Desalination using Pulsed Potential Capacitive Deionization

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This work addresses the water desalination using capacitive deionization (CDI) technology. CDI is an electrochemical process that operates by adsorbing ions in the double layer formed at the electrode-solution interface by applying a potential difference between the electrodes. It is therefore a low pressure process of deionization that has possibility of directly competing with reverse osmosis or distillation as a means of delivering waters free of ions at reduced cost and operating conditions (Anderson *et al.*, 2010). During the electrosorption cycle, cations and anions in solution are sequestered in the double layer of the negatively and positively charged electrodes. During regeneration, part of the electricity can be recovered since the electrode acts as a capacitor. A schematic of how this process works is shown in Figure 1.

In this work, we studied the effect of pulsed potential (PP) operation on the NaCl removal from aqueous solutions. The results of electrosorption were compared in terms of Kinetics, Coulombic Efficiency and Specific Energy Consumption.

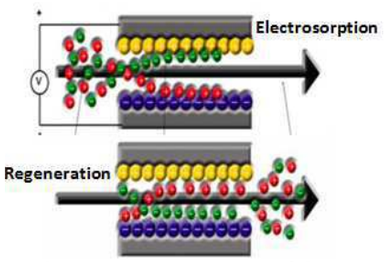

Figure 1. Schematic representation of the CDI process.

Figure 2 shows a schematic view of the CDI cell. Two pieces of 4.3 cm x 6.2 cm Hollingsworth & Voss carbon cloth (6) separated by a plastic mesh (4) worked as anode (2) and cathode (5) during the electrosorption cycle. The electric contact was made using titanium sheets (1). Gaskets were used to avoid leaking (3). The cathodic potential was measured using a saturated calomel electrode (SCE) (7). The potential pulses were generated by a potentiostat. The regeneration was performed applying +0.4 V during 3 minutes. The electrolyte was 30 mL of 300 mg/L NaCl.

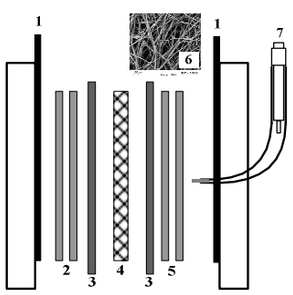

Figure 2. Schematic view of the CDI cell.

The concentration depletion was followed by measuring the electrolyte conductivity.

The idea for pulsing the potential is represented in Figure 3. We expected that during a short time in which the process is kept at positive or negative potentials the released ion could be pumped to the interior of the pores, reaching adsorption sites that were not accessible during the potentiostatic (CP) operation.

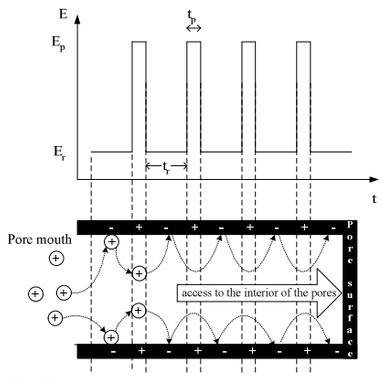

Figure 3. Schematic representation of the expected electrosorption process applying pulsed potential.

The results showed that by applying E_r = -0.8 V and pulsating to less negative potentials (-0.4 V, -0.2 V, and 0.0 V) the NaCl removal is inferior to that observed by applying a constant potential of -0.8 V. In terms of Coulombic Efficiency and Specific Energy Consumption, the pulsed mode also did not show any process improvement.

References

Anderson M.A., Cudero A.L., Palma J. Electrochimica Acta 55, 3845-3856, 2010.