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Energy Recovery System from Factory Waste Salt Water and Industrial Water Using Reverse Electrodialysis (RED)

Mitsuru Higa[1,2], Kenji Hori[1], Nobutaka Endo[1,2], Yuriko Kakihana[1,2]

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

Summary

The aim of this study is to develop an energy recovery system utilizing useless wastewaters dischared from a plant. Reverse electrodialysis (RED) is one of promising ways for energy harvesting which enable to produce electric energy from salinity gradient between solutons with different salinities. Hence, when wastewaters with different salinities can be avairable in a plant, a certain amount of usefull energy can be recovered before discharging them. Hence, we have investigated its energy potential of an RED energy recovering system using real wastewaters from an industrial plant.

We selected a typical salt production plant as a model case to obtain wastewaters because various types of salty solutions can be avairable from the plant. The plant applies electrodialysis (ED) process for up-concentration of seawater before evaporation to produce edible salts. We selected five types of salty solutions: (A) evaporated pure water, (B) bittern, (C) brine after ED, (D) dilute after ED and (E) seawater, as the RED feeds. In RED system, two membrane combinations (standard membranes (CMX/AMX) and one-sided monovalent selective membranes (CIMS/ACS-8T)) were used to evaluate the effect of membrane types on the RED performance. Since the RED performance depends on the both membrane potential and membrane resistance, depending on types of feed water due to the different divalent ion composition, a selection of suitable membrane combination is important to get high energy by RED. The RED tests revealed that RED stack with CIMS/ACS-8T showed not so much higher open circuit voltage (OCV) than that with CMX/AMX, even though the membrane potential of CIMS was much higher than of CMX. The stack resistance of CIMS/ACS-8T was higher than that of CMX/AMX, resulting the lower power density of the stack with CIMS/ACS-8T under the experimental conditions. This will be due to the fact that the structure of the distribution part of the RED stack, and the low salinity of the distilled water used as the low concentration side of the RED system will decrease the effect of OCV on the RED.

In conclutions, an RED stack with one-sided monovalent selective membranes operating under the conditions: optimal strugure of the distribution part and optimal salinity at the low concentration side will give a high RED performance.