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MHD mixed convection of nanofluid in a cubic cavity with a conductive partition for various nanoparticle shapes
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Abstract
Purpose: This paper aims to numerically examine the mixed convection of SiO 2 -water nanofluid flow in a three-dimensional (3D) cubic cavity with a conductive partition considering various shapes of the particles (spherical, cylindrical, blade, brick). The purpose is to analyze the effects of various pertinent parameters such as Richardson number (between 0.1 and 10), Hartmann number (between 0 and 10), solid nanoparticle volume fraction (between 0 and 0.04), particle shape (spherical, cylindrical, blade, brick) and different heights and lengths of the conductive partition on the fluid flow and heat transfer characteristics. Design/methodology/approach: The numerical simulation was performed by using Galerkin-weighted residual finite element method for various values of Richardson number, Hartmann number, solid nanoparticle volume fraction, particle shape (spherical, cylindrical, blade, brick) and different heights and lengths of the conductive partition. Two models for the average Nusselt number were proposed for nanofluids with spherical and cylindrical particle by using multi-layer feed-forward neural networks. Findings: It was observed that the average Nusselt number reduces for higher values of Richardson number and Hartmann number, while enhances for higher values of nanoparticle volume fraction. Among various types of particle shapes, blade ones perform the worst and cylindrical ones perform the best in terms of heat transfer enhancement, but this is not significant which is less than 3 per cent. The average Nusselt number deteriorates by about 6.53per cent for nanofluid at the highest volume fraction of spherical particle shapes, but it is 11.75per cent for the base fluid when Hartmann number is increased from 0 to 10. Conductive partition geometrical parameters (length and height) do not contribute to much to heat transfer process for the 3D cavity, except for the case when height of the partition reaches 0.8 times the height of the cubic cavity, the average Nusselt number value reduces by about 25per cent both for base fluid and for nanofluid when compared to case with cavity height which is 0.2 times the height of the cubic cavity. Originality/value: Based on the literature survey, a 3D configuration for MHD mixed convection of nanofluid flow in a cavity with a conductive partition considering the effects of various particle shapes has never been studied in the literature. This study is a first attempt to use a conductive partition with nanofluid of various particle shapes to affect the fluid flow and heat transfer characteristics in a 3D cubic cavity under the influence of magnetic field. Partial or all findings of this study could be used for the design and optimization of realistic 3D thermal configurations that are encountered in practice and some of the applications were already mentioned above. In this study, thermal performance of the system was obtained in terms of average heat transfer coefficient along the hot surface, and it is modeled with multi-layer feed-forward neural networks. © 2019, Emerald Publishing Limited.

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