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Effect of local thermal non-equilibrium model on natural convection in a nanofluid-filled wavy-walled porous cavity containing inner solid cylinder
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Abstract

In the current work, the impacts of local thermal non-equilibrium model and Al₂O₃-water nanofluid on natural convection heat transfer in a porous cavity consisting of a bottom heated wavy wall and an inner solid cylinder are investigated. The Galerkin weighted residual finite element method is utilized to simulate the dimensionless governing equations of the fluid flow and heat transfer. The effects of different parameters including Darcy number ($10^{-6} \leq Da \leq 10^{-2}$), nanoparticle volume fraction ($0 \leq \phi \leq 0.04$), modified conductivity ratio ($0.01 \leq \gamma \leq 1000$), number of undulations ($1 \leq N \leq 4$) and the porosity of the medium ($0.2 \leq \epsilon \leq 0.8$) on the field of the flow and the heat transfer mechanisms are described. The Forchheimer-Brinkman-extended Darcy model along with the Boussinesq approximation are assumed to hold. A comprehensive validation of the present code is obtained by comparing the results with those of previous studies. The results show that all the mentioned parameters have significant impacts on the fluid flow and the temperature distributions. In addition, increasing the thermal conductivity of the nanoparticles leads to an increase in the rate of heat transfer for the nanofluid condition and reaches its maximum value at $\phi=0.04$. Considering high values of ϵ the average Nusselt number increases by the augmentation of ϕ while at low values of the porosity, the average Nusselt number decreases after reaching a peak. The results of this study are very useful for designing a porous heat exchanger. © 2019 Elsevier Ltd

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