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MHD mixed convection and irreversibility analysis of hybrid nanofluids in a partially heated lid-driven cavity chamfered from the bottom side

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Abstract

In this research, magneto-convection flow in the cavity problem driven by the lid is examined using computational fluid dynamics (CFD) techniques. To this effect, the cavity considered in this numerical study has two rounded corners and is partially heated from the bottom side and filled with Al_2O_3-Cu/water hybrid nanofluid (HBNF). Accordingly, a solver based on C++ object-oriented language has been developed under OpenFOAM® libraries to solve the mathematical governing equations. The numerical findings are thoroughly validated with other studies. To this end, different parameters analysis is adopted, which consists of Richardson numbers ($0.1 \leq Ri \leq 10$), Hartmann numbers ($0 \leq Ha \leq 100$), magnetic field angle ($0^{\circ} \leq \gamma \leq 90^{\circ}$), solid volume fraction ($0 \leq \phi \leq 0.04$), composition ratio ($25\ \% \leq Cu, Al_2O_3 \leq 75\%$), corners radius ($0.01 \leq R \leq 0.3$). This analysis is achieved by exploring streamlines, isotherms, total entropy generation, local and average Nusselt numbers. After the data analyses, the findings indicated that

the magnetic field orientation strongly affects the hybrid nanofluid flow and temperature distribution. In other words, at Ri = 10, Applying a magnetic field perpendicular to the gravity force leads to better heat transfer. Furthermore, decreasing corners radius enhances heat transmission and reduces irreversibility. The composition ratio (Al_2O_3 75%, Cu 25%) gave the highest values of the mean Nusselt Number (Nu_m) and the total entropy production (S_g). Moreover, the heat transfer rate and irreversibility decrease with increasing *Ha* and decreasing Ri. Finally, suspending nanoparticles (NPs) in the base fluid improves heat transfer and increases irreversibility except for Ri = 10 at *Ha* = 100 and Ri = 1 at *Ha* = 50, where the opposite behavior has been observed.

- **Previous** article in issue
- **Next** article in issue

Keywords

Convection Entropy production MHD Cavity Corners Hybrid nanofluid