International J. of Pure & Engg. Mathematics (IJPEM)
ISSN 2348-3881, Vol. 4 No. III (December, 2016), pp. 11-20

UNSTEADY FREE CONVECTION MHD FLOW PAST A PERPENDICULAR PLATE WITH VARIABLE HIGH TEMPERATURE AND COMPOUND REACTION

M. VEMAN REDDY[1], T. LAXMINARAYANA[2] AND GANDHAM VIJAYKUMAR[3]
1, 3 Ramanandatirtha Engineering College, Nalgonda, India
[2] SRTIST-Nalgonda

Abstract

In this present paper investigation is performed to learn the effect of magnetic field on temporary without charge convection flow of an electrically conducting fluid over an precipitately ongoing isothermal perpendicular cover with inconsistent high temperature and with compound reaction. Solutions are obtained by Laplace transform technique with graphically for different values of physical parameters. It is observed that chemical reaction parameter and magnetic restriction authority with speed and absorption profile considerably.

1. Introduction

Industrial and engineering applications such as liquid metal cooling in nuclear reactors, magnetic control of molten iron flow in steel industry etc., magneto convection has also been ahead substantial attention amongst researchers already developed areas further

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Key Words : *Free convection, MHD, Inconsistent high temperature, Compound result.*
2000 AMS Subject Classification : 76R10, 76W05, 80A20, 80A32.

for more complex studies. Mass transfer with chemical reaction is one of the most commonly encountered circumstances in chemical industry as well as in physical and biological sciences. In some other areas such as food processing industry, paper processing technology, the evaporation or condensation process, solvent extraction, drying humidification, sublimation, oxygenation of blood, food and drug assimilation, respiration mechanism, etc. chemical reaction takes place. There are many situations where convection heat transfer phenomena are accompanied by mass transfer also. When mass transfer takes place in a fluid at rest, the mass is transfer simply by molecular diffusion consequential from attentiveness gradient. For low attentiveness of the accumulation in the liquid and low accumulation transfer rates, the convective high temperature and mass transfer process are alike in environment. A number of investigation have previously been carried out with collective heat and mass transport under the statement of dissimilar substantial situation.

2. Review Literature

Many authors deliberate mass transport by or with no compound reaction in flow precedent oscillating perpendicular cover by considering different outside environment but the learn on the effects of magnetic field on free convection heat and mass transfer within the attendance of transverse magnetic field and compound reaction with changeable temperature has not been found in literature and hence the motivation to assume this study, the effects of compound reaction on hydromagnetic flow precedent a perpendicular plate with variable temperature under the assumption of first order chemical response. However if the presence of such overseas mass is extremely low down next we can suppose the first arrange compound reaction so that heat creation due to chemical reply can be considered to be very negligible. The chemical reaction effects on vertical oscillating plate with variable temperature and compound reaction.

1. Chaudhary and Jain [2]: The magneto hydrodynamic temporary heat up with accumulation transport flow by free convection precedent a perpendicular plate, when the high temperature of the cover oscillates in point in time about a stable mean temperature and the cover is entrenched in a porous average.

2. Das ET. al. [3, 4, 5] The effects of mass transfer on free convection flow precedent

an on impulse started infinite vertical plate with constant heat flux and chemical reaction They also studied the passing without charge convection flow precedent endless perpendicular cover with periodic high temperature suspicious the effects of mass transfer on flow past an impetuously in progress perpendicular cover.

3. Deka and Neog [6], [7] Considered the combined belongings of thermal emission and compound react on free convection flow precedent a perpendicular cover in absorbent medium and with MHD respectively.

4. Gebhart and Pera [10]: the fact that free convection current caused by temperature differences is also caused by the differences in concentration or material constitution as suggested considered the effects of mass transfer on impetuously started infinite vertical plate with variable high temperature and standardized accumulation change. 5. Soundalgekar [14, 17]. In flow past oscillation vertical plate with exact solutions of free convection flow precedent a perpendicular cover in without charge convective flow was first obtain by and the same problem with mass transport result. Effect of accumulation transport on the flow precedent an infinite perpendicular oscillating plate with steady heat flux.

6. Soundalgekar et. al. [16]: The effects of mass transport on free convection flow past a semi-infinite vertical isothermal plate was first studied by and the effects of mass transfer on the flow past an impetuously started unbounded vertical plate with variable high temperature.

7. Muthucumaraswamy et. al. [12]. The process of free convection, chemical reaction also takes place due to the presence of as impurities in fluid. It is found that in many chemical engineering processes, chemical reaction takes place between foreign masses present in the form of ingredients and the fluid. This type of compound answer may change the high temperature and the heat content of the fluid and may affect the free convection process.

3. Mathematical Analysis

An unsteady normal convection flow of a viscous incompressible electrically conducting fluid precedent an endless perpendicular cover is considered here. To visualize the flow pattern a Cartesian co-ordinate system is careful

1. where x'-axis is in use the length of the infinite perpendicular cover,
2. where y'-axis is normal to the plate and fluid fills the region $y' \geq 0$
3. the fluid and the plate are kept at the same constant temperature T'_∞ and species concentration C'_∞.
4. At time $t' > 0$, the plate is understood to be affecting endlessly in its own plane by a uniform velocity U_0 and at the same time the plate temperature is raised linearly with time and the level of species concentration is raised to C'_∞.
5. A magnetic field of uniform strength B_0 is applied normal to the plate. It is understood that the magnetic Reynolds number is extremely small and the induced magnetic field is negligible in assessment to the oblique magnetic ground.
6. It is too understood so as to the result of viscous indulgence is small in the energy equation and the level of species attentiveness is extremely short so the Soret and Dufour effects are insignificant.

As the cover is endless in degree therefore the derivatives of all the flow variables

(i) With respect to x' vanish and they can be assumed to be functions of y' and t' only.

(ii) Thus the motion is one dimensional with only non-zero perpendicular speed component u', varying with y' and t' only.

Due to one dimensional nature, the equation of continuity is trivially satisfied.
Under the above assumptions and following Boussinesq approximation, the unsteady flow field is governed by the following equations:

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

$$\frac{\partial u'}{\partial t'} + v'\frac{\partial u'}{\partial y'} = \nu\frac{\partial^2 u'}{\partial y'^2} - \frac{\sigma B_0^2 u'}{\rho} - \frac{\nu u'}{K^*} + g\beta(T' - T'_\infty) + g\beta^*(C' - C'_\infty) \tag{2}$$

$$\frac{\partial C'}{\partial t'} + \nu'\frac{\partial C'}{\partial y'} = D\frac{\partial^2 C'}{\partial y'^2} - R^*(C' - C')^n \tag{3}$$

the length of with the next original and boundary conditions:

$$\frac{\partial T'}{\partial t'} + \nu\frac{\partial T'}{\partial y'} = \frac{1}{\rho C_\rho}\frac{\partial}{\partial y'}\left(K(T)\frac{\partial T'}{\partial y'}\right) - \frac{1}{\rho C_\rho}\frac{\partial q_r}{\partial y'} + \frac{\nu}{C_p}\left(\frac{\partial u'}{\partial y'}\right) \tag{4}$$

Currently to decrease the above equations in nondimensional outline we bring in the following non-dimensional quantity.

$$\begin{aligned} &t' \leq 0, \quad u' = 0, \quad T' \to T'_\infty, \qquad C' \to C'_\infty \ \text{ for all } \ y' \\ &t' > 0, \quad u' = 0, \quad T' = T'_w, \qquad C' - C'_w \ \text{ at } \ y' = 0 \\ &\qquad\quad\ u' \to 0, \quad T' \to T'_\infty, \qquad C' \to C'_\infty \ \text{ as } \ y' \to \infty \end{aligned} \tag{5}$$

non dimensional quantities (5), the equations (1), (2) and (3) then reduce to the following forms

$$\frac{\partial q_r}{\partial y'} = -4\sigma a^*(T'^4_\infty - T'^4) \tag{6}$$

$$T'^4 \approx 4T'T'^3_\infty - 3T'^4_\infty \tag{7}$$

$$K(T) = k_0\{1 + \gamma(T' - T'_\infty)\} \tag{8}$$

and the initial and boundary conditions (4) are as follows:

$$\begin{aligned} &U = \frac{u'}{U_0}, \quad y = \frac{y'U_0}{\nu}, \quad t = \frac{t'U_0^2}{\nu}, \quad \theta = \frac{T' - T'_\infty}{T'_w - T'_\infty}, \\ &C = \frac{C' - C'_\infty}{C'_w - C'_\infty}, \quad \alpha = \frac{\nu_0}{U_0}, \quad \tau = \gamma(T'_w - T'_\infty), \\ &Sc = \frac{\nu}{D},` \ Pr = \frac{\nu\rho c_\rho}{k_0}, \quad Ec = \frac{U_0^2}{c_\rho}(-T'_\infty), \\ &Gr = \frac{g\beta\nu(T'_w - T'_\infty)}{U_0^3}, \quad Gc = \frac{g\beta^*\nu(C'_w - C'_\infty)}{U_0^3}, \\ &K = \frac{K^*U_0^2}{\nu}, \quad N = \frac{16a\sigma^*T'^3_\infty\nu}{k_0U_0^2}, \quad M = \frac{\nu\sigma B_0^2}{\rho U_0^2},` \ Kr = \frac{\nu R^*(C'_w - C'_\infty)}{U_0^2}. \end{aligned} \tag{9}$$

Solutions of the equations (6), (7) and (8) subject to the initial and boundary conditions (9) are obtained with the help of Abramowtz and Stegum [1] and Hetnarski's [11] algorithm. They are obtained as follows:

$$\frac{\partial U}{\partial t} - \alpha\frac{\partial U}{\partial y} = \frac{\partial^2 U}{\partial y^2} - Mu - \frac{1}{K}U + Gr\theta + GcC \tag{10}$$

$$\frac{\partial C}{\partial t} - \alpha \frac{\partial C}{\partial y} = \frac{1}{Sc} \frac{\partial^2 C}{\partial y^2} - KrC^n \tag{11}$$

$$\frac{\partial \theta}{\partial t} - \alpha \frac{\partial \theta}{\partial y} = \frac{(1+\tau\theta)}{Pr} \frac{\partial^2 \theta}{\partial y^2} + \frac{\tau}{Pr} \left(\frac{\partial \theta}{\partial y}\right)^2 - \frac{N}{Pr}\theta + Ec \left(\frac{\partial U}{\partial y}\right)^2. \tag{12}$$

Here, the following symbols are used in the above solutions:

$$\begin{aligned} &t' \leq 0, \quad U = 0, \quad \theta \to 0, \quad C \to 0 \ \text{ for all } \ y \\ &t' > 0, \quad U = 0, \quad \theta = 1, \quad C = 1 \ \text{ at } \ y = 0 \\ &\quad\quad\quad\; U \to 0, \quad \theta \to 0, \quad C \to 0 \ \text{ as } \ y \to \infty \end{aligned} \tag{13}$$

4. Results and Discussion

1.the influence of different physical parameters viz., chemical reaction parameter, Schmidt number, thermal Grashof number, mass Grashof number, Hartmann number, Prandtl number and time on the physical flow situation, computations are carrier out for perpendicular rate, high temperature and attentiveness in calculation to they are presented graphically.Attentiveness profile are accessible for unlike standards of Sc and R.

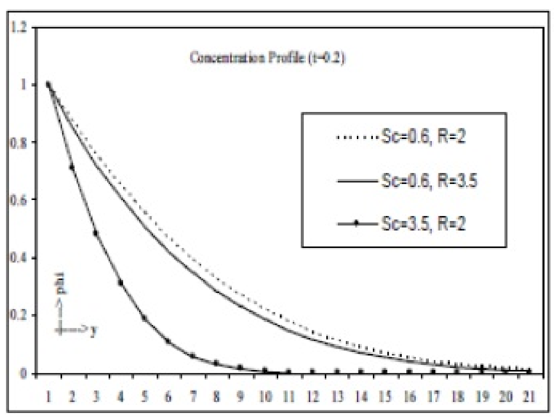

Figure-1 : Concentration Profile (Effect of Chemical reaction parameter and Schmidt number).

2. It increases of Schmidt number and compound reaction limitation lead to the reduce in attentiveness of the kind. Represents the elevated temperature profiles for dissimilar values of Pr represents temperature profiles at different times t.

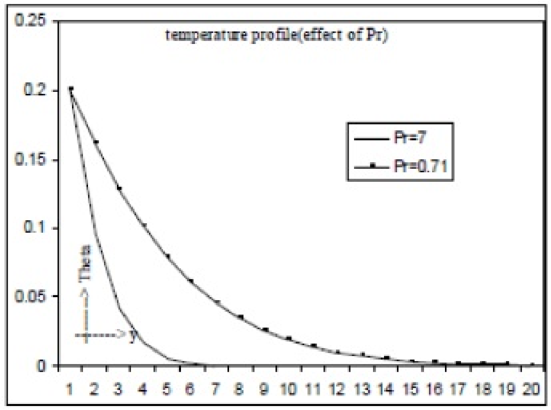

Figure-2:Temperature Profile (Effect of Pr)

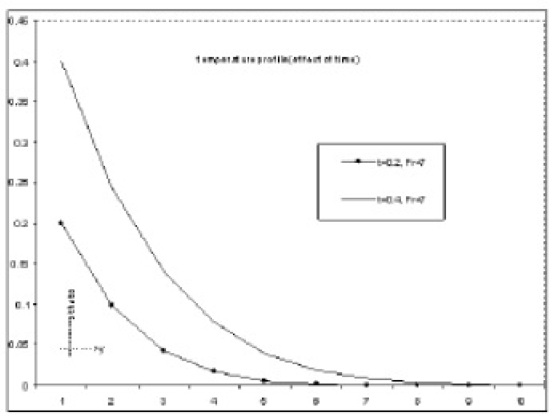

Figure-3.: Temperature Profile (Effect of time)

3. Since high temperature is measured as point in time needy, consequently it is obviously reflect the circumstances. It is additional experiential that temperature decreases with the increase of Pr. Velocity Profiles for unlike principles of parameter given graphs 4 and 5 control of Gr, Gm and R are given away in for fixed values of M, Sc and Pr.

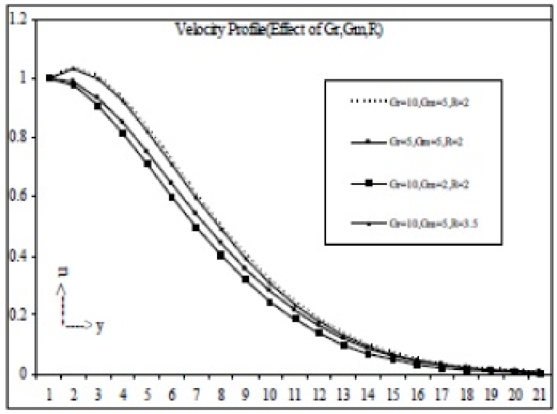

Figure-4.: Velocity Profile (Effect of Gr, Gm and R)

4. The velocity increases with the increase of Gr and Gm but decreases with the increases of R. In graph 5 of M and Sc are obtainable for some fixed values of t, Gr, Gm, Pr and R.

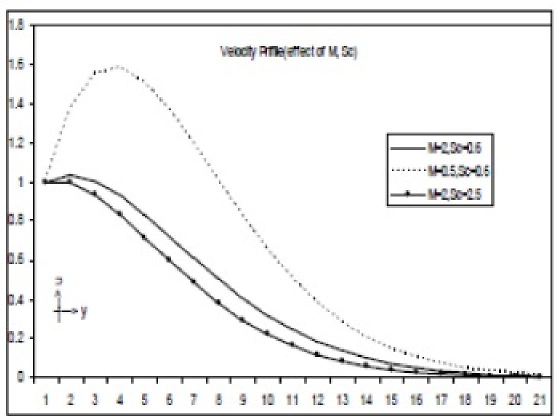

Figure-5.: Velocity Profile (Effect of M and Sc)

It is clear from the figure that velocity decreases when M and Sc increase.

5. Conclusions

1. An correct analysis is performed to study the influence of chemically reacting hydro-magnetic flow past a vertical plate with variable temperature and chem-

ical reaction. Exact solutions of equations are obtained by Laplace transform technique.

2. Some of the important conclusions of the study are as follows: Concentration decreases as Sc and R increase.Velocity increases with increasing Gr, Gm and decreasing M and R. Also increase in Sc and R lead to decrease in velocity.

3. The concentration increase with increasing reaction order parameter and time while the concentration decrease with increase in Schmidt number , suction parameter and chemical reaction parameter.

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