No. 2313

Development of Highly Efficient Salinity Gradient Energy Conversion System Using Novel Profiled Ion Exchange Membranes (II)

Mitsuru Higa[1, 2], Eiichi Toorisaka[1, 2], Yuriko Kakihana[1, 2], Minato Higa[1, 2]

[1] Graduate School of Sciences and Technology for Innovation, Yamaguchi University
[2] Blue Energy center for SGE Technology (BEST), Yamaguchi University

Summary

Reverse electrodialysis (RED) converts salinity gradient energy (SGE) between salt waters with different salinity concentrations into electricity. RED has a structure in which multiple pairs of unit cells are arranged between two electrodes, each of which is composed of a cation exchange membrane (CEM), a high concentration solution (HS) flow path, an anion exchange membrane (AEM), and a low concentration solution (LS) flow path. In order to perform the SGE conversion process of RED efficiently, in this study, we fabricate a profiled (PF) membrane with a concave-convex structure. This concave-convex structure increases the surface area of the PF membrane, and the membrane distance can be maintained without a spacer network, which has the advantage of reducing the electrical resistance of the membrane and the flow path.

FKS-50 and FAS-50 were used as the base flat membranes for PF membranes, respectively. The PF membranes were fabricated by forming a concave-convex structure on the surface of the flat membranes by a heat press method. Stacks with 5 pairs were fabricated using flat membranes (Flat stack) or PF membranes (PF stack) were fabricated. In the power generation test, 50 mS/cm NaCl solution (HS-A), 95.5 mS/cm NaCl solution (HS-B), and 185.5 mS/cm NaCl solution (HS-C) were fed to the stack as HS, and 0.3 mS/cm NaCl solution as LS to measure voltage-current curves. The open circuit voltage (V_{OC}), stack internal resistance (R_{INT}), and maximum power density (PD_{gross}) were calculated from the voltage-current curves.

When HS-A was supplied, R_{INT} of the PF stack was 31% lower, and PD_{gross} was 44% higher than those of the flat stack. When HS-B and HS-C were used as the HS, the PF and flat stacks showed almost the same V_{OC} values even when the HS concentration increased while PD_{gross} increased due to the decrease in R_{INT}. In all the types of HS, the PF stack showed about 40% higher PD_{gross} than the flat stack. In HS-C, which was six times higher salinity than HS-A, both the flat and PF stacks showed about two times higher PD_{gross} than that in HS-A, and the PF stack indicated 40% higher PD_{gross} than the flat stack, confirming the superiority of the PF membranes prepared in this study even in highly concentrated salt water.