...al Cylinder

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Abstract

This investigation explores the mixed convection phenomenon of a hybrid nanofluid flowing within a Channel oriented horizontally featuring a triangular cavity attached to the lower channel wall. The cavity houses a rotating circular cylinder with a radius of R=0.12. The fluid within the enclosure is a water-based nanofluid containing Ag-MgO nanoparticles. Two scenarios of combined natural and forced convection are examined: in Case 1, all channel walls, the left wall of the cavity, and the surface of the rotating cylinder are adiabatic, while the inclined wall of the cavity is isothermal. In Case 2, all channel walls, the ready wall of the cavity, and the surface of the rotating cylinder are adiabatic, except for the left wall of the cavity, which is isothermal. The dimensionless governing equations are solved under steady flow conditions for various physical parameters using a higher-order and stable Galerkin-based finite element method implemented through the software package FlexPDE. Key governing parameters such as Re number (falling within the amplitude of 10 to 100), Ri number (ranging from Ri=0.1 to 30), and the location of cylinder rotation (Xo = 0.65 to 0.9) are simulated. The study presents results in terms of average Nusselt numbers and contour maps of streamlines and isotherms. It is observed that the average Nusselt number increases with higher Reynolds number, angular rotation speed, cylinder location, and Richardson number. Specifically, heating the inclined surface suggests that the optimal location for the rotating cylinder is Xo = 0.9, whereas if the left wall of the cavity is heated, the preferred location for the cylinder is Xo = 0.75. These findings are corroborated by comparing them with previous research, demonstrating significant agreement.

Keywords: mixed flow; horizontal channel with triangular cavity; hybrid nanofluid.