Exploring the shape effect of nanoparticles on hybrid nanofluid flow over a curved surface with non-uniform porous medium

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Abstract

Thermal efficiency is becoming increasingly important in industrial systems, mechanical engineering, and advanced electronic devices. According to research, factors such as nanoparticle concentration, size, and shape influence the heat transfer properties of nanofluids. This study examines the sphere, needle, and lamina-shaped nanoparticles in a magnetized hybrid nanofluid flow driven by a permeable vertically oriented curved surface. Additionally, the surface is soaked in a Darcy-Forchheimer porous medium. Graphene Oxide(GO) and Molybdenum Disulfide(MoS_2) nanoparticles are suspended in a polymer solution of Polyvinyl Alcohol(PVA) to prepare the hybrid nanofluid. Mathematical formulations are developed using boundary layer approximations and with the help of suitable similarity transformations, the governing partial differential equations are induced into nonlinear ordinary differential equations. The physical solutions are analyzed using graphs produced by bvp4c in MATLAB. The remarkable impact of relevant parameters, including the shape factor, was analyzed on velocity and temperature profiles. It was observed that lamina-shaped nanoparticles elevate the temperature more effectively than other nanoparticle shapes. The effects of physical quantities, along with suction and injection parameters, are illustrated through graphs. The local skin friction coefficient increased by approximately 9% for all three nanoparticle shapes when the porous permeability parameter was raised. Additionally, the heat transfer rate appreciably improved for lamina-shaped nanoparticles as the concentration of nanoparticles in the hybrid nanofluid increased. To ensure our results with the existing literature, we consider our surface to be flat (i.e. curvature parameter, K→ ∞). This research provides preliminary predictions to assist scientists and engineers in efficiently achieving optimal results in relevant practical scenarios and modeling.

Keywords: Curved surface; Hybrid nanofluid; Nanoparticle shapes; Darcy-Forchheimer porous medium.

2010 Mathematics Subject Classification: 76D05, 76D10

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