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Self-standing nanofilms of polysulfone doped with sulfonated polysulfone via solvent evaporation for forward osmosis

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Abstract

A polysulfone (PSf) self-standing nanofilm was designed for forward osmosis (FO) via the solvent evaporation method and doping sulfonated polysulfone (SPSf) from 0 to 5 wt.% to tune the structure and surface property of the nanofilm. The separation performance of the nanofilm was investigated in hydraulic and osmotic pressure-driven processes. The experimental results showed that attributed to the formation of interconnected SPSf network in the PSf matrix, the pore size distribution of the PSf self-standing nanofilm narrowed down at the optimized SPSf content of 1 wt.%, above which SPSf aggregation occurred and the pore size distribution became broadened. Moreover, by doping SPSf, a more hydrophilic and negatively charged surface was obtained. At the SPSf content of 1 wt.%, the rejection of the nanofilm to Na_2SO_4 increased from 82.0% to 90.8% and the water flux was improved from 0.15 to 0.17 L m^{-2} h^{-1} in the pressure driven process. Correspondingly, the thinnest nanofilm with the thickness of 46 nm has a highest water flux of 46.4 L m^{-2} h^{-1} in the FO process using 1.25 mol L^{-1} Na_2SO_4 as the draw solution. Such a self-standing nanofilm provides a new approach to develop high performance FO membranes.

Abbreviations

$C_{DS,}$ draw solution concentration; $C_{SPSf,}$ SPSf content; CTA, cellulose triacetate; DMAc, dimethylacetamide; FESEM, field emission scanning electron microscope; FO, forward osmosis; HPD, hydraulic pressure driven; ICP, internal concentration polarization; $J_{s,}$ reverse salt flux; $J_{v,}$ water flux; Na_2SO_4, sodium sulfate; NF, nanofiltration; OPD, osmotic pressure driven; PSf, polysulfone; *R,* rejection; SPSf, sulfonated polysulfone; TFC, thin film composite; $\pi_{D,}$ osmotic pressure difference