

Unsteady MHD Boundary Layer Flow of a Non-Newtonian Power-Law Fluid Over an Infinite Porous Flat Plate Embedded in a Porous Medium

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Abstract The study of an unsteady incompressible electrically conducting viscous non-Newtonian power-law fluid over an infinite porous flat plate embedded in a porous medium has been made. The similarity transformations are used to reduce the governing coupled non-linear partial differential equations to a non-linear ordinary differential equation. An analytical solutions to the resulting non-linear ordinary differential equation are obtained using the method of successive approximations. The effects of the power-law index, the permeability and the magnetic parameters on the velocity distributions and the skin-friction coefficient are discussed.

Key Words: MHD, Non-Newtonian power-law fluid, Porous medium

1. Introduction

Non Newtonian fluids has received considerable attention because of the wide use of these fluids in chemical process industries, drilling of petroleum, polymer solutions, paints and molten plastics. Many of the non Newtonian fluids encountered in chemical engineering processes are known to follow the empirical Ostwald-de Waele power-law

model[1]. Flows of many plastics melts may be described in terms of this power-law.

The boundary layer concept in the theory of non Newtonian power-law fluids was first investigated by Schowalter[2], who formulated the boundary layer equations and established the conditions for the existence of a similarity solution. Acrivos[3] presented a theoretical analysis of laminar natural convection heat transfer to non-Newtonian fluid. Acrivos et al.[4-5] studied the steady flow of non-Newtonian fluids over a plate. Ezzat, M.[6] studied the flow of an unsteady incompressible electrically conducting viscous non-Newtonian power-law fluid past an infinite porous plate with a periodically alternating suction-injection of the fluid in the presence of a transverse uniform magnetic field.

Recently, Gamal Abdel- Rahman [7] has investigated the formation of magnetohydrodynamic, unsteady flow of an incompressible, non-Newtonian power-law electrically conducting fluid past an infinite porous plate in a porous medium. By assuming that the magnetic Reynolds number is small and applying a similarity solutions, Gamal has obtained a third order non-linear ordinary differential equation for $f(\eta)$ (see equation (10) in [1]). The transformed boundary conditions for the problem are $f'(0) = 0$ and $f'(\infty) = 1$. He assumed an additional boundary condition $f(0) = 0$ (equation (11) in [1]), which has not any physical meaning and is