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# Boron removal from dual-staged seawater nanofiltration permeate by electrodialysis

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**ABSTRACT**

The dual-staged nanofiltration to desalinate seawater is being proposed. The promising energy consumption, much lower than for RO seawater desalination, is reported. However, further reduction in boron is needed. In the authors' opinion, since the salinity of the second stage NF permeate is rather low, the easiest way to remove boron is to transfer it through an ion-exchange membrane (electrodialysis, ED). The relatively deep demineralization necessity is a shortcoming in the boron removal electrodialysis process, but ED seems to be privileged, since under these conditions boron (most likely borate) with its low mobility has to compete with small $Cl^-$ content only. In order to determine the applicability of the electrodialysis for boron removal from dual-staged nanofiltration the set of laboratory measurements was conducted. The simulated dual-staged nanofiltration permeate composition was as follows (mg/L): $Mg^{2+}$ — 0.2; $Ca^{2+}$ — 0.1; $Na^+$ — 92; $Cl^-$ — 117; $SO_4^{2-}$ — 0.2; B — 2.4. An ED unit, equipped with AMX and CMX Neosepta (Tokuyama Co.) membranes and 0.4 mm membrane-to-membrane distance, was applied. It was found that boron transport might be enhanced by high ED concentrate pH value, probably due to hydroxide ion back diffusion. Thus, despite the relatively low mean ED diluate pH, hydroxide ion content in the layer adjacent to the membrane is high enough to ensure ionization of boron species. The ED process was carried out to decrease the B content down to 0.4 mg/L. At the same time, the diluate was almost completely deionized to ca. 1 mg/L level of $Cl^-$. The boron current efficiency reached 30% and boron flux across membrane 40 μg/cm$^2$·h. The energy consumption found was as low as 0.25 kWh/m$^3$, at the promising unit cost equal to \$0.098/m$^3$.

*Keywords*: Dual-staged seawater NF permeate; Boron removal; Electrodialysis

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