R & D facts

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Novel Membranes for CO_2 Removal

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Background

As the stabilization of CO_2 concentrations in the atmosphere becomes increasingly important, the capture and sequestration of CO_2 emissions from advanced power generation will become a necessity. In the current carbon sequestration concept, separation and capture represent the greatest expense in the overall capture and sequestration process. Improvements in capture/separation have the greatest potential to affect the cost of CO_2 mitigation, and membrane technology holds significant promise in this area.

Membranes have a number of innate advantages over other separation techniques, including simple design with no moving parts, limited maintenance, lower energy requirement due to their lack of phase transitions, a single-step separation, and exceptional reliability. Such advantages have allowed them to make significant commercial advances in other CO_2 removal applications, such as natural gas sweetening. In fuel gas streams where pressures and CO_2 concentrations are high, membranes seem a natural choice for carbon capture.

Primary Project Goal

This research is aimed at developing robust membranes capable of selective CO_2 removal in reducing environments, such as in IGCC power plant fuel gas. One current research focus is on a class of salts known as ionic liquids. Certain ionic liquids have high solubility for CO_2 compared to H_2 and other light gases, greater diffusivities than polymers, and are stable to temperatures above 200 °C. These characteristics lead to the conclusion that ionic liquids have the potential to form the basis for a new and superior class of CO_2 selective membranes. Another area of focus is on polymers which dissolve readily in CO_2. These polymers have high molecular affinity for CO_2 and, as a result, are promising candidates for membrane materials.

Objectives

The project examines the development of techniques and materials that can be used to solidify ionic liquids and optimize polymers for use in membrane applications. Ionic liquids used in this project are supplied by researchers at the University of Notre Dame under a co-operative research and development agreement (CRADA) and polymers are developed under a partnership with the University of Pittsburgh.

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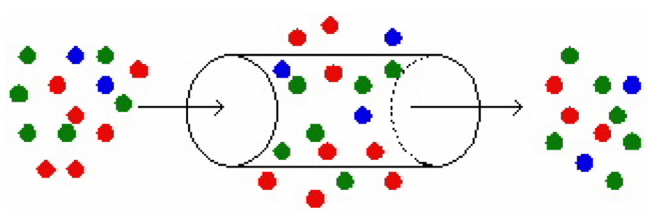
Work at both universities centers around optimization of the materials for CO_2 selective membrane applications. NETL researchers incorporate the ionic liquids into commercially available supports and fabricate polymer films in order to examine the performance of resulting membranes and determine whether or not particular candidates meet gas separation performance objectives. Beyond simply meeting high performance goals, the membranes are expected to perform at high temperatures in the presence of trace contaminants such as H_2S. Current testing includes experiments at temperatures above 300 °C and in the presence of a variety of contaminants.

Accomplishments

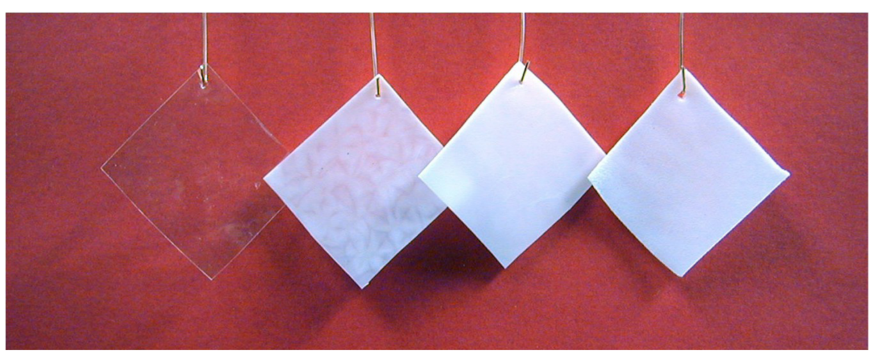
- Membranes have been prepared using both commercially available and fabricated polymer supports.
- Membranes have been tested which are stable to temperatures over 300 °C.
- CO_2/H_2 selectivities as high as 15 have been measured at 75 °C, a temperature and selectivity well beyond the performance of any conventional polymer membrane.

Benefits

The successful development of a commercially viable membrane would have several benefits. Industry would gain a simplified separation technique for CO_2/H_2 mixtures leading the way toward adoption of advanced power generation processes as part of an overall carbon abatement strategy. Membranes produced in this project may also have applicability to other important separation problems, such as the removal of CO_2 from crude natural gas and capture of CO_2 from conventional pulverized coal stack gas.



Fuel gas consisting of CO_2, H_2 and H_2O enters the membrane. The membrane produces both an enriched CO_2 and H_2 stream.



Series of polymeric films with increasing ionic liquid content.