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Fabrication of ultrafiltration membranes with enhanced antifouling capability and stable mechanical properties via the strategies of blending and crosslinking

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Abstract

In this study, a novel polysulfone (PSf) with pendant tertiary amine groups was synthesized and this functionalized PSf could be further crosslinked based on a facile reaction between tertiary amine and 1,3-dibromopropane (DBP). The synthesis of this new polymer and the occurrence of the crosslinking reaction were evidenced by FTIR, ^{1}H NMR and solid state ^{13}C NMR spectroscopy. The crosslinked PSf and sulfonated poly(ether ether ketone) (SPEEK) were mixed together to fabricate ultrafiltration membranes by the phase inversion method. All the composite membranes exhibited improved hydrophilicity over the pristine PSf membrane, attributed to the presence of sulfonic acid groups and/or quaternary ammonium groups. The crosslinked membrane demonstrated superior permeability and antifouling properties than the uncrosslinked membrane due to the conversion of tertiary amine groups to more hydrophilic quaternary ammonium groups. In particular, the membrane with crosslinked PSf：SPEEK ratio of 1：1 showed the most favorable performance, including almost 3.5 times of pure water flux of the pristine PSf membrane and 97% of flux recovery ratio. Meanwhile, the crosslinked membrane maintained superior dimensional stability and mechanical properties compared to the uncrosslinked membrane, which is a major challenge faced by highly hydrophilic polymers, because of the restricted molecular chain movement caused by the crosslinking network and electrostatic interaction. All the resultant membranes were fully characterized, including surface properties, morphologies, mechanical strength, thermal stability, permeability, and antifouling properties.

Keywords: ultrafiltration membrane, crosslinked, antifouling

1. Introduction

Membrane separation technology has been considered as an economical and energy efficient alternative for water purification [1,2]. Among the various separation membranes, ultrafiltration (UF) membrane stands out in terms of the rapid removal of macromolecular proteins, colloid particles, dye molecules, and bacteria [3-5]. The polymer-matrix UF membranes are more attractive than inorganic membranes due to the simple manufacture on a large scale [6,7]. However, the polymer-matrix