Numerical analysis on charged nano-pores for ion exchange membrane (IEM) application

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Increasing attention has been paid to nano-pore membranes for ion exchange applications. Numerous studies showed that the ion transport characteristics in nano-channels are strongly influenced by electrolyte concentration as well as surface charge density on channel walls. Previously, we discovered the selective ion diffusivity through charged nano-pore membranes decreased with an increase in electrolyte concentration due to the steep decay of electrical potential in the pore. In this study, we conducted numerical analyses investigating ion transport properties in cylindrical charged nano-channels for various electrolyte concentration. Poisson and Nernst-Planck equations were solved to calculate the electrical potential and ion distribution. For 3 nm pores with charge density of 50 mC/m^2, the transport numbers are evaluated as 0.91 and 0.85 at concentrations of 35 and 70 g NaCl/L, respectively. The transport number also decreased with an increase in pore size. However, the 20 nm pore membrane maintained ion exchange charateristics with transport numbers greater than 0.72 at the concentration of 35 g NaCl/L.