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ORIGINAL PAPER

Performance evaluation of polyvinylchloride/polyacrylonitrile ultrafiltration blend membrane

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Abstract Polyvinylchloride (PVC) membranes were modified by blending with polyacrylonitrile (PAN) as a second polymer. The miscibility of PVC/PAN blend was examined using an incompressible regular solution (CRS) model in no need to make a membrane. The results showed that the PVC/PAN blend was immiscible for all compositions at a temperature range of −25 to 225 °C. Furthermore, the prediction of the phase behavior of a PVC/PAN/DMF ternary system showed that the blend of two polymers was highly incompatible even in their common DMF solvent. However, this incompatibility led to a remarkable increase in the porosity of the blend membrane and pure water flux compared to those for pure PVC membrane. The pure water flux of the PVC membrane (37.9 ± 1.5 L/m^2 h) increased about 41 and 76% by adding 10 and 20 wt% PAN, respectively. The blend membranes also showed an enhanced flux recovery ratio (FRR) compared to a pure PVC membrane, although the PVC membrane rejection for Bovine serum albumin (BSA) was decreased after blending with PAN. The PVC/PAN (90/10) blend membrane was subjected to hydrolysis with NaOH alkaline solution at three different concentrations and contact times to further enhance its performance. The membrane, which was hydrolyzed with a 0.5 mol/L NaOH solution for 0.5 h, showed a highest pure water flux of 75.6 ± 7.2 L/m^2 h due to its increased hydrophilicity. This membrane also revealed an improved FRR and better thermal and mechanical properties compared to an unmodified membrane.

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Keywords PVC/PAN blend membrane · Miscibility · CRS model · Hydrolysis · Modification

Introduction

The features of polyvinylchloride such as low cost, good physical and mechanical properties as well as resistance to abrasion, acid, base, and microbial corrosion are attractive for some applications, especially membrane fabrication. Polyvinylchloride has been used in the fabrication of nanofiltration and heterogeneous ion-exchange membranes [1, 2] as well as ultrafiltration [3, 4] and microfiltration [5] for wastewater treatment. Nevertheless, the hydrophobicity of PVC hampers its application in wastewater treatment due to its reduced permeation and increased fouling on the membrane surface. In fact, this drawback of PVC gives rise to hydrophobic interactions between the membrane surface and molecules of dissolved substances including proteins, resulting in protein adsorption on the membrane surface. Therefore, it reduces the efficiency of PVC membrane for filtration of aqueous solutions.

Polymer blend membranes represent an effective approach to improve the physical and chemical properties of membranes. They represent some improved membrane characteristics such as permeability, selectivity, hydrophilicity, fouling resistance, and mechanical strength [6]. Polymers such as polyvinyl butyral (PVB) [7], chlorine-modified polyvinylchloride (CPVC) [8], cellulose acetate (CA) [1], polyvinyl formal (PVF) [9], polyvinyl pyrrolidone (PVP) [10], polyethylene glycol (PEG) [11], poly(methyl methacrylate-*b*-methacrylic acid) (P(MMA-*b*-MAA)) [12], carboxylated polyvinylchloride (CPVC) [13], poly acrylonitrile (PAN) [14–16], and polycarbonate (PC) [17] have been used to modify filtration membranes based on polyvinylchloride.