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FOREWORD

The 6th Annual Basic Science International Conference (BaSIC 2016) had been successfully held on 2 – 3 March 2016 at Atria Hotel, in Malang, Indonesia. The conference theme this year is "*Enhancing Innovation in Science for Sustainable Development*". The conference is aimed at promoting scientific research activities by fellow scientists in Indonesia and overseas, in the hope of building and strengthening networks and collaborations. Additionally, the conference is also designed to bring experts as well as students together from different disciplines related to basic sciences, to stimulate the formation of new collaborations. So, it is an event where new generation of scientists will coalesce with the senior and experienced ones.

We do thank all participants for their contributed talks, the keynote speakers, as well as the invited speakers for coming and sharing their knowledge with us. The presenters actively contributed in sending their articles to be published in this proceeding. We also thank Brawijaya University and Faculty of Sciences in particular, the organizing team from the Department of Mathematics, Faculty of Sciences, Brawijaya University, as well as all members of the scientific committee.

We are delighted that the proceeding of the 6th Annual Basic Science International Conference (BaSIC 2016) had been completed. It is a book containing papers that had been presented in the BaSIC conference. Moreover, the articles in this proceeding are divided into a breath of the conference subjects of Material Science and technology, Science and Technology Education, Environmental Science and Technology, Molecular and Health Science, Mathematics, Statistics, and Modeling, Instrumentation and Measurement, as well as Energy. The proceeding is aimed at collecting and sharing any useful information that had been gathered during the BaSIC conference.

The editorial team has made some editing and correction needed in some cases. Most of the editing correction are conducted and concentrated in the organization of the paper based on the guideline and the language. Some figures and tables were corrected, and placed accordingly. In addition, the language is the most time-consuming work; hence on behalf of the committee we apologize for the late publishing of this book and for any inconvenience as a result of the delay.

We give our gratitude to the reviewing and editing team for their hard work and for making the publication of this proceeding happen. We again thank all participants and presenters for the kindness to be part of the BaSIC conference. We hope the readers of this book could gain new knowledge, information, and idea for a research and further research collaboration, particularly in the topics or subjects related to basic sciences.

Best regards,

Achmad Efendi, PhD
Chairman of BaSIC 2016

WELCOME MESSAGE

On behalf of the Dean of Faculty of Mathematics and Natural Sciences, we are very pleased to welcome you in the proceeding of the Sixth Annual Basic Sciences International Conference 2016. This proceeding is one of the continuation for the conference. Based on these papers, hopefully more collaboration can be initiated or should be followed up.

I would like to express my gratitude to all of the contributed papers, also keynote and invited speakers. Many thanks also goes to the reviewers and the editorial team for the big effort in supporting this proceeding.

Last but not least my big appreciation to the steering and organizing committees, in realizing this proceeding.

Faculty of Mathematics and Natural Sciences,

Dean,

Prof. Dr. Marjono, M.Phil.

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Proceeding of the 6th Annual Basic Science International Conference
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Unsteady Mixed Convection Flow Past a Vertical Plate with The Effect of Magnetohydrodynamics

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Abstract – Mixed convection flow is the combination between forced and free convection flow. In this research, we consider a magnetohydrodynamics in boundary layer flow of viscous fluid past a vertical plate. The presence of magnetic field will be applied in the boundary layer flow. It is assumed that the flat plate is no slip condition, heat generation and viscous dissipation are neglected. We get the boundary layer governing equations under the Boussinesq and boundary layer approximation. Furthermore, we are reduced the boundary layer equations to a dimensionless form by applying several non-dimensional variable and transformed into similar equations. Based on the numerical result, the values of velocity profile increase when the magnetic parameter increase and the values of temperature profile decrease when the magnetic parameters increase. Otherwise, the value of velocity profile and temperature profile decrease when prandtl number increases.

1. INTRODUCTION

Mixed convection flow or combined forced and free convection flows, arise in many transport processes in engineering devices and in nature [1]. Mixed convection flow is characterized by the mixed convection parameter. Many researchers have investigated the boundary layer problem of mixed convection in different geometries such as flat plate, sphere and cylinder with Newtonian or Non-Newtonian fluid. Newtonian fluid is a fluid which has the viscous stresses arising from its flow, at every point, is linearly proportional to the local strain state. The Newtonian fluid is the simplest mathematical model of fluid that accounts for viscosity [2]. Viscous fluid is a Newtonian fluid and a simple yet basic type of fluid which is widely investigated. While no real fluid fits the definition perfectly, many common liquids and gases can be assumed to be Newtonian for practical calculations under ordinary conditions [3] and [4].

Research about boundary layer flow past a vertical plate with mixed convection have been investigated by Ishak et al. [5], presented MHD mixed convection steady flow with prescribed temperature. Recently, Mukhopadhyay and Mandal [6] investigated the mixed convection flow past a vertical plate in presence of slip and Chamkha et al [7] investigated mixed convection flow over vertical plate with magnetic field and suction (injection).

Motivated by the above-mentioned investigations, we present in this paper about unsteady mixed convection flow past a vertical plate in viscous incompressible fluid. The presence of magnetic field and variable temperature will be applied in the boundary layer flow. It is assumed that the flat plate is no slip condition and heat generation and viscous dissipation are neglected.

2. METHODS

2.1. Procedures

The governing equations are developed by continuity, momentum and energy equations based from physical model of vertical plate. We get the boundary layer governing equations under the Boussinesq approximation. Furthermore, we are reduced the boundary layer equations to a dimensionless form by applying several dimensionless variable and using boundary layer approximation. The dimensionless form are transformed into similarity equations by similarity variable and solved numerically by using Keller Box method.

2.2. Problem Formulation

2.2.1 Governing Equations

Consider unsteady two-dimensional mixed convection flow of viscous fluid with the effect of magnetohyrodynamics (MHD) past a vertical plate. Figure 1 is the physical model and the coordinate system of the vertical plate, where x and y are Cartesian coordinates measure along to flat plate and normal to it.

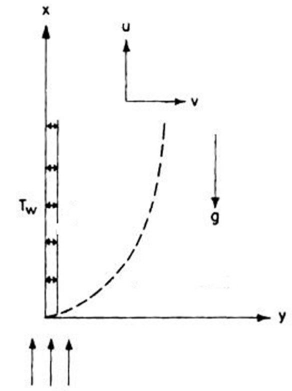

Figure 1 (Physical Model and Coordinate System of Vertical Plate)

Continuity Equation

$$\frac{\partial \bar{u}}{\partial \bar{x}}+\frac{\partial \bar{v}}{\partial \bar{y}}=0$$

Momentum Equation

$$\rho\left(\frac{\partial \bar{u}}{\partial \bar{t}}+\bar{u}\frac{\partial \bar{u}}{\partial \bar{x}}+\bar{v}\frac{\partial \bar{u}}{\partial \bar{y}}\right)=-\frac{\partial p}{\partial \bar{x}}+(\rho_\infty-\rho)g+\mu\left(\frac{\partial^2 \bar{u}}{\partial \bar{x}^2}+\frac{\partial^2 \bar{u}}{\partial \bar{y}^2}\right)-\sigma B_0^2\bar{u}$$

$$\rho\left(\frac{\partial \bar{v}}{\partial \bar{t}}+\bar{u}\frac{\partial \bar{v}}{\partial \bar{x}}+\bar{v}\frac{\partial \bar{v}}{\partial \bar{y}}\right)=-\frac{\partial p}{\partial \bar{y}}+(\rho_\infty-\rho)g+\mu\left(\frac{\partial^2 \bar{v}}{\partial \bar{x}^2}+\frac{\partial^2 \bar{v}}{\partial \bar{y}^2}\right)-\sigma B_0^2\bar{v}$$

Energy Equation

$$\rho C_p\left(\frac{\partial \bar{T}}{\partial \bar{t}}+\bar{u}\frac{\partial \bar{T}}{\partial \bar{x}}+\bar{v}\frac{\partial \bar{T}}{\partial \bar{y}}\right)=c\left(\frac{\partial^2 \bar{T}}{\partial \bar{x}^2}+\frac{\partial^2 \bar{T}}{\partial \bar{y}^2}\right)$$

These dimensional boundary layer equations are transformed into dimensionless form by substituting dimensionless variables. The dimensionless variables as follows:

$$x=\frac{\bar{x}}{L},\ y=Re^{\frac{1}{2}}\left(\frac{\bar{y}}{L}\right),u=\frac{\bar{u}}{U_\infty},\ v=Re^{\frac{1}{2}}\left(\frac{\bar{v}}{U_\infty}\right),u_e=\frac{\bar{u}_e(\bar{x})}{U_\infty}.\ T=\frac{(T-T_\infty)}{(T_w(x)-T_\infty)}\ t=\frac{U_\infty \bar{t}}{a},\ p=\frac{\bar{p}}{\rho U_\infty^2},$$

where $Re=\frac{U_\infty L}{\nu}$ is Reynolds number. $T_w(x)=T_\infty+T_o x$ is variable temperature.

Reduced the governing equations to a dimensionless form by applying several dimensionless variable and using boundary layer approximation, we obtain the dimensionless equations i.e.:

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0 \tag{1}$$

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=u_e\frac{\partial u_e}{\partial x}+\frac{\partial^2 u}{\partial y^2}-M(u-u_e)+\lambda Tx \tag{2}$$

$$\frac{\partial T}{\partial t}+u\frac{\partial T}{\partial x}+u\frac{T}{x}+v\frac{\partial T}{\partial y}=\frac{1}{\Pr}\frac{\partial^2 T}{\partial y^2} \tag{3}$$

2.2.2 Similarity Equations

Let us introduce the similarity variable to solve the set of dimensionless governing equations (1) to (3):

$$\psi=t^{\frac{1}{2}}u_e(x)f(\eta,t), T=\theta(\eta,t), \eta=y/t^{\frac{1}{2}}$$

where ψ is stream function which is defined as follows:

$$u=\frac{\partial\psi}{\partial y},\quad v=-\frac{\partial\psi}{\partial x}$$

With the use of stream function into Equation (1) to (3), we obtain:

$$\frac{\partial^2\psi}{\partial t\partial y}+\frac{\partial\psi}{\partial y}\frac{\partial^2\psi}{\partial x\partial y}-\frac{\partial\psi}{\partial x}\frac{\partial^2\psi}{\partial y^2}=u_e\frac{\partial u_e}{\partial x}+\frac{\partial^3\psi}{\partial y^3}-M\left(\frac{\partial\psi}{\partial y}-u_e\right)+\lambda Tx$$

$$\frac{\partial T}{\partial t}+\frac{\partial\psi}{\partial y}\left(\frac{\partial T}{\partial x}+\frac{T}{x}\right)-\frac{\partial\psi}{\partial x}\frac{\partial T}{\partial y}=\frac{1}{\Pr}\frac{\partial^2 T}{\partial y^2}$$

Using similarity variable into Equation (1) to (3) and substitute $u_e=x$, we obtain:

$$\frac{\partial^3 f}{\partial\eta^3}+\frac{\eta}{2}\frac{\partial^2 f}{\partial\eta^2}+t\left[1-\left(\frac{\partial f}{\partial\eta}\right)^2+f\frac{\partial^2 f}{\partial\eta^2}\right]+Mt\left(1-\frac{\partial f}{\partial\eta}\right)+\lambda t\theta=t\frac{\partial^2 f}{\partial\eta\partial t}$$

$$\frac{\partial^2\theta}{\partial\eta^2}+\frac{\Pr\eta}{2}\frac{\partial\theta}{\partial\eta}+\Pr t f\frac{\partial\theta}{\partial\eta}-\Pr t\,\theta\,\frac{\partial f}{\partial\eta}=\Pr t\frac{\partial\theta}{\partial t}$$

Subjected the boundary condition:

$t < 0 : f = \frac{\partial f}{\partial \eta} = \theta = 0$ for each x, η
$t \geq 0 : f = \frac{\partial f}{\partial \eta} = 0, \theta = 1$ at $\eta = 0$
$\frac{\partial f}{\partial \eta} = 1, \theta = 0$ at $\eta \to \infty$

3. RESULTS AND DISCUSSION

The problem is solved numerically by using Keller-Box method. The method has the following four main steps, there are:

- Reduce those equation to a first order equation
- Write the difference equations using central differences
- Linearize the resulting algebraic equation by Newton's Method
- Use the block tridiagonal elimination technique to solve the linear system

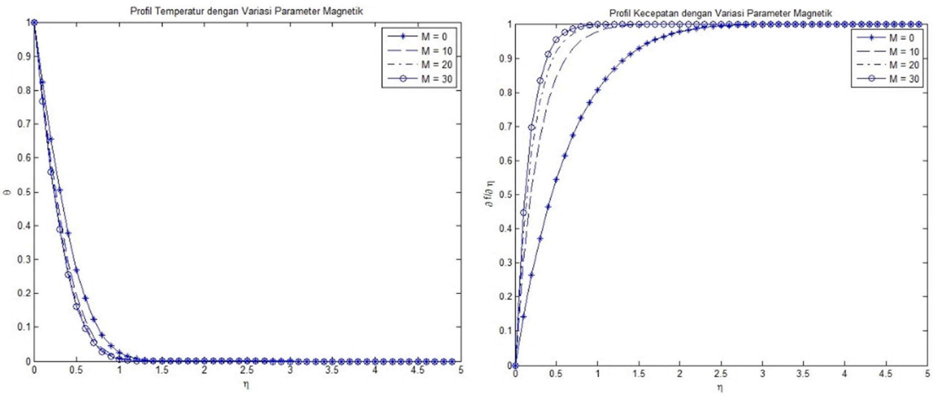

Figure 2 (Velocity Profiles and Temperature Profiles with Fixed $Pr = 7, \lambda = 1$ and Variation of Magnetic Parameter)

The influence of magnetic parameter on the velocity profiles and temperature profiles can be seen in Figure 2. These numerical results have been made at fixed values of $Pr = 7, \lambda = 1$. The result show that velocity profiles in Figure 2 increase when magnetic parameters increase. Mean while, the temperature profile decrease when magnetic parameter increase

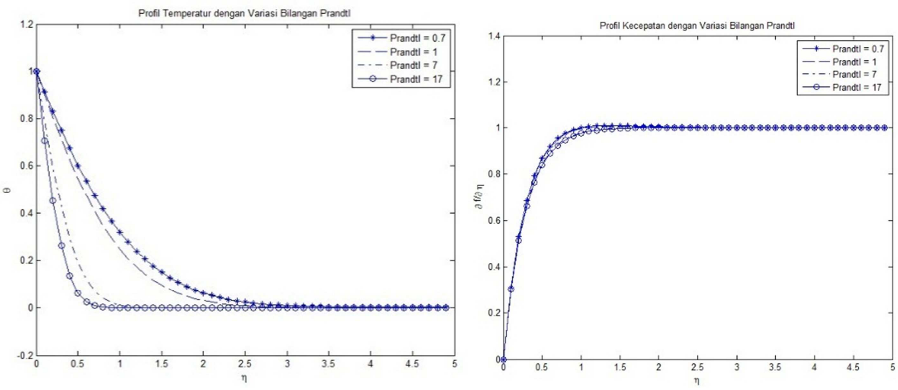

Figure 3 (Velocity Profiles and Temperature Profiles with Fixed $M = 10, \lambda = 1$ and Variation of Prandtl Number)

Figure 3 shows the effect of increasing Prandtl number on velocity profile and temperature profiles of the boundary layer flow. These numerical results have been made at fixed values of$M = 10, \lambda = 1$. The result shows that velocity profile and temperature profiles decrease when Prandtl numbers increase. This is expected because the increasing of Prandtl number will affect the kinematic viscosity and thermal diffusivity of the fluid.

4. CONCLUSION

Unsteady mixed convection past a vertical plate with the effect of magnetohydrodyamics is investigated numerically by using finite Keller-Box method. The effects of the magnetic parameter and Prandtl number on the flow characteristic have been examined. The results shows that the magnetic parameter increase then the velocity profile increase and the temperature profile decrease. The influence of Prandtl number shows that the velocity profile and temperature profile decrease when the Prandtl numbers increase.

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