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Journal of Magnetism and Magnetic Materials
Volume 586, 15 November 2023, 171175

Magnetohydrodynamic convection-entropy generation of a non-Newtonian nanofluid in a 3D chamber filled with a porous medium

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Highlights

- This paper presents numerical results of the buoyancy-driven flow of a nanofluid in a cavity in the presence of magnetic field.
- To encounter the non-Newtonian layer influence, the power-law model is considered.
- The solution of the governing equations is obtained by the Galerkin FEM method.
- The effects of geometrical parameters are discussed and illustrated.
- By simultaneously using non-Newtonian nanofluid and porous media, the heat exchange is positively affected.

Abstract

Magnetohydrodynamic (MHD) mixed convection in a 3D (three dimensional) lid-driven cavity loaded with a power-law nanofluid is examined. The bottom wavy wall is maintained at a hot temperature, while the upper lid is at a uniformly cold temperature. The vertical walls are kept in adiabatic conditions. The steady and three-dimensional flow of nanofluids is quantitatively studied utilizing thermophysical properties and the Galerkin Finite Element Method (GFEM). The findings were shown for a variety of Grashof numbers (Gr=10^3-10^5), Hartmann numbers (Ha=0–20), Reynolds numbers (Re=10–500), power-law indexes (n=0.8,1,1.6), and undulation numbers (N=1–4). The influence of the various parameters on flow, heat transfer, and entropy generation is illustrated by the streamlines, isotherms, and isentropic contours. Higher Re, γ, N, φ, and lower Ha enhance the heat transfer. Entropy generation is mostly due to heat transfer but also fluid-friction and magneto effects contribute. Also, the increase in Re from 50 to 500 gives an enhancement in Nu_{av} up to 87.5 %. Furthermore, the increase in power-law index (n) from 0.8 to 1 gives a reduction in Nusselt number up to 10.58 %.