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Radiation Absorption and Chemical Reaction Effects on MHD Radiative Heat Source/Sink Fluid Past a Vertical Porous Plate

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ABSTRACT
An analysis of radiation absorption and chemical reaction effects on unsteady MHD radiative heat source/sink fluid past a vertical porous plate have been discussed. The dimensionless governing equations are linear and coupled. These equations aresolved analytically by using perturbation technique. The expressions for velocity, temperature and concentration are obtained anddiscussed their variations under several parameters through graphs. The skin-friction, rate of heat transfer in the form of Nusseltnumber and the rate of mass transfer in the form of Sherwood number are also derived and discussed through tables.
Key words: Radiation absorption, Chemical reaction, MHD, Heat source/sink, Porous plate.

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I. INTRODUCTION

The study of magneto hydrodynamics (MHD) plays an important role in agriculture, engineering and petroleum industries. MHD has won practical applications, for instance, it may be used to deal with problems such as cooling of nuclear reactors by liquid sodium and induction flow water which depends on the potential difference in the fluid direction perpendicular to the motion and goes to the magnetic field and also study of MHD of viscous conducting fluids is playing a significant role, owing to its practical interest and abundant applications, in astro-physical and geo-physical phenomenon. Astro-Physicists and geo-physicists realized the importance of MHD in stellar and planetary processes. The main impetus to the engineering approach to the electromagnetic fluid interaction studies has come from the concept of the magneto hydro dynamics, direct conversion generator, ion propulsion study of flow problems of electrically conducting fluid, particularly of ionized gases is currently receiving considerable interest. Such studies have made for years in convection with astro-physical and geo-physical problems such as Sun spot theory, motion of the interstellar gas etc. Recently, some engineering problems need the studies of the flow of an electrically conducting fluid, in ionized gas is called plasma. Many names have been used in referring to the study of plasma phenomena.

The MHD generation process is based on Faraday's electro-magnetic induction law. So Magneto-hydrodynamic generator generates thermal energy or kinetic energy of a moving conducting fluid into directly electrical energy. Examples of such kind of fluids are ionized gas, plasma, liquid metals, and seawater. It's a plasma technology. The gas is continuously seeded with potassium nitrate, making the gas electrically conductive at lower temperatures. The alkali metal ionizes easily at lower temperatures. MHD generators are different from conventional electric generators in that they can operate at high temperatures without moving parts.

Unsteady MHD convective flow of rivlin-ericksen fluid over an infinite vertical porous plate with absorption effect and variable suction was studied by Veera sankar et al. [1]. Anuradha Punithavalli [2] studied the MHD boundary layer flow of a steady micro polar fluid along a stretching sheet with binary chemical reaction . Rama Krishna Reddy et al. [3] have examined the MHD free convective flow past a porous plate. Karuna Dwivedi et al. [4] have investigated the MHD flow through a horizontal channel containing porous medium placed under an inclined magnetic field. Chandra Reddy et al.[5] studied the MHD natural convective heat generation/absorbing and radiating fluid past a vertical plate embedded in porous medium – an exact solution .

Chemical reaction engineering (reaction engineering or reactor engineering) is a specialty in chemical engineering or industrial chemistry dealing with chemical reactors. Frequently the term relates specifically to catalytic reaction systems where either a homogeneous or heterogeneous catalyst is present in the reactor. Sometimes a reactor per se is not present by itself, but rather is integrated into a process, for example in reactive separations vessels, retorts, certain fuel cells, and photocatalytic surfaces. The issue of solvent effects on reaction kinetics is also considered as an integral part. Reactor Design uses information, knowledge and experience from a variety of areas - thermodynamics, chemical kinetcs, fluid mechanics, heat and mass transfer and economics. Chemical Reaction Engineering is the synthesis of all these factors with the aim of properly designing a Chemical Reactor.

Effects of Chemical Reaction on Unsteady MHD Casson Fluid flow past a moving Infinite Inclined Plate through Porous Medium was studied by Balakrishna et al. [6]. Rama Mohan et al. [7] Studied chemical reaction and thermal radiation effects on unsteady MHD free convection flow past an inclined moving plate with TGHS. Arifuzzaman et al. [8] was discussed chemically reactive and naturally convective high speed MHD fluid flow through an oscillatory vertical porous plate with heat and radiation absorption effect. Chemical reaction effect on MHD boundary-layer flow of two-phasenanofluid model over an exponentially stretching sheet with a heatgeneration was discussed by Eid [9]. Muthuraj et al.[10] was studied influences of chemical reaction and wallproperties on MHD Peristaltic transport of a Dusty fluid with Heat and Mass transfer. Chemical Reaction and radiation absorption effects on MHD convective heat and mass transfer flow of a viscoelastic fluid past an oscillation porous plate with heat generation/absorption studied by Ramaiah et al.[11].

The Study of heat generation or absorption effects in moving fluids is important in view of several physical problems such as fluids under-going exothermic or endothermic chemical reactions. The volumetric heat generation has been assumed to be constant or a function of space variable. For example, a hypothetical core-disruptive accident in a Liquid Metal Fast Breeder Reactor (LMFBR) could result in the setting of fragmented fuel debris on horizontal surfaces below the core. The porous debris could be saturated sodium coolant and heat generation will result from the radioactive decay of the fuel particulate.

Chemical reaction and radiation absorption effects on MHD convective heat and mass transfer flow of a visco-elastic fluid past an oscillating porous plate with heat generation / absorption was studied by Ramaiah et al. [12]. Recently researchers [13-21] showed interest in this area.

II. FORMULATION OF THE PROBLEM

Continuity equation:

$$\frac{\partial v*}{\partial y*}=0 \tag{1}$$

Momentum equation:

$$\frac{\partial u*}{\partial t*}+V*\frac{\partial u*}{\partial y*}=\vartheta\frac{\partial^2 u*}{\partial y*^2}+g\beta\ (T*-T_\infty)+gB^*(C*-C_\infty) -\frac{\sigma B_0^2}{\rho}u*-\frac{\vartheta}{K^*}u* \tag{2}$$

Energy equation:

$$\frac{\partial T*}{\partial t*}+V*\frac{\partial T*}{\partial y*}=\frac{K}{\rho C_p}\frac{\partial^2 T*}{\partial y*^2}+\frac{1}{\rho C_p}\frac{\partial q_r}{\partial y*}-\frac{Q_0}{\rho C_p}(T*-T_\infty)-\frac{L_1}{\rho C_p}(C*-C_\infty) \tag{3}$$

Concentration equation:

$$\frac{\partial C*}{\partial t*}+V*\frac{\partial C*}{\partial y*}=D\frac{\partial^2 C*}{\partial y*^2}-K*(C*-C_\infty) \tag{4}$$

The relevant boundary conditions are given as follows

$$u^* = L^*(\frac{\partial u^*}{\partial y^*}),\quad T^* = T_w^* + (T_w^* - T_\infty^*)e^{i\omega^* t^*},\ C^* = C_w^* + (C_w^* - C_\infty^*)e^{i\omega^* t^*}\ \text{at}\ y^* = 0 \tag{5}$$

$$u^* \to 0,\qquad T^* \to T_\infty^*,\qquad C^* \to C_\infty^* \qquad \text{as}\quad y^* \to \infty$$

Where $T_w^{\ *}$ and $T_\infty^{\ *}$ is the temperature at the wall and infinity, $C_w^{\ *}$ and $C_\infty^{\ *}$ is the species

Eq.(1) gives that V* = Constant = - V_0 (6)

Where V_0 is the constant suction velocity normal to the plate.

On introducing the following non-dimensional quantities,

$$u = \frac{u^*}{v_0^{\ *}}, y = \frac{v_0^{\ *} y^*}{\vartheta}, \theta = \frac{T^* - T_\infty^*}{T_w^* - T_\infty^*}, C = \frac{C^* - C_\infty^*}{C_w^* - C_\infty^*}, \Pr = \frac{\mu C_p}{K}, Sc = \frac{\vartheta}{D}, M = \frac{\sigma B_0^2 \vartheta}{\rho v^{*2}_0},$$

$$Gr = \frac{\vartheta g \beta_T (T_w^* - T_\infty^*)}{v^{*3}_0}, Gc = \frac{\vartheta g \beta_c^{\ *}(C_w^* - C_\infty^*)}{v^{*3}_0},\quad K = \frac{v^{*2}_0 K}{\vartheta^2}, t = \frac{t^* v_0^{\ *2}}{4\vartheta}, h = \frac{v_0 L^*}{\vartheta},$$

$$\gamma = \frac{\vartheta K_1}{v^{*2}_0}, R = \frac{4I^*\ \vartheta}{\rho C_p v_0^{\ *2}}, F = \frac{Q_0 v}{\rho C_p v_0^{\ *2} v_0^2}, L = \frac{L_1 \upsilon\ (C_w^* - C_\infty^*)}{\rho C_p v_0^{\ *2}(C_w^* - C_\infty^*)}, \tag{7}$$

The governing equations (2) to (4) can be rewritten in the non-dimensional form as follows

$$\frac{1}{4}\frac{\partial u}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial u}{\partial y} = \frac{\partial^2 u}{\partial y^2} + Gr\theta + GcC - M_1 u \tag{8}$$

$$\frac{1}{4}\frac{\partial \theta}{\partial t} - (1 + \varepsilon A e^{i\omega t})\frac{\partial \theta}{\partial y} = \frac{1}{\Pr}\frac{\partial^2 \theta}{\partial y^2} + F_1\theta + LC \tag{9}$$

$$\frac{Sc}{4}\frac{\partial C}{\partial t} - Sc(1 + \varepsilon A e^{i\omega t})\frac{\partial C}{\partial y} = \frac{\partial^2 C}{\partial y^2} - Sc\gamma C \tag{10}$$

The corresponding boundary conditions are given by

$$u = h(\frac{\partial u}{\partial y}),\ \theta = 1 + \varepsilon e^{i\omega t}, C = 1 + \varepsilon e^{i\omega t},\quad at\quad y = 0$$

$$u \to 0,\quad \theta \to 0,\quad C \to 0 \qquad as\quad y \to \infty \tag{11}$$

III. SOLUTION OF THE PROBLEM

The equations (8) to (10) are coupled, non-linear partial differential equations and these cannot be solved inclosed form. However, these equations can be reduced to a set of ordinary differential equations, which canbe solved analytically. So this can be done, when the amplitude of oscillations (ε<<1) is very small, we canassume the solutions of flow velocity u, temperature field θ and concentration C in the neighborhood of theplate as:

$$u(y,t) = u_0(y) + \varepsilon e^{i\omega t} u_1(y)$$

$$\theta(y,t) = \theta_0(y) + \varepsilon e^{i\omega t}\theta_1(y) \tag{12}$$

$$C(y,t) = C_0(y) + \varepsilon e^{i\omega t} C_1(y)$$

Substituting equations (12) into equation (8)–(10) and equating the coefficients at the terms with the same powers of ε, and neglecting the terms of higher order, the following equations are obtained.

Zero order terms:

$$u_0'' + u_0' - \mathrm{M_1 u_0} = -\mathrm{Gr}\ \theta_0 - \mathrm{Gc}\ C_0 \tag{13}$$

$$\theta_0'' + \Pr\theta_0' + \mathrm{PrF_1Q}\,\theta_0 = -\mathrm{PrL\ C_0} \tag{14}$$

$$C_0'' + Sc\ C_0' - \mathrm{Sc}\gamma C_0 = 0 \tag{15}$$

First order terms :

$$u_1'' + u_1' - (\mathrm{M}_1 + \frac{i\omega}{4})\mathrm{u}_1 = -\mathrm{Gr}\,\theta_1 - \mathrm{Gc}\,C_1 - \mathrm{A}u_0' \tag{16}$$

$$\theta_1'' + \Pr\,\theta_1' + \Pr(\mathrm{F}_1 - \mathrm{i}\omega/4)\mathrm{Q})\ \theta_1 = -\Pr\mathrm{A}\,\theta_0' - \Pr\mathrm{LC}_1 \tag{17}$$

$$C_1'' + ScC_1' - Sc(\gamma + \frac{i\omega}{4})C_1 = -\mathrm{Sc}\,\mathrm{A}C_0' \tag{18}$$

The corresponding boundary conditions are

$$u_0 = h(\frac{\partial u_0}{\partial y}), u_1 = h(\frac{\partial u_1}{\partial y})\ , \theta_0 = 1, \theta_1 = 1, C_0 = 1, C_1 = 1 \quad at \quad y = 0$$

$$u_0 \to 0, u_1 \to 0, \theta_0 \to 0, \theta_1 \to 0, C_0 \to 0, C_1 \to 0 \qquad as \quad y \to \infty \tag{19}$$

Solving equations (13) – (18) under the boundary conditions (19), the following solutions are obtained

$$C_0 = \exp(-m_1 y) \tag{20}$$

$$\theta_0 = B_1 \exp(-m_1 y) + B_2 \exp(-m_2 y) \tag{21}$$

$$u_0 = B_3 \exp(-m_1 y) + B_4 \exp(-m_2 y) + B_5 \exp(-m_3 y) \tag{22}$$

$$C_1 = B_6 \exp(-m_1 y) + B_7 \exp(-m_4 y) \tag{23}$$

$$\theta_1 = B_8 \exp(-m_1 y) + B_9 \exp(-m_2 y) + B_{10} \exp(-m_4 y) + B_{11} \exp(-m_5 y) \tag{24}$$

$$u_1 = B_{12} \exp(-m_1 y) + B_{13} \exp(-m_2 y) + B_{14} \exp(-m_3 y) + B_{15} \exp(-m_4 y) + B_{16} \exp(-m_5 y) + B_{17} \exp(-m_6 y) \tag{25}$$

Substituting equations(20)–(25)inequation (12) we obtain the velocity temperature and concentration field:

$$u = B_3 \exp(-m_1 y) + B_4 \exp(-m_2 y) + B_5 \exp(-m_3 y) + \varepsilon(B_{12} \exp(-m_1 y) + B_{13} \exp(-m_2 y) + B_{14} \exp(-m_3 y) + B_{15} \exp(-m_4 y) + B_{16} \exp(-m_5 y) + B_{17} \exp(-m_6 y))e^{i\omega t} \tag{26}$$

$$\theta = B_1 \exp(-m_1 y) + B_2 \exp(-m_2 y) + \varepsilon(B_8 \exp(-m_1 y) + B_9 \exp(-m_2 y) + B_{10} \exp(-m_4 y) + B_{11} \exp(-m_5 y))e^{i\omega t} \tag{27}$$

$$C = \exp(-m_1 y) + \varepsilon(B_6 \exp(-m_1 y) + B_7 \exp(-m_4 y))e^{i\omega t} \tag{28}$$

Skin Friction:

The non-dimensional skin friction at the surface is given by

$$\tau = -\left(\frac{\partial u}{\partial y}\right)_{y=0}$$

$$\tau = (m_1 B_3 + m_2 B_4 + m_3 B_5) + \varepsilon(m_1 B_{12} + m_2 B_{13} + m_3 B_{14} + m_4 B_{15} + m_5 B_{16} + m_6 B_{17})e^{i\omega t} \tag{29}$$

NusseltNumber :

The rate of heat transfer in terms of the Nusselt number is given by

$$Nu = -\left(\frac{\partial \theta}{\partial y}\right)_{y=0}$$

$$Nu = m_1 B_1 + m_2 B_2 + \varepsilon(m_1 B_8 + m_2 B_9 + m_4 B_{10} + m_5 B_{11})e^{i\omega t} \tag{30}$$

Sherwood Number :

The rate of mass transfer on the wall in terms of Sherwood number is given by

$$Sh = -\left(\frac{\partial \phi}{\partial y}\right)_{y=0}$$

$$Sh = m_1 + \varepsilon(m_1 B_6 + m_4 B_7)e^{i\omega t} \qquad (31)$$

IV. RESULTS AND DISCUSSION

In order to get a physical insight into the problem numerical calculations are carried out for theVelocity, Temperature and concentration profiles and the following discussion is set out.Throughout the computations we employ, Sc=0.22,Pr=0.71,Gr=5,Gc=1,γ=2,K=3,F=**0.**1,M=3, E=0.01,t=1,R=0.1,**ω=π/3, L**=0.02. h=0.5,A=1.

In order to reveal the effects of various parameters on the dimensionless velocity fields, temperature field, concentration field, skin friction, Nusselt number and Sherwood number and the effect of the various physical parameters such as the Grashof number (Gr), the modified Grashof number (Gc),Magnetic parameter (M), Porosity parameter(K), Prandtl number (Pr), Heat absorption parameter(F), Radiation Parameter (R),Radiation absorption Parameter (L),Schmidt number(Sc) and Chemical reaction parameter(γ) on velocity, temperature and concentration we draw a number of figures marked as figs. 1-10 and study these by choosing arbitrary values. The influence of these parameters on skin friction, Nusselt number and Sherwood number is also shown in Tables 1 – 3.

Figs. 1 – 4 demonstrate the variations of the fluid velocity under the effects of different parameters. In Fig.1, we represent the velocity profile for different values of Grashof number(Gr). From this figure it is noticed that, velocity increases with increases in Gr. In Fig.2 the effect of modified Grashof number (Gc) on velocity is presented. As Gc increases, velocity also increases.Fig.3, depicts the variations in velocity profiles for different values of permeability parameter (K). From where it is noticed that, velocity increases as K increases. In Fig. 4, velocity profiles are displayed with the variation in magnetic parameter (M). From this figure it is noticed the velocity gets reduced by the increase of magnetic parameter (M).

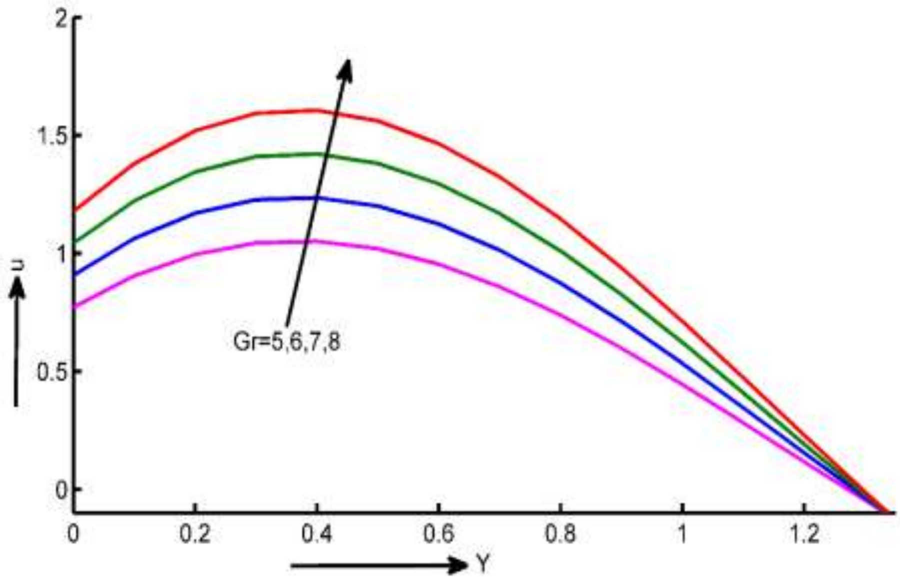

Figure 1: Effect of Thermal Grashof number on Velocity

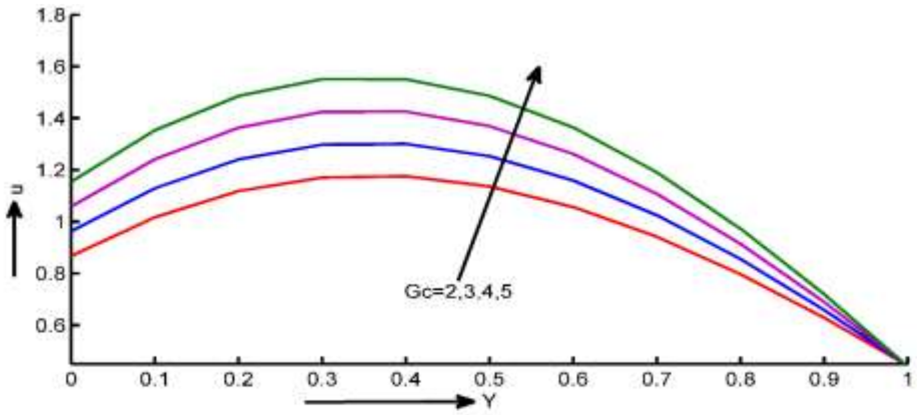

Figure 2: Effect of Modified Grashof number on Velocity

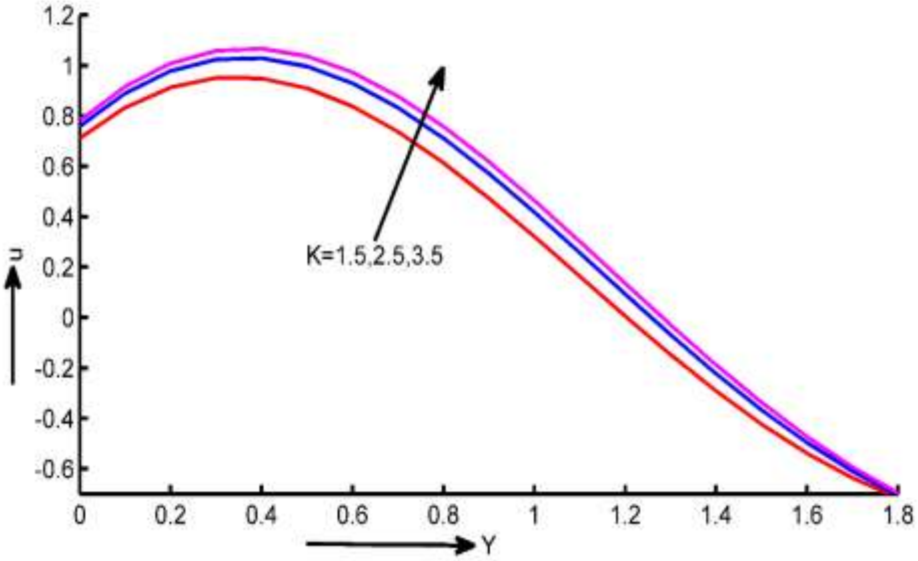

Figure 3: Effect of Porosity parameter on Velocity

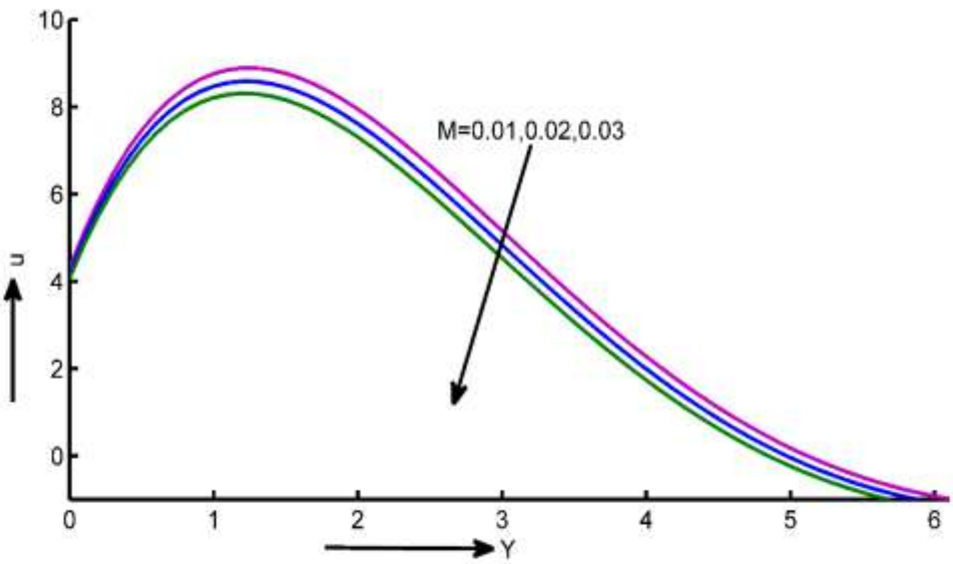

Figure 4: Effect of Magnetic parameter on Velocity

Figures 5– 8, display the variations of the fluid temperature under the effects of different parameters. From Fig5-7, it is clear that temperature decreases with the increase in Prandtal number (Pr),Radiation Parameter (R),Heat source parameter(F) .and In Fig 8, the effect of Radiation absorption Parameter (L), shown on the temperature profile. From these figure observed that temperature increases with an increase values in L.

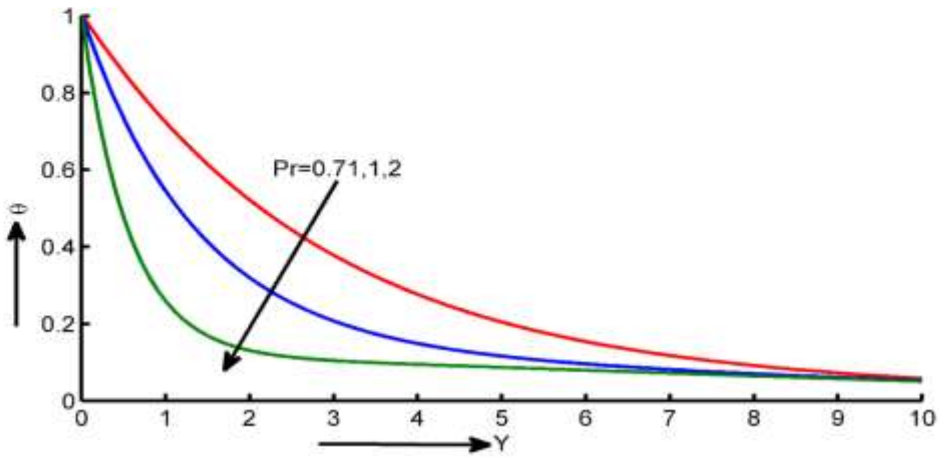

Figure 5: Effect of Prandtl number on Temperature

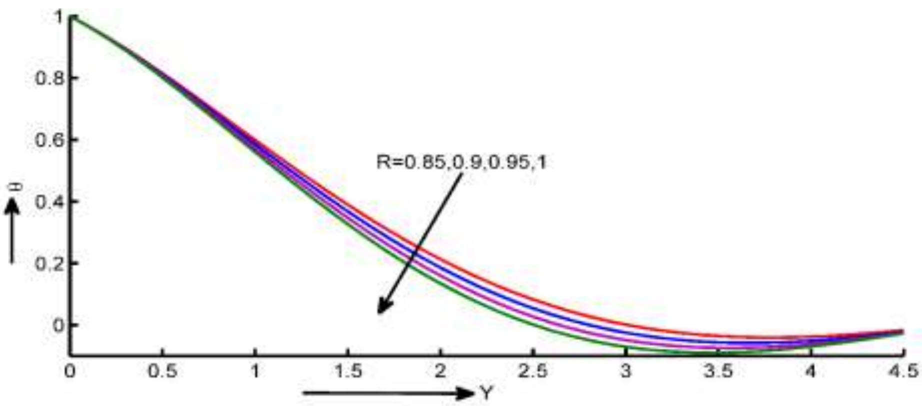

Figure 6: Effect of Radiation parameter on Temperature

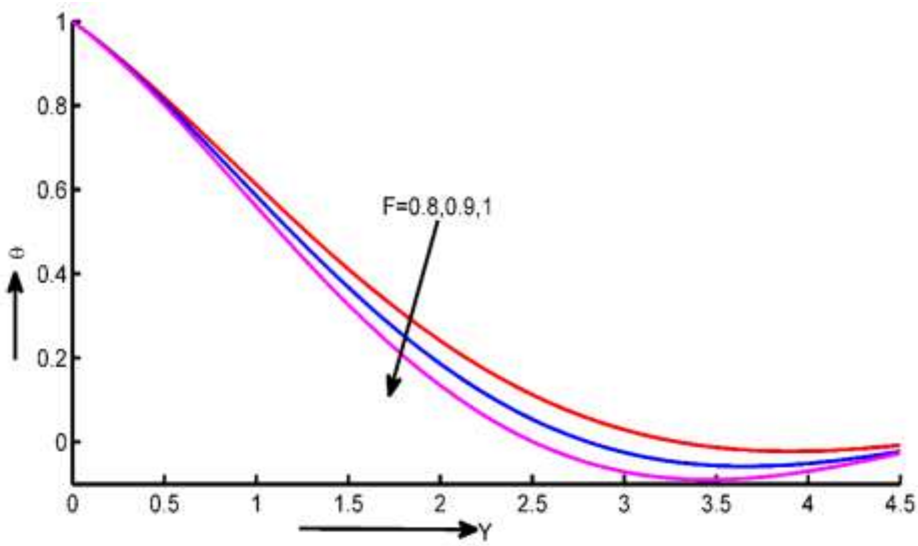

Figure 7: Effect of Heat source parameter on Temperature

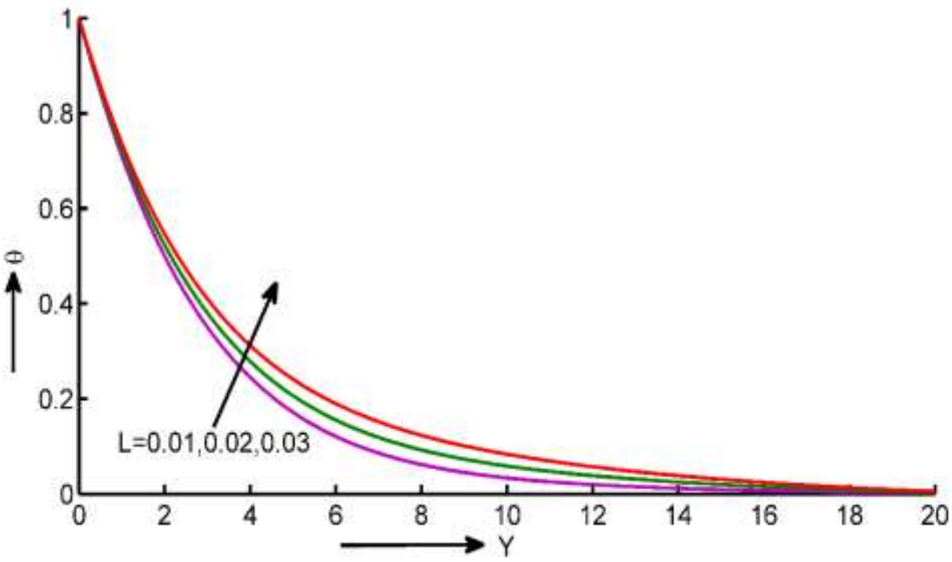

Figure 8: Effect of Radiation absorption on Temperature

To analyze the effect of Schmidt parameter(Sc) on the concentration profile in Fig.9. The result shows that the concentration field decreases when increases Sc. Fig.10 depicts the variations in Concentration profile for different values of Chemical Reaction Parameter(γ). From this figure it is noticed that, Concentration decreases when γ increases.

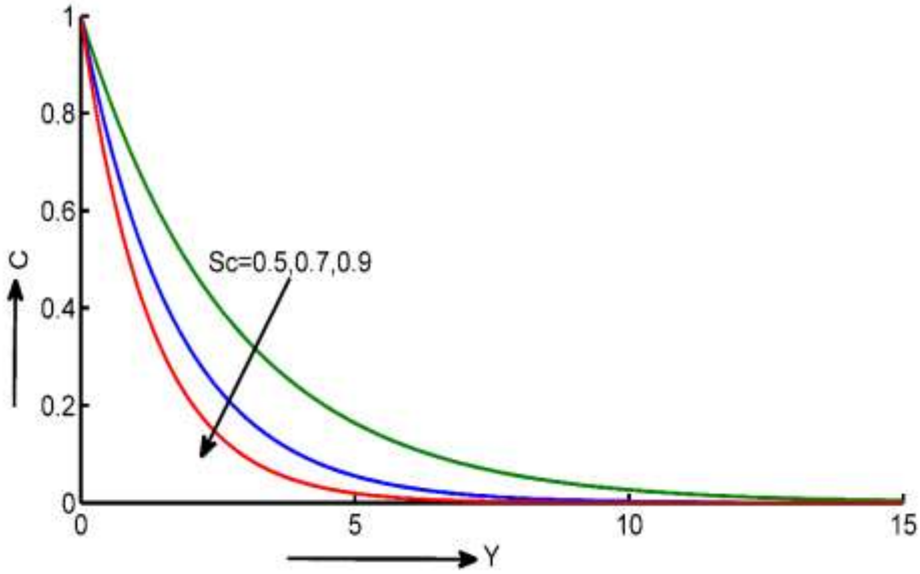

Figure 9: Effect of Schmidt number on Concentration

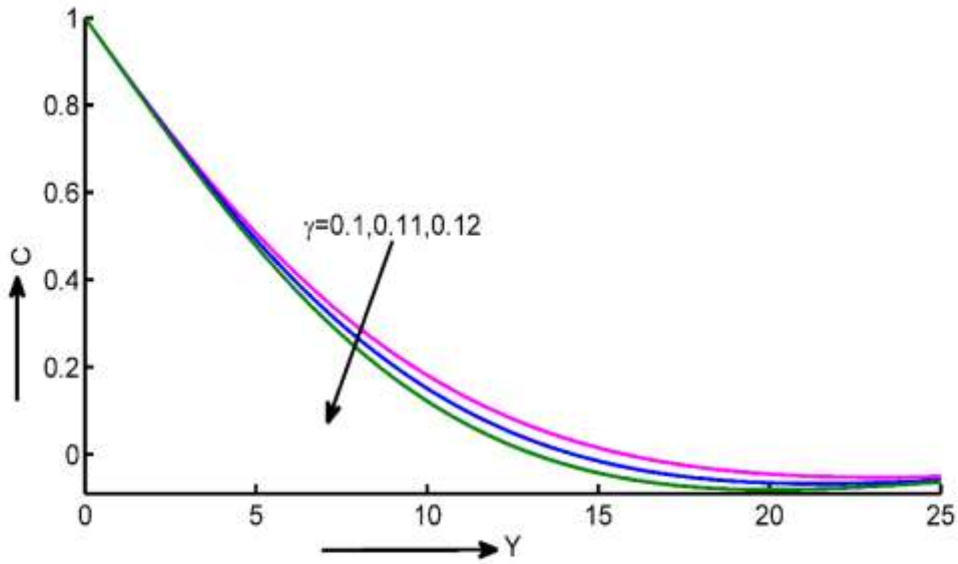

Figure 10: Effect of Chemical Reaction Parameter on Concentration

Table – 1, shows numerical values of skin-friction for various of Grashof number (Gr), modified Grashof number (Gc), Magnetic parameter (M), Porosity parameter (K) .From table 1, we observe that the skin-friction increases with an increase in Grashof number (Gr), modified Grashof number (Gm), Porosity parameter (K) where as it decreases under the influence of magnetic parameter .

Table-1:
Variations in Skin Friction

Gr	Gc	M	K	T
5				1.4843
6				1.7346
7				1.9820
8				2.2264
	2			1.6635
	3			1.8427
	5			2.2011
	7			2.5595
		0.1		5.6159
		0.2		4.9710
		0.3		4.5041
			0.5	1.0426
			0.6	1.1105
			0.7	1.1639

Table – 2 demonstrates the numerical values of Nusselt number (Nu) for different values of Prandtl number (Pr), Radiation parameter (R), Heat source parameter (F) and Radiation absorption parameter (L). From table 2, we notice that the Nusselt number increases with an increase in Prandtl number, Radiation parameter (R) ,Heat absorption parameter (F) and where as it decreases under the influence of Radiation absorption parameter (L).

Table-2:
Variations in Nusselt Number

Pr	R	F	L	Nu
0.3				0.1500
0.5				0.2500
0.71				0.3543
	0.1			0.1197
	0.5			0.5471

	0.7			0.6617
		0.4		0.4772
		0.6		0.6073
		0.8		0.7145
			0.1	0.0562
			0.2	-0.0231
			0.3	-0.1024
			0.4	-0.1818

Table – 3 shows numerical values of Sherwood number (Sh) for the distinction values of Schmidt number (Sc), Chemical reaction parameter (γ). It can be noticed from Table - 3 that the Sherwood number enhances with rising values of Schmidt number, and the Chemical reaction parameter.

Table-3:
Variations in Sherwood Number

Sc	Γ	Sh
0.2		0.6409
0.4		0.9088
0.6		1.1127
0.8		1.2823
	2	0.6725
	3	0.8319
	4	0.9672
	5	1.0873

V. CONCLUSIONS

In this problem, we have studied the radiation absorption and chemical reaction effects on unsteady MHD radiative heat source/sink fluid past a vertical porous plate. In the analysis of the flow the following conclusions are made:

1. Velocity increases with an increase in Grashof number and as well as modified Grashof number and Permeability parameter of the porous medium while, it decreases in the existence of magnetic parameter.
2. Temperature increases in the presence of Radiation absorption parameter while it decreases in the presence of Radiation parameter, Heat source parameter and Prandtl number.
3. Concentration decreases with an increase in Schmidt number and chemical reaction parameter.
4. As significant increase in seen in skin friction for Grashof number, modified Grashof number and permeability parameter while a decrease is seen in the presence of magnetic parameter.
5. The rate of heat transfer increases with Prandtl number, heat source parameter and Radiation paremeter where as it decreases with an increase in radiation absorption parameter.
6. The rate of mass transfer increases with Schmidt number and Chemical reaction parameter.

REFERENCES

[1]. Veera Sankar B and Rama Bhupal Reddy B. : Unsteady MHD Convective flow of Rivlin-Ericksen Fluid over an Infinite Vertical Porous Plate with Absorption Effect and Variable Suction. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 1 (2019) pp. 284-295 .

[2]. Anuradha S , Punithavalli R. : MHD Boundary Layer Flow of a Steady Micro polar Fluid along a Stretching Sheet with Binary Chemical Reaction .International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 2 (2019) pp. 440-446.

[3]. Rama Krishna Reddy P, Raju M. C.: MHD FREE CONVECTIVE FLOW PAST A POROUS PLATE.International Journal of Pure and Applied Mathematics Volume 118 No. 5 , 2018, 507-529.

[4]. Karuna Dwivedi , Khare R. K. and Ajit Paul . : MHD Flow through a Horizontal Channel Containing Porous Medium Placed Under an Inclined Magnetic Field. Journal of Computer and Mathematical Sciences, Vol.9(8), 1057-1062 August 2018.

[5]. Chandra Reddy P , Raju M. C. , Raju G. S. S. : MHD Natural Convective Heat Generation/Absorbing and Radiating Fluid Past a Vertical Plate Embedded in Porous Medium – an Exact Solution .Journal of the Serbian Society for Computational Mechanics / Vol. 12 / No. 2, 2018 / pp 106-127.

[6]. Balakrishna S, Rama Mohan S, Viswanatha Reddy G, Varma S.V.K: Effects of Chemical Reaction on Unsteady MHD Casson Fluid flow past a moving Infinite Inclined Plate through Porous Medium ,ISSN 2321 3361 © 2018 IJESC, Volume 8 Issue No.7.

[7]. Rama Mohan S, Viswanatha Reddy G and Varma S.V.K: Chemical reaction and thermal radiation effects on unsteady MHD free convection flow past an inclined moving plate with TGHS. Imperial journal of interdisciplinary research, vol-3, issue-1, 2017

[8]. Arifuzzaman S.M., Khan M.S., Mehedi M.F.U., Rana B.M.J., AhmmedS.F:Chemically reactive and naturally convective high speed MHD fluid flow through an oscillatory vertical porous plate with heat and radiation absorption effect. Engineering Science and Technology, an International Journal xxx (2018) xxx–xxx.

[9]. Eid M.R.: Chemical reaction effect on MHD boundary-layer flow of two-phase nanofluid model over an exponentially stretching sheet with a heat generation, J. Mol. Liq. 220 (2016) 718–725.

[10]. Muthuraj R, Nirmala K, Srinivasm S: Influences of chemical reaction and wall properties on MHD Peristaltic transport of a Dusty fluid with Heat and Mass transfer. Alexandria Eng. J. 55 (2016) 597–611.

[11]. Ramaiah P, Vijaya kumar varma S, Rama Krishna Prasad K and Balamurugan K.S.Chemical Reaction and radiation absorption effects on MHD convective heat and mass transfer flow of a viscoelastic fluid past an oscillation porous plate with heat generation/absorption. Int J.Chem. Sci:14(2), pp:570-584 (2016).

[12]. Ramaiah P., Vijaya Kumar, Varma S., Ramakrishna Prasad K. and Balamurugan K.S.: Chemical reaction and radiation absorption effects on MHD convective heat and mass transfer flow of a visco-elastic fluid past an oscillating porous plate with heat generation / absorption. Int. J. Chem. Sci., 2016, Vol. 14(2). pp.570-584.

[13]. S. Mohammed Ibrahim and K. Suneetha, "Heat source and chemical effects on MHD convection flow embedded in a porous medium with Soret, viscous and Joules dissipation," Aim Shams Engg Journal, Vol. 7, PP. 811-818 (2016).

[14]. Chamkha A.J. : MHD flow of uniformly stretched vertical permeable surface in the presence of heat generation / absorption and chemical reaction, Int. Commun.. Heat Mass transfer, 2003, Vol.30(3), pp.413-422.

[15]. Chandra Reddy P. , Raju M. C. , Raju G. S. S: MHD Natural Convective Heat Generation/Absorbing and Radiating Fluid Past a Vertical Plate Embedded in Porous Medium – an Exact Solution , Journal of the Serbian Society for Computational Mechanics / Vol. 12 / No. 2, 2018

[16]. Rama mohan reddy L, Raju M. C, Chandra reddy P, Raju G. S. S.:Thermal diffusion and joule-heating effects on magnetohydrodynamic, free-convective, heat-absorbing/-generating, viscous-dissipative newtonian fluid with variable temperature and concentration.Volume 45, issue 6 ,pages 553-56 ,internationaljournal of fluid mechanics (2018).

[17]. Venkateswara raju K , Raju m. C. , Ravi kumar v, Raju G. S. S. : Thermal diffusion and radiation effects onmagnetocasson fluid flow past a vertical porous plate . i-manager's journal on mathematics, vol. 7 l no. 2 l, april - june 2018.

[18]. Sandeep N, Vijaya Bhaskar Reddy A, Sugunamma V. : Effect of radiation and chemical reaction on transient mhd free convective flow over a vertical plate through porous media. Chemical and process engineering research vol 2,2012.

[19]. VeereshC. VarmaSVK. Vijaya Kumar AG , Umamaheswar M.and RajuMC.Joule heating and thermal diffusion effects on MHD radiative and convective casson fluid flow past anoscillating semi-infinite vertical porous plate. Frontiers in Heat and Mass Transfer (FHMT), 8, 1 (2017).

[20]. Mohammed Ibrahim.K and Suneetha.S. "Heat source and chemical effects on MHD convection flow embedded in a porous medium with Soret, viscous and Joules dissipation," Aim Shams Engg Journal, Vol. 7, PP. 811-818 (2016).

[21]. Triveni B and Raju G.S.S. radiation effects on unsteady MHD free convection flow past a vertical porous plate with thermal diffusion andchemical reaction.**International Journal of Current Research in Life Sciences, Vol. 07, No. 02, pp.1040-1049, February, 2018.**

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