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Simulation of highly non-linear electrokinetics using a weak formulation GAURAV SONI, TODD SQUIRES, CARL MEINHART, University of California Santa Barbara — In most electrokinetic simulations, the electrical double layer is modeled as a boundary condition using a linear capacitance model. However, the linear model is valid only for very low zeta potentials ζ and thus does not predict correct results for experimental conditions involving high ζ. We have formulated a highly nonlinear but very stable double layer boundary model which allows us to investigate electrokinetic phenomena even at very high ζ. The model is a time dependent partial differential equation for the double layer surface charge density $\boldsymbol{q}$, establishing a balance between accumulation and normal plus lateral fluxes of the charge. We first make this model stable by changing the dependent variable from $\boldsymbol{q}$ to ζ. In other words, we solve the PDE for ζ instead of $\boldsymbol{q}$. A nonlinear capacitance formula is used for changing the variables. Since the magnitudes of zeta potential are limited by geometry and applied voltage, the PDE becomes well behaved. Then we also transform the surface conduction term in such a way that it behaves like a diffusion term and thus makes our solution much more stable without changing the essential physics. We have simulated the effects of nonlinear capacitance and surface conduction at high applied voltages and compared our slip velocity results with experimental data. Our model reduces the existing discrepancy between the numerical and experimental results significantly.

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