Effect of substrate structure of composite membranes on pervaporation performance

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ABSTRACT

In this study, high pervaporation separation performance composite membranes were prepared by casting aqueous chitosan solution on a skin-free cellulose acetate (CA) membrane surface. A series of skin-free CA membrane prepared via immersion precipitation has been successfully fabricated using in-situ casting process with different polymer concentrations upon the non-woven support. The effect of the casting solution concentration on the membrane morphology was characterized by SEM and AFM. Compared with the traditional asymmetric CA membrane, the skin-free CA membranes with a higher water flux were obtained. The influence of CA support layer structure on pervaporation separation performance of the chitosan/CA composite membrane was also studied.

Introduction

For the separation of azeotropic mixtures, close boiling-point mixtures, structural isomers, recovery or removal of small quantities of impurities, pervaporation (PV) separation have shown its attractive performance and received considerable investigations. However, in order to increase the membranes potential, it is necessary to obtain more selective membrane with higher flux. In general, for a given membrane material, the selectivity is more or less fixed, while permeate flux is inversely proportional to its thickness. On the other hand, polymer membranes usually own high selectivity with low flux. Thus, in order to overcome the low flux, composite membranes with porous sublayer and thin dense selectivity layer are more suitable.

In general, the asymmetric membranes have a dense skin layer and a porous sublayer, resulting in the permeation flux decreases. Thus, it still represents a challenge to obtain a skin-free support membranes, due to the skin-free membrane had lower mass transfer resistance. The majority of membranes are prepared by controlled phase separation of polymer solution into two phases: one with a high polymer concentration, and the other one with a low polymer concentration. Hence, in-situ casting process with different polymer concentrations to fabricating skin-free CA membrane was investigated in this article. The influence of CA support layer structure on pervaporation separation performance of the chitosan/CA composite membrane was also studied.

Experimental

Material

Cellulose acetate (CA-394-60S), used in this study was supplied by Eastman Chemical Co. Ltd. The number average molecular weight is 60,000 g/mole. Chitosan (85% deacetylation) was supplied by Sigma Co. N-methyl-2-pyrrolidone (NMP) supplied by Aldrich Co. Ltd., was used as the solvent. The non-woven supplied by Ahlstrom Co. Wet Laid Polyester Ltd., was used as the support. All other reagents and solvents used in this study were supplied by commercial source.

Membrane preparation

Flat membranes were obtained by casting single polymer solution or in-situ casting different polymer concentrations upon the non-woven support. The polymer solutions used for obtaining the upper and the support layers were referred to as the solution A (CA/NMP=15wt%) and solution B (CA/NMP=0~15wt %) , respectively. The casting film was immersed in the coagulation medium. Fig. 1 shows the schematic representation of the in-situ casting process. The CS/CA composite membranes were made by coating 1.5wt% aqueous chitosan solution onto the surface of CA support membrane and were evaporated at 120°C for 20 min in the oven.

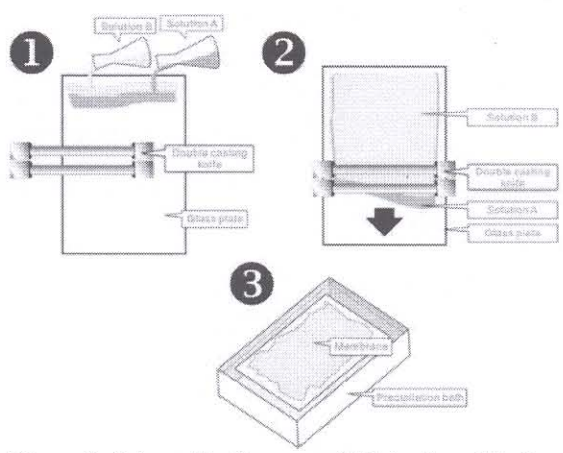

Figure 1. Schematic diagram of fabricating skin-free membranes using in-situ casting method.

Membrane Characterization

The morphology of CA membranes was observed with the scanning electron microscopy (Hitachi, Model: S-3000N). Tapping mode on a commercial AFM (Digital Instruments, DI-NS3a, USA) was used in determining topography and phase images of the polymer membrane surfaces. The water flux was measured at 1 kg/cm^2 and room temperature for the dead-end filtration process.