PROJECT facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Carbon Sequestration

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NETL

Membrane Process to Sequester CO_2 from Power Plant Flue Gas

CONTACTS

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Background

Carbon dioxide emissions from coal-fired power plants are believed to contribute significantly to global warming climate change. The direct approach to address this problem is to capture the carbon dioxide in flue gas and sequester it underground. However, the high cost of separating and capturing CO_2 with conventional technologies prevents the adoption of this approach. This project investigates the technical and economic feasibility of a new membrane process to capture CO_2 from power plant flue gas.

Description

Direct CO_2 capture from power plant flue gas has been the subject of many studies. Currently, CO_2 capture with amine absorption seems to be the leading candidate technology—although membrane processes have been suggested. The principal concern with previous membrane processes has been the enormous membrane area required for separation because of the low partial pressure of carbon dioxide in flue gas.

Recently, MTR has developed membranes with 10 times the CO_2 permeance of conventional gas separation membranes. The combination of these membranes with a novel countercurrent module design that utilizes incoming combustion air to generate separation driving force greatly reduces the projected cost of CO_2 capture from flue gas with membranes. In this project, the goal is to optimize the membrane and module performance for flue gas treatment.

Primary Project Goal

The overall technical objective of this project is to develop high CO_2 permeance, high CO_2/N_2 selectivity composite membranes that can be used for the economic capture of CO_2 from post-combustion flue gas.

Objectives

- Develop high-performance membranes with a CO_2 permeance of at least 3,000 gpu (where 1 gpu = 1×10^{-6} $cm^3(STP)/cm^2 \cdot s \cdot cmHg$) and a CO_2/N_2 selectivity of at least 50 at 50-80°C (where selectivity is the ratio of gas permeances).
- Optimize the membrane structure to maximize CO_2 permeance and the effectiveness of countercurrent sweep operation.
- Optimize module design to minimize pressure drop in the permeate side channels and maximize countercurrent flow patterns.

PROJECT DURATION

04/01/2007 to 03/31/2009

COST

Total Project Value

$985,333

DOE/Non-DOE Share

$788,266 / $197,067

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- Construct a bench-scale module test skid for countercurrent sweep operation.
- Perform parametric tests with countercurrent sweep modules using a simulated coal power station flue gas.
- Perform a technical and economic analysis of the commercial viability of scale-up and use of counterflow modules for flue gas treatment at power stations.

Benefits

Membranes for CO_2 sequestration will likely consume less parasitic energy and be less expensive than amine wet scrubbing, which is the current carbon capture technology.

Accomplishments

- Composite membranes with CO_2 permeances of 2,000 gpu and CO_2/N_2 selectivities of 50 have been prepared.
- Membranes have been fabricated into spiral-wound modules that operate in countercurrent/sweep mode.
- Module performance data have confirmed the benefit of sweep operation.
- A new module test system dedicated to this project was built to perform parametric vacuum and countercurrent module experiments.
- A lower-cost, more efficient membrane process design has been identified. CO_2 recovery of 90% and >99% water recovery is possible at a cost of ~$25/ton CO_2 using about 18% of power plant energy.

Planned Activities

MTR is currently working through the tasks described in the Statement of Project Objectives document. The focus at this time is on membrane module fabrication and parametric testing, as well as analysis of different possible membrane process designs. The first semi-annual report describing these activities will be available in October 2007.