IJARST

International Journal of Advanced Research in Science and Technology

journal homepage: www.ijarst.com

ISSN 2319 – 1783 (Print)

ISSN 2320 – 1126 (Online)

Heat Transfer in Two Ionized Fluids through a Horizontal Channel between Two Parallel Walls.

S. Sreedhar*

Department of Engineering Mathematics, Raghu Engineering College, Visakhapatnam-531162, (A.P.), India.

****Corresponding Author's Email: sreedhar_153@yahoo.com***

ARTICLEINFO

Article history:

Received : 03 Jan. 2016

Accepted : 20 Mar. 2016

Available online : 09 Apr. 2016

Keywords:

Heat Transfer,
Magnetohydrodynamic,
Viscous,
Ionized,
Incompressible,
Immiscible.

ABSTRACT

Magnetohydrodynamic heat transfer in the fully developed viscous flow of an ionized gas under the influence of a uniform transverse magnetic field with hall current, in different geometrical considerations and under varied conditions. It is assumed that the magnetic Reynolds number is small. The fluids in the two regions are assumed to be incompressible immiscible and electrically conducting with different viscosities and electrical conductivities. The governing differential equations are solved analytically, using the prescribed boundary conditions in both phases and obtained exact solutions for primary and secondary velocity distributions. Numerical calculations of the resulting solutions are performed and by varying the various physical parameters Hartmann number Ha, Hall parameter m, viscosity ratio, height ratio h, thermal conductivity ratio β on the behavior of heat transfer.

PAPER-QR CODE

IJARST

Volume 5, Issue 1

Citation: *S. Sreedhar, Heat Transfer in Two Ionized Fluids through a Horizontal Channel between Two Parallel Walls, Int. J. Adv. Res. Sci. Technol. Volume 5, Issue 1, 2016, pp.553-555.*

Introduction:

The current interest in using Magnetohydrodynamic principle to analyse the effects of influence of the uniform magnetic field on the motion of an electrically conducting fluid (liquid and gas) and its associated heat transfer aspects in two-fluid flow system with varied conditions and of different geometrical situations is an active area of research in many diversified fields; in view of its geophysical, astrophysical, astronautical, also various engineering and technological importance. The theory of heat transfer plays an important role in many design problems in aeronautical, chemical, civil, electrical, and metallurgical and mechanical engineering. Typical applications include design of thermal and nuclear power plants, heat engines, catalytic converters, heat shields for space vehicles, furnaces, electronic components (against overheating), etc

Basic governing equations with boundary, interface conditions and mathematical analysis of the problem

The fundamental equations to be solved are the equations of motion and current for the steady state two-fluid flow of neutral fully–ionized gas valid under assumptions given below and neglecting the asterisks, the non-dimensional forms of equations are simplified as:

(i) The ionization is in equilibrium which is not affected by the applied electric and magnetic fields.

(ii) The effect of space charge is neglected.

(iii) The flow is fully developed and stationary, that is $\partial/\partial t = 0$

And $\partial/\partial x = 0$ except $\partial p/\partial x \neq 0$.

(iv) The magnetic Reynolds number is small [so that the externally applied magnetic field is undisturbed by the fluid, namely the induced magnetic field is small compared with the applied field [Shercliff (1965)]. Therefore components in the conductivity tensor are expressed in terms of B_0.

(v) The flow is two-dimensional, namely $\partial/\partial z = 0$.

With these assumptions, the governing equations of motion and current can be formulated as follows for the two-dimensional steady state problem of study in two regions.

With the above transformations and for simplicity, neglecting the asterisks, the non-dimensional forms of equations are become:

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 boundary conditions are

$$\theta_1(1) = 0,$$

$$\theta_2(-1) = 0,$$

$$\theta_1(0) = \theta_2(0),$$

$$\frac{d\theta_1}{dy} = \frac{1}{\beta h}\frac{d\theta_2}{dy}\text{, at y = 0.}$$

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 figures 1and 2, also discussed in detail.

Results and discussion:

The effect of varying the Hartmann number H_a on temperature distributions in the two regions, (that is, for two-fluids) in the case of s=0 is shown in Fig.1. It is observed in both the regions that, an increase in Hartmann number increases the temperature distribution. Also it is noticed that the temperature profile in the channel moves above the channel centerline towards region-I i.e., profile is high in the upper region compared to the lower region for Hartmann number Ha when all the remaining parameters are fixed.

Fig.2 exhibit the effect of varying Hall parameter ‘m’ on temperature distributions in the case of s=0. From the figure, it is found that an increase in ‘m’ decreases the temperature distribution in the two regions. Also it is noticed that the temperature distribution is high in the upper region compared to the lower region for small values of Hall parameter (for m= 0.05 and 1) when all the remaining parameters held fixed.

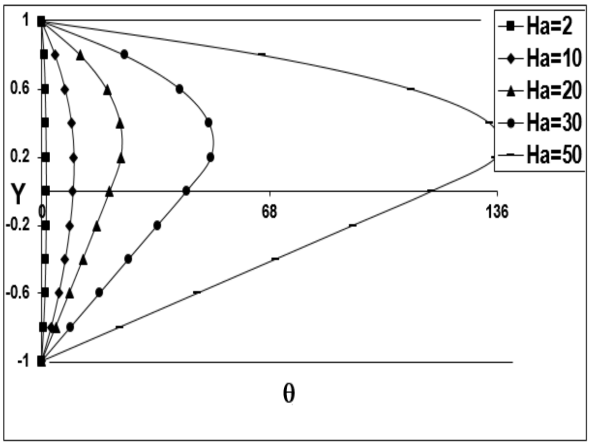

Fig. 1: Temperature profiles for different H_a and a=0.333, s_0=2, s_1=1.2, s_2=1.5, h=0.8, b=1, m=2, s=0.

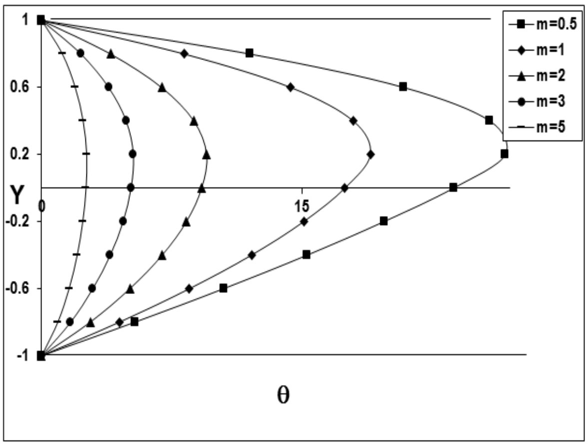

Fig. 2: Temerature Profiles for different m and H_a=10, a=0.333, s_0=2, s_1=1.2, s_2=1.5, b=1, h=0.8, s=0.

References:

1. Aboeldahab, E.M. and Elbarbary, E.M.E., Hall current effect magneto-hydrodynamics free convection flow past a semi.-infinite vertical plate with mass transfer. Int. J. Engng. Sci. (2001) 39, p.1641.
2. Attia, H.A., Velocity and temperature fields of a non-newtonian fluid above a rotating dish with hall effect, Int. Comm. Heat Mass Transfer. (2003) 30(4), p.525-534.
3. Chamkha A.J., Flow of Two-Immiscible Fluids in Porous and Nonporous Channels, ASME J. of Fluids Engineering. (2000) 122, p.117.
4. Chamkha A.J., Unsteady MHD convective heat and mass transfer past a semi-infinite vertical permeable moving plate with heat absorption, Int. J. Eng. Sci. (2004) 42, p.217.

5. Linga Raju T. and Murti, "Quasi-steady state solutions of Unsteady Ionized Hydro Magnetic Flow between Two Parallel porous walls in a rotating system", J. Indian Acad. Math. (2005) 27(2), p.242.
6. Linga Raju T. and Murti, "Hydro magnetic Two phase Flow and heat Transfer through two parallel plates in a rotating system", J. Indian Acad. Math. (2006) 28(2), p.343.
7. Linga Raju, T. and S.Sreedhar, "Ionized Hydro Magnetic Two Phased Flow between Two Parallel Walls", J. Indian Acad. Math. (2009) 31(2), p.112.