A COMPUTATIONAL STUDY OF HEAT AND MASS TRANSFER IN POWER LAW FLUID PAST AN ACCELERATED RIGA PLATE

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ABSTRACT

Due to the importance of the applications of non-Newtonian fluids for the design of equipments and in industrial processes, there have been increased interest in the study of such fluids. This study investigated the significance of heat generation/absorption, thermal radiation, inclination angle and chemical reaction on the convective heat and mass transfer in a power law fluid over an accelerated Riga plate. Pseudo-plastic fluid having non-Newtonian power law index $0 < n < 1$ and dilatant fluid with index $n > 1$ were considered. The Grinberg term incorporated into the momentum equation was utilized to express the Riga plate. By employing suitable transformation technique, the non-linear partial differential equations formulated were converted to ordinary differential equations. The resulting similarity equations were solved numerically by employing shooting method embedded in Matlab computational software. Graphs were utilized to illustrate the velocity, temperature, and concentration profiles due to variations in the physical fluid flow parameters such as the thermal radiation (R), chemical reaction (Γ), heat generation/absorption (Q), Prandtl number (Pr), power law exponent (n), Schmidt number (Sc), inclination angle (ϕ), porosity (k_p), magnetic (M), thermal Grashof number (Gr), and mass Grashof number (Gc). The numerical results revealed that at $0.5 \le M \le 4.0$, $1.0 \le Gr \le 6.0$, and $3.0 \le Gc \le 9.0$ velocity reduced for both the pseudoplastic and dilatant fluids, respectively. The heat generation/absorption parameter at $0.06 \le Q \le 0.6$ and the thermal relaxation parameter at $0.2 \le R \le 0.8$ were factors that enhanced the temperature of the fluids. The concentration of both the pseudoplastic and dilatant fluid reduced whenever the Schmidt number varied from 0.6 to 4.0 and the chemical reaction parameter at $0.1 \le \Gamma \le 0.8$. However, there was an increase in concentration for the power law exponent in the range $0.8 \le n \le 1.4$. The skin friction for the pseudoplastic and the dilatant fluids increased with increasing magnetic parameter and porosity parameter in the range $1.0 \le k_p \le 6.0$, while it reduced for the angle of inclination in the range $15^\circ \le \phi \le 60^\circ$. Nusselt number dropped with increasing heat generation/absorption parameter, while the Schmidt number and the chemical reaction parameter increased the Sherwood number. The results showed the usefulness of these parameters on the flow, mass and heat transfer of pseudoplastic and dilatant fluids for various desirable applications in medical and engineering industries.