Cross-Linking and Solvent Treatment of PEI Membranes

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Membranes are used for separating gases.

The polymer that we are constructing our membranes from is polyetherimide (PEI).

Solvent treatments intend to increase selectivity of the membranes and cross-linking prevents membranes from becoming plasticized. Plasticization occurs when gases absorb into the membrane in large quantities and disrupt the packing of the polymer chains causing the membrane to lose its selective permeability.

Background

Membranes were prepared by dissolving PEI in a solvent solution and then casting that solution onto a glass sheet. The membranes were then precipitated in a bath of acetone and dried.

Methods

Membranes were gas flux tested before and after each treatment.

Gas permeability was calculated by:

\[ \text{GPU} = \frac{\text{Volume} @ \text{STP}}{\text{Area} \times \text{Time} \times \text{Feed Pressure}} \]

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Cross-Linking Results

XRD and FTIR data indicate that we effectively crosslinked the membranes.

Key Findings

Most solvents negatively affected the membranes' gas selectivity. 1-Heptanol and n-Amyl alcohol showed improvements to the selectivity of the membranes.

Solvent Treatment Results

FTIR Data for Ethylene Diamine

Imide bands:
(1) \( \approx 1770 \text{ cm}^{-1} \)
(2) \( \approx 1700 \text{ cm}^{-1} \)
(3) \( \approx 1340 \text{ cm}^{-1} \)

Amide bands:
(1) \( = 1645 \text{ cm}^{-1} \)
(2) \( = 1530 \text{ cm}^{-1} \)

Research Objective

Treat PEI membranes with various solvents to heal imperfections and increase the selectivity of He to \( N_2 \) and He to \( O_2 \) gases through the membranes.

Determine most effective solvents and treatment styles.

Use diamines to cross-link PEI membranes through vapor exposure and liquid baths in alcohol-diamine solutions.