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Development of the Mixing Type Spacer to Achieve a High Current Density Operation for an Electrodialysis by Utilizing 3D Printer

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Summary

Electro-dialysis (ED) has been widely practiced in desalinations for brackish and seawater, deionization of aqueous solutions and salt productions. Salt ions are transported through ion-exchange membranes from one solution to another solution under the influence of an electrical potential difference. The concentration polarization takes place within a desalting surface of the membrane, so that salt ions dilute in a boundary layer for the desalting phase. When the current density exceeds the limiting current density, an electrical resistance increases drastically due to the depletion of the ions within the boundary layer on the membrane. The increasing of the limiting current density has been required in an electro-dialysis. Therefore, it is quite important to suppress the concentration polarization to increase the limiting current density in an electro-dialysis system.

In this study, in order to increase the limiting current density, we introduced 3 types of porous spacers made by 3D printer instead of the conventional mesh spacers. The mechanical fluid mixing which plays an important role in enhancing heat and mass transfer in the porous structures can be expected to suppress the concentration polarization and achieve a high limiting current density. In this study, a series of experiments have been carried out to examine the performance of porous spacers proposed for increasing the limiting current density. The effect of porous spacers filled in both dilute and concentrate channels on the stack voltage and the limiting current density has been investigated by comparing the cases with and without porous spacers. It has been found that the limiting current density with porous spacers is 1.8 to 4.0 times higher than that without porous spacer, as a result of mechanical dispersion caused by fluid mixing in porous structures. In this study, it has been proven that the insertion of porous spacers is quite useful in terms of suppressing the concentration polarization and increasing limiting current density.