the ENERGY lab

PROJECT FACTS

Carbon Sequestration

A Low Cost, High Capacity Regenerable Sorbent for Pre-combustion CO_2 Capture

Background

An important component of the Department of Energy (DOE) Carbon Sequestration Program is the development of carbon capture technologies for power systems. Capturing carbon dioxide (CO_2) from mixed-gas streams is a first and critical step in carbon sequestration. To be technically and economically viable, a successful separation method must be applicable to industrially relevant gas streams at realistic temperatures and practical CO_2 loading volumes. Current technologies that are effective at separating CO_2 from typical CO_2 containing gas mixtures, such as coal-derived shifted synthesis gas, are both capital and energy intensive.

In alignment with DOE Carbon Sequestration Program goals, the National Energy Technology Laboratory (NETL) has teamed with TDA Research (TDA) to test and validate a technology for pre-combustion CO_2 capture.

Project Description

TDA will test and validate the technical and economic potential of a regenerable physical sorbent for pre-combustion CO_2 capture. Physical sorbents separate CO_2 from a gas stream by preferentially attracting the CO_2 to their surfaces at high pressures. Regenerable sorbents can release the absorbed CO_2 through changes in pressure or by stripping with an easily separable gas, such as steam.

Synthesis gas (syngas) from a coal gasifier consists mainly of hydrogen (H_2) and carbon monoxide (CO). Typically, the syngas stream undergoes a water-gas-shift (WGS) reaction where CO reacts with water and is converted to CO_2 and H_2. The WGS reaction increases the total amount of carbon that can be removed by the sorbent. Following the WGS reaction, the sorbent removes the CO_2 from the gas stream, leaving a stream of high-purity H_2 that can be sent to a combustion turbine for power generation. When the sorbent is regenerated, the absorbed CO_2 is released in a highly concentrated stream that can be cost-effectively captured and sequestered, or reused.

Goals and Objectives

The project objective is to develop a low-cost, high-capacity CO_2 sorbent and demonstrate its technical and economic potential for pre-combustion CO_2 capture. First year objectives include optimizing the chemical and physical properties of the sorbent, scaling up sorbent production, and beginning long-term sorbent testing in the presence of contaminants in a laboratory reactor. Second year objectives include designing and building a prototype test unit and testing the unit in the presence of actual coal-derived syngas. TDA will perform these field tests with the oxygen-

CONTACTS

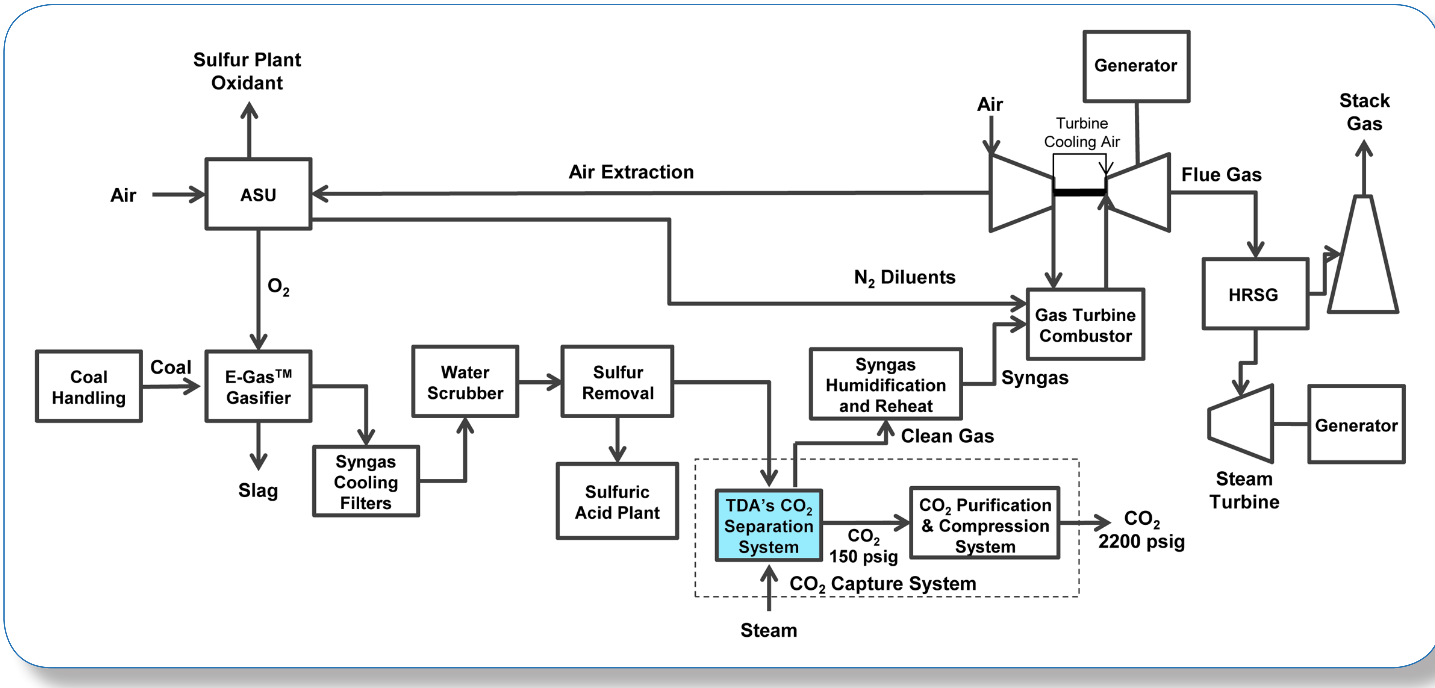
John T. Litynski
Sequestration Technology Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940 M.S. 922-1W13
Pittsburgh, PA 15236-0940
412-386-4922
john.litynski@netl.doe.gov

Arun C. Bose
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940 M.S. 922-273C
Pittsburgh, PA 15236-0940
412-386-4467
arun.bose@netl.doe.gov

Gokhan Alptekin
Principal Investigator
TDA Research, Inc.
12345 W 52nd Avenue
Wheat Ridge, CO 80033
303-940-2349
galptekin@tda.com

PARTNERS

ConocoPhillips
MeadWestvaco
Southern Company
University of California–Irvine



TDA's CO_2 capture system integrated with ConocoPhillips's E-Gas gasifier

blown E-Gas gasifier in Terre Haute, Indiana, and with the air-blown transport gasifier at the National Carbon Capture Center in Wilsonville, Alabama. TDA will work with ConocoPhillips to carry out a detailed design and sizing of sorbent reactors for each gasifier type. MeadWestvaco and the University of California–Irvine (UCI) will carry out a detailed engineering and an economic analysis to estimate sorbent and process costs. UCI will develop an Aspen™ simulation to perform energy and material balances and to estimate the sorbent's effect on plant efficiency. The technology's success will be determined by the sorbent's ability to remove CO_2 at high loadings and at a lower cost compared to conventional technologies.

PROJECT DURATION

Start Date
09/30/2009

End Date
09/30/2011

COST

Total Project Value
$ 2,500,000

DOE/Non-DOE Share
$ 2,000,000 / $ 500,000

Accomplishments

TDA has developed a novel, low-cost regenerable sorbent to remove CO_2 and has demonstrated its long-term stability through several thousand adsorption-desorption cycles. These tests have been run under commercially representative operating conditions and the sorbent showed no signs of degradation in its CO_2 adsorption capacity. The sorbent removed CO_2 via physical adsorption with an average working capacity of 8 percent by weight (lb. CO_2 absorbed per lb. sorbent). The sorbent maintained its CO_2 capacity and removal efficiency at greater than 95 percent for several thousand cycles. Aspen™ simulations performed by collaborators at UCI show that TDA warm gas CO_2 capture technology would provide higher net integrated gasification-combined cycle plant efficiency (33.1 percent) than competing processes that removes 90 percent of the pre-combustion CO_2.

Benefits

This new regenerable sorbent method for pre-combustion CO_2 capture will remove CO_2 at high loadings and at a lower capital and operating cost compared to conventional technologies. The CO_2 is weakly bonded to the sorbent surface which allows for fast regenerations requiring low energy consumption. The energy input needed for regeneration is more than 65 percent less than amine solvents and over 80 percent lower than chemical absorbents used in commercial processes. The sorbent requires short adsorption/regeneration cycles, thus reducing bed size and weight which attributes to the lower capital cost. The isothermal operating capability of the sorbent eliminates heat/cool transitions, which in turn reduces cycle time and increases sorbent utilization. TDA's regenerable sorbent recovers CO_2 at high pressure and, thus, reduces compression costs for transport and storage of CO_2.