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Investigation of the free convection of nanofluid flow in a wavy porous enclosure subjected to a magnetic field using the Galerkin finite element method

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Abstract

This paper provides a numerical simulation to explore natural convection and fluid flow in a three-dimensional wavy cubical enclosure subjected to a magnetic field along the z-axis. The main emphasis of this research is to discuss entropy generation inside a wavy porous cavity. Brinkman's extended non-Darcy flow model is utilized for studying the free convection in the permeable medium. The equations of the mathematical model were solved using Galerkin finite element method. Isotherms, streamlines, velocity profile, and variation of average Nusselt number are calculated for various values of Ra (10^3–10^6), Ha (0–100), and φ (0–0.08). The results show that the streamlines and isotherms increase with the increase of Darcy and Rayleigh numbers. Besides, entropy generation is sensitive to the values of Darcy number, Rayleigh number, Hartmann number, and the number of undulations. Besides, the variation of the Nusselt number is affected by the Rayleigh number and Darcy number. The highest Nusselt number can be obtained for a maximum number of undulations only at the small values of the Rayleigh number. Otherwise, this pattern will be changed in the opposite trend at large values of the Rayleigh number. At the highest values of Ra, increasing Ha from 0 to 100 decreased Nu_{avg} by 23%, while increasing Da from 10^{-5} to 10^{-2} enhanced it by 177%. Finally, it was found that the values of Be_{avg} are only being enhanced by only one parameter, namely the Hartmann number. The obtained results from the current non-Darcy flow model agree well with the available literature results.