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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

The Unsteady Flow Magnetohydrodynamic in Micropolar Fluid through Porous Sphere

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Abstract – Micropolar fluid is non-Newtonian fluid type with microstructure. Micropolar fluid support body couples and exhibit microrotational effects. The MHD is study about the motion of electrically conducting fluids under magnetic fields. This research is about unsteady MHD problem in micropolar fluid through porous sphere at stagnation point. The MHD effect in micropolar fluid is influence of magnetic field on the microrotation that also affect the motion of the fluid. The microrotation characteristic that has been taken into account is the attribute that distinguish micropolar fluid model from others. This research was developed from a mathematical model of MHD boundary layer flow in micropolar fluid. Micropolar fluid flow that influenced magnetic field evokes boundary layer. From the boundary layer formed a dimensional governing equation, it was continuity equation, momentum equation and angular of momentum equation. Then the equation is transformed into non-dimensional form and similiarity equation. The similiarity equations are solved numerically solution by Keller-Box method. Numerical results obtained, used to observe the influence of some parameters: magnetic parameter, micropolar parameter, and porous parameter of the velocity profile and the profile of the microrotation. The result of numerical solution that the velocity profile be increased along with magnetic parameter increased. Moreover the velocity decreased when micropolar parameter increased. When porous parameter increased, the velocity profile decreased but the difference not significant. Profile microrotation increased and changed with increased micropolar parameters.

1. INTRODUCTION

Fluid is a subtance that has the ability to change shape when exposed to a continuously shear stress [1,2]. Two types of fluids are Newtonian fluid and Non Newtonian fluid. In most real cases, fluids cannot be easily modeled as viscous fluid under the Newton’s law of motion or by the Navier-Stokes equations. Generally, any fluids that do not obey the Newton’s law of motion are classed as non-Newtonian fluids and micropolar fluid is one of them(Hayat et al., 2009). Example of non-Newtonian fluids is micropolar fluids.The theory of micropolar fluids developed by Eringen [4,5] has been of much interest because it can be used to explain the characteristics in certain fluids. Micropolar fluids is fluids with microstructure. The micropolar fluids are theoretically represent fluids that contain rigid randomly oriented particles with their own and microrotations, suspended in a viscous medium. In the micropolar fluid, rigid particels contained in a small volume element can rotate about the center of the volume element described by the microrotation vector [6].

Due to its importance, we conduct a research about micropolar fluid. In this paper will be discussed about the unsteady magnetohydrodynamics boundary layer flow in micropolar fluid past a porous sphere. Boundary layer is a thin layer which is near the solid surface caused by the viscosity of fluid flow on the porous medium. The equation is built by boundary layer theory which can be called boundary layer equation. By considering the MHD effect on micropolar fluid, this paper also discuss the influence of magnetic field on the microrotation and magnetohydrodynamics effect on velocity profiles.

2. METHODS

2.1 Procedures

The governing equations are developed by continuity, conservation equations of linier momentum and angular momentum based from physical model of porous sphere. The boundary layer governing equations get under the Boussinesq approximation. Furthermore, we reduce the boundary layer equations to a dimensionless form by applying several dimensionless variable and using boundary layer approximation. Then the equation is transformed into dimensionless form and similiarity equation. The similiarity equations are solved numerically solution by using Keller-Box method.

2.2 Problem Formulation

We consider the unsteady state two-dimensional near a porous sphere in micropolar fluid, as shown in Fig. 1, where a is the radius of the sphere. In this figure, the coordinate x and y are chosen such that x measures the distance along the surface of the sphere from the lower stagnation point and y measures the distance normal to the surface of the sphere, respectively[7]. For an incompressible micropolar fluid, in the presence of MHD, by neglecting the body force and body couple, the equation of continuity, the conservation equations of linier momentum and angular momentum are as follow.

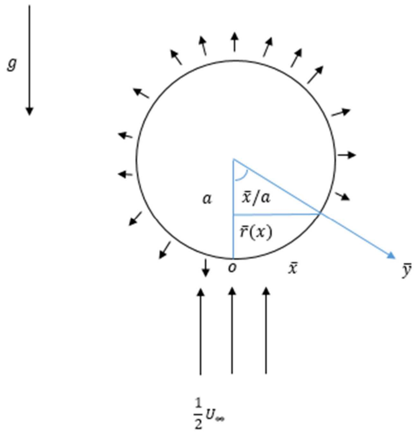

Figure 1. Physical model and coordinates for a porous sphere

Continuity Equation :

$$\frac{\partial(\bar{r}\,\bar{u})}{\partial\bar{x}}+\frac{\partial(\bar{r}\,\bar{v})}{\partial\bar{y}}=0 \tag{1}$$

Momentum Equation :

$$\rho\left(\frac{\partial\bar{u}}{\partial\bar{t}}+\bar{u}\frac{\partial\bar{u}}{\partial\bar{x}}+\bar{v}\frac{\partial\bar{u}}{\partial\bar{y}}\right)=-\frac{\partial\bar{p}}{\partial\bar{x}}+(\mu+k)\left(\frac{\partial^2\bar{u}}{\partial\bar{x}^2}+\frac{\partial^2\bar{u}}{\partial\bar{y}^2}\right)+k\frac{\partial\bar{N}}{\partial\bar{y}}-\sigma B_0^2\bar{u}\;-\;\frac{\mu_0}{K^*}\bar{u} \tag{2}$$

$$\rho\left(\frac{\partial\bar{v}}{\partial\bar{t}}+\bar{u}\frac{\partial\bar{v}}{\partial\bar{x}}+\bar{v}\frac{\partial\bar{v}}{\partial\bar{y}}\right)=-\frac{\partial\bar{p}}{\partial\bar{y}}+(\mu+k)\left(\frac{\partial^2\bar{v}}{\partial\bar{x}^2}+\frac{\partial^2\bar{v}}{\partial\bar{y}^2}\right)+k\frac{\partial\bar{N}}{\partial\bar{x}}-\sigma B_0^2\bar{v}-\frac{\mu_0}{K^*}\bar{v}$$

Momentum Angular Equation

$$\rho j\left(\frac{\partial\bar{N}}{\partial\bar{t}}+\bar{u}\frac{\partial\bar{N}}{\partial\bar{x}}+\bar{v}\frac{\partial\bar{N}}{\partial\bar{y}}\right)=\gamma\left(\frac{\partial^2\bar{N}}{\partial\bar{x}^2}+\frac{\partial^2\bar{N}}{\partial\bar{y}^2}\right)-k(2\bar{N}+\frac{\partial\bar{u}}{\partial\bar{y}}-\;\frac{\partial v}{\partial\bar{x}}) \tag{3}$$

In this problem the dimensionless variables are given as

$$x=\frac{\bar{x}}{a},y=Re^{1/2}\frac{\bar{y}}{a},u=\frac{\bar{u}}{U_\infty},t=\;\frac{U_\infty\bar{t}}{a},\quad r(x)=\frac{\bar{r}(\bar{x})}{a},v=Re^{\frac{1}{2}}\frac{\bar{v}}{U_\infty},p=\frac{\bar{p}}{\rho U_\infty^2} \tag{4}$$

where Reynold Number $Re=\frac{U_\infty a}{v}$. Substitution (4) into (1-3) leads to the following non-dimensional equations

$$\frac{\partial(ru)}{\partial x}+\frac{\partial(rv)}{\partial y}=0 \tag{5}$$

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=-\frac{\partial p}{\partial x}+\frac{(1+K)}{Re}\frac{\partial^2u}{\partial x^2}+(1+K)\frac{\partial^2u}{\partial y^2}+K\frac{\partial N}{\partial y}-(M+\;\phi)u \tag{6}$$

$$\frac{1}{Re}\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}\right)=-\frac{\partial p}{\partial y}+\frac{(1+K)}{Re^2}\frac{\partial^2v}{\partial x^2}+\frac{(1+K)}{Re}\frac{\partial^2v}{\partial y^2}-\frac{K}{Re}\frac{\partial N}{\partial x}-\frac{(M+\phi)}{Re}v$$

$$\frac{\partial N}{\partial t}+u\frac{\partial N}{\partial x}+v\frac{\partial N}{\partial y}=\left(1+\frac{K}{2}\right)\left(\frac{1}{Re}\frac{\partial^2N}{\partial x^2}+\frac{\partial^2N}{\partial y^2}\right)-K(2N+\frac{\partial u}{\partial y}-\frac{1}{Re}\frac{\partial v}{\partial x}) \tag{7}$$

where micropolar K, magnetic M and microrotation field N are dimensionless parameter.

In order to solve (5-7) using the same procedure of boundary layer approximation and the stream function, the following variables are assumed

$$\psi = xf(x,y), \quad \theta = \theta(x,y) \tag{8}$$

where stream function ψ defined as

$$u = \frac{\partial\psi}{\partial y}, \quad v = -\frac{\partial\psi}{\partial x}. \tag{9}$$

By substituting (8-9) into (5-7), we obtain :

$$(1+K)\frac{\partial^3 f}{\partial\boldsymbol{\eta}^3} + \frac{\boldsymbol{\eta}}{2}\frac{\partial^2 f}{\partial\boldsymbol{\eta}^2} + \frac{3}{2}\boldsymbol{\lambda}t\left[1-\left(\frac{\partial f}{\partial\boldsymbol{\eta}}\right)^2 + f\frac{\partial^2 f}{\partial\boldsymbol{\eta}^2}\right] + K\frac{\partial h}{\partial\boldsymbol{\eta}} + (M+\ \phi)t\left(1-\frac{\partial f}{\partial\boldsymbol{\eta}}\right) = t\frac{\partial^2 f}{\partial\boldsymbol{\lambda}\partial t} \tag{10}$$

$$\left(1+\frac{K}{2}\right)\frac{\partial^2 h}{\partial\boldsymbol{\eta}^2} + \frac{\boldsymbol{\eta}}{2}\frac{\partial h}{\partial\boldsymbol{\eta}} + \frac{1}{2}h + \frac{3}{2}\boldsymbol{\lambda}t\left(f\frac{\partial h}{\partial\boldsymbol{\eta}} - h\frac{\partial f}{\partial\boldsymbol{\eta}}\right) = t\frac{\partial h}{\partial t} + tK(2h + \frac{\partial^2 h}{\partial\boldsymbol{\eta}^2}) \tag{11}$$

with respect to the following Boundary Conditions

$$t < 0 : f = \frac{\partial f}{\partial\boldsymbol{\eta}} = h = 0 \text{at} x, \boldsymbol{\eta}$$

$$t \geq 0 : f = \frac{\partial f}{\partial\eta} = 0.\ h = -n\frac{\partial^2 f}{\partial\eta^2}, \text{at} \eta = 0 \tag{12}$$

$$\frac{\partial f}{\partial\eta} = 1,\ h = 0 \text{at} \eta \to \infty$$

At the lower stagnation point of the solid sphere, $x \approx 0$, Equation (12-14) are reduced to the following ordinary differential equation :

$$(1+K)f''' + \frac{\boldsymbol{\eta}}{2}f'' + \frac{3}{2}\boldsymbol{\lambda}t\left[1-(f')^2 + f\,f''\right] + K\,h' + (M+\ \phi)t(1-f') = t\,\frac{\partial f\prime}{\partial t} \tag{13}$$

and,

$$\left(1+\frac{K}{2}\right)h'' + \ \frac{\eta}{2}\ h' + \frac{h}{2} + \frac{3}{2}\lambda t\left[f\,h' - h\,f'\right] = t\,\frac{\partial h}{\partial t} + t\,K\,(2h + f'') \tag{14}$$

3. RESULTS AND DISCUSSION

The system of equation (13) and (14) are solved numerically for some values of the micropolar parameter (K) and magnetic parameter (M) using Keller-box method [8,9]. The variation on velocity and microrotation profile at front stagnation point ($x = \ 0^0$) with various value of magnetic parameter are illustrated in Fig. 2(a) and Fig. 2(b) respectively. These numerical results have been made at fixed values of micropolar K = 1. The results show that velocity profiles in Fig. 2(a) increase when the magnetic parameters increase, there is no values of velocity in negative. The microrotation profile of boundary layer flow in the MHD micropolar fluid of $n = 0$ at $x = \ 0^0$ and when $K = 1$. Increasing M leads to higher microrotation $-h$ under the influence of MHD at the region near the surface of a porous sphere but as $\eta > 0.5, -h$is decreased under the effect of MHD.

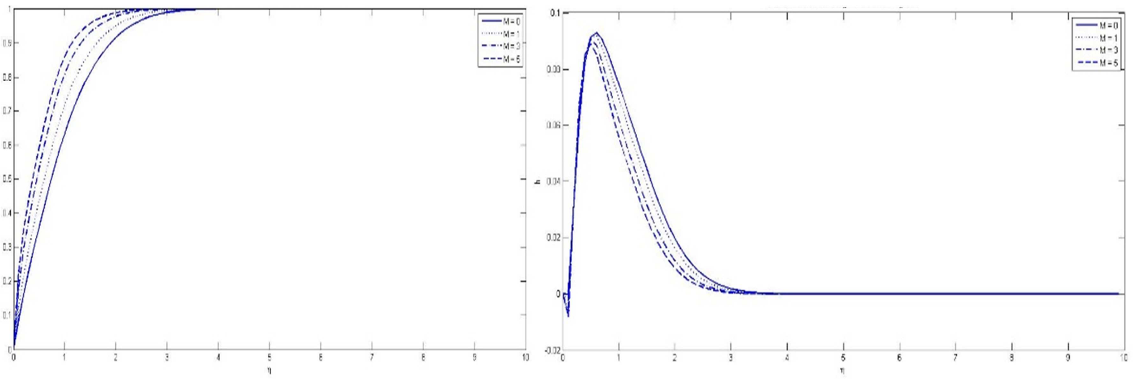

Figure 2.(a) Velocity profile for various M at lower stagnation point $(\mathbf{x} = \ \mathbf{0^0}), \mathbf{K} = \mathbf{1}, \boldsymbol{\phi} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$
(b) Microrotation profile for various M at lower stagnation point $(\mathbf{x} = \ \mathbf{0^0}), \mathbf{K} = \mathbf{1}, \boldsymbol{\phi} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$

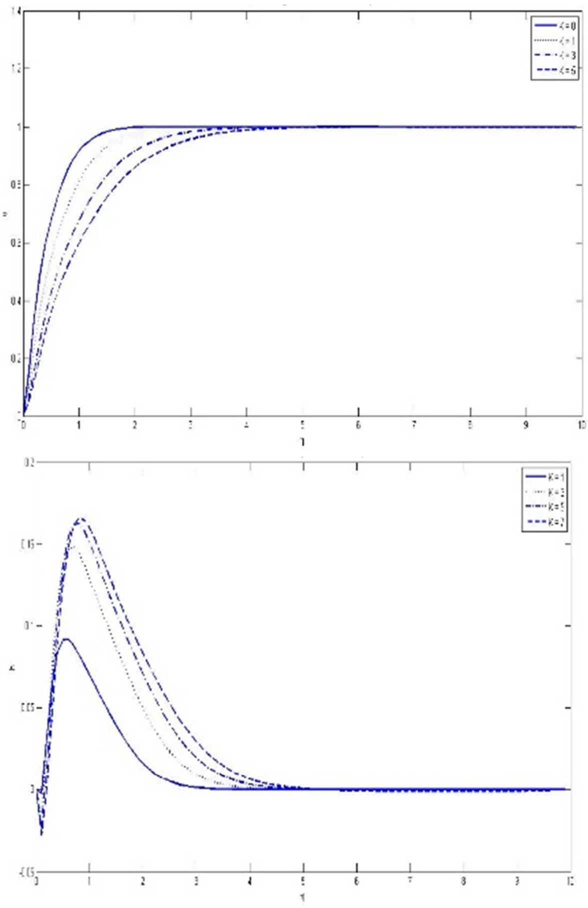

Figure 3(a) Velocity profile for various K at lower stagnation point $(\mathbf{x} = \mathbf{0^0}), \mathbf{M} = \mathbf{1}, \boldsymbol{\phi} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$
(b) Microrotation profile for various K at lower stagnation point $(\mathbf{x} = \mathbf{0^0}), \mathbf{M} = \mathbf{1}, \boldsymbol{\phi} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$

Figure 3(a) shows the velocity profile of the boundary layer flow in the magnetohydrodynamic micropolar fluid at various K when $n = 0$ and $M = 1$. It is noticed that u a micropolar fluid is decreasing with increasing K. The microrotation profile of boundary layer flow in the maghnetohydrodynamic micropolar fluid of $n = 0$ at $x = 0^0$ and when $M = 1$. Increasing K leads to higher microrotation $-h$ under the influence of micropolar parameter at the region near the surface of a porous sphere but as $\eta > 0.5, -h$is increased under the effect of micropolar parameter.

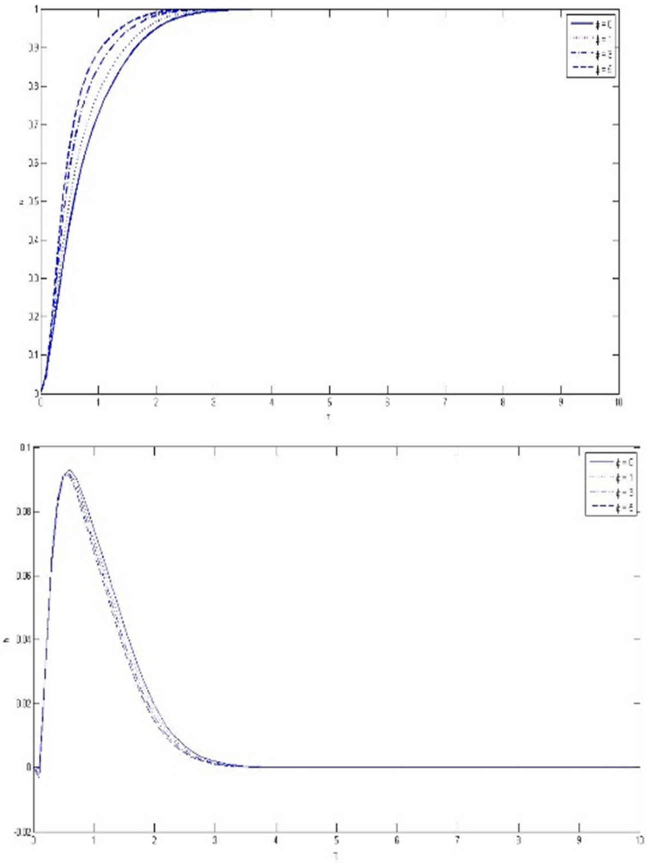

Figure 4(a) Velocity profile for various ϕ at lower stagnation point $(\mathbf{x} = \mathbf{0^0}), \mathbf{M} = \mathbf{1}, \mathbf{K} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$
(b) Microrotation profile for various ϕ at lower stagnation point $(\mathbf{x} = \mathbf{0^0}), \mathbf{M} = \mathbf{1}, \mathbf{K} = \mathbf{1}$, and $\mathbf{n} = \mathbf{0}$

The variation on velocity and microrotation profile at front stagnation point $(x = 0^0)$ with various value of porosity parameter are illustrated in Fig. 4(a) and Fig. 4(b) respectively. These numerical result have been made at fixed values of micropolar $K = 1$. The results show that velocity profiles in Fig. 4(a) increase when the porosity parameters increase, there is no values of velocity in negative. The microrotation profile of boundary layer flow in the MHD micropolar fluid of $n = 0$ at $x = 0^0$ and when $K = 1$. Increasingϕ leads to higher microrotation $-h$ under the influence of porous at the region near the surface of a porous sphere but as $\eta > 0.5, -h$is decreased under the effect of porous.

4. CONCLUSION

This paper considers the boundary layer flow in the MHD microfluid past a solid sphere. From the analysis and discussion of the result, the following conclusions are:

1. The governing equations are developed from continuity, momentum, and momentum anguler. Furthermore, those equations are transformed into boundary layer equations and transformed into a non-dimensional form. The resulting nonlinear system of partial differential equations are solved numerically using the Keller-Box method.
2. This research has revealed how the microrotation,magnetic and porosity parameter affect the velocity flow and microrotation characteristics. The velocity distributions increase and the microrotation decreases when the value of magnetic parameter and porous parameter increase.The velocity decreases and the microrotation increase when micropolar parameter increase.

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