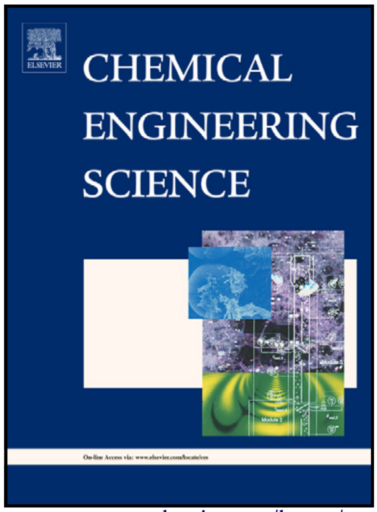

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Effect of temperature jump on forced convective transport of nanofluids in the continuum flow and slip flow regimes

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Abstract

In this paper, an attempt has been made to extend the modified Buongiorno model of nanofluids originally proposed by Yang et al. (2013a) from the continuum flow regime to the slip flow regime, in consideration of the effects of both velocity slip and temperature jump near the wall. Since the use of velocity slip boundary condition has been extensively applied and well-understood in the literature, the focus of the present study is on the temperature jump boundary condition. Based on the theoretical results obtained using the Runge-Kutta-Gill method, one can conclude that the temperature jump near the wall has more significant influence on the dimensionless temperature than the dimensionless velocity and volume fraction of nanoparticles in the cross section of a channel. Moreover, the neglect of temperature jump leads to the overestimation of Nusselt number based on the bulk mean nanofluid thermal conductivity Nu_B, especially in the slip flow regime. Subsequently, two key parameters of nanofluids, namely Knudsen number Kn and the ratio of Brownian and thermophoretic diffusivities N_{BT}, were discussed in order to investigate their effects on the fluid flow and heat transfer characteristics of nanofluids. The results indicated that the increase of Kn not only enhances heat transfer performance, but also reduces pressure drop, demonstrating the promising prospect of nanofluids applications in micro and nano-scales devices. Furthermore, it is found that the maximum Nu_B can be achieved when Kn is around 0.07 or when N_{BT} is around 0.5, which is useful for optimizing nanoparticles for practical applications.