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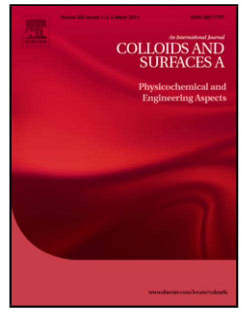

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Electroosmotic flow around a dielectric uncharged particle by considering the dielectric decrement effects

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Abstract

We consider the electroosmotic flow (EOF) around a chemically inert uncharged dielectric particle under an applied electric field. In presence of an applied external electric field, a dielectric particle could be polarized to create an inhomogeneous ζ-potential. The electrolyte permittivity is considered to vary with the ionic concentration. The existing studies consider either a perfectly conducting particle or dielectric particles under a thin Debye layer assumption. In the present case, the induced EOF is not only influenced by the applied electric field but also with the dielectric permittivity constant of the particle and Debye length. We have analyzed the EOF without invoking a thin layer or weak applied field assumptions. The governing nonlinear electrokinetic equations are solved numerically. The close agreement of the present computed solutions with the existing asymptotic analysis for limiting cases such as thin Debye layer for a dielectric particle and a conducting particle is encouraging. The surface conductivity, measured by the Dukhin number, found to become larger as the particle dielectric permittivity grows. The Dukhin number has a nonlinear dependence on the applied electric field. The dielectric decrement effects on the EOF has been addressed in the present analysis. It creates a reduction in the EOF around the particle. Our results show that when the Debye length is on the order of the particle size, the dependence of EOF on the applied electric field varies with the dielectric permittivity constant of the particle. However, a quadratic dependence of EOF on the applied field strength occurs at a thin Debye layer. Reduction in the Debye length creates an enhanced induced EOF.

Keywords: Dielectric colloid, Dielectric decrement, Induced-charge electroosmosis, Numerical solution, Vortices

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