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Note on the Nonlinear Electrokinetic Effects in Mircochannel Flow: Exact Analytical Solutions for Sinh-Poisson Equation ALAN CHENG HOU TSANG, KWOK WING CHOW, Department of Mechanical Engineering, The University of Hong Kong, Hong Kong, China — Electrokinectic effects are important phenomena for fluid flow in microchannels, especially in mechanical systems involving movable micromechanical devices. Electrokinectic effects arise from electric double layer, which is a layer of charges attached to the dielectric surfaces as a result of the interaction of charges between ionized solution and dielectric surfaces. Electric potential inside the flow field is governed by the nonlinear Poisson-Boltzmann equation. Owing to the difficulty in solving the nonlinear equation, Debye - Hückel approximation, having an assumption of small electric potential, is a common approach to solve the linearized problem. In the present work, exact analytical expressions are obtained for the fully nonlinear sinh - Poisson equation without invoking the linear approximation. These solutions give insight on treating flow problems when Debye - Hückel approximation does not hold. Selected examples of solutions for a rectangular cell with zero homogenous boundary conditions applied on three wall surfaces are used for comparisons between the fully nonlinear and the linearized cases. Significant discrepancies are observed if the potential is not small, hence the present nonlinear theory is essential to better describe the physics involved.

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