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The effect of incorporation of ZIF-67 nanoparticles on the polysulfone membranes in gas separation

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ABSTRACT

Polysulfone (PSF) membranes were developed and modified by incorporating ZIF-67 nanoparticles. The effect of various percentages of ZIF67 was investigated by scanning electron microscopy, fourier transform infrared, X-ray diffraction. The permeation properties and performance of pure gases (N₂, O₂, CO₂) was also evaluated. The ideal selectivity performance of composite membranes compared with the pure PSF membranes significantly increased in CO₂/N₂ and O₂/N₂ selectivity at pressure 1bar. It may due to, good interaction between the filler and the polymer and change in the polymer structure.

Keywords: Membrane, Gas Separation, Polysulfone, ZIF67

1. INTRODUCTION

The concern of global warming has attracted a unique public attention to the case of CO₂ emission, also finding an economically separation method is so essential. Membranes have gained an important place in chemical technology and are used in a broad range of applications. In the last two decades the separation of gas mixtures with membranes has being viable alternative process rather than traditional methods (cryogenic distillation, amine-based absorption and, pressure-swing adsorption). Organic polymers are the common materials for gas separation membranes. Many polymers exhibit a sufficient gas selectivity and they can be easily processed into membranes. And Polysulfone is one of the most important polymers for gas separation membranes. Plasticization and the trade-off between selectivity and permeability restricted the performance of the polymeric membranes. Thus inorganic materials due to their high properties are used in polymeric membranes to achieved better performance. In this work, synthesizing MMMs by using inorganic materials such as ZIFs, in this work ZIF-67 in PSF matrix was investigated [1] and [2].

2. EXPERIMENTAL

2.1 Materials

Cobalt nitrate hexahydrate (Co(NO₃)₂.6H₂O), 2-methylimidazole were procured from Sigma Aldrich company. Acetone, n-hexane, N-methylpyrrolidone (NMP) and Isopropyl alcohol were obtained from Merck (Germany). Polydimethylsiloxane (PDMS) (Sylgard®184 Silicone Elastomer) and the corresponding curing agent were bought from Dow Corning. Polysulfone (PSfUdel® P-3500) was purchased from Solvay Plastic. All chemicals were used without further purification and Deionized water (DI) was used throughout the study.

2.2 Preparation of ZIF67 nano particles

In a typical synthesized, ZIF-67 nano particles were achieved by dissolving 0.45g zinc nitrate in 3ml of deionized water and 5.5g 2-methylimidazole in 20ml deionized water separately, and then stirring the mixture of them at room temperature for 6h. The product was collected by repeated centrifugation (6500 rpm, 30 min) and washed thrice by DI water and methanol, and finally the product was dried at 80 degrees of centigrade overnight in a drying oven [3].

2.3 Preparation of mixed matrix membranes