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MHD convective heat transfer in a discretely heated square cavity with conductive inner block using two-phase nanofluid model

(2018) *Scientific Reports*, 8 (1), art. no. 7410, . Cited 15 times.

Abstract

The problem of steady, laminar natural convection in a discretely heated and cooled square cavity filled by an alumina/water nanofluid with a centered heat-conducting solid block under the effects of inclined uniform magnetic field, Brownian diffusion and thermophoresis is studied numerically by using the finite difference method. Isothermal heaters and coolers are placed along the vertical walls and the bottom horizontal wall, while the upper horizontal wall is kept adiabatic. Water-based nanofluids with alumina nanoparticles are chosen for investigation. The governing parameters of this study are the Rayleigh number (103 ≤ Ra ≤ 106), the Hartmann number (0 ≤ Ha ≤ 50), thermal conductivity ratio (0.28 ≤ k w ≤ 16), centered solid block size (0.1 ≤ D ≤ 0.7) and the nanoparticles volume fraction (0 ≤ φ ≤ 0.04). The developed computational code is validated comprehensively using the grid independency test and numerical and experimental data of other authors. The obtained results reveal that the effects of the thermal conductivity ratio, centered solid block size and the nanoparticles volume fraction are non-linear for the heat transfer rate. Therefore, it is possible to find optimal parameters for the heat transfer enhancement in dependence on the considered system. Moreover, high values of the Rayleigh number and nanoparticles volume fraction characterize homogeneous distributions of nanoparticles inside the cavity. High concentration of nanoparticles can be found near the centered solid block where thermal plumes from the local heaters interact. © 2018 The Author(s).

2-s2.0-85046903349
Document Type: Article
Publication Stage: Final
Source: Scopus
Access Type: Open Access