



## IN MEMORIAM

Charles R. Wilke  
Professor of Chemical Engineering, Emeritus  
Berkeley  
1917– 2003

Today (2005) every major chemical engineering department in the U.S. offers an academic program in biochemical engineering. In response to the growing importance of biochemistry in the chemical (and related) industries, numerous university departments are now called department of chemical and biochemical engineering. This expansion of the frontiers of chemical engineering was pioneered by a few far-sighted academic chemical engineers about 40 years ago. One of these pioneers was Charles R. Wilke, longtime faculty member of the Department of Chemical Engineering at the University of California, Berkeley, and its first department chair.

Charlie was born in Dayton, Ohio, February 4, 1917. He died at age 86 in Berkeley, October 2, 2003. Charlie obtained a B.S. degree in chemical engineering from the University of Dayton (1940) followed by a M.S. degree in physical chemistry from the State University of Washington (1942) and a Ph.D. in chemical engineering from the University of Wisconsin (1944). For one year (1944-45) he worked for the Union Oil Company of California, followed by one year (1945-46) as instructor in chemical engineering at the State University of Washington. In 1946, Charlie joined the faculty of the brand new Chemical Engineering Division in Berkeley's College of Chemistry as instructor. He was promoted to assistant professor in 1947, associate professor in 1951 and professor in 1953. That same year, succeeding Theodore Vermeulen, Charlie became chair of the Chemical Engineering Division. In 1957, when that division became the Department of Chemical Engineering, Charlie was appointed department chair, a position he held until 1963.

Although many chemical engineering departments in leading U.S. universities were well established much earlier, chemical engineering did not formally come to Berkeley until 1945 when Berkeley's College of Chemistry established a Chemical Engineering Division. At about the same time, Berkeley's College of Engineering also started a program in chemical engineering called process engineering. The two competing undergraduate programs were remarkably similar although the chemical engineering graduate program in the College of Chemistry was oriented toward physical chemistry while that in process engineering was in the direction of mechanical engineering. In the period 1946 to 1953, there was considerable rivalry between the two programs. Wilke and Vermeulen, aided by College of Chemistry Dean Kenneth Pitzer, were called upon to defend their chemical engineering program. When Clark Kerr became Berkeley's first chancellor in 1952, one of his first tasks was to decide which of the two programs would survive. Because the number of students in the College of Chemistry program was appreciably larger than that in the College of Engineering, Kerr decided in favor of the College of Chemistry, saying that he respected the opinion of the students "who had voted with their feet". The Process Engineering Program was phased out by 1957.

Wilke was a superb chair, an outstanding department leader. He had a clear vision of where the department should go. It was during his years as chair that Berkeley chemical engineering quickly rose to prominence. In

1953, Berkeley chemical engineering was virtually unknown in the academic world. Ten years later, thanks to Charlie's firm but gentle guidance, it had achieved an enviable worldwide reputation.

During these years, Charlie recruited some excellent young faculty who, along with the small original faculty of 1946, contributed much to the department's success. During his chairmanship, Charlie hired four young chemical engineers who later were elected to the National Academy of Engineering. One of these later became vice president for academic affairs of the University of California and two of the four received the National Medal of Science.

Until about 1968, Charlie's research was in the science and technology of mass transfer (distillation, absorption, drying), one of the key areas of classical chemical engineering. His Ph.D. thesis concerned mass transfer from a bed of small spherical particles to a flowing fluid; he developed a correlation of mass transfer coefficients that has remained standard to this day. At Berkeley, in his early years, Charlie measured and correlated transport properties of fluids and fluid mixtures. His article reporting a new correlation of liquid-phase diffusion coefficients is one of the most frequently cited papers in the chemical engineering literature. With colleague Charles Tobias, his work on mass transfer at a rotating electrode provides one of the cornerstones of electrochemical engineering. Always interested in large-scale chemical processes, Charlie (with colleague Donald Hanson) conceived and developed a two-liquid-phase process for desalinating seawater. With postdoctoral fellow Urs von Stockar (now professor of chemical engineering at the Swiss Federal Institute for Technology in Lausanne), Charlie established a standard technique for design of non-isothermal gas absorbers. With Ph.D. student William Wilcox (now professor of chemical engineering at the Clarkson Institute of Technology), Charlie was one of the first to investigate the engineering fundamentals of zone melting to produce ultrapure metals. With Ph.D. student Jack Powers (later professor of chemical engineering at the University of Michigan), Charlie published the first engineering-oriented study of separation of liquid mixtures by thermal diffusion.

Charlie served on a variety of professional committees of the American Institute of Chemical Engineers and was a member of California's state board for certifying professional engineers. For several years he served as assistant to Berkeley's vice chancellor for academic affairs. In 1969, he published an article entitled "How to Improve Education- Industry Relations". For many years, he was a consultant to the Monsanto Chemical Company in St. Louis.

At age 50, Charlie was an internationally prominent chemical engineer recognized by numerous professional awards and a member of the National Academy of Engineering. Author of *Mass Transfer*, a standard textbook (with Robert Pigford and Thomas Sherwood), Charlie was arguably the world's leading expert on mass transfer in chemical technology. At this time, he decided to redirect his attention to a totally different area, biochemical engineering, a subject entirely new to him. Without any previous experience in biochemistry, Charlie learned bacteriology and started research in the engineering aspects of fermentation, with an emphasis on biological routes for chemicals production. These studies were the beginning of biochemical engineering at Berkeley. Charlie had the courage to recognize that because his former area (mass transfer) was now a mature subject, he would direct his future efforts toward biotechnology, a subject that was then in its infancy. Charlie invited Bob Finn (Cornell University) and Shuichi Aiba (Tokyo), leading figures in biochemical engineering, to Berkeley for sabbatical leaves; their input helped broaden the scope of the research activities in biotechnology. Several years later, Charlie was influential in recruiting Harvey Blanch (later elected to the National Academy of Engineering), with whom he developed biochemical engineering at Berkeley. Today nearly 50 percent of Berkeley's chemical engineering faculty is devoted to research and teaching in biochemical engineering. Nearly 40 years ago, Charlie had the foresight to recognize that much of the future of chemical engineering lies in the engineering aspects of the biochemical sciences.

Charlie's early studies in biotechnology were directed at understanding the role of mass transfer in bioreactors and determining the kinetics of enzymatic and microbial growth processes. As a result of the energy crisis in the early 1970s, Charlie turned his attention to the production of alcohol fuels from renewable resources. He pioneered effective approaches for the enzymatic hydrolysis of cellulosic materials, including wood, newsprint, rice straw, and corn stover. Charlie's profound knowledge of mass transfer and separation processes was clearly apparent in the highly energy-efficient processes he developed for converting sugars into ethanol and other fuels. Today there is a resurgence of interest in renewable resources for fuels and chemicals; Charlie's efforts, about 30 years ago, provide the foundation for these new activities.

The late 1970s saw the advent of a revolution in biology; recombinant DNA provided exciting opportunities to produce therapeutic proteins and to engineer enzymes for new applications. Cell-fusion technologies

enabled monoclonal antibodies to be produced for use as exquisite separating agents and to target drugs. Charlie's research turned to address these opportunities. Much of the engineering underpinnings for modern biotechnology were the result of Harvey Blanch's and Charlie's studies on mammalian cell cultures, enzyme technology and separation processes. Their graduate students were among the first engineers at new biotechnology companies and many entered academic positions, providing a new generation of biochemical engineers versed in modern biology as well as classical chemical engineering. These students have continued strongly to influence biotechnology research and development.

Consistently helpful, Charlie was an effective mentor to junior faculty. Always modest and calm, he nevertheless participated actively in numerous discussions at the College of Chemistry lunch table in The Faculty Club; in friendly but heated debates, Charlie would often make some incisive comment to bring the far-flung, ethereal exchange back to reality. Similarly, at the weekly departmental research colloquia, Charlie would politely ask the speaker where he expected to find application of his (often highly theoretical) work. Charlie was most effective in reminding students and faculty that they were members of a chemical ENGINEERING department.

Charlie Wilke and Bernice Arnett were married in 1946. Bernice, an elementary school teacher and principal, used her artistic talents to restore fine antique furniture and artifacts in the lovely Wilke home in El Cerrito with a panoramic view of San Francisco Bay. In her last 10 or so years, Bernice suffered from Alzheimer's disease; Charlie's devoted care of her for many years was inspiring. Bernice preceded Charlie in death by about six months.

During his college- student years, Charlie participated in a band where he played trombone. On rare occasions, at cocktail parties in his home, after two martinis, Charlie could be persuaded to play a few short tunes in the manner of Tommy Dorsey. In his early years at Berkeley, Charlie could be seen on the campus tennis courts and, throughout town, driving a flashy convertible.

In his later years, Charlie applied his talents of empirical engineering analysis to making financial investment decisions. In his home, he had a powerful computer toward that end. He applied mathematical analysis to optimize securities portfolios not only for himself but also for some pension funds and private clients. He was one of the first to publish articles on effective investment in the blossoming biotechnology industry.

Charlie retired at the end of the spring semester 1987. In recognition of his extraordinary achievements at Berkeley, Charlie was nominated for the Berkeley Citation. In his letter of nomination for that award, Charlie's longtime colleague and collaborator, Professor Charles Tobias, wrote:

"I am writing in support of the nomination of Charles R. Wilke for the Berkeley Citation. Having joined the faculty of our department in 1947, I am well acquainted with Wilke's teaching and research activities, his service to the University, and his work as a leader in the profession of Chemical Engineering. The record is unambiguous, the research accomplishments massive, and benefits of his influence lasting.

The significance of Wilke's contributions to Mass Transport, a key component of the chemical engineering discipline, is beyond question. Characteristic of his work, done in part through collaboration with graduate student degree candidates, is incisive judgement and perspective in the choice of question addressed, solid scientific approach to the problem chosen, and lucid interest to a new field he helped to define: bio- chemical engineering. Specifically, he addressed the establishment of criteria by which microbial processes (fermentation) may be brought to the level of sophistication characteristic of modern chemical industry. His program became one of the leading efforts in the USA, a position maintained since then.

As a teacher on both the undergraduate and graduate level, Wilke played a role in devising our curriculum, initiating several of our undergraduate courses, and assisting young colleagues (myself included) in their first efforts. Early achievement of accreditation of the new program was especially remarkable, in view of our department being attached to the College of Chemistry, rather than to the College of Engineering.

During Wilke's chairmanship, the Department evolved from a small group of faculty within Chemistry, into a major department, with comparable intellectual strength to the leading departments in the Country. The task of hiring new faculty, developing the curriculum, building teaching and research laboratories, attracting talented undergraduate and graduate students was achieved within a remarkably small number of years. Wilke set high standards for faculty and students as well as for himself. What was most remarkable, however, was the spirit of respect, of cooperation, and of mutual assistance, that characterized the emerging department. Wilke's chairmanship set the pattern for our department ever since.

Throughout his career as a professor, and professional engineer, Wilke was called upon to serve in key positions within and outside the University. The number of Boards, Advisory Committees, Editorships he was asked to join attest to the high esteem in which he is held in academic and professional circles. Although a modest man, he was nevertheless recognized throughout his career by many honors.

Wilke served the Department, the University, and the profession of chemical engineering with equal distinction. It would be most appropriate to honor him with the Berkeley Citation.”

At the College of Chemistry graduation exercises in May 1988, Chancellor Heyman presented Charlie with the Berkeley Citation.

John Prausnitz  
Harvey Blanch