HYDRODYNAMICS OF CHEMICAL LOOPING COMBUSTION SYSTEMS: EFFECTS OF REACTOR DESIGN PARAMETERS

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Chemical looping combustion (CLC) has been considered a transformational technology for the carbon dioxide (CO2) capture in power plants. Extensive research has been conducted on the selection and preparation of oxygen carrier (OC) materials, their production and characterization, CLC process development, and reactor system demonstrations from bench to pilot scales. Different configurations of CLC system have been proposed and tested, such as interconnected circulating fluidized bed (CFB) reactor systems, CFB with counter-current moving bed reactor systems, and fixed bed reactor systems. Despite considerable research efforts on the development of CLC systems, the analysis of the effects of hydrodynamic characteristics of OC particles, such as particle size, density and support content, on the design and operation of the CLC system is still lacking. Further, major operational parameters that continue to be in need of exploration include the control of the solids circulation rate of the system, pressure balance and profile of the system, and the gas sealing from the interconnected reactors. This study examines the inter-relationships between the hydrodynamics and kinetics characteristics of the OC particles and the operating conditions of the reactors, along with the reaction and heat management of the system. The design principle that is applied to sizing the reactor system is developed. Parametric effects on the system performance due to the variation of particle parameters, reactor size, system pressure, and operating conditions are simulated and analyzed.