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Chapter 3: Analysis of Entropy Generation in MHD Dusty Fluid Flow along a Vertical Stretching Sheet with Variable Physical Properties

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Abstract: The objective of this paper is to examine the nature of irreversibilities in the form of entropy generation for a dusty fluid flow near an isothermal linearly stretching sheet in the presence of a uniform magnetic field with heat generation. Non-linear partial differential equations governing the motion are reduced to a system of ordinary differential equations using suitable similarity transformations. Resultant equations are then solved numerically using fourth order Runge-Kutta shooting method. The velocity, temperature and species concentration of fluid and solid particles are presented graphically for various physical parameters involved in the problem. Further, these profiles are used to evaluate the entropy generation.

Keywords: Dusty fluid, variable viscosity, variable thermal conductivity, entropy analysis.

Introduction

The problems of two-phase fluid flow containing dust particles have drawn the attentions of several researchers due to its wide range of applications in engineering, gas purification, fluidized beds, exhaust nozzle, sedimentation process and many more. Saffman [1] was the first to develop the boundary layer equations for laminar dusty fluid flow. Michael and Miller [2] have researched the dusty gas flow through flat parallel plates disregarding volume fraction.

Marble [3] investigated the dynamics of a gas with small solid particles. Baral [4] noticed a conducting dusty fluid flow in a plane parallel pattern. Chakrabarti [5] looked at the flow of a dusty gas in boundary layer. The movement of dusty gas in a channel with arbitrary time-varying pressure has been discussed by Gupta and Gupta [6]. The flow of a dusty fluid in a boundary layer across a semi-infinite flat plate has been discussed by Datta and Mishra [7]. Vajravelu and Nayfeh [8] examined the effects of fluid-particle interaction, particle loading, and suction on the flow characteristics in the MHD flow of a dusty fluid over a stretching sheet and contrasted their analytical solution with numerical ones. Gireesha *et al*. [9, 10] investigated the unsteady hydromagnetic boundary layer flow and heat transfer of dusty fluid across a stretching sheet with variable wall temperature (VWT) and variable heat flux (VHF). In these publications, it is explored how a magnetic field affects the flow and heat transmission of a dusty fluid over an uneven stretched surface when there is an irregular heat source or sink.

Due to the fact that high temperature enhances transport phenomena by causing a decline in the fluid viscosity across the hydrodynamic boundary layer, fluid physical properties such as viscosity and thermal conductivity cannot be assumed constant in engineering and industrial processes involving high temperatures. This in turn affects the thermal boundary layer, which in turn affects the rate of heat transfer. Investigating the effects of varying viscosity and thermal conductivity with temperature in the flow and thermal fields becomes crucial for a better prediction in such circumstances.