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Editorial

Transport phenomena of nanofluids in cavities: current trends and applications

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Abstract This special issue encompasses the experimental and theoretical investigations on transport phenomena of nanofluids in cavities. The contributions are classified as follows: (1) nanofluid flow in square/rectangular cavities, (2) nanofluid flow in cavities with obstacles, (3) nanofluid flow in wavy enclosures, (4) nanofluid flow in trapezoidal/circular/annular cavities, and (5) nanofluid flow in enclosures.

1 Nanofluid flow in square/rectangular cavities

Selimefendigil et al. [1] numerically investigated the impact of magnetic field and inclined partition at the inlet on the cooling performance of double-jet impingement of an isothermal plate with two different shear-thinning nanofluids. They observed that the cooling performance and convective heat transfer of the double-slot jet impingement system could be significantly regulated through the shear-thinning type nanofluid, magnetic field, inclination of the partition at the inlet, and velocity ratio of the jets. Saha et al. [2] examined the impact of geometric shape on heat transfer characteristics within square and circular cavities filled with CuO-water nanofluid/water/air. The results revealed that higher heat transfer could be achieved through geometric modifications. For instance, when air was considered as a working medium, an approximately 22.21% enhancement in heat transfer was observed for positioning the cavity horizontally, and 24.11% heat transfer enhancement was observed with an inclined cavity. Ali et al. [3] carried out a numerical investigation to study the transport features of mixed convective Al_2O_3-Cu-H_2O hybrid nanoliquid flow within a rectangular enclosure. They observed that an increase in the amplitude ratio and hybrid nanoparticle volume fraction tended to increase the heat transfer rate. Venkatadri et al. [4] constructed a mathematical model to explore the influence of Hall currents on magnetohydrodynamic (MHD) radiative-convective flow within an enclosure. They found that the thermofluidic features were substantially modified by varying the Hall current and radiative effects. Further, for small buoyancy ratios, the magnetic field suppressed the natural convection, whereas the thermal convective flow was suppressed by the magnetic field with large buoyancy ratios. Abderrahmane et al. [5] utilized the Galerkin finite element technique to numerically scrutinize the influence of magnetic field on mixed convective flow within a three-dimensional cubic enclosure filled with phase-change material including nanoparticles. Two rotating cylinders were located inside the enclosure. The authors observed that the phase-shifting constraint of phase-change material, angular rotation of the cylinders, enclosure height, cylinder locations, and Hartman number significantly influenced the fluid flow within the enclosure. Umavathi [6] utilized the Southwell over-relaxation technique to study the natural convective flow of two immiscible liquids within an enclosure. The enclosure had two discrete regions which contained a nanofluid and permeable fluid. Results revealed that among the copper, diamond, and titanium oxide nanoparticles, suspending the diamond nanoparticles in water yielded the highest rate of heat transfer.

2 Nanofluid flow in cavities with obstacles

Abdulsahib et al. [7] numerically analysed the characteristics of natural convection flow of Al_2O_3-H_2O nanoliquid within an enclosure in the presence and absence of two inner adiabatic cylinders. The study demonstrated that the fluid velocity accelerated when the inner adiabatic cylinders were located in middle of the cavity. Further, the highest heat transfer rate was obtained with an inclination angle of $\pi/6$. Al-Amir et al. [8] numerically investigated the MHD forced convective carbon nanotube-water nanofluid flow in an enclosure which contained a stationary hexagonal solid body. They showed that the energy transmission was

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strongly regulated by the high-volume fraction of carbon nanotube nanoparticles and size of the hexagonal solid body within the cavity. Kanimozhi et al. [9] constructed a mathematical model to examine the influence of viscous dissipation on Ag-MgO-H_2O hybrid nanoliquid flow within a cylindrical annulus. A thin circular baffle was anchored to the inner cylinder. They observed that the velocity was strongly regulated by the size and location of the fin. Further, the volume fraction of the nanoparticles had a considerable impact on the rate of heat transfer. Job et al. [10] analysed the features of MHD mixed convective silver-alumina-water hybrid nanofluid flow inside an enclosure with a rotating cylinder. They observed that increasing the radius of the cylinder and diameter of the nanoparticles tended to enhance the flow circulation regions near the rotating cylinder. Further, the heat transfer rate and nanofluid temperature were increased with an increased cylinder radius and reduced nanoparticle diameters. Hassen et al. [11] carried out a numerical investigation to explore the characteristics of MWCNT-Fe_3O_4-thermal oil hybrid nanoliquid flow inside an enclosure with a hot obstacle. When the hot obstacle was moved from the bottom to the top of the enclosure, a more than 170% increase in the convective energy transmission on the cold wall was achieved. Khan et al. [12] studied the MHD Casson fluid flow inside a triangular enclosure which contained a cylindrical obstacle. The results demonstrated that the energy transmission inside the enclosure was highly regulated by varying the length of the heating element. Further, increasing the Casson parameter caused a reduction in the heat transfer rate.

3 Nanofluid flow in wavy enclosures

Mandal et al. [13] presented a mathematical model to analyse the hydrothermal characteristics of Al_2O_3-Cu-H_2O hybrid nanoliquid flow inside a non-Darcian porous wavy cavity. They observed that the energy transmission inside the cavity increased with an increase in the amplitude of the wavy wall. Fereidooni [14] explored the influence of fin number and size on free convection of TiO_2-water nanofluid flow within a wavy trash bin-shaped enclosure. The results revealed that the local entropy generation decreased and the average rate of heat transfer increased with an increase in the number of fins around the inner cylinder. Further, a 31% decrease in the mean rate of heat transfer was observed with an increase in the amplitude of the wavy wall from 0.05 to 0.1. Reddy and Panda [15] utilized the Galerkin finite element technique to analyse the characteristics of MHD Casson nanofluid flow inside a wavy trapezoidal enclosure. When the Hartmann number was high, the rate of heat transfer was strongly regulated by varying the nanoparticle volume fraction and the Casson parameter.

4 Nanofluid flow in trapezoidal/circular/annular cavities

Khan et al. [16] numerically analysed the features of mixed convective flow of an Al_2O_3-Cu-H_2O hybrid nanoliquid within a trapezoidal enclosure containing a triangular-shaped cold obstacle. They found that the rate of heat transfer was strongly controlled by the variations in nanoparticle volume fraction. Further, at the sharp edges of the obstacle, a higher local Nusselt number was observed. Geridonmez and Oztop [17] studied the impact of partial magnetic fields on free convective flow of MgO-Ag-H_2O hybrid nanoliquid inside an a trapezoidal enclosure. The results demonstrated that the buoyancy-driven flow was suppressed with an increase in the oblique cold wall inclination angle. Further, a 25.41% decrease in the rate of heat transfer was observed with a change in the inclination angle from 0 to $\pi/9$. Awasthi et al. [18] performed a temporal instability analysis of a nanoliquid layer in a circular cylindrical cavity. They found that the stability in the system was affected by the nanoparticle volume fraction. Swamy al. [19] performed an entropy generation analysis on nanoliquid flow in an annular cavity. They observed that the aspect ratio of the geometry had a considerable impact on the optimization of the thermal dissipation rate.

5 Nanofluid flow in enclosures

Yıldız al. [20] investigated the impact of various nanoparticles, base fluids, Reynolds numbers, and nanoparticle volume fractions on the pressure drop and energy transmission in an automotive radiator. They determined that, depending on the choice of nanoparticle, base fluid, nanoparticle volume fraction, and Reynolds number, the energy transmission could be improved from 3.2 to 45.9%. Further, the utilization of nanofluid significantly increased the pressure drop. Muhammad et al. [21] analysed the combustion flow in an intake manifold with two inlets and one outlet. The results revealed that high pressure due to combustion was observed near the outlet. Ahmed et al. [22] studied the flow of Cu-H_2O nanoliquid inside a porous enclosure with two wavy walls. A decrease in the Darcy coefficient from 10^{-2} to 10^{-5} led to an 80% reduction in the heat transfer rate. Al-Farhany et al. [23] constructed a mathematical model to demonstrate the influence of magnetic field on mixed convective Cu-H_2O nanoliquid flow in a horizontal channel attached to two open enclosures. They found that higher Hartmann number values resulted in decreased fluid velocity. Joe and Perumal

[24] numerically studied the characteristics of pumping power requirements, entropy generation, thermal energy distribution, and flow structures within a battery pack. They observed that the thermophysical properties of the nanoparticles had no impact on the pumping power requirements. Dutta and Elnaqeeb [25] conducted a numerical investigation to study the characteristics of MHD free convective flow of Cu-H_2O nanoliquid inside a rhombic enclosure. The results demonstrated that increasing the nanoparticle volume fraction led to a considerable increase in the mean heat transfer rate. Rahmoune et al. [26] constructed a mathematical model to examine the features of free convection flow of Al_2O_3-H_2O nanoliquid within a cavity. The results showed that the heat transfer was increased by suspending the Al_2O_3 nanoparticles in water.

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