Diffussion of Thermo Effects on Unsteady Flow through Porous Medium

K. RamaPrasasd ,Ch. BabyRani

***Abstract**: The intention of this research is to research the impact of thermo physiological parameters at the porous medium. The hallway present, heat radiation and source absorption effects have been into account. The expressions for the speed, temperature, and also the immersion field are derived by employing perturbation technique.*

Keywords: Radiation absorption, Heat source, Iinclined porous plate, Heat transfer

I. INTRODUCTION

Radiation in free convection has also been studied by many authors because of its applications in many engineering and industrial processes.

"Dharmaiah and veeraKrishna [1] studied finite difference analysis on mhd free convection flow through a porous medium along a vertical wall. Veerakrishna and dharmaiah [2] analyzed mhd flow of a rivlin-ericson fluid through a porous medium in a parallel plate channel under externally applied boundary acceleration.in [2],[3],[4]. Dharmaiah performed effects of radiation, chemical reaction and soret on unsteady and Ramprasad et al., reported unsteady mhd convective heat and mass transfer flow past an inclined moving surface with heat absorption in [5],[6],[7].Analyzed chemical response, radiation and also dufour consequences on casson magneto hydro dynamics fluid flow on a vertical plate using Heating source/sink [8],[9],[10]over a vertical permeable plate Dharmaiah studied An unsteady magnetohydro lively heat transport flow in a rotating parallel plate station via a solid medium with radiation influence in [11],[12],[13],[14],[15].

Balamurugan et al., numerically analyzed effect of radiation absorption, viscous and joules dissipation on mhd complimentary convection chemically reactive and radiative stream at a moving likely porous plate using temperature dependent heat supply in[16],[17],[18],[19].

II. MATHEMATICALT FORMULATION

"In the Cartesian coordinate system, the $x'-$is direction of the flow and the $y'-$ axis normal to it. A normal magnetic field is assumed to be applied in the $y'-$ direction",

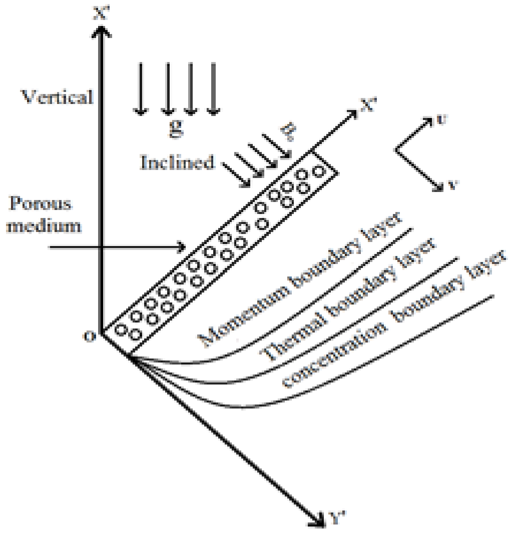

Figure 1: Geometry of the problem

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The governing equations are: "

$$\frac{\partial v'}{\partial y'}=0 \quad (1)$$

$$\frac{\partial u'}{\partial t'}+v'\frac{\partial u'}{\partial y'}=\nu\frac{\partial^2 u'}{\partial y'^2}+g\beta\left(T'-T'_\infty\right)\cos\alpha+g\beta^*\left(C'-C'_\infty\right)\cos\alpha-\frac{m}{1+m^2}\frac{\sigma B_0^2}{\rho}u'-\frac{\nu}{k'}u' \quad (2)$$

$$\frac{\partial T'}{\partial t'}+v'\frac{\partial T'}{\partial y'}=\frac{k}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2}+\frac{D_m k_T}{C_S c_p}\frac{\partial^2 C'}{\partial y'^2}-\frac{Q_0'}{\rho Cp}(T'-T_\infty')+Q_1'(C'-C_\infty') \quad (3)$$

$$\frac{\partial C'}{\partial t'}+v'\frac{\partial C'}{\partial y'}=D\frac{\partial^2 C'}{\partial y'^2}-K_r'\left(C'-C'_\infty\right) \quad (4)$$

The boundary conditions for the velocity, temperature, and concentration fields are given as follows:

$$u'=0, T'=T'_w+\varepsilon(T'_w-T'_\infty)e^{\eta' t'}, C'=C'_w+\varepsilon(C'_w-C'_\infty)e^{\eta' t'} \quad \text{at} \quad y'=0$$
$$u'=0, \quad T'\to T'_\infty, \quad C'\to C'_\infty \quad \text{as} \quad y'\to\infty \quad (5)$$

Where

T'_w and C'_w are the temperature and concentration near the plate respectively and η' is the constant. Thus, assuming the suction velocity to be oscillatory about a non-zero constant mean, one can write $v'=-v_0\left(1+\varepsilon e^{i\eta' t'}\right)$, "

The following non-dimensional quantities are: "

$$y=\frac{v_0 y'}{4\nu}, u=\frac{u'}{v_0}, t=\frac{t' v_0^2}{4\nu}, \theta=\frac{T'-T'_\infty}{T'_w-T'_\infty}, C=\frac{C'-C'_\infty}{C'_w-C'_\infty}, K=\frac{K' v_0^2}{\nu^2},$$
$$Gr=\frac{g\beta\nu(T'_w-T'_\infty)}{v_0^3}, \Pr=\frac{\nu\rho C_p}{k}, K_r=\frac{K'_r\nu}{v_0^2}, Gm=\frac{g\beta^*\nu(C'_w-C'_\infty)}{v_0^3},$$
$$Sc=\frac{\nu}{D}, \eta=\frac{4\nu\eta'}{v_0^2}, M=\frac{\sigma B_0^2\nu}{\rho v_0^2}, D_u=\frac{D(C'_w-C'_\infty)}{\nu(T'_w-T'_\infty)}, Q'_0=\frac{Q_h K v_0^2}{\nu^2}, \quad (6)$$
$$Q'_1=\frac{(T'_w-T'_\infty)v_0^2 Q_a}{(C'_w-C'_\infty)\nu}$$

The governing equations are

$$\frac{1}{4}\frac{\partial u}{\partial t}-\left(1+\varepsilon e^{i\eta t}\right)\frac{\partial u}{\partial y}=I_r\theta+I_m C+\frac{\partial^2 u}{\partial y^2}-Hu \quad (7)$$

$$\frac{1}{4}\frac{\partial \theta}{\partial t}-\left(1+\varepsilon e^{i\eta t}\right)\frac{\partial \theta}{\partial y}=\frac{1}{\Pr}\frac{\partial^2\theta}{\partial y^2}+D_u\frac{\partial^2 C}{\partial y^2}-\frac{1}{\Pr}\theta Q_h+Q_a C \quad (8)$$

$$\frac{1}{4}\frac{\partial C}{\partial t}-\left(1+\varepsilon e^{i\eta t}\right)\frac{\partial C}{\partial y}=\frac{1}{Sc}\frac{\partial^2 C}{\partial y^2}-K_r C \quad (9)$$

Where

$$I_r=Gr\cos\alpha, I_m=Gm\cos\alpha, H=\left(\frac{m}{1+m^2}M+\frac{1}{K}\right)$$

The boundary conditions are transformed to:

$$u=0, \ \theta=1+\varepsilon e^{i\eta t}, \ C=1+\varepsilon e^{i\eta t} \quad \text{at} \quad y=0 \text{ "}$$
$$u\to 0, \quad \theta\to 0, \quad C\to 0 \quad \text{as} \quad y\to\infty \quad (10)$$

III. SOLUTION OF THE PROBLEM

The following equations can be solved analytically. The representation of the velocity, temperature and concentration are "

$$u(y,t) = u_0(y) + \varepsilon e^{i\eta t} u_1(y) + o\left(\varepsilon^2\right) + ...$$

$$\theta(y,t) = \theta_0(y) + \varepsilon e^{i\eta t} \theta_1(y) + o\left(\varepsilon^2\right) + ...$$

$$C(y,t) = C_0(y) + \varepsilon e^{i\eta t} C_1(y) + o\left(\varepsilon^2\right) + ... \quad (11)$$

Substituting (11) in Eqs (7) – (9) and equating the harmonic and non – harmonic terms we get

$$u_0'' + u_0' - Hu_0 = -I_r\theta_0 - I_m C_0 \quad (12)$$

$$u_1'' + u_1' - F_2 u_1 = -I_r\theta_1 - I_m C_1 - u_0' \quad (13)$$

$$\theta_0'' + \Pr\theta_0' - Q_h\theta_0 = -\Pr D_u C_0'' - \Pr Q_a C_0 \quad (14)$$

$$\theta_1'' + \Pr\theta_1' - F_1\theta_1 = -\Pr\theta_0' - \Pr D_u C_1'' - \Pr Q_a C_1 \quad (15)$$

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$$C_0'' + ScC_0' - ScK_r C_0 = 0 \quad (16)$$

$$C_1'' + ScC_1' - Sc\left(K_r + \frac{i\eta}{4}\right)C_1 = -C_0' \quad (17)$$

The corresponding boundary conditions are

$$u_0 = 0, u_1 = 0, \theta_0 = 1, \theta_1 = 1, C_0 = 1, C_1 = 1 \quad \text{at} \quad y = 0$$

$$u_0 \to 0, u_1 \to 0, \theta_0 \to 0, \theta_1 \to 0, C_0 \to 0, C_1 \to 0 \quad \text{as} \quad y \to \infty \quad (18)$$

Solving eq's (12) – (17) under the (18) we get theexpressions for velocity, temperature and concentration are

$$u(y,t) = [A_{11}\exp(-m_5 y) - A_9\exp(-m_3 y) - A_{10}\exp(-m_1 y)] + \varepsilon\exp(i\eta t)\begin{bmatrix} A_{17}\exp(-m_6 y) + A_{12}\exp(-m_5 y) - A_{13}\exp(-m_4 y) \\ -A_{14}\exp(-m_3 y) - A_{15}\exp(-m_2 y) - A_{16}\exp(-m_1 y) \end{bmatrix} \quad (19)$$

$$\theta(y,t) = [A_4\exp(-m_3 y) + A_3\exp(-m_1 y)] + \varepsilon\exp(i\eta t)\begin{bmatrix} A_8\exp(-m_4 y) + A_5\exp(-A_3 y) \\ +A_6\exp(-m_2 y) + A_7\exp(-m_1 y) \end{bmatrix} \quad (20)$$

$$C(y,t) = \exp(-m_1 y) + \varepsilon\exp(i\eta t)\left[A_1\exp(-m_1 y) + A_2\exp(-m_2 y)\right] \quad (21)$$

The expressions forSkin-friction coefficient, the Nusselt number and the Sherwood number are

$$C_f = \left(\frac{\partial u}{\partial y}\right)_{y=0} = (m_3 A_9 + m_1 A_{10} - m_5 A_{11}) + \varepsilon\exp(i\eta t) \quad (22)$$

$$(-m_6 A_{17} - m_5 A_{12} + m_4 A_{13} + m_3 A_{14} + m_2 A_{15} + m_1 A_{16})$$

$$Nu = -\left(\frac{\partial\theta}{\partial y}\right)_{y=0} = (m_3 A_4 + m_1 A_3) + \varepsilon\exp(i\eta t)(m_4 A_8 + m_3 A_5 + m_2 A_6 + m_1 A_7) \quad (23)$$

$$Sh = -\left(\frac{\partial C}{\partial y}\right)_{y=0} = m_1 + \varepsilon\exp(i\eta t)(m_2 A_2 + m_1 A_1) \text{"} \quad (24)$$

IV. RESULTS AND DISCUSSION

The present study is the effects of diffusion thermo effects on unsteady free convective two-dimensional flow past an infinite inclined plate act of placing in a porous medium The effects of followingvarious parameterson like Gr, Gm, M, K, $\Pr$, Sc, D_u, Q_h, Q_a , α and K_r on the u, θ, c have been studiedanalytically.

Figure.1: Effects of Schmidt number on velocity profiles

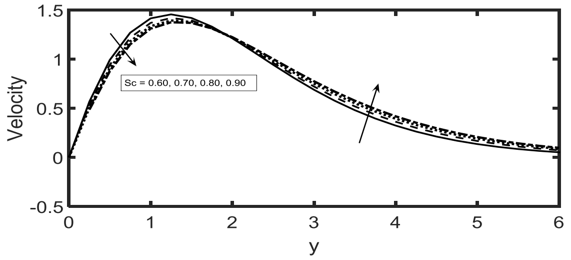

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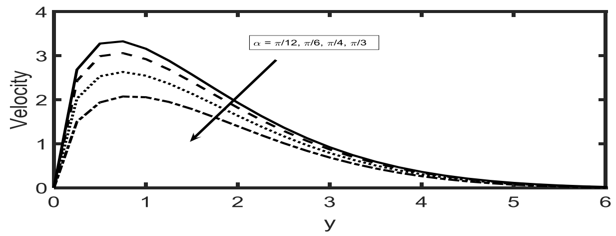
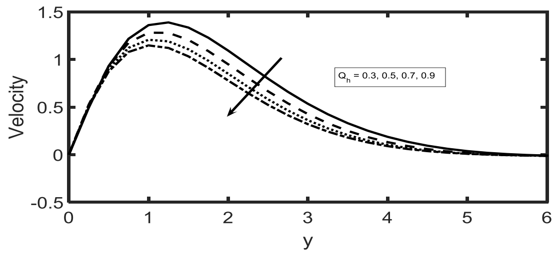
Figure 1 show sthat the velocity decreases with increasing Schmidt number until critical point after that it is increases. 4

Figure.2:Effects of inclined angled on velocity profiles



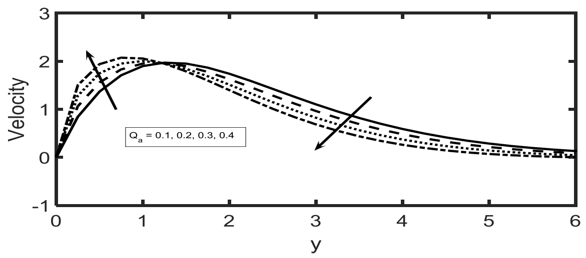
From figure 2it shows that boundary layer flow for the velocity decreases with the increase of the angle of inclination.

Figure.3: Effects of Heat Radiation on velocity profiles.



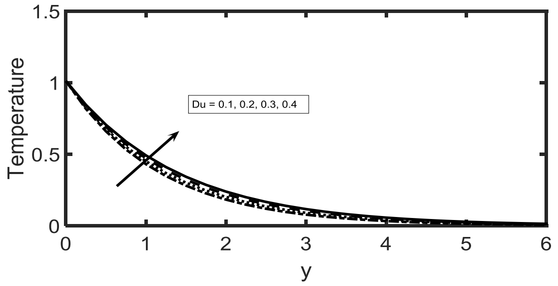
From figure 3, it is cleared that velocity decreases as the radiation parameter Q_h increases.

Figure.4: Effects of Heat Absorption on velocity profiles.



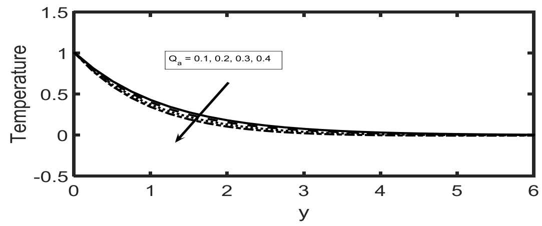
From figure 4it shows that, increase in Qa there is an increase in the velocity until critical point and afterwards it is decreases.

Figure5: Effects of Dufour parameter Du on temperature profiles



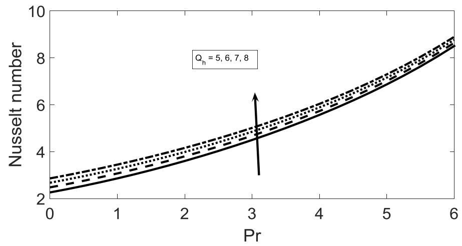
From figure 5 it showsthat the Dufour parameter increases, the fluid temperature distribution also increases.

Figure.6: Effects of Radiation Absorption Q_a on temperature profiles.



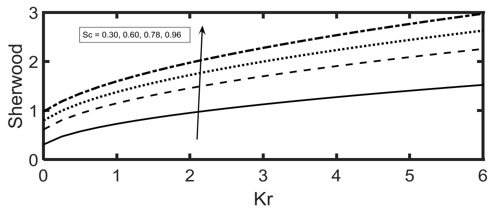
From figure 6, the effect of radiation absorption is found to decrease the temperature boundary layer.

Figure.7: Effects of Heat radiation parameter Q_h on Nusselt number.



From figure 7 shows that Nusselt number inecreases as an increase in Q_h.

Figure.8: Effects of Schmidt number Sc on Sherwood number



Fromfigure 8it showsthat Sherwood number inecreases as an increase in Sc

V. CONCLUSIONS:

The present numerical study isthe effects of diffusion thermo physical parameters in a porous.

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