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Numerical investigation of convective magnetized ternary hybrid nanofluid flow over a vertical stretching porous cylinder

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ABSTRACT

Nanoparticles has gained importance in research field due to its high thermal efficiency. They have significance in both technical and industrial field. The current study investigates the convective flow of ternary hybrid nanofluids with a stagnation point on a vertical stretching cylinder. The aim of this work is to analyse the thermal efficiency and velocity of a ternary hybrid nanofluid on a vertical stretching cylinder while accounting for the effects of porous medium, magnetic field, thermal radiation, Darcy-Forchheimer and Eckert number. Ternary hybrid nanofluid consists of Copper (Cu), Aluminium oxide (Al_2O_3) and Molybdenum disulphide (MoS_2) with Engine oil as base fluid which enhances thermal efficiency. Darcy-Forchheimer effect with porous medium and magnetic field are affecting the convective flow. Viscous dissipation and thermal radiation are incorporated with convective boundary conditions. System of partial differential equations (PDEs) are converted into nonlinear system of ordinary differential equations (ODEs) using similarity transformations. Solution for ODEs obtained by bvp4c MATLAB solver. Velocity and temperature profiles are obtained for Darcy-Forchheimer, porosity parameter, magnetic field, Eckert number and thermal radiation parameter. The outcome shows that Darcy-Forchheimer, porosity and magnetic field parameters impact velocity and thermal efficiency. Engine oil has a significant part in cosmical and geophysical fluid dynamics when paired with the influence of heat radiation. It is also engaged in automobile engineering.

RESEARCH AIM

The objective of this study is to analyse the thermal efficiency and velocity of ternary hybrid nanofluid on a vertical stretching cylinder by adding effect of Darcy-Forchheimer, porosity, magnetic field, thermal radiation parameter and Eckert number.

LITERATURE SURVEY

- Mehdi Mahboobtosi et al. investigated the convective flow around a vertical stretching cylinder, analysis the parameter and improve performance of ternary hybrid nanofluids in 2024.

- Ashish Paul et al. investigated the Thermo-mass flow of Casson ternary hybrid nanofluid around a stretching sheet and analysis the effect of Darcy-Forchheimer in 2024.
- Aisha M. Alqahtani et al. analysed the variations in thermal efficiency of a ternary hybrid nanofluid around a stretching/shrinking cylinder with the effect of Biot number in 2022.

PROBLEM FORMULATION

The following are the governing equations for a Ternary hybrid nanofluid flowing around a vertical stretching cylinder:

$$\frac{\partial(rv)}{\partial r}+\frac{\partial(ru)}{\partial x}=0 \tag{1}$$

$$v\frac{\partial u}{\partial r}+u\frac{\partial u}{\partial x}=u_e\frac{du_e}{dx}+\gamma_{tnf}\left(\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}\right)+\frac{\rho\beta_{tnf}}{\rho_{tnf}}g(T-T_\infty)-\frac{\mu_{tnf}}{\rho_{tnf}}\frac{1}{k_a}(u-u_e)$$
$$-\left(\frac{\sigma}{\rho}\right)_{tnf}B_0^2(u-u_e)-\frac{C_F}{\sqrt{k_b}}(u^2-u_e^2) \tag{2}$$

$$v\frac{\partial T}{\partial r}+u\frac{\partial T}{\partial x}=\left(\frac{k}{\rho C_p}\right)_{tnf}\left(\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right)+\left(\frac{\mu}{\rho C_p}\right)_{tnf}\left(\frac{\partial u}{\partial r}\right)^2-\frac{1}{(\rho C_p)_{tnf}}\frac{\partial q_r}{\partial r} \tag{3}$$

SOLUTION METHODOLOGY

In this article the system of partial differential equations is transformed into system of ordinary differential equations by applying similarity transformations. The bvp4c MATLAB solver provides the solution for obtained ordinary differential equations and graphically represented.

CONCLUSION

Investigated the effect of Darcy-Forchheimer, thermal radiation, porous medium, viscous dissipation and magnetic field in this study on ternary hybrid nanofluid around a vertical stretching cylinder. The nanoparticles which are suspended in a base fluid that is engine oil enhance the thermal efficiency of ternary hybrid nanofluid.

- Velocity got affected by Darcy-Forchheimer, it has a drag force which holds back the flow of fluid.

- Porous medium is one more reason to reduction in fluid flow, where porous medium resists the flow of fluid.
- Use of nanoparticles enhances the thermal efficiency, Ternary hybrid nanofluid has three nanoparticles, which boosts the thermal efficiency more.
- Addition to nanoparticles, Biot number and thermal radiation boosts the thermal efficiency.

REFERENCES

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