عنوان مقاله:

Heat Transfer Enhancement and Boundary Layer Separations for a Hybrid Nanofluid Flow past an Isothermal Cylinder

محل انتشار:

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نویسندگان:

Nepal Roy - *Department of Mathematics, University of Dhaka, Dhaka, Bangladesh*

Aysha Akter - *Department of Mathematics, University of Dhaka, Dhaka, Bangladesh*

خلاصه مقاله:

Unsteady magnetohydrodynamic mixed convection flow of an incompressible hybrid nanofluid (Cu-Al۲O۳/water) past an isothermal cylinder with thermal radiation effect has been studied. Appropriate non-dimensional variables are initiated to reduce the governing equations into a convenient form. By utilizing the procedure of finite difference, reduced equations are then solved for all time. Besides, series solutions are obtained using perturbation technique for short time and asymptotic method for long time which agree with the acquired numerical solution up to a good accuracy. When the mixed convection parameter Ri, radiation conduction parameter Rd, magnetic field parameter M and the volume fractions of nanoparticles ϕ۱ and ϕ۲ are increased, the local skin friction coefficient and the local Nusselt number are found to increase. Results revealed that the hybrid nanofluid (Cu-Al۲O۳/water) enhances the heat transfer about ۲۸.۲۸% in comparison to the Al۲O۳-water nanofluid and about ۵۱.۱۵% than the pure fluid. Contrary to this, the heat transfer of hybrid nanofluid is augmented about ۴۱.۷۶% than the Cu-water nanofluid and ۷۱.۴۱% than the base fluid. The streamlines and isotherms reveal that higher values of Ri, M and Rd delay the boundary layer separation and accordingly shrink the vortices. Moreover, the thermal boundary layer is thickened for the increment of aforesaid quantities. The surface temperature parameter augments the local skin friction coefficient, however, the reverse characteristic is observed for the local Nusselt number.

کلمات کلیدی:

Hybrid nanofluid, Mixed convection, Isothermal cylinder, Boundary layer separation, Thermal radiation