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Computational study of magnetite-ethylene glycol–water-based hybrid nanofluid dynamics on an exponential shrinking/stretching Riga surface under radiative heat flux

Abstract

The exceptional heat transfer capabilities of hybrid base ferrofluids have attracted numerous researchers, prompting an increase in investigations into these working fluids. In various applications, hybrid base nanofluids have demonstrated superior heat transfer performance. However, further research is needed to expand their range of applications. To address this need, the current study aims to explore the flow of a hybrid base nanofluid (magnetite with ethylene glycol and water as the base fluid) on an exponential shrinking/stretching Riga plate with radiative heat flux. The Riga plate, an electromagnetic actuator, consists of a spanwise-aligned array of alternating electrodes attached to a flat surface and permanent magnets. This setup enables the examination of heat transfer with Hartmann number, thermal radiation, and nanoparticle volume fraction. The governing PDE systems are transformed into ODE systems using similarity transformations, and the developed model is solved numerically using the bvp4c technique in MATLAB software. A comprehensive convergence analysis and comparative investigation of numerical data are conducted to ensure the accuracy of the results. Finally, the effects of physical parameters on skin frictional force, Nusselt number, velocity field, and temperature field are investigated, and the results are presented graphically and discussed in detail. The numerical values for the skin frictional quantity variation along suction with different Hartmann quantity obtained. The critical values Sci,i=1,2, and 3 observed are 2.2396,2.3795, and 2.7714 corresponding to the values of M = 0,0.02, and 0.04, respectively. Research suggests that dual solutions are present within a specific spectrum of suction and stretching/shrinking parameters. Additionally, the stability analysis of these dual solutions indicates that the primary solution is stable.

Keywords

Radiative heat flux; Magnetite; Riga plate; Ethylene glycol