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Capacitive Charging and Desalination with Porous Electrodes
HOWARD HU, MENGYING LI, HAIM BAU, University of Pennsylvania — Electrochemical capacitors (ECs) are attractive storage devices with many advantages over traditional batteries. In contrast to batteries, ECs store energy in the electric double layer and do not undergo electrochemical reactions during charging and discharging. In this work, we examine the charging/discharging process of an EC cell consisting of a conductive, granular medium confined between two parallel, current collecting, electrodes. The granular particles are porous, assembled by aggregation, and saturated with an electrolyte solution. They are separated into two compartments with an ion-permeable, electrically insulating membrane. The Debye screening length around and within porous particles is small compared to the characteristic size of the pores. We will present a mathematical model based on Poisson-Nernst-Planck equations to describe the charging/discharging process in the EC cell. Using this model, the ion distribution and potential variation within the cell are solved numerically as functions of time when the current collecting electrodes are subjected to a step change and to time-periodic alternations in electrodes' potentials. The same model can be also used for potential desalination applications.

Howard Hu
University of Pennsylvania

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