Comparison of conventional electrodialysis (ED) and monovalent selective electrodialysis (SED) in treating reverse osmosis (RO) brine

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1. Introduction –The discharge of reject brine from seawater desalination processes is a threat to marine ecosystems because of its high salinity and chemical dosages. Electrodialysis is a promising brine management techniques to recover mineral byproducts and increase water recovery from reverse osmosis (RO) brine. In this research, the conventional electrodialysis (ED) and monovalent selective electrodialysis (SED) were compared in hybrid electrodialysis-crystallization systems for high solubility liquid salts (HSLS) and magnesium salt production.

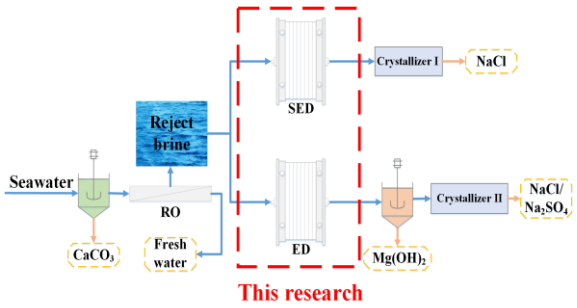

Image 1. The process of hybrid electrodialysis-crystallization systems for RO brine treatment.

2. Experimental - The limiting current density (LCD), concentration factor, current efficiency and specific energy consumption (ESEC) of conventional membranes (CMV/AMV) and monovalent selective membranes (CSO/ASV) were evaluated in treating RO brine with 90% calcium removal. Besides, the detrimental effects of divalent cations and the calcium scaling were elucidated.

3. Results and Discussion - Results showed that both of the ED and SED were effective to bring final brine TDS to more than 20%. In comparison, the LCD of SED was 11.35 mA/cm^2 whereas the LCD of ED was not detected when the recovery of Na^+ reached 90%. However, the current efficiency of SED was greater than ED with the current density ranging from 4.76 mA/cm^2 to 14.29 mA/cm^2, which was attributed to the hindrance of divalent ions by the positive charged modified layer and the preferential transport of Na^+. As a result, the energy consumption of SED was lower than ED. Moreover, the saturation index (SI) coefficient of $CaSO_4$ was -0.082 in the concentrated stream for ED while the SI of $CaSO_4$ was -0.501 in the diluted stream for SED when the recovery of Na^+ was over 90%, indicating that the SED had a lower potential of $CaSO_4$ scaling.

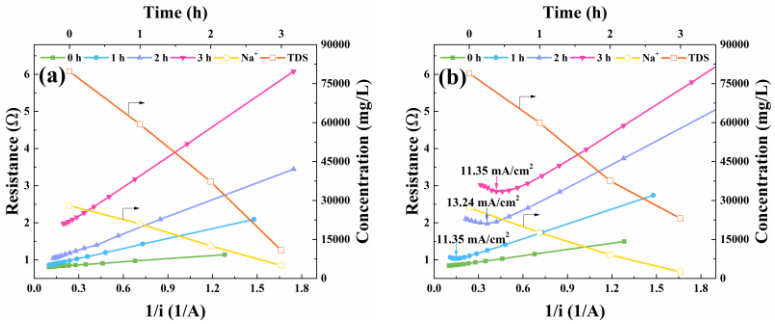

Image 2. Limiting current density (LCD) of (a) ED and (b) SED by the Cowan and Brown method.

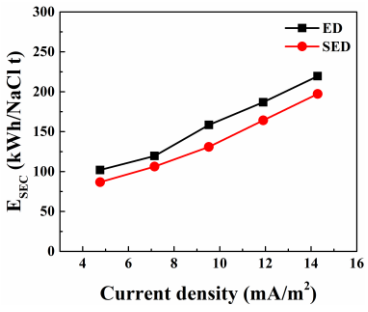

Image 3. Energy consumption of ED and SED.

4. Conclusions - Overall, the SED had a better performance in terms of current efficiency, energy consumption as well as $CaSO_4$ scaling resistance for RO brine treatment in hybrid electrodialysis-crystallization systems.