the ENERGY lab

PROJECT FACTS

Existing Plants, Emissions & Capture

Membrane Process to Capture CO_2 from Power Plant Flue Gas

Background

The U.S. Department of Energy's (DOE) Innovations for Existing Plants (IEP) Program is performing research to develop advanced technologies focusing on carbon dioxide (CO_2) emissions control for existing pulverized coal-fred plants. This new focus on post-combustion and oxy-combustion CO_2 emissions control technology, CO_2 compression, and bene fcial reuse is in response to the priority for advanced technological options for the existing feet of coal-fred power plants in order to address climate change.

Pulverized coal (PC) plants burn coal in air to produce steam, and comprise 99% of all coal-fred power plants in the United States. CO_2 is present in the fue gas exhaust at atmospheric pressure and a concentration of 10-15 volume percent. "Post-combustion" 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 (NO_x, SO_x, PM) in the fue gas that a fect adsorbing processes, and the parasitic energy load associated with the capture and compression of CO_2.

Description

The overall goal of this project is to demonstrate a cost-e fective membrane-based process to capture CO_2 from coal-fred power plant fue gas. The process will reduce power plant CO_2 emissions and mitigate the potentially damaging e fects of global warming. This project will provide a demonstration of CO_2 capture from actual coal-fred fue gas with a membrane system using commercial-scale components. Results from this feld test will provide key performance data to allow a thorough technical and economic evaluation of the proposed membrane process. The impact of system scale-up and the development of low-cost components on the capture process economics will be determined. The endpoint and primary technical objective of the program will be to complete a feld test of MTR's CO_2 capture membrane process at a coal-fred power plant.

Primary Project Goal

This project is a collaborative e fort between Membrane Technology and Research, Inc. (MTR), Arizona Public Service (APS), and the Electric Power Research Institute (EPRI) that will demonstrate a cost-e fective membrane-based process to separate CO_2 from coal-fred power plant fue gas through laboratory and slipstream feld tests at an operating coal-fred power generation plant. Testing results will provide vital performance data to allow thorough technical and economic evaluations of the proposed membrane process. Further analysis will focus on the economics

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PARTNERS

Membrane Technology & Research (MTR)
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Electric Power Research Institute (EPRI)

PERIOD OF PERFORMANCE

10/2008 to 9/2010

COST

Total Project Value
$4,394,749

DOE/Non-DOE Share
$3,347,119 / $957,630

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behind clarifying the challenges to scaling-up the system to meet commercial demands and on developing low-cost plastic components on the capture process in order to lower operational and maintenance costs.

Objectives

The objective of the proposed two-year research and development program is to develop, test, and validate a membrane process capable of effectively and efficiently capturing ≥90% of the CO_2 from coal-fired power plant flue gas in the temperature range of 50-60 °C. The testing will include a slipstream field test of MTR's membrane process using commercial modules to treat coal combustion flue gas.

Specific objectives include the following:

- Fabrication of commercial-scale modules that meet low pressure drop and high packing density performance targets using MTR's high-permeance CO_2 capture membranes.
- Build a membrane skid for use in a slipstream field test with coal combustion flue gas from an operating power plant.
- Carry out a six-month field test of MTR's membrane system at Arizona Public Service's (APS) Cholla power plant; the system will process 0.25 MMscfd of flue gas.
- Assess the performance of the membrane system, identify how it would be best integrated with an electric power plant, and prepare a comparative study of the membrane-based CO_2 capture process versus other existing capture technologies.
- Generate a cost-reduction roadmap that defines milestones and success criteria necessary to improve the economics of membrane-based CO_2 capture from existing PC-fired power plants.

The endpoint of the program will be to complete a field test of MTR's CO_2 capture membrane process. The membrane system will treat approximately 0.25 MMscfd of coal-fired flue gas for six months, separating about 1 ton CO_2/day. To accomplish this goal, MTR has assembled a team composed of MTR, APS and EPRI. APS will host the field test of MTR's membrane process at their 995 MW coal-fired Cholla power plant in Holbrook, Arizona. EPRI will evaluate integration of the membrane system into existing power plants and conduct a cost analysis of the membrane process compared to competing CO_2 capture technologies.

Picture of an MTR membrane test skid similar to one that will be built for a CO_2 capture demonstration unit to be installed at APS' Cholla, AZ, coal- red power plant.

Benefits

The benefits of successful completion of this project are the development and near-term deployment of cost-effective technology that is easily and reliably retrofitted into current PC-fired power plants to separate and capture CO_2. The technology will aid in greenhouse gas mitigation, at an acceptable level of parasitic energy demand. Furthermore, field tests provide a knowledge base and customer confidence that is critical to commercial application and acceptance of a technology. While other separation processes, such as amine absorption and chilled ammonia, are being evaluated for carbon capture from flue gas in demonstration projects of various sizes, membranes have not been examined at this scale to date. This program will provide a demonstration of CO_2 capture from real coal-fired flue gas with a membrane system using commercial-scale components. Results from this field test will provide key performance data to allow a thorough technical and economic evaluation of the proposed membrane process.

Planned Activities

First-year Phase I activities scheduled for each of the project partners are as follows:

- **MTR:** CO_2 capture membranes will be fabricated into modules designed to maximize the benefits of countercurrent sweep operation. Parametric module tests will be conducted to optimize performance with regard to pressure drop and transport characteristics.
- **MTR/APS:** Concurrently, MTR will build a membrane system skid, while APS conducts the necessary engineering to accommodate the system at their Cholla power plant.
- **EPRI:** EPRI will perform an economic analysis of MTR's membrane process compared to other capture technologies in accordance with NETL's Bituminous Baseline Study, and determine whether the MTR membrane capture system can achieve the program target of less than a 35% increase in the cost of electricity.

Phase II of the program will be dedicated primarily to the membrane system field testing.

- After delivery and shakedown, the membrane field system will run for six months, treating flue gas from APS' Cholla coal-fired power plant.
- The data from this test will then be used to optimize membrane system design and improve integration with the power plant operation.
- Finally, low-cost membrane system components will be designed and evaluated for potential use in future large-scale CO_2 capture systems.