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Flow and heat transfer in a microchannel partially filled with a microporous foam involving effects of flow inertia, flow/thermal slips, thermal non-equilibrium and thermal asymmetry

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A theoretical study of forced convection in a parallel-plate microchannel partially filled with a porous medium is performed based on the local thermal non-equilibrium (LTNE) model. The two walls sandwiching the channel are exposed to thermal asymmetry boundary conditions, and the flexible porous medium is not connected to the walls. Effects of flow inertia in porous medium, velocity jump at the porous/fluid interface, and flow slip and thermal slip at the solid/fluid interface are involved. Exact solutions are obtained for velocity and temperature in both porous medium region and fluid region. The flow heterogeneity coefficient defined for describing the nonuniform distribution of fluid flow is especially considered, and the effect of flow heterogeneity on heat transfer is revealed. The entropy generation analysis is performed for heat transfer and fluid friction irreversibilities in the channel partially filled with a porous medium. The benchmark solution provided in this work can be used for improving numerical scheme accuracy and validating similar research.

References

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