COMPUTATIONAL ANALYSIS OF CONVECTIVE HEAT AND MASS TRANSFER IN A CASSON NANOFLUID OVER A VERTICAL RIGA PLATE

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A Dissertation submitted to the Department of Mathematics, College of Physical Sciences, Federal University of Agriculture, Abeokuta in partial fulfillment of the requirements for the award of degree of Master of Science in Mathematics

October, 2025

ABSTRACT

The dynamics of heat and mass transport of Casson nanofluid has become centre of research in recent time due to its scientific and engineering applications in the petrochemical and metallurgical fields. This study examined the combined effects of some thermophysical parameters on Casson nanofluid over a vertical Riga plate. The equations of momentum, energy and mass describing the flow, heat and mass transfer were formulated and transformed into coupled non-linear ordinary differential equations using the similarity transformation method. The resulting self similar problems were solved using spectral collocation method. The impacts of associated pertinent parameters such as Hartmann number (M), Chemical reaction parameter (C_r), Thermal radiation (R), Soret number (S_r), Dufour number (Do), Eckert number (Ec), Prandtl number (Pr), Schmidt number (Sc), thermophoretic number (N_t) and Lewis number (Ln) were presented graphically on Velocity, Temperature and Concentration fields. The Skin friction (C_f), Nusselt number (N_u) and Sherwood number (S_h) were presented in tabular form. The results showed that variation in the values of modified Hartman number at $1.0 \leq M \leq 3.0$ caused abrupt increase in the velocity profile in the vicinity of the Riga plate wall. The increase in the thermal radiation at $0.0 \leq R \leq 1.0$ and Eckert number at $0.10 \leq Ec \leq 1.12$ were observed to increase the velocity, temperature and the thermal condition of the fluid. Various values of Prandtl number within the range $0.71 \leq Pr \leq 7.0$ were found to decrease the velocity and temperature profiles, indicating that at small values of Prandtl number, the fluid was more conductive while increase in thermal conductivity enhanced the velocity hydrodynamic boundary layer, temperature and thermal boundary layer thickness in the presence of Brownian motion parameter (N_b) at $4.0 \leq M \leq 12.0$. Furthermore, enhancement in R and Ec improved the Nusselt number which consequently increased the rate of heat transfer while the rate of mass transfer was boosted with various values of S_c and C_r. This study revealed that the pertinent parameters improved the flow, heat and mass transport in Casson nanofluid over a vertical Riga plate.