School for Engineering of Matter, Transport & Energy

Distinguished Scholar Lecture

F E A T U R I N G

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"Chemical Looping Technology Platform – Metal Oxides, Reactors and Processes"

ISTB 4 Marston Exploration Theater

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ABSTRACT

The concept of chemical looping reactions has been widely applied in chemical industries. Fundamental research on chemical looping reactions has also been applied to energy systems. Fossil fuel chemical looping applications were used with the steam-iron process for coal processing from the 1900s to the1940s and were demonstrated at a pilot scale with the HYGAS process and Carbon Dioxide Acceptor process in the 1970s. There are presently no chemical looping processes using carbonaceous fuels in commercial operation. Key factors that hampered the continued use of these earlier processes were the inadequacy of the recyclability and economic viability of the looping particles and their associated reactor system operation. With the CO_2 emission control now of great concern and the need for the development of high efficiency operational processes, interest in chemical looping technology has resurfaced for its unique ability in generating a sequestration-ready CO_2 stream with efficient and versatile process applications.

Chemical looping technology is a manifestation of the interplay among all the key elements of particle science and technology including particle synthesis, reactivity and mechanical properties, flow stability and contact mechanics, gas-solid reaction engineering and particulates system engineering. This presentation will describe the fundamental and applied aspects of modern chemical looping technology that utilizes fossil and other carbonaceous feedstock. Specifically, it will discuss the reaction chemistry, ionic diffusion mechanisms, metal oxide synthesis and thermodynamics, reactor configurations, and system engineering along with energy conversion efficiency and economics. The Coal-Direct Chemical Looping Process, STS Chemical Looping Process, and Syngas Chemical Looping Process being developed at Ohio State University at a pilot level will be illustrated. Further, the CO_2 emission control using the chemical looping technology will be compared with other CO_2 capture methods. Selective oxidation in the production of fuels and chemicals, solar based chemical looping technology and various process application options will also be discussed.

BIOSKETCH

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 Editor-in-Chief 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, 390 journal papers, and 46 patents.

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