THERMAL DIFFUSION EFFECT ON A THREE-DIMENSIONAL MHD FREE CONVECTION WITH MASS TRANSFER FLOW FROM A POROUS VERTICAL PLATE

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Abstract— **A systematic analysis to study the effect of thermal diffusion on a three dimensional free convective flow with mass transfer of an incompressible viscous electrically conducting fluid past a porous vertical plate with transverse sinusoidal suction velocity is presented. Due to this type of suction velocity at the plate the flow becomes three-dimensional one. A magnetic field of uniform strength is assumed to be applied normal to the plate directed into the fluid region. The magnetic Reynolds number is considered to be small so that the induced magnetic field can be neglected. An analytical solution of the problem is obtained. The expressions for the velocity field, fluid temperature, species concentration, fluid pressure, skin-friction, Nusselt number and Sherwood number and current density are obtained in non-dimensional forms. The effects of Hartmann number, Soret number, Reynolds number and Prandtl number on the velocity field, temperature and concentration distributions, skin friction at the plate and on the amplitudes of the first order skin-friction, the first order Nusselt number and the first order Sherwood number at the plate are discussed graphically. It is seen that the thermal diffusion and applied magnetic field have significant effects on the flow and on the heat and mass transfer characteristics**

Keywords -- **Thermal diffusion, Species concentration, free convection, skin-friction, electrically conducting.**

I. INTRODUCTION

Many natural phenomena and technological problems are susceptible to MHD analysis. Geophysics encounters MHD characteristics in the interactions of conducting fluids and magnetic fields. Engineers employ MHD principle in the design of heat exchange pumps and flow meters, in space vehicle propulsion, thermal protection, braking, control and re-entry, in creating naval power generating systems etc. From technological point of view, MHD convection flow problems are also very significant in the fields of stellar and planetary magnetospheres, aeronautics, chemical engineering and electronics. The application of MHD principles in medicine and biology are of paramount interest owing to their significance in bio medical engineering in general and in the treatment of various pathological state in particular. Applications in biomedical engineering include cardiac MRI, ECG etc. MHD is also used in stabilizing a flow against the transition from laminar to turbulent flow and in the reduction of turbulent drag and suppression of flow separation. Some Model studies of the above phenomena of MHD convection have been made by many. Some of them are Sanyal and Bhattacharya (1992), Ferraro and Plumpton (1996) and Cramer and Pai (1973). On the other hand, along with free convection currents caused by the temperature difference, the flow is also affected by the difference in concentrations of material constitutions. Many investigators have studied the phenomena of MHD free convection and mass transfer flow of who the names of Singh and Singh (2000) and Singh *et al.* (2007) are worth mentioning.

The effect of the three dimensional flow caused by the periodic suction perpendicular to the main flow when the difference between the wall temperature and free stream temperature gives rise to buoyancy force in the direction of the free stream on heat transfer characteristics was investigated by Singh *et al.* (1988), Ahmed and Sarma (1997) and Chaudhary and Chand (2002). The effects of transverse sinusoidal injection velocity distribution on the three dimensional free convective Couette flow of a viscous incompressible fluid in slip flow regime under the influence of heat source has been recently studied by Jain and Gupta (2006). Ahmed *et al.* (2006) obtained an analytical solution to the problem of the three-dimensional free convective flow of an incompressible viscous fluid past a porous vertical plate with transverse sinusoidal suction velocity taking into account the presence of species concentration.

However in the above mentioned works, the thermal – diffusion (Soret) effect was not taken into account. This assumption is justified when the concentration level is very low. The flux of mass caused due to temperature gradient is known as the Soret effect or the thermal – diffusion effect. The thermal diffusion effect is applied for isotope separation and in mixtures between gases with very light molecular weight (H_2,H_e) and medium molecular weight (N_2,air) where the diffusion – thermo effect is found to be of a magnitude such that it can not be neglected. The experimental investigation of the thermal – diffusion effect on mass transfer related problem was first performed by Charles Soret in 1879. There after this thermal – diffusion effect is termed as the Soret effect in honour of Charles Soret. In general