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Microfiber-polymer hydrogel monolith as forward osmosis draw agent

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Abstract

Stimuli-responsive polymer hydrogels have shown great potential for use as draw agent in emerging forward osmosis (FO) technology. The swelling pressure of hydrogel and the effective contact area between FO membrane and hydrogel are key parameters for achieving high water flux. In this work, we have demonstrated that the forward osmosis performance of hydrogels can be significantly improved by producing composite hydrogel monoliths containing thermoplastic polyurethane (TPU) microfibers. The use of monolithic hydrogels and the addition of microfibers enhance water diffusion through the draw agent and sustain high swelling pressure, resulting in improved FO performance. As observed in the sigmoidal swelling curves, the swelling kinetics of microfiber-hydrogel composite (TPU microfiber-poly (NIPAM-co-SA), TPU-PN5S5) is faster than that of pure hydrogel (PN5S5), and the time required for the composite to reach swelling equilibrium decreases significantly; the diffusion exponent of TPU-PN5S5 composite increases from 0.73 to 0.81, indicating that addition of microfibers increases the water diffusion rate. Further studies show that water transports more quickly through the microchannels around TPU microfibers due to their hydrophilicity and capillary forces. The composite monolith was tested as forward osmosis draw agent, and it was found that the 1st hour FO water flux and dewatering flux of TPU-PSA are 1.81 and 3.51 $L \cdot m^{-2} \cdot h^{-1}$, respectively, twice of those for PSA particles alone.

Keywords: TPU microfibers, polymer hydrogel, solvent diffusion rate, draw agent, forward osmosis