PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Carbon Sequestration

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BIOMIMETIC MEMBRANE FOR CO_2 CAPTURE FROM FLUE GAS

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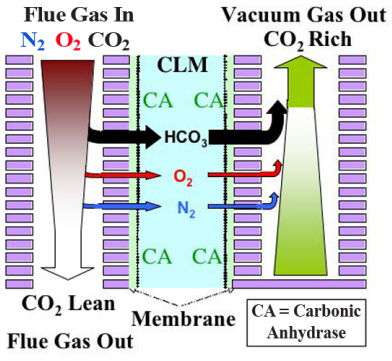
Background

Carbon Capture and Sequestration (CCS) is a three-step process including capture, pipeline transport and geologic storage of which the capture of carbon dioxide (CO_2) is the most costly and technically challenging. Current available methods impose significant energy burdens that severely impact their overall effectiveness as a significant deployment option. Of the available capture technologies for post combustion applications – absorption, adsorption, reaction and membranes chemically facilitated absorption promises to be the most cost-effective membrane solution for post combustion application.

The Carbozyme technology extracts CO_2 from low concentration, low pressure sources by means of chemical facilitation of a polymer membrane. The chemical facilitation is occurs through the use of a catalyzed Carbonic Anhydrase (CA), a carbonate-bicarbonate process that has exhibited, in the laboratory, lower parasitic loads than competing CO_2 capture technologies. CA is the fastest CO_2 catalyst known. The proposed process is applicable to both natural gas and coal-fired boilers.

Description

The performance of Carbozyme's enzyme-based CLM. technology depends upon more fully matching coal-based power plant operating conditions and economic constraints. This relies on appropriate use of the information on the chemical, physical and process-engineering characteristics of the enzyme based contained liquid membrane (EBCLM) design. This project addresses issues of particle management, permeator fluid condensation and increased operating temperature. These studies compliment previous work concerning the effects of acid gases on the contained liquid membrane (CLM).



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Primary Project Goal

This project's overall objective is to develop a very cost efficient, low energy, CO_2 capture system (EBCLM) applicable to coal based power plant flue gas exhaust exhaust streams. The successful EBCLM permeator will have high CO_2 permeance and high selectivity while maintaining low energy requirements for regeneration. The overall energy consumption target is under 15 percent.

Objectives

- Characterize the effect of operating parameters on water condensation.
- Investigate CO_2 removal efficiency at low temperature using different enzymes.
- Investigate CO_2 removal efficiency at high temperature using CAM, a member of the γ-CA family of isozymes.
- Develop a preliminary commercialization plan.

Benefits

- The EBCLM provides absorption and stripping in a single modular, scaleable apparatus.
- The EBCLM green design uses fully biodegradable materials.
- The EBCLM has the potential to reduce the overall energy burden associated with carbon dioxide capture which will in effect lower the overall increase in the cost of electricity compared to competing technologies.

Accomplishments

- A temperature control system has been developed and demonstrated in the laboratory to abate evaporative condensation within the EBCLM. Abatement of the condensation is important because previous studies have demonstrated its potential to impede the flow within the hollow fiber membrane. This approach will limit temperature changes to a few tenths of a degree Celsius.
- Several different enzymes were examined to show a desired operating temperature range of 4 °C – 85 °C.

Planned Activities

A key next step is to scale the permeators and test them under controlled actual conditions to focus on the ability to manage the flue gas streams from different ranks of coal.