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# PERVAPORATION DEHYDRATION OF ALCOHOLS THROUGH INTERFACIAL POLYMERIZED POLYAMIDE COMPOSITE MEMBRANES: IMMERSION TEMPERATURE EFFECT OF AMINE AQUEOUS SOLUTION

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Shu-Hsien Huang<sup>a</sup>, Cheng-Lee Lai<sup>b</sup>, Kueir-Rarn Lee<sup>a,\*</sup>, Juin-Yih Lai<sup>a</sup>

<sup>a</sup> R&D Center for Membrane Technology and Department of Chemical Engineering, Chung Yuan University, Chung Li 32023, Taiwan

<sup>b</sup> Department of Environmental Engineering and Science, Chia-Nan University of Pharmacy and Science, Tainan 717, Taiwan

## ABSTRACT

To improve the permeation rate of polyamide, the polyamide composite membrane was prepared by the interfacial polymerization of triethylenetetramine (TETA) and trimesoyl chloride (TMC) on the surface of the modified polyacrylonitrile (mPAN) membrane and was applied in the pervaporation separation of alcohol aqueous solutions. The effect of immersion temperature of TETA aqueous solution on the pervaporation performance was investigated. For the pervaporation separation of 90 wt% ethanol/water solution, the permeation rate increased with an increase in the immersion temperature of TETA aqueous solution. However, the water concentration in permeate decreased slightly (< 1 wt%) and then remained unchanged almost. When the immersion temperature of TETA aqueous solution increased, the permeation rate increased without sacrificing the water concentration in permeate for 70 wt% isopropanol/water solution. Nevertheless, both the permeation rate and the water concentration in permeate increased for 70 wt% tetrafluoropropanol/water solution.

## INTRODUCTION

Pervaporation provides an important option for the dehydration of alcohol aqueous solutions and the removal of trace substances in chemical industry. Polyamides have been studied as suitable membrane materials because of their high thermal stability, excellent mechanical strength and high resistance to organic solvents. However, the disadvantage of dense polyamide membranes for the pervaporation separation process is low permeation rate. To increase the permeation flux of polyamide membranes, the membrane morphology must be converted from a dense thick film into an asymmetrical or composite morphology. Composite membranes are superior to single-material asymmetrical membranes. Composite membranes are characterized by a top separation layer formed onto a chemically different asymmetrical porous substrate. The benefits of these independent polymeric layers can be combined to obtain the desired membrane performance. The development of composite membranes is a key factor for the successful polyamide membranes applied in many areas.

Interfacial polymerization is an effective technique for producing a composite membrane with a thin selective top layer. The interfacially polymerized thin-film composite membranes are usually studied on reverse osmosis (RO) or nanofiltration (NF), but there have been a few reports on pervaporation. In this study, to improve the permeation rate of polyamide membranes, polyamide thin-film composite membranes were prepared using interfacial polymerization with TETA and TMC onto the surface of the mPAN membranes and were applied in the pervaporation separation of alcohol aqueous solutions. The effect of immersion temperature of TETA aqueous solution on pervaporation performance was investigated.

## EXPERIMENTAL

The flat porous PAN support membranes were prepared by a polymer solution containing 15 wt% of PAN cast onto nonwoven polyester fabrics. The cast membrane was precipitated by immersion in a bath of water. The PAN membrane was hydrolyzed in 2 M NaOH solution at 50 °C to obtain the modified PAN (mPAN) membrane. The mPAN membrane was immersed in a 0.1 wt% TETA aqueous solution at different temperature for 5 sec. The excess amount of TETA aqueous solution remained on the mPAN support was removed. The mPAN membrane soaked TETA aqueous solution was contacted with a 0.05 wt% TMC organic solution at atmospheric temperature for 10 sec to carry out interfacial polymerization. The polyamide thin-film composite membrane was dried at atmospheric temperature and then was washed in methanol. The polyamide thin-film composite membranes were utilized in the pervaporation separation of alcohol aqueous solutions. The feed solution contacted with membrane directly. The effective area for pervaporation was 11.64 cm<sup>2</sup>. The permeation rate was determined by measuring the weight of permeate with the effective membrane area for a period of operation time. The compositions of the feed solution and permeate were measured by gas chromatography.

## RESULTS AND DISCUSSION

In general, the ability to move for the molecules increases because of an increase in the polymer chain flexibility during the heating process. Thus, the temperature of the TETA aqueous solution increased during the immersion of the mPAN membrane to make more TETA monomers penetrate into the mPAN membrane. This is expected that the thinner and dense polyamide active can be formed via the interfacial polymerization of more TETA and TMC to improve the