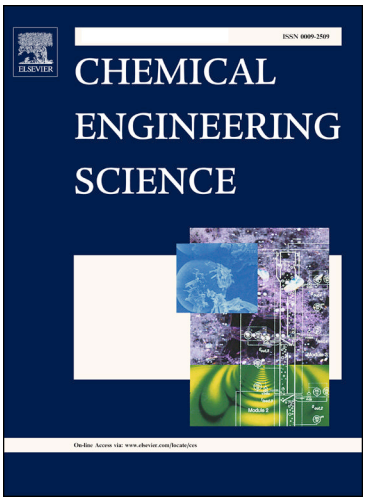

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A.K. Nayak, A. Haque, B. Weigand

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Analysis of electroosmotic flow and Joule heating effect in a hydrophobic channel

A. K. Nayak[a,*], A. Haque[a], B. Weigand[b,**]

[a] *Department of Mathematics, Indian Institute of Technology Rorkee, Roorkee, Uttarakhand, 247667, India*
[b] *Institut für Thermodynamik der Luft- und Raumfahrt, Pfaffenwaldring 31 70569 Stuttgart*

Abstract

In this paper, a mathematical model has been developed to analyze the fluid flow and heat transfer effect in a hydrophobic microchannel filled with a power law fluid. The effects of Joule heating, thermal radiation and velocity slip boundary conditions are analyzed by considering different slip parameters, EDL thickness, pressure gradient and flow behavior indices. The analytical expression for fluid flow and heat transfer have been derived in terms of the flow governing parameters based on the Debye-Huckel linearizing principle. Depending on the experimental existing flow behavior index, the analytical solutions are obtained in closed form where as numerical results are presented for general parametric values. The impact of slip velocity parameters in terms of a flow enhancement factor (E_{fb}), is studied to obtain the average flow velocity variation in a hydrophobic microchannel compared to a plane microchannel. The pressure assisted flow for pseudo-plastic (shear thinning) fluids achieve maximum velocity as compared to dilatant (shear thickening) fluids. The study finds that increase in thermal radiation minimizes heat transfer rate close to the hydrophobic wall, plays a vital role for the therapeutic treatment of hyperthermia (to understand the effect of heat transfer due to electric potential). It is also observed that Joule heating parameters enhance the heat transfer rate for classical Newtonian/non-Newtonian fluids for decrease in power indices and pressure gradient.

Keywords: Electroosmotic flow, Power-law fluid, Hydrophobic wall, Joule heating.

*Dr. A. K. Nayak
**B. Weigand
Email addresses: ameeyakumar@gmail.com (A. K. Nayak), bernhard.weigand@itlr.uni-stuttgart.de (B. Weigand)