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Preparation of Mixed Matrix Membranes Containing Polyether Block Amide and Silver Nanoparticles to Evaluate the Permeability of CO_2, N_2, and CH_4 Gases

Ehsan Ghasemi Estahbanati[1], Mohammadreza Omidkhah Nasrin[1] and Abtin Ebadi Amooghin[2]

1. Faculty of Chemical Engineering, Tarbiat Modares University, Tehran, Iran

2. Department of Chemical Engineering, Faculty of Engineering, Arak University, Iran

omidkhah@modares.ac.ir

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Introduction

Nowadays, membrane technologies play a leading role in separation processes due to their superior features in comparison with other ones [1,2].

It has been investigated by researchers to prepare membranes enjoying high permselectivity so as to optimize the separation processes. Actually, Mixed Matrix Membranes have been fabricated by them in order to overcome restrictions of polymeric and inorganic materials leading to high permselectivity in gas separation [3,4].

In this research, Polyether Block Amide as organic phase and silver nanoparticles as inorganic phase were used to prepare mixed matrix membranes. In addition, silver nanoparticles could enter to the polymer chains and also react with PEO segment, which both results in increasing the permselectivity of the membranes [5].

The prepared membranes were characterized by related analyses and also tested by gas mixtures in order to investigate their permeability and selectivity in various operating conditions.

Experimental Procedure

Mixed Matrix Membrane Preparation

For fabrication of the MMMs, silver nanoparticles were added to the solvent, and then the polymer pellets were added so as to prime the solution by stirring and heating for a day.

Gas Permeation

As the set-up to measure the permeability of the membranes is constant volume, permeability coefficients have been calculated in Barreras

follows (Equation 1):

$$P = \frac{273.15 \times 10^{10} \times V \times L}{760 \times A \times T \times [(P_0 \times 76)/14.7]} \left(\frac{dp}{dt}\right) \quad (1)$$

Then time lag and solution-diffusion methods have been used to calculate diffusion and solubility coefficients [5].

Results and Discussion

SEM

The analysis have shown that the nanoparticles are distributed without agglomeration in 1% loading, while there are some defects in higher ones.

FTIR

This analysis has revealed the effect of nanoparticles on the ether segment of the polymer.

XRD

This analysis has shown that the nanoparticles decrease the crystallinity of membranes and has made them more amorphous.

Gas Permeation

The tests showed promising improvement in permselectivity of the membranes at temperature of 35 °C and pressure of 10 bar. As shown in Figure 1, for the optimum membrane compared to the neat one, CO_2/CH_4 and CO_2/N_2 selectivities increased about 112 and about 76%, respectively.

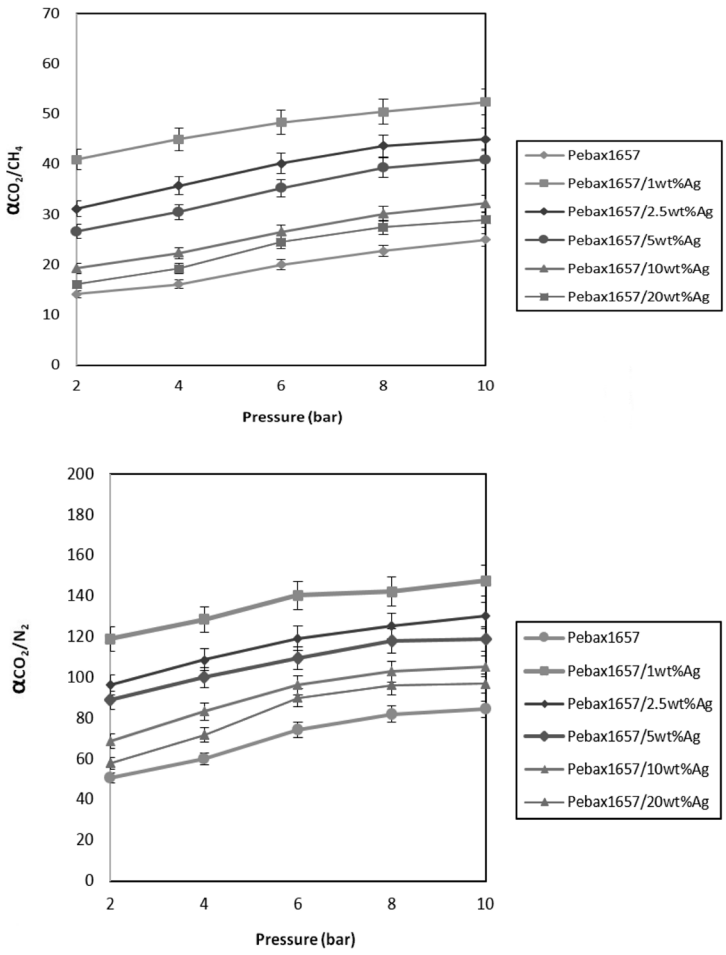

Figure 1: CO_2/CH_4 and CO_2/N_2 selectivities at temperature of 35°C and operating pressures from 2 to 10 bar.

Conclusions

AS it can be seen in Figure 2, the separation performance of the prepared mixed matrix membranes containing Silver nanoparticles and Polyether Block Amide not only could reach the Robeson upper bound 2008 for CO_2/CH_4, but also pass the bound for CO_2/N_2 showing that the membranes can be a promising candidate to be used in gas separation processes and CO_2 capture so as to delay global warming.

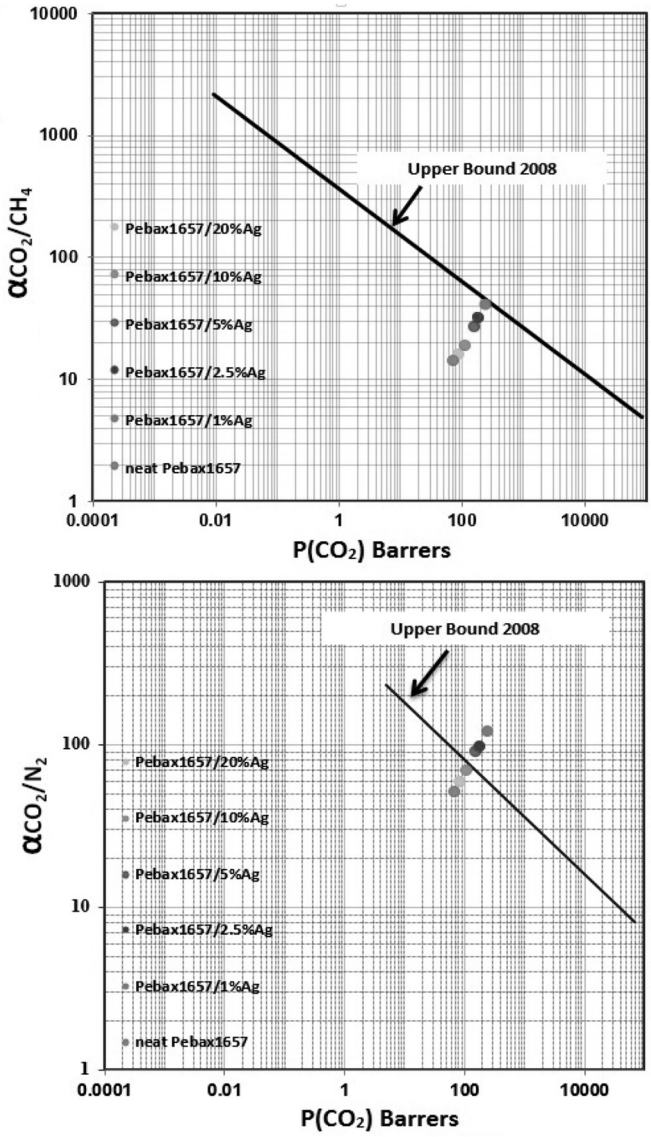

Figure 2: Separation performance of the prepared membranes at temperature of 35°C and pressure of 2 bar compared to Robeson upper bound 2008 [6].

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