Study on the desalination of high hardness water by electrodeionization reversal

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ABSTRACT

In this study, the simultaneous removal of cationic ions (Ca$^{2+}$, Mg$^{2+}$, Na$^+$, and K$^+$) from synthetic aqueous solutions using electrodeionization reversal (EDIR) was investigated. Under the condition of relatively high-concentration influent, characteristic curves of $V$–$I$ and $R$–$I$ were plotted at first and the polarity reversal period of 60 min or shorter was determined based on the resistance–time ($R$–$T$) relationship. Effects of various operation parameters including dilute flow rates (15, 30, 60, and 90 mL min$^{-1}$) and cation–anion resin volume ratios (3:7, 4.7:5.3, and 7:3) were studied, respectively. The experimental results showed that the operating current of 0.85 A, dilute flow rate of 30 mL min$^{-1}$, and cation–anion volume ratio of 4.7:5.3 were optimal for the process performance. The average removal efficiencies of cations were more than 88% (i.e. 93.12–94.56% for Ca$^{2+}$, 96.21–97.14% for Mg$^{2+}$, 89.11–90.76% for Na$^+$, and 92.99–95.35% for K$^+$) after three repeated experiments without membrane scaling. The transport of cations through ion exchange resins was evaluated in relation to hydrated ionic radius and ionic valence. Due to various affinities of cations to the resins, the migration of divalent ions was more enhanced compared to that of monovalent ions. This study would be helpful for applying EDIR process in the treatment of high-concentration water desalination.

Keywords: Electrodeionization process; Cation ions; Polarity reversal; Water desalination; Scale; Ion migration

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