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Effect of operating conditions on the treatment of brackish groundwater by electrodialysis

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ABSTRACT

Desalination of brackish groundwater by electrodialysis was examined in this study. Groundwater samples were taken from a coastal area in Korea where the intrusion of seawater to groundwater is significant. The ion concentrations of the samples were 1,288 mg/L for Cl^-, 107 mg/L for SO_4^{2-}, 273 mg/L for Na^+, 118 mg/L for Mg^{2+}, 201 mg/L for Ca^{2+}, and 4.7 mg/L for K^+, and electric conductivity was 3.85mS/m. Operating conditions are as follows: applied voltage (from 5 to 30 V), pH (3, 7, 9), concentration of electrolyte solution (from 0 to 10% as Na_2SO_4), flow rate of dilute/concentrate/electrolyte (1.08, 2.16, 3.24 L/min)/(1.08, 2.16, 3.24 L/min)/(1.68, 3.36, 5.04 L/min). Cations and anions of water samples were analyzed using ion chromatography (Alltech). The rapid increase in the removal of salt ions was observed until a certain level of removal reached. The higher removal was achieved as the applied voltage increased and linear increase in the removal was found as the voltage increased up to 20 V, while no significant increase in the removal rate appeared beyond 20 V. Although the removal of anions and cations was higher in neutral pH region, the pH condition on at the range of pH from 3 to 9 gave little effect. Drastic increase in the removal of various ions was observed as the electrolyte concentration increased from 0 to 0.5%, while the removal increased gradually at the electrolyte concentration over 1%. Flow rate of concentrate, dilute, and electrolyte compartments showed positive relationship with the removal of the ions. This study suggested that various operating conditions could have effects on the performance of electrodialysis in desalting the brackish groundwater. Because the desalting efficiency depends largely on the input energy, the optimal operating conditions should be considered based on the quality of raw and treated water, and the economic concerns for a practical use of electrodialysis in securing alternative fresh water resources.

Keywords: Brackish groundwater; Desalination; Electrodialysis; Seawater intrusion

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