Continuous operation of chemical looping process for hydrogen production

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A three-reactor chemical-looping system which consists of fuel reactor (FR), steam reactor (SR), and air reactor (AR) produces pure hydrogen with simultaneous capture of CO2. The iron oxide (Fe2O3), one of the most attractive metal oxides acting as an oxygen carrier circulates through the reactor. Combustion of methane occurs to produce CO2 and H2O through the reduction of iron oxide in FR, where CO2 is captured in the flue gas by condensing water. The reduced particles are transferred to SR where H2O is introduced and then decomposed to hydrogen by donating its oxygen to reduced iron oxide. The partially oxidized solid is fully oxidized by air in AR, and then returns to FR. In the present study, the reactivity of the iron oxide was determined in a batch fluidized reactor by alternating gases: CH4, steam. For FR, the reduction and the rate of solid were determined at different temperatures and flow rates. For SR, the effect of temperature and the reduction of particles on the water conversion and its rate were determined. Based on the reactivity data, the key parameters including bed inventory for each reactor and the circulation rate for the design of the system was determined. When the iron oxide is reduced between FeO0.7 and FeO0.5, over 40 % of water conversion is obtained and large temperature drop in FR is prevented. The extent of reduction of iron oxide in FR is related to the amount of hydrogen and the operating temperature of SR. It was determined that 800-1000 kg/MW oxygen carrier would be needed in the reactors. Similarly, the solids circulation rate among the reactors would need to be between 2-3 kg MW-1 s-1.