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Box–Behnken multi-response modeling and optimizing of brackish water reverse osmosis brine treatment using electrodialysis reversal with tortuous flow path

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ABSTRACT

One of the most important challenges of drinking water production using reverse osmosis (RO) is the management of the concentrated brine because of its large volume. Electrodialysis reversal (EDR) technology has the potential to be integrated with RO process to treat the RO brine stream and increase the water recovery of the hybrid treatment process. In this study, we treated brine wastewater from brackish water RO plant using an EDR stack with tortuous flow path. We designed the experiments utilizing the Box–Behnken method which was applied for modeling and optimization. We modeled the EDR energy consumption, desalination efficiency, ion flux as a function of voltage, feed flow rate, and initial feed electrical conductivity as main factors. The obtained correlations between the input and output variables were evaluated by different statistics tools. We also maximized the ion flux and desalination efficiency while minimizing the energy consumption using multi-response optimization methodology. The optimum values for applied voltage, flow rate, and initial conductivity were founded to be 7.7 V, 25 mL/min, and 13,000 μS/cm, respectively. At the optimal conditions, the desalination efficiency, ion flux and energy consumption were 8.69%, 15.25 mg/m²·s, and 0.81 Wh/L, respectively, which were very close to the predicted values.

Keywords: Electrodialysis reversal; Brackish water reverse osmosis; Box–Behnken; Energy consumption

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