Hybrid nanofluid flow over a permeable shrinking sheet embedded in a porous medium with radiation and slip impacts

ABSTRACT

The study of hybrid nanofluid and its thermophysical properties is emerging since the early of 2000s and the purpose of this paper is to investigate the flow of hybrid nanofluid over a permeable Darcy porous medium with slip, radiation and shrinking sheet. Here, the hybrid nanofluid consists of Cu/water as the base nanofluid and Al2O3–Cu/water works as the two distinct fluids. The governing ordinary differential equations (ODEs) obtained in this study are converted from a series of partial differential equations (PDEs) by the appropriate use of similarity transformation. Two methods of shooting and bvp4c function are applied to solve the involving physical parameters over the hybrid nanofluid flow. From this study, we conclude that the non-uniqueness of solutions exists through a range of the shrinking parameter, which produces the problem of finding a bigger solution than any other between the upper and lower branches. From the analysis, one can observe the increment of heat transfer rate in hybrid nanofluid versus the traditional nanofluid. The results obtained by the stability of solutions prove that the upper solution (first branch) is stable and the lower solution (second branch) is not stable.

Keyword: Boundary layer; Heat transfer; Darcy model; Hybrid nanofluid; Stability analysis