Energy Recovery in Parallel Capacitive Deionization Operations

James Landon, Xin Gao, James K. Neathery, and Kunlei Liu
Center for Applied Energy Research
University of Kentucky
2540 Research Park Drive
Lexington, KY

The use of high surface area carbon materials for capacitive deionization (CDI) holds promise as an alternative water desalination process. CDI has been touted as having minimum energy requirements significantly below that of current separation schemes such as reverse osmosis for desalinating brackish water[1]. One of the added benefits of this process is the possibility of energy recovery. However, the use of parallel CDI operations has received little attention. In this work, the use of parallel CDI cells for desalination is examined including the effect of the initial applied potential on the subsequent electrosorption capacities. Laboratory steps used to examine this process are shown in Figure 1.

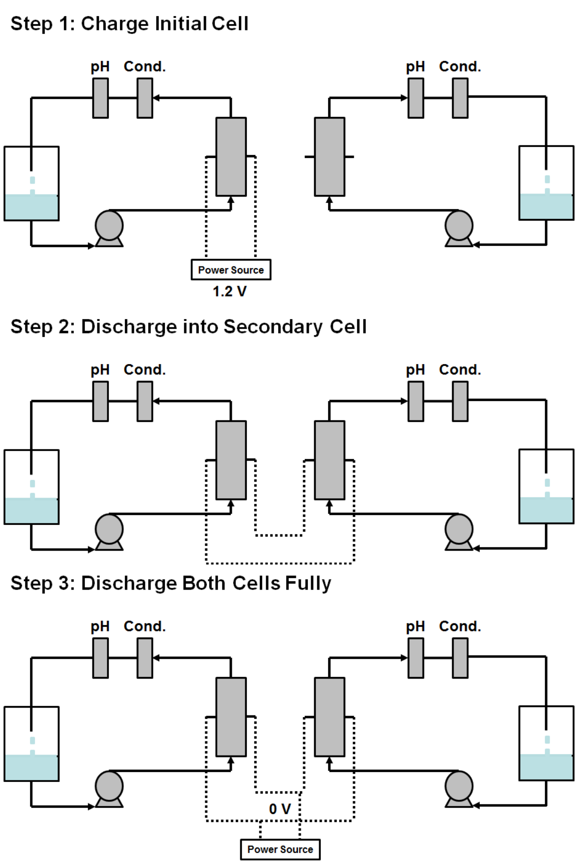

Figure 1. Parallel capacitive deionization processes investigated using this 3 step process

The primary CDI cell is initially charged using an applied potential of 1.2 V for one hour. Current, pH, and conductivity are tracked over time. In the second step, the primary cell is directly connected to a secondary cell. The secondary cell deionizes a separate stream using only the energy supplied from the primary cell. Finally, both cells are short-circuited, allowing the solution to return to its original conductivity.

Current, conductivity, and pH are tracked over the life of the experiment. Shown in Figure 2 is the current response for both the primary and the secondary cells corresponding to each experimental step. Applied potentials of 1.2, 1.4, and 1.6 V were used to initially charge the primary cell in an effort to determine the direct energy recovery from the primary cell as a functional of the initial applied potential.

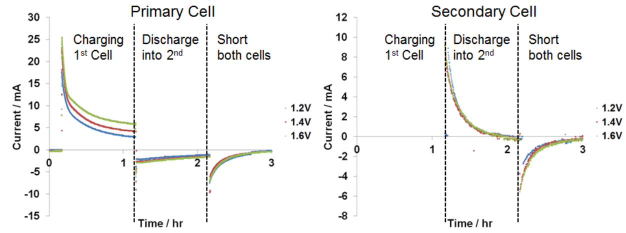

Figure 2. Charge-discharge curves for both the primary and secondary cells

Distinct charging-discharging curves are produced for both the primary and the secondary cells with initial charging curves increasing at higher applied potentials, as expected.

Shown in Figure 3 are the conductivity curves for both the primary and secondary cells. Significant energy recovery and electrosorption capacity is possible by directly utilizing the energy stored in the primary CDI cell. Capacities over 0.5 mg/g of carbon xerogel will be shown in the secondary cell without the use of an external power source beyond the energy stored in the primary cell.

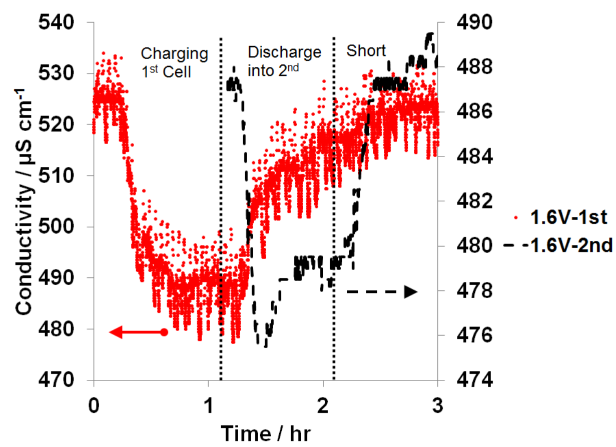

Figure 3. Successful deionization using energy stored in a CDI cell is shown here with an initial applied potential of 1.6 V in 500 ml of a 0.26 ppt NaCl solution

The use of parallel CDI processes offers the possibility of drastically lowering energy requirements for desalination activities. CDI is already the most energy efficient method for desalinating brackish water streams, but the addition of energy regeneration will enable the desalination of more concentrated waste streams.

Acknowledgements
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References

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