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Exact solution of thermal radiation on MHD flow over a stretching porous sheet

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Abstract

The effect of radiation on MHD steady asymmetric flow of an electrically conducting fluid past a stretching porous sheet in the presence of radiation has been analyzed. Exact solutions for the velocity and temperature fields have been derived and the effects of radiation, magnetic, Prandtl number, wall temperature and suction (or injection) parameters have been studied with the help of graphs.

Keywords: Radiative effects; Heat transfer; MHD transfer; Similarity solution; Stretching sheet; Kummer's function

1. Introduction

The effect of radiation on MHD flow and heat transfer problems have become more important industrially. At high operating temperature, radiation effect can be quit significant. Many processes in engineering areas occur at high

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temperatures and knowledge of radiation heat transfer becomes very important for the design of the pertinent equipment. Nuclear power plants, gas turbines and the various propulsion devices for aircraft, missiles, satellites and space vehicles are examples of such engineering areas. As the difference between the surface temperature and the ambient temperature is large, the radiation effect becomes important. In the aspect of convection radiation, Viskanta and Grosh [1] considered the effects of thermal radiation on the temperature distribution and the heat transfer in an absorbing and emitting media flowing over a wedge by using the Rosseland diffusion approximation. This approximation leads to a considerable simplification in the expression for radiant flux. In [1] and [2], the temperature differences within the flow are assumed to be sufficiently small such that T^4 may be expressed as a linear function of temperature, i.e., $T^4 \cong 4T_\infty^3 T - 3T_\infty^4$. The thermal radiation of a gray fluid, which is emitting and absorbing radiation in a non-scattering medium, has been examined by Ali et al. [3], Ibrahim [4], Mansour [5], Hossain et al. [6,7], and Elbashbeshy and Dimian [8]. In the present paper we determine the exact solution of radiation effects on MHD steady asymmetric flow of an electrically conducting fluid past a stretching porous sheet.

2. Analysis

Consider a steady two-dimensional incompressible flow caused by a moving sheet, which, is placed in a quiescent, electrically conducting fluid. A magnetic field of uniform strength is applied perpendicular to the stretching sheet. The magnetic Reynolds number is taken to be small enough so that the induced magnetic field can be neglected. The x-axis is chosen along the sheet and the y-axis perpendicular to it. The sheet issues from a thin slit at the origin ($x = 0$, $y = 0$). It is assumed that the speed of a point on the plate is proportional to its distance from the slit, the boundary layer approximation are still applicable. The radiative heat flux in the x-direction is considered negligible in comparison to that in the y-direction. The equations governing the problem are given by

Continuity equation:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0. \tag{1}$$

Momentum equation:

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = v\frac{\partial^2 u}{\partial y^2} - \frac{\sigma B_0^2}{\rho}u. \tag{2}$$