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Membrane Distillation by Novel Hydrogel Composite Membranes

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Abstract

Novel polyelectrolyte hydrogel composites are developed by UV-initiated graft polymerization of acrylic acid and 2-hydroxyethyl methacrylate (functional monomers) and ethylene glycol dimethacrylate (cross-linker), on polypropylene flat sheet membranes (support). Homogeneous and defect-free hydrophilic hydrogel layer are synthetized on the hydrophobic porous support at different degree of functionalization, by modulating the molar ratio between the functional monomers.

Composites, with good stability against delamination, are effectively used as smart gating devices in membrane distillation treatment of NaCl solutions. The presence of ionisable groups make polyelectrolyte hydrogel sensitive to salt ions concentration. The retention property and responsive behaviour of hydrogel membranes (swelling/shrinking) to salt solutions, and its dependence on the monomers composition in the gel synthesis, provides the unique opportunity to enhance control over mass transport and selectivity in MD processes.

The special transport mechanism arises from the synergistic connection between the polyelectrolyte layer and the hydrophobic substrate. Combination of Donnan exclusion effects and the swelling/shrinking behaviour of the hydrogel in response to the salt solution, which leads to strong anisotropic deformation of the soft gel layer anchored to the rigid support, affords tuneable water transport and ion rejection compared to conventional uncharged MD membranes. As a result, enhanced permeability and selectivity of composites, compared to pristine polypropylene membranes, are obtained when using saline solutions as feed.