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MHD Two Phase Flow Model and Co-ordinate system

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ABSTRACT: Two-fluid flows and two-phase flows are the most popular areas of research, have received much attention in the literature by various investigators due to their abundant applications in several fields, such as geophysical, astronomical, industrial and technological fields.Numerical calculations of the resulting solutions are performed and by varying the various physical parameters Hartmann number, Hall parameter, and represented graphically to discuss interesting features of the solutions. We observed that an increase thermal conductivity ratio increases the primary and secondary velocity distributions for fixed values of the remaining governing parameters.

KEY WORDS: MHD, Two Phases, Reynolds number, Ionized Fluids, Viscous.

INTRODUCTION

Consider a MHD two–dimensional steady state viscous two-fluid flow of an ionized gas driven by a common constant pressure gradient $\left(-\frac{\partial p}{\partial x}\right)$ in a horizontal channel consisting of two parallel walls extending in the x– and z–directions, taking Hall currents into account. These currents are included in this present analysis using the generalized Ohm's law. Figure illustrates the flow model and the coordinates system choosing the origin midway between the walls. The upper and lower fluids in the regions $0 \le y \le h_1$ and $-h_2 \le y \le 0$ are designated as Region-I and Region-II respectively. The Regions-I and II are occupied by two immiscible electrically conducting incompressible fluids having different densities ρ_1, ρ_2, viscosities μ_1, μ_2 and electrical conductivities σ_{01}, σ_{02}. And channel width is assumed to be very large in comparison with the channel height. Since the walls are infinite in extent along x- and z-directions, so all physical quantities except pressure will be functions of y only. A constant magnetic field $\mathbf{B_0}$ is applied in the **y**–direction i.e., transverse to the flow field. The interface between the two immiscible fluids is assumed to be flat, stress free and undisturbed. The boundaries of the channel are rigid. We assume that the magnetic Reynolds number is small. The x-axis is taken in the direction of hydrodynamic pressure gradient in the plane parallel to the channel walls but not in the direction of flow.

Region– I

$$\frac{1}{P_r}\frac{d^2\theta_1}{dy^2} = -\left\{\left(\frac{du_1}{dy}\right)^2 + \left(\frac{dw_1}{dy}\right)^2 + H_a^2 I_1^2\right\},\ I_1^{\,2} = I_{x_1}^{\;2} + I_{z_1}^{\;2},$$

Region– II

$$\frac{d^2\theta_2}{dy^2} = -\frac{\beta}{\alpha}\left[\left(\frac{du_2}{dy}\right)^2 + \left(\frac{dw_2}{dy^2}\right)\right] + h^2\sigma\beta H_a^2 I_2^{\,2},\ I_2^{\,2} = I_{x_2}^{\;2} + I_{z_2}^{\;2},$$

The velocity, temperature and interface boundary conditions are:

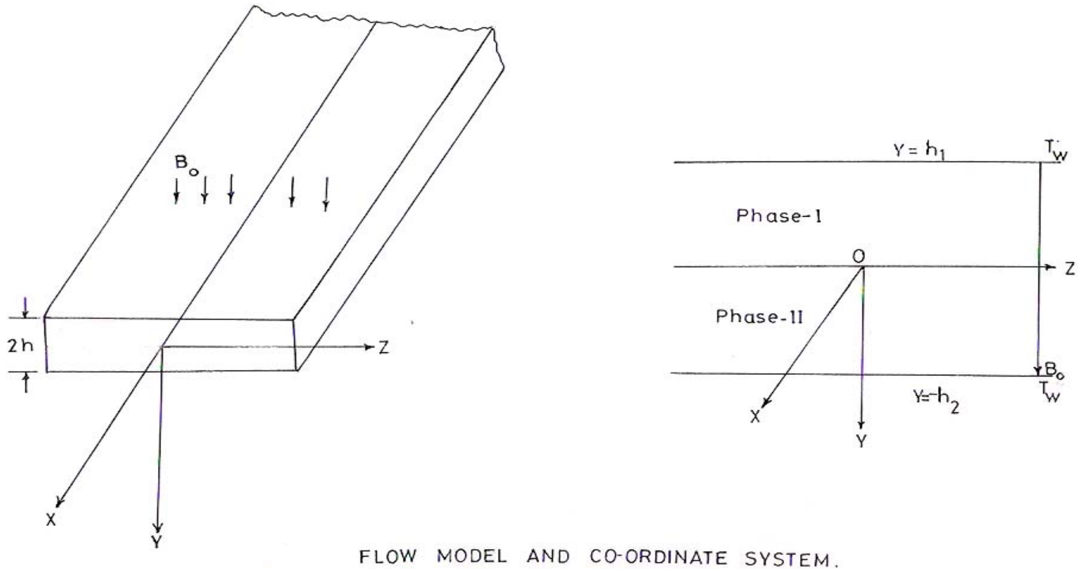
$$u_1(+1) = 0, w_1(+1) = 0, \quad (1)$$

$$u_2(-1) = 0, w_2(-1) = 0, \quad (2)$$

$$u_1(0) = u_2(0), w_1(0) = w_2(0), \quad (3)$$

$$\frac{du_1}{dy} = \frac{1}{\alpha h}\frac{du_2}{dy} \text{ and } \frac{dw_1}{dy} = \frac{1}{\alpha h}\frac{dw_2}{dy} \text{ at y=0.} \quad (4)$$

The conditions (1) and (2) represent the no-slip conditions at the walls. The conditions (3) and (4) represent the continuity of velocity and shear stress at the interface y=0.



FLOW MODEL AND CO-ORDINATE SYSTEM.

Solutions of the problem

Exact solutions of the governing differential equations with the help of boundary and interface conditions for the primary and secondary velocities u_1, u_2 and w_1, w_2 respectively. The numerical values of the expressions given at equations and computed for different sets of values of the governing parameters involved in the study and these results are presented graphically from figure, also discussed in detail.

Results and discussion

Fig.1 depicts the effect of the thermal conductivity ratio on temperature distribution. It is found that the temperature increases as β increases for both the fluids. Also it is noticed that the temperature profile in the channel moves above the channel centerline towards region-I i.e., temperature is high in the upper region compared to the lower region for small values of thermal conductivity ratio (for β= 0.1), the maximum temperature distribution in the channel tends to move below the channel centerline towards region-II (fluid in the lower region) for thermal conductivity ratio (for β= 0.5, 1, 1.5, 2) when all the remaining parameters held fixed.

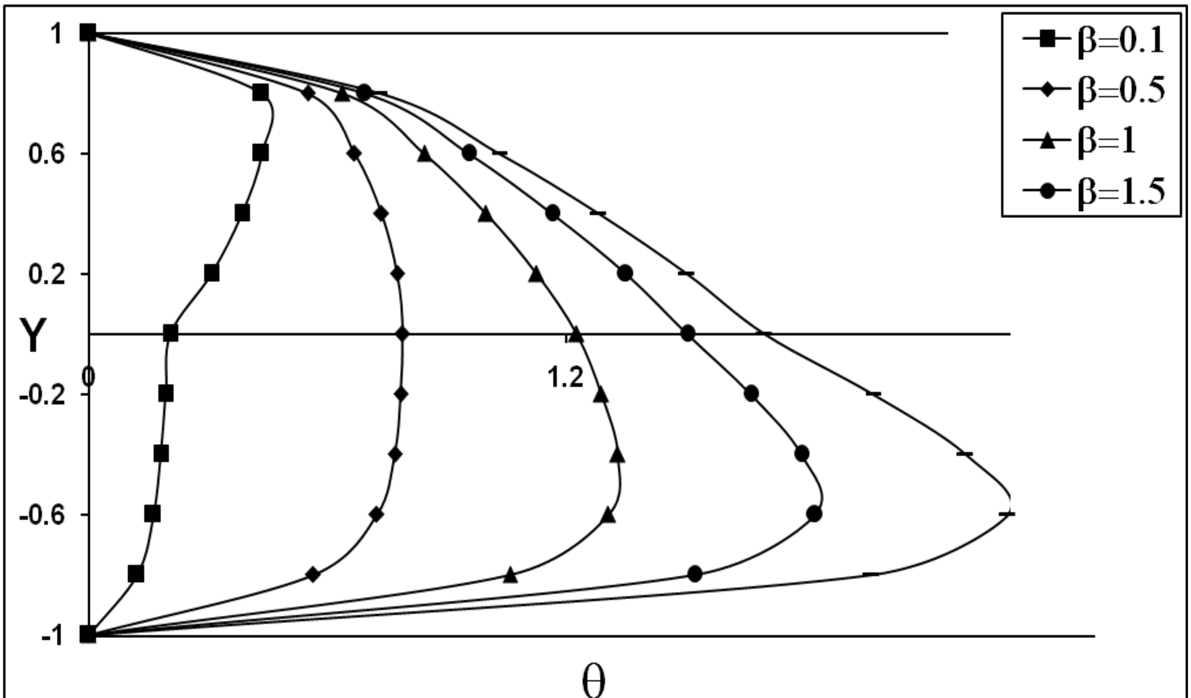


Fig.1 Temperature profiles for different β and H_a=10, α=0.333, σ_0=2, σ_1=1.2, σ_2=1.5, h=0.8, m=2.

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