

Lateefat Aselebe

Reacting System of Boundary Layer Flow of CuO-Oil-Based Nanofluid with Heat Generation through a Vertical Permeable Surface

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**REACTING SYSTEM OF BOUNDARY LAYER FLOW OF CuO-OIL-BASED
NANOFLUID WITH HEAT GENERATION THROUGH A VERTICAL
PERMEABLE SURFACE**

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**B. Tech. (Hons.) Pure and Applied Mathematics,
M. Tech. Applied Mathematics (LAUTECH)**

**A Ph.D Thesis Submitted to
THE DEPARTMENT OF PURE AND APPLIED MATHEMATICS,
FACULTY OF PURE AND APPLIED SCIENCES,
LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO**

**IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
DOCTOR OF PHILOSOPHY (Ph.D) DEGREE IN APPLIED MATHEMATICS OF
LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO,
NIGERIA**

OCTOBER 2022

CERTIFICATION

This Thesis titled **Reacting System of Boundary Layer flow of CuO-Oil-Based Nanofluid with Heat Generation through a Vertical Permeable Surface** submitted by **ASELEBE Lateefat Olanike** was carried out under my supervision in the Department of Pure and Applied Mathematics, Ladoke Akintola University of Technology, Ogbomoso.

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ATTESTATION

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ABSTRACT

The loss of energy in any thermo-dynamical system has been a challenge to power generating industries in recent times. It becomes necessary to control the factors responsible for this in order to prevent the engines from breaking down. The heat carrier fluids like water, oil, ethylene glycol etc. are useful in heat transfer but their performances are limited due to their low thermal conductivities. Nanofluids are known to enhance heat transfer properties better than conventional heat carrier fluids. The flow and heat transfer performance of nanofluids are highly influenced by their thermo-physical properties. This study, therefore, investigated the reacting system of boundary layer flow of CuO-oil-based nanofluids with heat generation through a vertical permeable surface.

The physical system was modeled into a system of Partial Differential Equations (PDEs) denoted as continuity, momentum, energy and concentration equations which were further simplified into a system of coupled nonlinear Ordinary Differential Equations (ODEs) by using suitable similarity variables. The considered nanofluids consisted of CuO as nanoparticles and engine oil as base fluid. During the analysis, the flow was considered to be steady, incompressible and two dimensional. Two cases were considered for the thermo-physical properties of nanofluids, viz-a-viz: temperature and concentration-dependent thermo-physical properties of CuO-Oil-based nanofluids with the physical parameters of viscosity variations (α, γ), specific heat (ξ, Σ), density (ϖ, Λ), thermal conductivity (ω, Ω), heat generation (δ), Brownian motion (Nb), thermophoresis (Nt), Suction (S), Grashof number (Gr), Biot number (Bi), Brinkmann number (Br), Chemical reaction (R), Permeability (K^*) and Prandlt number (Pr) at the free stream temperature T_∞ .

which moves over the right surface of the plate with a uniform free stream velocity U_{∞} . The resulting equations were solved numerically using fourth order Runge-Kutta method implemented on MAPLE 18.0 software. The velocity $f'(\eta)$, temperature $\theta(\eta)$ and concentration $\phi(\eta)$ profiles, skin friction coefficient $f''(\eta)$, Sherwood number $\phi'(\eta)$ and Nusselt number $\theta'(\eta)$ were examined for some associated physical parameters of CuO-Oil-based nanofluids and were presented via graphs and tables.

Results showed that as $Gr, \delta, \varpi, \alpha, \Lambda, \Omega, \omega, \gamma, S$, and φ increased the velocity profile increased and increase in K^* and Pr decreased the velocity profile in the two cases. The temperature of CuO-Oil based nanofluid increased as Ω, ω, K^* , and δ increased, but decreased as $S, \varpi, \Lambda, \xi, \Sigma, \alpha, \gamma$ and Pr increased. Furthermore, $f''(\eta)$ increased as $\varpi, \omega, \gamma, \Lambda, \alpha, \Omega, K^*$ and φ increased, but decreased as S and δ increased. $\theta'(\eta)$ increased as $S, \Omega, \omega, \varphi$ and δ increased but decreased as ϖ, Λ and K^* increased. Also $\phi'(\eta)$ increased as K^*, δ and φ increased but decreased as $S, \xi, \Sigma, \omega, \Omega$ increased.

In conclusion, combining some thermo-physical properties like thermal conductivity, viscosity, specific heat and density of CuO-oil-based nanofluids influenced the rate of flow of the fluid as well as the heat and mass transfer significantly. It also has the potential to reduce friction, fuel consumption and overheating of the engine which tends to prolong its life span.

TABLE OF CONTENTS

Title page	i
Certification	ii
Attestation	iii
Acknowledgements	iv
Abstract	vi
Table of contents	viii
List of table	xi
List of figures	xii
Nomenclature	xv

CHAPTER ONE

INTRODUCTION

1.1	Background of the Study	1
1.2	Statement of the Problem	4
1.3	Justification/ Motivation	4
1.4	Aim and Objectives	5
1.4.1	Aim	5
1.4.2	Objectives	5
1.5	Scope of the study	6

CHAPTER TWO

LITERATURE REVIEW

2.1	Definition of terms	7
2.1.1	Heat	7

2.1.2	Heat Transfer	9
2.2	Metal and Their Properties	12
2.3	Lubrication	13
2.4	Porous Channel	13
2.5	Nanofluids	14
2.6	Differential Equation	14
2.7	Initial and boundary value problems	15
2.8	Steady and unsteady flow	15
2.9	Governing Equation of Fluid	15
2.10	Review of Some Works on Porous Media	24
2.11	Review of Some Works on Chemically Reacting Systems	25
2.12	Review of Some Works on Nanofluids	26
2.13	Review of Thermophoresis and Brownian motion	27
2.14	Review of Some Works on the Density	30
2.15	Review of Some Works on the Specific heat capacity	30

CHAPTER THREE

METHODOLOGY/MATHEMATICAL FORMULATION

3.1	Research Methodology	32
3.2	Governing Equation	32
3.3	Case 1: Temperature dependent thermo physical properties	49
3.4	Case 2: Concentration of particles dependent thermo physical properties	52
3.5	Numerical procedure	58
3.6	Shooting method of boundary value problem	58

3.7	The Runge-Kutta	60
CHAPTER FOUR		
RESULTS AND DISCUSSION		
4.1	Numerical Results	62
4.1.1	Results for temperature dependent Thermo-physical properties (case 1) on Nusselt number, Sherwood and skin friction	66
4.1.2	Discussion of Results of case 1	92
4.1.3	The Results of Concentration of Nanoparticles dependent thermo-physical properties (case 2) on Skin Friction, Nusselt Number and Sherwood Number at the Plate	99
4.2	Discussions of Results	134
CHAPTER FIVE		
CONCLUSION, RECOMMENDATIONS AND CONTRIBUTIONS TO KNOWLEDGE		
5.1	Conclusion	127
5.2	Recommendations	128
5.3	Contributions to Knowledge	128
REFERENCES		
APPENDIX		

LIST OF TABLES

Table	Page
<u>4.1 Computations showing comparison</u>	<u>63</u>
4.2 Showing the values of case 1 on skin friction, Nusselt number and Sherwood numbers	64
<u>4.3 Showing the values of skin friction, Nusselt and Sherwood numbers</u> for case 2	<u>110</u>

LIST OF FIGURES

Figure	Page
4.1 Velocity profile varying Grashof number, Gr	68
4.2 Velocity profile varying Viscosity parameter, α	69
4.3 Velocity Profile for varying values of thermal conductivity of CuO oil-based nanofluid	70
4.4 Velocity Profile for varying values of Volume fraction, ϕ of CuO oil-based nanofluid	71
4.5 Velocity profile varying Permeability parameter, K^*	72
4.6 Velocity profile varying Hartman number parameter	73
4.7 Velocity profile varying Density parameter, ϖ	74
4.8 Velocity profile varying specific heat capacity parameter ξ	75
4.9 Velocity profile varying Prantl number parameter, Pr	76
4.10 Velocity profile varying Heat generation parameter, δ	77
4.11 Velocity profile varying Suction, S	78
4.12 Temperature profile varying Permeability parameter, K^*	79
4.13 Temperature profile varying Suction, S	80
4.14 Temperature Profile for varying values of Volume fraction, ϕ of CuO oil-based nanofluid	81
4.15 Temperature profile varying Viscosity variation parameter, α of CuO nanoparticles	82
4.16 Temperature profile varying Density parameter, ϖ	83
4.17 Temperature profile varying Heat generation parameter, δ of CuO oil based nanofluid	84