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Conjugate natural convection of Al2O3–water nanofluid in a square cavity with a concentric solid insert using Buongiorno's two-phase model
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Abstract
The problem of conjugate natural convection of Al2O3–water nanofluid in a square cavity with concentric solid insert and isothermal corner boundaries using non-homogenous Buongiorno's two-phase model is studied numerically by the finite difference method. An isothermal heater is placed on the left bottom corner of the square cavity while the right top corner is maintained at a constant cold temperature. The remainder parts of the walls are kept adiabatic. Water-based nanofluids with Al2O3 nanoparticles are chosen for the investigation. The governing parameters of this study are the nanoparticle volume fraction ($0 \le \phi \le 0.04$), the Rayleigh number ($102 \le Ra \le 106$), thermal conductivity of the solid block (kw=0.28, 0.76, 1.95, 7 and 16) (epoxy: 0.28, brickwork: 0.76, granite: 1.95, solid rock: 7, stainless steel: 16) and dimensionless solid block thickness ($0.1 \le D \le 0.7$). Comparisons with previously experimental and numerical published works verify good agreement with the proposed method. Numerical results are presented graphically in the form of streamlines, isotherms and nanoparticles volume fraction as well as the average Nusselt number and fluid flow rate. The results show that the thermal conductivity ratio and solid block size are very good control parameters for an optimization of heat transfer inside the partially heated and cooled cavity. © 2017 Elsevier Ltd

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