



**EXPERIMENTAL INVESTIGATION INTO CONVECTIVE HEAT
TRANSFER OF NANOFLUID AT THE ENTRANCE REGION
UNDER LAMINAR FLOW CONDITIONS**

**MOHAMMAD FIRDAUS BIN CHE MAT
(2006882168)**

A thesis submitted in partial fulfillment of the requirements for the award of Bachelor
Engineering (Hons) (Mechanical).

**Faculty of Mechanical Engineering
Universiti Teknologi Mara (UiTM)**

MAY 2009

ACKNOWLEDGEMENT

First and foremost, I would like to thank Allah s.w.t for giving me the faith and strength to finally complete this project successfully.

I would like to express my gratitude and appreciation for my project supervisor, Mr Baljit Singh a/l Bathal Singh for his supervision, continue support, generous guidance, advice and encouragement throughout the whole process of completing this project. Thank you for having the faith in me and trusted me all the way.

I also would like to express my appreciation to En Fadli from the Thermodynamic laboratory, En Faizal also from the Thermodynamic laboratory, and also En Faiz from Welding Laboratory for their guidance and assistance on the experiments done at the laboratory.

A big appreciation to my family for giving me a lot of support and always be there whenever I needed them.

Lastly, I would like to thank to all my friends for lending their hand to help me in any way.

Without all of their help and support, I wouldn't be able to complete this final year project successfully.

Thank You very much.

ABSTRACT

Nanofluids are suspensions of metallic or nonmetallic nanopowders in base liquid and can be used to increase heat transfer rate in various applications. Because of its enhanced heat transfer capability as compared to normal based fluids such as water, its was offered the engineer opportunities for development in heat transfer and thermodynamic areas. This project reports an experimental investigation of work on the convective heat transfer of nanofluids flowing through a copper tube in the laminar flow regime compare with water. The nanoparticles that use in this experiment was made of Aluminium Nitrate ($\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$) and Tin Chloride Hydrated (SnCl_2). These nanoparaticles is then mixed with water (H_2O). Experimental results proved that the enhancement of heat transfer coefficient is due to the nanoparticles present in the fluid. Heat transfer coefficient increases by increasing the concentration of nanoparticles in nanofluid which use 0.6% vol, 1.0% vol and 1.6% vol of water. The use of the nanoparticles that mixed with water can significantly enhance the convective heat transfer in the laminar flow regime. The increase in heat transfer coefficient due to present of nanoparticles is much higher than the prediction of single phase heat transfer correlation used with nanofluid properties.

TABLE OF CONTENTS

CONTENTS	PAGE
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	viii
LIST OF GRAPHS	x
LIST OF ABBREVIATIONS	xi
CHAPTER I INTRODUCTION	1
1.1 Introduction	1
1.2 Problem statement	3
1.3 Objective of project	4
1.4 Scope of Project	4
1.5 Significant of project	5
CHAPTER II LITERATURE REVIEW	6
2.1 Introduction	6
2.2 Nanofluids	7
2.2.1 Introduction of Nanofluids	7
2.2.2 Materials for nanoparticles and base fluids	9
2.2.3 Methods in Production of Nanofluids	10

2.2.4 Past researchers	11
CHAPTER III METHODOLOGY	13
3.1 Introduction	13
3.2 Preparation of Experiment Apparatus	14
3.2.1 Radiator	15
3.2.2 Electric water heater	16
3.2.3 Insulator	16
3.2.4 DC Power Supply	17
3.2.5 Copper tube	18
3.2.6 Pump	18
3.2.7 Data Logger Thermometer	19
3.2.8 Doppler Flowmeter	19
3.2.9 Weighing Device	20
3.2.10 Thermocouple Type K	21
3.2.11 Water Pipe	21
3.2.12 Tank	22
3.3 Preparation of Nanofluids	23
3.3.1 Aluminium Nitrate ($\text{Al}(\text{NO}_3)_3$)	24
3.3.2 Tin(II) chloride (SnCl_2)	25
3.4 Sample of Calculation	26
CHAPTER IV RESULT AND DISCUSSION	29
4.1 Introduction	29
4.1.1 Results for pure water	30
4.1.2 Results for Aluminium Nitrate	31
4.1.2.1 For 0.6% of volume water	31
4.1.2.2 For 1.0% of volume water	32
4.1.2.3 For 1.6% of volume water	33
4.1.2.4 Wall temperature of $\text{Al}(\text{NO}_3)_3$ compared with pure water	34