IJO - INTERNATIONAL JOURNAL OF MATHEMATICS

(ISSN: 2992-4421)

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https://ijojournals.com/

Volume 07 Issue 03 || March, 2024 ||

Mathematical study of MHD Convective flow with chemical reaction through a porous medium in a vertical wavy channel

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Abstract:
In this work, we examine how transitory free connective heat and mass transfer flow over a porous media in a vertical wavy channel is impacted by chemical reactions and radiation absorption. The oscillatory flux in the flow zone is the cause of the unsteadiness in the flow. The Laplace transformation approach is used to get the analytical solutions for the governing equations. Analysis is done on the profiles of temperature, concentration, and velocity. The governing parameters are varied, and the resulting expressions for the velocity, concentration, shear stress, and rate of heat and mass transfer are examined.

Key words: MHD, Wavy channel, Chemical reaction.

1. Introduction

The use of non-Newtonian liquids in engineering and industry is required due to their increasing significance. It is remarkable for its many applications in numerous areas, which include food processing, lubricant performance, plastic manufacture, and/or biological liquid transportation. Numerous fluids, including diluted polymer solutions, slurry flows, industrial oil, and numerous flow issues caused by different mechanical and/or thermal boundary conditions have been discussed, as well as the second graded fluid preserves these fluids. For the second-graded fluids, Tan and Masuoka [1] discovered the Stokes first difficulties, whereas Rashidi et al. [2] addressed the second-order fluids' unstable compressible flows. Hayat and associates. [3] investigated by the fluids of second grade with variable free stream and unstable stagnation point flow.

A branch of fluid dynamics called magnetohydrodynamics (MHD) examined how electrically conducting fluids interact with one another in a magnetic field. Many research projects in the field of MHD have been carried out during the course of the few decades that have preceded them, following Hartmann's well-established work [4]. flow in metalized fluid channels subjected

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(ISSN: 2992-4421)

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to an external magnetic field. The parabolic movement has several uses, such as solar cookers, solar concentrators, and parabolic through star collectors. There are several uses for solar cookers with parabolic concentrator models, including roasting, baking, and distilling. Applications for the solar concentrator model included increasing evaporation rates in dissipation streams, food dispensing, and generating drinking water from both seawater and saltwater. Murthy et al. [5] examined through the assessments of temperature exchanger units' thermal characteristics for parabolic

Diffusion-thermo effect, radiating-absorptions, Hall, and ion slip influences on the MHD liberated convection gyratory flows of the nanofluids passing the semi-infinite permeable inspiring plate with the constant temperature sources were recently investigated by Krishna and Chamkha [6]. Krishna et al. [7] investigated the effects of radiating and Hall currents on the unstable MHD freed central heating flows into the perpendicular channel/duct packed by the absorbent media. Krishna and Chamkha [8] took into consideration the temperature generating/absorption, thermo-diffusions on the unsteady complimentary convection MHD flows of radiation, and the chemically reactive second-grade liquid passing past an unbounded perpendicular plate during the absorbent media in addition to taking the Hall current into account.

For the few decades prior, convective heat transportations in a permeable medium have piqued intense curiosity. Numerous thermal engineering functions in a range of constraints, such as geophysics, thermal and insulation engineering, the model of crowded sphere beds, electronic system cooling, chemical catalytic reactor, ceramic processes, granular insulations and grains storage device fibers, gasoline reservoirs, coal combustion engines, groundwater pollution, and filtration processes, all stimulate its interests.

The partial differential equations recurrently appear in the lot of areas of the natural and physical disci- plines. They described dissimilar physical organisms, ranges from gravitational to fluid dynamics and had been utilized to solve the problem by the physical and chemical sciences, mathematical bio-sciences, solid mechanical engineering knowledge, etc. Soundalgekar and Takhar ini- tially, deliberated the consequence of radiation for the natural convective flow of the gasses over a semi infinite plate with numerical modeling. Takhar et al.[9] explored the impact of radiation on MHD free convective flow past semi-infinite vertical plate. Currently, Hossain et al.[10] exposed the effects of radiation on combined convective flow during an absorbent plate. Muthucumarswamy and Kumar[11] explored the heat radiation influences on affecting never-ending vertical plate with variable heat and mass diffusions.

2.Formulation of the Problem

We consider the effect of chemical reaction on the unsteady motion of viscous, fluid through a porous medium in a vertical channel bounded by wavy walls . The thermal buoyancy in the flow field is created by an oscillatory flux in the fluid region. The walls are maintained at constant temperature and concentration. The Boussinesq approximation is used so that the density variation

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(ISSN: 2992-4421)
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will be considered only in the buoyancy force. The viscous and Darcy dissipations are neglected in comparison with heat by conduction and convection in the energy equation. Also the Kinematic viscosity ν,the thermal conducting k are treated as constants. We choose a rectangular Cartesian system 0 (x ,y) with x-axis in the vertical direction and y-axis normal to the walls. The walls of the channel are at $y = \pm Lf(\frac{\delta x}{L})$.

The flow is maintained by an oscillatory volume flux for which a characteristic velocity is defined as

$$q(1 + k\,e^{i\omega t}) = \frac{1}{L}\int_{-Lf}^{Lf} u\,dy\,. \tag{1}$$

The boundary conditions for the velocity and temperature fields are

$$u = 0\ ,\ v = 0\ ,T=T_1\ ,C=C_1 \qquad \text{on } y = -Lf(\frac{\delta x}{L})$$

$$u = 0,\ v=0, T = T_2 \qquad C = C_2 \qquad \text{on } y = +Lf(\frac{\delta x}{L}) \tag{2}$$

In view of the continuity equation we define the stream function ψ as

$$u = -\psi_y\ ,\ v = \psi_x \tag{3}$$

The equations governing the flow, heat and mass transfer in terms of the Stokes steam function ψ are

$$[(\nabla^2\psi)_t + \psi_x(\nabla^2\psi)_y - \psi_y(\nabla^2\psi)_x] = \nu\nabla^4\psi - \beta g(T - T_0)_y - $$
$$ - \beta^* g(C - C_0)_y - (\frac{\mu}{k})\nabla^2\psi \tag{4}$$

$$\rho_e C_p(\frac{\partial T}{\partial t} + \frac{\partial\psi}{\partial y}\frac{\partial T}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial T}{\partial y}) = k_f\nabla^2 T - Q(T - T_o) + Q_1'(C - C_e) \tag{5}$$

$$(\frac{\partial C}{\partial t} + \frac{\partial\psi}{\partial y}\frac{\partial C}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial C}{\partial y}) = D_1\nabla^2 C - k_1(C - C_o) \tag{6}$$

Introducing the non-dimensional variables in (4)-(6) as

$$x' = x/L,\ y' = y/L, t' = t\omega, \Psi' = \Psi/\nu, \theta = \frac{T - T_2}{T_1 - T_2}, C' = \frac{C - C_2}{C_1 - c_2} \tag{7}$$

the governing equations in the non-dimensional form (after dropping the dashes) are

$$R(\gamma^2(\nabla^2\psi)_t + \frac{\partial(\psi, \nabla^2\psi)}{\partial(x,y)}) = \nabla^4\psi + (\frac{G}{R})(\theta_y + NC_y) - D^{-1}\nabla^2\psi \tag{8}$$

$$P(\gamma^2\frac{\partial\theta}{\partial t} + \frac{\partial\psi}{\partial y}\frac{\partial\theta}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial\theta}{\partial y}) = \nabla^2\theta - \alpha\theta + Q_1 C \tag{9}$$

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$$Sc(\gamma^2 \frac{\partial C}{\partial t} + \frac{\partial \psi}{\partial y}\frac{\partial C}{\partial x} - \frac{\partial \psi}{\partial x}\frac{\partial C}{\partial y}) = \nabla^2 C - KC \qquad (10)$$

where

$R = \frac{UL}{\nu}$ (Reynolds number), $G = \frac{\beta g \Delta T_e L^3}{\nu^2}$ (Grashof number)

$\mathrm{P} = \frac{\mu c_p}{k_f}$ (Prandtl number), $Sc = \frac{\nu}{D_1}$ (Schmidt Number),

$\alpha = \frac{QL^2}{k_f C_p}$ (Heat source parameter), $K = \frac{K_1 L^2}{D_1}$ (Chemical reaction parameter),

$\gamma^2 = \frac{\omega L^2}{\nu}$ (Wormsely Number), $D^{-1} = \frac{L^2}{k}$ (Darcy parameter),

$Q_1 = \frac{Q_1'(C_1 - C_2)L^2}{k_f (T_1 - T_2)}$ (Radiation absorption parameter)

The corresponding boundary conditions are

$$\psi(+1) - \psi(-1) = 1$$

$$\frac{\partial \psi}{\partial x} = 0, \quad \frac{\partial \psi}{\partial y} = 0 \quad at\, \eta = \pm 1 \qquad (11)$$

$$\theta(x, y) = 1, C = 1 \quad on \quad \eta = -1$$

$$\theta(x, y) = 0, C = 0 \quad on \quad \eta = 1$$

$$\frac{\partial \theta}{\partial y} = 0, \frac{\partial C}{\partial y} = 0 \quad at \quad \eta = 0 \qquad (12)$$

The value of ψ on the boundary assumes the constant volumetric flow in consistent with the hyphothesis (1) .Also the wall temperature varies in the axial direction in accordance with the prescribed arbitrary function t .

3. METHOD OF SOLUTION

The main aim of the analysis is to discuss the perturbations created over a combined free and forced convection flow due to traveling thermal wave imposed on the boundaries. The perturbation analysis is carried out by assuming that the aspect ratio δ to be small.

Introduce the transformation such that

$$\bar{x} = \delta x, \frac{\partial}{\partial x} = \delta \frac{\partial}{\partial \bar{x}} \quad \text{then} \quad \frac{\partial}{\partial x} \approx O(\delta) \to \frac{\partial}{\partial \bar{x}} \approx O(1)$$

For small values of δ<<1 ,the flow develops slowly with axial gradient of order δ

And hence we take $\frac{\partial}{\partial \bar{x}} \approx O(1)$

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Using the above transformation the equations(8 - 10) reduces to

$$\delta R(\gamma^2(\nabla_1^2\psi)_t + \frac{\partial(\psi,\nabla_1^2\psi)}{\partial(x,y)}) = \nabla_1^4\psi + (\frac{G}{R})(\theta_y + NC_y) - D^{-1}\nabla^2\psi \quad (13)$$

$$\delta P_1(\gamma^2\frac{\partial\theta}{\partial t} + \frac{\partial\psi}{\partial y}\frac{\partial\theta}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial\theta}{\partial y}) = (\frac{\partial^2\theta}{\partial y^2} + \delta^2 N_2\frac{\partial^2\theta}{\partial x^2}) - \alpha\theta + Q_1 C \quad (14)$$

$$\delta Sc(\gamma^2\frac{\partial C}{\partial t} + \frac{\partial\psi}{\partial y}\frac{\partial C}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial C}{\partial y}) = \nabla_1^2 C - KC \quad (15)$$

where

$$\nabla_1^2 = \delta^2\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$$

Introducing the transformation $\eta = \frac{y}{f(\bar{x})}$ the equations(13-15) reduce to

$$\delta Rf(\gamma^2(F^2\psi)_t + \frac{\partial(\psi,F^2\psi)}{\partial(\bar{x},\eta)}) = F^4\psi + (\frac{Gf^3}{R})(\theta_\eta + NC_\eta) - -(D^{-1}f^2)F^2\psi \quad (16)$$

$$\delta P(\gamma^2\frac{\partial\theta}{\partial t} + f(\frac{\partial\psi}{\partial\eta}\frac{\partial\theta}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial\theta}{\partial\eta}) = F^2\theta - \alpha\theta + Q_1 C \quad (17)$$

$$\delta Sc(\gamma^2\frac{\partial C}{\partial t} + f(\frac{\partial\psi}{\partial\eta}\frac{\partial C}{\partial x} - \frac{\partial\psi}{\partial x}\frac{\partial C}{\partial\eta}) = F^2 C - KC \quad (18)$$

Where

$$F^2 = \delta^2\frac{\partial^2}{\partial\bar{x}^2} + \frac{\partial^2}{\partial\eta^2}$$

We adopt the perturbation scheme and write

$$\psi(x,\eta,t) = \psi_0(x,\eta,t) + ke^{it}\overline{\psi}_0(x,\eta,t) + \delta(\psi_1(x,\eta,t) + ke^{it}.\overline{\psi}_1(x,\eta,t)) + ...$$

.

$$\theta(x,\eta,t) = \theta_0(x,\eta,t) + ke^{it}\overline{\theta}_0(x,\eta,t) + \delta(\theta_1(x,\eta,t) + ke^{it}.\overline{\theta}_1(x,\eta,t)) + ...$$

.

$$C(x,\eta,t) = C_0(x,\eta,t) + ke^{it}C\overline{\phi}_0(x,\eta,t) + \delta(C_1(x,\eta,t) + ke^{it}.\overline{C}_1(x,\eta,t)) + ... \quad (19)$$

.

On substituting (19) in (16) - (18) and separating the like powers of δ the equations and respective conditions to the zeroth order are

$$\psi_{0,\eta\eta\eta\eta} - (M_1^2 f^2)\psi_{0,\eta\eta} = -(\frac{Gf^3}{R})(\theta_{0,\eta} + NC_{0,\eta}) \quad (20)$$

$$\theta_{o,\eta\eta} - (\alpha f^2)\theta_0 = -Q_1 C_0 \quad (21)$$

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$$C_{o,\eta\eta} - (KScf^2)C_0 = 0 \tag{22}$$

with

$$\psi_0(+1) - \Psi_0(-1) = 1,$$
$$\psi_{0,\eta} = 0,\ \psi_{0,x} = 0 \quad \text{at } \eta = \pm 1 \tag{23}$$

$$\theta_o = 1, \quad C_0 = 1 \quad on \quad \eta = -1$$
$$\theta_o = 0, \quad C_0 = 0 \quad on \quad \eta = 1 \tag{24}$$

$$\overline{\theta}_{0,\mu\eta} - (iP\gamma^2 f^2)\overline{\theta}_0 = -Q_1\overline{C}_0 \tag{25}$$

$$\overline{C}_{0,\eta\eta} - (KSc\gamma^2 f^2)\overline{C}_o = 0 \tag{26}$$

$$\overline{\psi}_{0,\eta\eta\eta\eta} - ((M_1^2 + i\gamma^2)f^2)\overline{\psi}_{0,\eta\eta} = -(\frac{Gf^3}{R})(\overline{\theta}_{0,\eta} + N\overline{C}_{0.\eta}) \tag{27}$$

$$\overline{\theta}_o(\pm 1) = 0 \qquad \overline{C}_o(\pm 1) = 0$$
$$\overline{\psi}_o(+1) - \overline{\psi}_o(-1) = 1 \quad \overline{\psi}_{o,\eta}(\pm 1) = 0, \overline{\psi}_{o,x}(\pm 1) = 0 \tag{28}$$

The first order equations are

$$\psi_{1,\eta\eta\eta\eta} - (M_1^2 f^2)\psi_{1,\eta\eta} = -(\frac{Gf^3}{R})(\theta_{1,\eta} + NC_{1,\eta}) + (Rf)(\psi_{0,\eta}\psi_{0,x\eta\eta} - \psi_{0,x}\psi_{0,\eta\eta\eta}) \tag{29}$$

$$\theta_{1,\eta\eta} - (\alpha f^2)\theta_1 = (PRf)(\psi_{0,x}\theta_{o,\eta} - \psi_{0,\eta}\theta_{ox}) - Q_1C_1 \tag{30}$$

$$C_{1,\eta\eta} - (KScf^2)C_1 = (Scf)(\psi_{0,x}C_{o,\eta} - \psi_{0,\eta}C_{ox}) \tag{31}$$

$$\overline{\psi}_{1,\eta\eta\eta\eta} - ((M_1^2 + i\gamma^2)f^2)\overline{\psi}_{1,\eta\eta} = -(\frac{Gf^3}{R})(\overline{\theta}_{1,\eta} + N\overline{C}_{1,\eta}) + (Rf)(\overline{\psi}_{0,\eta}\psi_{0,x\eta\eta} + $$
$$+ \psi_{0,\eta}\overline{\psi}_{0,x\eta\eta} - \psi_{0,x}\overline{\psi}_{0,\eta\eta\eta} - \overline{\psi}_{0,x}\overline{\psi}_{0,\eta\eta\eta}) \tag{32}$$

$$\overline{\theta}_{1,\eta\eta} - ((iP\gamma^2 + \alpha)f^2)\overline{\theta}_1 = (PRf)(\psi_{0,\eta}\overline{\theta}_{o,x} + \overline{\psi}_{0,\eta}\theta_{ox} -$$
$$- \overline{\psi}_{0,x}\theta_{o,\eta} - \psi_{0,x}\overline{\theta}_{o\eta}) - Q_1\overline{C}_1 \tag{33}$$

$$\overline{C}_{1,\eta\eta} - ((K + i\gamma^2)Scf^2)\overline{C}_1 = (Scf)(\psi_{0,\eta}\overline{C}_{o,x} + \overline{\psi}_{0,\eta}C_{ox} -$$
$$- \overline{\psi}_{0,x}C_{o,\eta} - \psi_{0,x}\overline{C}_{o\eta}) \tag{34}$$

with

$$\psi_{1(+1)} - \psi_{1(-1)} = 0$$
$$\psi_{1,\eta} = 0,\ \psi_{1,x} = 0 \quad \text{at } \eta = \pm 1 \tag{35}$$
$$\theta_1(\pm 1) = 0 \quad C_1(\pm 1) = 0$$
$$\overline{\theta}_1(\pm 1) = 0 \qquad \overline{C}_1(\pm 1) = 0$$
$$\overline{\psi}_1(+1) - \overline{\psi}_1(-1) = 1 \quad \overline{\psi}_{1,\eta}(\pm 1) = 0, \overline{\psi}_{1,x}(\pm 1) = 0 \tag{36}$$

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The equations (20)- (22), (25)-(27)&(29)-(34) are solved analytically subject to the relevant boundary conditions. For sake brevity we are not presenting the solutions.

4.Nusselt number and Sherwood number

$$(\tau)_{y=-1} = d_6 + Ecd_7 + \delta d_8 + O(\delta^2)$$

The local rate of heat transfer coefficient Nusselt number (Nu) on the walls has been calculated using the formula

$$Nu = \frac{1}{\theta_m - \theta_w}\left(\frac{\partial \theta}{\partial y}\right)_{\eta=\pm 1} \quad \text{where} \quad \theta_m = 0.5\int_{-1}^{1} \theta \, d\eta$$

and the corresponding expressions are

$$(Nu)_{\eta=+1} = \frac{(d_9 + \delta d_{11})}{(\theta_m - Sin(x+\gamma t))} \qquad (Nu)_{\eta=-1} = \frac{(d_8 + \delta d_{10})}{(\theta_m - 1)} \quad ,$$

where $\theta_m = d_{14} + \delta d_{15}$

The local rate of mass transfer coefficient Sherwood Number (Sh) on the walls has been calculated using the formula

$$Sh = \frac{1}{C_m - C_w}\left(\frac{\partial C}{\partial y}\right)_{y=\pm 1} \quad \text{where} \quad C_m = 0.5\int_{-1}^{1} C \, dy$$

and the corresponding expressions are

$$(Sh)_{\eta=+1} = \frac{(d_4 + \delta d_6)}{(C_m)} \qquad (Sh)_{\eta=-1} = \frac{(d_5 + \delta d_7)}{(C_m - 1)}$$

5.Results and discussion

This investigation focuses on the impact of heat generation and thermo-diffusion on the unstable free convection MHD gy- rated flow of radiation and chemical reactive second order fluid across an unbounded perpendicular plate during absorbent medium. The analytical solutions for the governing equations are obtained by the application of the Laplace transformation procedure. The profiles of concentration, temperature, and velocity are analyzed graphically. For quite a few quantities of the magnetic field parameter M, chemical reaction parameter Kr, temperature generating and/or absorbing parameters, it is represented the second-grade fluid velocity, and concentration distributions. Magnetic field parameter M, chemical reaction parameter Kr,. We fiXed M = 0.5, K = 0.5, Pr = 0.71, R = 2, Gr = 10, Gm = 5, Sr = 0.1, H = 2, = 0.5, and t = 0.5 for computational purposes and drew the profiles with each parameter adjusted across the range. The concentration, temperature, and velocity profiles are shown in Figs. 1-4 to be less than those for isothermal temperature and ramped surface concentration in the case of ramped wall temperature. The magnetic domain parameter in the liquid flow generates an electrical field. Consequently, it

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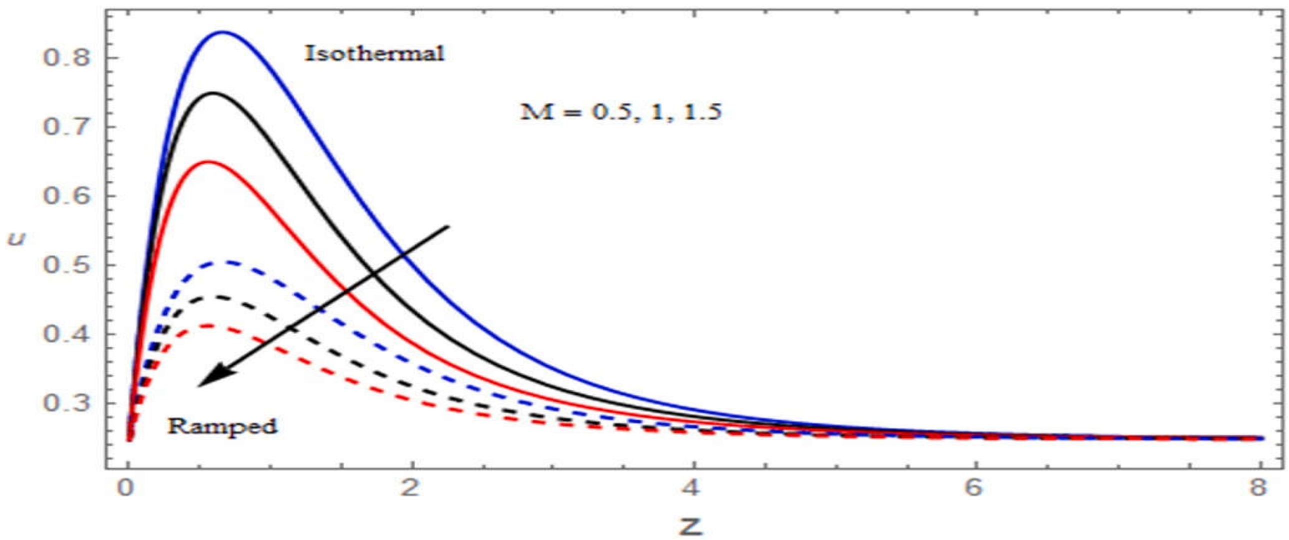
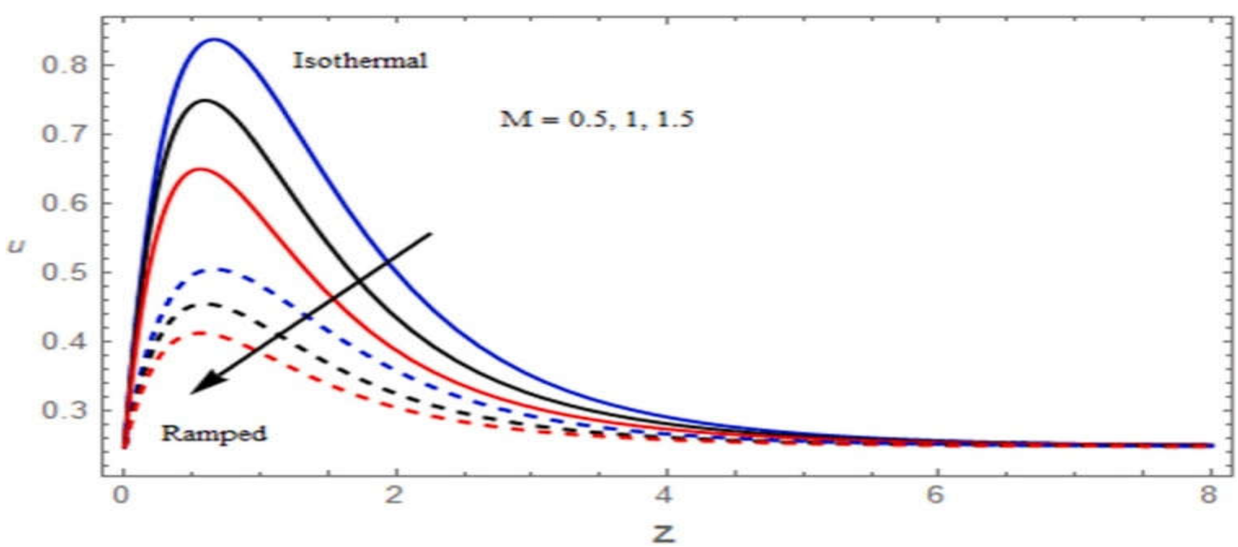
was deduced that when isothermal temperature and ramping surface concentration are present



simultaneously, the magnetic field lowers both of them. A fluid's velocity is expected to be slowed down by the addition of a magnetic field, which will increase the resistive model forces (Lorentz forces) acting on the fluid in the boundary layers.

Fig.1.The velocity profile for u against M

Fig. 2. The velocity Profile for *v* against M



Figs.1 and 2 has been shown that, the intensity of the magnetic field has reducing effects on velocity profiles for together heated circum- stances. It is anticipated to the information that, the representing of magnetic domain parameter produces electrical field in the liquid flow. This implied

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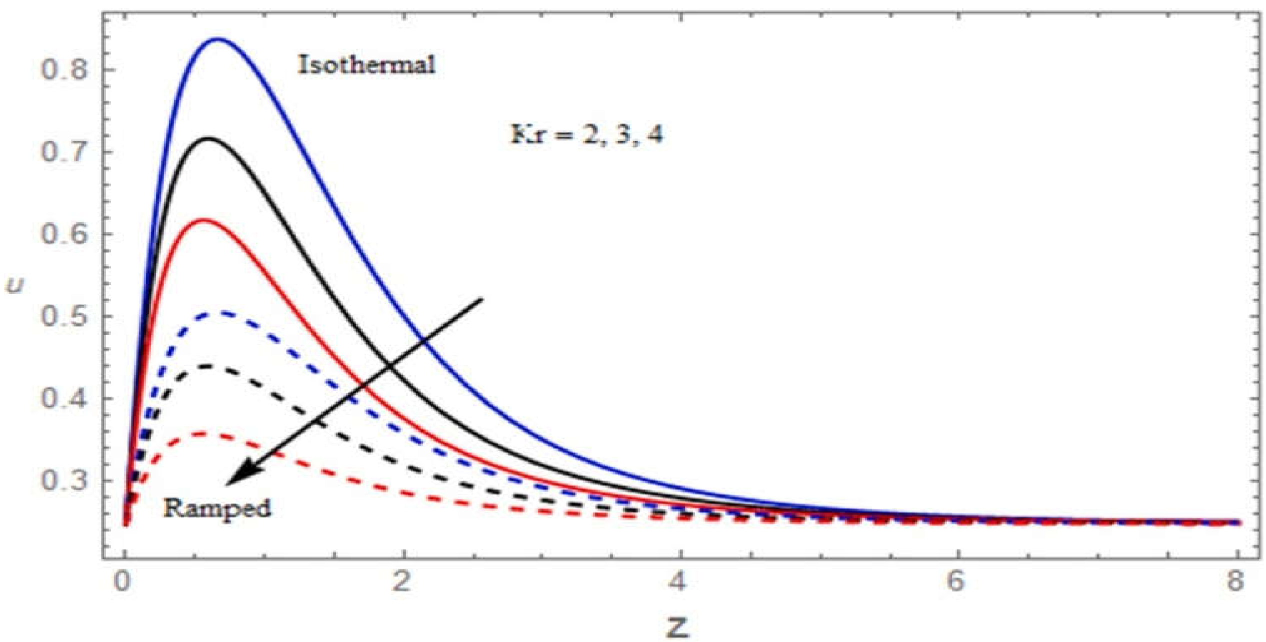
that, the magnetic field has reducing effect for together ramped wall temperature with ramped surface concentration as well as isothermal temperature with ramped surface concentration. It is expected to the information that, the application of the magnetic field to fluid give augment to the resistive model forces (Lorentz forces) on the fluid in the boundary layers, this slow down the movement of the fluid.

Fig.3 The velocity Profile for u against Kr.



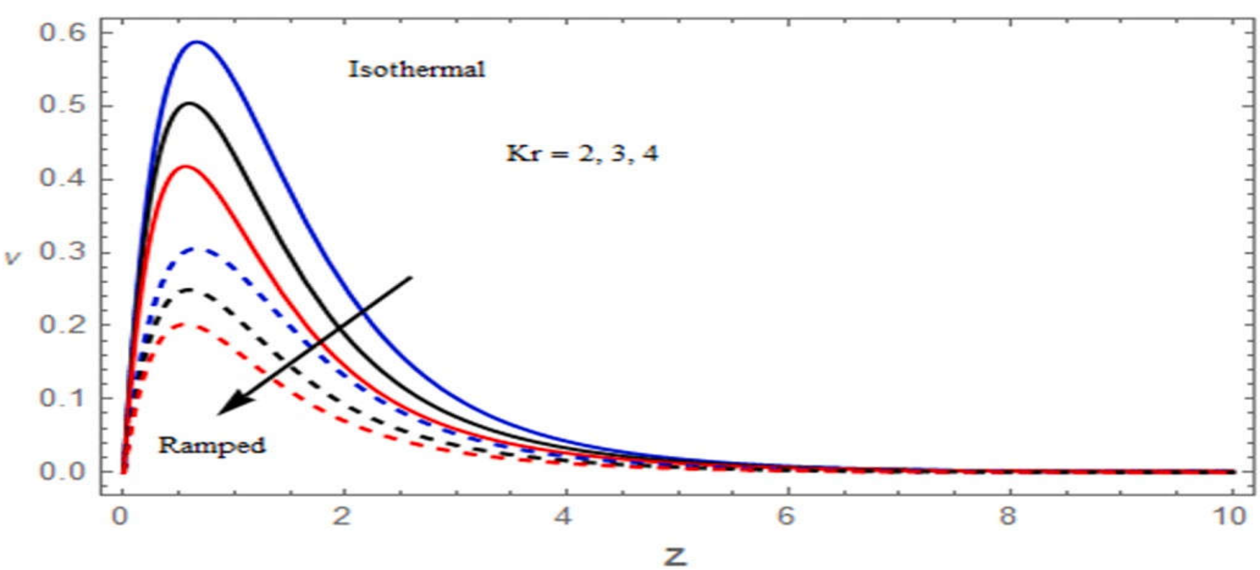


Fig.4 The velocity Profile for v against Kr.

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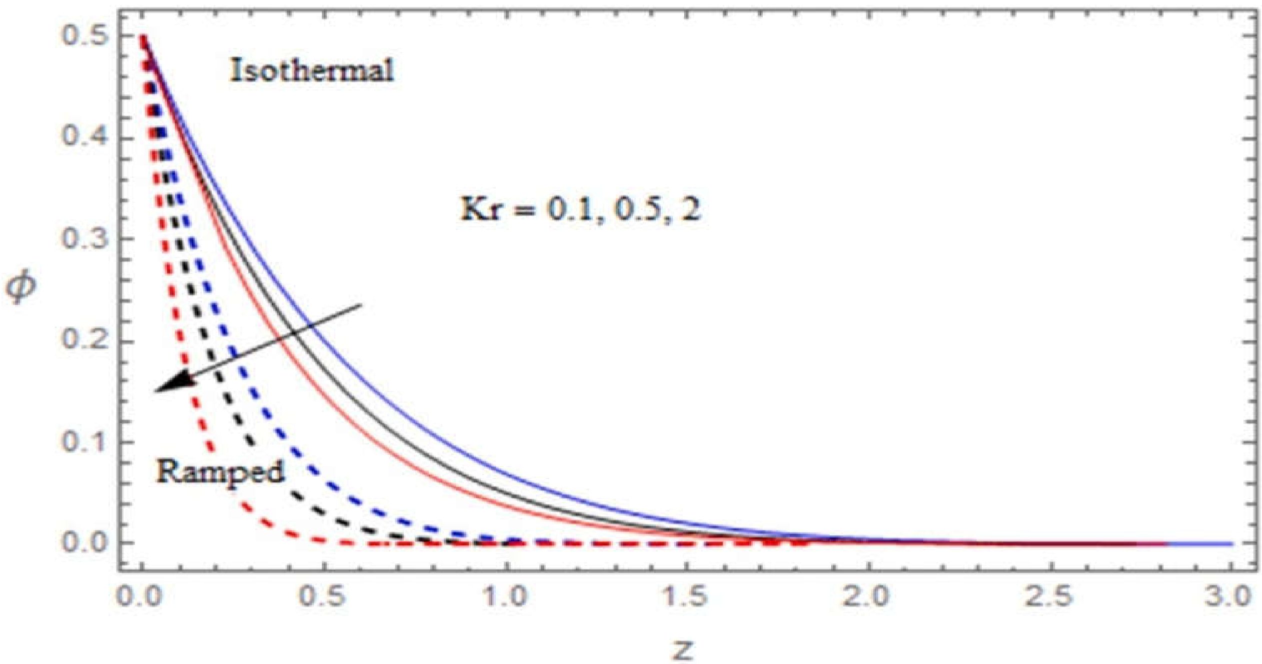
Additionally, it is noted that as the second grade parameter rises, the border layer widths decrease. As seen in Figs. 3 and 4, chemical reactions have a slowing effect on the velocity of liquid flows in combined thermal cases.

Fig.5 The Concentration Profile for Kr.



As shown in Fig. 5, the chemical reactions have a decreasing effect on the concentration profiles and liquid flow velocity for the combined thermal case. The destructive reactions $Kr > 0$ have been demonstrated to cause falls into the concentration field, which worsens the effects of buoyant forces because of the concentration gradient.

The flows domain is then narrowed down.depending on the Nusselt number, producing, absorbing, and/or radiating parameters H and R. When the temperature producing and/or absorbing parameter H and the Prandtl number Pr increase, the Nusselt number Nu increases. Conversely, when the radiating parameter R increases, the Nusselt number Nu decreases for both ramping wall temperature and isothermal plate. The Nusselt number decreases with increasing time for an isothermal plate and increases with ramping wall temperature.

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Table.1 The Nusselt number

P_r	R	H	t	Ramped Temperature	Isothermal Temperature
0.71	2	2	0.2	0.732255	1.779785
3				0.846796	2.077621
7				1.247212	2.379774
	5			0.694214	1.510547
	8			0.657995	1.227544
		-2		0.647895	1.513705
		5		0.846778	1.950562
			0.5	0.874546	1.469785
			0.8	0.958589	1.394958

The effects of temperature producing and/or absorbing parameter H, radiating parameter R, and Pr on the Nusselt number were shown in Table.1. When the temperature producing and/or absorbing parameter H and the Prandtl number Pr increase, the Nusselt number Nu increases. Conversely, when the radiating parameter R increases, the Nusselt number Nu decreases for both ramping wall temperature and isothermal plate. The Nusselt number decreases with increasing time for an isothermal plate and increases with ramping wall temperature.

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Table.2 The Shear stresses

M	K	α	K_r	S_r	G_r	G_m	H	R	Ramped Temperature		Isothermal Plate	
0.5	0.5	0.1	2	0.1	5	2	2	2	τ_x	τ_y	τ_x	τ_y
0.8									2.032214	0.075785	1.624789	0.79889
1									1.613058	0.086898	1.335469	0.828547
	1								1.269592	0.093578	1.105014	0.932554
	1.5								1.934796	0.053478	1.449635	0.732969
		1							1.705478	0.042502	1.304789	0.621559
		1.5							2.602466	0.086895	1.738966	0.931748
			3						3.735896	0.113547	1.880254	1.109589
			4						2.335895	0.083874	1.978801	0.998478
				0.5					2.968747	0.115748	2.965479	1.398041
				1					1.939745	0.049411	1.075884	0.479952
					8				1.749985	0.042115	0.330856	0.239658
					10				1.93211	0.053041	1.602147	0.767587
						5			1.703522	0.046874	1.580145	0.741847
						8			1.976547	0.064306	1.612265	0.790895
							-5		1.869954	0.049447	1.601458	0.767014
							5		1.939665	0.060256	1.565595	0.701748
								5	2.33565	0.086874	1.749854	0.901849
								8	2.105452	0.083289	1.738859	0.998954

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(ISSN: 2992-4421)
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Table.3 The Sherwood number(Pr=0.710,R=2.0,H=-2.0)

S_r	K_r	S_c	t	Ramped Temperature	Isothermal Temperature
0.1	2	0.22	0.2	0.430478	0.545478
0.5				0.347254	0.462254
1				0.292854	0.407854
	3			0.492785	0.607785
	4			0.570699	0.685699
		0.3		0.403895	0.518895
		0.6		0.370548	0.485548
			0.5	0.500897	0.615897

This is scrutinized from Table 2 that, it is notified that, for together ramped wall temperature and isothermal plate, the stress components τx as well as τy enhances by an increasing in second graded fluid parameter α, chemical reacting parameter Kr, temperature generations and/or absorptions H and thermal radiation parameter R, as well as it reduces by an increasing in the permeability parameter K, thermal-diffusion (Soret) parameters Sr, thermal Grashof numbers Gr and mass Grashof quantity Gm. This is also found that by an increasing in the intensity of the magnetic fields then the stress components τx retards and the component τy boosting up for together ramped wall and isothermal plate. Finally, the Sherwood number Sh is reduced with an increasing in the Soret number Sr as well as Schmidt number, and it is increasing with an increasing in chemically reacting parameter Kr and certain instant of time for together ramped wall temperature and an isothermal plate (Table 3).

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Volume 07 Issue 03 || March, 2024 ||

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