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Fabrication of high-performance nanofiber-based FO membranes

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ABSTRACT

Being partially commercialized and has specific application areas, where the reverse osmosis technology cannot serve, forward osmosis (FO) technology is continually receiving extensive research to promote its performance. In this study, high-performance FO nanofiber-based substrate membrane was fabricated for potential application of saline water desalination. Sulfonated polysulfone (sPSU) with definite sulfonation level was used to fabricate support layer. Tubular beadless fiber network owning scaffold-like structure with a fiber diameter of 247 nm was formed. Polysulfone was sulfonated by heterogeneous method using chlorosulfonic acid as a sulfonation agent. The substrate and FO membranes were characterized mainly by means of scanning electron microscopy (SEM), water permeation flux, porometry, contact angle, Fourier transform infrared (FTIR), as well as other tests, while the characterization of thin-film composite separation layer was restricted to SEM and FTIR. The characterization illustrates that the sPSU support layer is highly porous with a narrow pore size distribution. FO performance evaluation of two commercial and newly developed membranes was probed using FO and pressure-retarded osmosis (PRO) modes with cocurrent and counter-current flow scheme. The active layer presents excellent intrinsic properties with *A*/*B* of 17.31 and a high salt separation ratio of 99.54%. The newly developed membrane can achieve a high FO and PRO water flux of 65.7 and 313 L m^{-2} h^{-1}, respectively, using a 1 M NaCl draw solution and deionized water feed solution. The corresponding salt flux is only 2.5 and 5.3 g m^{-2} h^{-1}. The reverse flux selectivity represented by the ratio of water flux to reverse salt flux (J_w/J_s) was kept as high as 26.3 and 58.8 L g^{-1} for FO and PRO modes. To the best of our knowledge, the performance of the current work-developed membrane is superior to all FO membranes previously reported in the literature.

Keywords: Forward osmosis membrane; Pressure-retarded osmosis; Electrospinning; Nanofiber; Interfacial polymerization; Polyamide; Sulfonated polysulfone

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