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Hollow fiber ultrafiltration membranes prepared from blends of poly (vinyl chloride) and polystyrene

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ABSTRACT

Polymeric blend ultrafiltration membranes based on poly(vinyl chloride) (PVC) and polystyrene (PSR) were prepared by phase inversion method. The PSR concentration in dope solution varied from 1 to 6 wt.%. DMAC was used as a solvent, while water was used as internal and external coagulant. Scanning electron microscope (SEM) was utilized to characterize cross-section, outer, and inner surfaces of the hollow fiber structure. Differential scanning calorimetry (DSC) was used for the determination of the glass transition temperature (Tg) of the blends. From the experimental results it was found that, the structural morphology of the polymeric blend varied with the PSR concentration. There is no significant decrease in pure water permeation flux by using 1 and 2 wt.% PSR concentration in dope solution. The PVP K-90 rejection highly improved from 76.2% to 98.53% with the addition of 1 wt.% PSR concentration. The PVC/PSR blends show incompatibility by the results of SEM and DSC. Also it was found that the mechanical properties of PVC/PSR blend membranes were improved randomly compared with that of PVC membrane.

1. Introduction

Polymer blending is a good factor used to prepare new types of polymeric materials. The blend membranes have better performance and mechanical properties than that of membrane composed by the original individual polymers. Many researchers focused on the effect of polymer blend on the membrane structure and performance [1–23]. For example, poly(ether sulfonamide) (PESA)/poly(ether imide) (PEI) blends were compatible with blending of small amount of 1,3-diamino-2-propanol [1]. Ultrafiltration membranes and a polymer blend of polyacrylonitrile (PAN) and polysulfone (PSU) were prepared by Ling and Chen [2]. They found that the flux of the PAN/PS blend membranes is higher than that of PAN membranes. The effect of sulfonated poly(ether ether ketone) (SPEEK) in membrane formation and separation properties was investigated in polysulfone (PSU)/SPEEK/(NMP) and polyetherimide (PEI)/(SPEEK) systems [3,4]. Sajitha and Mohan, prepared ultrafiltration membranes from blends of cellulose acetate and carboxylated polysulfones having various degrees of carboxylation [5,6]. Sulfonated polyetherimide/polyetherimide (SPEI/PEI) ultrafiltration (UF) hollow fiber membranes were prepared with phase inversion method and SPEI was used as a polymer additive [7]. Several researchers studied the preparation of polyethersulfone (PES) membranes blended with P(VP-S), Pluronic polymers, PAI, cellulose acetate phthalate (CAP), and Cellulose diacetate. The blends exhibited better performance in solute rejection and water flux than those prepared from PES [8–12]. The addition of second polymer to the PVDF solution was studied by several authors. For example, Nunes and Peinemann, obtained an asymmetric ultrafiltration membrane from PVDF/PMMA blends [13]. While, Wu et al. studied the effects of some membrane preparation conditions on the characteristics and performance of PVDF/PES blend membranes [14].

Actually, poly(vinyl chloride) (PVC) represents an interesting material for producing membrane, due to its exceptional chemical resistance, excellent physical properties and mechanical performance. Some researchers have indicated the polymer blend with PVC. For example, microfiltration membranes from poly(vinyl chloride) and co-poly(butadiene-acrylonitrile) were prepared by Islam et al. [15]. The blended membrane showed better elastic properties than the pure poly(vinyl chloride) membrane. Peng and Sui [16], introduced poly(vinyl butyral) (PVB) as the second polymer component to hydrophilized PVC ultrafiltration membranes. They found that the water flux and hydrophilicity of the blended membranes were much better than that of the membranes made from pure PVC or PVB.

Based on what has been mentioned in the literature above, the effect of polystyrene (PSR) concentration as a second polymer in PVC dope solution on hollow fiber membrane morphology, performance, and mechanical properties has not been reported yet. One of the main objectives of this work is to prove that the separation performance of hollow fibers is highly enhanced by using low PSR concentrations as a second polymer. The characteristics of the hollow fibers fabricated from the blends of PVC and PSR were explored by means

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