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# Mixed matrix membranes of Matrimid 5218 loaded with zeolite 4A for pervaporation separation of water–isopropanol mixtures

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ABSTRACT

Mixed matrix membranes were prepared by incorporating zeolite 4A into polyimide of Matrimid 5218 using solution-casting technique. The fabricated membranes were characterized by scanning electron microscopy (SEM), differential scanning calorimeter (DSC) and thermo gravimetric analysis (TGA). It was found that the higher annealing temperature of 250 °C is more favorable to improve adhesion between zeolite and polymer phases. Effects of different parameters such as temperature (30–60 °C), water content in feed (10–40 wt.%), zeolite loading (0–15 wt.%) and polymer content (10 and 15 wt.%) on pervaporation dehydration of isopropanol were studied. Sorption studies were carried out to evaluate degree of swelling of the membranes in feed mixtures of water and isopropanol. The experimental results showed that both pervaporation flux and selectivity increase simultaneously with increasing the zeolite content in the membranes. The membrane containing Matrimid 5218 (10 wt.%)–zeolite 4A (15 wt.%) exhibits the highest separation factor ($\alpha$) of 29,991 with a substantial permeation flux ($J$) of 0.021 kg/m$^2$ h at 30 °C for 10 wt.% of water in the feed. The PV performance was also studied in term of pervaporation separation index (PSI). Permeation flux was found to follow the Arrhenius trend over the investigated temperature range.



*Keywords:* Mixed matrix membrane; Pervaporation; Matrimid 5218; Isopropanol; Zeolite 4A

## 1. Introduction

Economical, safe and eco-friendly pervaporation (PV) process exhibits excellent efficiency in separation of azeotropic and close boiling mixtures, isomers and heat-sensitive mixtures and is considered to be a promising alternative to conventional energy-intensive liquid mixtures separating technologies such as extractive or azeotropic distillation (Shao and Huang, 2007; Smitha et al., 2004). Development of higher performance membranes via tailoring their physical and chemical properties for separation and purification of different gas and liquid molecules in PV and gas separation processes has attracted a great deal of interest during the last two decades (Baker, 2004; Süer et al., 1994). Superior membrane stability and durability, high permeation flux and selectivity and low production cost are always the most important criteria when developing a membrane for a specific separation (Qiao et al., 2006). Also, the most significant challenge facing the membrane material design is to enhance its selectivity and at the same time improve its permeation flux or at least keeping that unchanged (Mahajan et al., 2002). Polymeric membranes are widely used in the membrane separation process due to their processability, flexibility and of course low cost. However, the chemical and thermal instability and swelling of polymeric membranes make them unsuitable for harsh chemical and high temperature environments which are often encountered in industrial applications (Qiao et al., 2006). Permeation and selectivity tradeoff should be added to these shortcomings. On the other hand, much higher in cost zeolitic and carbon molecular sieve membranes (~3000$/m$^2$ for ceramic, glass, carbon, and zeolite membranes in contrast with 20$/m$^2$ for polymeric membranes), exhibit better structural stability and superior chemical and thermal resistant properties, and also they can withstand much higher

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