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Chemical-Looping Combustion of Coal with Carbon Dioxide Capture

Abstract.

This proposal is for experimental and computational analyses of a system using chemical-looping combustion (CLC) of coal with inherent capture of carbon dioxide (CO_2). The system consists of a metal-based oxygen carrier, which is oxidized in the air reactor by the oxygen from air. The oxygen-carrier oxidizes the product of the coal gasification to mainly CO_2 and H_2O in the fuel reactor. Therefore, the direct contact between air and the coal is avoided. After condensing the H_2O, a flow of almost pure CO_2 becomes ready for sequestration. The reduced oxygen carrier returns to the air reactor to be oxidized and start a new reduction/oxidation cycle between the air and fuel reactors. The proposed CLC system uses air, coal, limestone, and steam. The limestone captures the sulfur in the coal and forms calcium sulfur (CaS) in the fuel reactor. The CaS serves as the oxygen carrier, which is oxidized to calcium sulfate ($CaSO_4$) in a heat releasing reaction with air in the air reactor. The $CaSO_4$ is cycled to the fuel reactor where it is reduced to CaS. CLC is tolerant of the impurities associated with coal and uses fluidized bed technology that comes with high conversion efficiency. The proposed proposal will allow us to construct a lab scale system and optimize it with the Aspen Plus simulator, and perform sensitivity analyses for the lowest unit cost of electricity production with CO_2 capture in a chemical-looping combustion combined cycle system.