PROJECT facts

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

Carbon Sequestration

08/2007

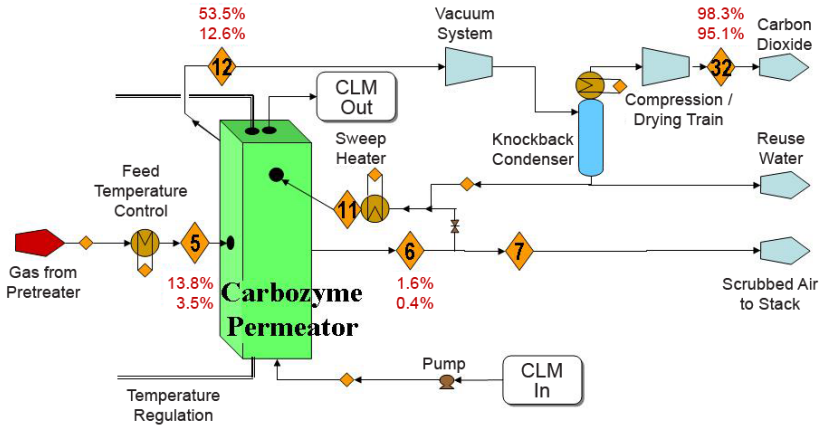
Development of Biomimetic Membrane for Near Zero PC Power Plant Emissions

Background

CO_2 capture is the largest single cost element of the Carbon Capture and Sequestration (CCS) program, accounting for more than 65 percent of the total. Capture methods currently available impose significant energy cost burdens (parasitic loads) that severely impact their overall effectiveness. Development, system testing, and scale-up demonstrations of efficient, cost-effective methods for CO_2 capture are essential to enable wide-scale deployment at both existing and new power plants.

Description

The Carbozyme contained-liquid membrane (CLM) system leverages the most efficient CO_2 catalyst known, carbonic anhydrase (CA). CA rapidly converts CO_2, at very low energy, to bicarbonate at the flue gas interface and reverses the process at the CO_2 product interface. This process allows for efficient, simple, and scalable designs for the capture of CO_2 from low-concentration, low-pressure sources such as power plant flue stacks. In addition, the process is green technology because all of the materials are biodegradable or environmentally benign.



Process Engineering Schematic

Primary Project Goal

The goal of this project is to demonstrate the ability of an enzyme-based CLM permeator to efficiently extract CO_2 from a variety of flue gas streams, including coal and natural gas. The permeator performance will be considered successful if it achieves the DOE target values, at least 90 percent separation, and 95 percent

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purity in the captured flue gas stream with a cost of energy of less than 20 percent by 2012. The project objective is to achieve a parasitic load of less than 15 percent. The proposed development work is expected to demonstrate progressive cost, performance, and feature improvements that will support acceptance of the CLM permeator system for both retrofit and greenfield power plants.

Objectives

The main objective of this project is to demonstrate and evaluate, at pre-pilot scale, the ability of the Carbozyme enzyme-based CLM permeator to capture CO_2 from a variety of combusted coal rank flue gas streams. Subsidiary objectives include:

- Development of a flue gas pretreatment system that meets the acceptance criteria for SO_x, NO_x, mercury, and particulates.
- Selection and commercial-scale development of a preferred enzyme variant (isozyme).
- Development and scale-up of the hollow fiber CLM permeator, culminating in a prepilot permeator skid that successfully removes CO_2 to the target goals.
- Development of a novel, enzyme-based electrodialytic prototype that demonstrates feasibility and improved performance, and that scales to a multi-cell stack to realize optimized system cost and efficiencies.
- Engineering and Economic Analysis of the CLM and electrodialytic technologies as they relate to retrofit and greenfield installations.
- Development of a commercialization study to provide a path to rapid introduction and application.

Benefits

The Carbozyme technology could provide power plants with a cost effective means to capture CO_2 from flue gas. The enzyme-based, CLM permeator has shown the promise of capturing CO_2 from simulated and actual flue gas streams at significantly reduced cost compared to an absorption technology, MEA.

Planned Activities

Successful scale-up of the Carbozyme technology will entail:

- Definition and identification of flue gas pretreatment systems with acceptable performance for the Carbozyme CLM CO_2 capture system.
- Development and validation of methods to produce CA enzyme on an industrial scale.
- Design and prototype of a fully scalable, modular, skid-based hollow fiber contained liquid membrane CO_2 capture system that can be arranged to fit most footprints, and has the ability to be built and staged off-site.
- Design and development of a fully scalable, modular, electrochemical CLM CO_2 capture system.
- Evaluation of multiple strategies for CO_2 capture, including assessments of efficiency, as well as capital and operating costs.
- Process engineering design activities in support of system scale-up.
- Comprehensive commercialization planning to help accelerate market entry.

PARTNERS

Carbozyme, Inc.
Siemens Power Generation
Novozymes NA
Energy and Environmental Research Center (EERC)
Argonne National Laboratory
Visage Energy Corp.
SRI International
ElectroSep, Inc.
Kansas State University
KES Inc.
North Dakota Lignite Council
Cogentrix Energy, Inc
Otter Tail Energy
Great River Energy
Montana Dakota Utilities

PROJECT DURATION

03/28/2007 to 03/27/2010

COST

Total Project Value
$7,181,243

DOE/Non-DOE Share
$5,743,981 / $1,437,262

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov