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On Steady Hydromagnetic Boundary-Layer Flow of a non-Newtonian Power-Law Fluid over a Continuously Moving Surface with Suction

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Analytical studies for the problem of flow and heat transfer of an electrically conducting non-Newtonian power-law fluid with low electrical conductivity on a continuously moving infinite porous plate in the presence of viscous dissipation and a uniform transverse magnetic field have been presented. It is found that steady solutions for dimensionless velocity exist only for a fluid in which its power-law index n satisfies $0.5 < n < 1$ with suction at the plate. The problem is also solved numerically by using the shooting method. The results show a good agreement between the analytical and the numerical results. The influences of the magnetic parameter, suction parameter, the power-law index, and the Prandtl number on the velocity and temperature profiles are studied. Also the effects of the various parameters on the skin-friction coefficient and the rate of heat transfer at the surface are discussed and displayed in tables.

Keywords Analytical solution; Magnetic field; Moving surface; Non-Newtonian power-law fluid

Introduction

In recent years, the problem of non-Newtonian fluid has received considerable attention because of the wide use of these fluids in various branches of science, engineering, and technology. From a rheological point of view some of these fluids are of power-law behavior in which the viscosity is a function of shear rate; these have been called Ostwald-de Waele fluids by some authors. Molten plastics, paints, blood, polymer solutions, industrial suspensions, and multigrade oils are examples of non-Newtonian fluids. The important concept of boundary layer was applied to power-law fluids by Schowalter (1960). Acrivos (1960) investigated the natural convection behavior of a non-Newtonian fluid from a body with an isothermal surface. Acrivos et al. (1960) studied the steady flow for non-Newtonian fluids over a plate. Similarity solutions of boundary layer equations for power-law fluids were obtained by Kapur and Srivastava (1963), Lee and Ames (1966), and Pascal (1992).

Another situation commonly observed in industrial problems is the flow of a stationary fluid past a continuously moving plate. Boundary layer behavior on a moving continuous surface is an important type of flow occurring in many manufacturing processes such as metal extrusion, glass fiber production, hot rolling,

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