Effects of electric field, MHD micropolar hybrid nanofluid flow with mixed convection and thermal radiation

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1. INTRODUCTION & OBJECTIVE

The fluid flow across a fixed surface is an important topic of fluid mechanics, which was first introduced by Blasius. Later on, Sakia modified this problem as the fluid flow over a moving surface. Such types of flow problems have received much attention from researchers, due to their tremendous applications in engineering and industries, such as plastic extrusion, continuous casting, glass fiber, and crystal development. The fluid that is comprised of micro-scale elements and possesses internal micro-structure characteristics is termed as micropolar fluid. These fluids exhibit micro-rotational inertial characteristics and micro-rotational phenomena. Micropolar fluid has several uses inside electronic circuits, textiles, plastic sheets, power generation turbines, and other excessively heated parts of heavy machinery. Many studies have been published with an emphasis on heat transfer characteristics by employing micropolar fluid.

Hybrid nanofluids substantially impact the development of pure fluid's thermal properties. The flow of mixed convective MHD micropolar electrically conducted hybrid nanofluid past a flat surface is investigated in this paper. The alumina and silver nanoparticles make up the hybrid nanofluid flow, with water acting as the base fluids. The plate has been positioned vertically in a permeable material with suction and injection effects. Joule heating, electrical effects, thermal radiation, and viscous dissipation are also taken into account. The set of the modeled equation was transformed into a dimension-free form and then solved by R.K 4^{th} order. The current study findings were numerically compared with those of past studies that had been published in certain exceptional cases.

2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

This study explores the MHD natural convective micropolar hybrid nanofluid flow past a stretching plate. The fluid is influenced by thermal radiation and Joule heating effects. The plate is placed vertically in a permeable medium with suction and injection effects. The analysis has shown that fluid mobility increases with increasing the magnetic field parameter and the mixed convection parameter and decreases with an increase in the micropolar component. Fluid micro rotational velocity increases with increasing micropolar parameter values. For expanded values of magnetic effects, radiation factor, Eckert number, and the heat source, the thermal flow behavior increases. the velocity profile increases with increasing the electric field. The skin friction has decreased due to an increase in magnetic intensity and mixed convection components and has increased with large values of the micropolar parameter. With the escalation of magnetic effects, radiation factor, and Eckert number the Nusselt number has gone up.

The Highlights are Micropolar fluid is considered at a stagnation point, Mixed convection effects with heat source are employed in the flow system, Suction/injection, viscous dissipation, electrical effects, thermal radiations, and Joule heating effects are taken into consideration.

REFERENCES

1. V. M. Job, S. R. Gunakala, and A. J. Chamkha, "Numerical investigation of unsteady MHD mixed convective flow of hybrid nanofluid in a corrugated trapezoidal cavity with internal rotating heat-generating solid cylinder," *Eur. Phys. J. Spec. Top.*, vol. 231, no. 13–14, pp. 2661–2668, Sep. 2022, doi: 10.1140/epjs/s11734-022-00604-8.A. Gelman, J. B. Carlin, H. S. Stern, and D. B. Rubin, *Bayesian Data Analysis*, Chapman and Hall, London, 1995.
2. E. A. Algehyne, I. Haq, Z. Raizah, F. S. Alduais, A. Saeed, and A. M. Galal, "A passive control strategy of a micropolar hybrid nanofluid flow over a convectively heated flat surface," *J. Magn. Magn. Mater.*, vol. 567, p. 170355, Feb. 2023, doi: 10.1016/j.jmmm.2023.170355.S. F. Gull, "Developments in maximum-entropy data analysis," in *Maximum Entropy and Bayesian Methods*, J. Skilling, ed., pp. 53-71, Kluwer Academic, Dordrecht, 1989.
3. S. Shaw, S. S. Samantaray, A. Misra, M. K. Nayak, and O. D. Makinde, "Hydromagnetic flow and thermal interpretations of Cross hybrid nanofluid influenced by linear, nonlinear and quadratic thermal radiations for any Prandtl number," *Int. Commun. Heat Mass Transf.*, vol. 130, p. 105816, Jan. 2022, doi: 10.1016/j.icheatmasstransfer.2021.105816.
4. R. M. Muntazir, M. Mushtaq, S. Shahzadi, and K. Jabeen, "MHD nanofluid flow around a permeable stretching sheet with thermal radiation and viscous dissipation," *Proc. Inst. Mech. Eng. Part C J. Mech. Eng. Sci.*, vol. 236, no. 1, pp. 137–152, Jan. 2022, doi: 10.1177/09544062211023094.
5. N. T. Eldabe, M. E. Gabr, A. Z. Zaher, and S. A. Zaher, "The effect of Joule heating and viscous dissipation on the boundary layer flow of a magnetohydrodynamics micropolar-nanofluid over a stretching vertical Riga plate," *Heat Transf.*, vol. 50, no. 5, pp. 4788–4805, Jul. 2021, doi: 10.1002/htj.22102.