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Development of Desalination System Using Salinity Gradient Energy

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Summary

There is a salinity difference energy (SGE) between salt solutions with different concentrations, and it was reported that 1.7 MJ of energy can be obtained by mixing 1 m^3 of seawater and 1 m^3 of river water. In this research, as an effective use technology of this SGE, we constructed a system in which the ED flow path part that desalinates salty water by using supplied electric power and the RED flow path part that converts SGE to electric power are integrated in one stack. Then, model seawater (0.5 M NaCl) and model brackish water (0.018 M NaCl) were supplied to this system, and using SGE of the two solutions, it was examined to desalinize a part of the brine supplied. First, by using simulation based on the theoretical equations for ionic flux, the desalination performance of the system was evaluated at various unit ratio of the RED and ED parts. As a result, it was found that the desalination rate was highest when the unit ratio of RED and ED was 7/3.

An experiment in brine desalination using the RED/ED system constructed with 1, 2, and 3 ED parts under the condition that the total unit number was fixed to 10 by using commercially available cation exchange membrane and anion exchange membrane was performed to compare the results with the simulations in the desalination process. The experiments indicate that the highest desalination rate was obtained when the number of ED unit is 3 as predicted by the simulation, and 2,000 ppm of brine was desalinated to the drinking water level in about 100 minutes by using the SGE between the model seawater and the model brine. It was also confirmed that the simulation method proposed in this study quantitatively predicts the experiments in the desalination of the RED/ED system. The simulations also predict that the RED/ED system whose RED/ED unit ratio are 1 and 2 generates about 700 J and 400 J, respectively while the system desalinate brine to 2 mM of salt solution.

In conclusion, it is shown that the RED/ED system can desalinate a part of the brine only by supplying seawater and brine without obtaining external energy..