the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Bench-Scale Silicone Process for Low-Cost CO_2 Capture

Background

The mission of the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) Existing Plants, Emissions, & Capture (EPEC) Research & 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 (PC) plants burn coal in air to produce steam and comprise 99 percent of all coal-fired power plants in the United States. CO_2 is exhausted in the flue gas at atmospheric pressure and a concentration of 10 to 15 percent by volume. Post-combustion separation and capture of CO_2 is a challenging application due to the low pressure and dilute concentration of CO_2 in the waste stream, trace impurities in the flue gas that affect removal processes, and the parasitic energy cost associated with the capture and compression of CO_2. Solvent-based CO_2 capture involves chemical or physical sorption of CO_2 from flue gas into a liquid carrier. Although solvent-based systems are used commercially to remove CO_2 from industrial gases, they have not been applied to the removal of large volumes of gas, as in coal-fired power plant flue gas, due to significant cost and efficiency penalties. One promising development for solvent systems is the use of non-aqueous solvents, which can effectively reduce the energy requirements for regeneration and reuse of the solvent.

Project Description

GE Global Research, along with their partners GE Energy and SiVance LLC, will continue the development and testing of a novel aminosilicone-based solvent using a continuous bench-scale system to capture CO_2 from simulated coal-fired flue gas. In a previous DOE-funded project (DE-NT0005310), the novel solvent was developed and tested in a laboratory-scale continuous CO_2 capture system. The testing and associated detailed cost modeling and analysis demonstrated that the novel solvent has superior performance for CO_2 capture as compared to a baseline monoethanolamine (MEA) process.

As this solvent system effectively demonstrated cost-effective CO_2 capture from flue gas at the laboratory scale, development and testing of a bench-scale system represents a readily achievable next step on the path to commercialization.

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PARTNERS

GE Energy
SiVance, LLC

PERFORMANCE PERIOD

Start Date	**End Date**
10/01/2011	12/31/2013

COST

Total Project Value
$3,747,879

DOE/Non-DOE Share
$2,998,303 / $749,576

AWARD NUMBER

DE-FE0007502

U.S. DEPARTMENT OF ENERGY

Previously measured experimental data from the laboratory-scale CO_2 capture system will be used to design the continuous bench-scale system. Basic engineering data, such as kinetics and mass transfer information, will be obtained at the bench scale to determine process scalability and likely process economics. A manufacturing plan for the aminosilicone solvent and price model will be used for optimization of the solvent system. GE Global Research will design, build, and operate the bench-scale system and gather the engineering and property data required to assess the technical and economic feasibility of the process. GE Energy will be responsible for developing a model of the bench-scale process and the cost of electricity (COE), performing the technical and economic feasibility studies, and developing the scale-up strategy. SiVance will evaluate the manufacturability of the aminosilicone capture solvent, analyze the cost to manufacture the solvent, provide material for bench-scale and property testing, and perform a technology Environmental, Health, & Safety (EH&S) risk assessment.

Laboratory-scale continuous CO_2 capture system.

Project Goal

The overall project goal is to operate, at bench scale, a post-combustion CO_2 capture process using a novel aminosilicone-based solvent system capable of achieving 90 percent CO_2 capture efficiency with less than a 35 percent increase in the COE.

Objectives

The project objectives are to generate (1) a technical and economic feasibility study that analyzes the impact of the proposed process on the COE, (2) a COE model that more accurately predicts the capture efficiency and capture costs by incorporating experimental data and material cost information obtained in this program, (3) a technology EH&S assessment aimed at identifying any EH&S concerns associated with the aminosilicone capture system, and (4) a scale-up strategy identifying suitable process configurations for commercial-scale operations, preliminary absorber/desorber and heat transfer equipment designs and architectures, desorber steam requirements, and estimated pressure drops expected in the absorption-cycle components.

Planned Activities

This 27-month project is divided into two phases.

Phase 1:

- Perform preliminary technical and economic feasibility study
- Design and build bench-scale absorption/desorption system
- Determine manufacturability of solvent
- Develop cost-effective plan for large-scale manufacture

Phase 2:

- Synthesize material for bench-scale testing
- Perform bench-scale testing to determine scale-up effects and performance of aminosilicone-based solvent system
- Determine suitable materials of construction
- Develop model of bench-scale system performance and update COE calculations
- Perform final technical and economic feasibility study
- Develop scale-up strategy
- Perform technology EH&S risk assessment

Accomplishments

- Project awarded in September 2011

Benefits

The development of a scalable bench-scale process using a novel aminosilicone-based solvent for post-combustion CO_2 capture that shows the potential to achieve the DOE goal of 90 percent capture efficiency with a COE increase of less than 35 percent can enable a practical technology path to later development at larger scales and ultimately to commercialization.