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Effects of Radiation on Mixed Convection in Power Law Fluids along Vertical Wedge Embedded in a Saturated Porous Medium under Prescribed Surface Heat Flux Condition

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Abstract : Heat transfer in Power Law Fluids across cylindrical surfaces has copious engineering applications. These applications comprises of areas such as underwater pollution, bio medical engineering, filtration systems, chemical, petroleum, polymer, food processing, recovery of geothermal energy, crude oil extraction, pharmaceutical and thermal energy storage. The quantum of research work with diversified conditions to study the effects of combined heat transfer and fluid flow across porous media has increased considerably over last few decades. The most non-Newtonian fluids of practical interest are highly viscous and therefore are often processed in the laminar flow regime. Several studies have been performed to investigate the effects of free and mixed convection in Newtonian fluids along vertical and horizontal cylinder embedded in a saturated porous medium, whereas very few analysis have been performed on Power law fluids along wedge. In this study, boundary layer analysis under the effects of radiation-mixed convection in power law fluids along vertical wedge in porous medium have been investigated using an implicit finite difference method (Keller box method). Steady, 2-D laminar flow has been considered under prescribed surface heat flux condition. Darcy, Boussinesq and Roseland approximations are assumed to be valid. Neglecting viscous dissipation effects and the radiate heat flux in the flow direction, the boundary layer equations governing mixed convection flow over a vertical wedge are transformed into dimensionless form. The single mathematical model represents the case for vertical wedge, cone and plate by introducing the geometry parameter. Both similar and Non- similar solutions have been obtained and results for Non similar case have been presented/ plotted. Effects of radiation parameter, variable heat flux parameter, wedge angle parameter 'm' and mixed convection parameter have been studied for both Newtonian and Non-Newtonian fluids. The results are also compared with the available data for the analysis of heat transfer in the prescribed range of parameters and found in good agreement. Results for the details of dimensionless local Nusselt number, temperature and velocity fields have also been presented for both Newtonian and Non-Newtonian fluids. Analysis of data revealed that as the radiation parameter or wedge angle is increased, the Nusselt number decreases whereas it increases with increase in the value of heat flux parameter at a given value of mixed convection parameter. Also, it is observed that as viscosity increases, the skin friction co-efficient increases which tends to reduce the velocity. Moreover, pseudo plastic fluids are more heat conductive than Newtonian and dilatant fluids respectively. All fluids behave identically in pure forced convection domain.

Keywords : porous medium, power law fluids, surface heat flux, vertical wedge
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