

Non-uniform heat generation effect on heat transfer of a non-Newtonian power-law fluid over a non-linearly stretching sheet

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Abstract The effects of non-uniform heat generation/absorption and viscous dissipation on heat transfer of a non-Newtonian power-law fluid on a non-linearly stretching surface have been examined. The governing nonlinear partial differential equations describing the problem are transformed to a system of non-linear ordinary differential equations by using suitable similarity transformation. The transformed system of ordinary differential equations is solved numerically using fourth order Runge-Kutta method with the shooting technique. Graphical solutions for the dimensionless temperature are presented and discussed for various values of the power-law index parameter, the Prandtl number, the heat generation/absorption parameter and the Eckert number. The results show that the local Nusselt number is reduced with increasing the Eckert number or the heat generation parameter, whereas the heat absorption parameter has the effect of enhancing the local Nusselt number.

Keywords Power-law fluids · Non-uniform heat generation/absorption · Non-linearly stretching surface · Viscous dissipation

1 Introduction

In many practical applications, such as molten plastics, polymer, blood, food stuff, etc., fluids are non-Newtonian in their flow characteristics. The study of flow and heat transfer over a stretching surface issuing from slit has gained considerable attention of many researchers due to its importance in many industrial applications. For example, in extrusion of polymer sheet from a die, the sheet is sometimes stretched. During this process, the properties of the final product depend on the rate of cooling and the stretching rate by drawing such sheet into a cooling system. The boundary layer flow of non-Newtonian fluids over a stretching surface has been studied by many authors under various conditions. Maneschy et al. [1] studied the flow of a second-grade fluid over a porous elastic stretching sheet. Mahmoud [2] investigated the effects of chemical reaction and variable viscosity on the boundary layer flow and heat transfer of a non-Newtonian viscoelastic fluid over a stretching surface immersed in a porous medium. Abel et al. [3] examined the influence of the magnetic field on the flow and heat transfer of an upper-convected Maxwell fluid over a stretching sheet. Babaelahi et al. [4] studied the momentum and heat transfer of characteristics in an incompressible electrically conducting viscoelastic boundary layer fluid flow over a linear stretching sheet in the presence of viscous and Ohmic dissipations. Many of the non-Newtonian fluids encountered in chemical engineering processes are known to follow the empirical Ostwald-

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