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Alsabery, A.I., Chamkha, A.J., Saleh, H., Hashim, I.

Heatline visualization of conjugate natural convection in a square cavity filled with nanofluid with sinusoidal temperature variations on both horizontal walls

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Abstract
The problem of conjugate natural convection in a square cavity filled with a nanofluid with sinusoidal temperature variations on both horizontal walls is visualized by heatlines. Water-based nanofluids with Ag, Cu, Al2O3, or TiO2 nanoparticles are chosen for investigation. The governing equations together with the specified boundary conditions are solved numerically using the finite difference method over a wide range of Rayleigh number ($10^5 \leqslant Ra \leqslant 10^8$), nanoparticle volume fractions ($0 \leqslant \phi \leqslant 0.2$), phase deviations ($0 \leqslant \gamma \leqslant \pi$), amplitude ratios ($0 \leqslant \varepsilon \leqslant 1$), wall to nanofluid thermal conductivity ratios ($0.44 \leqslant Kr \leqslant 23.8$) and wall thickness to height ratios ($0 \leqslant S \leqslant 0.7$). Comparisons with previously published work verify good agreement with the proposed method. Detailed computational results for the influence of the various parameters on streamlines, heatlines, isotherms, and the overall heat transfer are shown graphically. It is found that the heat transfer rate is significantly enhanced by incrementing the solid wall thickness. Different values of the thermal conductivity ratio are shown to depict a variety of enhancements for the heat transfer rate. © 2016 Elsevier Ltd

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