## ABSTRACT

Chapter-1 is introductory. Migration of charged /uncharged particle upon influence of hydrodynamical flow and electroosmosis has been studied in Chapter-2 (Section I and II). Section-I deals with the migration of a colloidal particle at an arbitrary velocity under the influence of an external electric field in an electrolyte solution. The effect of nonlinear convection on the polarization of the electric double layer and ion distribution near the particle is analyzed. In Section-II, mixed convective heat transfer around an uncharged heated or cooled sphere is analyzed for a wide range of Richardson number and Reynolds number.

Migration of a positively charged spherical polyelectrolyte in extent of electrolyte solution has been studied extensively in Chapter-3 and 4. The permeability of the particle enables the electroosmotic flow to penetrate the particle, which causes the Debye layer polarization (DLP) effect. The penetration of counterions inside the particle causes a neutralization of particle charges, which reduces the electric force exerted on the particle. The distribution of counterions, net charge density and the effective volume charge density of the aggregate is evaluated. The effect of nonlinear convection on hydrodynamic drag and electrostatic force experienced by the charged porous aggregate either in electrophoresis or migrating at an arbitrary speed are analyzed.

Chapter-5 presents the numerical study on analyte preconcentration by isotachophoresis (ITP) for both peak and plateau mode. Our numerical algorithm is based on a finite volume method along with a higher-order upwind scheme, QUICK. In peak mode ITP, the focused sample concentration estimated by the Kohlrausch's regulating function (KRF) overpredicts the computed solution. Depending on the mobility ratio in a peak mode ITP at steady state, the sample ion distribution may show asymmetry.

The dispersion on the transition zone due to mismatch of electroosmotic slip velocity of electrolytes is analyzed in Chapter-6. The dispersion of the ITP interface depends on the local pressure gradient. Our results show that the 1-D Taylor-Aris model is suitable to predict the dispersed ITP when the average convection speed of electrolytes is in the order of the ideal ITP speed.

A particular mode of ITP is considered in Chapter-7, which employs a pressure-driven flow opposite to the sample electromigration direction in order to anchor a sample zone at a specific position along a channel or capillary. The imposed Poiseuille flow profile leads to a significant dispersion of the sample zone. The impact of convective dispersion is characterized by the area-averaged width of a sample zone. The 1-D Taylor-Aris model is found to be in good agreement with the finite-volume calculations.

*Keywords*: Electrophoresis; Advective flow; Electrophoresis; Double Layer Polarization effect; Isotachophoresis; Interfaces; Electrophoretic mobility; Peak and Plateau mode; Numerical solution; QUICK Scheme.