Combined Sorbent/wgs-based Capture Process with Integrated Heat Management for IGCC Systems

Project Summary

The project will combine key technologies to develop an integrated CO_2 capture/WGS reactor with integrated heat management for IGCC applications. Multiple CO_2 sorbents will be compared to identify the best performance under conditions amenable to WGS. Performance of a commercial WGS catalyst will be validated under expected adsorption/desorption conditions to confirm that activity is maintained. Upon successful demonstration of the sorbents and WGS catalysts, an integrated CO_2 capture/WGS reactor with integrated heat management will be constructed and tested. A reactor model will be developed and utilized for a preliminary assessment of a commercial process based on this technology for the potential to meet DOE energy performance goals of 90% CO_2 capture rate with 95% CO_2 purity at a cost of electricity 30% less than baseline capture approaches.

Background

Coal-fired power plants in the United States have made significant progress in reducing emissions of sulfur dioxide (SO_2), nitrogen oxide (NOx), and particulate matter since the passage of the Clean Air Act; however, global greenhouse gases, such as CO_2, have steadily increased over the past century and have been linked to increasing global temperatures. Carbon capture and storage (CCS) is one of many approaches critical to significantly reducing CO_2 emissions. Energy and capital cost associated with 2nd generation carbon capture systems are projected to be prohibitive for deployment in markets without relying on sale of CO_2 to offset the high cost of CCS. DOE, through its Carbon Capture Program, is investigating transformational, low-cost technology solutions that allow leveraging and competitive operation of our nation's fossil-based power generation infrastructure in a low-carbon future. This project was funded under a program seeking development and testing of transformational post-combustion and pre-combustion CO_2 capture systems for new and existing coal-based power plants in the USA.

Project Description

Funded through DOE/NETL, Southern Research (SR) has been conducting laboratory scale research for the development of a combined CO_2 capture/WGS process. The 36-month project will advance the current IGCC system by demonstrating the technology's key advantages and its potential to meet the energy performance goal of 90% total carbon capture with 95% CO_2 purity production

SOUTHERN RESEARCH

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PARTNERS
ARTC

PROJECT DURATION
Start Date: October 2015
End Date: September 2018

COST
Total Project Value
$2,452,740

DOE/NON-DOE SHARE
$1,962,192/$490,548

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Goals and Objectives

The objective of this project is to conduct laboratory-scale research to develop a combined magnesium oxide (MgO)-based CO_2 sorbent with a WGS catalyst reactor that offers high levels of durability, simplicity, flexibility and heat management ability. The ultimate goal is to develop a combined CO_2 capture/WGS process with advanced integrated heat management to capture 90% of the CO_2 from syngas produced from gasifiers such as the Transport Reactor Integrated Gasifier (TRIG) and GE Energy for integrated gasification combined cycle (IGCC) applications. The project aims to reduce the cost of electricity by 30% over IGCC plants employing conventional methods of CO_2 capture.

Accomplishments and Future Plans

The hybrid CO_2 capture/WGS reactor has been run for 100s of cycles at bench scale and testing so far has shown the sorbent to meet both CO_2 capture capacity (3 mmol/g) and durability targets. Also, the WGS performance has been close to target (92% CO conversion). Reactor modeling and techno-economic evaluation tasks have been initiated. Also a 1000 cycle test will be conducted at optimum conditions to demonstrate long-term durability.

Technology Highlights:

- Could replace conventional two-stage WGS reactor system with intercooling plus a separate CO_2 capture unit with a single WGS reactor unit, with potential for energy efficiency increase and equipment cost savings.
- CO_2 capture drives equilibrium-limited WGS toward CO_2 and H_2.
- Integrated heat management maintains thermodynamically favorable reaction temperatures for both exothermic CO_2 capture/WGS and endothermic regeneration.
- The current state-of-the-art CO_2 capture process involves scrubbing the gas stream at low temperature. SR's elevated temperature CO_2 capture technique eliminates the need to cool the gas stream coming from WGS reactor
- SR's high capacity and highly regenerable CO_2 sorbent provides fast adsorption/desorption kinetics that can be applied in a pressure swing process under minimum temperature swing condition.

ABOUT SOUTHERN RESEARCH

Founded in 1941 in Birmingham, Alabama, Southern Research is a scientific and engineering research organization that conducts preclinical drug discovery and development, advanced engineering research in materials and systems development, and energy and environmental technologies research. SR supports clients and partners in the pharmaceutical, biotechnology, defense, aerospace, environmental, and energy industries.

We pursue entrepreneurial and collaborative initiatives to develop and maintain a pipeline of intellectual property and innovative technologies that contribute to the growth of the organization and positively impact real world problems.

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