

Analytical solutions of hydromagnetic boundary-layer flow of a non-Newtonian power-law fluid past a continuously moving surface

M. A. A. Mahmoud and M. A.-E. Mahmoud, Benha, Egypt

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Summary. The boundary-layer flow of a power-law non-Newtonian fluid over a continuously moving surface in the presence of a magnetic field $B(x)$ applied perpendicular to the surface has been investigated. An analytical solution is obtained and compared with the numerical solution of the resulting non linear ordinary differential equation. The effects of the Stewart number (N) and the power law-index (n) on the velocity profiles and the skin-friction are studied.

1 Introduction

The boundary-layer flow over moving surfaces is of increasing importance in technical applications, such as in metallurgy and chemical processes industries. An example for a moving continuous surface is a polymer sheet or filament extruded continuously from a die, or a long thread travelling between a feed roll and a wind-up roll. Sakiadis [1] was the first who analyzed the boundary layer on a continuous flat surface. Many authors [2]–[8] have studied the boundary layer flow on a continuous moving surface under different situations. All of the above investigators, however, restrict their analysis to the flow of Newtonian fluids. Most fluids such as molten plastics, artificial fibres, drilling of petroleum, blood and polymer solutions are considered non-Newtonian fluids. Schowalter [9] has introduced the concept of the boundary layer in the theory of non-Newtonian power-law fluids. Acrivos, Shah and Petersen [10] have investigated the steady laminar flow of non-Newtonian fluids over a plate.

In recent years, several authors [11]–[18] have dealt with the problem of non-Newtonian power-law fluids over continuously stretching surfaces with and without applying a magnetic field.

Exact solutions of the equations of motion of power-law non-Newtonian fluids are difficult. The difficulty arises not only due to the nonlinearities but also due to the order of the differential equations.

The aim of this work is to solve the problem of a two-dimensional, steady, incompressible power-law non-Newtonian electrically conducting fluid past a continuously moving surface in the presence of a transverse magnetic field $B(x)$ analytically.