# Chemical Looping Technology for Hydrogen Production – Commercialization Prospect

**by**

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## Abstract

The concept of chemical looping reactions in redox operating schemes has been recognized as a valuable means in the synthesis of fuels and chemicals in industries. Fundamental research on chemical looping reactions has also been conducted for many decades. The well-recognized chemical looping reactions could be represented by the steam-iron process using coal from the late 1800s to early1900s and were applied at a pilot scale for synthetic natural gas production with the IGT HYGAS Process and for syngas production with the $CO_2$ Acceptor Process in the 1960s and 1970s. There are presently, however, no chemical looping processes 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 product yields. 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 $CO_2$ 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 as a platform 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, biomass and other feedstocks. 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 hydrogen production. The partial and selective oxidation for syngas and chemicals generation will also be discussed to highlight the versatility of this technology. The Ohio States University has developed a number of advanced chemical looping gasification and reforming processes which have been licensed to industries for commercialization. This presentation will highlight the on-going commercialization activities for hydrogen production using natural gas and solid feedstocks. The tech-

economic analyses of this technology in comparison with the steam-methane reforming and the auto-thermal reforming will also be discussed.