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Enhanced Fuel Conversion by Staging Oxidization in a Continuous Chemical Looping Reactor based on Iron ore Oxygen Carrier

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Abstract: Natural iron ore as an oxygen carrier for chemical looping combustion (CLC) has recently attracted increasing attention. However, low fuel conversion efficiency is the major issue for the CLC process based on iron ore. The unconverted gaseous fuel causes energy loss and degrades CO_2 purity. Based on the technology of interconnected fluidized bed, a new 2 kW CLC reactor was constructed with a two-stage fuel reactor. Staging oxidization of fuel was proposed in the special fuel reactor to promote fuel conversion. The fuel oxidation primarily occurs in the 1st stage fuel reactor, and the remaining unconverted combustible gas is further oxidized by fresh oxygen carrier in the 2nd stage fuel reactor. This CLC reactor was tested using an Australian iron ore as oxygen carrier and syngas and CH_4 as gaseous fuels, respectively. The staging oxidization of gaseous fuel in this new configuration was evaluated by comparing with the results from a 1 kW reactor with one stage fuel reactor. For the syngas tests, fuel conversion efficiency in the 2 kW reactor maintained between 92.9% and 98.3%, while that in the 1 kW reactor maintained at only about 80%. For the CH_4 tests with thermal power input of 1 - 2 kW, up to 92.9% CH_4 was converted and CO_2 yield reached around 88% at 980 ^oC. Finally, the oxygen carrier particles were characterized by XRD and SEM. Overall, staging oxidation of fuel is an effective method to enhance fuel conversion when using a Fe-based oxygen carrier.

Keywords: staging oxidization; iron ore; oxygen carrier; chemical looping combustion; CO_2 capture

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