Adsorption enhanced chemical looping gasification of biomass with Fe_2O_3/CaO: Oxygen carrier activity and process optimization study

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Adsorption enhanced chemical looping gasification of biomass is an important technology for the future because it can uniquely allow inherent capture of CO_2 during conversion process, thus promoting syngas production and acquiring carbon credit. The advantages for adsorption enhanced chemical looping gasification includes: a) Oxygen provided by oxygen carrier can be used for biomass gasification, which is more economical then pure CO_2/H_2O gasification; b) In-situ CO_2 adsorption by CaO can promote the useful syngas production. c)The oxidation of oxygen carrier is an exothermic reaction, which can provide heat for biomass gasification through oxygen carrier circulation; d) The oxygen carrier can be potentially used for tar cracking. In this study, oxygen carrier was prepared with wet impregnation method by using calcium nitrate tetrahydrate (Sigma-Aldrich, >99%) and iron oxide (Sigma-Aldrich, >99%). After calcination at 800 °C for 4 h in a muffle furnace under air atmosphere, oxygen carriers were obtained with different ratio of Fe_2O_3 and CaO. Then the oxygen carriers were applied for chemical looping gasification of rice straw in steam/N_2 atmosphere to generate H_2 with in-situ CO_2 adsorption. Different temperatures, steam/biomass ratios, oxygen carrier/biomass ratios, and Fe:Ca ratios were investigated during chemical looping process to optimize the reaction conditions for carbon conversion, syngas/H_2 production. The characterization of oxygen carriers before and after reaction were carried out by X-Ray Diffractometer, Scanning Electron Microscope, and Temperature

Programmed Oxidation to explore the reactivity of different oxygen carriers. With the increase of reaction temperature, the gasification conversion was promoted which increased the carbon conversion, while the CO_2 adsorption efficiency was decreased when temperature higher than 800 °C. The CO_2 capture by calcium cycle enhanced both the biomass gasification and oxygen carrier reduction process which benefited the fuel gas production. The content of H_2 was enriched by the iron ore reduction and the following CO_2 adsorption. Chemical looping gasification of rice straw with in-situ CO_2 adsorption by Fe_2O_3/Cao shows oxidation activity for fuel gas/H_2 production.