Hubert H. Kellogg

HERBERT H. KELLOGG

1920–2016

Elected in 1978

"Strengthening the scientific base of metallurgical processes, and ability to unite theoretical studies with practical industrial needs."

BY SAM MARCUSON
SUBMITTED BY THE NAE HOME SECRETARY

HERBERT HUMPHREY KELLOGG JR., leading practitioner of metallurgical thermodynamics, environmental activist, and professor at Columbia University, died January 16, 2016, at age 95.

He was born in Brooklyn, New York, on February 24, 1920, to Herbert H. Kellogg Sr. and Gladys L. Falding Kellogg. He attended Erasmus Hall High School and Columbia University, where he received BS and MS degrees in metallurgy in 1941 and 1942. In 1940 he married his high school sweetheart, Jeanette Louise Halstead, who survives him as do their children Thomas, Elizabeth, Jane, and David.

Herb had a lifelong passion for the outdoors, harvesting grapes and making wine every fall, sailing the New England coast from New York to Maine in the summer, and occasionally skate-sailing on frozen lakes near his Palisades, NY, home, an 18th century farmhouse that he extensively renovated.

A gentleman with insatiable curiosity whose first priority in all endeavors was excellence, Herb's career was characterized by ever evolving interests. Entering Columbia College to major in chemistry, his focus shifted to a more applied field, mineral processing, studying under Arthur H. Taggart, a founding architect of the field.

In 1946, after 3 years of teaching and research at Pennsylvania State University and a year of service in the US Army, Herb returned to Columbia to teach and do research in pyrometallurgy. He was named the Stanley Thompson Professor of Chemical Metallurgy in 1968, and in 50 years of teaching had 11 doctoral and 15 master's thesis students. He published 92 papers. His students and his papers were influential in both academic and industrial settings.

In the 1950s much of his work concentrated on halide metallurgy. He chaired the Titanium Advisory Committee of the Office of Defense Mobilization (1953–54), charged with defining a national strategy for the production and use of the light but strong metal. His other interest at the time was the thermodynamics of high-temperature metal extraction. A notable paper resulting from this work, "Thermodynamic Properties of the System Pb-S-O to 1100 K" (coauthored with S.K. Basu, 1960, *Transactions of the Metallurgical Society of AIME* 218:70–81), won the Best Paper Award of the Extractive Division of the Minerals, Metals and Materials Society (TMS), and the graphical data analysis approach he developed became known as Kellogg diagrams.

Herb was fascinated by mathematical modeling of thermodynamic and industrial processes. He started with mechanical calculators (about which he said that a day of calculations would "shake your teeth out") and became an early adopter of digital computing. Stacks of Hollerith cards enabled him to create a model of the zinc slag fuming furnace, a model that effectively replicated and reliably predicted industrial furnace behavior.[1] Later he combined sophisticated thermodynamic models of silicate slag and nickel matte to create a model of the nickel converting process.[2] These two papers spawned a number of knock-off publications reporting "improved models" that actually did little to advance understanding

[1] A Computer Model of the Slag Fuming Process. 1967. *Transactions of the Metallurgical Society of AIME* 293:1439–1449.

[2] Thermochemistry of Nickel-Matte Converting. 1987. *Canadian Metallurgical Quarterly* 8(4):285–298.

beyond what Herb had established, a testament to the originality and thoroughness of his work.

In about 1970 Herb met Barry Commoner, environmental activist and author of *The Closing Circle*. The encounter was a turning point in his career. It awoke in him a nascent environmentalism and he devoted much of the rest of his work to understanding environmental challenges of metal production and championing positive action.

Bringing to bear his prestige, position, and considerable skills in clarity of thought, engineering, speaking, and writing, he advocated that engineers should develop "new technologies that use resources more economically and have minimal stress on the environment," and he called on his fellow metallurgists to "publicly urge the adoption of new methods for collection and recycling of waste metals, new laws restricting the use of scarce metals for purposes that preclude recycling.… In short, we must offer our allegiance to the broad social good in place of the narrow interests of one company or one industry" (1972, "Engineers and the Environment," *Journal of Metals [JOM]* 24(6):13–17).

He was particularly proud of a spicy exchange with an Alcoa vice president that played out in the pages of the *Journal of Metals*[3] (Kellogg, 1995, "Reflections on a professional career," unpublished manuscript). Alcoa was promoting aluminum cans as an "energy bank," contending that the cans both increasd the value of municipal waste and stored the large amount of energy consumed in aluminum production in a type of "bank"; when the cans were recycled, the energy would be recovered in the same way that one withdraws money from a bank. Herb likened this promotion to salting a gold mine, and asked the vice president whether he would deposit his funds in a bank that immediately lost 84 percent of the value. The recycling rate of aluminum cans at the time was 16 percent.

[3] The 1973 article that sparked the exchange was by E.A. Walker, "Engineers and the environment: Being heard and being right," *JOM* 25(4):11–14.

Herb did much more than advocate for environmental improvements. At the time, energy accounting around metallurgical processes was crude at best and in many cases wrong. He began analyzing industrial processes to learn and classify the features of energy-conserving, efficient, clean metallurgical techniques.

In three seminal papers on copper processing, he developed a method to account for the energy inputs into smelting and refining processes and applied this technique to analyze both the conventional smelting processes of the time and those in development, which are now dominant in the industry. The last of these papers, "Energy Use in Sulfide Smelting of Copper" (coauthored with J.M. Henderson, 1976, *Proceedings of the International Symposium on Copper Extraction and Refining*, Metallurgical Society of AIME 1:373–415), is an amalgam of industrial data and academic application of first principles. The 40-page paper is still referenced, and the methods Herb developed are embedded in present-day lifecycle analyses.

In addition to his election to the National Academy of Engineering, his numerous professional honors included the AIME James Douglas Medal in 1973 and in 1977 the Sir Julius Wernher Lecture of the UK Institution of Mining and Metallurgy. In the latter part of his career he was regularly invited to visit industrial operations and offer advice.

By nature a sagacious, principled introvert, quiet but strong, from his desk at Columbia University Herb touched the lives of all he taught, guided and influenced the professional community, and helped awaken both industry and the scientific community to the importance of their responsibilities to society.