Bioconvective flow of Nanofluid past a cylinder subject to Thompson and Troian slip

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1. INTRODUCTION & OBJECTIVE

The bioconvective flow of a nanofluid past a cylinder under the impact of Thompson and Troian slip conditions is studied in this work. The non-zero velocity at the boundary, which affects the distribution of shear stress and, in turn, the overall flow pattern, is explained by this slip condition. Additionally, the study covers the dynamics of nanofluid flow, the bioconvection processes, and their impact on the mass and heat transfer. The governing equations are in the form of Partial differential equations (PDEs) that are converted into a system of ordinary differential equations (ODEs) which is solved using RKF-45 method. The outcomes of this study are interpreted in the form of graphs.

Choi, in the year 1995 introduced the term nanofluid as a fluid that contains nanometer-sized particles that led to notable improvements in the transfer of heat. Puneeth et al. [1] analysed the thermal characteristics of nanofluid flowing past a stretching sheet due to bioconvection. Bioconvection is a phenomenon that occurs due to the swimming of microorganisms. The upward swimming of microorganisms forms a heavy layer that sinks, causing a cycle of upward and downward movement, and formation of distinctive patterns. The study of bioconvection patterns contributes to the knowledge of complex fluid behaviors which aids the design of microfluidic devices and other engineering systems. The enhancement in the transfer of energy and mass in the presence of bioconvection was described by Anandika et al. [2]. Song et al. [3] analysed the bioconvective flow of bi-viscous nanofluid when subjected to Thompson and Troian [4] slip conditions. This nonliner velocity slip existed between local shear rate at a solid surface and amount of slip. The interaction of liquid with the unevenness of surface energy of solid is determined by the behaviour of a liquid at boundary. The study on influence of Thompson and Troian slip on flow and heat transfer of a nanofluid moving through a porous material was investigated by Dey et al. [5]. The influence of nonlinear radiative heat on the transfer of heat through magnetic nanofluid was investigated by Akaje et al. [6].

The research intends to provide deeper insights into the behavior of nanoscale fluids under practical settings. Understanding boundary layer behavior can be improved by using the Thompson and Troian slip models, which take into consideration slip at the fluid-solid interface, which can drastically modify the flow and thermal properties. The necessity to maximize fluid flow and thermal control in a wide range of applications is what drives this study. In the field of engineering, higher heat transfer efficiency can result in better cooling systems, lower energy usage, and better machinery performance.

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2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

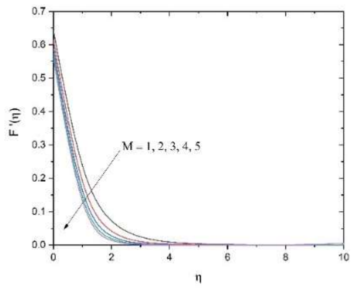

Figure 1 Effect of M on $f'(\eta)$

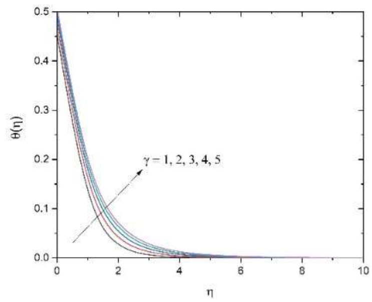

Figure 2 Effect of γ on $\theta(\eta)$

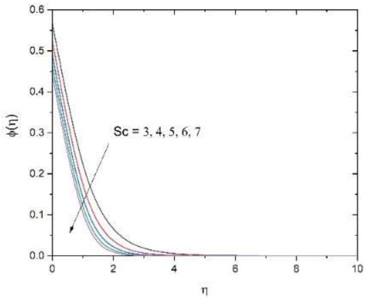

Figure 3 Effect of Sc on $\phi(\eta)$

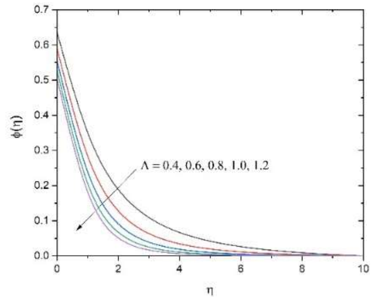

Figure 4 Effect of Λ on $\phi(\eta)$

- The external magnetic field has significantly reduced the fluid flow speed and has contributed to the enhancement of the thermal conductance.
- The critical stress tensor due to the Thompson and Troian slip enhances the temperature of the nanofluid.
- The higher Schmidt number signifies a greater diffusivity due to which the concentration and the density profiles decrease.
- The increase in the stretching rate diminishes the concentration profile of the nanofluid.

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