this work was so enthusiastically received by the reviewers that it was published in the *AIChE Journal* within nine weeks of its original submission. Other recent work that Stan is especially proud of includes developing thermodynamic bounds for microbial growth processes, the use of quantum mechanics and other computational chemistry methods in chemical engineering thermodynamics, and (with Eric Kaler) on the separation of biological materials. His research activities also include phase behavior studies relevant to environmental protection which have included obtaining data for the reformulation of gasoline, the behavior of organic pollutants in aqueous solution, and (with Michael Paulaitis) on CFC replacements. All this work has been enthusiastically received by the international thermodynamics community, and in recent years Stan has been invited to speak on his research in France, Germany, Canada, Mexico, Denmark, China, South Korea, Italy, the Czech Republic, Poland, Australia, Argentina, and at many universities and companies in the United States. Recently Stan has been the Phillips Lecturer at Oklahoma State University, the Aston Hall Carey Lecturer at Georgia Tech, and the ICI Distinguished Lecturer at the University of Alberta.

ACADEMIC LEADERSHIP

Shortly after returning to Delaware from his 1981 sabbatical leave, Stan was named the H.B. du Pont Professor of Chemical Engineering and a short time later was asked to become chair of the department (in which capacity he served until 1986). His efforts as chair led to the successful nomination of five PYIs (Paulaitis, Dhurjati, Klein, Barteau, and Lenhoff). He may still hold the record for the ChE department chair, and perhaps any department chair, with the most successful Presidential Young Investigator nominations! He also rebuilt the chemical engineering faculty by hiring Antony Beris, Prasad Dhurjati, Hank Foley, Bramie Lenhoff, and Andrew Zydney. He remains a mentor to many of these, and other, faculty.

Stan has also given his time to the University. His service activities have included several terms in the University Senate, chair of successful search committees for the chemistry and electrical engineering department chairs, membership on the Provost search committee (twice), head of major University committees such as the Budget and Space Priority Committee and the Committee on Committees, and member of many other committees.

The University of Delaware recognized Stan's special campus role by bestowing on him its highest faculty honor, the Francis P. Alison Award. This nicely summarizes the high esteem in which he is held by colleagues, who continue to see him as the consummate scholar, educator, and mentor. ❐

ChE book review

PATTY'S INDUSTRIAL HYGIENE AND TOXICOLOGY

Volume II, Part A, 4th Edition
Edited by G.D. Clayton and F.E. Clayton
John Wiley and Sons, Inc., New York, NY; 945 pages (1994)

Reviewed by
Klaus D. Timmerhaus
University of Colorado

This is the first of six books of a well-respected industrial toxicology source book. Part A of this comprehensive compilation in Volume II contains fifteen chapters from a total of forty-six chapters covering thousands of chemicals. The first book of Volume 2 begins with an overview of industrial toxicology followed by the general criteria for identifying and clarifying toxic properties and recognizing occupational carcinogens of chemical substances. The following twelve chapters analyze a number of well-known toxins with their physical and chemical properties, industrial resources, analytical determination, physiological response in terms of toxicity and human effects, and exposure limits. The chemical substances covered in Part A of this revised series include:

- Occupational carcinogens
- Complex mixtures of tobacco smoke
- Acetone
- Aldehydes and acetals
- Epoxy compounds
- Ethers
- Organic peroxides
- Aliphatic nitro, nitrate, and nitrite compounds
- N-nitrosamines

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