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Influence of Varying Temperature and Concentration on (MHD) Oscillatory Slip Flow for Carreau-Yasuda Fluid with variable Viscosity through an inclined Channel

Qasim Ali Shaker, Ahmed A .Hussein Al-Aridhee

Faculty of Computer Science and Information Technology, University of Al-Qadisiyah, Diwaneyah, Iraq

ABSTRACT: The main theme of the present examined the influence of heat transfer on magneto hydrodynamics (MHD) for the Oscillatory Slip Flow for Carreau-Yasuda Fluid with variable Viscosity through an inclined Channel for kind of geometries "Poiseuille flow flow" through a porous medium inclined channel. The momentum equation for the problem, is a non-linear differential equations, has been found by using "perturbation technique" and intend to calculate the solution for the small number of Weissenberg (We<<1) to get clear forms for the velocity field by assisting the (MATHEMATICA) program to obtain the numerical results and illustrations. The physical features of Darcy number, magnetic parameter, Grashof number and radiation parameter are discussed simultaneously through presenting graphical discussion. Investigated through graphs the variation of a velocity profile for various pertinent parameters. While the velocity behaves strangely under the influence of the Brownian motion parameter and local nanoparticle Grashof number effect. On the basis of this study, it is found that the velocity directly with Grashof number, Darcy number, radiation parameter, and reverse variation with magnetic parameter and frequency of the oscillation and discussed the solving problems through graphs.

KEYWORDS: Carreau-Yasuda Fluid, variable Viscosity, Heat Transfer, (MHD), inclined channel.
MSC2010: 76A05, 76Wxx.

I. INTRODUCTION

Central porosity is a matter containing a number of small holes distributed throughout the matter. A porous medium flows through the fluid infiltration and water infiltration into the river beds. The movement of groundwater, water, and oils are some important examples of flows through porous means. The oil tank often contains a sedimentary structure such as limestone and sandstone in which the oil is contained. Another example of flow through a porous medium is leakage under the dam which is very important. Examples: of natural porosity such as sand ash, wood, filtering, human lung, bitterness and yellow stones, oil production engineering and many other processes. In [1] show the exact solutions for fourth kinds of flows between two parallel plates. [2] studied the influence of inclined magnetic field between two infinite parallel plates, [3] discussed the laminar flow between parallel plates under the action of the transverse magnetic field and heat transfer. [4] discussed the two kinds of geometries Poiseuille flow and Couette flow of Carreau fluid with pressure dependent viscosity in a variable porous medium. Viscosity is one of the most important specifications for fluids, [6] studied the variable viscosity through a porous medium and used the homotopy analysis method to solve the problem. [7] studied the related of the variable viscosity through a porous medium by using generalized Darcy's law, to solve the problem he using the perturbation technique. [8] Influence of heat transfer on magneto hydrodynamics oscillatory flow for Williamson fluid through a porous medium. [9] studied the variable viscosity of Jeffrey fluid in an asymmetric channel. In most systems, channels or ducts used are sloped. This fact stimulated scientists to explore the associated flows in a slanted channel (see Refs [10-13]).
The study considers a mathematical model for the influence of MHD oscillatory slip flow for Carreau-Yasuda fluid through inclined channel with varying temperature and concentration. The perturbation technique series use to solve the problem. The result of the physical parameters problem was discussed by using the graphs.

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II.MATHEMATICAL FORMULATION

Let us consider the flow of a Carreau-Yasuda fluid in a channel of width $\boldsymbol{h}$ under the effects of electrically applied magnetic field and radioactive heat transfer as depicted in (Fig. 1). Supposed that the fluid has very small electromagnetic force produced and the electrical conductivity is small. We are considering Cartesian coordinate system such that, $(u(y),0,0)$ is a velocity vector in which u is the x-component of velocity and y is perpendicular to the x-axis.

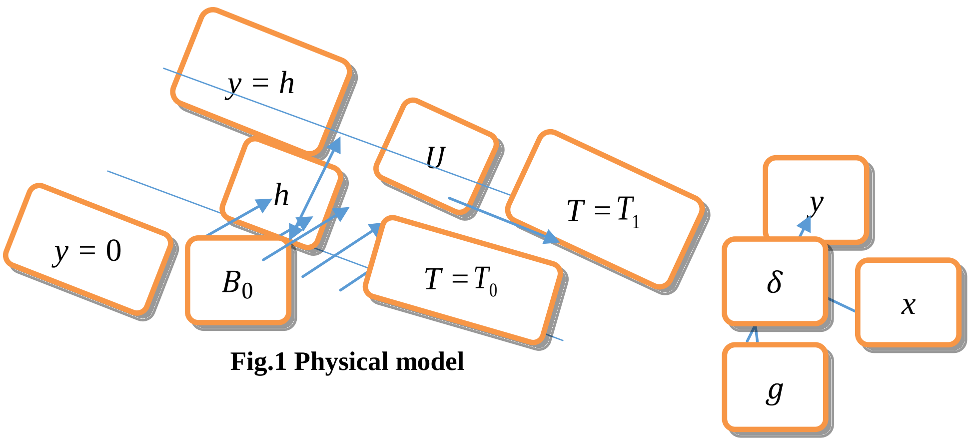

Fig.1 Physical model

III. BASIC EQUATIONS:

The basic equations governing for Carreau-Yasuda fluid are given by:

The continuity equation is given by: $\frac{\partial \bar{u}}{\partial \bar{x}} + \frac{\partial \bar{v}}{\partial \bar{y}} = 0$ (1)

The momentum equations are:

In the x – direction:

$$\rho\left(\frac{\partial \bar{u}}{\partial \bar{t}} + \bar{u}\frac{\partial \bar{u}}{\partial \bar{x}} + \bar{v}\frac{\partial \bar{u}}{\partial \bar{y}}\right) = -\frac{\partial \bar{p}}{\partial \bar{x}} + \frac{\partial \bar{\tau}_{\overline{xx}}}{\partial \bar{x}} + \frac{\partial \bar{\tau}_{\overline{xy}}}{\partial \bar{y}} + \rho g \beta_T (T - T_0) Sin(\xi) + \rho g \beta_C (C - C_0) Sin(\xi)$$

$$-\sigma B_0^2 Sin^2(\xi)\bar{u} - \frac{\mu(T)}{k}\bar{u} + \rho g\, sin(\delta) \quad (2)$$

In the y – direction:

$$\rho\left(\frac{\partial \bar{v}}{\partial \bar{t}} + \bar{u}\frac{\partial \bar{v}}{\partial \bar{x}} + \bar{v}\frac{\partial \bar{v}}{\partial \bar{y}}\right) = -\frac{\partial \bar{p}}{\partial \bar{y}} + \frac{\partial \bar{\tau}_{\overline{xy}}}{\partial \bar{x}} + \frac{\partial \bar{\tau}_{\overline{yy}}}{\partial \bar{y}} - \frac{\mu(T)}{k}\bar{v} + \rho g \cos(\delta) \quad (3)$$

The temperature equation is given by:

$$\frac{\partial T}{\partial \bar{t}} = \frac{K}{\rho C_p}\frac{\partial^2 T}{\partial \bar{y}^2} - \frac{1}{\rho C_p}\frac{\partial q}{\partial y} + \frac{Q_H}{\rho C_p}(T - T_0) \quad (4)$$

The concentration equation is given by:

$$\frac{\partial C}{\partial \bar{t}} = D\frac{\partial^2 C}{\partial \bar{y}^2} - K_r^*(C - C_2) + \frac{DK_T}{T_m}\frac{\partial^2 T}{\partial \bar{y}^2} \quad (5)$$

The fundamental equation for Carreau- Yasuda fluid given by:

$$\boldsymbol{S} = -\bar{p}\boldsymbol{I} + \tau \quad (6)$$

$$\bar{\tau} = [\mu_\infty + (\mu(T) - \mu_\infty)(1 + (\Gamma\bar{\dot{\gamma}})^b)^{\frac{n-1}{b}}]A_1 \quad (7)$$

where $\bar{p}$ is the pressure, $\boldsymbol{I}$ is the unit tensor, $\bar{\tau}$ is the extra stress tensor, Γ is the time constant, μ_∞ and $\mu(T)$ are the infinite shear rate viscosity and fluid viscosity dependent on temperature, then $\dot{\gamma}$ is defined as:

$$\dot{\gamma} = \sqrt{\frac{1}{2}\sum_i \sum_j \dot{\gamma}_{ij}\dot{\gamma}_{ji}} = \sqrt{\frac{1}{2}\Pi}$$

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Here $\prod$ is the second invariant strain tensor. We consider thefundamental Eq. (7), the case for which $\Upsilon < 1$, and$\mu_\infty = 0$. We can write the component of extra stress tensor according to follows as:

$$\bar{\tau} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b \bar{\dot{\gamma}}^b\right] A_1 \quad (9)$$

where μ_0 is the zero shear rate viscosity and $\dot{\gamma}$is the strain. The Rivlin-Ericksen tensors are given by:

$$A_1 = \nabla\bar{V} + (\nabla\bar{V})^t \quad (10)$$

where $(\nabla\bar{V})$ is the fluid velocity in the Cartesian coordinates system $(x, y, z)$and $(\nabla\bar{V})^t$ is the transpose of the fluid velocity in the Cartesian coordinates system(x, y, z)

Now

$$\dot{\gamma} = \sqrt{\frac{1}{2}\sum_i^3\sum_j^3 \dot{\gamma}_{ij}\dot{\gamma}_{ji}} \text{ implies that } \quad \dot{\gamma}^2 = \frac{1}{2}\sum_i^3\sum_j^3 \dot{\gamma}_{ij}\dot{\gamma}_{ji}$$

$$= \frac{1}{2}(\dot{\gamma}_{11}^2 + \dot{\gamma}_{12}\dot{\gamma}_{21} + \dot{\gamma}_{13}\dot{\gamma}_{31}) + \frac{1}{2}(\dot{\gamma}_{12}\dot{\gamma}_{21} + \dot{\gamma}_{22}^2 + \dot{\gamma}_{23}\dot{\gamma}_{32}) + \frac{1}{2}(\dot{\gamma}_{13}\dot{\gamma}_{31} + \dot{\gamma}_{23}\dot{\gamma}_{32} + \dot{\gamma}_{33}^2)$$

$$= \frac{1}{2}[(\dot{\gamma}_{11}^2 + \dot{\gamma}_{22}^2 + \dot{\gamma}_{33}^2) + (2\dot{\gamma}_{12}^2 + 2\dot{\gamma}_{13}^2 + 2\dot{\gamma}_{23}^2)]$$

$$= \frac{1}{2}[(\dot{\gamma}_{11}^2 + \dot{\gamma}_{22}^2 + \dot{\gamma}_{33}^2) + 2(\dot{\gamma}_{12}^2 + \dot{\gamma}_{13}^2 + \dot{\gamma}_{23}^2)]$$

$$= \frac{1}{2}\left[4(u_x^2 + v_y^2 + w_z^2) + 2\left(\left(u_y + v_x\right)^2 + (u_z + w_x)^2 + \left(v_z + w_y\right)^2\right)\right]$$

hence

$$\dot{\gamma}^2 = 2\left\{\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2 + \left(\frac{\partial w}{\partial z}\right)^2\right\} + \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)^2 + \left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right)^2$$

The stress component are given by:

$$\left.\begin{aligned}
\tau_{xx} &= 2\mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial x}\right) \\
\tau_{yy} &= 2\mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial v}{\partial y}\right) \\
\tau_{zz} &= 2\mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial w}{\partial z}\right) \\
\tau_{xy} &= \tau_{yx} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right) \\
\tau_{xz} &= \tau_{zx} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial x}\right) \\
\tau_{yz} &= \tau_{zy} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y}\right)
\end{aligned}\right\} \quad (11)$$

then

$$\tau_{xx} = \tau_{yy} = \tau_{zz} = \tau_{xz} = \tau_{yz} = 0 \quad (12)$$

$$\tau_{xy} = \tau_{yx} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)$$

implies that

$$\tau_{xy} = \tau_{yx} = \mu(T)\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial y}\right) \quad (13)$$

And the stress variable viscosity for Carreau-Yasuda fluid is:

$$\bar{\tau}_{\bar{x}\bar{y}} = \mu(T)[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b]\left(\frac{\partial \bar{u}}{\partial \bar{y}}\right) \quad (14)$$

where $\bar{v}$ is the axial velocity, T is a fluid temperature, $B_0$is a magnetic field strength, ρ is a fluid density, σ is a conductivity of the fluid, β is a coefficient of volume amplification due to temperature, g is a hastening due to gravity, k is a permeability,$c_p$is a specific heat at constant pressure,$\mu(T)$fluid viscosity dependent on temperature, K is a thermal conductivity, $(0 \leq \xi \leq \pi)$ is the angle between velocityfield and magnetic field strength and q is a radioactive heat flux.

The temperatures at the walls of the channel are given as:

$$T = T_0 \text{ at } \bar{y} = 0\,, \text{ and } T = T_1 \text{at } \bar{y} = h \quad (15)$$

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The radioactive heat flux [8]is given as:

$$\frac{\partial q}{\partial y} = 4\eta^2 (T_0 - T) \tag{16}$$

The radiation absorption denoted by η.

IV.METHOD OF SOLUTION:

The governing equations of the motion, we may introduce the non-dimensional conditions are as follows:

$$\left.\begin{array}{l} x = \frac{\bar{x}}{h}\ , y = \frac{\bar{y}}{h}\ , u = \frac{\bar{u}}{U}\ , \theta = \frac{T - T_0}{T_1 - T_0}\ , t = \frac{\bar{t}U}{h}\ , p = \frac{\bar{p}h}{\mu_0 U}\ , M^2 = \frac{\sigma B_0^2 h^2}{\mu_0} \\ Fr = \frac{U}{gh}, \mu(\theta) = \frac{\mu(T)}{\mu_0}, We = \frac{\Gamma U}{h}, \tau_{xx} = \frac{h}{\mu_0 U}\bar{\tau}_{\overline{xx}}, \tau_{xy} = \frac{h}{\mu_0 U}\bar{\tau}_{\overline{xy}}, Da = \frac{k}{h^2} \\ \dot{\gamma} = \frac{h}{U}\bar{\dot{\gamma}}, Re = \frac{\rho h U}{\mu_0}\ , Pe = \frac{\rho h U c_p}{K}\ , N^2 = \frac{4\eta^2 h^2}{K}, Gr = \frac{\rho g \beta\, h^2 (T_1 - T_0)}{\mu_0 U} \end{array}\right\} \tag{17}$$

where (U) is the mean flow velocity, (Da) is Darcy number, (Re) is Reynolds number, (Gr) is Grashof number, (M) is magnetic parameter, (Pe) is the Peclet number and (N) is the radiation parameter.

$$\rho\left(\frac{U\partial v}{\frac{h}{U}\partial t} + Uu\frac{U\partial v}{h\partial x} + Uv\frac{U\partial v}{h\partial y}\right) = -\frac{\frac{\mu_0 U}{h}\,dp}{h\,dy} + \frac{\frac{\mu_0 U}{h}\partial\tau_{xy}}{h\partial x} + \frac{\frac{\mu_0 U}{h}\partial\tau_{yy}}{h\partial y} - \frac{\mu(\theta)\mu_0 U}{k}v + \rho g\cos(\delta) \tag{18}$$

implies that $\rho(0 + Uu.0 + Uv.0) = -\frac{\frac{\mu_0 U}{h}\,dp}{h\,dy} + 0 + 0 - 0 + \rho g\cos(\delta)$ (19)

implies that $\frac{dp}{dy} = 0$ (20)

Substituting (17) into equations (1), (2),(4) and (5), we obtain:

$$\rho\frac{U^2}{h}\frac{\partial u}{\partial t} = -\frac{\mu_0 U}{h^2}\frac{dp}{dx} + \frac{\mu_0 U}{h^2}\frac{\partial\tau_{xy}}{\partial y} + \rho g\beta_T(T_1 - T_0)\theta Sin(\xi) + \rho g\beta_C(C_1 - C_2)\Phi Sin(\xi) - \sigma B_0^2 Sin^2(\xi)Uu - \mu(\theta)\frac{\mu_0 U}{k}u + \frac{Re}{Fr}sin(\delta)$$

(21)

$$\frac{\rho U}{h}\frac{\partial(\theta(T_1 - T_0) + T_0))}{\partial t} = \frac{k}{C_p h^2}\left[\frac{\partial^2(\theta(T_1 - T_0) + T_0))}{\partial y^2} - \frac{h^2}{k}4\eta^2\big(T_0 - (\theta(T_1 - T_0) + T_0)\big) + Q\big(\theta(T_1 - T_0)\big)\right] \tag{22}$$

$$\frac{U}{h}(C_1 - C_2)\frac{\partial\Phi}{\partial t} = \frac{U}{hS_c}(C_1 - C_2)\frac{\partial^2\Phi}{\partial y^2} - \frac{U}{h}K_r\Phi(C_1 - C_2) + \frac{DK_T}{T_m}\frac{(T_1 - T_0)}{h^2}\frac{\partial^2\theta}{\partial y^2} \tag{23}$$

$$\frac{\mu_0 U}{h}\tau_{xy} = \frac{\mu_0 U}{h}\mu(\theta)\left[\left[1 + \left(\frac{n-1}{b}\right)\Gamma^b\dot{\gamma}^b\right]\left(\frac{\partial u}{\partial y}\right)\right] \tag{24}$$

Finally, we get

$$Re\frac{\partial u}{\partial t} = -\frac{dp}{dx} + \frac{\partial}{\partial y}\left(\mu(\theta)\left[\frac{\partial u}{\partial y} + \left(\frac{n-1}{b}\right)We^b\left(\frac{\partial u}{\partial y}\right)^{b+1}\right]\right) + Gr\theta Sin(\xi) + Gc\Phi Sin(\xi) - M_1^2 u - \frac{\mu(\theta)}{Da}u + \frac{Re}{Fr}sin(\delta) \tag{25}$$

$$Pe\ \frac{\partial\theta}{\partial t} = \frac{\partial^2\theta}{\partial y^2} + (R + Q)\theta$$

$$\frac{\partial\Phi}{\partial t} = \frac{1}{S_c}\frac{\partial^2\Phi}{\partial y^2} - K_r\Phi + Sr\frac{\partial^2\theta}{\partial y^2} \tag{27}$$

where $M_1 = MSin(\xi)$,

with the boundary conditions:

V. REYNOLD'S MODEL OF VISCOSITY

The Reynold's model and variation of viscosity with temperature are defined as:

$$\mu(\theta) = e^{-\alpha\theta} \tag{28}$$

By using the Maclaurin series, we get:

$$\mu(\theta) = 1 - \alpha\theta \quad \alpha << 1 \tag{29}$$

In this case, the viscosity is fixedat $\alpha = 0$, by substituting Eq. (29) into Eq. (25), we get:

$$Re\frac{\partial u}{\partial t} = -\frac{dp}{dx} + \frac{\partial}{\partial y}\left[(1 - \alpha\theta)\left[\frac{\partial u}{\partial y} + \left(\frac{n-1}{b}\right)We^b\left(\frac{\partial u}{\partial y}\right)^{b+1}\right]\right] + Gr\theta Sin(\xi) + Gc\Phi Sin(\xi) - M_1^2 u - \frac{(1-\alpha\theta)}{Da}u + \frac{Re}{Fr}sin(\delta) \tag{30}$$

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Solution of Motion Equation:

Poiseuille flow

We suppose that the rigid flakes are at $y = 0$ and $y = h$ are at rest. Therefore

$\bar{u} = 0$ at $\bar{y} = 0$, and $\bar{u} = 0$ at $\bar{y} = h$

The non-dimensional boundary conditions are as follows:

$$u(0) = 0\,,\; u(1) = 0\,. \tag{31}$$

To solve the momentum Eq. (30), let

$$-\frac{dp}{dx} = \lambda e^{i\omega t}\;;\; u(y,t) = f(y)e^{i\omega t} \tag{32}$$

By substituting Eq. (32) into Eq. (30), we equalize the powers of (We), and we obtain:

$$Re\frac{\partial}{\partial t}f(y)e^{i\omega t} = \lambda e^{i\omega t} + (1-\alpha\theta)\frac{\partial}{\partial y}\left[e^{i\omega t}\frac{\partial}{\partial y}f(y) + \left(\frac{n-1}{b}\right)We^{b}e^{i\omega(b+1)t}\left(\frac{\partial}{\partial y}f(y)\right)^{b+1}\right] + Gr\theta Sin(\xi) + Gc\Phi Sin(\xi) - M_1^2 f(y)e^{i\omega t} - \frac{(1-\alpha\theta)}{Da}f(y)e^{i\omega t} + \frac{Re}{Fr}sin(\delta) \tag{33}$$

implies that

$$Re\, i\omega e^{i\omega t}f(y) = \lambda e^{i\omega t} + (1-\alpha\theta)\left[e^{i\omega t}\frac{\partial^2}{\partial y^2}f(y) + \left(\frac{n-1}{b}\right)(b+1)We^{b}e^{i\omega(b+1)t}\left(\frac{\partial}{\partial y}f(y)\right)^{b}\frac{\partial^2}{\partial y^2}f(y)\right] + Gr\theta - M_1^2 f(y)e^{i\omega t} - \frac{(1-\alpha\theta)}{Da}f(y)e^{i\omega t} + \frac{Re}{Fr}sin(\delta) \tag{34}$$

implies that

$$Re\, i\omega f(y) = \lambda + (1-\alpha\theta)\left[\frac{\partial^2}{\partial y^2}f(y) + \left(\frac{n-1}{b}\right)(b+1)We^{b}e^{i\omega bt}\left(\frac{\partial}{\partial y}f(y)\right)^{b}\frac{\partial^2}{\partial y^2}f(y)\right] + Gr\theta_0 Sin(\xi) + Gc\Phi_0 Sin(\xi) - M_1^2 f(y) - \frac{(1-\alpha\theta)}{Da}f(y) + \frac{Re}{Fr}sin(\delta) \tag{35}$$

Equation (35) is a non-linear differential equation and it is hard to find an exactsolution, so will be used the perturbation technique to find the problem solution, as follows:

$$f = f_0 + We^{b}f_1 + O(We^{2b}) \tag{36}$$

Now, By substituting Eq. (36) and Eq. (32) into Eq. (35), we obtain:

$$Re\, i\omega(f_0 + We^{b}f_1) = \lambda + Gr\theta_0(y)Sin(\xi) + Gc\Phi_0(y)Sin(\xi) + \frac{Re}{Fr}sin(\delta) \tag{37}$$

implies that

$$Re\, i\omega f_0 + We^{b}f_1 Rei\omega = \lambda + Gr\theta_0 Sin(\xi) + Gc\Phi_0 Sin(\xi) + \frac{Re}{Fr}sin(\delta) - \left(M_1^2 + \frac{(1-\alpha\theta)}{Da}\right)f_0 - We^{b}\left(M_1^2 + \frac{(1-\alpha\theta)}{Da}\right)f_1 + (1-\alpha\theta)\frac{\partial^2 f_0}{\partial y^2} + We^{b}(1-\alpha\theta)\frac{\partial^2 f_1}{\partial y^2} + e^{bi\omega t}(1-\alpha\theta)(b+1)\left(\frac{n-1}{b}\right)\left[\left(\frac{\partial f_0}{\partial y}\right)^{b}\frac{\partial^2 f_0}{\partial y^2}We^{b}\right] \tag{38}$$

***i* - Zeroth-order system (We^0)**

$$Re\, i\omega f_0 = \lambda + Gr\theta_0 Sin(\xi) + Gc\Phi_0 Sin(\xi) + \frac{Re}{Fr}sin(\delta) - \left(M_1^2 + \frac{(1-\alpha\theta)}{Da}\right)f_0 + (1-\alpha\theta)\frac{\partial^2 f_0}{\partial y^2} \tag{39}$$

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The associated boundary conditions are:

$$f_0(0) = f_0(1) = 0 \tag{40}$$

ii **- First-order system (We^b)**

$$Re\ i\omega f_1 = -\left(M_1^2 + \frac{(1-\alpha\theta)}{Da}\right) f_1 + (1-\alpha\theta)\frac{\partial^2 f_1}{\partial y^2} + e^{bi\omega t}(1-\alpha\theta)(b+1)\left(\frac{n-1}{b}\right)\left(\frac{\partial f_0}{\partial y}\right)^b . \frac{\partial^2 f_0}{\partial y^2} \tag{41}$$

The associated boundary conditions are:

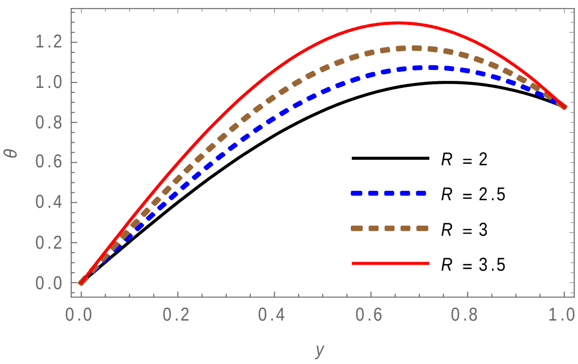
$$f_1(0) = f_1(1) = 0 \tag{42}$$

Finally, the perturbation solutions up to second term for f are given by:

$$f = f_0 + We^b f_1 + O(We^{2b}) \tag{43}$$

VI .RESULTS AND DISCUSSION

We discuss the influence of MHD oscillatory slip flow for Carreau-Yasuda fluid through inclined channel with varying temperature and concentration in some results through the graphical illustrations. Numerical assessments of analytical results and some of the graphically significant results are presented in **Figs**. (2-11). We use the (MATHEMATICA-11) program to find the numerical results and illustrations. The momentum equation is resolved by using perturbation technique and all the results are discussed graphically. **Fig.(2)** shows the temperature increases with the increase in R.**Fig.(3)**. show us that with the increasing of ω the temperature θ decreases. **Fig.(4)** we observed that the influence ω in concentration profile Φ by the increasing ω then Φ decreases. The concentration profile Φ decreases with increase R in **Fig. (5)**.**Fig. (6)**and**Fig. (7)** show the velocity profile $u$increasing with the increasing δ and ξ.**Fig.(8)** illustrates the influence Fr on the velocity profiles function u vs. y. It is found by increasing Fr the velocity profile function u decreases.**Fig. (9)** shows that velocity profile u rising up by the increasing influence the parameter λ.**Fig. (10)**,**Fig. (12)**and **Fig. (13)** illustrate the influence Gc, Da and Gr on the velocity profiles function u vs. y. It is found by the increasing Gc, Da and Gr the velocity profiles function u increases. **Fig. (12)** illustrates the influence M on the velocity profiles function u vs. y. It is found by increasing M the velocity profile function u decreases.



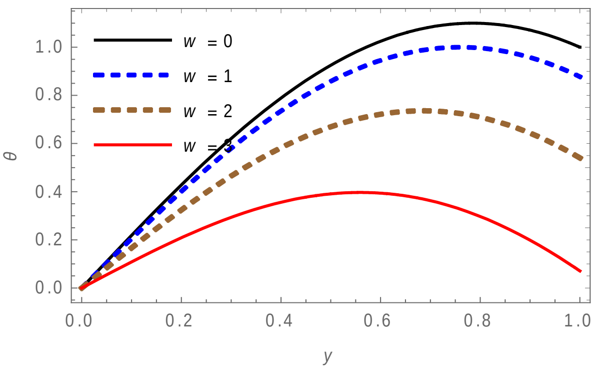


Fig.(2) Influence of R on Temperature for $t = 0.5, \omega = 1, Q = 2, Pe = 0.7$.

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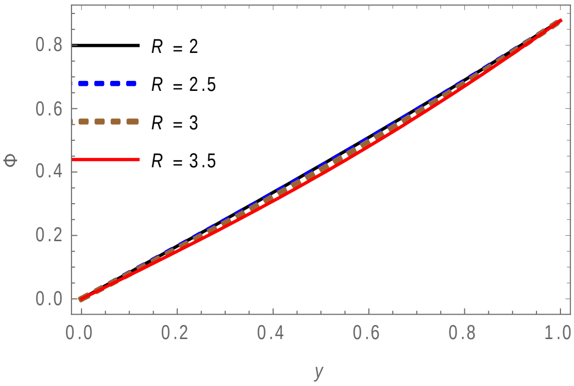


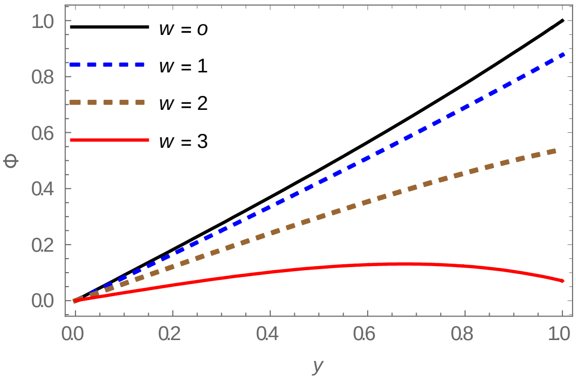
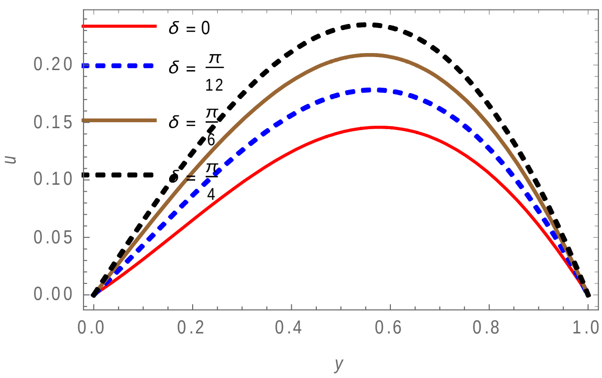


Fig.(4) Influence of R on concentration for $\mathrm{Sr} = 0.1, \mathrm{Sc} = 0.6, \mathrm{Q} = 2, \mathrm{Pe} = 0.7, \omega = 1, \mathrm{K_r} = 0.5$.

Fig.(5) Influence of ω on concentration for $\mathrm{Sr} = 0.1, \mathrm{R} = 2, \mathrm{Q} = 2, \mathrm{Pe} = 0.7, \mathrm{K_r} = 0.5, \mathrm{Sc} = 0.6, \mathrm{t} = 0.5$.



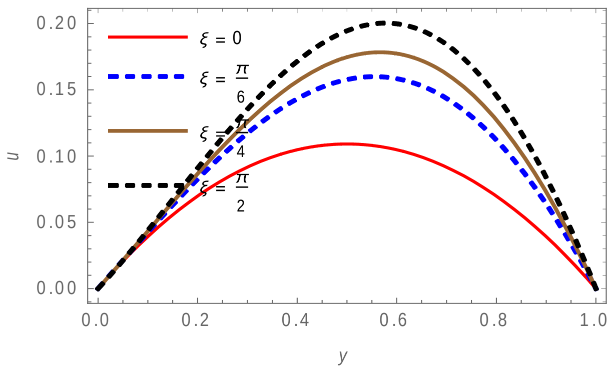
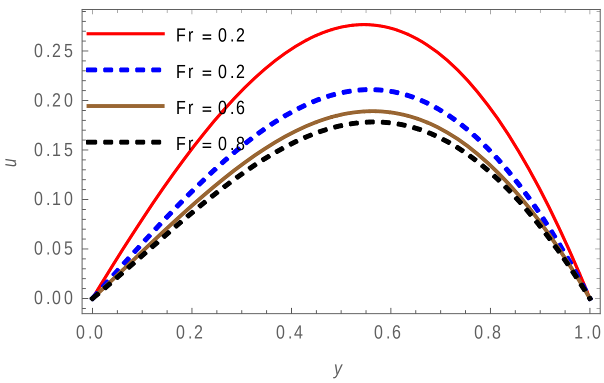


Fig.(7) Velocity profile for ξ with $\mathrm{Sc} = 0.6, \mathrm{Gc} = 1, \mathrm{R} = 2, \mathrm{Pe} = 0.7, \lambda = 1, \mathrm{Q} = 2, \mathrm{Sr} = 0.1, \omega = 1, \mathrm{Re} = 1, \mathrm{Da} = 0.8, \mathrm{Gr} = 1, \mathrm{M} = 1, \mathrm{K_r} = 0.5, \mathrm{We} = 0.05, \mathrm{t} = 0.5$.



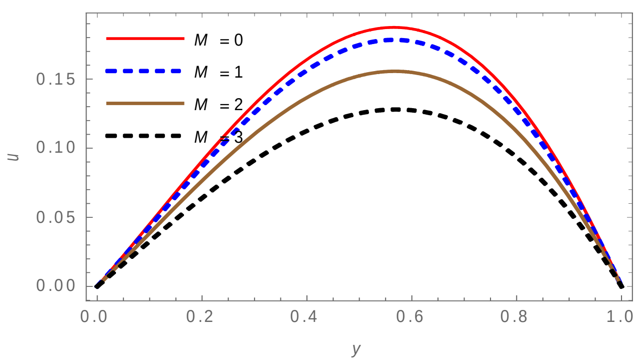


Fig.(9) Velocity profile for λ with $\mathrm{Gc} = 1, \mathrm{R} = 2, \mathrm{Pe} = 0.7, \xi = \frac{\pi}{4}, \mathrm{Sr} = 0.1, \mathrm{Q} = 2, \mathrm{Sc} = 0.6, \omega = 1, \mathrm{Re} = 1, \mathrm{Da} = 0.8, \mathrm{Gr} = 1, \mathrm{M} = 1, \mathrm{K_r} = 0.5, \mathrm{We} = 0.05, \mathrm{t} = 0.5$

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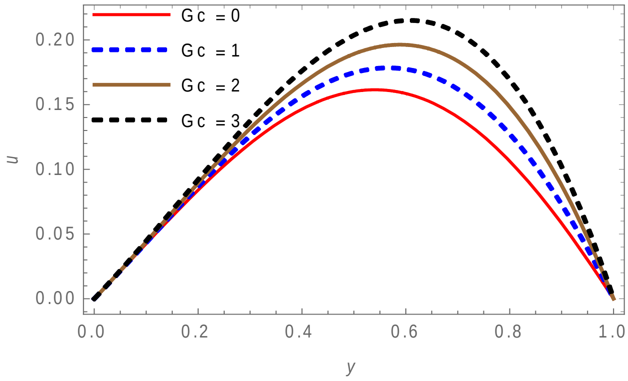


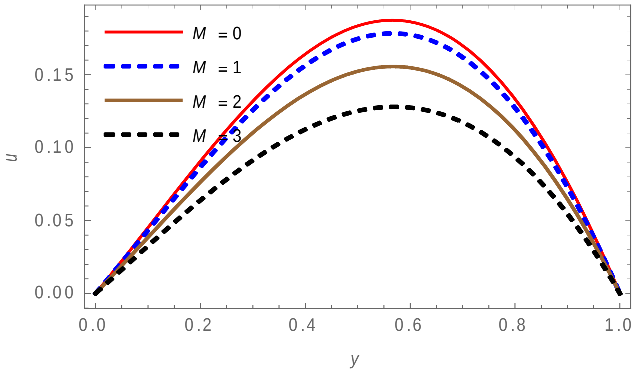
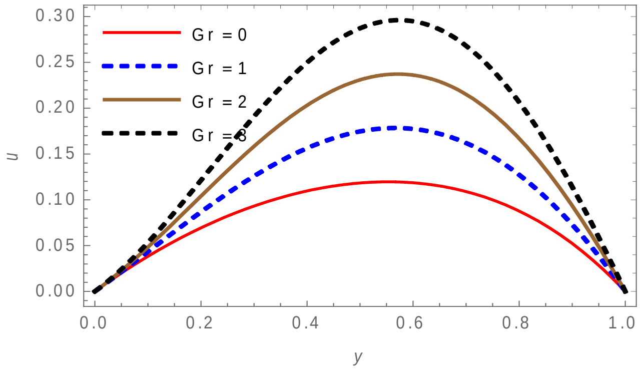


Fig.(11) Velocity profile for M with $R = 2, Q = 2, Pe = 0.7, \xi = \frac{\pi}{4}, Sr = 0.1, K_r = 0.5, Sc = 0.6, \omega = 1, Re = 1, Gr = 1, Gc = 1, Da = 0.8, \lambda = 1, We = 0.05, t = 0.5$.



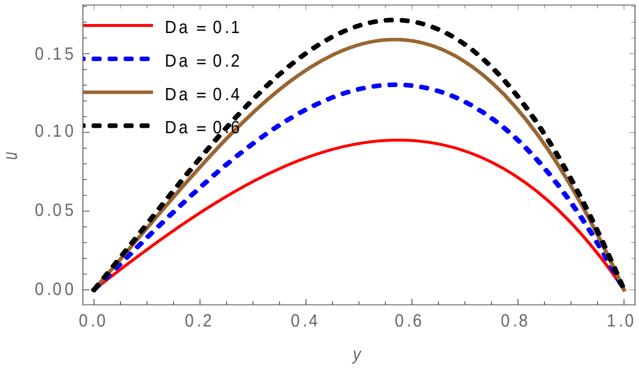


Fig.(13) Velocity profile for Gr with $R = 2, Q = 2, \xi = \frac{\pi}{4}, Pe = 0.7, Sr = 0.1, K_r = 0.5, Sc = 0.6, \omega = 1, Re = 1, Da = 0.8, Gc = 1, M = 1, \lambda = 1, We = 0.05, t = 0.5$.

VII.CONCLUSION AND REMARKS

We discuss the Influence of Varying Temperature and Concentration on (MHD) Oscillatory Slip Flow for Carreau-YasudaFluid with variable Viscosity through an inclined Channel are found analytical, and use different values to find the results of pertinent parameters, namely for the velocity andtemperature. The key point is listed below:

i. The velocity profiles increase with increasing $\delta, \xi, Gc, Gr,$ $and\ Da$for the Poiseuille.

ii. The velocity profiles decrease with increasing magnetic parameter a , $Fr\ and\ M$. for the Poiseuille flow.

iii. Show that by the increase of R the temperature increases and by the increase of w the temperature decreases.

iv. Show that by the increase of R the concentration decreases and by the increase of w the concentration decreases.

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