Research Article

Heat generation and Chemical reaction impact on MHD Rotating flow past a Vertical Porous plate

Madhumohana Raju A B[a] Konduru Venkateswara Raju[b*] Poli Chandra Reddy[c]
Malaraju Changal Raju[d] G Sankara Sekhar Raju[e]

[a] Department of Mathematics, New Horizon College of Engineering, Bangalore-560103, Karnataka, India,

[b*] Department of B S & H (Mathematics), Chadalawada Ramanamma Engineering College (Autonomous), Tirupati-517506, A.P.,India. email: venky.sakku@gmail.com

[c] Department of Mathematics, Annamacharya Institute of Technology and Sciences (Autonomous), Rajampet516126, A.P., India. email: chandramsc@gmail.com

[d ,e] Department of Mathematics, JNTUA College of Engineering, Pulivendula, A.P., India. email: mcrmaths@yahoo.co.in

Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 4 June 2021

Abstract: The purpose of this article is to examine the second-grade fluid MHD rotary stream past the imprudently flowing porous upward platter with the impact of warm and chemical reactions. The dimensionless controllers are paired with nonlinear configurations for analytical consequences, calculated by the method of finite differences. The speed, temperature and concentration profiles are expressed graphically, whilst the skin friction, Nusselt, and Sherwood numerous are offered in an understandable form for momentous flow parameters. Thermal radiation and warm dissemination both are thundering the boundary layer area help to increase the fluid temperature. Mass distribution continues to maximize concentration across the whole border region. The pivot and fluid parameter of the second grade appear to boost in x and z directions. The velocity, temperature and concentration outlines are built in particular for different control boundaries. Hartman Number (M2), Heat Source (Q0), Thermal Radiation Parameters (N), Thermal Grashof (Gr), Mass Grashof (Gc), Prandtl (Pr). The thermal boundary layer thickness is indicated to be substantially increased if the content of the Dufour number is expanded. The existence of a chemical reaction enhances the mass transfer rate, the optimal consequence of the organisms' progression.

Keywords: Chemical reaction, MHD, Finite difference method, Porous plate, Heat source.
MSC 2020 No.:76W05, 76M55, 76D05, 76S05

1. Introduction

Non-Newtonian fluids are commonly employed in a variety of scientific, biological, medical, agricultural, etc. The equations of Navier-Stokes are scarce in the analysis of non-Newtonian liquids owing to the nonlinear interaction between stress and strain rate; thus, the rheological models used for Navier-Stokes equations are different. MHD is the synthesis of magnet fields and fluids, MHD fluxes exist in ionosphere generators, sun and electricity generators, etc. Special hydromagnetic effects are essential for the analysis of non-Newtonian fluids. The analysis of fluids of non-Newtonian nature under a heat source or sink control has numerous applications such as chemical refining, nuclear plants, electric conductions and cooling. The radiation influence of free convection flow was exposed by Chamka, A.J. et al.[3], past a semi-unbounded upward platter with mass transfer. Ganesan, P. et al. [4-8] examined the expected convection effects of heat and mass propagation on the pulsed inclined plate. K. VB kumar et al. [9] studied the steady MHD Casson In the presence of Soret Ohmic heating and the viscous dissipative fluid stream, Hall and Ion-slip currents move an unbounded upward porus layer. Summary Nandita et al. [10] possessed In Hall current and rotation the unstable Free movement of convective MHD going past a porous vertical platform with periodic movement and slipping age. B. R. Sharma et al. [12] The MHD movement, heat and mass transfer was researched by under the influence of radiation, chemical reaction and heat production or absorption effects in permeable revolving vertical cones. M. Veera Krishna et al.[17] has examined MHD Spinning Flow Heat and Mass transmission of Second Grade Fluid, and has passed an Infinite Square in Uniform Permeable object with Hall Results.

In the application of geophysics, petrochemistry, meteorology, oceanography and aeronautics, the principle of fluid movement and mass transmission via a porus object in revolving atmosphere plays an important part. The stimulus for scientific studies on the rotating fluid system is primarily extracted from geophysical applications and fluid engineering. The rotational flow principle shall be used to calculate fluid viscosity, rotor shape and other centrifugal machinery. The fluid flow issues in rotating media have brought many researchers to focus on who has studied the hydrodynamic flux of viscous and incompressible fluid in a rotating medium in various ways. F. The chemical reaction results of an MHD spinning fluid were explored by Mabood et al. [11]

over a upward Platform Embedded with Heat Source, Journal of thermal physics engineering. R Mohana Ramana et al. [14] researched the melting and radiation impact of Casson flow over a permeable spreader in the presence of a chemical reaction on MHD heat and mass transmission.

Rapid attempts have been made to research both experimentally and theoretically, the impact of different porous media fields. Porous medium flows are of crucial significance in industrial infrastructure, water supply and water drainage, Petroleum technology to investigate the distribution of natural gas, oil and water by oil wells in river channels, and filtration and purification devices in oceans. How fluid moves through porous media is critical for oil extraction. Besides adding further to current expertise, most questions have significant operational importance in a permeable object by natural convection. Nakayama et al.[2] studied integral therapy for heat and mass transmission On MHD Casson Fluid Flow Past revolving platter, Harshad R. Patel[14] possessed the impact of Heat Output, Thermal Radiation, and Current Hall In Porous Media, Science and Technology. The free convective flow of visco-elastic fluid past a vertical unbounded revolving pore platform with varying temperature and concentration was explored by Unsteady MHD. [15] Ramesh Babu and al., respectively. A very recently Pavankumar et al. [17] have analyzed Analytical solution of thermal diffusion and diffusion thermo effects on MHD Casson fluid flow past an oscillating inclined plate embedded through porous medium in the presence of thermal radiation, aligned magnetic field and chemical reaction. Obulesu et al. [18] have analyzed Radiation Absorption Effects on MHD Jeffrey fluid flow Past a Vertical Plate through a Porous Medium in Conducting Field. Raghunath et al. [19] have possessed Heat and mass transfer on an unsteady MHD flow through porous medium between two porous vertical plates. Obulesu et al. [20] have studied Hall current effects on MHD convective flow past a porous plate with thermal radiation, chemical reaction with radiation absorption. Raghunath et al. [21] have discussed Heat and mass transfer on MHD flow of Non-Newtonian fluid over an infinite vertical porous plate. Raghunath et al. [22] have possessed Heat and mass transfer on Unsteady MHD flow of a second grade fluid through porous medium between two vertical plates. Raghunath et al. [23] have studied Hall Effects on MHD Convective Rotating Flow of through a Porous Medium past Infinite Vertical Plate. Raghunath et al. [24] have discussed Heat and Mass Transfer on Unsteady MHD Flow of a Visco-Elastic Fluid Past an Infinite Vertical Oscillating Porous Plate. GVN Prasad et al. [25] have expressed MHD flow of a Visco-elastic fluid over an unbounded rotating porous plate with Heat source and Chemical reaction. Suresh babu et al. [26] has studied Finite Element Analysis of Free Convection Heat Transfer Flow in a Vertical Conical Annular Porous Medium. Recently K V Raju et al. [27] have discussed Chemical Reaction effects on maxwell base MHD Fluid Flow of Nonmaterial over vertical moving Surface with Radiation. Mohana ramana et al. [28] have possessed Multiple Slips and Chemical Reaction Effects on unsteady MHD Heat and Mass Transfer Flow over a Permeable Stretching Sheet with Radiation. Reddappa et al. [29] have analysed Jeffrey fluid flow over boundary layer magnetohydrodynamic exponentially enlarged sheet with thermally stratified medium in existence of suction.

For engineers and scientists, the research of heat transfer and mass transmission with chemically reaction is particularly relevant since it has become almost ubiquitous in many branches of study and engineering. S. In the influence of chemical and irradiation, Ram Prakash Sharma et al. [16] examined the MHD movement of revolving fluid past a upward porus platter on the buoyance of an unstable MHD chemical reacting and turning fluid flow past a scale of a permeable object.

Formulation and solution of the problem

MHD considered the rotating flow of an eclectically conducting, viscous, incompressible, and optically substantial rotating fluid past a vertical porous plate with the effect of heat generation and the chemical reaction. The plate temperature is elevated or decreased, while the plate temperature is controlled and maintained at a reliable temperature $t > t_0$, (t_0 being characteristic time). In comparison, the concentration of organisms on the plate's surface is elevated to the attention of invariable species and is retained afterwards. Because the plating is indefinitely directed, all physical amounts except pressure are based solely on them. The equations for controlling the flow in a revolving frame through the porous medium, taking into account Hall current, heat production and chemical reaction. Under Boussinesq approximation, are defined by

$$\frac{\partial u}{\partial t} + 2\Omega w = \vartheta \frac{\partial^2 u}{\partial y^2} + \frac{\alpha_1}{\rho}\frac{\partial^3 u}{\partial y^2 \partial t} - \frac{\sigma B_0{}^2}{\rho(1+m^2)}(u + mw) - \frac{\vartheta}{K_1}u + g\beta(\theta - \theta_\infty) + g\beta'(\phi - \phi_\infty) \quad (1)$$

$$\frac{\partial w}{\partial t} + 2\Omega u = \vartheta \frac{\partial^2 w}{\partial y^2} + \frac{\alpha_1}{\rho}\frac{\partial^3 w}{\partial y^2 \partial t} + \frac{\sigma B_0{}^2}{\rho(1+m^2)}(\mathrm{m}u - w) - \frac{\vartheta}{K_1}w \quad (2)$$

$$\rho c_p \frac{\partial \theta}{\partial t} = k\frac{\partial^2 \theta}{\partial y^2} - \frac{\partial q_r}{\partial y} + Q_0(\mathrm{T}-\mathrm{T}_\infty) \tag{3}$$

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

Original and boundary requirements are

$$u = w = 0,\ \theta = \theta_\infty,\ \phi = \phi_\infty \quad \text{for} \quad y \ge 0 \text{ and } t \le 0, \tag{5}$$

$$u = U_0,\ w = 0 \text{ at } y = 0 \text{ for } t > 0,\ \phi = \phi_w \text{ at } y = 0 \text{ for } t > 0 \tag{6}$$

$$\theta = \theta_w \text{ at } y = 0 \text{ for } t > t_0,\ \theta = \theta_\infty + (\theta_w - \theta_\infty)\frac{t}{t_0} \text{ at } y = 0 \text{ for } 0 < t \le t_0, \tag{7}$$

$$w \to 0;\ \theta \to \theta_\infty;\ \phi \to \phi_\infty \text{ as } y \to \infty \text{ for } t > 0 \tag{8}$$

We followed the Roseland approximation for the radiative flux vector for an optically important fluid, discharge and self-importance.

$$q_r = -\frac{4\sigma^*}{3k^*}\frac{\partial \theta^4}{\partial y}, \tag{9}$$

In the Taylor sequence concerning linearization of equation (9), presume that minor temperature differences between θ and θ_∞, θ^4 are expanded after leaving second and higher order terms in second and higher order terms $\theta - \theta_\infty$

$$\theta^4 \cong 4\theta_\infty{}^3\theta - 3\theta^4{}_\infty \tag{10}$$

With the support of equations (9) as well as (10), equation (3) decreases to

$$\frac{\partial \theta}{\partial t} = \frac{k}{\rho c_p}\frac{\partial^2 \theta}{\partial y^2} + \frac{1}{\rho c_p}\frac{16\sigma^*\theta^3{}_\infty}{3k^*}\frac{\partial^2 \theta}{\partial y^2} + \frac{Q_0}{\rho c_p}(T - T_\infty) \tag{11}$$

Introducing variables that are dimensionless

$$y^* = \frac{y}{U_0 t_0};\ u^* = \frac{u}{U_0};\ \mathrm{w}^* = \frac{w}{U_0 t_0};\ t^* = \frac{t}{t_0};\ \theta^* = \frac{(\theta - \theta_\infty)}{(\theta_w - \theta_\infty)};\ \phi^* = \frac{(\phi - \phi_\infty)}{(\phi_w - \phi_\infty)};\ M^2 = \frac{\sigma B_0{}^2 \vartheta}{\rho U_0{}^2};$$

$$R^2 = \frac{\vartheta \Omega}{U_0{}^2};\ m = w_e t_e;\quad K = \frac{K_1 U_0{}^2}{\vartheta_2};\ \alpha = \frac{U_0{}^2 \alpha_1}{\rho \upsilon^2};\ y^* = \frac{y}{U_0 t_0};\ Gr = \frac{g\beta\vartheta(\theta_w - \theta_\infty)}{U_0{}^3};\ Sc = \frac{\vartheta}{D};$$

$$N = \frac{16\sigma^*\theta_\infty{}^3}{3kk^*};\ Gc = \frac{g\beta^*\vartheta(\phi_w - \phi_\infty)}{U_0{}^3};\ \Pr = \frac{\vartheta\rho c_p}{k};\ \mathrm{Kr} = \frac{\vartheta(\mathrm{C}-\mathrm{C}_\infty)}{(\phi_w - \phi_\infty)};\ Q_1 = \frac{\mathrm{Q}_0\,\vartheta}{\rho\,\mathrm{cp}}; \tag{12}$$

Equations.(1),(2),(4) and (11) are equations using dimensionless variables.

$$\frac{\partial u}{\partial t} + 2R^2 w = \frac{\partial^2 u}{\partial y^2} + \alpha\frac{\partial^3 u}{\partial y^2 \partial t} - \frac{M^2}{(1+m^2)}(u + mw) - \frac{u}{K} + Gr\theta + Gc\phi \tag{13}$$

$$\frac{\partial w}{\partial t} - 2R^2 u = \frac{\partial^2 u}{\partial y^2} + \alpha\frac{\partial^3 u}{\partial y^2 \partial t} + \frac{M^2}{(1+m^2)}(\mathrm{m}u - w) - \frac{w}{K_1} \tag{14}$$

$$\frac{\partial\theta}{\partial t}=\frac{(1+N)}{Pc}\frac{\partial^2\theta}{\partial y^2}+Q_1\theta \tag{15}$$

$$\frac{\partial\phi}{\partial t}=\frac{1}{Sc}\frac{\partial^2\phi}{\partial y^2}+K_r\theta \tag{16}$$

Characteristic time t_0 is debated in line with the dimensionless methodology as $t_0=\frac{\vartheta}{U_0^{\ 2}}$.

The related conditions of original and border are

$$F=\theta=\phi=0,\ \text{for}\quad y\ge 0 \text{ and } t\le 0, \tag{18}$$

$$F=1 \text{ at } y=0 \quad \text{for } t>0,\ \phi=1 \text{ at } y=0 \text{ for } t>0 \tag{19}$$

$$\theta=t \text{ at } y=0 \text{ for } \ 0<t\le 1,\ \theta=1 \text{ at } t>1 \tag{20}$$

$$F\to 0;\ \theta\to 0;\ \phi\to 0 \text{ as } y\to\infty \text{ for } t>0 \tag{21}$$

2. Method of solution

Simulations (5) - (7) are mathematical models which are non-linear, together that must be overcome by utilizing (8). For this series of equations, however, correct solution is not feasible and thus we solve these equations by the technique of finite difference. The following are the corresponding Schemes of finite disparities in equations for (5)- (7):

$$\left.\begin{aligned}&\frac{u_{i,j+1}-u_{i,j}}{\Delta t}+2R^2w_{i,j}=Gr\,\theta_{i,j}+Gc\,\phi_{i,j}+\frac{u_{i-1,j}-2u_{i,j}+u_{i+1,j}}{(\Delta y)^2}\\&\qquad+\lambda\left(\frac{u_{i-1,j+1}-2u_{i,j+1}+u_{i+1,j+1}-u_{i-1,j}+2u_{i,j}-u_{i+1,j}}{\Delta t(\Delta y)^2}\right)-\frac{u_{i,j}}{k}-\frac{M^2}{(1+m)^2}\left(u_{i,j}+mw_{i,j}\right)\end{aligned}\right\} \tag{22}$$

$$\left.\begin{aligned}&\frac{w_{i,j+1}-w_{i,j}}{\Delta t}-2R^2u_{i,j}=\frac{u_{i-1,j}-2u_{i,j}+u_{i+1,j}}{(\Delta y)^2}-\frac{w_{i,j}}{k}-\frac{M^2}{(1+m)^2}\left(u_{i,j}+mw_{i,j}\right)\\&\qquad+\lambda\left(\frac{u_{i-1,j+1}-2u_{i,j+1}+u_{i+1,j+1}-u_{i-1,j}+2u_{i,j}-u_{i+1,j}}{\Delta t(\Delta y)^2}\right)\end{aligned}\right\} \tag{23}$$

$$\text{Pc}\left(\frac{\theta_{i,j+1}-\theta_{i,j}}{\Delta t}\right)=(1+N)\left(\frac{\theta_{i-1,j}-2\theta_{i,j}+\theta_{i+1,j}}{(\Delta y)^2}\right)+PcQ_1\theta_{i,j} \tag{24}$$

$$Sc\left(\frac{\phi_{i,j+1}-\phi_{i,j}}{\Delta t}\right)=\left(\frac{\phi_{i-1,j}-2\phi_{i,j}+\phi_{i+1,j}}{(\Delta y)^2}\right)+K_r\,Sc\,\phi_{i,j} \tag{25}$$

Here, the index that corresponds to y and j refers to time. By taking Δy = 0.1, the mesh system is isolated. The following analogous initial state is obtained from equation (8).

$$u(i,0)=0,\ \theta(i,0)=0,\phi(i,0)=0 \text{ for all } \ i \tag{26}$$

The restricting conditions of (8) are expressed in the form of finite differences as follows.

$$u(0,j)=1,\theta(0,j)=1,\phi_{i-1,j}-\phi_{i+1,j}=-2.\Delta y \text{ for all } j$$
$$u(i_{\max},j)=0,\theta(i_{\max},j)=0,\phi(i_{\max},j)=0 \text{ for all } j \quad (27)$$

(I_{max} was taken as 20 right here)

2.1 Skin-friction

In non-dimensional shape, the skin-friction is generated by

$$\tau=-\left(\frac{du}{dy}\right)_{y=0}, where\ \tau=\frac{\tau^1}{\rho U_0^2}$$

2.2 Rate of Heat and Mass transfer:

The dimensionless rate of transmission of heat and mass is supported by

$$Nu=-\left(\frac{d\theta}{dy}\right)_{y=0} \quad \text{and} \quad Sh=-\left(\frac{d\phi}{dy}\right)_{y=0}$$

3. Results and Discussion:

This segment presents the detailed study of influences of various physical specifications like Magnetic specification M , Chemical reaction specification K_r , Schmidt number specification S_c , Prandtl P_c , Heat source specification Q_0 ,Thermal radiation specification N , and α on the Velocity, Temperature and Concentration. In the present study, the following default parameter values are adopted for computations: Gr=3;Gm=5;M=0.5;m=0.1;K=0.5;Pc=0.71;Sc=0.22;Qo=0.5;N=1;R=1;A=1;Kr=0.5;

Therefore, unless explicitly stated in the relevant table, all the graphs refer to these values. Figures 1- 11 demonstrate the distributions of Velocity, concentration and temperature, respectively. In columns, the variations in skin friction, Nusselt, and Sherwood Nemours are seen (1-3).

From a fig. 1, we found that when the amplitude of the magnetic field is enhanced, the primary velocity portion is decreased. This is attributed to the assumption that there is a propensity or affinity to establish the drag known as the Lorentz force that appears to resist the flow with the application of a transverse magnetic field, natural to the flow path. The effect of the primary velocity is depicted in Fig.2. It is clear that the results of Grashof numbers on primary velocity are seen in Fig.3 and 4. Primary velocity decreases on the development of . It represents the mass and thermal buoyancy powers possessions at the primary velocity. We also found that primary velocity often rises as and increases. Fig. For different values of, and ., the consequence of the dimensionless temperature is seen in 5, 6 and 7. We found that with the thermal radiation parameter values, the temperature rises . Thermal radiation is also inclined to raise the temperature of fluids in the area of the boundary sheet. Thermal radiation thus produces diffuse energy since an enhancement means a decline in the fixed values of . It is apparent that the temperature of the fluid decreases with development. In Fig.6, the effect of the heat generation parameter on the temperature is seen. In this figure, temperature decreases were observed as a consequence of an improvement in the heat generation parameter along the boundary layer. This is how it is resistively converted into heat by electrical energy. The outcome of the dimensionless concentration for different Schmidt number and chemical reaction parameter values was shown in Fig.8 and 9 . It is apparent from the figure that with the rise of ., the concentration profiles decrease. This illustrates that the buoyancy effects on the plate are significant (due to the difference in concentration and temperature). In addition, because of the chemical reaction, it is found that fluid motion is delayed. It is found that the concentration decreases with rising Schmidt number from Fig.8 where it rises with time.

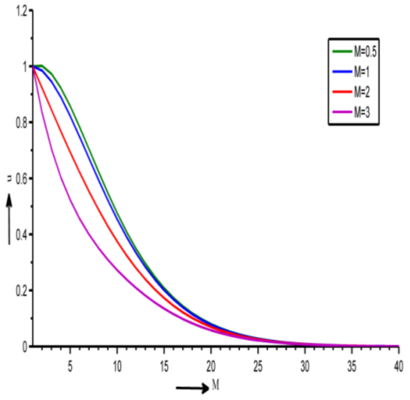

Fig: 1: Plot of Velocity for varying M

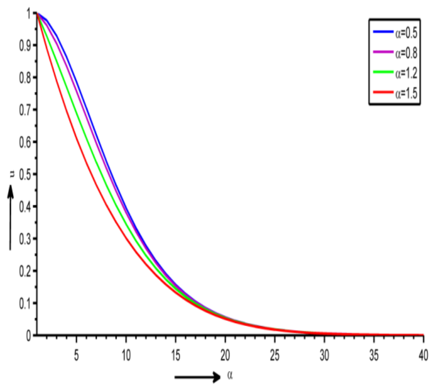

Fig: 2: Plot of Velocity for varying α

Fig. 9 that the fluid concentration diminishes with the rising values of the chemical reaction. The impact of the magnetic field on the secondary velocity w is defined by Fig.10. It is apparent that the secondary velocity of the plates decreases on rising values. The secondary velocity often rises as the radiation parameter values are changed, as is apparent from Fig. 11.

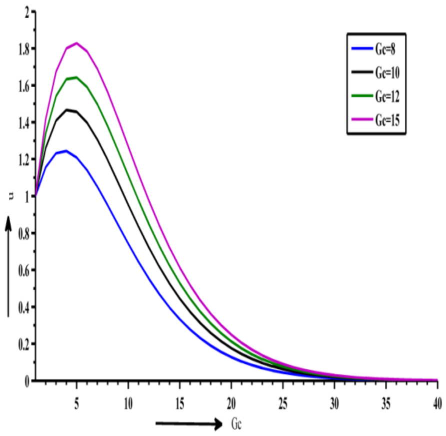

Fig: 3: The Velocity Plot for Varying Gc

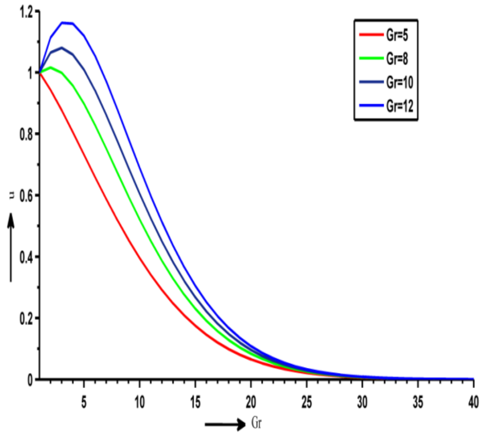

Fig: 4: The Velocity Plot for Varying Gr

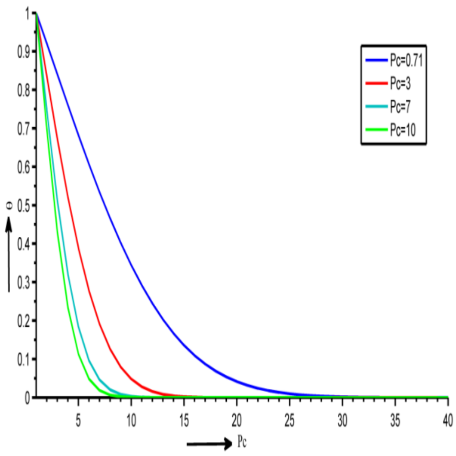

Fig: 5: The Velocity Plot for Varying P_c

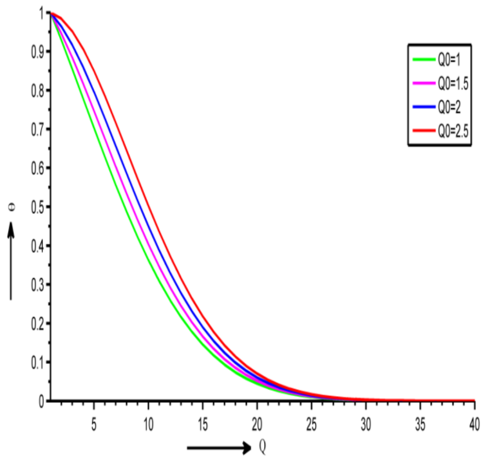

Fig: 6: The Velocity Plot for Varying Q_0

We also found that the difference in the specification of skin friction, the rate of heat transmisssion in the form of the Nusselt numerous (Nu) and the rate of mass transmission in the form of the Sherwood number (Sh) was analysed in Tables 1-3 for several specifications. The coefficient of skin friction τ_x and τ_z rises for the ramped temperature from Table-1 and decreases for the increasing isothermal plate. For the Magnetic parameter, the reversal conduct is observed (M). With development of the ramped temperature and isothermal plate respectively, the skin friction coefficient rises and decreases. For both the covers, and with enhancement of m, Gr, Gc, N and t . The temperature and isothermal plate of the Ramped decreases and rises with the growth of $\Pr$ and Sc . Whereas ramped temperature (τ_x) rises and with rise of and decreases isothermal temperature (τ_z).

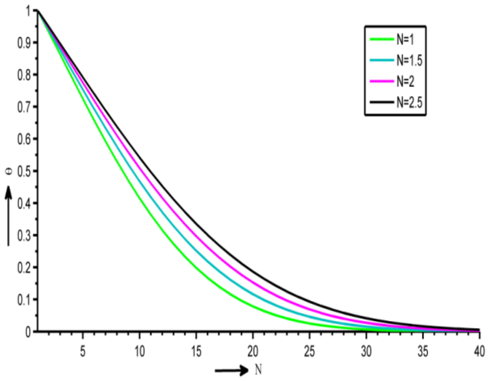

Fig: 7: Temperature graph with differing temperatures N

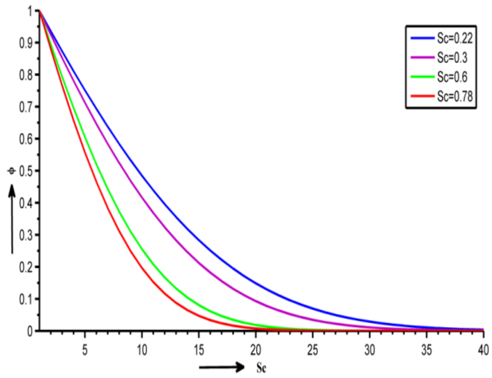

Fig: 8: Concentration graph with differing temperatures S_c

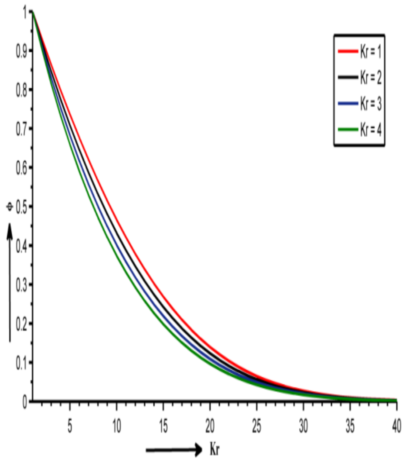

Fig: 9: Concentration graph with differing temperatures Kr

Table.2: Nusselt number:

Pc	Q_1	t	Ramped temperature	Isothermal temperature
0.71	1	0.5	0.273489	0.192079
3			0.162582	0.159333
			0.429152	0.245493
	0.3		0.191411	0.592801
	0.6		0.134978	0.607916
		0.3	0.564190	0.398942
		0.8	0.861814	0.609394

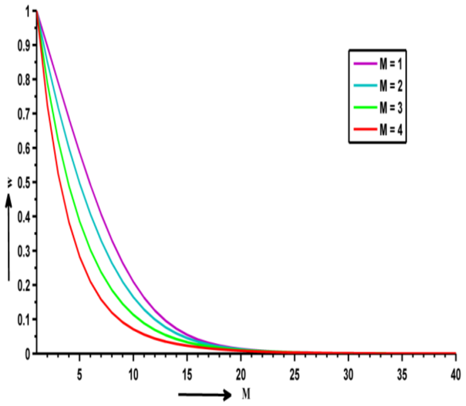

Fig:10: Secondary Velocity Plot with various M

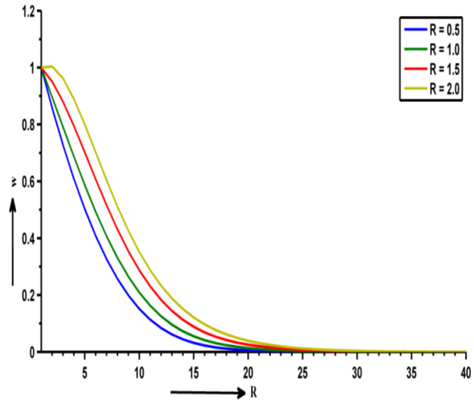

Fig: 11: Secondary Velocity Plot with various R

Table .3: Sherwood Number

Sc	t	Kr	Sh
0.22	0.2	0.1	-0.591727
0.3			-0.690988
0.6			-0.977205
	0.4		-0.418414
	0.8		-0.295864
		0.2	-0.341434
		0.6	-0.541962

From Table.2, the sum of Nusselt Nu is raised by growing time and instances of τ_x and τ_z. However, we found an opposite pattern for the heat source parameter. The temperature of the ramp reduces, and as it rises Q_1, the isothermal temperature increases. For it is diminished initially and then increases with the growth of Prandtl number Pc. Similarly, with the growing values of Schmidt number and Chemical reaction parameter at the plate, the Sherwood number rises from the table. Three and decreases with increasing time.

Table .1: **Skin Friction**:

K	M	t	α	m	Sc	Gr	Gc	N	Pr	*Ramped temperature*		*Isothermal Temperature*	
										$-\tau_x$	$-\tau_z$	$-\tau_x$	$-\tau_z$
0.5	0.5	0.3	1	1	0.22	3	5	2	0.71	2.85599	1.98532	2.15480	2.41510
1										3.25455	2.32766	1.70540	1.85497
1.5										3.64575	2.66532	1.24938	1.41098
	1									3.14546	1.54070	1.85960	2.66010
	1.5									3.41059	1.35014	1.70414	2.87020
		0.5								2.71045	2.15821	2.11019	2.85380
		0.8								2.51104	2.40899	1.89156	3.20279
										3.24549	2.13428	2.48922	2.83596
										3.60219	2.59791	2.86445	3.21140
										2.45023	2.20211	1.82955	2.62989
										2.21140	2.59481	1.53412	2.98908

					0.3					2.97255	1.80135	2.35462	2.22094
					0.6					3.11512	1.67268	2.52087	2.01228
						4				2.55966	2.32602	2.15675	2.64580
						5				2.0152	2.51785	1.86501	2.81145
							6			2.45628	2.15005	1.88029	2.80535
							7			2.14550	2.36860	1.50281	3.20011
								3		2.71275	1.91532	2.01435	2.45120
								4		2.60447	2.00145	1.89965	2.47885
									3	3.32602	1.82568	2.38256	2.29101
									7	3.66189	1.79145	2.61089	2.01155

Conclusion: It is necessary to compose the essential points from this review as follows:

- With rising parameter values for thermal radiation N, the temperature rises.
- Due to a rise in the heat production parameter along with the boundary sheet Q_0, temperature decreases were reported.
- With the rising amount of Schmidt Sc and chemical reaction parameters Kr, concentration decreases.
- On rising the values of radiation vector, the secondary velocity increases.
- The ramped temperature declines and the isothermal temperature rises as the ramped temperature increases Q_1.

References:

[1] S. Sivaiah, MHD flow of a rotating past a vertical porous flat plate in the presence of Chemical reaction and radiation, Journal of Engineering Physics and Thermophysics, Vol. 86, No. 6 (2013), https://doi.org/10.1007/s10891-013-0957-1

[2] A. Nakayama, M.A. Hossain, An integral treatment for combined heat and mass transfer by natural convection in a porous medium, International Journal of Heat and Mass Transfer, Volume 38, Issue 4, 1995, Pages 761-765, https://doi.org/10.1016/0017-9310(95)93012-7.

[3] Chamkha, A. et al. "Radiation effects on free convection flow past a semi-infinite vertical plate with mass transfer." *Chemical Engineering Journal* 84 (2001): 335-342.

[4] P. Ganesan and G. Palani, "Natural Convection Effects on Impulsively Started Inclined Plate with Heat and Mass Transfer," Heat Mass Transfer, Vol. 39, 2003, pp. 277-283.

[5] Eckert, E.R., Drake, R.M., Analysis of Heat and Mass Transfer. Mc-Graw Hill NY (1972)

[6] Gebhart, B., Jaluria, Y., Mahajan, R.L., Sammakia,B., Buoyancy Induced Flow and Tran.(1998).

[7] Nield, D.A., Bejan, A., Convection in Porous Media. 3rd Ed. Springer NY (2006).

[8] Pop, A., Ingham, D.B., Convective Heat Transfer: Mathematical and Computational Mod-elling of Viscous Fluids and Porous Media. Oxford Pergamon (2001).

[9] Rajakumar, K. V. B. , Umasankara Reddy, M., Balamurugan, K. S. , Raja Ram, K. V. B. S. , Steady MHD Casson Ohmic heating and viscous dissipative fluid flow past an infinite vertical porous plate in the presence of Soret, Hall, and ion-slip current. Heat Transfer, January, 2020;1–30, DOI: 10.1002/htj.21680.

[10] Susmay Nandia, Bidyasagar Kumbhakara, Unsteady MHD free convective flow past a permeable vertical plate with periodic movement and slip age in the presence of Hall current and rotation, Thermal Science and Engineering Progress,19,2020, https://doi.org/10.1016/j.tsep.2020.100561.

[11] Mabood, F. , Ibrahim, S.M., Lorenzini, G. , Chemical Reaction Effects on MHD Rotating Fluid over a Vertical Plate Embedded in Porous Medium with Heat Source, Journal of Engineering Thermo physics, 2017, Vol. 26, No. 3, pp. 399–415, DOI:10.1134/S1810232817030109.

[12] Sharma , B. R. , Konwar, H. , MHD flow, heat and mass transfer about a permeable rotating vertical cone in presence of radiation, chemical reaction and heat generation or absorption effects, Latin american applied research, 46:109-114(2016).

[13] Harshad R. Patel, Effects Of Heat Generation, Thermal Radiation, And Hall Current On Mhd Casson Fluid Flow Past An Oscillating Plate In Porous Medium, Multiphase Science and Technology, Doi: 10.1615/Multscientechn.2019029514,Pages 87-107 ,31(1),2019.

[14] Mohana Ramana, R., Girish Kumar, J., Venkateswara raju, K., Melting and radiation effects on MHD heat and mass transfer of Casson fluid flow past a permeable stretching sheet in the presence of chemical reaction, AIP Conference Proceedings 2246, 020021 (2020); https://doi.org/10.1063/5.0014732

[15] Ramesh Babu, K., Parandhama, A., Venkateswara Raju, K., Raju, M.C., Satya Narayana, P.V., Unsteady MHD free convective flow of a visco-elastic fluid past an infinite vertical porous moving plate with variable temperature and concentration, International journal of applied and computational mathematics,3(4), 3411-3431, DOI 10.1007/s40819-017-0306-8,2017.

[16] Ram Prakash Sharma, Raju, M.C., Oluwole Daniel Makinde, Krishna Reddy, P.R., Chandra Reddy, P., Buoyancy Effects on Unsteady MHD Chemically Reacting and Rotating Fluid Flow Past a Plate in a Porous Medium, Defect and Diffusion Forum, (Volume 392),pp.1-9, April 2019, https://doi.org/10.4028/www.scientific.net/DDF.392.1

[17] C Pavan Kumar, K Raghunath, M Obulesu, Thermal Diffusion And Inclined Magnetic Field Effects On Mhd Free Convection Flow Of Casson Fluid Past An Inclined Plate In Conducting Field, Turkish Journal of Computer and Mathematics Education Vol.12 No.13 (2021), 960-977

[18] M. Obulesu, K. Raghunath, And R. Sivaprasad, Radiation Absorption Effects on MHD Jeffrey fluid flow Past a Vertical Plate through a Porous Medium in Conducting Field., Annals Of Faculty Engineering Hunedoara -International Journal Of Engineering Tome Xix [2021], Fascicule 1.

[19] K. Raghunath, M. Obulesu and R. Sivaprasad, Heat and mass transfer on an unsteady MHD flow through porous medium between two porous vertical plates, AIP Conference Proceedings 2220, 130003 (2020) https://doi.org/10.1063/5.0001103.

[20] M. Obulesu, K. Raghunath, and R. Sivaprasad, Hall current effects on MHD convective flow past a porous plate with thermal radiation, chemical reaction with radiation absorption, AIP Conference Proceedings 2246, 020003 (2020), https://doi.org/10.1063/5.0014423.

[21] K. Raghunath, R. Siva Prasad, and G.S.S. Raju, Heat and mass transfer on MHD flow of Non-Newtonian fluid over an infinite vertical porous plate, International Journal of Applied Engineering Research, Volume 13, Number 13 (2018), pp. 11156-11163.

[22] K.Raghunath, R.Siva Prasad, and G.S.S.Raju, Heat and mass transfer on Unsteady MHD flow of a second grade fluid through porous medium between two vertical plates, JUSPS-B Vol. 30(2) (2018), pp.1-11.

[23] K.Raghunath, R.Siva Prasad, and G.S.S.Raju, Hall Effects on MHD Convective Rotating Flow of Through a Porous Medium past Infinite Vertical Plate, Annals of Pure and Applied Mathematics, Vol. 16, No. 2, 2018, 353-263.

[24] K. Raghunath, M. Veerakrishna, R. Siva Prasad, and G.S.S. Raju, Heat and Mass Transfer on Unsteady MHD Flow of a Visco-Elastic Fluid Past an Infinite Vertical Oscillating Porous Plate, British Journal of Mathematics & Computer Science, 17(6): 1-18, 2016.

[25] G V Nagendra Prasad, G Nagesh, K Raghunath, Dr R Siva Prasad, MHD flow of a Visco-elastic fluid over an unbounded rotating porous plate with Heat source and Chemical reaction, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 24 (2019) pp. 16927-16938.

[26] G Suresh babu, G Nagesh, K Raghunath, Dr R Siva Prasad, Finite Element Analysis of Free Convection Heat Transfer Flow in a Vertical Conical Annular Porous Medium, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 1 (2019) pp. 262-277.

[27] Konduru VenkateswaraRaju, Ravuri Mohana Ramana, Malraju ChangalRaju, Kodi Raghunath, Chemical Reaction effects on maxwell base MHD Fluid Flow of Nonmaterial over vertical moving Surface with Radiation, Turkish Journal of Computer and Mathematics Education, Volume 12, Issue 12, Pages 3760-3769.

[28] R.MohanaRamana, K.VenkateswaraRaju, J.GirishKumar, Multiple Slips and Chemical Reaction Effects on unsteady MHD Heat and Mass Transfer Flow over a Permeable Stretching Sheet with Radiation, Turkish Journal of Computer and Mathematics Education, Vol.12 No.6 (2021), 4489-4498.

[29] B. Reddappa , A. Parandhama, K. Venkateswara Raju and S. Sreenadh, Analysis of the Boundary Layer Flow of Thermally Conducting Jeffrey Fluid over a Stratified Exponentially Stretching Sheet, Turkish Journal of Computer and Mathematics Education Vol.12 No.13 (2021), 730-739.