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Development of Novel Nanofiltration Membranes for Separating Mg^{2+} and Ca^{2+} from Effluent in Electrodialysis

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Summary

The objectives of this study are to develop novel nanofiltration membranes that enables the separation and purification of Mg^{2+} and Ca^{2+} from effluents in the electrodialysis process in salt productions, and to design a novel recovery process of these ions using the nanofiltration membranes.

The nanofiltration membranes involve positively charged and negatively charged ones. As for the positively charged nanofiltration membranes, we tested three preparation procedures using the plasma graft polymerization of poly(2-methacryloyloxyethyl)trimethylaminium chloride) and a preparation procedure using post treatment with polyethyleneimine. Among these, the nanofiltration membranes prepared by the interfacial polymerization of piperazine (PIP) and trimesoyl chloride (TMC) onto polysulfone ultrafiltration membranes followed by the plasma graft polymerization showed an excellent performance. Those prepared by the interfacial polymerization of PIP and TMC followed by the surface modification using branched polyethylenimine also showed an excellent performance. As for the negatively charged nanofiltration membranes, we tested two preparation procedures. Among these, the nanofiltration membranes prepared by the interfacial polymerization of PIP and TMC together with iminodiacetic acid (IDA) having negative charges showed the best performance from the viewpoints of pure water permeability and ion separation properties. This is because the molecular weight cut-off was slightly enlarged with higher density of negative charges with the introduction of IDA.

Finally, we demonstrated the feasibility of the novel IDA-incorporated negatively charged nanofiltration membranes to the ion separation from the real effluents in the electrodialysis process in salt productions. We also succeeded in the prediction of the ion separation performance, which will result in the design of a novel recovery process of Mg^{2+} and Ca^{2+}.