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Effect of Multifluid Flow for Internal Heat Generation or Absorption in Presence of Concentration in a Vertical Channel

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Abstract- **The effect in heat mass transfer and of multi-fluid flow characteristics in vertical channel is investigated in this paper. The fluids are incompressible in both the region and assumed the transport properties of fluid flow are constant. By the help of analytical method all the basic equations governing th set of coupled nonlinear ordinary differential equations are solved. These results are illustrated by plotting graphs and for various physical parameters. Here we can control result by heat absorption coefficient, width ratio and viscosity ratio.**

Keywords- **Free convection, heat absorption, heat generation, regular perturbation method.**

I. INTRODUCTION

The flow of mixed convection in heat absorbing or heat generating an electrically conducting fluid during a porous media within the occurring of a field of force is larger in line with the very fact importance for the region of its frequent presence in sizable amount of commercial applications example: geothermal reservoirs, insulation and petroleum an oversized natural cooling of nuclear reactors, thermal insulation and petroleum reservoirs there has been extent published work handling free, forced and mixed convection problems of every other geometries embedded in porous and non porous media within the presence of absence of a field [1-15].

In studying flows in porous media, Darcy's law is frequently employed. there's a supported reaction between the continual physical force exerted on drop across the porous medium and therefore the viscous and gravitational forces. Minkowcyz et al [16, 17] Darcy s is employed for the structure of something fluid flow and warmth transfer in porous media.

In begun years, the problems of free convection and heat transfer flows done under the influence of a magnetic field a porous medium have attracted the attention of a number of researches because of their possible applications in many branches of science and technology, example of its applications in transportion cooling of re-entry vehicles and rocket booters, cross-hatching on Ablative surfaces and film vaporization in the process of burning something chambers on other hand flow done a porous medium has many engineering and geophysical applications. Such as in Chemical engineering for filtration and purification process, in agricultural engineering to study the under ground water resources, in petroleum technology to study the movement of natural gas,oil through the oil a large natural.

Done at the same time heat and mass transfer from each other geometers embedded in porous media has many engineering and geophysical applications example: Geothermal reservoirs drying of porous solids, thermal insulation, enhanced oil recovery, packed- bed catalytic reactors, cooling of nuclear reactors and under ground energy carry from one place to another.

The study of many industrial and tecnological applications magnetohydrodynamic flow and heat transfer in porous media with natural convection, example: purifications of metallic from non metal enclosures,plasma studies, nuclear reactor, geothermal energy extractions, polymer technology and metallurgy, transfer systems, design of power generators, solar heating system

Many applications of practical heat transfer involve the conversion of some form of mechanical, electrical, nuclear or chemical energy to thermal energy in the media such media are said to involve internal heat generation For example: a large amount of heat is generated in the fuel elements from atomic reactors as a result of atomic division that serves as the heat place for the nuclear power plants.

The heat generated in the sun as a result of the process of hydrogen in to helium makes the sun a large nuclear reactor that supplies heat to the earth possible heat generation effects may modify temperature distribuion and therefore the particle deposition rate. In the porous medium Anisotropy arises from the geometry of the grains or agglomeration of solid sediments which allow the

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passages of perocolating velocity of the fluid. In the generalized Darcy's law the permeability peroperty is considered as a general tensor capable of being assigned to direction dependency.

Free Convection of Composite Porous Medium in a Vertical Channel, Studied by .J. C. Umavathi. fluid flow Convective and heat transfer in vertical rectangular duct containing a horizontalporous medium and fluid layer is analysed by . C. Umavathi, O. Anwar Beg. And also OM Prakash,Devendra Kumar YK Dwivedi studied Stokes Problem for the flow of dusty conducting fluid through porous medium Free convection effects and radiative heat transfer in MHD [18-20]

Hence by the applications of heat absorbtionan or generation motivated to consider this problem of flow of heat and mass transfer of mutifluid flow, by considering concentration in a vertical channel.

II. MATHEMATICAL FORMULATION

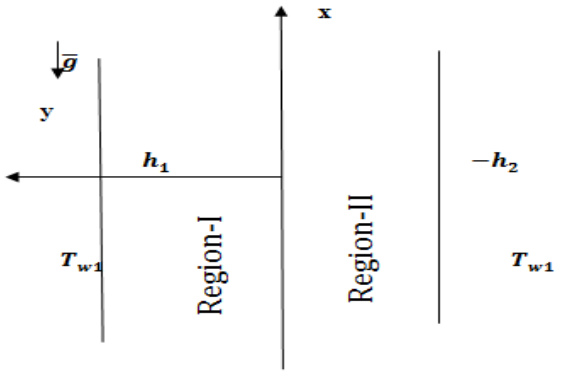

Fig 1. Physical Configuration.

Under the consideration of geometry, consists two infinite parallel plates maintained at each other constant temperatures and concentrations. The region-I, is being used by viscous fluid of density ρ_1, viscosity μ_1, thermal conductivity k_1 and the region is being used by another viscous fluid of density ρ_2, viscosity μ_2, and thermal conductivity k_2. We suppose to be the case that and transport properties of both the fluid flows are assumed to be constant, and also heat absorbing and generation have constant properties excepting the the degree of compactness of a substance in the buoyancy.

Govening equations for continuety of momentum, enrgy and mass corewponding to region-I and region-II are:

REGION-I

$$\mu_1 \frac{d^2u_1}{dy^2} + \rho_1 g\beta_{T1}(T_1\text{-}T_{w2}) + \rho_1 g\beta_{c1}(c_1 - \bar{c_2}) - \frac{\partial p}{\partial x} - \frac{\mu_1}{k_1}u_1 - \frac{\rho_1 C_{F1}}{\sqrt{k_1}}|u_1|u_1 = 0 \quad \textbf{(2.1)}$$

$$k_1 \frac{d^2T_1}{dy^2} + \mu_1(\frac{du_1}{dy})^2 + \frac{\mu_1}{k_1}{u_1}^2 \pm Q_1(T_1 - T_{w2}) = 0 \quad \textbf{(2.2)}$$

$$\frac{d^2c_1}{dy^2} = 0 \quad \textbf{(2.3)}$$

REGION-II

$$\mu_2 \frac{d^2u_2}{dy^2} + \rho_2 g\beta_{T2}(T_2\text{-}T_{w2}) + \rho_2 g\beta_{c2}(c_1 - \bar{c_2}) - \frac{\mu_2}{k_2}u_2 - \frac{\rho_2 C_{F1}}{\sqrt{k_2}}|u_2|u_2 - \frac{\partial p}{\partial x} = 0 \quad \textbf{(2.4)}$$

$$k_2 \frac{d^2T_2}{dy^2} + \mu_2(\frac{du_2}{dy})^2 + \frac{\mu_2}{k_2}{u_2}^2 \pm Q_2(T_2 - T_{w2}) = 0 \quad \textbf{(2.5)}$$

$$\frac{d^2c_2}{dy^2} = 0 \quad \textbf{(2.6)}$$

It is seen from equations (2.1) and (2.4) are fluids which share a common pressure gradient. It should be mentioned that the negative sign of Q1 and Q2 correspond to the heat absorption and positive sign for Q1 and Q2 corresponding to the heat generation of both fluids.

Eqution (2.71 to 2.9d) are the boundary and interface conditions for velocity, temperatue and concentrations respectively:

Velocity are

$$u_1(h_1) = 0 \quad \textbf{(2.7a)}$$
$$u_1(0) = u_2(0) \quad \textbf{(2.7b)}$$
$$u_2(-h_2) = 0 \quad \textbf{(2.7c)}$$
$$\mu_1 \frac{du_1}{dy_1} = \mu_2 \frac{du_2}{dy_2} \text{ at } y=0 \quad \textbf{(2.7d)}$$

Temperature are

$$T_1(h_1) = T_{w1} \quad \textbf{(2.8a)}$$
$$T_1(0) = T_2(0) \quad \textbf{(2.8b)}$$
$$T_2(-w1) = T_{w2} \quad \textbf{(2.8c)}$$
$$k_1 \frac{dT_1}{dy_1} = k_2 \frac{dT_2}{dy_2} \text{ at } y=0 \quad \textbf{(2.8d)}$$

Concentration are

$$c_1(h_1) = \bar{c}_1 \quad \textbf{(2.9a)}$$
$$c_1(0) = c_2(0) \quad \textbf{(2.9b)}$$
$$c_2(-h_2) = \bar{c}_2 \quad \textbf{(2.9c)}$$
$$D_1 \frac{dc_1}{dy_1} = D_2 \frac{dc_2}{dy_2} \text{ at } y=0 \quad \textbf{(2.9d)}$$

Using the Following non-dimension transformations, assuming

$$u_i^* = \frac{u_i}{\bar{u_i}}; \quad y_i^* = \frac{y_i}{h_i}; \quad \theta_1 = \frac{(T_1 - T_0)}{(T_{w1} - T_{w2})}; \quad p = \frac{{h_1}^2}{\mu_1 \bar{u_1}}\frac{\partial p}{\partial x}, \quad \varphi_1 = \frac{(\bar{c}_i - \bar{c}_2)}{(\bar{c}_1 - \bar{c}_2)} \quad (i=1, 2)$$

$$G_r = \frac{g\beta_1 {h_1}^3 \Delta T}{{\vartheta_1}^2} \quad Re = \frac{\bar{u_1}h_1}{\vartheta 1}; \quad \emptyset_i = \frac{Q_i {h_i}^2}{k_i}; \quad \sigma = \frac{h_1}{\sqrt{k_1}}; \quad I = \frac{C_{F1}\bar{u}_1 {h^2}_1}{\sqrt{k_1}\vartheta_1} \quad \textbf{(2.10)}$$

Substituting equation (2.10) in equations (2.1) to (2.5) which gives the following dimensionless equations.

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REGION-I

$$\frac{d^2u_1}{dy^2}+\frac{Gr}{Re}\theta_1+\frac{Gc}{Re}\varphi_1-\sigma^2u_1-I|u_1|u_1-p=0 \quad \textbf{(2.11)}$$

$$\frac{d^2\theta_1}{dy^2}+Ecp_r(\frac{du_1}{dy})^2+EcPr\sigma^2{u_1}^2\pm\emptyset_1\theta_1=0 \quad \textbf{(2.12)}$$

$$\frac{d^2\emptyset_1}{dy^2}=0 \quad \textbf{(2.13)}$$

REGION-II

$$\frac{d^2u_2}{dy^2}+\frac{Gr}{Re}bt\,m\,n\,h^2\theta_2+\frac{Gc}{Re}bc\,m\,n\,h^2\emptyset_2-\sigma^2h^2ku_2-m\,h^2p=0 \quad \textbf{(2.14)}$$

$$\frac{d^2\theta_2}{dy^2}+\frac{k}{m}Ecp_r(\frac{du_2}{dy})^2+PrEckh^2{u_2}^2\pm\emptyset_2\theta_2=0 \quad \textbf{(2.15)}$$

$$\frac{d^2\emptyset_2}{dy^2}=0 \quad \textbf{(2.16)}$$

The non-dimensional boundary and interface conditions are as fallows:

$$uu_1(1)=0 \quad \textbf{(2.17a)}$$
$$u_1(0)=u_2(0) \quad \textbf{(2.17b)}$$
$$u_2(-1)=0 \quad \textbf{(2.17c)}$$
$$\frac{du_1}{dy}=\frac{1}{mh}\frac{du_2}{dy} \text{ at } y=0 \quad \textbf{(2.17d)}$$
$$\theta_1(1)=1 \quad \textbf{(2.18a)}$$
$$\theta_1(0)=\theta_2(0) \quad \textbf{(2.18b)}$$
$$\theta_2(-1)=0 \quad \textbf{(2.18c)}$$
$$\frac{d\theta_1}{dy}=\frac{1}{kh}\frac{d\theta_2}{dy} \text{ at } y=0 \quad \textbf{(2.18d)}$$
$$\varphi_1(1)=1 \quad \textbf{(2.19a)}$$
$$\varphi_1(0)=\varphi_2(0) \quad \textbf{(2.19b)}$$
$$\varphi_2(-1)=0 \quad \textbf{(2.19c)}$$
$$\frac{d\varphi_1}{dy}=\frac{d}{h}\frac{d\varphi_2}{dy} \text{ at } y=0 \quad \textbf{(2.19d)}$$

Where

$Gr=\frac{g\beta_1\rho_1{h_1}^3(T_{w1}-T_{w2})}{{\mu_1}^2}$; $Ec=\frac{{\bar{u}_1}^2}{c_p(T_{w1}-T_{w2})}$; $Re=\frac{\bar{u}_1h_1\rho_1}{\mu_1}$; $Pr=\frac{\mu_1c_p}{K_1}$;

$\emptyset_1=\frac{Q_1{h_1}^2}{K_1}$; $\emptyset_2=\frac{Q_2{h_2}^2}{K_2}$; $m=\frac{\mu_1}{\mu_2}$; $h=\frac{h_2}{h_1}$; $n=\frac{\rho_2}{\rho_1}$; $\beta=\frac{\beta_2}{\beta_1}$; $K=\frac{K_1}{K_2}$

III. SOLUTION

The governing equations (2.11)-(2.15) are to be solved analytically, by the appropriate boundary and interface conditions, (2.17 a to 2.19 d) for velocity, temperature and concentrations respectively. These equations are coupled and nonlinear because of the inclusion of the dissipation terms in the energy equation.

In most of the practical problems the Eckert number, Ec is very small and is of order 〖10〗^(-5). Accordingly the product Pr. Ec (=ε) is very small and hence this expression can be used in regular perturbation method where ε as the perturbation parameter. We assume the solution in the form

$$(u_1,\theta_1)=(u_{10},\theta_{10})+\varepsilon(u_{11},\theta_{11})+\cdots\ldots\ldots\ldots \quad \textbf{(3.1)}$$

$$(u_2,\theta_2)=(u_{20},\theta_{20})+\varepsilon(u_{21},\theta_{21})+\cdots\ldots\ldots\ldots \textbf{(3.2)}$$

Equating the like powers of ε to zero and one we get the zeroth and first order equation as follows:

Region-I
Zeroth-order equations

$$\frac{d^2u_{10}}{dy^2}+\frac{Gr}{Re}\theta_{10}+\frac{Gc}{Re}\varphi_1-\sigma^2u_{10}-p=0 \quad \textbf{(3.3)}$$

$$\frac{d^2\theta_{10}}{dy^2}\pm\emptyset_1\theta_{10}=0 \quad \textbf{(3.4)}$$

First-order equations

$$\frac{d^2u_{11}}{dy^2}+\frac{Gr}{Re}\theta_{11}-\sigma^2u_{11}=0 \textbf{ (3.5)}$$

$$\frac{d^2\theta_{11}}{dy^2}+(\frac{du_{10}}{dy})^2+\sigma^2{u^2}_{10}\pm\emptyset_1\theta_{11}=0 \quad \textbf{(3.6)}$$

Region-II
Zeroth-order equations

$$\frac{d^2u_{20}}{dy^2}+\frac{Gr}{Re}bt\,m\,n\,h^2\theta_{20}+\frac{Gc}{Re}bc\,m\,n\,h^2\varphi_2-\sigma^2h^2ku_{20}-m\,h^2p=0 \quad \textbf{(3.7)}$$

$$\frac{d^2\theta_{20}}{dy^2}\pm\emptyset_2\theta_{20}=0 \quad \textbf{(3.8)}$$

First-order equations

$$\frac{d^2u_{21}}{dy^2}+\frac{Gr}{Re}btmn\theta_{21}-{\sigma_2}^2u_{21}=0 \quad \textbf{(3.9)}$$

$$\frac{d^2\theta_{21}}{dy^2}+\frac{K}{m}(\frac{du_{20}}{dy})^2+{\sigma_3}^2{u_{20}}^2\pm\emptyset_2\theta_{21}=0 \quad \textbf{(3.10)}$$

Corresponding boundary and interface conditions are:
Zeroth-order conditions

$$u_{10}(1)=0 \quad \textbf{(3.11a)}$$
$$u_{10}(0)=u_{20}(0) \quad \textbf{(3.11b)}$$
$$u_{20}(-1)=0 \quad \textbf{(3.11c)}$$
$$\frac{du_{10}}{dy}=\frac{1}{mh}\frac{du_{20}}{dy} \text{ at } y=0 \quad (3.11d)$$
$$\theta_{10}(1)=1 \quad \textbf{(3.12a)}$$
$$\theta_{10}(0)=\theta_{20}(0) \quad \textbf{(3.12b)}$$
$$\theta_{20}(-1)=0 \quad \textbf{(3.12c)}$$
$$\frac{d\theta_{10}}{dy}=\frac{1}{kh}\frac{d\theta_{20}}{dy} \text{ at } y=0 \textbf{ (3.12d)}$$

First-order conditions

$$u_{11}(1)=0 \quad \textbf{(3.13a)}$$
$$u_{11}(0)=u_{21}(0) \quad \textbf{(3.13b)}$$
$$u_{21}(-1)=0 \quad \textbf{(3.13c)}$$
$$\frac{du_{11}}{dy}=\frac{1}{mh}\frac{du_{21}}{dy} \text{ at } y=0 \quad \textbf{(3.13d)}$$

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$$\theta_{11}(1) = 0 \qquad \textbf{(3.14a)}$$
$$\theta_{11}(0) = \theta_{21}(0) \qquad \textbf{(3.14b)}$$
$$\theta_2(-1) = 0 \qquad \textbf{(3.14c)}$$
$$\frac{d\theta_{11}}{dy} = \frac{1}{kh}\frac{d\theta_{21}}{dy} \text{ at } y=0 \qquad \textbf{(3.14d)}$$

Equations (3.3)-(3.10) subject to the boundary and interface conditions (3.11 a to d) to (3.14 a to d) are solved analytically and these solutions are given below.

The solutions for θ_1 and θ_2 is different depending upon whether $\emptyset_1$ and $\emptyset_2$ is positive or negative. Therefore, the corresponding cases are of heat-generating fluids $(+\emptyset_2 > +\emptyset_1 > 0)$, and heat absorbing fluids $(+\emptyset_2 < 0 + \emptyset_1 < 0,)$ are came for two different solutions for θ_1 and θ_2.

Where in the both case one of the fluids is heat absorbing and another one is heat generating, which can be came in the same manner.

1. Solution for concentration:

$$\varphi_1 = c_1 y + c_2$$
$$\varphi_2 = c_3 y + c_4$$

$$\boldsymbol{\theta_{11}} = A_5 Cos\sqrt{\emptyset_1}y + \mathrm{A}_6 Sin\sqrt{\emptyset_1}y + \boldsymbol{B}_1 + B_2\, y + B_3 y^2 + B_4 \mathrm{Cos}2\sqrt{\emptyset_1}\, y + B_5\, \mathrm{Sin}2\sqrt{\emptyset_1}\, y + B_6\, y\, \mathrm{Cos}\sqrt{\emptyset_1}\, y + B_7 y \mathrm{Sin}\sqrt{\emptyset_1}\, y + B_8 y^2 \mathrm{Cos}\sqrt{\emptyset_1}\, y + B_9 Sin\sqrt{\emptyset_1} y + B_{10}\mathrm{Cos}2\sigma_1 y + B_{11}\mathrm{Sin}2\sigma_1 y + B_{12}\mathrm{Cos}\sigma_1 y + B_{13}\mathrm{sin}\sigma_1 y + B_{14} y \mathrm{Cos}\sigma_1 y + B_{15} y \mathrm{sin}\sigma_1 y + B_{16}\mathrm{cos}(\sigma_1 + \sqrt{\emptyset_1})y + B_{17}\mathrm{sin}\,(\sigma_1 + \sqrt{\emptyset_1})y + B_{18}\mathrm{cos}\,(\sigma_1 - \sqrt{\emptyset_1})y + B_{19}\mathrm{sin}\,(\sigma_1 - \sqrt{\emptyset_1})y$$

$$\boldsymbol{\theta_{21}} = A_7 Cos\sqrt{\emptyset_2}y + A_8 Sin\sqrt{\emptyset_2}y + \mathrm{B}_{20} + \mathrm{B}_{21}\, y + \mathrm{B}_{22}\, y^2 + \mathrm{B}_{23}\mathrm{Cos}\sigma_2 y + \mathrm{B}_{24}\, \mathrm{Sin}\sigma_2 y + \mathrm{B}_{25}\, \mathrm{Cos}2\sigma_2 y + \mathrm{B}_{26}\mathrm{Sin}2\sigma_2 y + \mathrm{B}_{27} y\, \mathrm{Cos}\sigma_2 y + \mathrm{B}_{28} y\, \mathrm{Sin}\sigma_2 y + \mathrm{B}_{29} y\, \mathrm{Sin}\sqrt{\emptyset_2}\, y + \mathrm{B}_{30} y\, \mathrm{Cos}\sqrt{\emptyset_2}\, y + \mathrm{B}_{31} y^2\, \mathrm{Sin}\sqrt{\emptyset_2}\, y + \mathrm{B}_{32} y^2\, \mathrm{Cos}\sqrt{\emptyset_2} y + \mathrm{B}_{33}\mathrm{Cos}2\sqrt{\emptyset_2} y + \mathrm{B}_{34}\mathrm{Sin}2\sqrt{\emptyset_2} y + \mathrm{B}_{35}\mathrm{Cos}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{B}_{36}\mathrm{Cos}(\sigma_2 - \sqrt{\emptyset_2})y + \mathrm{B}_{37}\mathrm{Sin}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{B}_{38}\mathrm{Sin}(\sigma_2 - \sqrt{\emptyset_2})y$$

$$\boldsymbol{u_{11}} = \mathrm{R}_1 + \mathrm{R}_2\, y + \mathrm{R}_3\, y^2 + \mathrm{A}_7\, \mathrm{Cos}\sigma_1 y + \mathrm{A}_8\, \mathrm{Sin}\sigma_1 y + \mathrm{R}_4\, \mathrm{Cos}\sqrt{\emptyset_1}\, y + \mathrm{R}_5 \mathrm{Sin}\sqrt{\emptyset_1}\, y + \mathrm{R}_6\, \mathrm{Cos}2\sqrt{\emptyset_1}\, y + \mathrm{R}_7 \mathrm{Sin}2\sqrt{\emptyset_1}\, y + \mathrm{R}_8 y\, \mathrm{Cos}\sqrt{\emptyset_1}\, y + \mathrm{R}_9\, y\, \mathrm{Sin}\sqrt{\emptyset_1}\, y + \mathrm{R}_{10}\, y^2 \mathrm{Cos}\sqrt{\emptyset_1}\, y + \mathrm{R}_{11} y^2\, \mathrm{Sin}\sqrt{\emptyset_1}\, y + \mathrm{R}_{12} y^2 \mathrm{Cos}2\sigma y + \mathrm{R}_{13}\, \mathrm{Sin}\sigma 1 y + \mathrm{R}_{14}\, y\, \mathrm{Sin}\sigma 1 y + \mathrm{R}_{15} y\, \mathrm{Cos}\sigma 1 + \mathrm{R}_{16} y^2\, \mathrm{Sin}\sigma 1 y + \mathrm{R}_{17}\, y^2\, \mathrm{Cos}\sigma 1\, y + \mathrm{R}_{18}\, \mathrm{Cos}(\sigma_1 + \sqrt{\emptyset_1})y + \mathrm{R}_{19} y^2 \mathrm{Sin}(\sigma_1 + \sqrt{\emptyset_1})y + 20\mathrm{Cos}(\sigma_1 - \sqrt{\emptyset_1})y + \mathrm{R}_{21}\mathrm{Sin}(\sigma_1 - \sqrt{\emptyset_1})y$$

$$\boldsymbol{u_{21}} = \mathrm{R}_{24} + \mathrm{R}_{25}\, y + \mathrm{R}_{26} y^2 + \mathrm{A}_{11}\, \mathrm{Cos}\sigma_2 y + \mathrm{A}_{12}\mathrm{Sin}\sigma_2 y + R_{27} Cos\sqrt{\emptyset_1}\, y + \mathrm{R}_{28}\mathrm{Sin}\sqrt{\emptyset_2}\, y + \mathrm{R}_{29}\, y\, \mathrm{Cos}\sigma_2 y + \mathrm{R}_{30} y\, \mathrm{Sin}\sigma_2 y + \mathrm{R}_{31}\mathrm{Cos}2\sigma_2 y + \mathrm{R}_{32}\mathrm{Sin}2\sigma_2 y + R_{33} y^2 Sin\sigma_2 y + R_{34} y^2 Cos\sigma_2 y + R_{35} y\, Sin\sqrt{\emptyset_2}\, y + \mathrm{R}_{36} y\, \mathrm{Cos}\sqrt{\emptyset_2}\, y + \mathrm{R}_{37} y^2 \mathrm{Sin}\sqrt{\emptyset_2}\, y + \mathrm{R}_{38} y^2 \mathrm{Cos}\sqrt{\emptyset_2}\, y + \mathrm{R}_{39}\mathrm{Cos}2\sqrt{\emptyset_2}\, y + \mathrm{R}_{40}\mathrm{Sin}2\sqrt{\emptyset_2}\, y + \mathrm{R}_{41}\mathrm{Cos}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{R}_{42}\mathrm{Sin}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{R}_{43}\mathrm{Cos}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{R}_{44}\mathrm{Sin}(\sigma_2 + \sqrt{\emptyset_2})y$$

2. Heat absorption case$(+\emptyset_1 < 0, +\emptyset_2 < 0)$:
In a same way as in the case of $+\emptyset_2 > 0\ and\ +\emptyset_1 > 0$, solutions can be came. Solutions of the zeroth-order equations (3.3), (3.4), (3.7) and (3.8) using boundary conditions (3.11 a to d) and (3.12 a to d) are:

$$\boldsymbol{\theta_{10}} = c_5 Cosh\sqrt{\emptyset_1}y + c_6 Sinh\sqrt{\emptyset_1}y$$
$$\boldsymbol{\theta_{20}} = c_7 Cosh\sqrt{\emptyset_2}y + c_8 Sinh\sqrt{\emptyset_2}y$$

$$\boldsymbol{u_{10}} = \mathrm{A1}\, \mathrm{Cosh}\sigma_1 y + \mathrm{A2}\, \mathrm{Sinh}\sigma_1 y + r_2 + r_1 y + r_3 Cosh\sqrt{\emptyset_1}\, y + r_4 Sinh\sqrt{\emptyset_1} y$$
$$\boldsymbol{u_{20}} = \mathrm{A3}\, \mathrm{Cosh}\sigma_1 y + \mathrm{A4}\, \mathrm{Sinh}\sigma_1 y + r_5 + r_6 y + r_7 Cosh\sqrt{\emptyset_2}\, y + r_8\, Sinh\sqrt{\emptyset_2} y$$

The solutions of first-order equations (3.5), (3.6),(3.9) and (3.10) using boundary conditions (3.13 a to d) and (3.14 a to d) are:

$$\boldsymbol{\theta_{11}} = A_5 Cosh\sqrt{\emptyset_1}y + \mathrm{A}_6 Sinh\sqrt{\emptyset_1}y + \boldsymbol{B}_1 + B_2\, y + B_3 y^2 + B_4\, \mathrm{Cosh}\, 2\sqrt{\emptyset_1}\, y + B_5\, \mathrm{Sinh}2\, \sqrt{\emptyset_1}\, y + B_6\, y\, \mathrm{Cosh}\sqrt{\emptyset_1} y + B_7 y \mathrm{Sinh}\sqrt{\emptyset_1}\, y + B_8 y^2 \mathrm{Cosh}\sqrt{\emptyset_1}\, y + B_9 Sinh\sqrt{\emptyset_1} y + B_{10}\mathrm{Cosh}2\sigma_1 y + B_{11}\mathrm{Sinh}2\sigma_1 y + B_{12}\mathrm{Cosh}\sigma_1 y + B_{13}\mathrm{sinh}\sigma_1 y + B_{14} y \mathrm{cos}\sigma_1 y + B_{15} y \mathrm{sinh}\sigma_1 y + B_{16}\mathrm{cosh}(\sigma_1 + \sqrt{\emptyset_1})y + B_{17}\mathrm{sinh}\,(\sigma_1 + \sqrt{\emptyset_1})y + B_{18}\mathrm{cosh}\,(\sigma_1 - \sqrt{\emptyset_1})y + B_{19}\mathrm{sinh}\,(\sigma_1 - \sqrt{\emptyset_1})y$$

$$\boldsymbol{\theta_{21}} = A_7 Cosh\sqrt{\emptyset_2}y + A_8 Sinh\sqrt{\emptyset_2}y + \mathrm{B}_{20} + \mathrm{B}_{21}\, y + \mathrm{B}_{22}\, y^2 + \mathrm{B}_{23}\mathrm{Cosh}\sigma_2 y + \mathrm{B}_{24}\, \mathrm{Sinh}\sigma_2 y + \mathrm{B}_{25}\, \mathrm{Cosh}2\sigma_2 y + \mathrm{B}_{26}\mathrm{Sinh}2\sigma_2 y + \mathrm{B}_{27} y\, \mathrm{Cosh}\sigma_2 y + \mathrm{B}_{28} y\, \mathrm{Sinh}\sigma_2 y + \mathrm{B}_{29} y\, \mathrm{Sinh}\sqrt{\emptyset_2}\, y + \mathrm{B}_{30} y\, \mathrm{Cosh}\sqrt{\emptyset_2}\, y + \mathrm{B}_{31} y^2\, \mathrm{Sinh}\sqrt{\emptyset_2}\, y + \mathrm{B}_{32} y^2\, \mathrm{Cosh}\sqrt{\emptyset_2} y + \mathrm{B}_{33}\mathrm{Cosh}2\sqrt{\emptyset_2} y + \mathrm{B}_{34}\mathrm{Sinh}2\sqrt{\emptyset_2} y + \mathrm{B}_{35}\mathrm{Cosh}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{B}_{36}\mathrm{Cosh}(\sigma_2 - \sqrt{\emptyset_2})y + \mathrm{B}_{37}\mathrm{Sinh}(\sigma_2 + \sqrt{\emptyset_2})y + \mathrm{B}_{38}\mathrm{Sinh}(\sigma_2 - \sqrt{\emptyset_2})y$$

$$\boldsymbol{u_{11}} = \mathrm{R}_1 + \mathrm{R}_2\, y + \mathrm{R}_3\, y^2 + \mathrm{A}_7\, \mathrm{Cosh}\sigma_1 y + \mathrm{A}_8\, \mathrm{Sinh}\sigma_1 y + \mathrm{R}_4\, \mathrm{Cosh}\sqrt{\emptyset_1}\, y + \mathrm{R}_5 \mathrm{Sinh}\sqrt{\emptyset_1}\, y$$

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$$+R_6\,\mathrm{Cosh}\,2\sqrt{\emptyset_1}\,y + R_7\mathrm{Sinh}2\sqrt{\emptyset_1}\,y + R_8 y\,\mathrm{Cosh}\sqrt{\emptyset_1}\,y + R_9\,y\,\mathrm{Sinh}\sqrt{\emptyset_1}\,y + R_{10}\,y^2\mathrm{Cosh}\sqrt{\emptyset_1}\,y + R_{11}y^2\,\mathrm{Sinh}\sqrt{\emptyset_1}\,y + R_{12}y^2\cosh 2\sigma y + R_{13}\,\mathrm{Sinh}2\sigma 1 y + R_{14}\,y\,\mathrm{Sinh}\sigma 1 y + R_{15} y\,\mathrm{Cosh}\sigma 1 + R_{16}y^2\,\mathrm{Sinh}\sigma 1 y + R_{17}\,y^2\,\mathrm{Cosh}\sigma 1\,y + R_{18}\,\mathrm{Cosh}\left(\sigma_1+\sqrt{\emptyset_1}\right) + R_{19}y^2\mathrm{Sinh}\left(\sigma_1+\sqrt{\emptyset_1}\right) + 20\mathrm{Cosh}\left(\sigma_1-\sqrt{\emptyset_1}\right) + R_{21}\mathrm{Sinh}\left(\sigma_1-\sqrt{\emptyset_1}\right)$$

$$\boldsymbol{u_{21}} = R_{24} + R_{25}\,y + R_{26}y^2 + A_{11}\,\mathrm{Cosh}\sigma_2 y + A_{12}\mathrm{Sinh}\sigma_2 y + R_{27}Cosh\sqrt{\emptyset_1}\,y + R_{28}\mathrm{Sinh}\sqrt{\emptyset_2}\,y + R_{29}\,y\,\mathrm{Cosh}\sigma_2 y + R_{30}y\,\mathrm{Sinh}\sigma_2 y + R_{31}\mathrm{Cosh}2\sigma_2 y + R_{32}\mathrm{Sinh}2\sigma_2 y + R_{33}y^2 Sinh\sigma_2 y + R_{34}y^2 Cosh\sigma_2 y + R_{35}y\,Sinh\sqrt{\emptyset_2}\,y + R_{36}y\,\mathrm{Cosh}\sqrt{\emptyset_2}\,y + R_{37}y^2\mathrm{Sinh}\sqrt{\emptyset_2}\,y + R_{38}y^2\mathrm{Cosh}\sqrt{\emptyset_2}\,y + R_{39}\mathrm{Cosh}2\sqrt{\emptyset_2}\,y + R_{40}\mathrm{Sinh}2\sqrt{\emptyset_2}\,y + R_{41}\mathrm{Cosh}\left(\sigma_2+\sqrt{\emptyset_2}\right)y + R_{42}\mathrm{Sinh}\left(\sigma_2+\sqrt{\emptyset_2}\right)y + R_{43}\mathrm{Cosh}\left(\sigma_2+\sqrt{\emptyset_2}\right)y + R_{44}\mathrm{Sinh}\left(\sigma_2+\sqrt{\emptyset_2}\right)y$$

The constants in the solutions are not presented here to conserve space. Solutions of equations (3.15) to (3.30) are evaluated analytically and are represent by graphically from Figs. 2 to 13 by fixing the some of the physical parameters namely p = -5, Re=5, n=0.5, bt=0.5, bc=0.5, ε=0.1.

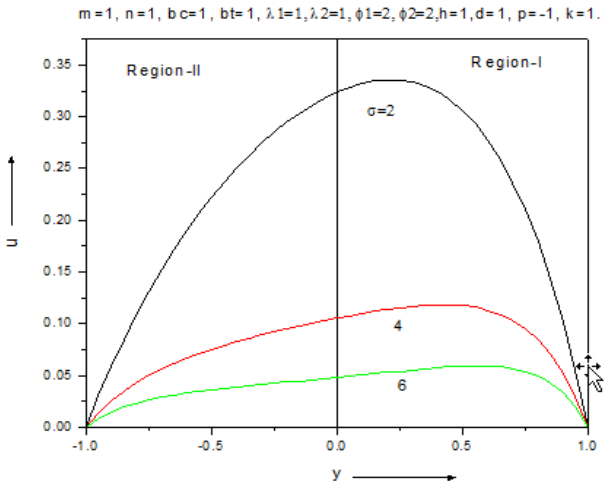
IV. RESULTS AND DISCUSSION

In this part the convective flow and heat trasfer results for two fluid permeble flow through a verticle channel in the occurring of source or sink is discussed. The flow is shape with the Darcy-lapwood –Brinkman equation.

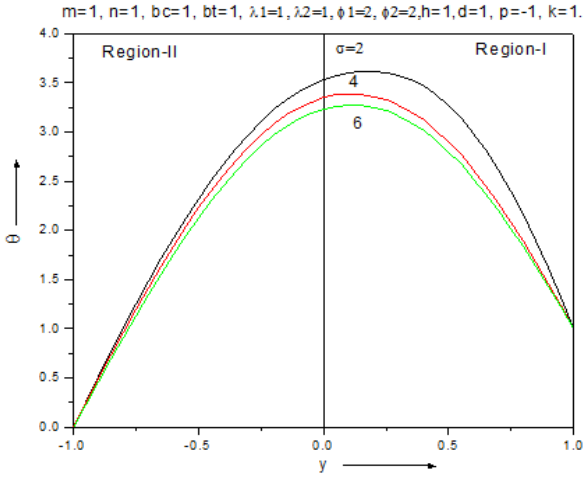
The viscous and Darcy dissipated living terms are included in the energy equation. The basic governing equations the flow are solved analytically using the regular perturbation method and numerically by the finite difference method.

The product of Prandtl number and Eckertbnumber (ε=Pr×Ec) is used as the perturbation parameter Two cases are extents depending on the thermal charectoristic of the problem such as heats generation and heat absorption

Fig. 2(a) and 2(b) Shown the opposite reason behind the porous parameter σ on the rate and temperature fields the occurance of a porous medium within the channel features a variety of behaviour to provide a flow restriction causing



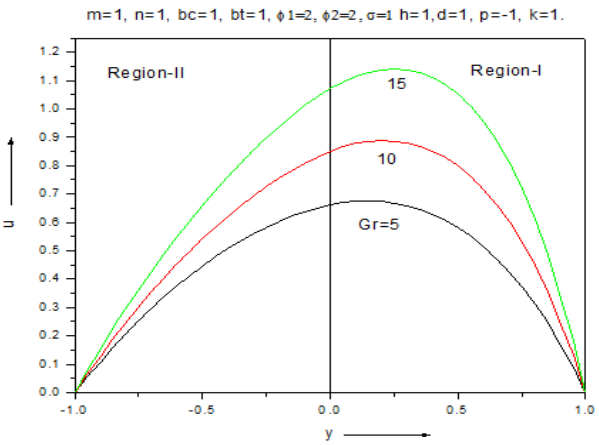
(a)



(b)

Fig 2. (a) and (b) Shown the opposite reason behind the porous parameter σ on the rate and temperature fields.

the speed profile to decrease. This decrease within the flow speed continues and also the velocity profile begin to be flatter because the porous medium parameter σ increases.



(a)

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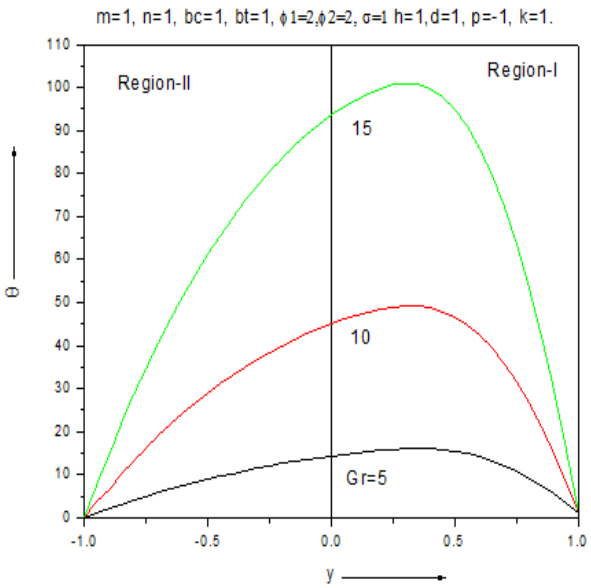
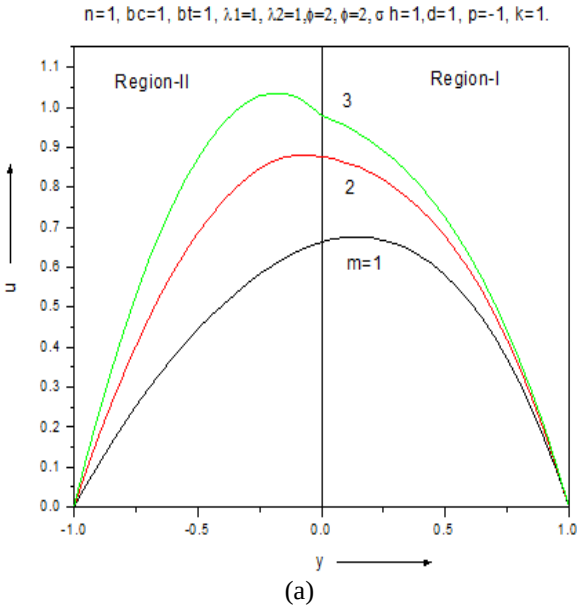


(b)

Fig 3. (a) and (b) illustrates the opposite reason for Grashof number Gr on velocity and temperature fields repectively.

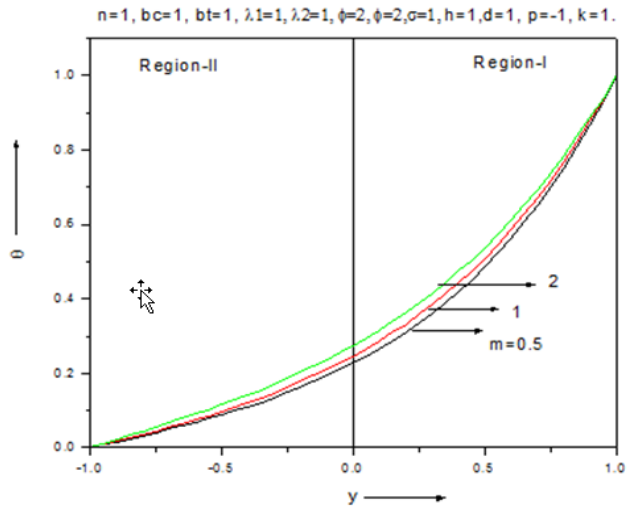
Fig. 3(a) and 3(b) illustrates the opposite reason for Grashof number Gr on velocity and temperature fields repectively. it's unecpectedly that the effect of the enhanceing Grashof number is to boost the rate and temperature fields as thought to be likely.

An enhance within the Grashof number physically means enhance of the buoyancy force which supports the flow.



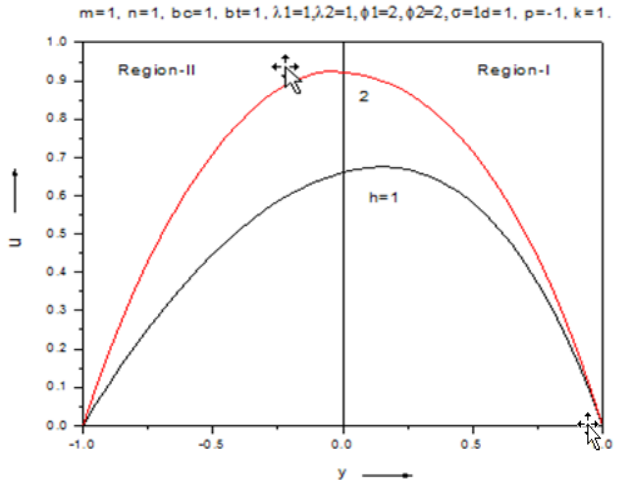
(a)

Fig. 4(a) and 4(b) Shown the other cause of the viscosity ratio m on velocity and temperature fields. It is seen from this figure that as the viscosity ratio m enhances, the velocity and temperature also enhance.

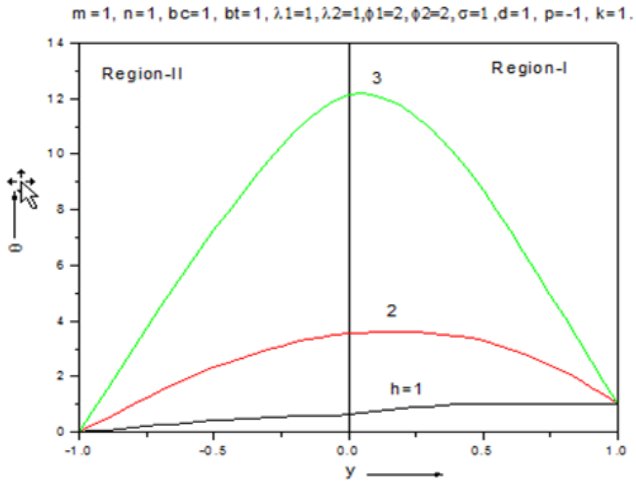


(b)

Fig 4. (a) and (b) Shown the other cause of the viscosity ratio m on velocity and temperature fields.



(a)



(b)

Fig 5. (a) and (b) Shown other cause of the width ratio h on velocity and temperature fields.

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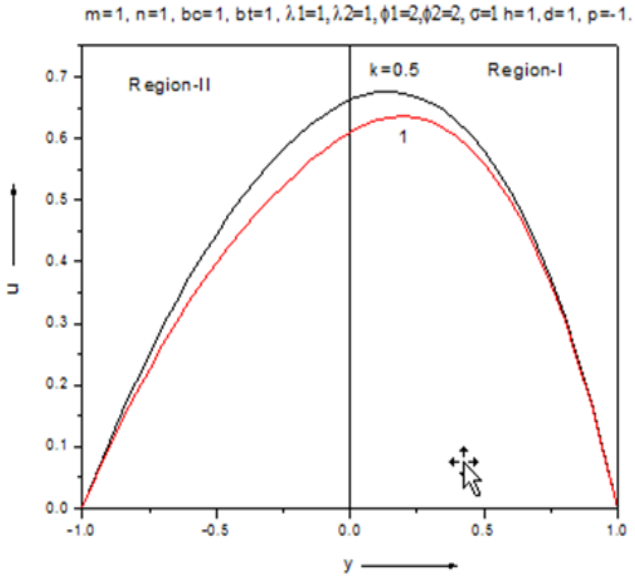
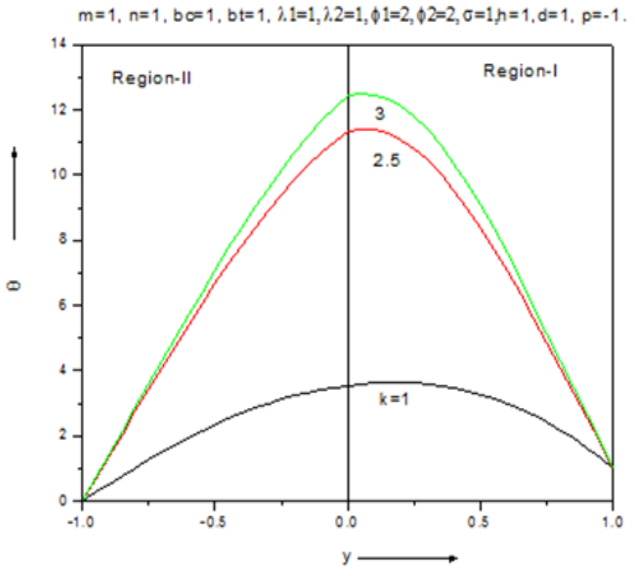
Fig. 5 (a) and 5(b) Shown other cause of the width ratio h on velocity and temperature fields. Velocity and temperature enhance as he width ratio h enhance. The enhancement is similar to the ratio of viscosities.



(a)

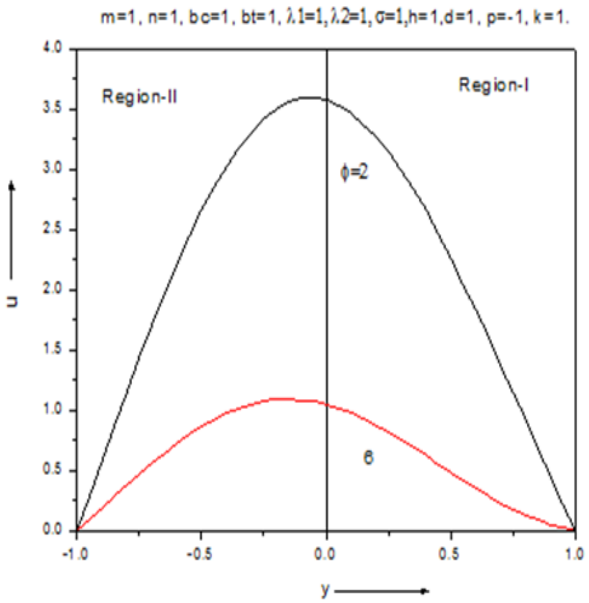


(b)

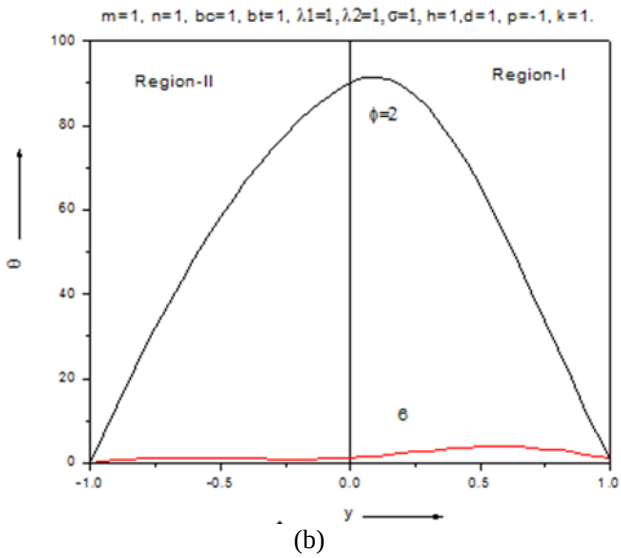
Fig 6. (a) and (b) shows the effect of thermal conductivity ratio (k) on velocity and temperature.

Fig. 6(a) and 6(b) shows the effect of thermal conductivity ratio (k) on velocity and temperature. By above figure we obsereve that increse in the conductivity ratio incresases fluid flow velocity in both the regions.

The thermal conductivity effect shows that as the value of k increasing temperature profile is enhanced. We also observe temperature profiles for small values of k are almost linear and become non linear for large values of k.



(a)



(b)

Fig 7. (a) and (b) Shows that influence of heat generation coefficient in both fluids $\emptyset_1 and \emptyset_2$ for simplicity, which takes $\emptyset_1 and \emptyset_2 = \emptyset$.

Figure 7 (a) and 7 (b) Shows that influence of heat generation coefficient in both fluids $\emptyset_1 and \emptyset_2$ for simplicity, which takes $\emptyset_1 and \emptyset_2 = \emptyset$.

The effect of heat generation parameter $\emptyset$ for both the fluids has the type of behaviour on velocity and temperature filed shows that when velocity and the temperature enhance with the enhancement of heat generation parameter $\emptyset$ increases.

Fig.8(a) and 8(b) represented by graphically the influence of warmth absorption coefficients of both the fluids ∅1 and ∅2 on the flow field. for straightforward to grasp, it's taken that ∅_1 and∅_2=∅ (for all graphs). In general, heat

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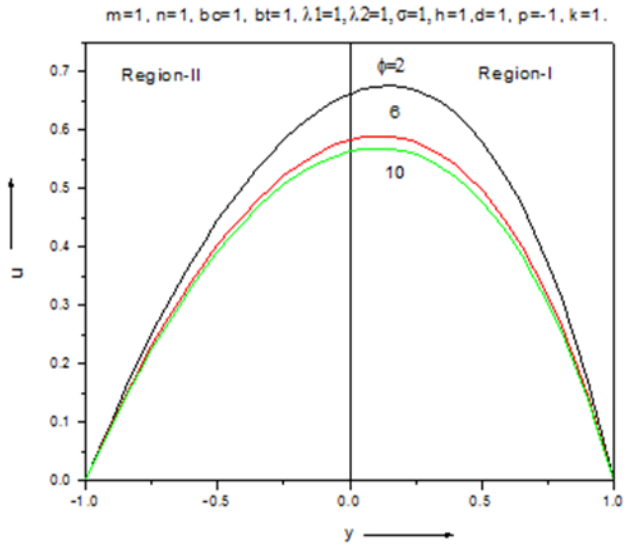
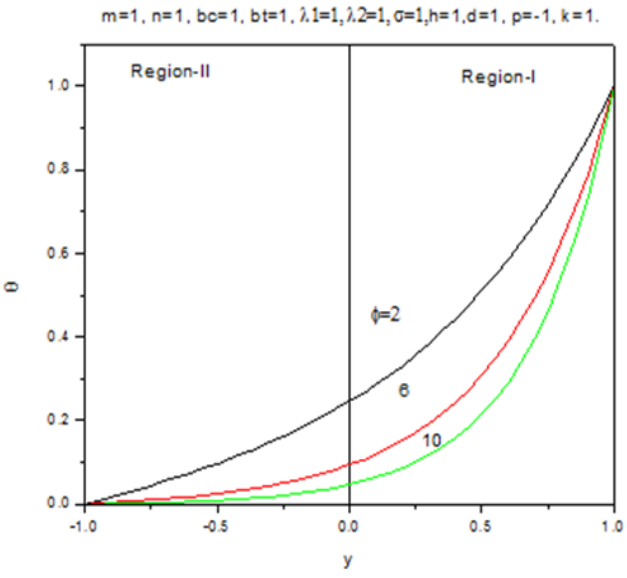
absoption for both the fluids has the sort of behaviour to enhancement both the rate and temperature filieds. It allows that because the Heat absorption Ø increases the also enhance. Heat absorption of fluid has tendency to reinforce the temperature.



(a)

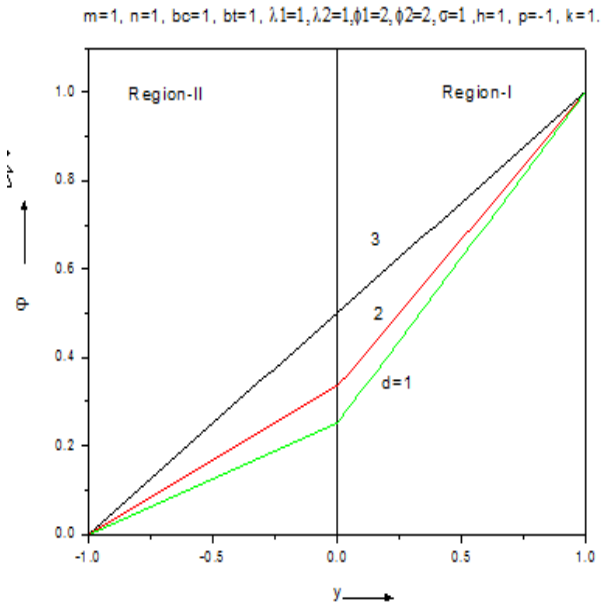


(b)

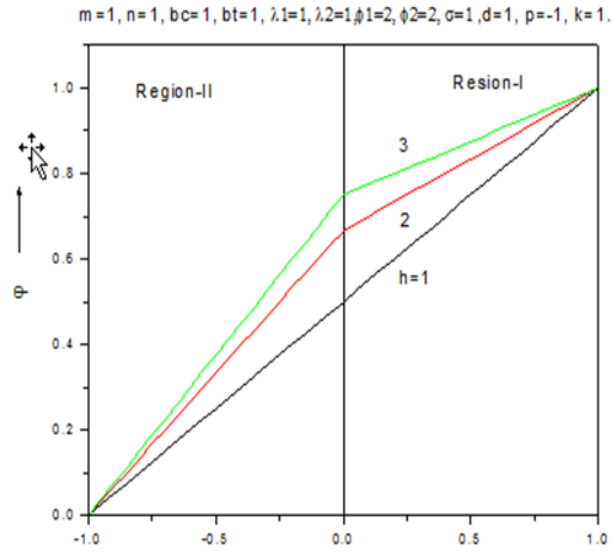
Fig 8. (a) and (b) represented by graphically the influence of warmth absorption coefficients of both the fluids Ø1 and Ø2 on the flow field.

Concentration profiles for defferent values of difusion coefficient ratio is ploted in Fig. 9(a) and 9(b). It is observed thta the increses in diffusion coefficient ratio d as a result it supresses the fow.

Concentration profiles for different values of width ratio in ploted in it is observed that increse in width ratio increse the fluid flow.



(a)



(b)

Fig 9. (a) and (b) Concentration profiles for defferent values of difusion coefficient ratio is ploted.

It is showing curiosity to note that the effect of porous parameter, Grashof number, viscisity ratio, width ratio, and thermal conductivity ratio on velocity and trmprature remains the same for heat absorption estimate to heat generation and is not represented pictorially in order to minimize the number of graphs.

The presence of heat absorption of both fluids has the tendency to decrease velocity and temperature. This causes a decrease in the buoyancy force and hence has the direct effect of decreasing the buoyancy –induced flow in the channel.

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V. CONCLUSION

We have studied the effect of multifluid flow for internal heat generation or absorption in a vertical channel by concidering the concentration. Results obtained for different physical parameters are ploted graphically.

It observed the presence of heat generation and buoyancy force enhance the flow rate in the channel. Where as we can see its opposite nature and its hold good for heat absorption. The flows in both regions were enhanced. source and sink control the heat and momentum transfer, these results are more helpful in the field of mechanical and civil enginering students.

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