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THE 1ST YOUNG SCIENTIST INTERNATIONAL CONFERENCE OF WATER RESOURCES DEVELOPMENT AND ENVIRONMENTAL PROTECTION

MALANG - INDONESIA

5 - 7 June 2015

PROCEEDING

Environmental Engineering & Water Technology
Integrated Water Systems & Governance
Water Science & Engineering

WATER RESOURCES ENGINEERING DEPARTMENT
FACULTY OF ENGINEERING

FOREWORD

The 1st Young Scientist International Conference of Water Resources Development and Environmental Protection 2015 (ICWRDEP 2015) Water Resources Engineering Department, Faculty of Engineering, University of Brawijaya was conducted on 5 - 7 June 2015. The Conference was organized by Faculty of Engineering and collaborated with International University of Malaya (UM), Universiti Sains Malaysia (USM) and Universiti Tun Hussein Onn Malaysia (UTHM).

The participants of the Conference are about 60 participants come from more than 20 higher institutions, such as; Sepuluh Nopember Institute Of Technology, Surabaya (ITS), Bandung Institute of Technology (ITB), Bogor Agricultural University (IPB), The University of Lampung, Sriwijaya University, University of Muhammadiyah Malang (UMM), University of Brawijaya (UB), Padjajaran University, State University of Malang (UM), National Institute of Technology (ITENAS), Tidar university, State Polytechnic of Malang (Politeknik Negeri Malang), Mulawarman University, State Polytechnic of Padang (Politeknik Negeri Padang), Malang National Technology Institute (Institut Teknologi Nasional Malang), BBWS Mesuji Sekampung, Bengkulu University, Diponegoro University (UNDIP), Nusa Cendana University, Khairun University, Bantara University, University of Jember, State Polytechnic of Samarinda (Politeknik Negeri Samarinda), UM (University of Malaya), Universiti Sains Malaysia (USM) and Universiti Tun Hussein Onn Malaysia (UTHM), and others, which reflect the importance water resources engineering development and environmental protection.

The topics of conference are Environmental Engineering & Water Technology, Integrated Water System & Governance and Water Science & Engineering. The conference provide platform for researchers, engineers and academician to meet and share ideas, achievement as well as experiences through the presentation of papers and discussion. These events are important to promote and encourage the application of new concept of water resources development and techniques to practitioners as well as enhancing the knowledge of environmental protection with the current requirements of analysis, design and construction of any engineering concept.

As Head of Water Resources Engineering Department, we would like to express our deepest gratitude to the Rector University of Brawijaya, Keynote Speakers (Prof Satoru Oishi & Prof Tsuyoshi Imai from Japan, Assoc. Prof Faridah Othman and Prof Amir Hamzah from Malaysia), International Advisory Board members, organizing committee and also to all participants.

We would like to express our deepest gratitude to the Faculty of Engineering conducted such conference. This is the first International conference for the Department and we expect that this is will become 2nd annual activity for our Department.

Malang, 5 June 2015

Ir. Mohammad Sholichin, MT., Ph.D
Head of Water Resources Engineering Department
Faculty of Engineering University of Brawijaya

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Viscoelastic Fluid Past A Flat Plate With The Effect Of Magnetohydrodynamic

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ABSTRACT

One type of non-Newtonian fluids is viscoelastic fluid. The characteristics of this fluid are viscous and elastic. Many researches have been done on non-Newtonian fluid, one of which the magneto hydrodynamics viscoelastic fluid, especially for the application in engineering field. This study will research about the problem of magneto hydrodynamics viscoelastic fluid passing through the flat plate. The governing equation of the flow is solved using the boundary layer theory. The boundary layer equations are then transformed into a non-dimensional form using the stream function equation. The numerical results are analyzed the effect of viscoelastic parameter (K), magnetic parameter (M), and Prandtl number (Pr) to the velocity profile(f') and temperature profile (θ). Based on numerical simulations that have been conducted, it can be concluded that the values of velocity (f') decrease when the magnetic parameter, viscoelastic parameter, and Prandtl number increase. The values of temperature profile increase (θ) when the viscoelastic parameter and magnetic parameter increase, but it will be decrease when Prandlt number increase.

KEYWORDS

Magnetohydrodynamic, Visco-elastic, Prandtl number

INTRODUCTION

The reseach about Non-Newtonian fluids has grown considerably because of more application in industrial fields such as in petroleum production, wire drawing, paper production etc. The Walters-B viscoelastic fluid model was first developed by Walters [1] that investigated the foundation of linier viscousity. The result have shown that different choices of the measure of strain correspond different theories of finite linear viscoelasticity. Much work has been done in order to understand the effect of velocity profile and heat transfer in viscoelastic fluids. In the last few decades, heat and velocity analysis fluid flow through a flat plate have attracted a considerable attention of researchers because such process exist in many branches of science and technology [2]-[4]. In most of the studies, the effects of magnetohydrodynamics in a fluid flow became interested because of it's application in engineering. Many researches have studied the magnetohydrodinamics in viscoelastic fluid [7]-[8]. Kayvan [9] had presented that all parameter such as Reynolds number, Weissenberg number, and the magnetic number have a profound effect on the velocity profiles. Kasim [10] studied magnetohydrodynamic flow of viscoelastic fluid past over a flat plate in steady state and incompressible, that was solved numerically by Box-Keller method. In this research, the free convection flow in viscoelastic fluid with the effect of magnetohydrodynamics is

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analyzed and solved with the explicit finite difference scheme of forward time and central space (FTCS).

METHODOLOGY

In order to study the problem of MHD viscoelastic fluid past over a flat plate, several steps are used to solve this problem as follows

- Thermodynamics conservation law, Newton's second law, and mas conservation are used to constructing the equation of energy, momentum, and continuity .
- Determining boundary condition and several related parameters such as visco-elastic number (K), Prandtl number (Pr), Magnetic number (M), and Euckert number (Ec).
- The stream functions are used to transform the mathematical model into non-dimentional form.
- Forward in time and centered in space scheme (FTCS) is used to discretized the mathematical model and the graphical illustrations help to understand the physics of the problem.
- Finding the effect visco-elastic (K) , Magnetic parameter $(M)$and Prandtl number (Pr) parameters on velocity profile (f') and temperature profile (θ).

MATHEMATICAL FORMULATION

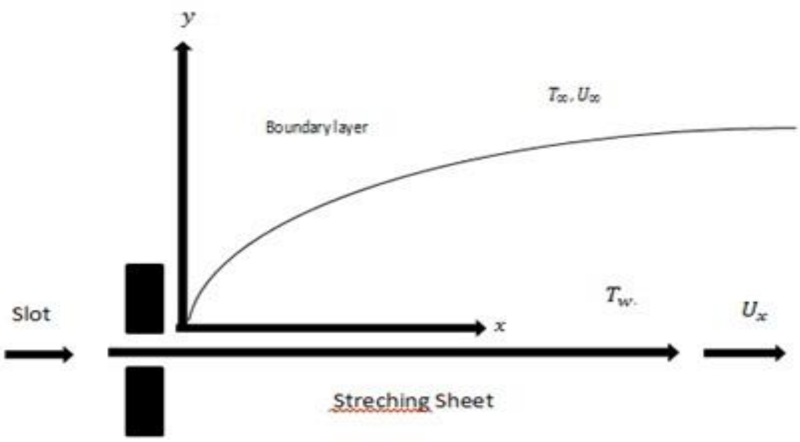

Figure 1. Physical Model of Visco-elastic Fluid Past Over A Flat plate

This Problem considered steady two dimensional flow with constant velocity U_w to the free stream velocity U_∞, as shown in Figure 1, where the x- axis extends parallel to the plate and y -axis extends upwards normal to the plate. The type of tensor that is used in the momentum equation is Waltes'b fluid[5]. Thermodynamics conservation law, Newton's second law, and mas conservation are used to construct Mathematical model as follows [6]

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \quad (1)$$

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$$u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}=\alpha\frac{\partial^2 T}{\partial y^2}+\frac{v}{c_p}\left(\frac{\partial u}{\partial y}\right)^2 \qquad (2)$$

$$u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}=\frac{\mu_0}{\rho}\left[\frac{\partial^2 u}{\partial y^2}\right]-\frac{k_0}{\rho}\left[u\left(\frac{\partial^3 u}{\partial x\partial y^2}\right)+v\frac{\partial^3 u}{\partial y^3}-\frac{\partial u}{\partial y}\left(\frac{\partial^2 u}{\partial y\partial x}\right)+\frac{\partial u}{\partial x}\left(\frac{\partial^2 u}{\partial y^2}\right)\right]-\frac{1}{\rho}\sigma u{B_0}^2 \qquad (3)$$

with boundary condition:

$$u=U_{x,}\quad v=V_x(x),\quad T=T_w \quad \text{at} \quad y=0 \qquad (4)$$

$$u=U_{\infty,}\quad \frac{\partial u}{\partial y}=0,\quad T=T_\infty \quad \text{at} \quad y\to 0 \qquad (5)$$

The matematical model can be non-dimensionalized using stream function ψ. So the velocity components can be written as

$$u=\frac{\partial\psi}{\partial y},\qquad v=-\frac{\partial\psi}{\partial x} \qquad (6)$$

The stream function can be made dimensionless as follows:

$$\psi=U_\infty xv(2)^{\frac{1}{2}}f(\eta),\qquad \theta(\eta)=\frac{T-T_\infty}{T_w-T_\infty}$$

$$,\eta=\left(\frac{U_\infty}{2xv}\right)^{\frac{1}{2}}y \qquad (7)$$

by substituting (6)-(7) into (1)-(3), dimensionless equation can be obtained:

$$\frac{1}{P_r}\theta''+f\theta'+E_c(f'')^2=0 \qquad (8)$$

$$f'''+ff''+\frac{K}{2}[ff''''+2f'f'''-(f'')^2]-Mf'=0 \qquad (9)$$

with boundary condition:

$$f(0)=f_w\quad f'(0)=\lambda_m\quad f'(\infty)=1, \qquad (10)$$

$$f''(\infty)=0,\qquad \theta(0)=1,\quad \theta(\infty)=0 \qquad (11)$$

where viscoelastic parameter (K), moving parameter (λ_m), Euckert number (Ec) and Magnetic parameter (M) defined as:

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$$K = \frac{k_0 U_\infty}{\rho \nu}, \quad \lambda_m = \frac{U_w}{U_\infty}, \quad Ec = \frac{{U_\infty}^3}{C_p (T_w - T_\infty)}, M = \frac{k_0 U_\infty}{\rho \nu} \quad (12)$$

NUMERICAL SOLUTON

In order to solve the Eqs. (8) - (9) under the initial and boundary condition (10)-(11) an explicit finite difference scheme of forward time and central space (FTCS) type has been employed. The finite difference equations corresponding to Eqs. (8)–(9) are discretized using the (FTCS) Method as follows:

$$r_3(f_{i+2} - f_{i-2}) + A(f_{i+1} - f_{i-1}) + r_2(f_i f_{i+1} - f_i f_{i-1}) + C(f_i^2) + \frac{K}{2}[r_4 f_i (f_{i+2} - f_{i-2}) + G(f_{i+1} f_{i+2} - f_{i+1} f_{i-2} - f_{i-1} f_{i+2} + E((f_{i+1})^2 + (f_{i-1})^2)) + F(f_{i-1} f_{i+1})] = 0 \quad (13)$$

$$\theta_i = \frac{\left(\frac{r_2}{Pr} + r_1 f_i\right)\theta_{i+1} + \left(\frac{r_2}{Pr} + r_1 f_i\right)\theta_{i-1} + Ec.r_2(f_{i+1} - 2f_i + f_{i-1})}{\left(\frac{2r_2}{Pr}\right)} \quad (14)$$

further the Gauss Seidel iteration method is used in equation (13), as follows:

$$f_i = \left[\left(-r_3(f_{i+2} - f_{i-2}) - A(f_{i+1} - f_{i-1}) - r_2(f_i f_{i+1}) - \frac{K}{2}[r_4 f_i (f_{i+2} - f_{i-2}) + G(f_{i+1} f_{i+2} - f_{i+1} f_{i-2} - f_{i-1} f_{i+2} + E((f_{i+1})^2 + (f_{i-1})^2)) + F(f_{i-1} f_{i+1})]\right) / C\right]^{\frac{1}{2}} \quad (15)$$

where $r_1 = \frac{1}{2\Delta y}$, $r_2 = \frac{1}{\Delta y^2}$, $r_3 = \frac{1}{2\Delta y^3}$, $r_4 = \frac{1}{\Delta y^4}$, $A = -2r_3 - Mr_1$, $C = Kr_4 - 2r_2$, $G = 2r_1 r_3$
$E = -4r_1 r_3 - r_4$, $F = 8r_1 r_3 - 2r_4$

RESULT AND DISCUSSION

In order to get a physical insight into the problem, factors such as velocity, temperature, have been discussed by assigning numerical values to various parameters obtained in the mathematical formulation of the problem and the results are graphically shown in Figs. 1–8.

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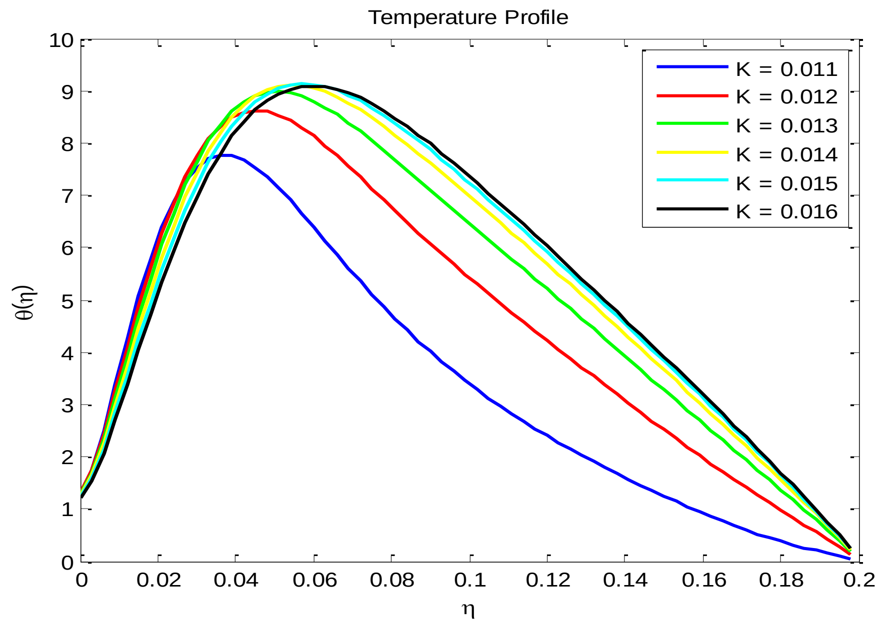

Figure 1.Effect of viscoelastic parameter K on temperature profile

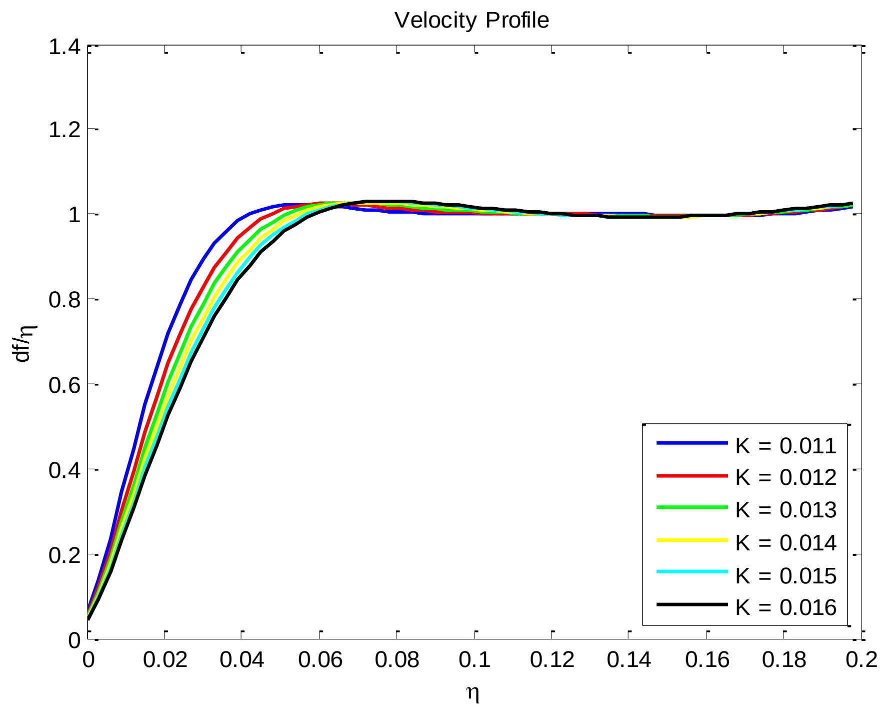

Figure 2. .Effect of viscoelastic parameter K on velocity profile

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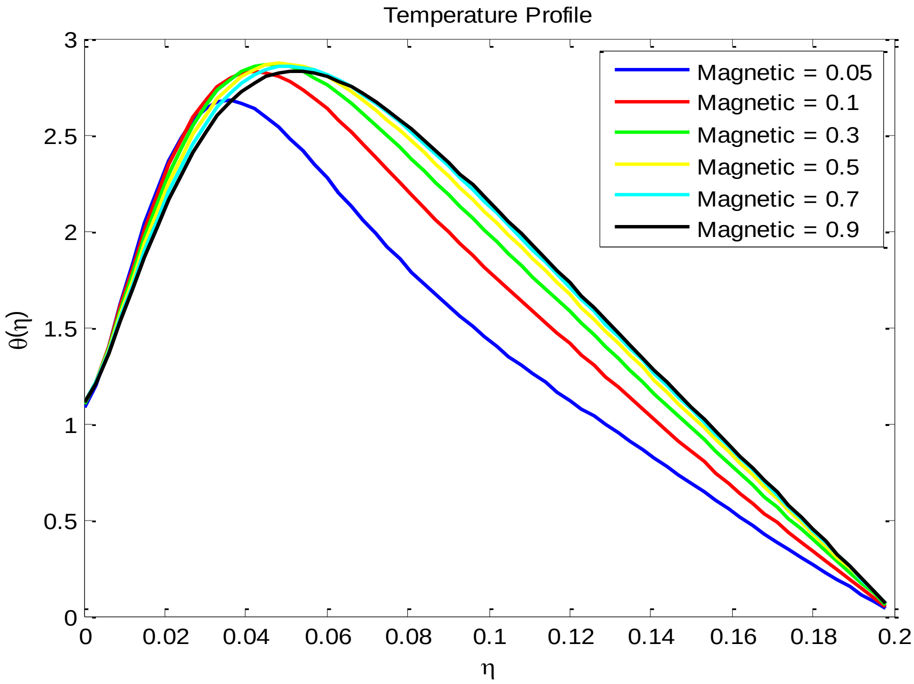

Figure 3. Effect of magnetic parameter M on temperature profile

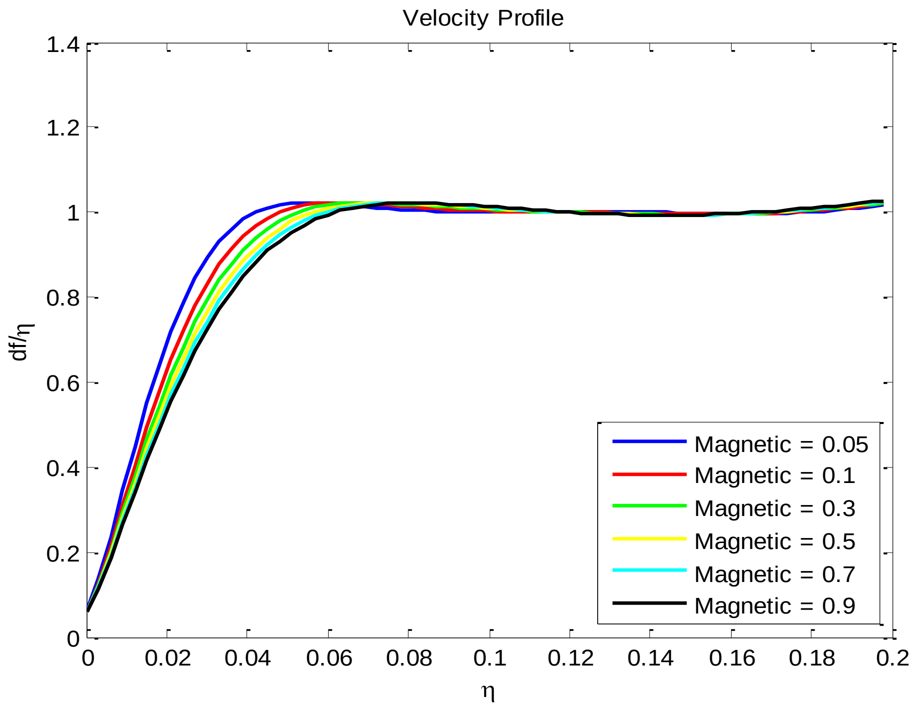

Figure 4. Effect of magnetic parameter M on velocity profile

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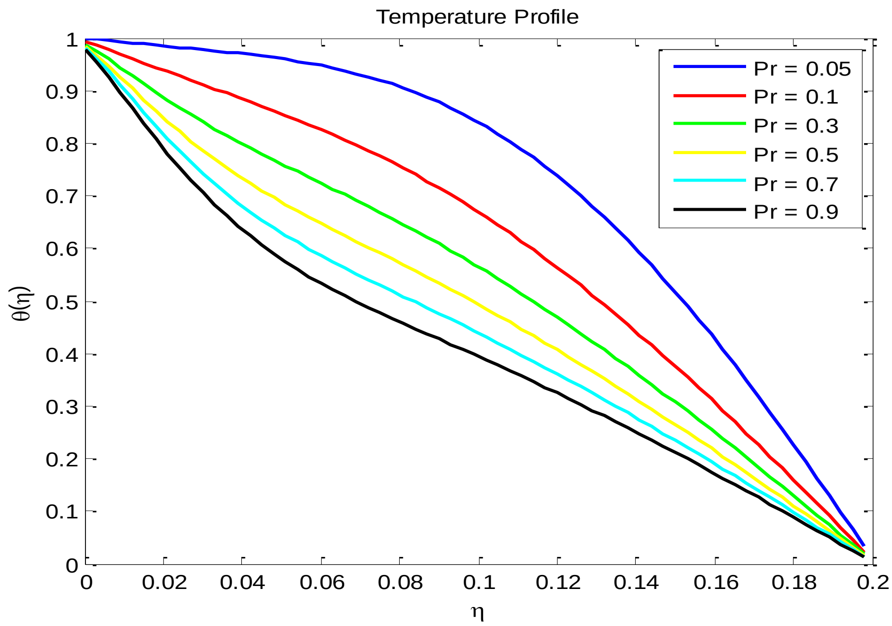

Figure 5. Effect of Pradntl number Pr on temperature profile

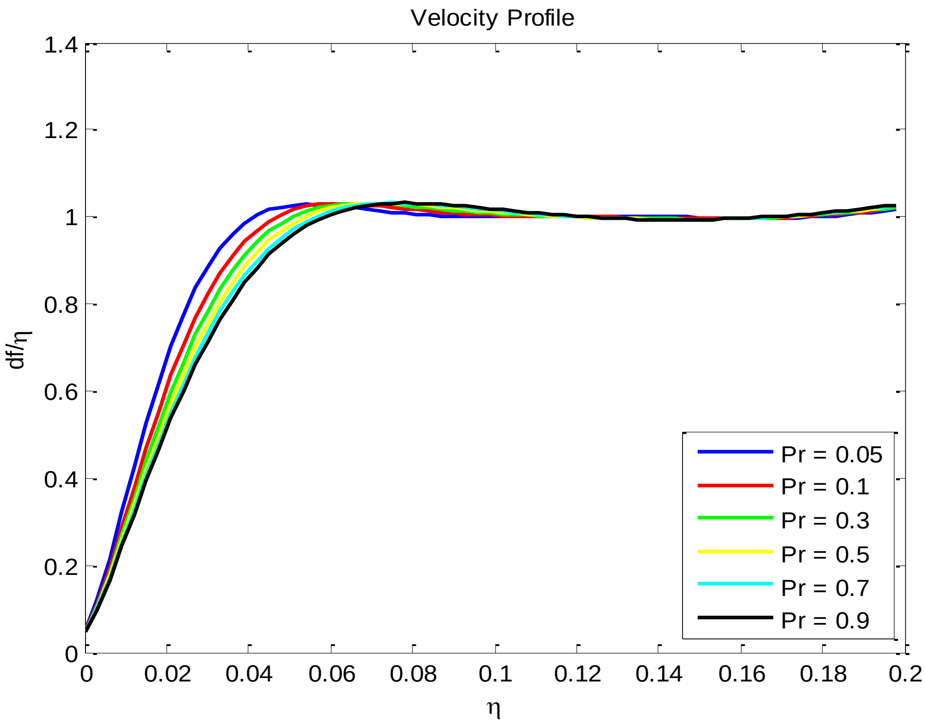

Figure 6. Effect of Pradntl number Pr on velocity profile

It is observed from fig.1 and Fig.2 that an increase in the value viscoelastic parameter increase the temperature of the fluids but decrease the velocity profile.

The presence of transverse magnetic field produces the Lorentz force. As the Lorentz force increases, the fluid exhibits a resistance to this force by increasing the friction between its layers. This resistance appears as an increase in the temperature, the temperature profile increase when the magnetic parameter increase that describe in Fig.3. The existence of a transverse magnetic field to an electrically conducting fluid gives rise to a type force, called as Lorentz force. This force has the tendency to slow down the motion of the fluid. The result

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qualitatively agrees with the expectations, since magnetic field give force on the free convective flow which decreases the motion of the fluid Fig.4.

It is clear from Fig.6 that the velocity profiles decrease for increasing the Prandtl number. As the Prandtl number increases, viscous forces tend to suppress the buoyancy force which decreases the fluid velocity in the boundary layer. Temperature profile decrese when Pradtl number increase Fig.5.

CONCLUSION

We have examined the influence of variable viscosity and magnetic on viscoelastic fluid flow over a flat plate. The FTCS method is used to solve the problem and the numerical results are presented to analyze the fluid flow, temperature profile and velocity profile. The following main conclusions can be drawn from the present study:

- The velocity profiles decrease for the increasing of viscoelastic parameter, Padntl number, and magnetic parameter.
- The temperature profile increase for increasing viscoelastic parameter and magnetic parameter, but decrease with the increasing of Prdntl number.

ACKNOWLEDGMENT

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