RESEARCH PAPER

MHD Oscillatory Flow along a porous medium bounded by inclination plate and Oscillation plate with Hall Current and DuFour effect in presence of radiation

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ABSTRACT
Magneto hydrodynamics oscillation flow between two plates, one of the plate is placed as a stationary with inclination angle and another one plate is oscillatory plate along with effects of Dufour along with this hall current is studied. The basic governing equations is converted into differential equations in non-dimensional part, followed by it solved the techniques to regular perturbation and to find the temperature, velocity and profile concentration. The discussions of various parameter effects on the temperature, velocity and profile concentration proof are ended up effectively by using Mathematical programs along with the help of graphs. The brief explanations of the above fields are discussed with the help of the diagrams which are obtained from non-dimensional differential equations.
Keywords: Chemical Reaction, Dufour Effect, Heat Source, Hall Current, MHD, Oscillatory, Porous Medium.
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Nomenclature

Gr	Grashof Number
Gm	Modified Grashof Number
d	Distance Between the plates
M	Hartmann Number
Re	Reynolds Number
Sc	Schmidt Number
K	Permeability of Porous medium
Pe	Peclet Number
R	Chemical Reaction Parameter
S	Heat Source
U_0	Uniform Velocity of the Plate
u	Non-Dimensional Primary Velocity
w	Non-Dimensional Secondary Velocity
V_0	Constant suction / injection
B_0	Electromagnetic Induction
ω	Frequency of Oscillation
Du	Dufour effect

Introduction

MHD free convective flows is bounded by two plates. One is Inclination plate and other is Stationary plate have a wide range of applications and received many researchers attention. The importance of plasma or ionized-gas are made and analyzed through the magnetic field interaction and transformation of heat fluid flow along with the porous plates. In the present era, the problems of many engineering is mainly related to transfer the heat and mass. Itis playing a major role in the recent field of innovation. In order to understand the characteristics through many studies in the various systems includes chemical reactors, pulse combustors, reciprocating engines etc.., The flux energy is produced by composition of gradient is known as the diffusion –thermo effect or dufour.

With the intention of study about the resources of water in the underground, the seepage of water in the beds of river, the purification of water and the processes of filtration. In the field of chemical engineering to understand about fluid flow one must need the knowledge through the porous medium. The flows of Oscillatory fare is connected with the rates of high transformation of mass and heat. The need to understand its characteristics many studies have been made in various systems such as chemical reactors, pulse combustors, reciprocating engines etc., the flow of Modulation and Oscillatory are related with the presentations with the transformation of mass and heat. The flux energy produced by the composition of gradient is known as the diffusion –thermo effect or dufour. Through this medium, the weight in molecular effect of the dufour is originated to be in the form of a significant magnitude that this couldn't be omitted.

Bharat Keshari Swain and Nityanada Senapati [1] have examined the transformation of mass effect under the radiations of MHD free flow of convective ended in an vertical plate is surrounded in a porous medium. Ch and. K, R. Kumar and S. Sharma [2] have calculated that the Hydromagnetic oscillatory flow interconnected by source of heat and by two porous plates which is in vertical with effects of soret and through a porous medium. Helena Nayar and Patrick Azere Phiri [3] both of them were investigated with the convective MHD flow along with the transformation of mass and heat. With the vertical plate in the medium of porous coincides in a vertical plate aligned with modified transformation differentiation. Karthikeyan R and P.Ranjani [4] have undergone the deep investigation with the effects of parameters in various field of MHD oscillatory flow with aporous medium. And it is associated by two porous plates vertically with help and hall current influence with the effects of dufour jointly with the occurrence in gradient temperature associated in the heat source but results in the reaction chemically.

Karthikeyan R.,.T.Priya and Mohan kumar S [5] also investigated the effects which is related to Dissipation on Viscous MHD on free effects of flow is Unsteady with the help of Radiation effect over the plates of vertical porous. Linga Raju et.al [6] studied the MHD heat transfer is closely connected through a proper channel within the conducting fluids with the flow of two layered. And it is associated in rotation system with two plates in parallel porous. Makinde O.D [7] investigated on the field of boundary MHD – the main layer flows and the transformation of mass acts as a plate of vertical in a medium of porous along with help support of constant flux heat. Mangali Veera Krishna., Kamboji Jyothi., Ali J. Chamkha [8] have dealt through readings of the transformation of Heat and mass in unsteady magnetohydro dynamic and the second grade of oscillatory fluid flow concluded in a medium of porous two plates vertically with a help of in-between source fluctuation of sink/ andheatends in the chemical reaction.

Nazibuddin Ahmed, Kishor Kumar Das [9] have investigated the transformation of Mass flow MHD passed through a vertical plate porous and it joined in a porous medium in a flow slip coincidesthe thermal radius ends in the reaction chemically. Nandyala Ravi Kumar, Rachamallu Bhuvana Vijaya [10] is also analyzed the transformation of mass and heat based on convective MHD flow completed with the plate porous vertically infinitive along the help of source heat and it reacts chemically. Rabin N. Barik., Gourange C.Dash., Aroita Mohanty [11] were investigated the reaction of chemical effect through a porous medium on MHD Oscillatory flow which is fully limited by two plates porous vertically with the help of source heat and effect of soret. Salman Akhta [12] has added in a studied that effects of Soret and dufourin convective free flow of MHD over the disposed porous plate through the porous medium.

The main aim of paper is to examine the flow of hydromagnetic oscillatory in the medium of porous confined by one inclination plate and the another one is oscillation plate with the Dufour effect and source of heat and is in the existence of reaction chemically. The current analysis of situation presented an analysis the effortis extended to Karthikeyan et.al for fluid mass flow and transformation of heat with a porous plates vertically in the strong existence along the field magnetic in dufour effects.

2. Formulation of the Problem

The flow of Oscillation is in-between the two vertical plates, one plate is considered as a stationary with inclination angle and another one plate is considered as a oscillation plate along with the effects of Dufour and the hall current is evaluated. To Neglect the dissipation of Joulean heatto apply the approximation of Boussinesq's, the flow governing equations are followed.

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

$$\frac{\partial u^*}{\partial t^*} + V_0\frac{\partial u^*}{\partial y^*} = -\frac{1}{\rho}\frac{\partial p^*}{\partial x^*} + \nu\frac{\partial^2 u^*}{\partial y^{*2}} - \frac{\sigma B_0{}^2}{\rho(1+m^2)}u^* + g\beta(T^* - T_d)COS\alpha + g\beta_c(C' - C_d)COS\alpha - \frac{\nu}{K^*}u^* \qquad (2)$$

$$\frac{\partial T^*}{\partial t^*} + V_0\frac{\partial *}{\partial y^*} = \frac{k}{\rho C_p}\frac{\partial^2 T^*}{\partial y^{*2}} - \frac{1}{\rho C_p}\frac{\partial q_r}{\partial y^*} + \frac{Q}{Cp}(T^* - T_d) + \frac{D_m k_T}{C_s C_p}\frac{\partial^2 C}{\partial y^2} \qquad (3)$$

$$\frac{\partial C^*}{\partial t^*} + V_0\frac{\partial C^*}{\partial y^*} = D\frac{\partial^2 C^*}{\partial y^{*2}} - R'(C^* - C_d) \qquad (4)$$

$$u^* = 1, T^* = T_0 + \varepsilon(T_0 - T_d)cos\omega' t^*, C^* = C_0 + \varepsilon(C_0 - C_d)cos\omega' t' at \;\; y = 0$$
$$u^* = 0, T^* = T_d, C^* = C_d \qquad at \;\; y = d \qquad (5)$$

Introducing the parameters and non- dimensional variables

$$y = \frac{y^*}{d},\quad t = \frac{t^* V_0}{d},\quad \omega = \frac{\omega^* d}{V_0},\quad u = \frac{u^*}{U_0},\quad K = \frac{K^* V_0}{\nu d}, \theta = \frac{T^* - T_d}{T_0 - T_d{}'}, C = \frac{C^* - C_d}{C_0 - C_d}, Pe = \frac{\rho C_p V_0 d}{k},$$
$$R = \frac{R^* d}{V_0},\; e = \frac{V_0 d}{\nu}\; S = \frac{Q^* d}{\rho C_p V_0},\; U = \frac{U^*}{U_0},\; Gr = \frac{\nu g\beta(T_0 - T_d)}{U_0 V_0{}^2},$$
$$Gm = \frac{\nu g\beta_c(C_0 - C_d)}{U_0 V_0{}^2},\qquad Sc = \frac{\vartheta}{D},\quad M = B_0 d\sqrt{\frac{\sigma}{\mu}}\;,$$
$$, F = \frac{4I_1 d}{\rho C_p V_0}, Du = \frac{D_m k_T(C_w - C_d)}{C_s C_p d V_0(T_w - T_d)} \qquad (6)$$

$$\frac{\partial q_{r'}}{\partial y'} = 4I_1(T' - T_d) \qquad (7)$$

where $I_1 = \int_0^\infty K_{\lambda\omega}\frac{\partial e_{b\lambda}}{\partial T'}d\lambda$, $K_{\lambda\omega}$ considered as coefficient absorption at wall

And $\boldsymbol{e_{b\lambda}}$ as function of Planck's

In equation (2),(3), and (4), we are Substituting (6) one can get

$$\frac{\partial u}{\partial t} + \frac{\partial u}{\partial y} = \frac{\partial U}{\partial t} + \frac{1}{Re}\frac{\partial^2 u}{\partial y^2} - \left(\frac{M}{Re} + \frac{1}{K}\right)(u - U) + Gr\theta Re\; COS\alpha + GmCRe\; COS\alpha \qquad (8)$$

$$\frac{\partial \theta}{\partial t} + \frac{\partial \theta}{\partial y} = \frac{1}{Pe}\frac{\partial^2 \theta}{\partial y^2} + (S - F)\theta + Du\,\frac{\partial^2 C}{\partial y^2} \qquad (9)$$

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

(10)

The conditions in boundary is associated with the non-dimensional variables are

$u = 1, \quad \theta = 1 + \frac{\epsilon}{2}\left(e^{i\omega t} + e^{-i\omega t}\right), \quad C = 1 + \frac{\epsilon}{2}\left(e^{i\omega t} + e^{-i\omega t}\right) \quad at\ y = 0$

$u = 0,$
$\theta = 0, \ C = 0 \quad at\ y = 1$ (11)

3. Method of Solution

In order to solve the equation (8), (9) and (10), applying the regular perturbation methods To Assume ε it as smaller quantity that it expresses u, θ and C as a series regular perturbation in the conditions of ε according to nearer plate as

$\theta = \theta_0(y) + \frac{\epsilon}{2}\theta_1(y)e^{i\omega t} + \frac{\epsilon}{2}\theta_2(y)e^{-i\omega t}$

C= $C_0(y) + \frac{\epsilon}{2}C_1(y)e^{i\omega t} + \frac{\epsilon}{2}C_2(y)e^{-i\omega t}$

u = $u_0(y) + \frac{\epsilon}{2}u_1(y)e^{i\omega t} + \frac{\epsilon}{2}u_2(y)e^{-i\omega t}$(12)

Using the equation (12) in the equations (8), (9) and (10), one can get the respective component equations for $c_0, c_1, c_2, \theta_0, \theta_1, \theta_2, u_0, u_1, u_2$ as follows

$\frac{d^2C}{dy^2} - ScRe\frac{dC}{dy} - ScReRC = 0$ (13)

$\frac{d^2C_1}{dy^2} - ScRe\frac{dC1}{dy} - ScRe(R + i\omega)C_1 = 0$ (14)

$\frac{d^2C_2}{dy^2} - ScRe\frac{dC2}{dy} - ScRe(R - i\omega)C_2$=0 (15)

$\frac{d^2\theta_0}{dy^2} - Pe\frac{d\theta_0}{dy} + (S - F)Pe\theta_0 = -PeDu\frac{d^2C_0}{dy^2}$ (16)

$\frac{d^2\theta_1}{dy^2} - Pe\frac{d\theta_1}{dy} + ((S - F) - i\omega)Pe\theta_0 = PeDu\frac{d^2C_1}{dy^2}$ (17)

$\frac{d^2\theta_2}{dy^2} - Pe\frac{d\theta_2}{dy} + ((S - F) + i\omega)Pe\theta_2 = PeDu\frac{d^2C_2}{dy^2}$ (18)

$\frac{d^2u_0}{dy^2} - Re\frac{du_0}{dy} - \left(M_1 + \frac{Re}{K}\right)u_0 = -GrRe^2\theta_0 - GmRe^2C_0 - (M_1 + \frac{Re}{K})U_0$ (19)

$\frac{d^2u_1}{dy^2} - Re\frac{du_1}{dy} - \left(M_1 + \frac{Re}{K} + Rei\omega\right)u_1 = -GrRe^2\theta_1 - GmRe^2C_1 - \left(M_1 + \frac{Re}{K} + Rei\omega\right)U_0$

$\frac{d^2u_2}{dy^2} - Re\frac{du_2}{dy} - \left(M_1 + \frac{Re}{K} + Rei\omega\right)u_1 = -GrRe^2\theta_2 - GmRe^2C_2 - (M_1 + \frac{Re}{K} + Rei\omega)U_0$

4. Results and Discussion :

In terms of practical problematic insight, we had studied under the flow in field of mass and heat and also in velocity acts as a various parameters in its functions like Grashof number , Modified Grashof number, Prandtl number, Reynolds number, Schmidt number, etc,.Now, graphically we can able to see clearly that the influence of parameters on the various fields. In the field of Velocity, there is a great change and it increases in Grashof number and slightly changes in Grashof number also enhances the profile velocity of the flow in fluid. Due to growth of the magnetic field, under the process reverse flow fluid exits as same. The Angle Inclination of stationary plate reaches high automatically ends in result of decrease in velocity of flow fluid.

With the purpose of insight in the problem physical, the studies of flow, under the influence of mass Grashof number, Schmidt number, Thermal Grashof number. The effects of velocity field in parameters, also in the field of Temperature and Concentration, viewed seriously in number and with the help of numerical values discussed. In the association of Graphs indicated the parameter effect on the any field accurately and exactly without any bias output. In each graph, minimum three effects are analyzed by its increase any one parameter of field respectively. Using the output of graph, we are analyzing the exact effects of parameters of the non-dimensional differential equations.

Due to increasing the Permeability Parameter effect of the K., Grashof number Gr, Modified Grashof Number Gm, Dufour effects (Du) accelerates flow field of the transient velocity. In addition to the effects in inverse exists under the flow fluid velocity transiently on the other hand, it increases Magnetic Parameter (M)

The profiles of the temperature in the flow fluid parameters stimulated way like Grashof Number Gr, Heat Source S, Peclet number Pe, Permeability parameter K,Magnetic Parameter M. and so on. Temperature profile exposed it as increase things while it grows parameters like Heat Source S, Dufour number. However, the inverse effect exists while it increases the Radiation parameter (f). Increases of the reaction of chemically and Schmidt parameter in the field of concentration, they reduce the concentration of boundary thickness layer of the flow of fluid. Using the various parameters in different types of field of ordinary differential equation we obtained the results exactly.

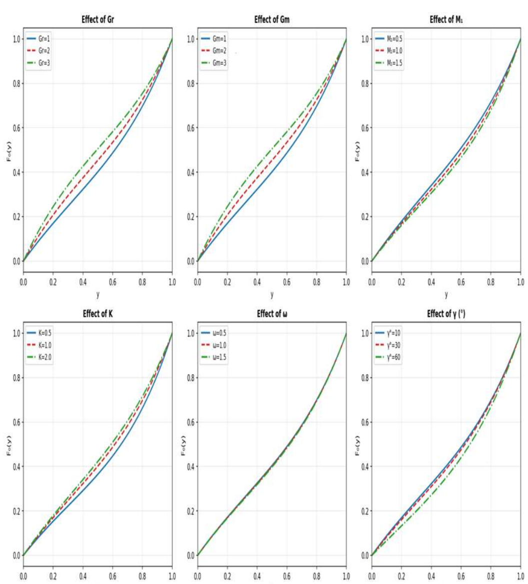

Figure 1: Velocity Profile for various parameters like Grashof number Modified Grashof Number, Hall Current.

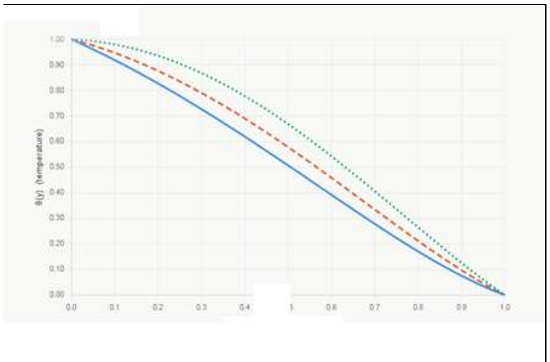

Figure 2: Temperature Profile for various values of Heat Source

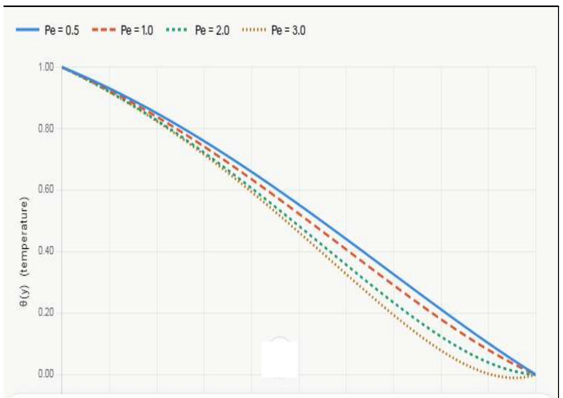

Figure 3: Temperature Profile for various values of Peclet Number

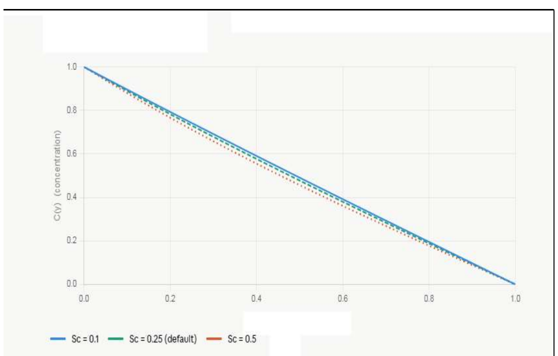

Figure 4: Concentration Profile for various values of Schmidt Number

Figure 5: Concentration Profile for various values of Reynolds Number

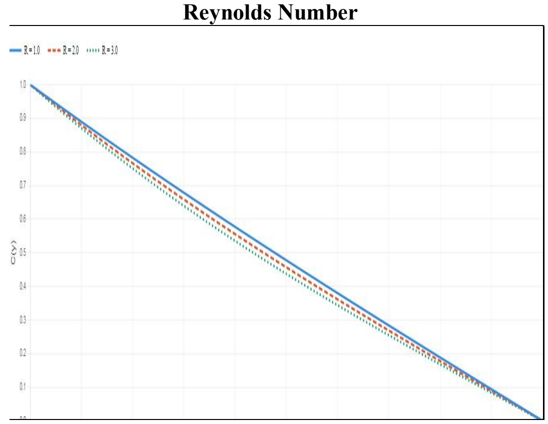

Figure 6: Concentration Profile for various values of Radiation Number

From the first six diagram, we observed the velocity profile under the influence of various parameters like Grashof Number, Modified Grashof Number, Hall Current etc., In this observations, velocity profile increases while increase of Grashof Number, Modified Grashof Number. Velocity Profile deceases while increase of hall current as well as increases of Inclination Angle. Follow that temperature profile indicates the increase effects while increase of Heat source, but retards while increases of Peclet parameter. Concentration Profile goes on decrease while increases of Schmidt number, Reynolds number and Radiation Parameters. Reason for increase and decrease were discussed in conclusion section.

5. Conclusion:

The Grashof number is the ratio of thermal forces to viscous forces due to buoyancy. An increase in the Grashof number means that buoyancy forces dominate over viscous resistance. This causes warmer, less dense fluid to rise more quickly. An increase in the Modified Grashof number strengthens buoyancy forces driven by concentration, which in turn boosts fluid velocity. Increasing the magnetic parameter enhances the opposing Lorentz force. This leads to a steeper velocity profile, causing the velocity to become more restricted and often stick close to a surface. When the inclination of the plate increases, it raises the viscous drag coefficient. This drag works against the flow, causing the fluid to slow down. Increasing the intensity of the heat source directly raises the fluid flow temperature due to increased heat dissipation. While an increase in the Peclet number typically lowers the temperature in the heat domain, the heat transfer rate may increase because the temperature at the surface gradient is very high. An increase in the

Schmidt number shows that momentum transfers faster than mass transfer. This results in thinner diffusion boundary layers. Higher Schmidt numbers arise from increased viscosity or decreased diffusion coefficients, which lead to lower concentration values and reduced concentration diffusion. To increase the impact of fluid flow on chemical reactions, a typical consumption rate is represented by a faster rate. Generally, this also decreases the thickness of the concentration boundary layers.

6. References:

[1] Bharath Keshari Swain., Nityanadha senapti., (2015),The effects of mass transfer on MHD free convective radiating flow over an impulsively started vertical plate embedded in a porous medium, *Journal of Applied analysis and Computation* . **5(**1), 18-27.

[2] Chand. K, R. Kumar and S. Sharma., (2012), Hydromagnetic oscillatory flow through a porous medium bounded by two vertical porous plates with heat source and soret effect., *Pelagia Research Library*., **3** (4), 2169-2178.

[3] Helena Nayar., Patrick Azere Phiri., (2025),Investigation of heat and mass transfer of free convective MHD flow along a vertical plate in a porous medium using the new modified differential transform –decomposition method. *Results in Engineering.*, Vol. **25**, 1-11,.

[4] Karthikeyan R., Ranjani P., (2020),MHD Oscillatory flow along a porous medium bounded by two vertical porous plates under the influence of hall current with dufour effects in presence of temperature gradient with heat source and chemical reaction. *Journal of Applied analysis and computation*. **66**(6), 602 - 632.

[5] Karthikeyan R.,.T.Priya and Mohankumar S., (2025),Viscous Dissipation effects on MHD free convective effects of Unsteady flow over a vertical porous plate with effects of Radiation. *Communications on applied non linear analysis*, **32(**2), 1745-1772,.

[6] Linga Raju**.,** et.al**., (**2013),MHD heat transfer in two layered flow of conducting fluids through a channel bounded by two parallel porous plates in rotating system**.,** *International Journal of Applied Mechanics and Engineering*, **21** (3), 623 -648.

[7] Makinde O.D., (2009), On MHD boundary – layer flow and mass transfer past a vertical plate in a porous medium with constant heat flux. *International journal of numerical methods for heat and fluid flow*.**9** (3)546-554,.

[8] Mangali Veera Krishna, Kamboji Jyothi, Ali.J.Chamkha, (2018), Heat and Mass transfer on unsteady magneto hydrodynamic, oscillatory flow of second grade fluid through a porous medium between two vertical plates under the influence of fluctuating heat source/sink and chemical reaction, *International Journal of Fluid Mechanics Research.*,**45**,(5),459-477,

[9] Nazibuddin Ahmed, Kishor Kumar Das., (2013), MHD Mass transfer flow past a vertical porous plate embedded in a porous medium in a slip flow regime with thermal radiation and chemical reaction. *Open Journal of fluid dynamics*,**3(**3), 521-543.,.

[10] Nandyala Ravi Kumar, Rachamallu Bhuvana Vijaya., (2021) ,Heat and mass transfer on MHD convective flow over a infinite vertical porous plate with heat source and chemical reaction,. *Wiley online publication*, **50**, (8**),**455–468,

[11] Rabin N. Barik., Gourange C.Dash., Aroita Mohanty., (2013), Chemical reaction effect on MHD Oscillatory flow through a porous medium bounded by two vertical porous plates with heat source & soret effect. *Journal of Applied Analysis & computation*.**3**,(4)307-321,

[12] Salman Akhtar, (2025), Dufour & Soret Effects on Free convective MHD flow over an inclined porous plate in porous medium. *Advance and Application of fluid dynamics*. **32(** 1),.37-55.