International Journal of Mathematics And its Applications
Volume 4, Issue 1–B (2016), 47–56.
ISSN: 2347-1557
Available Online: http://ijmaa.in/

International Journal of Mathematics And its Applications

Radiation Effects of MHD Oscillatory Rotation Flow Through a Porous Medium Bounded by Two Vertical Porous Plates in the Presence of Hall Current and Dufour Effect with Chemical Reaction

Research Article

Dr.K.Balamurugan[1] and R.Karthikeyan[2]*

1 Associate Professor, Department of Mathematics, Government Arts College, Tiruvannamalai, Tamilnadu, India.

2 Research Scholar, Department of Mathematics, Government Arts College, Tiruvannamalai, Tamilnadu, India.

Abstract: In this Article, Radiation Effects of Oscillatory flow through a porous medium bounded by two vertical porous plates in the presence of Hall Current and Dufour Effect with homogeneous First order chemical reaction under the influence of uniform magnetic field is studied. One plate is kept stationary and another plate is oscillating with uniform velocity. The Plates are subjected to the constant injection and suction velocities respectively. The basic governing equations of the problem are transformed into a system of non dimensional differential equations, which are solved analytically by using Perturbation techniques. The dimensionless Velocity, temperature and concentration profiles are displayed graphically showing the effects of fluid flow for the different values of the parameters involving in this problem like Hartmann Number M, Radiation Parameter f, Grashof Number Gr, chemical reaction parameter R, Dufour effects Du, It is observed that increase of Permeability parameter K, Hall Parameter m, shows the increase effects of Velocity profile. The increase of chemical reaction parameter R shows decrease effects of concentration.

Keywords: Hall Current, Dufour Effect, Chemical Reaction, MHD, Porous Medium, Oscillatory flow, Heat Source, Rotation effect.

1. Introduction

The influence of strong magnetic field on viscous incompressible flow of electrically conducting fluid has its importance in many applications such as extrusion of plastics in the manufacture of rayon and nylon, etc,.Magnetohydrodynamics free convective flows bounded by two vertical porous plates are studied, because of their wide application and hence it has attracted the attention of many research scholar, investigators and scientists. The ionized gas or plasma can be made to interact with the magnetic field and can frequently alter heat transfer on the bounding surface. Heat transfer by thermal radiation is of great importance when we are concerned with space applications, higher operating temperature and also power engineering.

Oscillatory flows are associated with higher rates of heat and mass transfer. Many studies have been done to understand its characteristics in different systems such as reciprocating engines, pulse combustors and chemical reactors etc. Oscillatory and modulated flows are associated applications in heat and mass transfer. The energy flux caused by a composition gradient is called the Dufour or diffusion -thermo effect. Temperature gradients can also create mass fluxes, and this is the soret

* *E-mail: karthilib007@yahoo.com*

or thermal-diffusion effect.The Soret effect, for instance, has been utilized for isotope separation, and in mixtures between gases with very light molecular weight.For medium molecular weight the dufour effect was found to be of a considerable magnitude such that it cannot be neglected. To study the underground water resources, seepage of water in river beds, the filtration and water purification processes in chemical engineering, one need the knowledge of the fluid flow through porous medium. The porous medium is in fact a non homogeneous medium but for the sake of analysis, it may be possible to replace it with a homogeneous fluid saturated medium which has dynamical equal to those of non homogeneous continuum. Ahmed [1] has studied the MHD Convection with soret and dufour effect in the Three dimensional flow past an infinite vertical porous plate. The same studies extended by including the mixed convective flow in the flow field by Ahmed S [2] has explained the magnetic field effect on a three dimensional mixed convective flow with mass transfer along an infinite vertical porous plate. Magnetohydrodynamics free convective flows bounded by two vertical plates are studied because of their wide application and hence it has attracted the attention of many research scholars, investigators. Under that view, Attia H.A [3] has studied the Transisent MHD flow and heat transfer between two parallel plates with temperature dependent viscosity. MHD plays an important role in agriculature, petroleum industries, geophysics and in astrophysics. Elbashbeshy E.M.A [4] has made a detailed study on Heat and mass transfer along a vertical plate with variable surface temperature and concentration in the pressure of the magnetic field. Gupta G.D and Johari Rajesh [5] have studied the MHD three dimensional flows past a porous plate. Combined heat and mass transfer problems with chemical reaction are importance in many processes and have received a considerable amount of attention in recent years. Gupta G.D and Johari Rajesh [6] have discussed the influence of magnetic field in the fluid flow domain by taking his experiments in the domain of fluid flow over a porous plate. Hossain M.A and Das S.K [7] have studied the heat transfer response of MHD free convection flow along a vertical plate to surface temperature oscillations. Now days, Radiation effects of fluid have many practical applications in industries. Ibrahim S Y and Makinde O.D [8] have studied the Radiation effect on chemically reacting MHD boundary layer flow of heat and mass transfer through porous vertical flat plate. Kim Y.J [9] has studied the Unsteady MHD Convective heat transfer past a semi-infinite vertical porous moving plate with variable suction.

Makinde O.D and ogulu [10] studied the effect of thermal radiation on heat and mass transfer flow of a variable viscosity fluid past a vertical porous plate permeated by a transverse magnetic field. Mudagi [11] has explained the Heat transfer in three dimensional hydromagnetic flow along a porous infinite plate in the presence of viscous dissipative heat. Combined heat and mass transfer of fluid over a vertical porous plate attracted many researchers in recent trends. Muthucumarasamy R [12] studied the Effect of Heat and mass transfer on flow past an oscillatory vertical plate with variable temperature. Palani G and Abbas I [13] have studied the effects of free convection MHD flow with thermal radiation from an impulsively started vertical plate. Sahoo P.K. and Data N [14] have studied the magneto hydrodynamics unsteady free convection flow past an infinite vertical plate with constant suction and heat sink. Sathappan K.E and Muthukumarasamy [15] have discussed the numerical study of hydromagnetic effects on flow past an oscillating semi infinite isothermal vertical plate with uniform mass diffusion in the presence of thermal radiation. The objective of this paper is analyzed hydro magnetic oscillatory flow through porous medium bounded by two vertical porous plates with heat source and dufour effect in the presence of chemical reaction.The aim of the present is to extend the work of Rabin N. Barik et.al

2. Formulation of the Problem

We consider Oscillatory flow through a porous medium bounded by two vertical porous plates in the presence of Hall Current and Dufour Effect with homogeneous first order chemical reaction under the influence of uniform magnetic field is studied. One plate is kept stationary and another plate is oscillating with uniform velocity. The X' axis is taken in vertically upward direction along the plate and Y' axis is chosen normal to it. Neglecting the Joulean heat dissipation and applying Boussinesq's approximation the governing equations of the flow field are written as follows.

$$\frac{\partial v'}{\partial y'} = 0; v' = V_0(Constant) \tag{1}$$

$$\frac{\partial u'}{\partial t'} + V_0\frac{\partial u'}{\partial y'} + 2\Omega w' = \nu\frac{\partial^2 u'}{\partial y'^2} - \frac{\sigma B_0^2}{\rho(1+m^2)}(u'+mw') + g\beta(T'-T_d) + g\beta_c(C'-C_d) - \frac{\nu}{K'}u' \tag{2}$$

$$\frac{\partial w'}{\partial t'} + V_0\frac{\partial w'}{\partial y'} - 2\Omega u' = \nu\frac{\partial^2 w'}{\partial y'^2} - \frac{\sigma B_0^2}{\rho(1+m^2)}(w'-mu') - \frac{\nu}{K'}w' \tag{3}$$

$$\frac{\partial T'}{\partial t'} + V_0\frac{\partial T'}{\partial y'} = \frac{k}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} - \frac{1}{\rho C_p}\frac{\partial q_r}{\partial y'} + \frac{Q}{Cp}(T'-T_d) + \frac{D_m k_T}{C_s C_p}\frac{\partial^2 C'}{\partial y'^2} \tag{4}$$

$$\frac{\partial C'}{\partial t'} + V_0\frac{\partial C'}{\partial y'} = D\frac{\partial^2 C'}{\partial y'^2} - R'(C'-C_d) \tag{5}$$

$$\left.\begin{aligned} &u' = 0, w' = 0, T' = T_0 + \epsilon(T_0 - T_d)\cos\omega' t', C' = C_0 + \epsilon(C_0 - C_d)\cos\omega' t' \ \text{ at } \ y = 0 \\ &u' = U'(t') = U_0(1+cos\omega' t'), w' = 0, T' = T_d, C' = C_d \ \text{ at } \ y = d \end{aligned}\right\} \tag{6}$$

Now, Introducing the following non- dimensional variables and parameters.

$$\left.\begin{aligned} &y = \tfrac{y'}{d},\ t = \tfrac{t'V_0}{d},\ \omega = \tfrac{\omega' d}{V_0},\ u = \tfrac{u'}{U_0},\ K_p = \tfrac{K'V_0}{\nu d},\ \theta = \tfrac{T'-T_d}{T_0-T'_d},\ C = \tfrac{C'-C_d}{C_0-C_d}, \\ &P_e = \tfrac{\rho C_p V_0 d}{k},\ R = \tfrac{R'd}{V_0},\ R_e = \tfrac{V_0 d}{\nu},\ S = \tfrac{Q'd}{\rho C_p V_0},\ U = \tfrac{U'}{U_0},\ Gr = \tfrac{\nu g\beta(T_0-T_d)}{U_0 V_0^2},\ Gm = \tfrac{\nu g\beta_c(C_0-C_d)}{U_0 V_0^2}, \\ &Sc = \tfrac{\vartheta}{D},\ M = B_0 d\sqrt{\tfrac{\sigma}{\mu}},\ f = \tfrac{4I_1 d}{\rho C_p V_0},\ \tfrac{\partial q_{r'}}{\partial y'} = 4I_1(T'-T_d),\ M_1 = \tfrac{M^2}{Re(1+m^2)},\ K^2 = \tfrac{d^2\Omega}{\nu},\ D_u = \tfrac{D_m k_T(C_o-C_d)}{C_s C_p d V_0(T_o-T_d)} \end{aligned}\right\} \tag{7}$$

Where $I_1 = \int\limits_0^\infty K\frac{\partial e_{b\lambda}}{\partial T'}d\lambda$, K$\lambda w$ is the absorption coefficient at wall and $e_{b\lambda}$is Planck's function $Gr$is Grashof Number, Gm is Modified Grashof Number, $M$is Hartmann Number, Re is Reynolds Number, Sc is Schmidt Number, K_p is Permeability of Porous medium Pe is Peclet Number, R is Chemical Reaction Parameter, S is Heat Source, U_0 is Uniform Velocity of the Plate, u, w is non-Dimensional Velocities,V_0 is Constant suction / injection, B_0 is Electromagnetic Induction, ω is Frequency of Oscillation, Du is the Dufour Number, t is non-dimensional time co-ordinate, θ is Non-Dimensional Temperature, Cp is specific heat at constant pressure, d is the distance between the plates.

Substituting equation (7) in equations (2),(3), (4) and (5) under boundary conditions (6) we get

$$\frac{\partial u}{\partial t} + \frac{\partial u}{\partial y} + 2K^2 w = \frac{1}{Re}\frac{\partial^2 u}{\partial y^2} - \frac{M}{1+m^2}(u+mw) + Gr\theta R_e + GmCR_e - \frac{1}{Kp}u \tag{8}$$

$$\frac{\partial w}{\partial t} + \frac{\partial w}{\partial y} - 2K^2 u = \frac{1}{Re}\frac{\partial^2 w}{\partial y^2} + \frac{M}{1+m^2}(mu-w) - \frac{1}{Kp}w \tag{9}$$

$$\frac{\partial \theta}{\partial t} + \frac{\partial \theta}{\partial y} = \frac{1}{Pe}\frac{\partial^2 \theta}{\partial y^2} + (S-f)\theta + D_u\frac{\partial^2 C}{\partial y^2} \tag{10}$$

$$\frac{\partial C}{\partial t} + \frac{\partial C}{\partial y} = \frac{1}{ScRe}\frac{\partial^2 C}{\partial y^2} - RC \tag{11}$$

With the following boundary conditions

$$\left.\begin{aligned} &u = 0, w = 0, \theta = 1 + \tfrac{\varepsilon}{2}(e^{i\omega t} + e^{-i\omega t}), C = 1 + \tfrac{\varepsilon}{2}(e^{i\omega t} + e^{-i\omega t}) && \text{at } y = 0 \\ &u = 1 + \tfrac{\varepsilon}{2}(e^{i\omega t} + e^{-i\omega t}), w = 0, \theta = 0, C = 0 && \text{at } y = 1 \end{aligned}\right\} \tag{12}$$

Now Introducing the Complex Velocity $F = u + iw, M_1 = \frac{M}{1+m^2}(1-im)$, we express the Equation (2) and (3) can be combined into a single equation of the form

$$\frac{\partial F}{\partial t} + \frac{\partial F}{\partial y} = \frac{1}{Re}\frac{\partial^2 F}{\partial y^2} - (M_1 + \frac{1}{Kp} - 2Ik^2)F + Gr\theta R_e + GmCR_e \tag{13}$$

With the following boundary conditions

$$\left.\begin{aligned} &F = 0, && \text{at } y = 0 \\ &F = 1 + \tfrac{\varepsilon}{2}(e^{i\omega t} + e^{-i\omega t}) && \text{at } y = 1 \end{aligned}\right\} \tag{14}$$

3. Method of Solution

To solve equations, (10) ,(11) and (13) Assuming $\epsilon$to be small so that one can express $F, \theta and C$as a regular perturbation series interms ϵ as in the neighborhood of the plate as

$$\begin{aligned} \theta &= \theta_0(y) + \frac{\varepsilon}{2}\theta_1(y)e^{i\omega t} + \frac{\varepsilon}{2}\theta_2(y)e^{-i\omega t} \\ C &= C_0(y) + \frac{\varepsilon}{2}C_1(y)e^{i\omega t} + \frac{\varepsilon}{2}C_2(y)e^{-i\omega t} \\ F &= F_0(y) + \frac{\varepsilon}{2}F_1(y)e^{i\omega t} + \frac{\varepsilon}{2}F_2(y)e^{-i\omega t} \end{aligned} \tag{15}$$

Using the equations (15), we express the velocity, temperature and concentration equations as like as follows:

$$\frac{d^2C_0}{dy^2} - ScRe\frac{dC_0}{dy} - ScReRC_0 = 0 \tag{16}$$

$$\frac{d^2C_1}{dy^2} - ScRe\frac{dC_1}{dy} - ScRe(R + i\omega)C_1 = 0 \tag{17}$$

$$\frac{d^2C_2}{dy^2} - ScRe\frac{dC_2}{dy} - ScRe(R - i\omega)C_2 = 0 \tag{18}$$

$$\frac{d^2\theta_0}{dy^2} - Pe\frac{d\theta_0}{dy} + (S - f)Pe\theta_0 = -PeD_u\frac{d^2C_0}{dy^2} \tag{19}$$

$$\frac{d^2\theta_1}{dy^2} - Pe\frac{d\theta_1}{dy} + ((S - f) - i\omega)Pe\theta_0 = PeD_u\frac{d^2C_1}{dy^2} \tag{20}$$

$$\frac{d^2\theta_2}{dy^2} - Pe\frac{d\theta_2}{dy} + ((S - f) + i\omega)Pe\theta_2 = PeD_u\frac{d^2C_2}{dy^2} \tag{21}$$

$$\frac{d^2F_0}{dy^2} - Re\frac{dF_0}{dy} - (M_1 + \frac{Re}{K} - 2IK^2)F_0 = -GrRe^2\theta_0 - GmRe^2C_0 \tag{22}$$

$$\frac{d^2F_1}{dy^2} - Re\frac{dF_1}{dy} - (M_1 + \frac{Re}{K} + Rei\omega - 2IK^2)F_1 = -GrRe^2\theta_1 - GmRe^2C_1 \tag{23}$$

$$\frac{d^2F_2}{dy^2} - Re\frac{dF_2}{dy} - (M_1 + \frac{Re}{K} + Rei\omega - 2IK^2)F_1 = -GrRe^2\theta_2 - GmRe^2C_2 \tag{24}$$

Solving the equations (16) to (24) we get the solutions as below

$$C_0 = A_1e^{m_1y} + A_2e^{m_2y} \tag{25}$$

$$C_1 = A_3e^{m_3y} + A_4e^{m_4y} \tag{26}$$

$$C_2 = A_5e^{m_5y} + A_6e^{m_6y} \tag{27}$$

$$\theta_0 = A_9e^{m_7y} + A_{10}e^{m_8y} + A_7e^{m_1y} + A_8e^{m_2y} \tag{28}$$

$$\theta_1 = A_{13}e^{m_9y} + A_{14}e^{m_{10}y} + A_{11}e^{m_3y} + A_{12}e^{m_4y} \tag{29}$$

$$\theta_2 = A_{17}e^{m_{11}y} + A_{18}e^{m_{12}y} + A_{15}e^{m_5y} + A_{16}e^{m_6y} \tag{30}$$

$$F_0 = A_{27}e^{m_{13}y} + A_{28}e^{m_{14}y} + A_{19}e^{m_1y} + A_{20}e^{m_2y} + A_{21}e^{m_7y} + A_{22}e^{m_8y} + A_{23}e^{m_1y} + A_{24}e^{m_2y} \tag{31}$$

$$F_1 = A_{37}e^{m_{15}y} + A_{38}e^{m_{16}y} + A_{29}e^{m_3y} + A_{30}e^{m_4y} + A_{31}e^{m_9y} + A_{32}e^{m_{10}y} + A_{33}e^{m_3y} + A_{34}e^{m_4y} \tag{32}$$

$$F_2 = A_{47}e^{m_{17}y} + A_{48}e^{m_{18}y} + A_{39}e^{m_5y} + A_{40}e^{m_6y} + A_{41}e^{m_{11}y} + A_{42}e^{m_{12}y} + A_{43}e^{m_5y} + A_{44}e^{m_6y} \tag{33}$$

3.1. Skin Friction

$$\tau_\omega = -\mu\left(\frac{\partial F}{\partial y}\right)_{y=1} = -(A_{27}m_{13}e^{m_{13}} + A_{28}m_{14}e^{m_{14}} + A_{19}m_1e^{m_1} + A_{20}m_2e^{m_2} + A_{21}m_7e^{m_7} + A_{22}m_8e^{m_8} + A_{23}m_1e^{m_1}$$
$$+ A_{24}e^{m_2} + \frac{\varepsilon}{2}(A_{37}m_{15}e^{m_{15}} + A_{38}m_{16}e^{m_{16}} + A_{29}m_3e^{m_3} + A_{30}m_4e^{m_4} + A_{31}m_9e^{m_9} + A_{32}m_{10}e^{m_{10}}$$
$$+ A_{33}m_3e^{m_3} + A_{34}m_4e^{m_4})e^{I\omega t} + \frac{\varepsilon}{2}(A_{47}m_{17}e^{m_{17}} + A_{48}m_{18}e^{m_{18}} + A_{39}m_5e^{m_5} + A_{40}m_6e^{m_6} + A_{41}m_{11}e^{m_{11}}$$
$$+ A_{42}m_{12}e^{m_{12}} + A_{43}m_5e^{m_5} + A_{44}m_6e^{m_6})e^{-I\omega t}) \tag{34}$$

3.2. Heat Flux

$$Nu = -\left(\frac{\partial \theta}{\partial y}\right)_{y=1} = -(A_9m_7e^{m_7} + A_{10}m_8e^{m_8} + A_7m_1e^{m_1} + A_8m_2e^{m_2} + \frac{\varepsilon}{2}(A_{13}m_9e^{m_9} + A_{14}m_{10}e^{m_{10}}$$
$$+ A_{11}m_3e^{m_3} + A_{12}m_4e^{m_4})e^{I\omega t} + \frac{\varepsilon}{2}(A_{17}m_{11}e^{m_{11}} + A_{18}m_{12}e^{m_{12}} + A_{15}m_5e^{m_5} + A_{16}m_6e^{m_6})e^{-I\omega t} \tag{35}$$

3.3. Mass Flux

$$Sh = \left(\frac{\partial C}{\partial y}\right)_{y=1} = A_1m_1e^{m_1} + A_2m_2e^{m_2} + \frac{\varepsilon}{2}(A_3m_3e^{m_3} + A_4m_4e^{m_4})e^{I\omega t} + \frac{\varepsilon}{2}(A_5m_5e^{m_5} + A_6m_6e^{m_6})e^{-I\omega t} \tag{36}$$

4. Results and Discussion

In order to get physical insight of the problem we have studied the primary, secondary flows, skin friction, heat and mass flux as functions of various parameters like Reynolds Number, Prandtl Number, Suction parameter, Frequency parameter, Schmidt number, Thermal Grashof number and mass Grashof number. The effect of flow parameters on velocity field, Temperature field, Concentration field, skin friction, Nusselt Number and Sherwood number have been analyzed numerically and discussed with the help of numerical values.

4.1. Velocity field

The increasing effects of permeability parameter Kp., Grashof number for heat transfer Gr, Hall Effects m, Modified Grashof Number Gm,Heat Source S and Dufour effects Du accelerate the transient velocity of the flow field. As well as inverse effects exists in the transient velocity of the flow field while increasing Magnetic Parameter (M)

4.2. Temperature Field

Temperature profiles of the flow field with the effected parameters like Peclet number Pe, Permeability parameter Kp ,Grashof Number Gr,Heat Source S,Magnetic Parameter M, are graphically shown its effects on the flow field. Temperature profile goes on increase while growing parameter Peclet Number (Pe) and Heat Source S.

4.3. Concentration Field

Schmidt Number and Chemical reaction parameter plays important role in the concentration fluid flow field. The effects of these parameters on the fluid flow field graphically shown. While growing Schmidt number (Sc) and chemical reaction parameter (R) decrease the concentration boundary layer thickness of the flow.

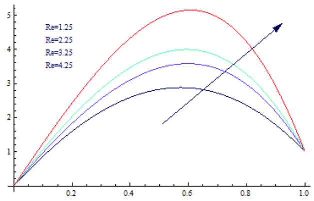

Figure 1: Primary Velocity Profile for various values of Re
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3, K^2=4.0,M=1.05, m=0.15

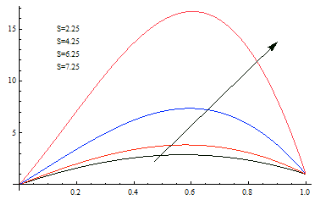

Figure 2: Primary Velocity Profile for various values of S
Pe=1.5, Kp=1.0,ω=1.0, t=1.0,Re=1.25, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3, K^2=4.0,M=1.05, m=0.15

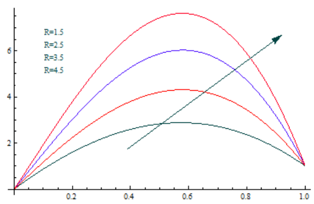

Figure 3: Primary Velocity Profile for various values of R
Pe=1.5, S=8.25, Kp=1.0,ω=1.0, t=1.0, S=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3, K^2=4.0=4.0, M=1.05, m=0.15

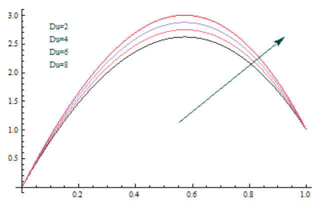

Figure 4: Primary Velocity Profile for various values of Du
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, R=1.25, f=1.0, Gr=2, Gm=3, K^2=4.0,M=1.05, m=0.15

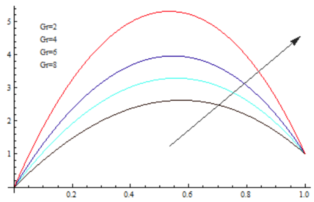

Figure 5: Primary Velocity Profile for various values of Gr
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2,Gm=3, K^2=4.0,M=1.05, m=0.15

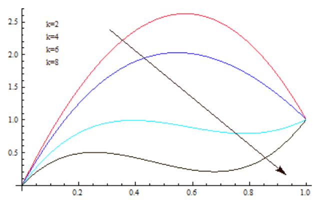

Figure 6: Primary Velocity Profile for various values of k^2
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0,R=1.5, Sc=0.22,ε=0.01, Du=1.0, f=1.0, Gr=2,Gm=3, K^2=4.0, M=1.05, m=0.15

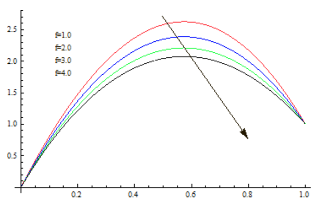

Figure 7: Primary Velocity Profile for various values of f
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2,Gm=3, K^2=4.0, M=1.05, m=0.15

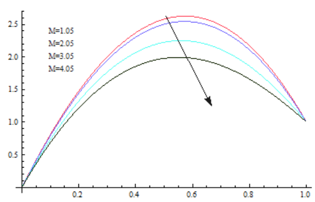

Figure 8: Primary Velocity Profile for various values of M
Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5,Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3, K^2=4.0, M=1.05, m=0.15

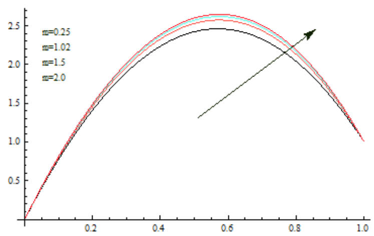

Figure 9: Primary Velocity Profile for various values of m Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2,Gm=3, K^2=4.0, M=1.05

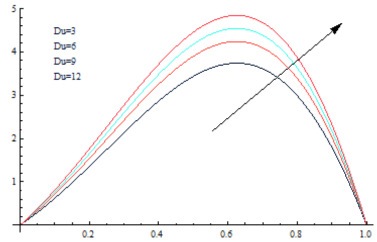

Figure 10: Primary Velocity Profile (w) for various values of Du Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5,Sc=0.22, ε=0.01, f=1.0, Gr=2, Gm=3, K^2=4.0, M=1.05, m=0.15

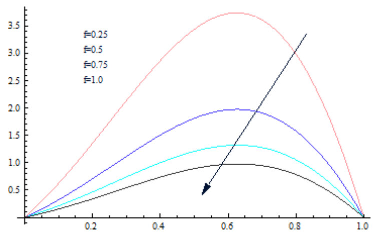

Figure 11: Secondary Velocity Profile (w) for various values of f Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, Gr=2,Gm=3, K^2=4.0, M=1.05, m=0.15

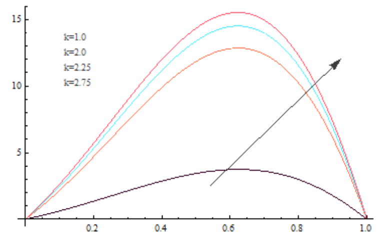

Figure 12: Secondary Velocity Profile (w) for various values of S Pe=1.5, S=8.25, Kp=1.0, ω=1.0, t=1.0, R=1.5,Sc=0.22, ε=0.01, f=1.0, Gr=2, Gm=3, K^2=4.0, M=1.05, m=0.15

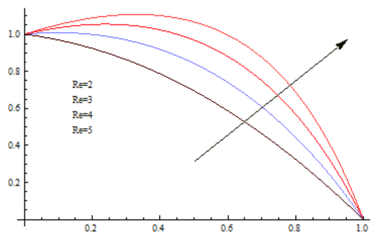

Figure 13: Temperature Profile for various values of Re Pe=1.25, S=1.25,ω=1.0, t=1.0, Sc=0.22, ε=0.001,Du=1.0,f=1.0

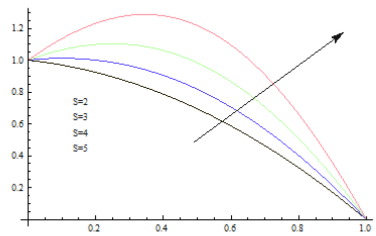

Figure 14: Temperature Profile for various values of S Pe=1.25, Re=1.25, ω=1.0, t=1.0, R=1.5,Sc=0.22, ε=0.001, Du=1.0, f=1.0

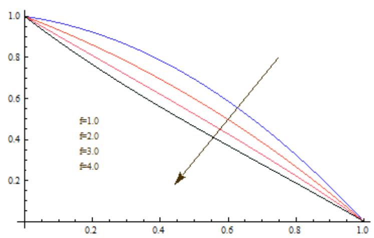

Figure 15: Temperature Profile for various values of f Pe=1.25, S=1.25, ω=1.0, t=1.0, R=1.5, Sc=0.22 ε=0.001, Du=1.0, S=1.0

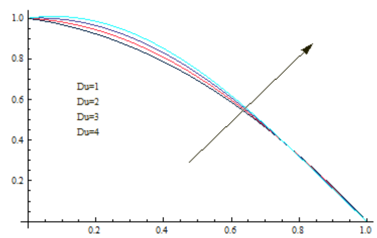

Figure 16: Temperature Profile for various values of Du Pe=1.25, S=1.25, Re=0.25, ω=1.0, t=1.0, R=1.5, Sc=0.22, ε=0.001, f=1.0

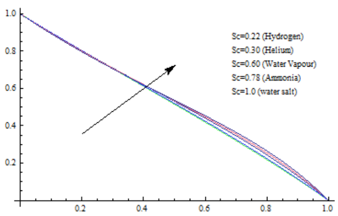

Figure 17: Concentration Profile for various values of Sc Pe=1.25, S=1.25, Re=1.25, ω=1.0, t=1.0, R=1.5, ε=0.001, f=1.00

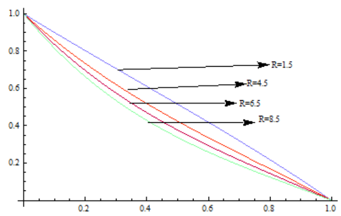

Figure 18: Concentration Profile for various values of R Pe=1.25, S=1.25, Re=1.25, ω=1.0, t=1.0, Sc=0.22, ε=0.001, f=1.00

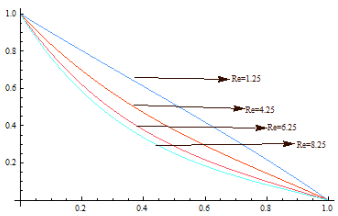

Figure 19: Concentration Profile for various values of Re Pe=1.25, S=1.25, ω=1.0, t=1.0, Sc=0.22, ε=0.001, f=1.00

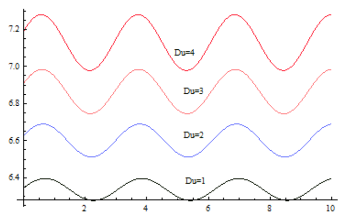

Figure 20: Skin friction for various values of Du Pe=1.5, S=2.25, Re=1.25, ω=2.0, R=1.5, Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3, K^2=1.0, M=1.05, m=3.15, Kp=1.0

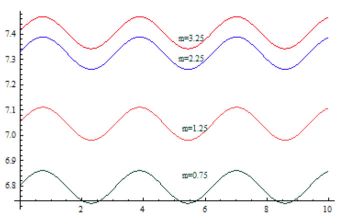

Figure 21: Skin friction for various values of m Pe=1.5, S=2.25, Re=1.25, ω=2.0, R=1.5,Sc=0.22, ε=0.01, Du=1.0, f=1.0, Gr=2, Gm=3

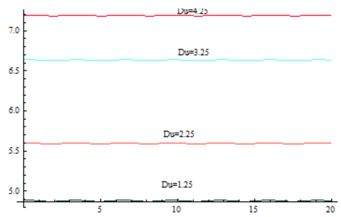

Figure 22: Heat flux for various values of Du Pe=1.25, S=1.25, Re=0.25,ω=2.0, R=1.5, Sc=0.22, ε=0.01, Du=0.25, f=1.0 K^2=1.0, M=1.05, Kp=1.0

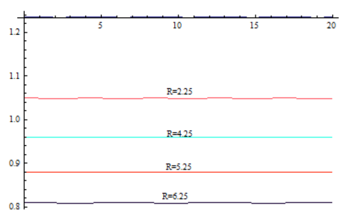

Figure 23: Mass Flux for various values of Chemical Reaction Pe=1.25, S=1.25, Re=1.25, ω=0.5, R=0.75, Sc=0.22,ε=0.001, f=1.00

5. Conclusion

Here, some of the results of physical interest on the velocity, temperature, concentration distribution and also on the wall shear stress and the rate of heat transfer, rate of mass transfer at the wall were discussed. In this work, we have studied the

Radiation Effects of MHD Oscillatory Flow along a Porous Medium bounded by two vertical porous plates in the presence of Hall current and Dufour Effect with chemical Reaction. The Governing equations are solved by using perturbation techniques.

An asymptotic solution of the resulting differential equations under the prescribed boundary conditions is obtained. Numerical results are discussed with help of graphs. The conclusions of the study are as follows:

- Presence of Grashof number for heat, Du four effects enhance the velocity of fluid flow.
- It is noticed that an increase of heat source and chemical reaction increase the velocity of the flow domain.
- It is remarked that an increase of Reynolds number enhances the velocity of the flow domain.
- The increase effect of Hartmann number is just opposite to the velocity components of the fluid flow.
- The effect of hall parameter enhances the velocity of fluid flow.
- Increase of rotation parameter retards the main velocity of the fluid flow.
- Increase of radiation parameter retards the main velocity of the fluid flow.
- Increase of Du four number enhance of temperature profile of the fluid flow.
- The increasing of Du four number enhance the skin friction and heat flux of the fluid flow domain.
- The increasing of Chemical Reaction decrease the mass flux of the fluid flow domain.
- The increase of Reynolds number enhances the temperature profile of the fluid flow
- Increase of Chemical Reaction decrease the boundary layer of Concentration fluid flow.

References

[1] N.Ahmed, *MHD Convection with soret and dufour effect in the Three dimensional flow past an infinite vertical porous plate*, Journal of Energy, Heat and Mass Transfer, 32(2010), 55-70.

[2] S.Ahmed, *Mmagnetic field effect on a three dimensional mixed convective flow with mass transfer along an infinite vertical porous plate*, International Journal of Engg Science and Technology, 2(2010), 117-135.

[3] H.A.Attia, *Transisent MHD flow and heat transfer between two parallel plates with temperature dependent viscosity*, Mech Res. Commun., 26(1997), 115-121.

[4] E.M.A.Elbashbeshy, *Heat and mass transfer along a vertical plate with variable surface temperature and concentration in the pressure of the magntic field*, International Journal Eng Sci., 34(1997), 515-522.

[5] G.D.Gupta and Johari Rajesh, *MHD three dimensional flow past a porous plate*, Indian journal pure applied mathematics, 3(2001), 371-386.

[6] M.A.Hossain and S.K.Das, *Heat transfer response of MHD free convection flow along a vertical plate to surface temperature oscillations*, International journal of non linear mechanical, 3(1998), 541-553.

[7] S.Y.Ibrahim and O.D.Makinde, *Radiation effect on chemically reacting MHD boundary layer flow of heat and mass transfer through porous vertical flat plate*, International Journal of the Physical Sciences, 6(2011), 1508-1516.

[8] Y.J.Kim, *Unsteady MHD Convective heat transfer past a semi-infinite vertical porous moving plate with variable suction*, International Journal of Engg Science, 38(2000), 833-845.

[9] O.D.Makinde and Ogulu, *Effect of thermal radiation on heat and mass transfer flow of a variable viscosity fluid past a vertical porous plate permeated by a transverse magnetic field*, Chemical Engineering Communication, 12(2008), 1575-1584.

[10] Mudagi, H*eat transfer in three dimensional hydromagnetic flow along a porous infinite plate in the presence of viscous dissipative heat*, International Journal of Pure and Applied Mathematics, 52(2009), 489-500.

[11] R.Muthucumarasamy, *Effect of Heat and mass transfer on flow past an oscillatory vertical plate with variable temperature*, International Journal of Appl. Math and Mech., 4(2008), 59-65.

[12] G.Palani and I.Abbas, *Free convection MHD flow with thermal radiation from an impulsively started vertical plate*, Nonlinear analysis modeling and control, 14(2009), 73-84.

[13] P.K.Sahoo and N.Data N, *Magnetohydrodynamics unsteady free convection flow past an infinite vertical plate with constant suction and heat sink*, Indian journal of pure and applied mathematics, 34(2003), 145-155.

[14] K.E.Sathappan and Muthukumarasamy, *Numerical study of hydromagnetic effects on flow past an oscillating semi infinite isothermal vertical plate with uniform mass diffusion in the presence of thermal radiation*, Annual of faculty Engineering Hunedoara, International Journal of Engg, 9(2)2011.

[15] P.R.Sharma and K.Sharma, *Effect of oscillatory suction and heat source on heat and mass transfer on MHD flow along a vertical porous plate bounded by porous medium*, Mod. Meas and Control B, ASME J.France, 76(2007), 34-60.