



Wesley

WERNER STUMM

1924–1999

BY JAMES J. MORGAN

WERNER STUMM, professor emeritus at the Swiss Federal Institute of Technology (ETH Zürich) and former director of the Institute for Water Resources and Water Pollution Control (EAWAG) in Dübendorf, Switzerland, died at his home in Küsnacht, Switzerland, on April 14, 1999.

Werner Stumm was born in Wolfhalden, Switzerland, on October 8, 1924, and received his early education in Switzerland. He earned the Ph.D. in chemistry from the University of Zürich in 1952. His thesis research was in inorganic chemistry under the mentorship of Professor Gerold Schwarzenbach, a coordination chemist who was a pioneer in the use of complexing agents for chemical analysis. Werner's doctoral research centered on the use of ion-exchange resins and complexing agents for chemical analysis.

After receiving his Ph.D., Werner joined the chemistry staff of the Institute for Water Resources and Water Pollution Control, or EAWAG, a research institute of ETH Zürich. At EAWAG, he became interested for the first time in water treatment and water quality protection. Seeking to deepen his understanding of water chemistry, in 1954 and 1955 he spent a postdoctoral year at Harvard, in the Division of Engineering and Applied Physics, pursuing independent and unusually innovative research on iron corrosion in natural waters, which resulted in a highly original paper, "Calcium Carbonate Deposition at Iron Surfaces."

In 1956 he was called to Harvard as assistant professor of sanitary chemistry. At Harvard he initiated a research program into topics such as corrosion, rates of iron oxidation reactions in water, and coagulation of particles in water. In 1961 he became the Gordon McKay Associate Professor of Applied Chemistry, then Gordon McKay Professor of Applied Chemistry in 1964. He became a U.S. citizen in 1968.

From 1956 through 1970 Werner Stumm established a strong research and teaching program in water chemistry at Harvard. His laboratory became a magnet for doctoral students in environmental engineering, postdoctoral scholars in many disciplines, and visiting research scientists and engineers from the United States and other parts of the world. The emphasis in his research during the Harvard years was on application of fundamental chemistry to water quality engineering processes and ecosystem protection. Among the leading research accomplishments of that period in Werner Stumm's career were his work on rates of iron corrosion in relation to water chemistry, kinetic laws for iron and manganese oxidation in water, chemical aspects of coagulation processes in water, buffering in natural waters, the role and control of algal nutrients in water pollution, polymer flocculation of microorganisms, and chemical aspects of rapid filtration processes for particle removal. It is interesting to note that of the group of Ph.D. students and postdoctoral fellows who worked with Werner Stumm in the 1960s, five have since been elected to membership in National Academy of Engineering. His influence as a research leader and mentor was great indeed.

During his last few years as a professor at Harvard, Werner Stumm began to formulate a unified approach to natural water chemistry, a broad vision encompassing both applications to water technology and processes in the natural water environment. In 1966 he organized a symposium on "Equilibrium Concepts in Natural Waters" at a national meeting of the American Chemical Society. In the resulting proceedings, Werner first introduced the idea of aquatic chemistry as a unifying approach. Two traditions were joined: that of van't Hoff, Goldschmidt, and Sillén in explaining natural water compositions; and that of

Langelier, Buswell, Larson, and Black in improving corrosion control and water treatment. The widely used textbook *Aquatic Chemistry*, which first appeared in 1970, was one of the early fruits of his remarkable vision.

In 1970 Werner Stumm returned to Switzerland to become professor of aquatic chemistry at ETH and director of the EAWAG, the institute where he began his career eighteen years before. At the EAWAG Werner provided the intellectual leadership for a vigorous program of research in aquatic chemistry. At the same time that he guided the institute to a position at the forefront of environmental research, his own studies became more sharply focused on the chemistry of interfaces. Study of chemical processes in Swiss lakes and rivers received great emphasis. His own research had two principal goals: quantitative description of solid-water interface processes in natural waters; and understanding how to better protect aquatic systems under the stress of human activities. For protection of aquatic systems, Stumm urged an ecosystem perspective for all aquatic systems, integrating understanding of pertinent chemical, geochemical, biological and physical processes. Among the impacts on aquatic systems that EAWAG investigated under his leadership were those from atmospheric deposition, such as acid rain and fog, as well as a wide range of terrestrial inputs.

As EAWAG's director, Stumm shaped the institute along multidisciplinary lines in applied research, building up strength in both environmental sciences and environmental engineering. Through his efforts he helped bring EAWAG to a preeminent position worldwide. He recruited outstanding scientists and engineers to develop EAWAG's programs. Innovations in environmental analysis, water technology, modeling of aquatic systems, and chemical and biological dynamics in water were fostered during his time as the director. Scientists and engineers from the world over came to EAWAG to pursue research and to learn of new developments in environmental science and technology.

The fundamental contributions of Werner Stumm to understanding surface chemistry and particle removal in water technology earned him election to the National Academy of Engi

neering in 1991. The central theme of his research into particles and surfaces was that of chemical speciation, the distinct forms of charged and neutral chemical entities on particle surfaces. Surface species were in turn related to species concentrations in water through equilibrium, for example, protons, metal ions, anions, and polymers. In his early studies at Harvard, continuing on through his twenty-two years of research at EAWAG, the concept of *speciation* in water and on surfaces presented a satisfying picture of many key processes in environmental systems, such as adsorption of contaminants, rates of solid dissolution, oxidation-reduction processes in water, and surface catalysis. Werner Stumm played a seminal role in developing the surface complex formation model of adsorption to particles in water. The principal findings from Stumm's research were based primarily on macroscopic equilibrium and kinetic experiments, interpreted through simple chemical models, augmented by then-available tools for molecular observations, such as electron-nuclear double resonance and IR spectroscopy. Over the past decade, many of the important conclusions in his early work on surface speciation have been confirmed and extended by other scientists using newer spectroscopic and microscopic methods.

For Werner Stumm pursuit of a deep understanding of the processes governing natural water systems was a unifying theme of his life. He firmly believed that information at the molecular level was needed to understand local, regional, and global aspects of elemental cycles and impacts of pollution. Paralleling his love of natural water chemistry was his great dedication to teaching and mentoring young scientists and engineers. He was extremely generous of his time and energy. He was "Doctor Father" for more than forty Ph.D. students. During his career he authored or coauthored more than 300 research papers and produced sixteen books. In addition to his professorial tenures at Harvard and at ETH Zürich, he was, at various times in his career, visiting professor at the University of North Carolina, Chapel Hill; the University of Bern; University of Washington; Caltech; and Johns Hopkins. He traveled widely to many parts of the world to lecture on aquatic chemistry.

Werner was much honored in his lifetime. The University of Geneva, KTH Stockholm, University of Crete, Northwestern University, and Technion conferred honorary doctorates. He was recognized with the American Chemical Society's Monsanto Prize for Pollution Control in 1977, the Tyler Prize for Environmental Achievement in 1986, the Simon W. Freese Award of the American Society of Civil Engineers in 1991, the Goldschmidt Medal of the Geochemical Society in 1998, and the Stockholm Water Prize in 1999. On occasions of such honors, Werner unfailingly expressed his heartfelt appreciation to his students and scientific colleagues. On the occasion of receiving the Goldschmidt Medal he remarked: "It has been an especially gratifying privilege to be a teacher and to interact with my students over nearly five decades. My own research could not have been completed without the help and enthusiasm of [my] doctoral students." Werner Stumm was a man of great scientific and personal generosity. His contributions to the environment will be lasting. We cherish his legacy.