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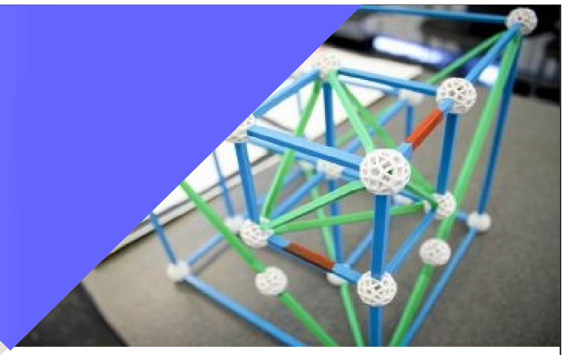
Proceeding

"Recent innovative issues and findings on the development and the education of mathematics and science"

2nd ICRIEMS



Proceeding

"Recent innovative issues and findings on the development and the education of mathematics and science"

2nd ICRIEMS

The 2nd International Conference on Research, Implementation and Education of Mathematics and Science

17 - 19 May 2015
Yogyakarta State University

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Conference Proceedings

2nd INTERNATIONAL CONFERENCE ON RESEARCH, IMPLEMENTATION AND EDUCATION OF MATHEMATICS AND SCIENCE (2nd ICRIEMS)

Yogyakarta, 17 – 19 May 2015

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Recent Innovative Issues and Findings
on The Development and The Education
of Mathematics and Science

Faculty of Mathematics and Science
Yogyakarta State University

2nd ICRIEMS : Recent Innovative Issues and Findings on The Development and The Education of Mathematics and Science

- Mathematics & Mathematics Education
- Physics & Physics Education
- Chemistry & Chemistry Education
- Biology & Biology Education
- Science Education

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Preface

Bless upon God Almighty such that this proceeding of 2nd International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) may be compiled according to the schedule provided by the organizing committee. All of the articles in this proceeding are obtained by selection process by the reviewer team and have already been presented in the conference on 17 – 19 May 2015 in the Faculty of Mathematics and Science, Yogyakarta State University. This proceeding comprises nine fields, these are mathematics, mathematics education, physics, physics education, chemistry, chemistry education, biology, biology education, and science education.

The theme of this 2nd ICRIEMS is '*Recent Innovative Issues and Findings on The Development and The Education of Mathematics and Science*'. The main articles in this conference are written by seven keynote speakers, which are Prof. David F. Treagust (Curtin University, Australia), Prof. Slava Kalyuga (University of New South Wales, Australia), Prof. Dr. Sopia binti Md Yassin (Universiti Pendidikan Sultan Idris, Malaysia), Susanne W. Brahmia, Ph.D. (Rutgers University, USA), Dr. Norjan Yusof (Universiti Pendidikan Sultan Idris, Malaysia), Prof. Dr. Supriadi Rustad, M.Si (Directorate General of Higher Education, Indonesia) and Prof. A.K. Prodjosantoso, Ph. D. (Yogyakarta State University, Indonesia). Besides the keynote speakers, there are also regular articles presenting the latest research results in the field of mathematics and sciences, and the education in the parallel sessions. These regular speakers are academics, researchers, teachers and practitioners from various places in Indonesia and abroad, including Australia, Malaysia and Thailand.

Hopefully, this proceeding may contribute in disseminating research results and studies in the field of Mathematics and Sciences and the Education such that they are accessible by many people and useful for the future development.

Yogyakarta, May 2015

The Editor Team

Forewords From The Head Of Committee

Assalamu'alaikum warrahmatullah wabarakatuh.
May peace and God's blessings be upon you all.

This conference entitled International Conference on Research, Implementation, and Education of Mathematics and Science (ICRIEMS) 2015 is organized by the Faculty of Mathematics and Science, State University of Yogyakarta. This is the second time that our Faculty is proudly holding an international conference, where this year's theme is "Recent innovative issues and findings on the development and the education of mathematics and sciences". This conference is also dedicated to the 51st anniversary of Yogyakarta State University.

This conference facilitates academics, researchers and teachers from two areas, mathematics and science which may be classified into physics, chemistry and biology. Innovative issues and findings are emerging from time to time, especially in the field of mathematics, science, and the education. It is through education that these developments may be understood and implemented. Hence, it is therefore necessary for us to follow come together and discuss these exciting recent developments of mathematics, science, and the education through this conference.

On behalf of the organizing committee of this conference, I would like to express my highest appreciation and gratitude to the keynote speakers from Australia, the USA, Malaysia and Indonesia. They and the keynote title are:
From educational field:

1. Prof. Slava Kalyuga (School of Education, University of New South Wales, Sydney, Australia), "Cognitive load issues in teaching and learning mathematics"
2. Prof. David Treagust (School of Science, Curtin University, Perth, Australia), "The development and use of diagnostic instruments for assessing students' chemistry knowledge and understanding"
3. Prof. Dr. Sopia binti Md Yassin (Department of Science Education, Universiti Pendidikan Sultan Idris, Malaysia), "Teaching Science And Mathematics In English (TeSME): The Malaysian CLIL Experience"
4. Suzanne W. Brahmia, Ph.D (Rutgers University, New Jersey, US), "Developing expert mathematization of physics in the introductory course: an impedance mismatch"
5. Prof. Dr. Supriadi Rustad (Directorate General of Higher Education, Department of Research, Technology and Higher Education), "Current reform and research in higher education in Indonesia"

From basic knowledge field:

1. Prof. AK. Prodjosantoso, Ph.D. (Department of Chemistry Education, Yogyakarta State University, Indonesia), "The chemistry of heavy metals immobilisation in Portland Cement"

2. Dr. Norjan Yusof (Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Malaysia), "Pollution and management of landfill leachate".

Furthermore, I would also like to express my appreciation to about 180 regular presenters who have travelled from Australia, China, Malaysia, Thailand, Sumatera, Kalimantan, Sulawesi, Papua, Bali and many places in Java and Yogyakarta to attend this conference. Slightly more than 30 per cent of the presenters are from mathematics education and around 20 per cent are from mathematics. About 16 per cent of the presenters deliver findings on chemistry and the education, and about 14 per cent on physics and the education. The other 20 per cent presents biology, biology education and general science education. We do hope this conference will bear fruitful results and promote networking and future collaborations for all participants from diverse background of expertise, institutions, and countries to promote science, mathematics, and the education.

Finally, I would like to extend my highest appreciation to the organizing committee who has been working very hardly since a half of a year ago to ensure the success of the conference. However, should you find any shortcomings and inconveniences, please accept my apologies.

Hope all participants have a very good moment during the conference and enjoy the city of Yogyakarta, the city of education, cultural and tourism. Thank you very much.

Wassalamu'alaikum warrahmatullah wabarakatuh. May peace and God's blessings be upon you all.

Yogyakarta, 17 May 2015

Endah Retnowati, Ph.D.

Forewords From The Dean Of Faculty Of Mathematics And Science, Yogyakarta State University

Assalamu'alaikum warahmatullahi wabarakatuh. My greetings for all of you. May peace and God's blessings be upon us all.

On behalf of the Organizing Committee, first of all allow me to extend my warmest greeting and welcome to the International Conference on Research, Implementation, and Education of Mathematics and Sciences, the second to be held by the Faculty of Mathematics and Science, State University of Yogyakarta, one of the excellent and qualified education universities in Indonesia. This conference is also celebrate the 51th Anniversary of State University of Yogyakarta.

This conference proudly presents keynote speeches by seven excellent academics, these are: Prof. Dr. Supriadi Rustad, Prof. Slava Kalyuga, Prof. A. K. Prodjosantoso, Dr. Norjan Yusof, Prof. Dr. Sopia Binti Md Yasin, Prof. David F. Treagust, and Dr. Suzanne W. Brahmia, and around 180 reguler speakers.

The advancement of a nation will be achieved if education becomes a priority and firmly supported by the development of technology. Furthermore, the development of technology could be obtained if it is supported by the improvement of basic knowledge such as mathematics, physics, chemistry, and biology. The empowerment of this fundamental knowledge may be achieved by conducting research which is then implemented in developing the technology and the learning process in schools and universities.

This international conference is aimed to gather researchers, educators, policy makers, and practitioners to share their critical thinking and research outcomes. Moreover, through this conference it is expected that we keep updated with new knowledge upon recent innovative issues and findings on the development and the education of mathematics and science, which is in accord with the theme of the conference this year. All material of the conference which are compiled in the abstract book and proceedings can be useful for our reference in the near future.

This conference will be far from success and could not be accomplished without the support from various parties. So let me extend my deepest gratitude and highest appreciation to all committee members who have done an excellent job in organizing this conference. I would also like to thank each of the participants for attending our conference and bringing with you your expertise to our gathering. Should you find any inconveniences and shortcomings, please accept our sincere apologies.

To conclude, let me wish you fruitful discussion and a very pleasant stay in Yogyakarta.

Wa'alaikumsalam warahmatullahi wabarakatuh

Yogyakarta, 17 May 2015
Dean Faculty of Mathematics and Science
Yogyakarta State University

Dr. Hartono

Forewords From The Rector Of Yogyakarta State University

Assalamu'alaikum warrahmatullah wabarakatuh. May peace and God's blessings be upon you all.

First of all, allow me to express my great thanks to God, Allah SWT, who gives us health and opportunity, so that we can join this very important conference, may Allah always bless us. It is a great honor and pleasure for me to welcome you all to the 2nd International Conference on Research, Implementation and Education of Mathematics and Science. Educational Research and Innovation (ICRIEMS) organized by the Faculty of Mathematics and Science, Yogyakarta State University in Yogyakarta, Indonesia. On behalf of the university and the committee, let me extend my warmest greetings and appreciation to all speakers and participants who have travelled hundreds or even thousands of miles by various transportation means to come to Yogyakarta to attend this conference.

It is indeed a privilege for Yogyakarta State University to have the opportunity to organise this very important conference in which educational researchers and practitioners on mathematics and science and the education, to get together to share ideas, experiences, expectations, and research findings. This conference is held as one of the activities, in the agenda of Yogyakarta State University to celebrate its 51st anniversary.

Research is one of the activities among the academic members of a university. It is a systematic effort to solve the problems or answer the questions by collecting data, formulating the generalities based on the data, then finding and developing organized knowledge by scientific method. It is expected that from research activities, valuable empirical facts can be obtained to improve and develop the theory and practice to bring a better quality of education.

Mathematics and science have been seen as important knowledge to be acquired by our children since it could assist them solving daily life problems. Efforts to improve the quality of teaching of mathematics and science must be continuously supported to produce new innovations, high-quality research and practice. In responding to this, the conference has taken a theme namely "Recent innovative issues and findings on the development and the education of mathematics and science". Participants, either speakers or non-speakers, in this conference are highly encouraged to discuss not only the recent findings of instructional theory or practice, but also new findings of basic knowledge of mathematics and science that may be useful to be applied in our life.

It is expected that this conference provides researchers, teachers, lecturers, education practitioners, college students, and policy makers the opportunity to share their knowledge, experiences, and research findings which are innovative and relevant to develop the educational practices focusing on the process and product. Eventually, this conference is aimed to facilitate academics, researchers and teachers to yield some recommendations on the importance of education and development of mathematics and science based on empirical proofs which bring the benefits of the prosperity of all.

This international conference will not be what it is without the cooperation and support rendered by the whole committee whose names I will impossibly mention one by one. Therefore, I would like to take the opportunity to extend my highest appreciation and sincerest gratitude to especially the Dean of Faculty of Mathematics and Science. I would also like to thank the organizing committee for their commitment and hard work. Only with their support will this international conference certainly reach its declared objectives successfully. Yogyakarta State University has done its best to make this conference a big success. However, should you find any shortcomings and inconveniences, please accept my apologies.

To conclude, let me wish you all a productive conference and enjoyable stay here in Yogyakarta State University. Also I wish you all great success and this international conference will bring us fruitful benefits in education. Thank you very much. Wassalamu'alaikum warahmatullah wabarakatuh. May peace and God's blessings be upon you all.

Yogyakarta, 17 May 2015
Rector,

Prof. Dr. Rochmat Wahab, M.Pd., M.A.

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THE NUMERICAL SOLUTION OF FREE CONVECTION FLOW OF VISCOELASTIC FLUID PAST OVER A SPHERE

Wayan Rumite[1], Basuki Widodo[2], Chairul Imron[3]
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Abstract

Free convection flow is heat transfer on fluid caused by buoyancy forces because of density difference. We further use The boundary layer theory to obtain governing equations. The governing equations are further transformed into non-dimensional and then transformed into the non-similar governing equation. The non-similar governing equations are solved numerically by using explicit finite difference method. The numerical results are analyzed correlation viscoelastic and Prandtl number with velocity and temperature profile. Based on the numerical results of free convection flow of viscoelastic fluid past over a sphere, we obtained that the velocity profile decreases when we apply the increasing in the values of viscoelastic and Prandtl number. The temperature profiles increases with the increasing in the values of viscoelastic, but decreases when the values of Prandtl number increases.
Keywords: Navier-Stokes, Explicit Finite Difference Method, Viscoelastic, Prandtl number Mathematics Subject Classification: 65C20, 65M06, 76A10, 76D05, 76D10

INTRODUCTION

Heat transfer is the transfer of energy from one object to another due to temperature differences between the two objects. Generally, the heat transfer process is divided into three, i.e. conduction, convection, and radiation. Convection heat transfer is the transfer of heat from a place to another caused by the movement of fluid. Heat transfer by convection is divided into two, i.e. free and forced convection. Free convection is the transfer heat caused by buoyancy forces because of the differences in density. When a fluid exposed to heat, the fluid will expand and its density will change such that the fluid move. Part of the fluid exposed to heat, its density will becomes smaller so that the fluid move to the top and turn into a cooler fluid, then the cold fluid that its density is greater than the top will move down. Forced convection is heat transfer occurs because forced by external forces.

These last few years, topics of free convection flow specifically have been developed by several researchers such as Molla, et al., (2006), Salleh, et al., (2010b). Taher (2005) examines natural convection boundary layer flow on an isothermal sphere in presence of heat generation, assuming incompressible flow in a state then resolved by using the finite difference method Keller box. Prasad, et al., (2011) examines unsteady free convection heat and mass transfer in a walters-b viscoelastic flow past a semi-infinite vertical plate. Kasim (2014) examines the free convection flow of viscoelastic fluid which past over a sphere then numerically solved by Keller box finite difference method. However, the problems in free convection fluid flow of viscoelastic non-Newtonian fluid that past over of a sphere have not been investigate, especially convection flow in a non-Newtonian fluid with a steady state viscoelastic type, incompressible, thermal power plants, and with the completion of an explicit finite difference method with Lax-Wendroff scheme.

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Non-Newtonian fluid is a fluid whose viscosity changes when there are forces acting on the fluid. This causes the viscosity of non-Newtonian fluid is not constant. Non-Newtonian fluid has several types such as: solid plastic, exponential fluid, and viscoelastic fluid. Examples of non-Newtonian fluids in their daily lives, such as paint, metal composite materials, bitumen, dough, nylon, lubricating oil, sludge, blood, liquid pharmaceuticals, pulp, etc. Viscoelastic fluid is a type of non-Newtonian fluid that viscous and elastic. Examples of these fluids are bitumen, dough, nylon, etc. Viscoelastic fluid applied in oil drilling, food and paper industry. This probem solved by using mathematical model derived from the boundary layer equations. Boundary layer is a thin layer which is near the solid surface, caused by the viscousity of fluid flow on the solid surface. Boundary layer equations are simplified from complex equations, then use for describing the characteristic of a flow. The equations derived from boundary layer equations, i.e. continuity, momentum, and energy equations.

RESEARCH METHOD

Research methods developed for accomplishing the problem free convection of viscoelastic fluid past over a sphere as below.

- Constructing mathematical modeling free convection of viscoelastic fluid past over a sphere of mass, second Newton's, and thermodynamics conservation law.
- Determining boundary condition and several related parameters such like viscoelastic number (K), Prandtl number (Pr), heat generation (γ), and Grashof number (Gr).
- Getting the mathematical model consisting of continuity, momentum, and energy equations in dimensional equations form.
- Transforming mathematical modeling dimensional into non-dimensional form, then into similar form.
- Discretization of similar mathematical modeling using Forward in Time and Centered in Space and than create a simulation program based on the discretization by using softwere *MATLAB* 2012b.
- Finding the effect viscoelastic (K) and Prandtl number (Pr) parameters on velocity profile (f') and temperature profile (θ) at lower stagnation point $(x \approx 0)$.

MATHEMATICAL MODELLING

The problems observed boundary layer are described in Figure 1.

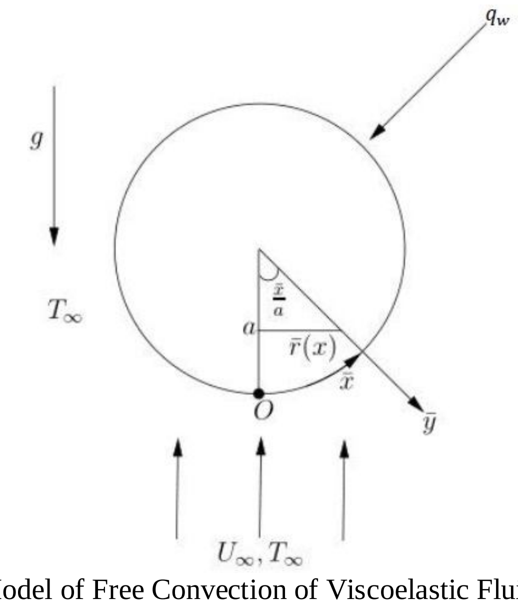

Figure 1. Physical Model of Free Convection of Viscoelastic Fluid Past Over A Sphere

Figure 1. shows shape geometry of the boundary layer problems in spherical coordinate system. The flow of fluid is assumed to move across the surface of a sphere with radius a immersed in a viscous and incompressible fluid. The ambient temperature is T_∞ and assumed that the heat flux from the surface of the sphere is q_w. Mathematical modeling free convection of viscoelastic fluid past over a sphere as below.

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

$$\bar{u}\frac{\partial \bar{u}}{\partial \bar{x}} + \bar{v}\frac{\partial \bar{u}}{\partial \bar{y}} = \nu\left[\frac{\partial^2 \bar{u}}{\partial^2 \bar{y}}\right] + g\beta(\bar{T}-\bar{T}_\infty)\sin\left(\frac{\bar{x}}{a}\right) - \frac{k_0}{\rho}\left[\bar{u}\left(\frac{\partial^3 \bar{u}}{\partial \bar{x}\partial \bar{y}^2}\right) + \bar{v}\frac{\partial^3 \bar{u}}{\partial \bar{y}^3} - \frac{\partial \bar{u}}{\partial \bar{y}}\left(\frac{\partial^2 \bar{u}}{\partial \bar{x}\partial \bar{y}}\right) + \frac{\partial \bar{u}}{\partial \bar{x}}\left(\frac{\partial^2 \bar{u}}{\partial \bar{y}^2}\right)\right] \quad (2)$$

$$\bar{u}\frac{\partial \bar{T}}{\partial \bar{x}} + \bar{v}\frac{\partial \bar{T}}{\partial \bar{y}} = \alpha\frac{\partial^2 \bar{T}}{\partial \bar{y}^2} + \frac{Q_0}{\rho C_p}(\bar{T}-\bar{T}_\infty) \quad (3)$$

with boundary condition:

$$\bar{u} = \bar{v} = 0, \quad \frac{\partial \bar{T}}{\partial \bar{y}} = -\frac{q_w}{k} \quad \text{at } \bar{y} = 0, \qquad \bar{u} = 0, \frac{\partial \bar{u}}{\partial \bar{y}} = 0, T = T_\infty, \quad \text{at } \bar{y} \to \infty \quad (4)$$

with non-dimensional parameters in e.q. (5):

$$v = \frac{a}{\nu}Gr^{-\frac{1}{4}}\bar{v}, \theta = \frac{(\bar{T}-\bar{T}_\infty)}{\left(\frac{q_w a}{k}\right)}, x = \frac{\bar{x}}{a}, y = Gr^{\frac{1}{4}}\left(\frac{\bar{y}}{a}\right), u = \frac{a}{\nu}Gr^{-\frac{1}{2}}\bar{u}, r(x) = \frac{\bar{r}(\bar{x})}{a} \quad (5)$$

and than substitution to e.q. (1), (2), and (3) we obtain model of free convection of viscoelastic fluid past over a sphere in non-dimensional form, such as e.q. (6), (7), and (8).

$$\frac{\partial}{\partial \bar{x}}(ru) + \frac{\partial}{\partial \bar{y}}(rv) = 0 \quad (6)$$

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = \frac{\partial^2 u}{\partial y^2} - K\left[\frac{\partial}{\partial x}\left(u\frac{\partial^2 u}{\partial y^2}\right) + v\frac{\partial^3 u}{\partial y^3} + \frac{\partial u}{\partial y}\frac{\partial^2 v}{\partial y^2}\right] + \theta\sin x \quad (7)$$

$$u\frac{\partial \theta}{\partial x} + v\frac{\partial \theta}{\partial y} = \frac{1}{Pr}\frac{\partial^2 \theta}{\partial y^2} + \gamma\theta \quad (8)$$

with boundary condition:

$$u = v = 0 \quad \theta' = -1 \quad \text{at} \quad y = 0, u = 0, \frac{\partial u}{\partial y} = 0, \theta = 0, \quad y \to \infty, \quad (9)$$

where $K$and Pr is viscoelastic and Prandtl number parameter, Gr and γ is Grashof number and heat generation defined as:

$$K = \frac{k_0 Gr^{5/2}}{a^2} \; and \; Pr = \frac{\nu}{\alpha}, \quad Gr = \frac{g\beta a q_w a^3}{k\nu^2} \; and \; \gamma = \frac{a^2 Q_0}{\nu\rho C_p Gr^{\frac{1}{2}}}$$

further, by using similari transformation function defined as:

$$\psi = xr(x)f(x,y), \qquad \theta = \theta(x,y) \quad (10)$$

where:

$$u = \frac{1}{r}\frac{\partial \psi}{\partial y} \quad \text{dan} \quad v = -\frac{1}{r}\frac{\partial \psi}{\partial x} \quad (11)$$

and than substitution to e.q. (11) we obtain model of free convection of viscoelastic fluid past over a sphere in non-similar form, such as e.q. (12), and (13).

$$\frac{\partial^3 f}{\partial y^3} - \left(\frac{\partial f}{\partial y}\right)^2 + \left(1 + x\frac{\cos x}{\sin x}\right) f \frac{\partial^2 f}{\partial y^2} + \theta\frac{\sin x}{x} - K\left[2\frac{\partial f}{\partial y}\frac{\partial^3 f}{\partial y^3} - \left(1 + x\frac{\cos x}{\sin x}\right)\left(f\frac{\partial^4 f}{\partial y^4} + \left(\frac{\partial^2 f}{\partial y^2}\right)^2\right)\right] = Kx\left[\frac{\partial^2 f}{\partial x\partial y}\frac{\partial^3 f}{\partial y^3} + \frac{\partial f}{\partial y}\frac{\partial^4 f}{\partial x\partial y^3} - \frac{\partial f}{\partial x}\frac{\partial^4 f}{\partial y^4} - \frac{\partial^2 f}{\partial y^2}\frac{\partial^3 f}{\partial x\partial y^2}\right] + x\left(\frac{\partial f}{\partial y}\frac{\partial^2 f}{\partial x\partial y} - \frac{\partial f}{\partial x}\frac{\partial^2 f}{\partial y^2}\right) \quad (12)$$

$$\frac{1}{Pr}\frac{\partial^2\theta}{\partial y^2} + f\left(1 + x\frac{\cos x}{\sin x}\right)\frac{\partial\theta}{\partial y} + \gamma\theta = x\left(\frac{\partial f}{\partial y}\frac{\partial\theta}{\partial x} - \frac{\partial f}{\partial x}\frac{\partial\theta}{\partial y}\right) \quad (13)$$

with boundary condition:

$$f = 0, \frac{\partial f}{\partial y} = 0 \quad \theta' = -1 \quad at\ y = 0 \quad \frac{\partial f}{\partial y} = 0, \frac{\partial^2 f}{\partial y^2} = 0 \quad \theta = 0\ at\ y \to \infty \quad (14)$$

when $x \to 0$, then e.q. (12) e.q (13) become:

$$f''' - f'^2 + 2ff'' + \theta + 2K\left(ff'''' - f'f''' + \left(f''\right)^2\right) = 0 \quad (15)$$

$$\frac{1}{Pr}\theta'' + 2f\theta' + \gamma\theta = 0 \quad (16)$$

with boundary condition:

$$f(0) = f'(0) = 0, \quad \theta'(0) = -1\ f'(\infty) = 0,\ f''(\infty) = 0, \quad \theta(\infty) = 0 \quad (17)$$

NUMERICAL SOLUTON

Mathematical model shown in equation (15) and equation (16) discretized by using explicit finite difference method with the scheme of forward time central space (FTCS) and acquired forms of discretization as follows:

$$r_2\left(\frac{1}{2}f_{i+2} - f_{i+1} + f_{i-1} - \frac{1}{2}f_{i-2}\right) + s_1\left(f_{i+1}^2 + f_{i-1}^2\right) + s_2 f_{i+1}f_{i-1} + s_3\left(f_i f_{i+1} + f_i f_{i-1}\right) + s_4 f_i^2 + \theta_i + Kr_3\left[2f_i f_{i+2} + 2f_i f_{i-2} - \frac{1}{2}f_{i+1}f_{i+2} + \frac{1}{2}f_{i+1}f_{i-2} + \frac{1}{2}f_{i-1}f_{i+2} - \frac{1}{2}f_{i-1}f_{i-2}\right] = 0 \quad (18)$$

$$\theta_i = \frac{(r_4 + r_5 f_i)\theta_{i+1} + (r_4 - r_5 f_i)\theta_{i-1}}{\gamma - 2r_4} \quad (19)$$

Then by applying the Gauss Seidel iteration method in equation (18), we obtained:

$$f_i = \left[-\frac{1}{s_4}\left\{r_2\left(\frac{1}{2}f_{i+2} - f_{i+1} + f_{i-1} - \frac{1}{2}f_{i-2}\right) + s_1\left(f_{i+1}^2 + f_{i-1}^2\right) + s_2 f_{i+1}f_{i-1} + s_3\left(f_i f_{i+1} + f_i f_{i-1}\right) + s_4 f_i^2 + \theta_i + Kr_3\left(2f_i f_{i+2} + 2f_i f_{i-2} - \frac{1}{2}f_{i+1}f_{i+2} + \frac{1}{2}f_{i+1}f_{i-2} + \frac{1}{2}f_{i-1}f_{i+2} - \frac{1}{2}f_{i-1}f_{i-2}\right)\right\}\right]^{\frac{1}{2}} \quad (20)$$

where $r_1 = \frac{1}{\Delta y^2}$, $r_2 = \frac{1}{\Delta y^3}$, $r_3 = \frac{1}{\Delta y^4}$, $r_4 = \frac{1}{Pr\Delta y^2}$, $r_5 = \frac{1}{\Delta y}$, $s_1 = 3Kr_3 - \frac{1}{4}r_1$, $s_2 = \frac{1}{2}r_1 + 2Kr_3$, $s_3 = 2r_1 - 16Kr_3$, $s_4 = 20Kr_3 - 4Kr_1$

RESULT AND DISCUSSION

The results obtained from simulation are the effect of viscoelastic parameters (K) and Prandtl number (Pr) to the velocity profile (f') and temperature profile (θ).

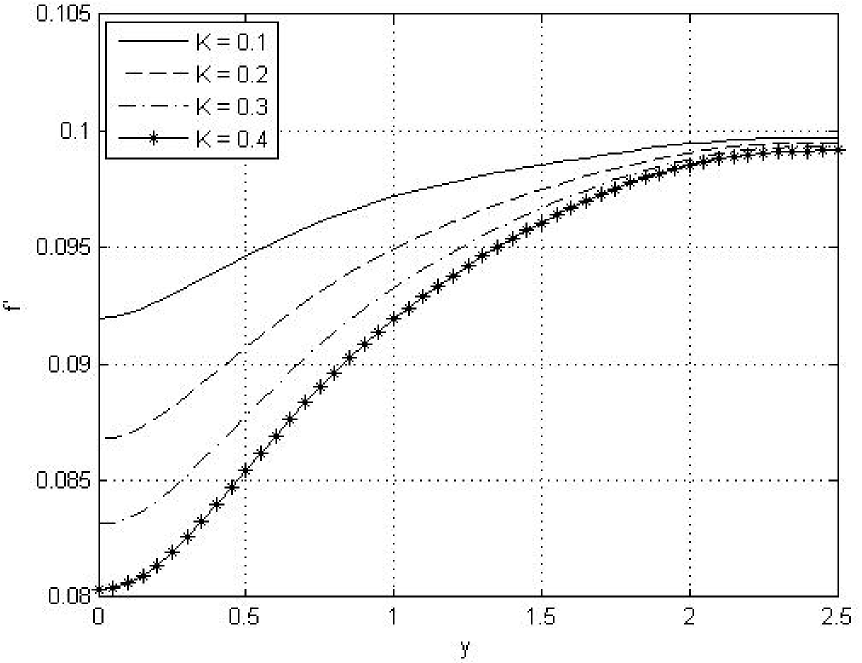

Figure 2. Velocity Profile with respect to the thickness and various K

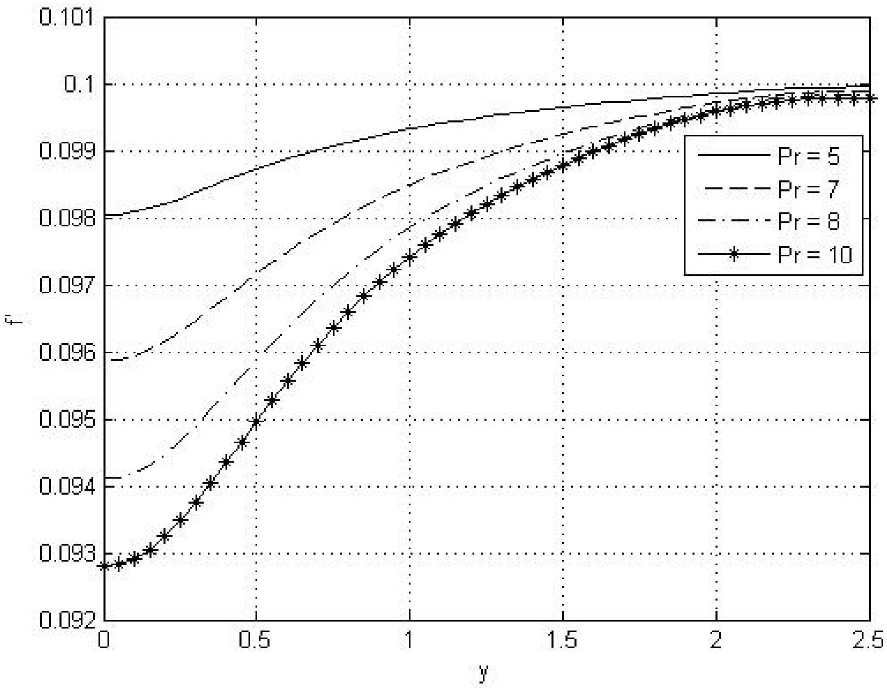

Figure 3. Velocity Profile with respect to the thickness and various Pr

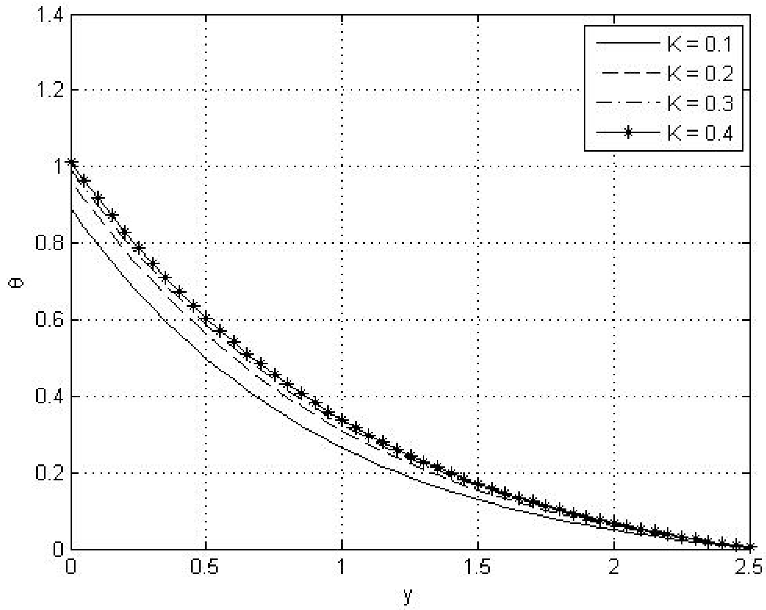

Figure 4. Temperature Profile with respect to the thickness and various K

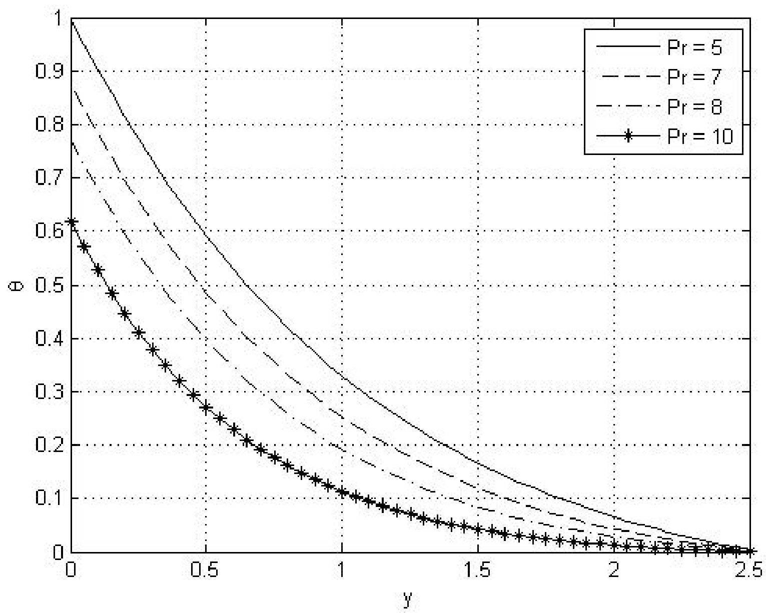

Figure 5. Temperature Profile with respect to the thickness and various Pr

Figure 2. describes the effect of viscoelastic parameters to the velocity profile. The increasing of the viscoelastic parameter, causes decreasing of the velocity of fluid flow across the surface of a sphere. This is because the viscoelastic parameters (K) shows the viscosity of a fluid, that causes a friction between the sphere with fluid, so that the fluid flow become slower. Figure 3. describes the effect of Prandtl number to the velocity profile. The increasing of Prandtl number, causes decreasing of the velocity of fluid flow across the surface of a sphere. This is because the Prandtl number is proportional to the viscosity kinematic fluid $(Pr \sim \nu)$, and the kinematic viscosity of the fluid is directly proportional to a coefficient of viscosity of the fluid

$(\nu \sim \mu_0)$, so the Prandtl number of parameters also directly proportional to the coefficient of viscosity of the fluid $(Pr \sim \mu_0)$.

Based on the results of the graph in Figure 4, the viscoelastic parameters versus proportional to the temperature profile. The increasing of viscoelastic parameter causes the increasing of the temperature profile. This is because the more viscous fluid that past over a sphere, the greater the friction between the fluid and sphere surface, then the greater fluid temperature becomes. Figure 5 describes the effect of Prandtl numbers to temperature profile. The increasing of Prandtl number causes the decreasing of the temperature profile. This is because Prandtl numbers shows temperature distribution on the free convection flow past over a sphere.

CONCLUSION

The numerical results of free convection flow of viscoelastic fluid past over a sphere indicate that the velocity profile decreases when we apply the increasing in the values of viscoelastic and Prandtl number. The temperature profiles increases with the increasing in the values of viscoelastic, but decreases when the values of Prandtl number increases.

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