the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Low-cost Sorbent for Capturing CO_2 Emissions Generated by Existing Coal-fired Power Plants

Background

The mission of the U.S. Department of Energy's (DOE) Existing Plants, Emissions & Capture (EPEC) Research and Development (R&D) Program is to develop innovative environmental control technologies to enable full use of the nation's vast coal reserves, while at the same time allowing the current fleet of coal-fired power plants to comply with existing and emerging environmental regulations. The EPEC R&D Program portfolio of post- and oxy-combustion carbon dioxide (CO_2) emissions control technologies and CO_2 compression is focused on advancing technological options for the existing fleet of coal-fired power plants in the event of carbon constraints.

Pulverized coal-fired (PC) power plants are the largest point source for CO_2 emissions. This could lead to regulations for the electric utility industry. At this time, no cost-effective technologies capable of capturing CO_2 generated at PC power plants exist. TDA Research, Inc. will address this need by designing a new, low-cost solid sorbent-based process that will capture 90 percent of CO_2 emissions from existing PC plants.

WRI's Combustion Test Facility

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PARTNERS

Babcock & Wilcox
Louisiana State University
Western Research Institute

PERIOD OF PERFORMANCE

11/1/2008 to 10/31/2011

COST

Total Project Value
$1,374,380

DOE/Non-DOE Share
$1,097,839 / $276,541

AWARD NUMBER

DE-NT0005497

U.S. DEPARTMENT OF ENERGY

NATIONAL ENERGY TECHNOLOGY LABORATORY

Albany, OR • Fairbanks, AK • Morgantown, WV • Pittsburgh, PA • Sugar Land, TX

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Description

TDA will produce a low-cost solid alkalized alumina sorbent, evaluate its cyclic life, and measure its performance in a bench-scale test apparatus on simulated coal gases at TDA and then on a slipstream of a coal-derived flue gas at Western Research Institute's (WRI's) coal combustion test facility. The mass and energy balances for a commercial-scale PC-fired power plant retrofit with TDA's CO_2 capture system will be modeled and losses in plant efficiency will be calculated by Louisiana State University (LSU) using Aspen Plus®. The experimental and simulation data will be used to carry out an extensive engineering and economic analysis of the post-combustion CO_2 capture system. The analysis will be done using the DOE National Energy Technology Laboratory's (NETL) 2005 "Carbon Capture and Sequestration Systems Analysis Guidelines."

Primary Project Goal

The goal for this project is to develop a low-cost, regenerable CO_2 sorbent system capable of removing and concentrating 90 percent of the CO_2 emissions from PC-fired power plant flue gas.

Objectives

The objective of this project is to demonstrate that TDA's low-cost sorbent can cost-effectively and efficiently capture CO_2 produced by existing PC-fired power plants. More specifically, this project will develop a low-cost CO_2 sorbent and evaluate its performance by fabricating a bench-scale unit, testing with simulated and real coal-derived flue gases, modeling the mass and energy balances, and calculating the loss in plant efficiency for a commercial-scale PC-fired power plant.

Benefits

This project will demonstrate a new, sorbent-based CO_2 capture system that can be added to existing PC-fired power plants and has the potential to capture 90 percent of the CO_2 emissions with less than a 35 percent penalty in the cost of energy.

Planned Activities

In the first year of this project, TDA will:

- Develop a low-cost sorbent.
- Evaluate sorbent performance (loading, cycling rate, and resistance to sulfur dioxide and nitrogen oxides).
- Conduct Aspen Plus® modeling of the CO_2 capture system.
- Calculate the cost for CO_2 captured and avoided.

In the second year, TDA will:

- Conduct a 1,500 hour extended test on the selected sorbent. The sorbent will be cycled for 1,500 hours under simulated operating conditions to determine if extended use affects either the loading capacity or regeneration rate.
- Revise the Aspen Plus® model based on the experimental data.
- Revise the cost estimate.
- Prepare a preliminary design of the bench-scale unit.

In the third year, TDA will:

- Fabricate a bench-scale unit.
- Test the unit in simulated coal gases at TDA.
- Test the unit in real coal gases at WRI.
- Revise their costs for CO_2 captured and avoided in accordance with the latest DOE guidelines for CO_2 capture and sequestration.

Accomplishments

- Over 30 different sorbent compositions were developed and tested in a lab-scale fixed bed reactor for optimum performance in the cyclic CO_2 capture process. Each sorbent was evaluated for loading, cycling rate, and effect of contaminants.
- Two sorbent variations with different alkali loadings were scaled up for further testing under simulated flue gas and regeneration conditions. Test results were promising and indicate the sorbent is tolerant of varying moisture levels and the presence of sulfur dioxide, and has good cycling performance with no loss of activity over 2000 cycles in the fixed-bed reactor.
- To predict system efficiency, an Aspen Plus® simulation was completed that models the CO_2 capture system integrated with a coal-fired power plant.
- An alternative reactor with multiple fixed beds in series has been developed to circulate the large volume of sorbent between the absorption and regeneration processes. This design has the potential to provide significant power savings. A detailed engineering review of this approach was completed. TDA will construct and test this design at the laboratory-scale in the coming months.

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