COMPARATIVE STUDY ON STABILITY OF NANOFLUID USING TWO DIFFERENT DISPERSING AGENTS

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

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DECLARATION

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

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Khas untuk keluarga tersayang, Khusus untuk ibunda

dan ayahnada tercinta

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ABSTRACT

Nanofluid have a big potential in term of heat transfer and become a need in industries and also for scientist around world . Apart from that nanofluid also can be used in variety of application such as cooling agent in automotive sector, heat transfer in electronic application and also used in cooling industries. Carbon Nanotube (CNT) is hard to disperse in base water and need a help from dispersing agent. So an experiment need to be run in order to produce the stable nanofluid based on uses of carbon nanotube and dispersing agents. The type of carbon nanotube used for this experiment is manufactured by Materials and Electrochemical Research Corporation (MER). This carbon nanotube is Multi-wall Carbon Nanotube (MWNT) and have large surface area and able to help during heat removing process. Regarding to this matter, two dispersing agent was introduced in order to help the CNT to disperse well in base water. Those two dispersing agent used in this experiment were Sodium Dodecyl Sulphate (SDS) and Polyvinylpyrrolidone (PVP). This surfactants help to reduce the water surface tension and increase the stability of nanofluid. The experiment started by weight percentage and ratio between the CNT and dispersing agent. Then the formation was homogenized, has been ultrasonic and checked the pH value. The stability result of nanofluids was determine after 100 hours kept in room temperature and being tested by using the stability test rig. The formation between MER and PVP give the best result in term of stability and also thermal conductivity. PVP is very good surfactant that help to increase the stability and thermal conductivity due to the efficient characteristic which are very soluble in water and produce less foam and bubble.

ABSTRAK

Bendalir -nano mempunyai potensi yang sangat besar dalam penukaran haba dan menjadi keperluan serta tarikan dari pelbagai industri dan juga saintis seluruh dunia. Selain daripada itu, bendalir-nano juga digunakan dalam pelbagai kegunaan seperti ejen penyejukan dalam sektor automotif, penukaran haba dalam aplikasi elektronik dan juga dalam industri penyejukan. Projek ini dijalankan adalah untuk menghasilkan bendalir nano yang stabil dengan menggunakan karbon nanotiub dan ejen penyebar. Jenis karbon nanotiub yang digunakan adalah MER. Karbon nanotiub in adalah jenis (MWNT) dan mempunyai permukaan yang luas dan mampu memberikan bantuan ketika proses pembuangan haba. Walaupun struktur karbon nanotiub adalah bagus tetapi ia tetap mempunyai satu masalah besar iaitu hydrofobik. Ini bermakna karbon nanotiub ini sukar untuk tehurai didalam air. Untuk menangani masalah ini dua ejen penyebar digunakan untuk membantu karbon nanotiub untuk terhurai di dalam air biasa. Dua ejen penyebar itu adalah (SDS) dan (PVP). Ejen penyebar ini akan megurangkan tekanan permukaan air dan menugkatkan kestabilan bendalir nano. Sebelum eksperimen dijalankan perbezaan dan nisbah diantara tiub karbon nano dan ejen penyebar perlu dikirakan dahulu. Keputusan kestabilan bendalir nano hanya dapat ditentukan selepas 100 jam di simpan pada suhu bilik dengan menggunakan rig ujian kestabilan. Gabungan antara MER dan PVP adalah yang terbaik dari segi kestabilan dan juga pengaliran haba. PVP mempunyai kriteria yang sangat bagus iaitu sangat mudah terlarut dalam air dan kurang menghasilkan buih.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Nanofluid is a material that consist of nanometer size particle which is able to disperse in base fluid such as water, ethylene glycol and engine oil. Nanofluid is used in important fields such as electronics, transportations, medicals, and Heating Ventilation and Air Conditioning (HVAC). Besides, nanofluid also known as a fluid that has properties of solid such as metal object that can transfer more heat or have a high thermal conductivity. Based on Xue. Q (2005) the thermal conductivity not only depends on volume fraction of a solid or liquid, but also depended on the particle size and interfacial properties. Nanofluid are also suspension of nanoparticles inside base fluid and there are many types of solid particles we used to prepare nanofluid . Nanofluid is the better choice compare to the solid even though solid is a good thermal conductivity but it cannot be used as a transfer heat equipment. It also have a large

surface area to volume ratio and thus have great potential in heat transfer. That the reason why nanofluid is widely used in industries now days.

1.1 Problem Statement

The main problem in this project is to determine which dispersing agent either SDS or PVP is better in term of stability and thermal conductivity. This experiment carry on to identify whether the nanoparticle is able to disperse in the water base or not. The nanoparticle used during this activity carry on is Carbon nanotube (CNT). In fact, the criterion of Carbon nanotube (CNT) is hydrophobic and in order to help CNT to disperse well in water, two dispersing agents are used. There are Sodium Dodecyl Sulphate (SDS) and Polyvinylpyrrolidone (PVP). Besides that, dispersing agent also help to increase the stabilize of nanofluid and enhance the thermal conductivity. Hence a further study about the water based carbon nanotube need to be done to see whether the nanofluid is better for cooling agent than the base water.

1.2 Objective

The main objective of this project is:

To determine the stability of nanofluid based nanocarbon by using the dispersing agent which are Sodium Dodecyle Sulphate (SDS) and Polyvinylpyrrolidone (PVP).

1.3 Scope

1. To prepare the nanofluid by using carbon nanotube manufactured by Meterial Electrochemical Research (MER) with using the Sodium Dodecyle Sulphate (SDS) and Polyvinylpyrrolidone (PVP) as dispersing agent.

2. To identify the stability of nanofluid.

3. To find the suitable ratio of the amount of carbon nanotube and the amount of the dispersing agent to be mix with a certain amount of water.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Nanotechnology is define as the technology used for design and fabrication material, devices and systems with control at nanometers dimensions. Nanotechnology is considered to be rather new technology but it has a lot of potentials that can be explore and the application. This technology is widely used in industries recently due to the benefit of nanoparticle structure. According to Kwak.K (2005), nanotechnology is the process of produce and use of materials with purposely engineered features close to the atomic or molecular scale. It means that the nanotechnology is dealing with small structure of atom which is they need some special device to be investigate and also invisible by the naked eyes. On the other hand, nanotechnology raises lots of the same concerns as virtually any new engineering, including concerns in regards to the toxicity and also environmental influence of nano components. Researchers tried to increase the thermal conductivity of base fluids by suspending solid nanoparticles in fluids since the

thermal conductivity of solid is typically better than liquids (Wang, et al, 2008). This technology is still fresh and new in industries field and got a lot of potentials to be explored. The continuously research need to keep in progress in order to achieve the main goal for development of nanotechnology and able conquer all industries around the world.

2.1 Nanofluid

2.1.1 Definition of Nanofluid

According to Singh A.K (2008), nanofluid are a suspension mixture of suspended nanoparticles in a base liquid is defined as a nanofluid. Nanofluid is refer to engineered colloids made of base fluids and nanoparticles (Cheng, 2009). Base fluids such as water, ethylene and engine oils are conventional fluids that been used as heat transfer fluids. According to Wang and Mujumdar (2006), nanofluid has a much larger relative surface area of nanoparticles compared to conventional heat transfer fluid. Nevertheless, it will not only increase the thermal conductivity but also the stability of the suspension. There are several examples of natural nanofluid which are blood, a complex biological nanofluid where different nanoparticles able to accomplish different functions. Apart from that, the function of the component actively respond to their local environment and also improve the abrasion relation of those properties when compare to the conventional solid or fluid mixture. Besides that nanofluids is a mixture of nanoparticles and fluid which are have enormous potential to improve the efficiency of heat transfer fluids, Hong and Tae-Keun (2000). When nanofluids are used as coolant in a liquid cooling process, the purely convective mode of heat transfer with the base fluid becomes a heat transfer problem with convection and conduction effects. In fact, mostly nano-element with high thermal conductivity can be dispersed in base fluids but only a few from that are suitable to be used for nanofluid purpose

2.1.2 Application of Nanofluids

There are several application of nanofluid due to the dynamic structure of nanoparticle which is now day be attractive by developer around the world. According to (Lixin, 2009), the replacement of cooling and heating water with nanofluid has the great potential to conserve one trillion Btu of energy where one Btu approximately to 1055.056 Joule.

2.1.2.1 Automotive application

In automotive application the nanofluid able to replace the existed material such as engine oils, automatic transmission fluids, coolants, lubricants, and other synthetic high-temperature due to the thermal conductivity of nanofluid is more better compare to these materials. Using nanofluid as coolants allows for smaller dimension and better positioning from the radiators. The usage of high-thermal conductive nanofluid inside radiators can cause a lowering of the frontal section of the radiator. The effective use of nanofluid furthermore contributed with a reduction regarding friction and also wear, lowering parasitic loss, operation regarding components for instance pumps and also compressors. So the nanofluid is really play their role as a coolant wisely and give a greater improvement of savings for the future plan.

2.1.2.2 Electronic application

Nanofluid is a new invention which is used for cooling of microchips in computers and other electronic appliances. The most important principal in developing smaller microchips is the rapid heat dissipation. So the nanofluid is really suitable to be used as liquid cooling in order to dissipated heat from microchip due to their high thermal conductivity. By using the nanofluid as a cooling agent, it can help to increase the life time of the electronic system. This new invention also able to make a greater improvement in electronic marketing.

2.1.2.3 Heat transfer application

Based on Routbort et al.(2008), noticed that employed nanofluid in industrial cooling that could result a great energy savings and resulting emissions reductions. The scientist around the world make an estimation that the replacement of nanofluid as cooling and heating water has potential to conserve in about 1 trillion Btu of energy. According to Thomas (2010) the system have used phase change materials as nanoparticles in nanofluid to ensure the simultaneously enhance the effective thermal conductivity and specific heat of the fluids. The main properties of nanofluid which make them is the good cooling agents are having good thermal conductivity and viscosity.

2.1.3 Stability of nanofluid

Nanofluid are new invention of engineering material consisting of nanometer-sized particles dispersed in base fluid. Based on the research , there are various properties of nanoparticles, such as multi-walled carbon nanotube (MWCNT), Single-Walled Carbon Nanotube (SWNT), fullerene, copper oxide, and silicon dioxide have been used to produce nanofluid. The production of nanofluid is about for enhancing thermal conductivity and lubricity. According to.Chen.L (2008), nanofluid technology becomes a new challenge for the heat transfer fluid because of these fluid is really good in thermal conductivity. The stability of nanofluid still need to be evaluate to ensure the nanofluid is in good condition. The nanofluid are considered to be stable when the nanoparticle size of supernatant particles remain constant. Sedimentation method of nanofluid in test tubes and then taken picture of the nanofluid mixture is also a usual method for observing the stability of nanofluid, Wei Yu and Xie. H (2011).

The suspension fraction of graphite nanoparticles should be calculated at a certain time in order to determine the stability result of nanofluid. For the sedimentation method, a long period for observation is the limitation that need to faced on. Therefore, other method has been created which is centrifugation method to evaluate the stability of nanofluid. Excellent stability of the nanofluid is due to the protective role of dispersing agent. The dispersing agent also help to retard the growth and agglomeration of nanoparticle by certain effect. The stability of nanofluid based nanocarbons are important because thermal conductivity enhancement depends on the volume fraction of the suspended particles, thermal conductivities of the particles and base fluids. The characteristics of the suspended particle and base fluids such as the particle morphology and the chemical structure of the particles is really effect the stability of the nanofluid, Kanagraj. S (2005).

2.2 Carbon Nanotube (CNT)

Carbon nanotubes (CNTs) are defined as the tubular structures that are typically of nanometer diameter and commonly micrometers in length, according to (Dresselhaus et. al 2004). Carbon-based materials such as diamond and in-plane graphite, display the highest measured thermal conductivity of any known material at moderate temperatures. Carbon nanotube are also good in mechanical and electrical properties and it has been proven by Lifei (Chen et al. 2008) in their journal. Carbon nanotubes also have high carrier mobility, ballistic transport and high compressible with high dielectrics. There tend to be many feasible symmetries or even geometries that may form on the cylindrical area in carbon nanotubes without having introducing any risk of strain. Based on Xue Q.Z. (2005), Carbon nanotubes (CNTs) have a very unique of structure and remarkable physical properties and already attracting much attention in the past few years. Apart from that, the well-known graphite carbon can build close and open cages based on the honeycomb atomic arrangement and pattern. Carbon nanotubes consist of rolled graphene sheets built from hybridized carbon atoms. Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes (MWNTs).