The CO_2/CH_4 separation of PSF/PEG blend membrane filled with grapheme-hydroxyl nanoparticles

Morassa Raouf[1], Reza Abedini[2,*],Mohammad Reza Omidkhah[3]
[1] Department of Chemical Engineering, Mazandaran University of Science and Technology, Babol, Iran
Morassae.raouf@yahoo.com
[2] Faculty of Chemical Engineering, Babol Noshirvani University of Technology, Babol, Iran
*Corresponding author: abedini@nit.ac.ir
[3] Faculty of Chemical Engineering, Tarbiat Modares university
omidkhah@modares.ac.ir

ABSTRACT

In this study a series of mixed matrix membranes were prepared comprising poly-sulfone by poly-ethylene glycol mixed matrix and ordered graphene hydroxyl nanoparticles as filler with loadings varying between 1 and 3wt %. The interaction between the filler and the polymer was studied by scanning electron microscopy and permeability analysis for CO_2, CH_4. The gas permeation fluxes of the derived nanocomposite membranes are increased nearby 69% in mixed matrix membrane with 10wt % PEG introduced. According to permeability and selectivity results derived from gas separation tests, the membrane with 1wt % graphene hydroxyl nanoparticles have stronger interaction with PSF (PPG-10-1) which can increase the permeability of gases could increase selectivity of CO_2/CH_4.

Keywords: mixed matrix, membrane, gas separation, poly-sulfone, poly-ethylene glycol, graphene hydroxyl

1. INTRODUCTION

In the past several decades, gas separation by using polymer membranes has attracted considerable attention not only from research areas but also from industries. Compared with traditional gas separation methods, such as cryogenic distillation and adsorption, the separation of gases and/or liquids by membranes is more effective, environmental friendly and energy saving [1]. Generally, for certain separation needs, the higher the permeability of the membrane used, the smaller the membrane area is required. The higher selectivity means the lower driving force. Therefore, for economical consideration, the permeability and selectivity of the membranes should be maximized for providing commercially attractive separation behavior and achieving more efficient separation. However, the polymeric membranes show a near-universal trade-off between flux and selectivity and CO_2 reveals a Robeson upper bound relationship for the mixtures [2,3]. Therefore, poly-sulfone by nanocomposite membranes, defined as inorganic nano-fillers dispersed in polymer matrix, have been studied as an alternative approach to solve the trade-off problem of polymeric membranes in gas separation as well as it can be. Compared to the pure polymer membranes, many polymers as nanocomposite membranes show higher permeability without sacrificing gas selectivity or even improve selectivity [4-8]. Among others, when using nanoparticle materials, MMMs have the advantage of combining the benefits of both phases: the superior gas transport properties and thermal resistance of molecular sieves with the desirable mechanical properties, low price, and good permeability of polymers. Poly-sulfone (PSF) is one of the most common amorphous glassy polymers used for gas membrane separation. A considerable research effort has examined the use of nanoparticle materials in PSF-based MMMs. Glassy polymers, such as PSF-PEG, which presents a rigid and high-strength structure, frequently offer better transport performance for specific gas permeation mixtures when compared to rubbery materials, and have the disadvantage of strong polymer chain mobility during the membrane formation. This mobility may result in a good interaction between microporous fillers such as G-OH and the polymer as a result of its inadequate wetting. If polymer chains are completely able to surround nanoparticles, it's desirable that channels may be created between both phases [9-12].