PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

POWER GENERATION & UTILITY FUELS

Development of Chemical Looping Combustion/Gasification for Solid Fuels

Among the available or proposed technologies involving CO_2 purification, pressurized chemical looping combustion/gasification (CLC/G) may be the most promising. In CLC/G, coal is not combusted in the usual sense. Rather, coal may be used to chemically reduce a metal oxide to its metallic form while the oxygen removed from the metal is used to oxidize the carbon in the coal. To envision this, consider the way coke is used to reduce iron ore to iron in a smelter. The iron ore, consisting of a mixture of iron oxides, supplies oxygen to oxidize the coke to CO and CO_2. CLC/G produces a flue gas concentrated in CO_2 using atmospheric air for combustion and can do so with a much more modest power-output derate than absorption/ stripping or oxy-combustion. CLC/G technology differs from IGCC technology in that the production of syngas is not the objective in the CLC/G process. Rather, the application of in-situ gasification serves to promote the reaction rate between the solid fuel (coal) and the solid oxygen carrier and to decrease the reactor dimensions.

The CLC process has two reactors:
1) an Oxidizer in which oxygen from air is selectively fixed into an oxygen-carrier structure, and
2) a Reducer (Redox) in which coal is burned by the oxygen carrier (OC).

The PCLC will generate two gas streams:
(1) a high-temperature, high-pressure, alkali-free, clean gas from the oxidizer used to drive an aero-turbine (Brayton Cycle) followed by a heat-recovery steam generator for Rankie Cycle, and
(2) a small-volume CO_2-enriched stream from the Redox for sequestration.

The objectives of the project are to:
(1) develop a high-efficiency alternative to IGCC for CO_2 capture for future coal-based power plants;
(2) develop an innovative oxygen carrier for solid-fuel combustion;
(3) demonstrate the feasibility of using solid fuel in a circulating fluidized-bed-based chemical looping combustion/gasification process;

Potential impacts from the project include:
(1) provision of a higher-efficiency (~50% vs. ~36%) alternate technology to IGCC for CO2 capture;
(2) a cost-effective means to control pollutants such as sulfur, mercury and trace metals by their pre-removal into a small volume, N_2-free gas stream; and
(3) deep reductions in NOx formation due to low-temperature, coal-free combustion of OC to generate steam.

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