the ENERGY lab

PROJECT FACTS

Gasification

Molecular Separations Using Micro-Defect Free Ultra-Thin Films

Background

Current methods for separating carbon dioxide (CO_2) from methane (CH_4) in fuel gas streams are energy and cost-intensive. Molecular sieve membrane development for carbon capture has been pursued for several decades because of the potential these membranes have for high selectivity while using less energy than cryogenic separation methods and greater flux (permselectivity) than is possible from polymeric membranes. However, the adoption of molecular sieve membrane technology has been hindered by high production costs and the micro-defect fissures that always accompany this type of membrane when fabricated using conventional techniques.

The Department of Energy's (DOE) National Energy Technology Laboratory (NETL), has partnered with Eltron Research, Inc. (Eltron) to develop a novel carbon capture process that uses micro-defect free ultra-thin films for molecular-sieve membrane separations. The project is funded through the DOE's Small Business Innovation Research (SBIR) Program, a highly competitive program that encourages small businesses to explore novel technological potential and provides them with incentives to profit from its commercialization.

Project Description

Eltron is developing a process for eliminating the defects in thin molecular sieve films to provide an inexpensive means of separating CH_4 from CO_2. Eltron's method for sealing off the defect fissures in thin film molecular sieves provides a means of cost-effectively fabricating these membranes and of repairing zeolite membranes that have cracked due to fouling or aging, thereby extending their usable lifetimes.

Phase I of this research focused on demonstrating whether the technique for closing defect fissures can be employed without impairing the ability of the membranes to separate molecules based on various parameters such as differences in size, shape, or affinity for adsorption. While the particular membranes that were evaluated in Phase I were for the separation of CO_2 and CH_4, the technique being developed is applicable to all types of zeolite membrane filters—for separating both liquids and gases—enabling their use in a wide range of applications.

In Phase II of the project, Eltron continues to develop novel techniques to simply and inexpensively close non-zeolite defect fissures in thin film zeolite (microporous aluminosilicate mineral) membranes. The project will establish the temperature and pressure boundaries under which these materials can operate efficiently as well as the optimal production processes for bringing this technology to market.

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PARTNERS

None

PROJECT DURATION

Start Date	End Date
07/20/2009	08/14/2013

COST

Total Project Value
$1,100,000

DOE/Non-DOE Share
$1,100,000 / $0

AWARD NUMBER

SC0000868

Goals and Objectives

The objective of this research is to develop a cost-effective means of fabricating zeolite ultra-thin films for recovering highly pure CH_4 from mixed CH_4-CO_2 streams.

Accomplishments

Eltron experimentally demonstrated at a commercially relevant separator operating pressure range and practical feed flow rate, a seven-fold improvement in the separation selectivity of CO_2 and CH_4 through the application of its technique for blocking non-zeolite fissures. In addition, the research achieved a CO_2 flux roughly an order of magnitude greater than that of other silicoaluminophosphate-34 (SAPO-34) membranes reported in the literature. Eltron has also developed a probabilistic techno-economic model to evaluate its CO_2 separation membrane technology and provide a basis for comparison with competing technologies.

Eltron modeled a natural gas membrane separation system using experimental results from their silicoaluminophosphate-34 membrane separation plant. Eltron developed capital and operating expenditure charts that can help optimize operating parameters to reduce the cost of removing CO_2 from natural gas.

Benefits

Cost-effective fabrication of molecular sieve membranes will enable a higher separation efficiency of CO_2 from CH_4 in fuel gas streams. Achieving this separation efficiency will benefit the natural gas industry, make the capture and use of landfill gas much more economical, and reduce the emission of methane—a potent greenhouse gas—into the atmosphere. This technology will also provide a means to economically repair other types of zeolite-based separation membranes that crack due to fouling or aging, presumably including those for separation of CO_2 from coal-derived syngas streams, thereby extending their usable lifetimes. Zeolite membrane permeation rates (productivity) and separation efficiency (selectivity) are superior to those of other conventional polymeric membranes. Cost-effective separation of CO_2 from CH_4 may result in new applications of molecular sieve membranes for removal of CO_2 from coal-derived syngas streams.

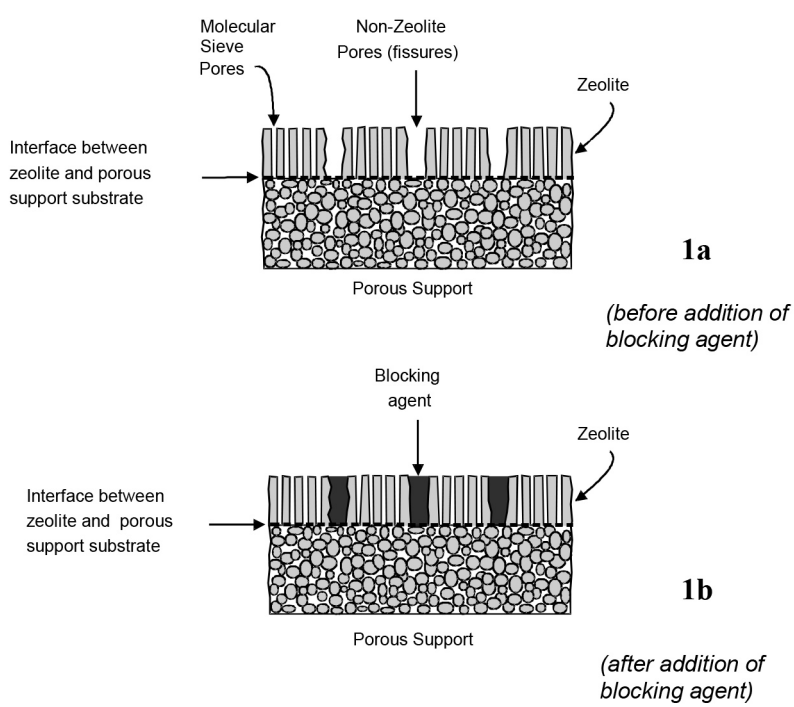

Figure 1a is a schematic showing the interface between the zeolite film and the porous support before addition of the blocking agent. In Figure 1b, only the non-zeolite pores remain open after addition of the blocking agent.