Executive Summary of Minor Research Project on

An Oscillatory Free Convective MHD Flow Through Porous Medium in a Rotating Vertical Porous Channel with Heat Source

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The hydromagnetic convection with heat transfer in a rotating porous medium has been studied due to its importance in the design of Magnetohydrodynamics(MHD) generators and accelerators in geophysics, in design of underground water energy storage system, soil sciences, astrophysics, nuclear power reactors, MHD boundary layer control of reentry vehicles and so on. Magnetohydrodynamics is currently undergoing a period of great enlargement and differentiation of subject matter. The interest in these new problems generates from their importance in liquid metals, electrolytes and ionized gases. In the laboratory many new devices have been made which utilize the MHD interaction directly such as propulsion units and power generators; or which involve fluid electromagnetic field interactions, such as electron beam dynamics, traveling wave tubes, electrical discharges and many others. Attia and Kotb (Attia and Kotb 1996) studied the MHD flow between two parallel porous plates. Yen and Chang (Yen and Chang 1964) analyzed the effects of wall electrical conductance on the magnetohydrodynamic couette flow. A magnetohydrodynamic flow in a duct has also been studied by Chang and Lundgren (Chang and Lundgren 1961)

Flows through porous media are very much prevalent in nature and, therefore, the study of flows through porous media has attracted the attention of a number of scholars because of its scientific and engineering applications. Civil engineering deals, for examples, with the flow of water in aquifers, transport of pollutants in aquifers and the propagation of stresses under foundations of structures. Agriculture engineering deals, for example, with the movement of water and solutes in the root zone in the soil. Reservoir engineers deal with the flow of oil, water and gas in petroleum reservoirs . On account of their varied importance, these flows have been studied by several authors. Raptis (Raptis 1983) analyzed the unsteady flow through a porous medium bounded by an infinite porous plate subjected to a constant suction and variable temperature. Raptis and Perdikis (Raptis and Perdikis 1985) further studied the problem of free convective flow through a porous medium bounded by a vertical

porous plate with constant suction when the free stream velocity oscillates in time about a constant mean value.

Apart from the above two dimensional studies a number of three dimensional flows through porous medium have also been studied. Singh et al. (Singh et al. 2000) also investigated the effect of permeability variation on the heat transfer and three dimensional flow through a highly porous medium bounded by an infinite porous plate with constant suction. Singh and Verma (Singh and Verma 1995) studied further the flow of a viscous incompressible fluid through porous medium when the free stream velocity oscillates in time about a non-zero constant mean. The flow of fluids through porous medium bounded by rotating porous channels find many industrial applications particularly in the fields of centrifugation, filtration and purification processes.

In the recent years a number of studies have appeared in the literature involving rotation to a greater or lesser extent viz. Vidyanidhu and Nigam (Vidyanidhu and Nigam 1967), Gupta (Gupta 1972a) Jana and Datta (Jana and Datta 1977), Singh (Singh 2000), Guria et al(Guria et al. 2006). Injection/suction effects have also been studied extensively for horizontal porous plate in rotating frame of references byMazumder (Mazumder 1975), Mazumder et al. (Mazumder et al. 1976), Soundalgekar and Pop (Soundalgekar and Pop 1973), Singh (Singh 1999), Alphonsa and Singh (Alphonsa and Singh 2008, 2014) for different physical situation.

A number of analytical studies such as Ostrach(Ostrach 1952, 1958), Singh(Singh 2001),Ahmed and Kalita(Ahmed and Kalita 2012)Mohammed and Bhaskar(Mohammed and Bhaskar 2012) have also been carried out for various forms of heat generation to analyze MHD free convection and mass transfer flow with heat source and thermal diffusion due to its great applicability to ceramic tiles production problem. Singh and Kumar (Singh and Kumar 2012), Singh and Pathak (Singh and Pathak 2013), Sengupta and Ahmed(Sengupta and Ahmed 2014) analyzed the MHD free convection flow of radiating fluid in a porous channel filled with porous medium and electrically conducting fluid through a rotating vertical porous channel in the presence of thermal radiation. In the present paper an attempt has been made to study the effects of the permeability of the porous medium bounded by channel plates and the injection/suction through the porous plates on the free convective MHD flow in the presence of heat source .

The present thesis is divided into five chapters. The first Chapter is devoted to the introduction of fluid mechanics. In that Need for the study, Some Definitions , Navier stokes

equations, Governing Equations for Rotating System, Dimensionless Parameters, Perturbation Technique, Boundary Layer, Separation of Boundary Layers, Boundary Layer Control are discussed in detail.

Chapter Second deals with Lorentz Transformation, The Maxwell-Lorentz Transformation, The Electromagnetic Body Force, The Body Force in a Fluid, Flow under the action of Electromagnetic Body Force, Magnetohydrodynamic Assumptions, The Fundamental Equations of MHD Flow, Non-dimensional parameters of MHD.

Chapter Three include the features of flow through porous media, mainly Porosity, Darcy's Law, Permeability of Porous Medium, Governing Equations of Porous Media.

In Chapter Four, an oscillatory free convective flow of a viscous incompressible and electrically conducting fluid in a vertical channel is investigated. The two plates are subjected to a constant injection and suction. A uniform magnetic field is applied in the direction normal to the plates. The entire system rotates about the axis normal to the plates with uniform angular velocity Ω. For small and large rotations the dependence of the steady and unsteady resultant velocities and their phase differences on various parameters are discussed in detail.

Chapter five an analysis of an oscillatory free convective flow of a viscous incompressible and electrically conducting fluid through porous medium in a vertical porous channel in the presence of heat source/sink is carried out. The two porous plates are subjected to a constant injection and suction. A uniform magnetic field is applied in the direction normal to the plates. The entire system rotates about the axis normal to the plates with uniform angular velocity Ω. For small and large rotations the dependence of the steady and unsteady resultant velocities and their phase differences on various parameters are discussed in detail.

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