UNIVERSITI TEKNOLOGI MARA

FLOW FIELDS ANALYSIS OF THERMOPHORETICS HYDROMAGNETIC THIRD-GRADE NON-NEWTONIAN NANOFLUIDS THROUGH POROUS CYLINDER WITH HEAT GENERATION OR ABSORPTION

NUR DAYANA KHAIRUNNISA BT ROSLI

Dissertation submitted in partial fulfilment of the requirements for the degree of
Master of Science

Faculty of Computer and Mathematical Sciences

July 2014

ABSTRACT

Nanoparticles have benefited many areas of nanotechnologies such as drug development, water decontamination and information and communication technologies. High concentration of nanoparticles in a base fluid exhibits non-Newtonian behaviour. In this study, the velocity, temperature and nanoparticles concentration in a hydromagnetic non-Newtonian nanofluids flow of a third-grade in porous cylinder are investigated numerically in the presence of heat sources or sink. The heat generation/absorption rate is assumed to be linearly dependent on temperature. The governing system of mass, momentum, energy and nanoparticles concentration are formulated and transformed into a system of nonlinear ordinary differential equations by using suitable non-dimensional parameters. The solutions are obtained numerically by using the Runge-Kutta-Fehlberg method. The effects of porosity parameter, pressure gradient parameter, MHD parameter, third-grade parameter, Brownian motion parameter and thermophoretic parameter on velocity, temperature and nanoparticles concentration distribution in the presence of heat generation and heat absorption are analysed. The effects of heat generation and absorption on velocity, temperature and nanoparticles concentration are also observed. Heat generation increases the velocity boundary layer thickness and thermal boundary layer thickness but decreases the nanoparticles concentration boundary layer thickness. Heat absorption decreases the thermal boundary layer thickness but increases the velocity and nanoparticles concentration.

ACKNOWLEDGMENT

Firstly, I wish to thank ALLAH SWT for giving me the opportunity to embark on my Master and for completing this challenging journey successfully. I would like to express my deepest appreciation to my dissertation's supervisor Associate Professor Dr. Seripah Awang Kechil, who has the attitude and the substance of a genius. She continually and convincingly conveyed a spirit of adventure in regard to research and an excitement in regard to teaching. Without her guidance and persistent help, this dissertation would not have been possible.

In addition, I am thankful to my dear friend, who is the other student under the same supervisor for her kindness on sharing her knowledge to me about some of the mathematical derivations and proofs. Thanks to her because I managed to get new ideas in solving some of the hard and complicated problems regarding to this project.

Last but not least, I thank the Faculty of Computer and Mathematical Sciences for the permission to use the computers at the mathematical laboratory in order to complete this dissertation.

Let me thank again for the generosity of everyone who involved in completing this dissertation and I end this with four lines of pantun.

The Pandan Island is far from land,
Three peaks has the Daik Mountain,
Though the body has rot in the sand,
The good deeds are never forgotten.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Nanoscale products and nanosmart materials derived from non-Newtonian fluids and nanofluids have a wide - ranging of current technological applications such as in the biomedical industry especially for sensing and imaging purposes. In recent times, colloidal gold which is the most stable of all colloids has been used in chemical catalysis, non-linear optics, supramolecular chemistry, molecular recognition and the biosciences. Nanofluids have been established in some cases as a smart fluid. By operating as a heart valve to control the flow of heat, Donzelli et al. (2009) presented that a certain class of nanofluids can be applied as a smart material. In low concentration of nanoparticles, the nanofluids conduct heat poorly, or in high concentration, the dissipation is more effective. Addition of nanoparticles to base fluids leads to high thermal conductivity (Yu et al., 2008). Nanofluids applied in industrial cooling yield in great energy savings and resulting emissions reductions (Routbort et al., 2009) which could yield in great energy savings and resulting emissions reductions. Nanotechnology has played an essential role in the development of smart materials technology.

Nanofluids comprise of base fluids and suspended nanoparticles and common base fluids are water and organic fluids such as oil, ethanol and ethylene glycol. The nanoparticles are made of metallic or nonmetallic particles with the size of nanometers (Das et al., 2007). Nanoparticles are made of metal such as kuprum (Cu), aluminium oxide (Al_2O_3), gold (Au), titanium dioxide (TiO_2), cuprous oxide (CuO), silver (Ag) and silicon dioxide, also known as silica (SiO_2). Choi (1995) was the first who defined the term nanofluid as a liquid containing dispersed submicronic solid particles (nanoparticles). The small size particles (1-100 nm) are able to enhance the heat transfer coefficient several times higher as compared to base fluids only. The production of nanofluids with particles such as aluminum oxide, copper, copper oxide, gold, silver, silica nanoparticles and carbon nanotubes in base fluids such as water, oil, acetone, decene and ethylene glycol has received substantial research interest