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Oscillatory Electroosmotic Flow of Power-Law Fluids in a Microchannel

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Abstract : The Oscillatory electroosmotic flow (OEOF) in power law fluids through a microchannel is studied numerically. A time-dependent external electric field (AC) is suddenly imposed at the ends of the microchannel which induces the fluid motion. The continuity and momentum equations in the x and y direction for the flow field were simplified in the limit of the lubrication approximation theory (LAT), and then solved using a numerical scheme. The solution of the electric potential is based on the Debye-H¨uckel approximation which suggest that the surface potential is small,say, smaller than 0.025V and for a symmetric (z : z) electrolyte. Our results suggest that the velocity profiles across the channel-width are controlled by the following dimensionless parameters: the angular Reynolds number, Reω, the electrokinetic parameter, ¯κ, defined as the ratio of the characteristic length scale to the Debye length, the parameter λ which represents the ratio of the Helmholtz-Smoluchowski velocity to the characteristic length scale and the flow behavior index, n. Also, the results reveal that the velocity profiles become more and more non-uniform across the channel-width as the Reω and ¯κ are increased, so oscillatory OEOF can be really useful in micro-fluidic devices such as micro-mixers.

Keywords : low zeta potentials, non-newtonian, oscillatory electroosmotic flow, power-law model
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