A milestone for new carbon-dioxide capture/clean coal technology

20 March 2013

An innovative new process that releases the energy in coal without burning—while capturing carbon dioxide, the major greenhouse gas—has passed a milestone on the route to possible commercial use, scientists are reporting. Their study in the ACS journal *Energy & Fuels* describes results of a successful 200-hour test on a sub-pilot scale version of the technology using two inexpensive but highly polluting forms of coal.

Liang-Shih Fan and colleagues explain that carbon capture and sequestration ranks high among the approaches for reducing coal-related emissions of the carbon dioxide linked to global warming. This approach involves separating and collecting carbon dioxide before it leaves smokestacks. Fan's team has been working for more than a decade on two versions of carbon capture termed Syngas Chemical Looping (SCL) and Coal-Direct Chemical Looping (CDCL). They involve oxidizing coal, syngas or natural gas in a sealed chamber in the absence of the atmospheric oxygen involved in conventional burning. Metal compounds containing oxygen are in the chamber. They provide the oxygen for oxidation, take up coal's energy, release it as heat in a second chamber and circulate back for another run in the first chamber.

Their report describes the longest continuous operation of the CDCL test system. It operated successfully for 200 hours without an involuntary shutdown. The system used sub-bituminous and lignite coals, which are the main source of carbon dioxide emissions at U.S. coal-fired power plants. Carbon dioxide captured during operation had a purity of 99.5 percent.

More information: "Iron-Based Coal Direct Chemical Looping Combustion Process: 200-h Continuous Operation of a 25-kWth Subpilot Unit" *Energy Fuels*, Article ASAP
DOI: 10.1021/ef400010s

Abstract

The coal direct chemical looping (CDCL) combustion process using an iron-based oxygen carrier has been developed and demonstrated in a 25-kWth subpilot unit. The CDCL subpilot unit is the first chemical looping demonstration unit with a circulating moving bed for the solid fuel conversions. To date, the CDCL subpilot unit at OSU has been operated for more than 550 h. The feasibility of the subpilot unit with various types of solid fuels including sub-bituminous coal and lignite coal has been tested. This article discusses the operational experience of a successful 200-h integrated, continuous demonstration with sub-bituminous coal and lignite coal. Throughout the 200-h continuous operation, the CDCL subpilot unit showed steady behavior in terms of solid circulation, coal handling, and oxygen carrier reactivity and recyclability. Tests with both coals confirmed more than 90% coal conversion with 99.5 vol % purity of CO2 achieved in the reducer. The sound design of the reducer allowed for nearly full coal conversion with a high purity of CO2, eliminating the need for additional downstream fuel polishing and separation units. The combustor gas contained lean oxygen concentrations with minute amounts of carbonaceous gases (CO2, CO, and CH4) detected. The combustor gas analysis implied the proper regeneration of iron-based oxygen carriers, good gas sealing between the reducer and combustor, and no indication of unconverted carbon carry-over. Moreover, the fates of coal pollutants such as NOx and SOx that are commonly observed in the conventional coal combustion process were also investigated during the subpilot unit operation. The NOx analysis showed that the CDCL process is capable of significantly reducing NOx emissions by avoiding thermal NOx formation. The sulfur analysis indicated SO2 generation in both reducer and combustor, agreeing with the sulfur chemistry in the CDCL scheme.

Provided by American Chemical Society