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Area Averaging Analysis of Electroosmosis and Electro migration in a Rectangular Cell

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The use of mathematical models for predicting the concentration gradient of a molar species under electrophoretic and electroosmotic forces has been exploited in a variety of applications over recent years. Some of these uses include revising methods for removing harmful ions during water desalination, improving the efficiency of electrokinetic remediation of soil pollutants, and accurately modeling certain drug delivery methods in the biomedical field. Many existing models, however, are only suited for very narrow applications within these fields. They are rooted primarily in data analysis rather than the concrete equations that govern the phenomena at play. While certainly beneficial, these existing models fail at being flexible enough to account for multiple parameter changes, making them less widely applicable. This contribution aims to provide an accurate generalized mathematical model for the concentration gradient of a molar species undergoing electrophoretic and electroosmotic forces in a rectangular channel. This is accomplished by coupling models for a species' electrostatic potential and velocity profile to produce an accurate concentration profile. More specifically, the model relies on solutions to various fluid mechanics equations such as the Poisson-Boltzmann equation, the Navier Stokes equation, and the molar species continuity equation. Uniquely, the model incorporates factors such as the fluid's diffusivity, susceptibility, and electrostatic potential as variable parameters rather than fixed constants. The study is particularly novel in that it leverages area averaging techniques to solve the molar species continuity equation in this context. Furthermore, this study presents an analysis of the working model and includes descriptions of the most useful parameter configurations. For instance, the model shows that, for highly convective systems, a

species is highly concentrated in the center of the channel. Other such findings are presented, and concluding remarks are given to outline scientific impact and suggestions for further research.