CHEMICAL LOOPING GASIFICATION AND REFORMING – A PERSPECTIVE AND PROSPECTS OF NOVEL CIRCULATING FLUIDIZED BED SYSTEMS

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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 from the late 1800s to early1900s and were demonstrated at a pilot scale for synthetic natural gas production with the IGT HYGAS Process and the CO2 Acceptor Process in the 1960s and 1970s. There are presently no chemical looping processes using carbonaceous fuels in commercial operation. Key technical factors that determine commercial viability of the technology lie in the sustainability of the reactivity and recyclability of the metal oxide oxygen carriers and the ability of configuring the reactor assembly for optimal operation and control of the solids flow system. The chemical looping system is developed on the circulating fluidized bed platform. The successful deployment of this technology requires thorough knowledge of two interconnected fields, i.e., metal oxide reaction engineering and particle science and technology. With now CO2 emission control of great concern and process conversion efficiency enhancement of great interest, activities on research and development of chemical looping technology have resurfaced.

Specifically, chemical looping technology is a manifestation of the interplay among such key elements of metal oxide reaction engineering and particle science and technology as 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 features of modern chemical looping technology in the context of the circulating fluidized bed platform that utilizes fossil and other carbonaceous feedstock. It will discuss the reaction chemistry, ionic diffusion mechanisms, metal oxide synthesis and thermodynamics, reactor design, and system engineering along with energy conversion efficiency and economics of the chemical looping processes for, specially, partial and selective oxidation for syngas and chemicals production. The Ohio States University has developed a number of advanced chemical looping gasification and reforming processes which will be highlighted in this presentation. Potential for solar based chemical looping technology will also be discussed.