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Development of Hollow Fiber Ion Exchange Membrane Having High Ionic Permeability

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Summary

The goal of this study is to prepare novel hollow fiber (HF) type cation-exchange membranes (CEMs) from polysulfone (PSF)-based graft copolymers. To this end, in this study, PSF with graft chains of poly (sodium *p*-styrenesulfonate) (PSF-*g*-PSSS) were synthesized, and flat sheet PSF-based CEMs were prepared from the graft copolymers. We measured the ionic transport properties of the obtained CEMs to evaluate the relationship between the transport properties and the preparation conditions.

In order to prepare such a graft copolymer, a macro-initiator of chloromethylated polysulfone was prepared by chloromethylation of polysulfone with chloromethyl methyl ether to introduce a chloromethyl group into the polysulfone main chain. A graft copolymer was synthesized using atom transfer radical polymerization (ATRP) by grafting *p*-styrene sulfonate (EtSS) on the macro-initiator changing EtSS content in the polymers. PSF-based CEMs were prepared by casting a 1-methyl-2-pyrrolidinone solution of the graft copolymers on a teflon sheet and drying in a vacuum at 80 ºC for 24 h, and then by immersing the obtained membrane in hot water (95 ºC) for 24 h to remove the ethyl groups of EtSS by hydrolysis reaction.

The ion-exchange capacity (*IEC*) of the CEMs increases with increasing of the EtSS content in the reaction mixture. The *IEC* has a good correlation with EtSS content in the reaction mixture. This means that the side chain length of the graft-copolymer will be controlled by changing the EtSS content in the reaction mixture. Mechanical properties (tensile strength) of the CEMs increased with the decrease in water uptake.

The dynamic transport number of the CEMs increased as the membrane resistance increased. The transport number of the CEM (CM content = 8.4 mol%, and EtSS ratio = 46 wt.%) was 0.98, and the same as that of CMX. The membrane resistance of the CEM was 2.3 $\Omega \cdot cm^2$, and lower than that of CMX, 3.0 $\Omega \cdot cm^2$. The flat sheet PSF-based CEMs did not have any support materials although CMX had support materials such as PVC cloth. Hence, HF type CEMs will be prepared from PSF-*g*-PSSS. The results in this paper indicate that HF type CEMs prepared from PSF-*g*-PSSS will have both high counter-ion selectivity and high ionic flux. Therefore, the HF type CEMs have potential applications to diffusion dialysis processes in many fields such as the purification of acid or alkaline streams.