the ENERGY lab

PROJECT FACTS

Gasification Technologies

Advanced CO_2 Capture Technology for Low Rank Coal Integrated Gasification Combined Cycle (IGCC) Systems

Background

Gasification of coal or other solid feedstocks (wood waste, petroleum coke, etc.) is a clean way to produce electricity and produce or co-produce a variety of commercial products. The major challenge is cost reduction; current integrated gasification combined cycle (IGCC) technology is estimated to produce power at a cost higher than that of pulverized coal combustion. However, the Gasification Program is supporting research and development (R&D) to develop technologies with the potential to produce electric power with greater than 90 percent carbon capture at a cost of electricity (COE) that will be lower than the COE of any other coal-fueled power generation technology with carbon capture. The public benefits of the Gasification Program are significant—lower cost power, cleaner environment, reduced carbon footprint, less water use, reduced dependence on imports, increased U.S. technological competitiveness, and high-value U.S. jobs.

Approximately 50 percent of the coal produced in the United States is low-rank coal (sub-bituminous coal and lignite). Low-rank coal has less energy per pound than higher-ranked eastern (bituminous) coal, but costs much less. In alignment with Department of Energy (DOE) Gasification Program goals, the National Energy Technology Laboratory (NETL) is partnering with TDA Research, Inc. (TDA) to demonstrate the technical and economic viability of a new IGCC power plant designed to efficiently process low rank coals.

Project Description

Through systems analysis and physical tests, TDA will show the technical and economic advantages of using an integrated carbon dioxide (CO_2) sorbent and Water-Gas-Shift (WGS) catalyst system in an IGCC power plant, fueled with low rank coal, and designed to capture over 90 percent of the CO_2 emissions.

The proposed system uses a high-temperature physical adsorbent capable of removing CO_2 above the dew point of the synthesis gas, and a contaminant-tolerant WGS catalyst that can effectively convert carbon monoxide to hydrogen and CO_2 in the presence of a wide range of contaminants, particularly the alkali, sulfur, and phosphorous compounds resulting from the gasification of low rank coals. The integrated operation of the WGS catalyst and CO_2 removal processes in

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PARTNERS

UCI
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PROJECT DURATION

Start Date
10/01/2011

End Date
09/30/2012

COST

Total Project Value
$625,000

DOE/Non-DOE Share
$500,000 / $125,000

a single step drives the equilibrium-limited WGS reaction toward hydrogen without the need to add large amounts of water (H_2O) to the synthesis gas, greatly reducing the cost of CO_2capture. Preliminary system analysis suggests that maintaining the H_2O:C ratio of reactants entering the shift reactor (syngas and added shift steam) close to that required by the reaction stoichiometry (1:1) rather than using an excess of close to 2:1 will improve IGCC plant efficiency by more than two percentage points by reducing the consumption of shift steam. The process intensification provided by carrying out two unit operations (WGS and CO_2 removal) in the same reactor will reduce the capital cost and improve the process economics of new IGCC plants.

Goals and Objectives

This project aims to optimize the integrated WGS-CO_2 capture system design; assess the efficacy of the integrated capture system, first in bench-scale experiments and then in a slipstream field demonstration at ConocoPhillips' Wilsonville, AL site using actual coal-derived synthesis gas; and perform a techno-economic analysis using Aspen Plus™ software to estimate the impact of the integrated WGS-CO_2 capture system on the thermal efficiency of the plant and the COE.

Benefits

The successful development of advanced technologies and innovative concepts that reduce emissions of CO_2 into the atmosphere is a key objective to help mitigate the effects of climate change. The project will promote the commercialization of low-ranked coal-based IGCC with carbon capture by advancing technologies to make the process more economical. The project supports the DOE's goal of using gasification to provide power from coal with 90 percent carbon capture, utilization, and storage at minimal increase in the cost of electricity. DOE is developing advanced technologies to ensure the nation's abundant energy resource can be used in a manner that strengthens the economy and protects the environment.

Figure 1. TDA's CO_2 removal skid.

Figure 2. TDA's Gas conditioning skid.