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Feasibility Study of Plant Design with Biomass Direct Chemical Looping Combustion for Power Generation

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Abstract : The increasing demand for energy and concern of global warming are intertwined issues of critical importance. With the pressing needs of clean, efficient and cost-effective energy conversion processes, an alternative clean energy source is needed. Biomass is one of the preferable options because it is clean and renewable. The efficiency for biomass conversion is constrained by the relatively low energy density and high moisture content from biomass. This study based on bio-based resources presents the Biomass Direct Chemical Looping Combustion Process (BDCLC), an alternative process that has a potential to convert biomass in thermal cracking to produce electricity and CO2. The BDCLC process using iron-based oxygen carriers has been developed as a biomass conversion process with in-situ CO2 capture. The BDCLC system cycles oxygen carriers between two reactor, a reducer reactor and combustor reactor in order to convert coal for electric power generation. The reducer reactor features a unique design: a gas-solid counter-current moving bed configuration to achieve the reduction of Fe2O3 particles to a mixture of Fe and FeO while converting the coal into CO2 and steam. The combustor reactor is a fluidized bed that oxidizes the reduced particles back to Fe2O3 with air. The oxidation of iron is an exothermic reaction and the heat can be recovered for electricity generation. The plant design's objective is to obtain 5 MW of electricity with the design of the reactor in 900 °C, 2 ATM for the reducer and 1200 °C, 16 ATM for the combustor. We conduct process simulation and analysis to illustrate the individual reactor performance and the overall mass and energy management scheme of BDCLC process that developed by Aspen Plus software. Process simulation is then performed based on the reactor performance data obtained in multistage model.

Keywords : biomass, CO2 capture, direct chemical looping combustion, power generation
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