Effects of a Sinusoidally Heated Left Wall on Natural Convection within a Superposed Cavity Filled with Composite Nanofluid-Porous Layers

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***Abstract*— Natural convection inside composite nanofluid-porous layers with a sinusoidal thermal boundary condition has been investigated using numerical techniques via the Galerkin finite element method. Two layering cases are considered in the vertical (case 1) and horizontal (case 2) directions of the nanofluid-porous layers. Sinusoidal heating is applied to the left wall of the enclosure while a uniform cold temperature is assumed at the right wall; the horizontal walls are kept insulated. The range of the selected parameters in the current study is presented for the Rayleigh number (Ra), $10^3 \leq Ra \leq 10^7$, the Darcy number (Da), $10^{-7} \leq Da \leq 1$, the porous layer thickness (S), $0.1 \leq S \leq 0.9$, the thermal conductivity ratio of porous/nanofluid layers (K_r), $0.1 \leq K_r \leq 100$, the thermal frequency (N), $1 \leq K_r \leq 7$, the thermal amplituid (A), $0.2 \leq A \leq 1$ and the nanoparticle volume fraction (ϕ), $\phi = 0.2$. The results show that the thinner porous layers can strongly enhance the local heat transfer. The rate of heat transfer increases with increasing the Rayleigh number and thermal amplitude, while it decreases with increasing the odd values of the thermal frequency (N). At the low values of the Darcy number, the rate of heat transfer is increased more in case 2 compared to case 1 when $K_r \geq 1$ for different values of A, N, and Ra. The low values of K_r have produced a higher heat transfer rates in case 1, compared to case 2 for different values of Rayleigh numbers.**