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

Haiming Gu^{1*}, Laihong Shen^{2*}, Siwen Zhang¹, Miaomiao Niu¹, Rongyue Sun¹, Shouxi Jiang²

1, School of Energy and Power Engineering, Nanjing Institute of Technology, Nanjing 211167, China

2, Key Laboratory of Energy Thermal Conversion and Control of Ministry of Education, School of Energy and Environment, Southeast University, Nanjing 210096, China

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 CO₂ 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 CH₄ 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 CH₄ tests with thermal power input of 1 - 2 kW, up to 92.9% CH₄ was converted and CO₂ yield reached around 88% at 980 °C. Finally, the oxygen carrier particles were characterized by XRD and SEM. Overall, staging oxidization 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; CO₂ capture

* To whom correspondence should be addressed. Tel: +86-25-86118355. Fax: +86-25-86118355.

E-mail: hmg@seu.edu.cn (H. Gu); lhshen@seu.edu.cn (L. Shen)

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