459f Solution of the Poisson-Boltzmann Equation under Non-Isothermal Conditions and Its Effects on Electroosmotic Velocity Predictions in a Rectangular Geometry

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The appropriate prediction of electroosmotic velocity profiles is key factor on the study of electrokinetic processes, such as electro-assisted drug delivery, micro-electrophoretic separations, soil remediation, and material processing just to name a few. To succeed on this task, more accurate predictions of the electrostatic potential are needed. In a recent contribution, Oyanader and Arce* proposed a novel and simpler solution of the complete Poisson-Boltzmann equation for systems where the electrostatic potential is not affected by non isothermal conditions. On this contribution, the analysis previously reported by Oyanader and Arce has been extended to those cases where temperature profiles developed across a rectangular batch cell cannot be neglected in the prediction of electrostatic potentials. In particular, the application of values of electrical field that will promote a temperature gradient inside the system leads to a situation where the electroosmosis alone may promote distinct flow regimes.

In this contribution, the role of asymmetrical conditions of zeta-potential and wall temperature is also analyzed. By using the generalized Robin boundary conditions for the heat transfer in a rectangular bath cell, it has been possible to identify clearly conditions under which the velocity field will depend crucially from the Joule heating generation. The behavior is intimately tied to the imposed asymmetrical conditions over the system. Several numerical examples will illustrate the trends.

(*) Oyanader, M., Arce, P., "A New and Simpler Approach for the Solution of the Electrostatic Potential Differential Equation. Enhanced Solution for Planar, Cylindrical and Annular Geometries," Journal of Colloid and Interface Science, 2005, 284, 315.