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Effects of Properties and Structure of Carbonized Fiber Membranes on Membrane Distillation Performance

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Summary

Membrane distillation (MD) is a membrane technology that uses a vapor pressure difference as a driving force caused by the temperature difference between the feed and permeate solutions across a hydrophobic porous membrane. When cloth fibers such as synthetic fiber Cupra are carbonized at a high temperature, a highly hydrophobic carbonized fiber material can be obtained while maintaining the high porosity inherent in the cloth fibers. In this study, MD was measured with carbonized fiber membranes. For comparison, a porous polyvinylidene fluoride (PVDF) membrane, polysulfone (PSf) membrane and polydimethylsiloxane (PDMS) membrane were also used. The effect of the type and morphology of the membrane on MD performance was discussed. Furthermore, a composite membrane of PVDF with a hydrophilic polyvinyl alcohol (PVA) layer was also prepared, and the anti-fouling performance of the PVA/PDMS composite membrane was evaluated.

PVDF and PSf membranes were prepared through the non-solvent induced phase separation process. The water contact angle and the surface porosity were evaluated. In the MD measurement, a 3 wt% NaCl aqueous solution and mixed solution of NaCl and bovine serum albumin (BSA) heated to about 60°C were used as a feed solution.

The carbonized fiber membrane showed a higher contact angle than the porous PVDF, PSf and PDMS membranes. It was concluded that the carbonized fiber membrane is an excellent hydrophobic porous material. In MD measurement, a linear relationship was observed between the permeation and time. The permeation flux was calculated from the slopes. The permeation flux across the carbonized fiber membrane was more than 2 times higher than that of other porous membranes. In the MD measurement using a NaCl aqueous solution and a NaCl/BSA mixed aqueous solution as feed solutions, the permeation flux decreased by about 20% due to the addition of BSA in the case of PVDF membrane. On the other hand, no decrease in permeation flux was observed for the PVA/PVDF composite membrane. This is because the attachment of BSA could be suppressed by adding the PVA layer on the PDMS membrane.