PROJECT facts

Sequestration

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

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CO_2 Separation Using a Thermally Optimized Membrane

Background

The last decade has witnessed a dramatic increase in the use of polymer membranes as an effective, economic, and flexible tool for many commercial gas separations, including air separation, the recovery of hydrogen from nitrogen, carbon monoxide, and methane mixtures, and the removal of carbon dioxide from natural gas. In each of these applications, processes with high fluxes and excellent selectivities have relied on glassy polymer membranes, which separate gases based on both size and solubility differences. To date, however, membrane technology has focused on optimizing materials for near ambient conditions.

Los Alamos National Laboratory (LANL), in collaboration with Idaho National Engineering and Environmental Laboratory (INEEL), will develop a high-temperature polymer membrane that will exhibit permselectivity for CO_2 an order of magnitude higher than current polymer membranes. The project will focus on the separation of CO_2/CH_4, CO_2/N_2 and H_2/CO_2gas pairs, which represent separations that are industrially and environmentally important. Capitalizing on the interplay between polymer structure and gas diffusion at temperatures between 100°C and 400°C will lead to structures with unprecedented stability and selectivity. By increasing the rigidity of the thermally stable polybenzimidazole (PBI) backbone and using semi-interpenetrating polymer networks, the researchers will inhibit interchain mobility and control diffusion pathways. This approach will lead to polymer membranes with tunable permeability, polymer modification and casting protocols. Collaboration with the University of Colorado involves the development of a new technique to simultaneously measure compaction and permeation of the new materials. This type of measurement will provide great insight into the long-term performance of the membranes from short-term laboratory tests. Industrial collaboration with Pall Corporation provide the project with direct involvement of world leaders in membrane production.

Primary Project Goal

The purpose of this project is to develop polymeric-metallic membranes for carbon dioxide separation that operate under a broad range of industrially relevant conditions not accessible with present membrane units.

PBI coated metal

CONTACT POINTS (continued)

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PROJECT PARTNERS

LANL

INEEL

Pall Corporation

University of Colorado

Shell Oil Company

COST

Total:	$1,400,360
DOE Share:	$1,400,360
Non-DOE Share:	$0

WEBSITE

www.netl.doe.gov

Objectives

The major objective is the development of polymeric materials that achieve the important combination of high selectivity, high permeability, and mechanical stability at temperatures significantly above 25°C and pressures above 10 bar.

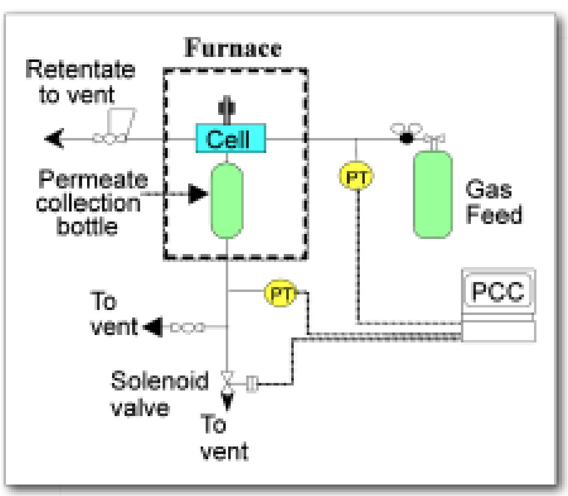
Accomplishments

Progress to date includes the first ever fabrication of a polymeric-metallic membrane that is selective from room temperature to 400°C. This achievement represents the highest demonstrated operating temperature at which a polymeric based membrane has successfully functioned.

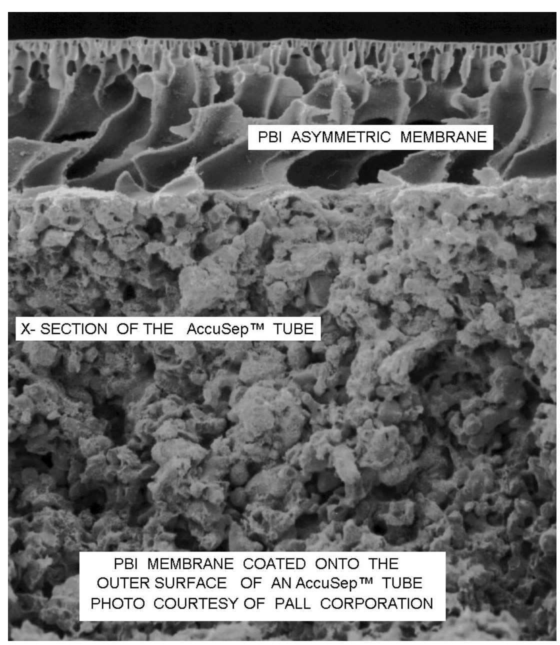
We have also fabricated a shell and tube module of the PBI coated on an AccuSepä tube. This module has significant selectivity at room temperature. Further testing is in progress to demonstrate performance at elevated temperatures using simulated process gases. Additionally, the synthesis efforts of this project have resulted in the first modified polybenzamidizoles that are soluble in common organic solvents. The pendant group modifications of the polymer include both organic and hybrid organic-inorganic systems that provide additional polymer flexibility, ability to fit complex shapes, and modified gas transport properties. Finally, a technique has been developed that has enabled the first-ever simultaneous measurements of gas permeation and membrane compaction at elevated temperatures. This technique provides a unique approach to the optimization of long-term membrane performance under challenging operating conditions based on short-term laboratory studies.

Benefits

The development of high temperature polymeric-metallic composite membranes for carbon dioxide separation at temperatures of 100-450°C and pressures of 10-150 bar will provide a pivotal achievement with both economic and environmental benefits. This technology could further reduce the cost of CO_2 sequestration by providing a CO_2 stream at higher pressures than existing technologies, thereby reducing compression costs significantly.



Membrane Testing Equipment



PBI coated AccuSepä tube used for module development