Electrokinetic Microflow Analysis based on Nernst-Planck Approach for the Case of Electrolyte Fluids

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The motion of electrolyte fluid flow in a charged micochannel can be obtained by solving the Navier-Stokes equation coupled with a Poisson-Boltzmann field. The electric current is a sum of the streaming current and the conduction current obtained by the Nernst-Planck equation. Many previous studies dealt with well-characterized channels such as and cylindrical geometry. However, most microfluidic devices frequently require more complicated geometry. This presentation devotes to the microflow analysis in the conical channel having either divergent or convergent flows. It has advantage in applications to micro diffuser, valveless micro pump, and single molecule detection, and it can be found in both the asymmetric membrane pore and the living body. A method of multi-layer is applied here in order to compute a rigorous flow-induced streaming potential and an apparent viscosity. We obtain general trends concerning a dependency of the correction ratio relative to the Helmholtz-Smoluchowski principle upon both the channel radius and the zeta potential. Regarding the effect of channel geometry, the correction ratio increases with increasing the divergent angle, whereas the electroviscous effect decreases. This results from the main contribution of increased channel radius.