INVESTIGATION OF THERMAL CONDUCTIVITY AND VISCOSITY OF NANOFLUID

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SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quantity for the award of the degree of
Bachelor of Mechanical Engineering (Thermal-Fluids)”

Signature: ……..
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Date: ……...

DECLARATION

"I hereby declare that the work in this report is my own except the summaries and quotations which have been duty acknowledge."

Signature: ……..……..

Author: ……..……..

Date: ……...……..

Khas buat

Ayah dan Ibu Tersayang

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ABSTRACT

Nanofluids are the new technology related to the heat transfer, thermal conductivity and others. Nanofluids can be produce by combination between base fluids and nanoparticles. In this experiment, the type of nanoparticles that used is carbon nanotube. The type of base fluids is water as the water has a good thermal conductivity which is widely used especially in the industry. In nanofluid research, the selection of the carbon nanotube in nanofluid formation is very important. Hence, the Pyrograf HHT 24 has been chosen as the nanoparticles. As the carbon nanotube characteristic is hydrophobic, a dispersing agent was introduced to allow the carbon nanotube dispersed completely in the water. The type of dispersing agent in this research is Sodium Dodecyl Sulphate (SDS). So, the formation of nanofluid will be completed with the combination between carbon nanotube, dispersing agent and water. The stability of nanofluid combination also has been considered in order to continue another test which is thermal conductivity and viscosity. As the nanofluid can enhance the thermal conductivity of the water, the thermal conductivity test has been carried out in order to compare the thermal conductivity of water and nanofluid. Besides that, the viscosity test also being carry out to determine the rate of viscosity of nanofluid. The result shows the thermal conductivity of nanofluid is greater than water as the enhancement is achieved. Besides that, the viscosity of nanofluid increase with the addition of carbon nanotube in the water. The greatest enhancement of thermal conductivity that been achieved is at NF013 which has 47.93 % at temperature 40°C. In conclusion, the enhancement of thermal conductivity and investigation of nanofluid viscosity was achieved.

ABSTRAK

Bendalir nano adalah teknologi baru yang berkaitan dengan pemindahan haba, kealiran haba dan lain-lain. Bendalir nano dihasilkan oleh dengan cecair asas dan partikel nano. Dalam eksperimen ini, jenis nanopartikel yang digunakan adalah tiub nano karbon. Sepanjang penyelidikan nanofluid, pemilihan bagi karbon nanotiub dalam penghasilan nanofluid adalah sangat penting. Jadi, Pyrograf HHT 24 telah dipilih dalam kajian ini. Ciri-ciri karbon nanotiub adalah hidrofobik, ejen campuran telah diperkenalkan untuk membolehkan karbon nanotiub bercampur dalam air. Jenis ejen campuran dalam kajian ini adalah Sodium Sulfat Dodesil. Jadi, pembentukan bendalir nano telah digabungkan antara tiub nano karbon, ejen campuran dan air. Kestabilan gabungan bendalir nano juga perlu dipertimbangkan untuk menjalankan ujian seterusnya ynag merupakan kealiran haba dan kelikatan. Seperti mana bendalir nano boleh meningkatkan kealiran haba air, ujian kealiran haba akan dijalankan untuk membandingkan keberaliran haba air dan bendalir nano. Selain itu, ujian kelikatan juga telah dijalankan untuk menentukan kelikatan bendalir nano. Jadi, hasil yang dijangkakan yang berkaitan dengan kestabilan, kekonduksian terma dan kelikatan harus dicapai seperti yang dinyatakan dalam objektif kajian. Keputusan eksperimen menunjukkan bahawa kekonduksian terma bendalir nano lebih tinggi daripada air. Selain itu, kelikatan bendalir nano meningkat dengan penambahan karbon nanotiub. Nilai peningkatan kealiran haba tertinggi adalah pada NF013 yang mempunyai peratusan 47.93% pada 40°C. Kesimpulanya, peningkatan kekonduksian bendalir nano dan kajian ke atas kelikatan bendalir nano telah dicapai dengan jayanya.

TABLE OF CONTENT

CHAPTER	CONTENT	PAGE
	DECLARATION	i
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	TABLE OF CONTENT	vii
	LIST OF TABLES	x
	LIST OF FIGURES	xi
	LIST OF APPENDIX	xiii
CHAPTER I	**INTRODUCTION**	
	1.1 Introduction	1
	1.2 Problem Statement	2
	1.3 Objective	2
	1.4 Scope	2
CHAPTER II	**LITERATURE REVIEW**	
	2.1 Introduction	3
	2.2 Nanofluid	4

2.2.1 Definition of nanofluid 4
2.2.2 Application of Nanofluid 4
2.2.2.1 Chiller 5
2.2.2.2 Domestic Refrigerator 5
2.3 Carbon Nanotubes 6
2.3.1 Single-walled Carbon Nanotube 7
2.3.2 Multi-walled Carbon Nanotube 8
2.3.3 Mechanical Properties of CNT 9
2.4 Dispersing Agent 10
2.4.1 Sodium Dodecyl Sulphate 10
2.5 Synthesis of Nanofluid 11
2.5.1 Two Step Method 11
2.5.2 Chemical Approach Method 11
2.5.3 Laser Ablation Method 12
2.6 Stability of Nanofluid 12
2.7 Thermal Conductivity of nanofluid 12
2.7.1 Influence of Nanoparticles 13
2.7.2 Influence of Base Fluids 13
2.7.3 Interface of the Liquid 14
2.8 Viscosity of Nanofluid 14

CHAPTER III METHODOLOGY

3.1 Introduction 16
3.2 Parameter 17
3.2.1 Properties of Parameter 17
3.2.1.1 Based Fluids 17
3.2.1.2 Carbon Nanotubes CNT) 18
3.2.1.3 Carbon Nanotubes CNT) 18
3.2.1.4 Weight Percentage 19
3.3 Equipment 19
3.4 Equipment Description 20

3.4.1 Mechanical Homogenizer 20
3.4.2 Ultrasonic Cleaner 20
3.4.3 pH Meter 21
3.4.4 Stability Test Rig 22
3.4.5 KD2-Pro 22
3.4.6 Viscometer 23
3.4 Procedure 24
3.5 Safety Precaution 25

CHAPTER IV RESULT AND DISCUSSION
4.1 Result 26
4.1.1 Stability Test 26
4.1.2 Thermal Conductivity Test 28
4.1.2.1 Percentage of Enhancement 31
4.1.3 Viscosity Test 33
4.2 Discussion 35
4.2.1 Analysis of Stability 35
4.2.2 Analysis of Thermal Conductivity 35
4.2.2.1 Temperature 36
4.2.2.2 Types of CNT 36
4.2.3 Analysis of Viscosity 38

CHAPTER V CONCLUSION
5.1 Conclusion 39
REFERENCE 41
BIBLIOGRAPHY 46
APPENDIX A 47
APPENDIX B 48
APPENDIX C 50

LIST OF TABLES

NO	TITLE	PAGE
3.1	Properties of Dionized water (DI)	18
3.2	Weight Percentage	19
4.1	Sample of Nanofluid	26
4.2	Thermal Conductivity of Pyrograf HHT 24 CNT	27
4.3	Thermal Conductivity of Deionized Water	29
4.4	Percentage Enhancement of Thermal Conductivity	30
4.5	Viscosity of Pyrograf HHT 24 CNT	33
4.6	Properties of Pyrograf HHT 24 CNT	36

LIST OF FIGURE

NO	TITLE	PAGE
2.1	Lattice Structure of Graphene	7
2.2	Graphene Sheet Rolled into Tubes	7
2.3	TEM image of MWNT	8
2.4	Stress Strain Curve	9
2.5	Sodium Dodecyl Sulphate (SDS)	10
3.1	Flow Chart	16
3.2	Mechanical Homogenizer	20
3.3	Ultrasonic Cleaner	21
3.4	pH Meter	21
3.5	Stability Test Rig	22
3.6	KD2-Pro	23
3.7	Viscometer	23
4.1	Graph of Thermal Conductivity of CNT	28
4.2	Thermal Conductivity at 6°C	31
4.3	Thermal Conductivity at 25°C	31
4.4	Thermal Conductivity at 40°C	32
4.5	Graph of Viscosity of CNT	

4.6	SEM image for Pyrograf	
5.1	Stable Nanofluid	46
5.2	Unstable Nanofluid	
5.3	Thermal Conductivity Test Using KD2Pro	47
5.4	Viscosity Test Using Viscometer	47
5.5	Gantt Chart	50

LIST OF APPENDIX

NO	TITLE	PAGE
A	Sample Calculation	47
B	Experiment	48
C	Gantt Chart	50

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Nanofluid is a material that contains nanometer-sized allergens dispersed inside base fluids. It is well known around the world that water, oil and also other fluid can be a good heat transfer essential fluids but this kind of previous essential fluids has their particular limitation to be able to transfer and also carry temperature. It can be known in which solid for instance metal thing can exchange more temperature or use a high thermal conductivity test to essential fluids. Even though solid is an excellent thermal conductivity nonetheless it cannot provide as any transfer temperature equipment. It really is known the bigger surface area, the increased of thermal conductivity. According to Xue (2005), the particular thermal conductivity not merely depends on volume fraction of your solid or perhaps liquid, but its depend on the particle dimensions and interfacial attributes.

1.2 PROBLEM STATEMENT

In nanofluid, there are several type of fluid used as a base. Water is one of fluid used as a coolant in various types of machine and industries around the world as the water has good thermal conductivity. In this research, CNT is chosen to produce nanofluid. However, CNT properties are hydrophobic and dispersing agent is introduced to make the nanofluid stable. The stable nanofluid will improve and increased the thermal conductivity. In conclusion, this research will focus on investigating of thermal conductivity and viscosity in nanofluid.

1.3 OBJECTIVE

The main objective of this project is:

- To analyze and investigate thermal conductivity and viscosity in nanofluid prepare from Pyrograf HHT24 carbon nanotube, Sodium Dodecyl Sulphate (SDS), and water

1.4 SCOPE

- To prepare nanofluid with additional CNT to enhance its thermal conductivity higher than normal rate of water
- To investigate thermal conductivity and viscosity for nanofluid prepared

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Nanofluid is dilute suspension of nanometer-size particles that dispersed in base fluid. In nanofluid, there are various tests or experiment conducted including heat transfer, stability, thermal conductivity and others. This nanotechnology gives a lot of advantages based on high specific area which gain the heat transfer between particles and fluids and the enhancement of base water. In other words, nanoparticles have a tremendous potential to more effectively improve the thermal transport if compared to the micrometer and milimeter sized particles according to the tininess of nanoparticles. This significant size will increase the specific surface area of nanoparticles. Moreover, the tininess of nanoparticles can gives a great potential to be used in miniaturized electronic cooling and microchannels. In this chapter, the definition of nanofluid, application of nanofluid, synthesis of nanofluid, carbon nanotube, dispersing agent, thermal conductivity and viscosity will be reviewed and discussed.

2.2 NANOFLUIDS

2.2.1 Definition of Nanofluid

Nanofluids are generally engineered colloids created from a starting fluid along with nanoparticles (1-100 nm), Lixin (2009). According to (Tang et al. 2008), nanofluids are generally suspensions involving nanoparticles throughout conventional fluids including water, ethylene glycol along with engine gas, have captivated great awareness from a lot of researchers this can potential positive aspects and purposes in critical fields including microelectronics, electricity supply, travelling and Heating Ventilation Air Conditioning (HVAC). Singh (2008) has stated that nanofluids are usually suspensions regarding nanoparticles inside base essential fluids, a fresh challenge regarding thermal sciences given by nanotechnology. Nanofluids have got unique features distinctive from conventional solid-liquid mixtures where mm or perhaps μm measured particles regarding metals and also non-metals are usually dispersed. In the investigation of (Peng et al. 2005), nanofluid is a mixture between nanoparticles and fluid which have big potential to improve the efficiency of heat transfer and thermal conductivity.

2.2.2 Application of Nanofluid

There is various kind of application in nanofluid which is in industrial, commercial, and residential.

2.2.2.1 Chiller

Numerous reported which 40% improve in energy conductivity with regard to 0.4% quantity fraction associated with nanofluids. Thus giving an chance of improving overall performance of chillers in AC systems. Remarkably, the air conditioning capacity from the nanofluids might be increased through 4.2% in the standard score conditions. The 6.7% increase within the capacity had been encountered in a flow price of 60 l/min. The actual unexpected rise within the cooling capacity from the nanofluids had been related towards the dynamic interaction from the flow field and also the nanopowder, (Saidur et al. 2011).

2.2.2.2 Domestic Refrigerator

Several investigations were performed with nanoparticles inside refrigeration systems to utilize advantageous attributes of nanoparticles to boost the performance and trustworthiness of appliances. For illustration, (Wang et al. 2003) identified that TiO_2 nanoparticles may be used since additives to boost the solubility with the mineral acrylic in the particular hydrofluorocarbon (HFC) refrigerant. (Peng et al. 2009) made the research in term impact of nanoparticles about the heat transfer characteristics associated with refrigerant-based nanofluids circulation boiling in the horizontal sleek tube, as well as presented the correlation with regard to predicting warmth transfer overall performance of refrigerant-based nanofluids.

2.3 CARBON NANOTUBE (CNT)

Carbon nanotube can be divided into two types which single-walled carbon nanotube (SWNT) and multi-walled carbon nanotube (MWNT). The formation of carbon nanotube is made up from the product of nanoparticles. Based on (Paritosh et al. 2009), nanoparticle can be in form of spherical and cylindrical. Carbon nanoparticle in cylindrical form and tubular structure which in nanometer size of diameter called carbon nanotube. According to Xue (2005), Carbon Nanotubes (CNTs) have the unique structure and remarkable physical properties which attract much attention in past several years. (Patel et al. 2008) state that the stable suspensions connected with nanoparticles (diameter < 100 nm) with liquids usually are called nanofluids, in contrast to suspension connected with carbon nanotube (CNT) from the liquid is referred to as CNT nanofluid. As well as nanotubes (CNTs) are generally relatively brand-new materials that will possess a number of unique components including substantial moduli involving elasticity, substantial aspect rates, and substantial thermal conductivity, (Moisala et al. 2011). In this research, the type of carbon nanotube used is HHT 24 pyrograf which single-walled carbon nanotube.

2.3.1 Single-walled Carbon Nanotube (SWNT)

According to (MceEuen et al. 2002), SWNT are the nanoparticles that build up from nanometer-diameter cylinders consisting of single graphene sheet wrapped up to form a tube. Figure 2.1 shows the lattice structure of graphene and the formation of SWNT by rolled up graphene sheet.

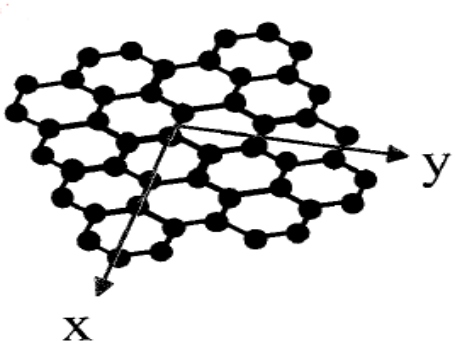

Figure 2.1: Lattice structure of graphene

(Source: MceEuen et al. 2002)

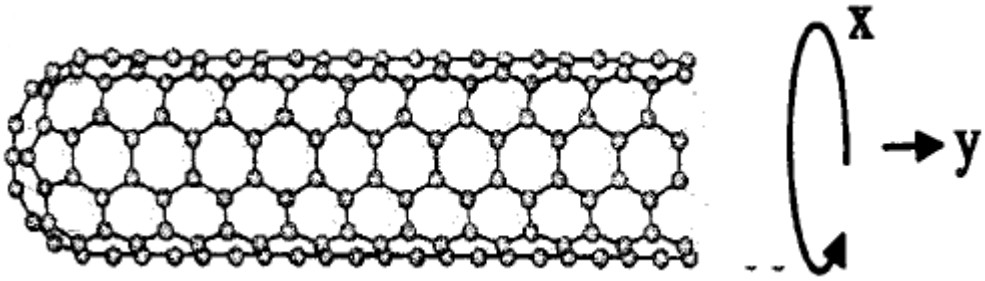

Figure 2.2: Graphene sheet rolled into tubes to form SWNT

(Source: MceEuen et al. 2002)

Based on (Aida et al. 2007), theoretical and experimental work exhibit an uniquely great thermal conductivity in excess of 3000 W/mK to get multi-wall and also carbon nanotubes (MWNT) plus single-wall and also carbon nanotubes (SWNT).

2.3.2 Multi-walled Carbon Nanotube (MWNT)

Multi-walled carbon nanotube (MWNT) is another type of carbon nanotube which is involved in formation of nanofluid. This carbon nanotube is called multi-walled because it has double concentric tube in single configuration. MWNT is the first to be discovered which contain the concentric cylinder around common central hollow with a same separation between the layers close to the graphite interlayer spacing, (Tang et al. 2003). Figure 2.3 shows the TEM image of MWNT.

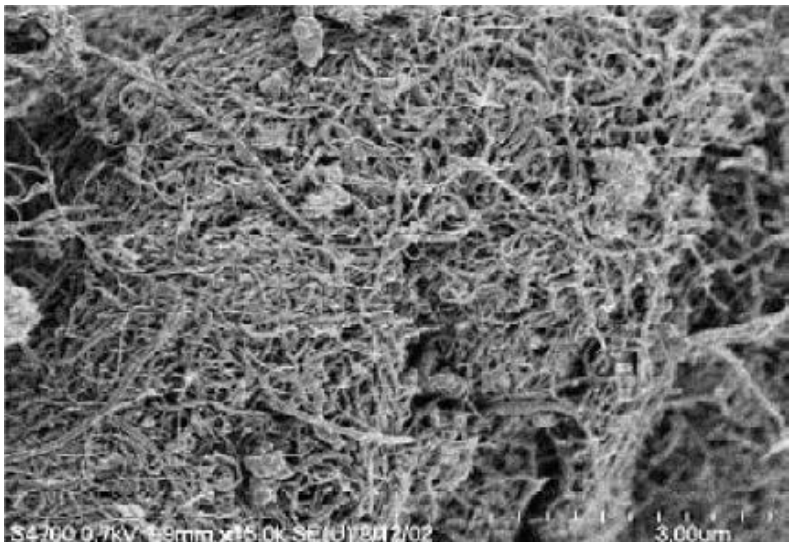

Figure 2.3: TEM image of MWNTs

(Source: Wang et al. 2003)

In the research of Moisala (2006), MWNTs instead of SWNTs happen to be predominantly utilized as conductive fillers because of their lower price, better accessibility and simpler dispersability. Nevertheless, the possibly higher innate electrical as well as thermal conductivity associated with SWNTs should enable an additional reduction within the filler content material required for any given enhancement within the composite qualities.

2.3.3 Mechanical Properties of CNT

From the type of carbon nanotube above, both SWNT and MWNT have different mechanical properties. Based on Jonathan (2006), the mechanical properties can follow the analogy of graphite which has stiffness of 1.06 TPa. Besides that, the tensile strength is estimated as high as 130 GPa from properties of C-C bonds. The yield strength also been determined which is 20 GPa, Jonathan (2006). This shows the carbon nanotube is expected to have high strength and stiffness. Figure 2.3 shows the stress and stain curve for MWNT.

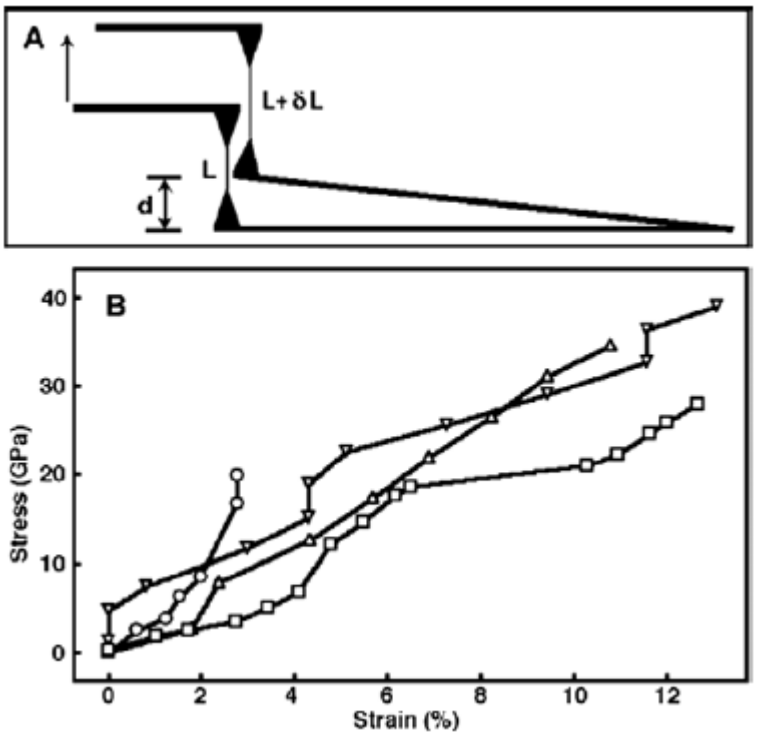

Figure 2.4: Stress strain curve for individual MWNT

(Source: Jonathan, 2006)