College of Engineering Distinguished Seminar Series

Presents

Chemical Looping Technology and CO_2 Capture

by

L.- S. Fan, Distinguished University Professor

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Professor of Chemical and Biomolecular Engineering

The Ohio State University

Date: Wednesday, April 24, 2013
Time: 10:30 - 11:45 am
Place: Room S105 in Technology Hall

Abstract:

The concept of chemical looping reactions has been widely applied in chemical industries, e.g., the production of hydrogen peroxide (H_2O_2) from hydrogen and oxygen using 9,10-anthraquinone as the looping intermediate. Fundamental research on chemical looping reactions has also been applied to energy systems, e.g., the splitting of water (H_2O) to produce oxygen and hydrogen using ZnO as the looping intermediate. Fossil fuel chemical looping applications had been used commercially with the steam-iron process for coal from the 1900s to the1940s and had been demonstrated at a pilot scale with the carbon dioxide acceptor process in the 1960s and 1970s. There are presently no chemical looping processes using fossil fuels in commercial operation. A key factor that hampered the continued use of these earlier processes for fossil energy operation was the inadequacy of the reactivity and recyclability of the looping particles. This factor led to higher product costs for using the chemical looping processes, compared to the other processes that were petroleum or natural gas based. With CO_2 emission control now being considered as a requirement, interest in chemical looping technology has resurfaced. In particular, chemical looping processes are appealing due to their unique ability to generate a sequestration-ready CO_2 stream while yielding high energy conversion efficiency. Renewed fundamental and applied research since the early 1980s has emphasized improvement over the earlier shortcomings. New techniques have been developed for direct processing of coal or other solid carbonaceous feedstock in chemical looping reactors. Significant progress is underway in particle design, reactor development, and looping system integration, as demonstrated by the operation of several pilot or sub-pilot scale units worldwide, making it possible that chemical looping technology may be commercially viable in the future for processing carbonaceous fuels.

This presentation will describe the fundamental and applied aspects of modern chemical looping technology that utilizes fossil and biomass as feedstock. The presentation will discuss reaction engineering and solids flow issues associated with this technology. Specifically, it will highlight reactions, reactors and solids-gas issues associated with the optimum feedstock conversion and relationship among the metal oxide conversion, solids flux and reactor configurations. Opportunities and challenges for chemical looping process scale-up and commercialization will also be illustrated.

L.-S. Fan

Background:

L.-S. Fan is Distinguished University Professor and C. John Easton Professor in Engineering in the Department of Chemical and Biomolecular Engineering at The Ohio State University. He has been on the faculty of Chemical Engineering at Ohio State since 1978 and served as Department Chair from 1994 – 2003. Professor Fan received his B.S. (1970) from National Taiwan University, and his M.S. (1973) and Ph.D. (1975) from West Virginia University, all in Chemical Engineering. In addition, he earned an M.S. (1978) in Statistics from Kansas State University.

Professor Fan's expertise is in fluidization and multiphase flow, powder technology and energy and environmental reaction engineering. He is an inventor of 7 industrially viable clean fossil conversion processes: OSCAR, CARBONOX, PH Swing, CCR, Calcium Looping, Syngas and Coal-Direct Chemical Looping Processes. These processes control sulfur, nitrogen oxide and carbon dioxide emissions and convert carbonaceous fuels to hydrogen, electricity or liquid fuels. He also invented the electrical capacitance volume tomography for 3-dimensional, real time multiphase flow imaging that is currently being used in academia and industry. Professor Fan is the U.S. Editor of *Powder Technology* and has served as a consulting editor of ten other journals and book series, including the *AIChE Journal*, *I&EC Research*, and the *International Journal of Multiphase Flow*. He has authored or co-authored four books, 370 journal papers, and 39 patents.

Professor Fan has received a number of awards in recognition of his research and teaching including the ACS E. V. Murphree Award in Industrial and Engineering Chemistry, AIChE Alpha Chi Sigma Award for Chemical Engineering Research, ASEE Dow Lectureship Award in Chemical Engineering, CCR Malcolm Pruitt Award and The Ohio State University Charles E. MacQuigg Award for Outstanding Teaching and Joseph Sullivant Medal for Distinguished Teaching, Research and Service. He is a Fellow of the American Association for the Advancement of Science (AAAS) and the AIChE, a member of the U. S. National Academy of Engineering, a Corresponding Member of the Mexican Academy of Sciences, an Academician of Academia Sinica, and a Foreign Member of Chinese Academy of Engineering. Professor Fan was named in 2008 as one of the "One Hundred Engineers of the Modern Era" by the AIChE.