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ANALYSIS OF SORET EFFECTS ON UNSTEADY MHD MIXED OSCILLATORY FLOW THROUGH A POROUS MEDIUM

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Abstract: In this paper, the effect soret analyzed on the unsteady MHD mixed convective oscillatory flow in the porous medium. The effect of soret buoyamoy, heat source, thermal radiation and chemical reaction are studied. The governing equations of the problem are converted into a system of non dimensional differential equations. By using slip boundary condition, different kind of velocity, temperature and concentration results are obtained by graphs. Then the equations are solved by perturbation techniques. The effects of fluid flow for the various parameters like G_r, G_c, Sc, Sr on velocity, temperature and concentration fields have been obtained in the help of graphs.

Keywords: Chemical reaction; Magneto hydro dynamic; Planer channel; and Oscillatory flow.

1. Introduction

The Effect on MHD oscillatory flow of fluid in a porous channel with heat and mass transfer and chemical reaction has applications in the fields of engineering, geophysics, agriculture etc. Several researches have studied and have related literatures on the effect on unsteady MHD oscillatory flow of fluid in a porous channel with heat and mass transfer and chemical reaction.

Muthucumaraswamy et al. [1] discussed the variable temperature and mass diffusion on the oscillating indefinite by the effect of first order chemical reaction on homogeneous equation. Beg [2] analyzed the Soret and Dufour effect on two-dimensional heat and mass transfer of an incompressible fluid passes through a moving vertical surface embedded in a Darcy porous medium. Rawat and Bhargava[3] consider, the thermal convection of heat transfer and mass transfer in a micropolar fluid saturated Darcian porous medium in the presence of significant Dufour and Soret effects. Lakshmi Narayana and Murthy [4] recently, the effect of Soret and Dufour parameters on free convection heat and mass transfer from a vertical surface in a doubly stratified Darcian porous medium presented. AhmedSahin [5] studied the Magneto hydrodynamic and

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chemical reaction effects on unsteady flow of heat and mass transfer characteristics in a viscous fluid and also taken into incompressible and electrically conduction fluid over a semi-indefinite vertical porous plate in a slip-flow region. Joshi and Kumar [6] considered the combined influence of chemical reaction; radiation and MHD on mixed convection heat and mass transfer join with a moving surface. Anghel et al. [7] examined the effects of Dufour and Soret on free convection boundary layer over a vertical surface embedded in a porous medium. Pal and Mondal [8] studied the reaction of heat and mass transfer and the effects of buoyancy and solutal buoyancy parameters over a stretching sheet. Joseph K. et al [9] obtained the characteristics of heat and mass transfer, the effects of chemical reaction on unsteady MHD oscillatory flow in an optically thin fluid through a planer channel in the attentation of a temperature-based on the heat source.

In the analysis, the investigations to oscillatory flow on a planner channel with variable temperature and concentration have received much attention. Therefore the objective of this paper is to analyze soret Effects on unsteady MHD oscillatory slip flow passing through a thin fluid on planer channel in the presence of temperature based on a heat source. The solutions for velocity, temperature and concentration are presented graphically and the characteristics of soret Effects on heat and mass transfer are studied in detail and presented graphically and discussed qualitatively.

2. Formulation of the Problem

We consider the unsteady mixed convective slip flow of an electrically conducting also taken into heat generating and chemical reaction with oscillatory flow in a planer channel filled with porous medium in the presence of soret effect. Consider the magnetic field of magnitude be B_0, It is applied in the available of thermal solutal buoyamoy effect and soret effect in the direction of Y-axis.

3. The motion of governing equation:

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

$$\frac{\partial u'}{\partial t'} = -\frac{1}{\rho}\frac{\partial P'}{\partial x'} + \frac{v\partial^2 u'}{\partial y'^2} + g\beta\left(T' - T_1'\right) + g\beta^*\left(C' - C_1'\right) - \frac{v}{k'}u' - \frac{\sigma B_0^2}{\rho}u' - v'\frac{\partial u'}{\partial y'} \qquad \text{(2)}$$

$$\frac{\partial T'}{\partial t'} = \frac{K}{\rho C_P}\frac{\partial^2 T'}{\partial y'^2} - \frac{1}{\rho}\frac{\partial q_r'}{\partial y'}g + \frac{Q\left(T' - T_1'\right)}{\rho C_P} - v'\frac{\partial T'}{\partial y'} \qquad \text{(3)}$$

$$\frac{\partial C'}{\partial t'} = \frac{D\partial^2 C'}{\partial y'^2} - \frac{K_r'\left(C' - C_1'\right)}{d} - v'\frac{\partial C'}{\partial y'} + \frac{D_{K_T}}{T}\frac{\partial^2 T'}{\partial y'^2} \qquad \text{(4)}$$

Where $v^{'} = -v_0\left(1+\varepsilon e^{i\omega t}\right)$ is suction velocity.

4. Boundary condition:

$$u^{'} = L_1 \frac{\partial u^{'}}{\partial y^{'}},\ T^{'} = T_1^{'} + \delta_T^{*} \frac{\partial T^{'}}{\partial y^{'}},\ C^{'} = C_1^{'} \delta_C^{*} \frac{\partial C^{'}}{\partial y^{'}} \quad at \ \ y = 0 \ \_\_\_\_\_\_\_(5)$$

$$u^{'} = 0,\ T^{'} = T_2^{'} + \delta_T^{*} \frac{\partial T^{'}}{\partial y^{'}},\ C^{'} = C_2^{'} \delta_C^{*} \frac{\partial C^{'}}{\partial y^{'}} \quad at \ \ y = d \qquad \_\_\_\_\_\_\_(6)$$

5. The non-dimensional quantities:

$$x = \frac{x^{'}}{d}\ ,\ y = \frac{y^{'}}{d}\ ,\ P = \frac{dP^{'}}{\mu u_0}\ ,\ u = \frac{u^{'}}{u_0}\ ,\ v = \frac{T^{'} - T_1^{'}}{T_2 - T_1}\ ,\ \phi = \frac{C^{'} - C_1^{'}}{C_2 - C_1}$$

$$t = \frac{u_0 t^{'}}{d}\ ,\ R_e = \frac{u_0 d}{v}\ ,\ \gamma = \frac{K^{'}}{d^2}\ ,\ M = \frac{\sigma B_0^2 d^2}{\mu}\ ,\ G_r = \frac{g\beta (T_2 - T_1) d^2}{v u_0}$$

$$G_C = \frac{g\beta^{*} (C_2 - C_1) d^2}{v u_0}\ ,\ R = \frac{4I^{'} d^2}{K}\ ,\ P_e = \frac{PC_P u_0 d}{K}\ ,\ S_C = \frac{D}{u_0 d}$$

$$K_r = \frac{K_r^{'}}{u_0}\ ,\ d_2 = \frac{\delta_T^{*}}{d}\ ,\ d_1 = \frac{\delta_C^{*}}{d}\ ,\ K^{'} = Kd^2\ ,\ S_r = \frac{D_{K_T}}{T} \frac{(T_\omega - T_\infty)}{(C_\omega - C_\infty)}$$

The basic equations (2) to (4) can be written as,

$$\mathrm{Re} \frac{\partial u}{\partial t} = -\frac{\partial P}{\partial x} + \frac{\partial^2 u}{\partial y^2} + \lambda_1 \frac{\partial u}{\partial y} + G_r \theta + G_C \varphi - \left(M + \frac{1}{K} \right) u \ \_\_\_\_\_\_\_(9)$$

$$Pe \frac{\partial \theta}{\partial t} = \frac{\partial^2 \theta}{\partial y^2} + Pe \lambda_2 \frac{\partial \theta}{\partial y} + (C_P R + \alpha)\, \theta \qquad \_\_\_\_\_\_\_(10)$$

$$\frac{\partial \varphi}{\partial t} = S_C \frac{\partial^2 \varphi}{\partial y^2} + \lambda_3 \frac{\partial \varphi}{\partial y} - K_r \varphi + S_r \frac{\partial^2 \varphi}{\partial y^2} \qquad \_\_\_\_\_\_\_(11)$$

6. The boundary conditions :(t >0)

$$u = \gamma \frac{\partial u}{\partial y}\ ,\ \theta = d_2 \frac{\partial \theta}{\partial y}\ ,\ \varphi = d_1 \frac{\partial \varphi}{\partial y} \quad at \ \ y = 0 \qquad \_\_\_\_\_\_\_(12)$$

$$u = 0\ ,\ \theta = 1 + d_2 \frac{\partial \theta}{\partial y}\ ,\ \varphi = 1 + d_1 \frac{\partial \varphi}{\partial y} \quad at \ \ y = 1 \qquad \_\_\_\_\_\_\_(13)$$

7. Solution of the problem

To obtain the equation (9) to (11) by using the boundary conditions (12) & (13) oscillatory flow,

$$u(y,t) = u_0(y)e^{i\omega t} \quad \text{\_\_\_\_\_\_\_\_\_\_}(14)$$

$$\theta(y,t) = \theta_0(y)e^{i\omega t} \quad \text{\_\_\_\_\_\_\_\_\_\_}(15)$$

$$\varphi(y,t) = \varphi_0(y)e^{i\omega t} \quad \text{\_\_\_\_\_\_\_\_\_\_}(16)$$

$$-\frac{\partial P}{\partial x} = e^{i\omega t} \quad \text{\_\_\_\_\_\_\_\_\_\_}(17)$$

Substituting the equations (14) to (17) in equations (9) to (13) we get,

$$u_0''(y) + a_1 u_0'(y) - a_2 u_0 = -(\lambda + G_r v_0 + G_C \varphi_0) \quad \text{\_\_\_\_}(18)$$

$$\theta_0''(y) + a_5 v_0'(y) - a_2 v_0 = 0 \quad \text{\_\_\_\_}(19)$$

$$\varphi''(y) + \frac{\lambda_3}{S_C}\varphi' - \left(\frac{K_r + \omega}{S_C}\right)\varphi = \frac{S_r}{S_C}\left(A_5 e^{m_5 y} m_5^2 + A_6 e^{m_6 y} m_6^2\right) \quad \text{\_\_\_\_\_\_}(20)$$

8. Boundary Condition

$$u_0 = \gamma u_0', \ \theta_0 = d_2\theta_0', \ \varphi_0 = d_1\varphi_0' \quad at \ \ y = 0 \quad \text{\_\_\_\_\_\_\_\_}(21)$$

$$u_0 = 0, \ \theta_0 = 1 + d_2\theta_0', \ \varphi_0 = d_1\varphi_0' \quad at \ \ y = 1 \quad \text{\_\_\_\_\_\_\_\_}(22)$$

Solution of the velocity, temperature and concentration are,

$$u_0(y,t) = A_1 e^{m_1 y} + A_2 e^{m_2 y} + K_1 + K_2 e^{m_5 y} + K_3 e^{m_6 y} + K_4 e^{m_3 y} + K_5 e^{m_4 y}$$

$$\theta_0(y,t) = A_5 e^{m_5 y} + A_6 e^{m_6 y}$$

$$\varphi_0(y,t) = A_3 e^{m_3 y} + A_4 e^{m_4 y} - \frac{S_r}{S_C} K_{21} e^{m_5 y} - \frac{S_r}{S_C} K_{22} e^{m_6 y}$$

9. Result and discussions

From figure – 1and 2

The effect of Grashof number of Heat and mass transfer on the velocity field noted that its raising initially and slowly dropping at the last. The other related parameters are treated as constants.

From figure – 3

For various values of Sr, which is soret effect on the velocity increases the increment of velocity in the initial stage and then decreased slowly in the channel.

From figure – 4 and 5

For different values of Kr and M, Which is chemical reaction and Magnetic on velocity field is increases in the porous medium.

From figure – 6 and 7

By the soret effect in the temperature field and concentration field also got much more attenuation. The different values of alpha and R increases on the temperature field in the region.

From figure – 8

The effect of increases of Da, which is the Darcy number on the temperature field, also increases.

From figure – 9, 10 and 11

The effect of the different values of Sc, Sr and Kr increases, It is observe that increment of concentration in the porous channel.

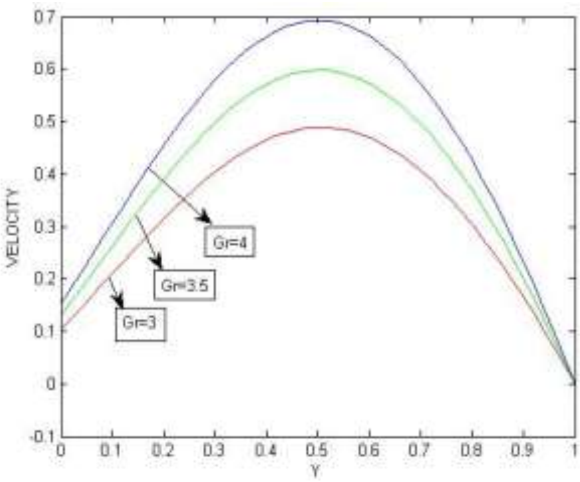

Figure 1

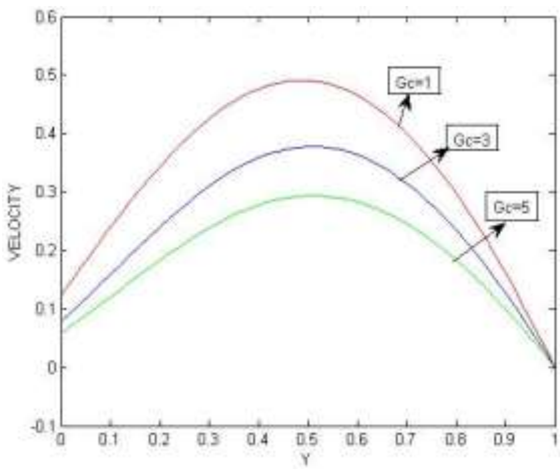

Figure 2

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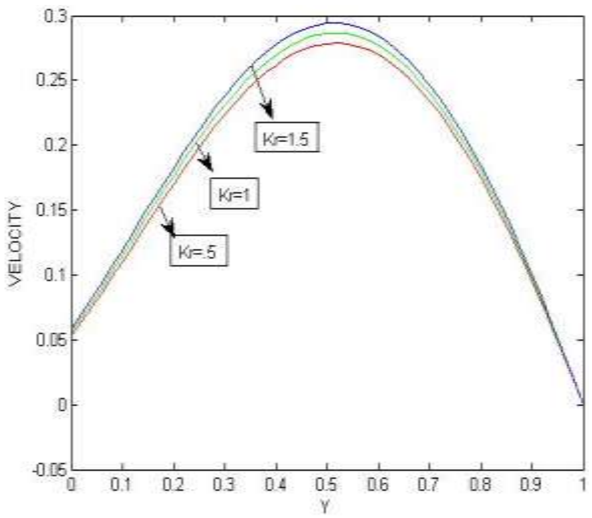
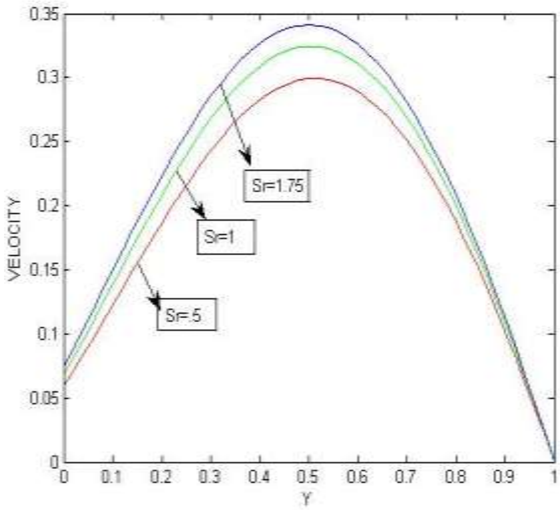


Figure 3



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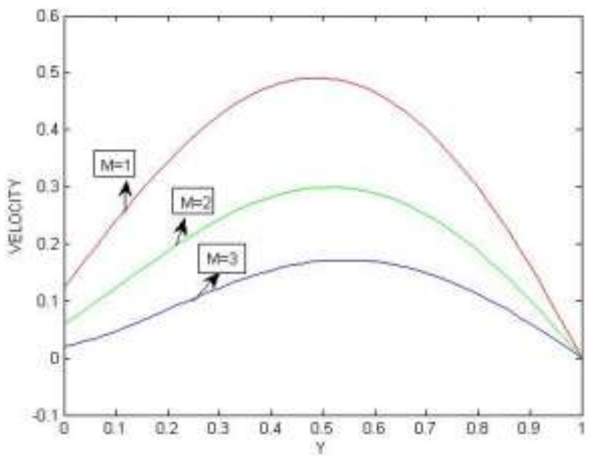


Figure 5

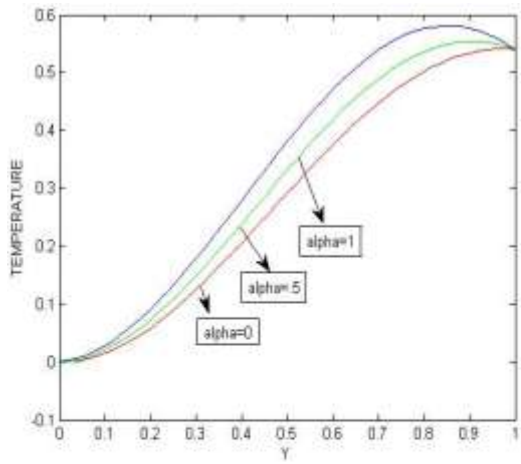
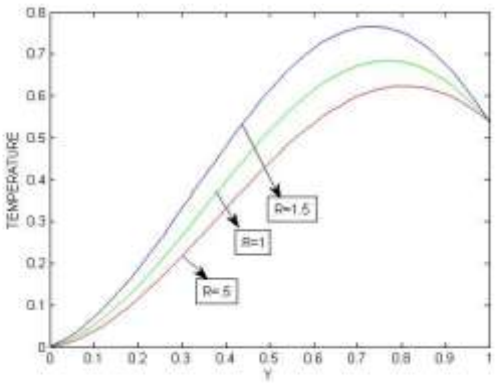


Figure 6



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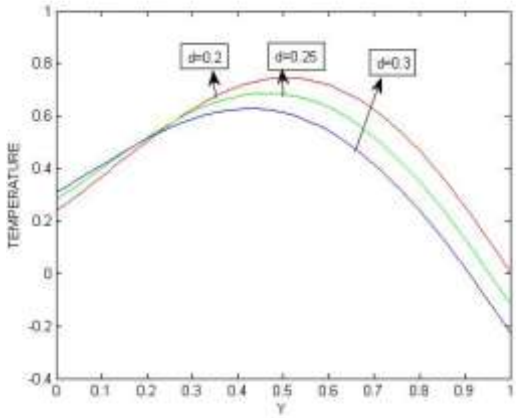

Figure 8

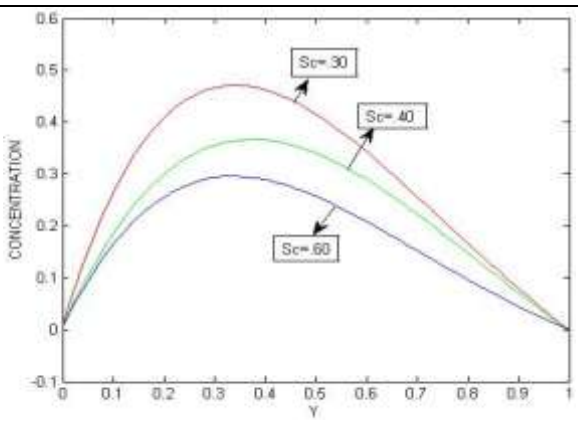

Figure 9

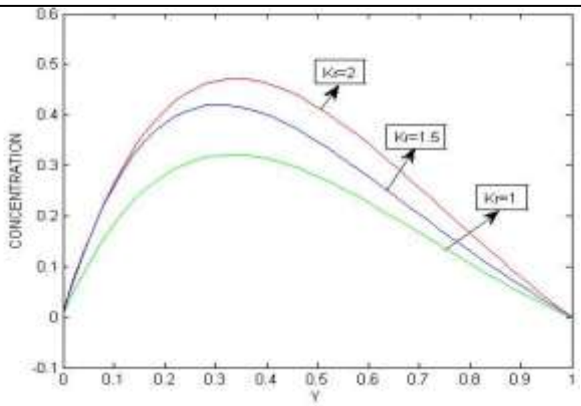

Figure 10

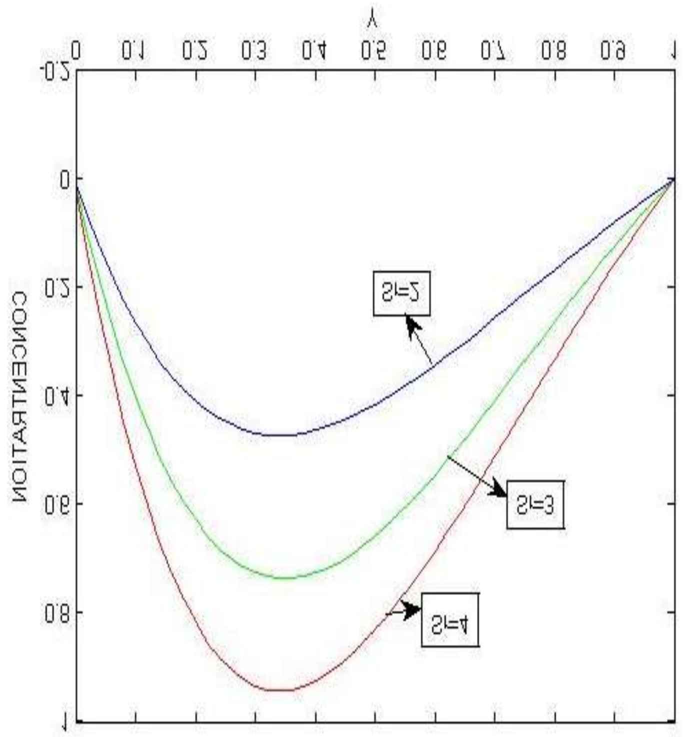

Figure 11

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10. Conclusion

The velocity field obtained for various parameters like Gr, Gc, M, Kr, and Sr are solved numerically and found the results graphically. The effect of soret got attention in the temperature and concentration fields. The different values of alpha, Da, R, Sc, Sr, and Kr are increases in the temperature and concentration fields. These results obtained graphically.

Where K-series, A-series are as follows

$K_1 = \frac{\lambda_1}{a_2}$	$m_1 = \frac{-a_1 + \sqrt{a_1^2 - 4a_2}}{2}$	$a_1 = \lambda_1$
$K_2 = \frac{-G_r A_5}{m_5^2 + a_1 m_5 - a_2}$	$m_2 = \frac{-a_1 - \sqrt{a_1^2 - 4a_2}}{2}$	$a_2 = M + \frac{1}{K} + i\omega \mathrm{Re}$
$K_3 = \frac{-G_r A_6}{m_6^2 + a_1 m_6 - a_2}$	$m_3 = \frac{-a_3 + \sqrt{a_3^2 - 4a_4}}{2}$	$a_3 = \frac{\lambda_3}{S_C}$
$K_4 = \frac{-G_C A_3}{m_3^2 + a_1 m_3 - a_2}$	$m_4 = \frac{-a_3 - \sqrt{a_3^2 - 4a_4}}{2}$	$a_4 = \frac{K_r + i\omega}{S_C}$
$K_5 = \frac{-G_C A_4}{m_4^2 + a_1 m_4 - a_2}$	$m_5 = \frac{-a_5 + \sqrt{a_5^2 - 4a_6}}{2}$	$a_5 = Pe\lambda_2 i\omega$
$K_6 = 1 - d_2 m_5$	$m_6 = \frac{-a_5 - \sqrt{a_5^2 - 4a_6}}{2}$	$a_6 = C_P R + \alpha - Pei\omega$
$K_7 = 1 - d_2 m_6$		$A_1 = \frac{K_{14}}{K_{12}} - \frac{K_{13}}{K_{12}} K_{18}$
$K_8 = K_{29} K_6$		$A_2 = K_{18}$
$K_9 = K_{30} K_7$		$A_5 = \frac{K_7}{K_7 K_8 - K_6 K_9}$
$K_{10} = K_1 + K_2 + K_3 + K_4 + K_5$		$A_6 = \frac{-K_6}{K_7 K_8 - K_6 K_9}$
$K_{11} = \gamma(K_2 m_5 + K_3 m_6 + K_4 m_3 + K_5 m_4$		

$A_3 = \frac{S_r}{S_C}\left(K_{21}K_{25}\left(K_{29}-K_{28}\right)\right)+\frac{S_r}{S_C}\left(K_{22}K_{26}\left(K_{30}-K_{28}\right)\right)$	$K_{12} = 1-\gamma m_1$
	$K_{13} = 1-\gamma m_2$
$A_4 = \frac{S_r}{S_C}\left(K_{21}K_{25}\left(K_{27}-K_{29}\right)\right)+\frac{S_r}{S_C}\left(K_{22}K_{26}\left(K_{27}-K_{30}\right)\right)$	$K_{14} = K_{11}-K_{10}$
	$K_{16} = e^{m_1}$
$K_{15} = K_1 + K_2K_{29} + K_3K_{30} + K_4K_{27} + K_5K_{28}$	$K_{17} = e^{m_2}$
$K_{18} = \frac{K_{14}K_{16}+K_{12}K_{15}}{K_{13}K_{16}+K_{12}K_{17}}$	$K_{23} = 1-d_1m_3$
	$K_{24} = 1-d_1m_4$
$K_{21} = \frac{A_5m_5^2}{m_5^2+a_3m_5-a_4}$	$K_{25} = 1-d_1m_5$
	$K_{26} = 1-d_1m_6$
$K_{22} = \frac{A_6m_6^2}{m_6^2+a_3m_6-a_4}$	$K_{27} = e^{m_3}$; $K_{28} = e^{m_4}$
	$K_{29} = e^{m_5}$; $K_{30} = e^{m_6}$

11. References

[1] Muthucumaraswamy.R and Meenakshisundaram.S. Theoret. Appl. Mech.,vol.33, No.3 (2006), pp.245- 257.

[2] OA Beg, R Bhargava, S Rawat, E Kahya. Numerical study of micropolar convective heat and mass transfer in a non-Darcy porous regime with Soret and Dufour effects. *Emirates Journal for Engineering Research*, 13(2008): 51-66

[3] S Rawat, R Bhargava. Finite element study of natural convection heat and mass transfer in a micropolar fluid satu-rated porous regime with Soret/Dufour effects. *Int. J. of Appl. Math and Mech.* ,5(2009):58-71

[4] PA Lakshmi Narayana, PVSN Murthy. Soret and Dufour effects in a doubly stratified darcy porous medium. *Journalof Porous Media*, 10(2007): 613-624

[5] Ahmed Sahin, Emirates Journal for Engineering Research, 15 (1), 25-34 (2010).

[6] Joshi, N. and Kumar, M., "The combined effects of chemical reaction, radiation, MHD on mixed convection heat and mass transfer along a moving surface," *Applications and Applied Maths.,* vol.5, *no.10, pp.1631-1640, 2010.*

[7] Anghel, M., Takhar, H. S. and Pop, I, "Dufuour and Soret effects on free-convection boundary layer over a vertical surface embedded in a porous medium," *Studia Universitatis Babes-Bolya, Mathematica,* vol. XLV, pp.11-21, 2000.

[8] Pal, D. and Mondal, H., "Soret and Dufuour effects on MHD non-Darcian mixed convection heat and mass transfer over a stretching sheet with non-uniform heat source/sink," *Physica B.,* vol. 85, pp. 941-951, 2010.

[9] Joseph K., Ayuba p., Yusuf L, Mohammed S.M. And Ayok ''chemically reacting fluid on unsteady mhd oscillatory slip flow in a planer channel with varyingtemperature and concentration inthe presence of suction/injection**."** *International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-5, August 2015*