

Title : Development of the Three-Tower Chemical Looping Coal Combustion Technology

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Abstract : To protect the environment changing, coal combustion must reduce its CO₂ emission by capture and storage. Chemical looping is a potentially high technology for coal combustion with CO₂ capture efficiently. A chemical-looping-combustion system, using circulating fluidized bed witch consist two main reactors, a fuel reactor and an air reactor. An oxygen carrier, typically a metal oxide, is employed to transfer oxygen from the air reactor to the fuel reactor, and circulates between these two reactors. During 2012-2014, JCOAL, MHPS (Mitsubishi Hitachi Power Systems (2012-2013 Babcock-Hitachi)) and IAE(The Institute of Applied Energy) have a project funded by NEDO (New Energy and Industrial Technology Development Organization) to surveyed chemical looping technology development in the world, studied market needs of chemical looping combustion, investigated carrier costs and reactivity, etc., in order to reduce CO₂ separation recovery cost to 2,500 yen/ton of CO₂ or less. A small-scale reactor was used to study the behaviors of the direct reaction of coal with an oxygen carrier. It was found that the coal conversion efficiency increases with increasing iron level in the carrier, that the volume of unreacted CO gas increases when oxygen use in the carrier exceeds the range of Fe₂O₃ --> Fe₃O₄, and that there is no notable surface melting that could obstruct particle circulation at 950̊C or less. A basic model of the CLC process was produced using the AspenPlus software and used to analyze the process under the conditions of a 250MWth plant. It found that the volume of circulating CLC carrier is roughly the same as the circulation of CFBC medium, and that inner desulfurization and ultra-low NOX combustion are possible. Using the results of research and process analysis, a three-tower chemical looping coal combustion technology that consists primarily of an air reactor (AR), coal reactor (CR), and volatiles reactor (VR) was selected, and an conceptual design was produced for the reactor configuration and technical parameters.