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Effect of pH-Dependent Surface Charge on the Electroosmotic Flow through Nanochannel

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Abstract : In this article, we have studied the effect of pH-regulated surface charge on the electroosmotic flow (EOF) through nanochannel filled with binary symmetric electrolyte solution. The channel wall possesses either an acidic or a basic functional group. Going beyond the widely employed Debye-Huckel linearization, we develop a mathematical model based on Nernst-Planck equation for the charged species, Poisson equation for the induced potential, Stokes equation for fluid flow. A finite volume based numerical algorithm is adopted to study the effect of key parameters on the EOF. We have computed the coupled governing equations through the finite volume method and our results found to be in good agreement with the analytical solution obtained from the corresponding linear model based on low surface charge condition or strong electrolyte solution. The influence of the surface charge density, reaction constant of the functional groups, bulk pH, and concentration of the electrolyte solution on the overall flow rate is studied extensively. We find the effect of surface charge diminishes with the increase in electrolyte concentration. In addition for strong electrolyte, the surface charge becomes independent of pH due to complete dissociation of the functional groups.

Keywords : electroosmosis, finite volume method, functional group, surface charge
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