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Magneto-Hydrodynamic Mixed Convection of Water-Al2O3 Nanofluid in a Wavy Lid-Driven Cavity

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Abstract : This paper examines numerically the laminar steady magneto-hydrodynamic mixed convection flow and heat transfer in a wavy lid-driven cavity filled with water-Al2O3 nanofluid using FDM method. The left and right sidewalls of the cavity have a wavy geometry and are maintained at a cold and hot temperature, respectively. The top and bottom walls are considered flat and insulated while, the bottom wall moves from left to right direction with a uniform lid-driven velocity. A magnetic field is applied vertically downward on the bottom wall of the cavity. Based on the numerical results, the effects of the dominant parameters such as Rayleigh number, Hartmann number, solid volume fraction, and wavy wall geometry parameters are examined. The numerical results are obtained for Hartmann number varying as $0 \leq Ha \leq 0.6$, Rayleigh numbers varying as $103 \leq Ra \leq 105$, and the solid volume fractions varying as $0 \leq \varphi \leq 0.0003$. Comparisons with previously published numerical works on mixed convection in a nanofluid filled cavity are performed and good agreements between the results are observed. It is found that the flow circulation and mean Nusselt number decrease as the solid volume fraction and Hartmann number increase. Moreover, the convection enhances when the amplitude ratio of the wavy surface increases. The results also show that both the flow and thermal fields are significantly affected by the amplitude ratio (i.e., wave form) of the wavy wall.

Keywords : nanofluid, mixed convection, magnetic field, wavy cavity, lid-driven, SPH method
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