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Comparison of Adsorption Properties of Different Configurations of CDI Cells

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This study aims to investigate the influence of different configurations of capacitive deionisation (CDI) cells on desalination performance. Based on the modified Donnan model, a three-dimensional transient model of a CDI desalination unit considering the coupling of solution flow, charge transport and electric field and potential was established, and the entire adsorption process was simulated. After conducting experiments to verify the accuracy of the model, four CDI units with different architectures were set first, after which the flow state of the solution in the four CDI units were compared, along with the influence on the desalination performances of the CDI units. Finally, the influences of different inlet velocities on the desalination performances of the CDI units were compared and analysed. Simulation results reveal the following: (1) if the boundary conditions are the same, compared with the plate-inflow/outflow CDI unit, the middle hole of the plate flows into the two-hole outflow CDI unit, the flow from the middle of the square plate to the surrounding outflow CDI unit and the flow from the middle of the disk to the surrounding outflow CDI unit reduced the average flow velocities of the solutions in the flow passage to 34.04%, 16.88%, and 15.96%, respectively. This also resulted in the corresponding increase in the retention time of the solution in the flow passage by 40%, 44.52%, and 50.95%, resulting in better desalination performance than that of the plate-inflow/outflow CDI unit. (2) Compared with the three other types of CDI units, the one with middle holes flowing in and out at both ends of the plate generates a 0 m/s solution flow rate at the four corners, which cannot easily flow out, thus reducing the desalination performance of the CDI unit. (3) Apart from the inlet velocity boundary condition, all other boundary conditions are the same. Thus, improving the inlet flow rate can help transform the flow around the square plate into a middle- type CDI unit, and the disc into the flow around the CDI unit can effectively reduce desalination and lessen the impact of inlet velocity increase. This can also reduce the CDI unit desalination performance of less than flat CDI unit and flow type and transform a flat-type hole into two holes in the CDI unit.

Keywords: Capacitive deionisation (CDI); MD model; fluid distribution; three-dimensional transient model; numerical simulation.

FULL TEXT