

**EFFECTS OF VISCOUS DISSIPATION AND HEAT GENERATION (ABSORPTION)
IN A THERMAL BOUNDARY LAYER OF A NON-NEWTONIAN FLUID OVER
A CONTINUOUSLY MOVING PERMEABLE FLAT PLATE**

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The problem of boundary-layer flow and heat transfer of a non-Newtonian power-law fluid over a moving porous infinite flat plate in the presence of viscous dissipation and heat generation or absorption is investigated analytically. It is assumed that both the momentum and the energy equations are coupled by the stress friction factor, and an assumption is introduced regarding the heat-transfer index. It is found that exact analytical solutions for velocity and temperature exist only for pseudo-plastic fluids in the presence of suction at the surface. The effects of the suction parameter, Eckert number, and the heat generation or absorption parameter on the velocity and temperature profiles, as well as on the skin-friction coefficient and Nusselt number are discussed.

Key words: non-Newtonian power-law fluids, moving surface, heat generation or absorption.

Introduction. Flow and heat transfer associated with a continuously moving surface in an otherwise quiescent fluid is of relevance in many manufacturing processes, such as hot rolling, wire drawing, continuous casting, paper production, and extrusion of metallic, glass, and polymeric materials. Sakiadis [1, 2] initiated the study of boundary layer flow over a continuous solid surface moving with constant speed. Erickson et al. [3] extended Sakiadis' problem to the case in which the transverse velocity at the moving surface is non-zero, with heat and mass transfer in the boundary layer being taken into account. Tsou et al. [4] confirmed the results of Sakiadis experimentally and investigated the heat-transfer effects of a moving sheet with constant surface velocity and temperature. Chen [5] studied the problem of forced convection flow and heat transfer about a flat sheet with suction or injection, continuously moving in a quiescent or flowing fluid. The thermal boundary-layer problem of a semi-infinite flat plate moving in a constant-velocity free stream was studied by Fang [6]. Cortell [7] examined numerically the momentum and heat transfer of an incompressible viscous moving fluid over a moving flat surface.

All the above-mentioned investigations were restricted to flows of a Newtonian fluid. Many important fluids, however, such as molten plastics, polymers, printing ink, food stuff, etc., are non-Newtonian in their flow characteristics. The interest in studying flow and heat-transfer characteristics of non-Newtonian fluids has increased in the last four decades because of their importance in many industries. Schowalter [8] was the first one who studied the boundary-layer flow of a non-Newtonian fluid. Similarity solutions were obtained by Acrivos et al. [9], Kapur and Srivastava [10], Lee and Ames [11], Berkovskii [12], Hansen and Na [13], and others. Thomson and Snyder [14–15] studied the effect of injection on the flow of a non-Newtonian power-law fluid over a flat plate. Liu [16] presented a class of asymptotic solutions for the flow of power-law fluids over a flat plate with suction.

Forced convective flow over a flat plate in non-Newtonian power-law fluids was studied by Huang and Lin [17]. Howell et al. [18] applied the Merk–Chao series expansion method to solve the problem of combined momentum and heat transfer in the boundary layer of the moving surface in a power-law fluid. Rao et al. [19] studied the problem of momentum and heat transfer in a power-law fluid with arbitrary injection (suction) at a moving wall using the