THE EFFECTS OF RADIATION ON UNSTEADY MHD CONVECTIVE HEAT TRANSFER PAST A SEMI-INFINITE VERTICAL POROUS MOVING SURFACE WITH VARIABLE SUCTION

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***Abstract*— Numerical solutions for the effects of radiation on a MHD convective heat transfer past a semi-infinite porous plate with a magnetic field are obtained. It is assumed that the porous plate moves with a constant velocity in the direction of fluid flow, and the free stream velocity follows the exponentially increasing small perturbation law. The magnetic field acts perpendicular to the porous surface which absorbs the fluid with a suction velocity varying with time. The governing equations for the flow are transformed into a system of nonlinear ordinary differential equations by perturbation technique and then are solved numerically by using the shooting method. The effects of the various parameters on the velocity, temperature profiles as well as the surface skin-friction and surface heat transfer are illustrated graphically.**

***Keywords*— Unsteady state, Radiation, Moving surface, Magnetic field, Suction.**

I. INTRODUCTION

It is known that the effects of radiation on MHD flow and heat transfer problem have become more important industrially. At high operating temperature, radiation effects can be quite significant. Many processes in engineering areas occur at high temperature and a 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. Raptis (1998) investigate the steady flow of a viscous fluid through a very porous medium bounded by a porous plate subjected to a constant suction velocity by the presence of thermal radiation. Bestman (1990) examined the natural convection boundary layer with suction and mass transfer in a porous medium. His results confirmed the hypothesis that suction stabilizes the boundary layer and allows the most efficient method in boundary layer control yet known. Abdus Sattar and Hamid Kalim (1996) investigated the unsteady free convection interaction with thermal radiation in a boundary layer flow past a vertical porous plate. Makinde (2005) examined the transient free convection interaction with thermal radiation of an absorbing emitting fluid along moving vertical permeable plate.

Chamkha (2004) assumed that the plate is embedded in a uniform porous medium and moves with a constant velocity in the flow direction in the presence of a transverse magnetic field. Raptis and Perdikis (2002) studied the unsteady free convection flow of water near 4 ^{o}C in the laminar boundary layer over a vertical moving porous plate. Soundalgekar and Patti (1980) studied the problem of the flow past an impulsively started isothermal infinite vertical plate with mass transfer effects.

Takhar *et al.* (1996) studied the radiation effects on MHD free-convection flow of a gas past a semi-infinite vertical plate. Seddeek (2000, 2001) studied thermal radiation and buoyancy effects on MHD free convective heat generating flow over an accelerating permeable surface with temperature-dependent viscosity in the case of steady state. The radiation effects on heat transfer over a stretching surface have been studied by El-bashbeshy (2000).

In spite of all these studies, the unsteady MHD convective heat transfer in the presence of radiation has received little attention. Hence, the main objective of the present investigation is to consider the case of a semi-infinite moving porous plate in a porous medium with the presence of radiation and constant velocity in the flow direction when the magnetic field is imposed transverse to the plate and subjected to variable suction. It is also assumed that an exponential variation with time is imposed to temperature.

II. MATHEMATICAL FORMULATION

We consider, unsteady flow of a laminar, incompressible fluid past a semi-infinite vertical porous moving plate embedded in a porous medium in the presence of radiation and subjected to a transverse magnetic field (Fig. 1). In our problem we assumed that there is no applied voltage which implies the absence of an electric field. The transversely applied magnetic field and magnetic Reynolds number are very small and therefore the induced magnetic field is negligible (Cowling, 1957). Viscous and Darcy's resistance terms are taken into account with constant permeability of the porous medium. The governing equations for our problem under the usual boundary layer approximation can be written as follows:

$$\frac{\partial \hat{\upsilon}}{\partial \hat{y}} = 0, \qquad (1)$$