Extension of the Helmholtz-Smoluchowski velocity to the hydrophobic microchannels with velocity slip

손희상, 김태원, 박흥목*
서강대학교 화공생명공학과
(hmpark@sogang.ac.kr*)

Electrokinetic flows through hydrophobic microchannels experience velocity slip at the microchannel wall, which affects volumetric flow rate and solute retention time. The usual method of predicting the volumetric ow rate and velocity profile for hydrophobic microchannels is to solve the Navier-Stokes equation and the Poisson-Boltzmann equation for the electric potential with the boundary condition of velocity slip expressed by the Navier slip coefficient, which is computationally demanding and defies analytic solutions. In the present investigation, we have devised a simple method of predicting the velocity profiles and volumetric ow rates of electrokinetic flows by extending the concept of the Helmholtz-Smoluchowski velocity to microchannels with Navier slip. The extended Helmholtz-Smoluchowski velocity is simple to use and yields accurate results as compared to the exact solutions. Employing the extended Helmholtz-Smoluchowski velocity, the analytic expressions for volumetric ow rate and velocity prole for electrokinetic ows through rectangular microchannels with Navier slip have been obtained at high values of zeta potential. The range of validity of the extended Helmholtz-Smoluchowski velocity is also investigated.