the ENERGY lab

PROJECT FACTS

Carbon Sequestration

Hydrogen Selective Exfoliated Zeolite Membranes

Background

An important component of the Department of Energy (DOE) Carbon Sequestration Program is the development of carbon capture technologies for power systems. Capturing carbon dioxide (CO_2) from mixed-gas streams is a first and critical step in carbon sequestration. To be technically and economically viable, a successful separation method must be applicable to industrially relevant gas streams at realistic temperatures and volumes. Current technologies that are effective at separating CO_2 from typical mixtures are costly and energy intensive.

In alignment with DOE Carbon Sequestration Program goals, the National Energy Technology Laboratory (NETL) has teamed with the University of Minnesota to develop a technically and economically viable membrane for CO_2 separation from typical water-gas-shift (WGS) mixture feeds.

Description

This project will further develop a novel, silica molecular sieve membrane for the pre-combustion capture of CO_2 from coal-based integrated gasification combined cycle (IGCC) power plants. These membranes have the potential to contribute to carbon capture by high-temperature separation of hydrogen (H_2) from CO_2 and other gases present in shifted synthesis gas (syngas). Extensive efforts have been made over the last several decades to explore high-temperature H_2-selective membranes made of silicon dioxide (SiO_2), other oxides, palladium (Pd) and other metals or alloys, polymers, various zeolites, and non-aluminosilicate molecular sieves. Although promising separation results have been reported for many of these technologies, they all suffer from high processing costs for membrane fabrication and/or long term stability limitations. This project will introduce a new, simple concept for the fabrication of ultra-thin and stable H_2-selective membranes and bring this CO_2 capture technology closer to commercial reality.

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PARTNERS

None

PROJECT DURATION

10/01/2009 to 09/30/2013

COST

Total Project Value
$254,308

DOE/Non-DOE Share
$197,558 /$56,750

Goals/Objectives

The goal of this project is to further develop recently developed membrane technology based on exfoliated zeolite coatings as components for carbon capture in IGCC plants. The membrane must demonstrate high flux, high selectivity, and stable performance. This effort will determine the feasibility of integrating these membranes in WGS reactors. Both technical performance and economic criteria will be evaluated.

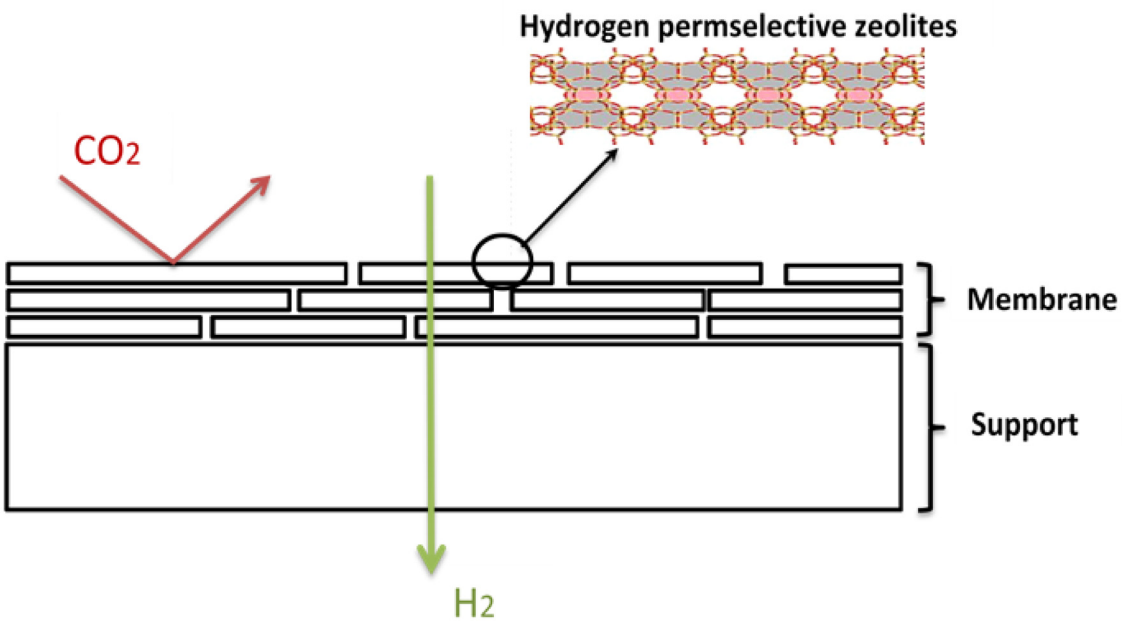
Specific tasks will focus on developing a membrane manufacturing method, testing membranes under WGS and shifted syngas conditions, determining H_2 permeance and selectivity, evaluating hydrothermal stability, developing a membrane reactor model and integrating it into an IGCC flowsheet, and performing a techno-economic and operability analysis.

Accomplishments

The project team has completed hydrothermal stability tests of exfoliated silicate powders. Results showed that the material under test kept its crystalline structure under harsh hydrothermal conditions.

Benefits

This project, when successfully executed, will demonstrate at an appropriate scale that the membrane-based separation device can cost-effectively separate the desired species—hydrogen or CO_2—from typical WGS mixture feeds at practical rates and acceptable purity. Additionally, hydrogen can be introduced into the operating environments of combustion turbines in IGCC plants. This project will introduce a new, simple concept for the fabrication of ultra-thin and stable H_2-selective membranes and bring this technology closer to commercial reality.



Molecular sieve membrane for the pre-combustion capture of CO_2