Kurdistan Regional Government- Iraq
Ministry of Higher Education & Scientific Research
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Improving Performance in Engine Cooling System Using CuO/Water Nanofluid

A project submitted to the scientific committee in the chemistry department inpartial fulfillment of the requirement for the degree of bacterial science in

Chemistry

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April,2024 Nowruz,2724 Ramadan,1445

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صَدَقَ اللهُ العظيمُ

سورة العلق : من الاية (1)

Acknowledgement:

First of all, I would like to give thanks and glory to my Lord for the opportunity to this review project, to express my gratitude and appreciation to all those who gave me the possibility to complete this research project. Special thanks are due to my supervisor Dr. Ropak Ahmed Sheakh mohamad whose help, stimulating suggestions and encouragement helped me in all time of fabrication process and in writing this project. I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

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Abstract:

Antifreeze and coolant are essential fluids used in automotive and industrial applications to manage the temperature of engines and machinery. Antifreeze, typically based on ethylene glycol or propylene glycol, functions by lowering the freezing point of water, preventing coolant from solidifying in cold conditions and potentially damaging engine components. Coolant, a mixture of antifreeze and water, circulates through the engine to absorb heat generated by combustion, thereby regulating the engine's operating temperature. In addition to preventing freezing, antifreeze and coolant formulations often include corrosion inhibitors to protect engine parts, along with additives to enhance heat transfer and prevent boiling at high temperatures. Proper maintenance of antifreeze and coolant systems is crucial for ensuring engine efficiency, longevity, and protection against temperature-related issues. This abstract summarizes the importance and functionality of antifreeze and coolant in modern engine cooling systems.

Keywords: Radiator Coolant, Nanofluid, cooling system.

CHAPTER ONE

Introduction

1. Introduction:

Day today the people's needs own automotive vehicle to make their work faster and simpler. So by seeing the increasing demand of vehicle, automotive industries continuously doing development for making high efficient and economical engines which consumes less fuel to attract the customers. There are various ways to increase the efficiency of engine like by using optimized design of engine which reduce the weight of automotive and efficient engine cooling system which will increase the performance of vehicle. Use of optimized designed fins and micro size tube is most conventional way to increase the performance of radiator is now reached to its limit. Another way of enhance the cooling effect is use of efficient coolant in the vehicle radiator. As conventional coolant is the mixture of water and ethylene glycol as anti-freeze agent to increase the boiling point and reduce the freezing point of water. By adding the anti-freeze in water make it possible to use water for wide range of temperature but for that we have to compromise the heat transfer performance of the radiator as the heat capacity of mixture is less that of water.(Adwani and Choudhary, 2014)

The history of antifreeze dates back to the early 20th century when ethylene glycol was first used as a coolant in automobile radiators to prevent freezing during cold weather. Before that, various substances like alcohol and saltwater were used, but they were less effective.

Ethylene glycol became the standard antifreeze due to its low freezing point and high boiling point, making it effective in both cold and hot temperatures. Over time, antifreeze formulations evolved to include additives for corrosion protection and to enhance its effectiveness. Today, antifreeze is a crucial component in the cooling systems of vehicles and many other applications where freezing or overheating needs to be prevented.(Ali et al., 2015)

An antifreeze is an additive which lowers the freezing point of a water-based liquid. An antifreeze mixture is used to achieve freezing-point depression for cold environments and also achieves boiling-point elevation to allow higher coolant temperature. Freezing and boiling points are colligative properties of a solution, which depend on the concentration of the dissolved substance. Because water has good properties as a coolant, water plus antifreeze is used in internal combustion engines and other heat transfer applications. The purpose of antifreeze is to prevent a rigid enclosure from bursting due to expansion when water freezes. Commercially, both the additive (pure concentrate) and the mixture (diluted solution) are called antifreeze, depending on the context. Careful selection of an antifreeze can enable a wide temperature range in which the mixture remains in the liquid phase, which is critical to efficient heat transfer and the proper functioning of heat exchangers.(Bhatt et al., 2014)

Ethylene glycol solutions became available in 1926 and were marketed as "permanent antifreeze" since the higher boiling points provided advantages for summertime use as well as during cold weather. They are used today for a variety of applications, including automobiles, but gradually being replaced by propylene glycol due to its lower toxicity. When ethylene glycol is used in a system, it may become oxidized to five organic acids (formic, oxalic, glycolic, glyoxalic and acetic acid). Inhibited ethylene glycol antifreeze mixes are available, with additives that buffer the pH and reserve alkalinity of the solution to prevent oxidation of ethylene glycol and formation of these acids. Nitrites, silicates, theodin, borates and azoles may also be used to prevent corrosive attack on metal.(Bozorgan et al., 2012)

Antifreeze solutions exhibit coligative properties, which are properties that depend on the number of solute particles in a solution rather than the identity of the solute. In the case of antifreeze, the solute is typically ethylene glycol or propylene glycol.One important coligative property of antifreeze solutions is freezing point depression. When antifreeze is mixed with water, it lowers the freezing point of the resulting solution compared to pure water. This occurs because the presence of the antifreeze solute disrupts the formation of ice crystals, requiring lower temperatures for freezing to occur.

Another coligative property is elevation of the boiling point. Antifreeze solutions have a higher boiling point than pure water due to the presence of the solute particles. This means that the engine coolant can withstand higher temperatures without boiling, which is important for preventing engine overheating. These coligative properties make antifreeze solutions effective for regulating engine temperature and preventing freezing or overheating, thus protecting the engine from damage.(Chandrasekaran et al., 2014)

Antifreeze mixtures work by altering the freezing and boiling points of water, as well as providing corrosion protection and lubrication within the cooling system. Here's how they work:

- Freeze Protection: Antifreeze lowers the freezing point of water, preventing it from solidifying into ice even at low temperatures. This allows the coolant to remain in liquid form, ensuring that it can still circulate through the engine and radiator to absorb and dissipate heat.

- Boil Protection: Antifreeze raises the boiling point of water, allowing the coolant to withstand higher temperatures without vaporizing. This helps prevent the coolant from boiling over and causing the engine to overheat.

- Corrosion Protection: Antifreeze contains corrosion inhibitors that protect metal components within the cooling system from rust and corrosion. This helps extend the lifespan of the radiator, water pump, hoses, and other parts.

- Lubrication: Some antifreeze formulations contain lubricating agents that help reduce friction within the cooling system, improving the efficiency of the water pump and other moving parts.

Antifreeze mixtures ensure that the coolant can effectively regulate the temperature of the engine, prevent damage from freezing or overheating, and maintain the integrity of the cooling system over time.

However Coolant is a liquid substance used in the cooling systems of vehicles, machinery, and various other applications to regulate temperature and prevent overheating. It typically consists of a mixture of water and antifreeze, with the antifreeze component (usually ethylene glycol or propylene glycol) providing freeze protection in cold temperatures and boil protection in hot temperatures.

Coolant circulates through the engine, absorbing heat generated by combustion and transferring it to the radiator, where it dissipates into the surrounding air. In addition to preventing freezing and overheating, coolant also contains additives to inhibit corrosion, lubricate moving parts, and improve overall cooling system efficiency. Regular maintenance of coolant levels and quality is essential for ensuring optimal engine performance and longevity.(Chang et al., 2011)

The shift from primarily referring to the liquid in a vehicle's cooling system as antifreeze to coolant likely stems from a desire for more accurate terminology that reflects the broader function of the substance. Here are a few reasons for this shift:

- Comprehensive Terminology: While antifreeze accurately describes the function of preventing freezing, it doesn't encompass the entire role of the liquid in the cooling system. Coolant is a more comprehensive term that reflects both the antifreeze properties preventing freezing and the heat transfer properties cooling of the liquid.
- Usage in Different Systems: The term "coolant" is also used in various other cooling systems beyond automotive, such as industrial machinery, HVAC systems, and electronics. Using coolant as a universal term helps standardize terminology across different applications.

- Marketing and Branding: Some manufacturers and marketers may prefer the term coolant as it emphasizes the broader functionality and positive connotations of keeping the engine cool and functioning optimally.

- Consumer Understanding: The term coolant may be more intuitive and easier for consumers to understand, especially those who are not familiar with the technical aspects of automotive maintenance. It conveys the idea of maintaining a cool engine more clearly than antifreeze alone.

The transition from antifreeze to coolant reflects a desire for more precise and encompassing terminology that accurately describes the function of the liquid in a vehicle's cooling system.(Ali et al., 2015)

1.1Ethylene glycol and water:

Ethylene glycol is commonly mixed with water to create a coolant solution for use in vehicle and industrial cooling systems. The most common mixture ratio is 50% ethylene glycol to 50% water, although variations in the ratio may be used depending on specific requirements and climate conditions.Ethylene glycol lowers the freezing point of water, preventing it from solidifying into ice even at very low temperatures. This ensures that the coolant remains in liquid form, allowing it to flow through the engine and radiator without causing damage due to freezing. Ethylene glycol also raises the boiling point of the coolant mixture, allowing it to withstand higher temperatures without evaporating or boiling over.It's essential to use the correct mixture ratio of ethylene glycol and water as recommended by the manufacturer to ensure optimal performance and protection for the cooling system. Too much ethylene glycol can reduce the coolant's heat transfer efficiency, while too little can compromise its antifreeze and boil protection properties.(Devireddy et al., 2016)

1.1.2 Water as coolant:

Water is a commonly used coolant in various applications, including vehicle engines, industrial machinery, and electronic devices. While water alone may not offer the same level of freeze and boil protection as coolant solutions containing additives like ethylene glycol.

it still possesses several important cooling properties high thermal conductivity water has excellent thermal conductivity, meaning it can efficiently absorb and transfer heat away from heat-generating components, such as engine cylinders or electronic circuits.(Dhale et al., 2015)

1.2 Nanofluids:

Nanofluids are engineered colloidal suspensions containing nanoparticles typically less than 100 nanometers in size dispersed within a base fluid, such as water, oil, or ethylene glycol. These nanoparticles can be metallic, ceramic, or carbon-based, and they impart unique properties to the base fluid when dispersed in it.The addition of nanoparticles to the base fluid can lead to enhancements in thermal conductivity, heat transfer efficiency, and other physical properties. This makes nanofluids promising candidates for various heat transfer applications, such as cooling systems in automotive engines, electronics, and industrial processes.(Chang et al., 2011)

Nanofluids have been studied extensively in recent years due to their potential for improving the performance of heat transfer systems. However, challenges remain in terms of cost-effectiveness, stability of the nanoparticle dispersion, and scalability for practical applications. Research and development in nanofluid technology continue to explore ways to address these challenges and unlock the full potential of nanofluids for real-world applications.(Eastman et al., 2001)

1.2.1 types of Nanofluids:

Nanofluids can be categorized based on the type of nanoparticles dispersed in the base fluid. Here are some common types of nanofluids:

1. Metallic Nanofluids: These nanofluids contain metallic nanoparticles dispersed in the base fluid. Common metallic nanoparticles used include copper, silver, gold, aluminum, and iron. Metallic nanofluids are often used in heat transfer applications due to their high thermal conductivity and excellent heat transfer properties.

2.Ceramic Nanofluids: Ceramic nanofluids contain ceramic nanoparticles dispersed in the base fluid. Examples of ceramic nanoparticles include alumina (Al_2O_3), titania (TiO_2), silica (SiO_2), and copper oxide (CuO). Ceramic nanofluids are known for their stability, resistance to corrosion, and potential for high-temperature applications.

3. Carbon-based Nanofluids: Carbon-based nanofluids contain carbon nanoparticles dispersed in the base fluid. Carbon nanoparticles can include graphene, carbon nanotubes (CNTs), and fullerenes (such as buckyballs). Carbon-based nanofluids offer unique properties such as high mechanical strength, electrical conductivity, and thermal stability.

4. Hybrid Nanofluids: Hybrid nanofluids combine nanoparticles from different material categories to create nanofluids with tailored properties. For example, hybrid nanofluids may contain a combination of metallic, ceramic, and/or carbon-based nanoparticles dispersed in the base fluid. Hybrid nanofluids aim to leverage the advantages of multiple nanoparticle types to achieve enhanced performance in specific applications.

These are just a few examples of the types of nanofluids available. The choice of nanofluid type depends on the specific application requirements, desired properties, and performance objectives.(Elango et al., 2015)

1.2.2 Nanofluids in cooling system:

Nanofluids have garnered interest for use in cooling systems due to their potential to improve heat transfer efficiency and overall cooling performance. When introduced into a cooling system, nanofluids disperse nanoparticles within the base fluid, typically water or ethylene glycol. These nanoparticles, which are typically metallic, ceramic, or carbon-based, can enhance the thermal conductivity of the coolant. In a cooling system, nanofluid coolant can help dissipate heat more effectively from components such as automotive engines, electronic devices, and industrial machinery. By improving thermal conductivity, nanofluids can facilitate faster heat transfer and more efficient cooling, which can lead to lower operating temperatures and reduced risk of overheating.(Hojjat et al., 2011)

However the practical implementation of nanofluids in cooling systems faces challenges such as nanoparticle stability, cost-effectiveness, and compatibility with existing cooling system materials. Additionally, proper dispersion and uniform distribution of nanoparticles within the coolant are crucial for optimal performance.Despite these challenges, ongoing research and development efforts continue to explore the potential benefits of nanofluids in cooling systems and address the associated technical and practical considerations. While widespread adoption may still be on the horizon, nanofluids hold promise for improving thermal management in a variety of applications.(Hwang et al., 2009)

1.3 Copper oxide nanofluids:

Copper oxide nanofluid is a type of nanofluid in which copper oxide nanoparticles are dispersed in a base fluid, such as water, ethylene glycol, or oil. Copper oxide (CuO) nanoparticles have attracted significant attention due to their unique thermal, electrical, and optical properties, making them suitable for various applications, including heat transfer enhancement.In copper oxide nanofluids, the dispersed nanoparticles interact with the base fluid, altering its thermal conductivity and heat transfer characteristics. Copper oxide nanoparticles have high thermal conductivity, which can enhance the heat transfer efficiency of the nanofluid compared to traditional base fluids.(Hwang et al., 2007)

Copper oxide nanofluids have been studied for use in heat transfer applications such as cooling systems for electronics, automotive engines, and industrial machinery. They offer the potential to improve heat dissipation, reduce operating temperatures, and increase overall system efficiency.((Jung et al., 2006)

1.3.1 CuO in cooling system:

Copper oxide nanoparticles can be incorporated into coolant fluids to create nanofluid coolant solutions. These nanofluid coolants have the potential to enhance heat transfer and improve the overall efficiency of cooling systems in various applications.When copper oxide nanoparticles are dispersed in a coolant fluid, they can increase the thermal conductivity of the mixture. This means that heat can be transferred more efficiently from the heat-generating components to the coolant, and then dissipated away from the system more effectively.(Devireddy et al., 2016)

As a result, using copper oxide nanofluid coolant in cooling systems can help reduce operating temperatures, prevent overheating, and improve the overall performance and longevity of the system. In automotive cooling systems, for example, using copper oxide nanofluid coolant may lead to better engine temperature regulation, especially under high-stress conditions or in extreme temperatures. Similarly, in electronic cooling applications, such as in computers or power electronics, copper oxide nanofluid coolant can help dissipate heat more efficiently, leading to improved device performance and reliability.(Godley et al., 2015)

chapter two

PREPARATION METHOD

2. Experiment method:

The matreials used for preparation are Cupric Nitrate, D Glucose, Sun flower Oil. The entire above chemical reagent used in this project is of analytical grade.(Godley et al., 2015)

2.1. Synthesis of CuO Nanoparticle:

Copper Oxide nanoparyicles has been prepared using Auto combustion method. 3 gms of cupric Nitrate is mixed with 10 ml of distilled water. The mixture is then homogenized by stirring it continuously for 15 minutes.Blue coloured solution was obtained. Now 2.8 gms of D Glucose has been added in 10ml of distilled waterseparately. Here, D Glucose is used as fuel for combustion process. The prepared hexamine solution was then added to the copper nitrate solution. The colour and texture of solution gets changed from solution to gel form. Then the solution is been placed in a heating mantle at 80 C. After reaching particular temperature gel starts burned out forming black coloured powder. The ashes obtained after combustion burning was copper oxide nanoparticles which is shown in figure 1.

Figure 1 Combustion burning of Copper Oxide.

2.2. Preparation of copper oxide nanofluid:

The prepared copper Oxide nanoparticles are dispersed in 10ml of sunflower oil. The mixture is stirred continuously for half an hour for obtaining saturated fluid. Then the saturated solution is kept in ultra sonicator for 1hour for complete dispersion of nanoparticle in base fluid. Thus the obtained nanofluids have kept undisturbed to study the stability of nanoparticle in base fluid. The stability has been analyzed using sedimentation method.

2.3 Result And Discussion:

A. Variations of viscosity for nanofluid at different volume fraction.

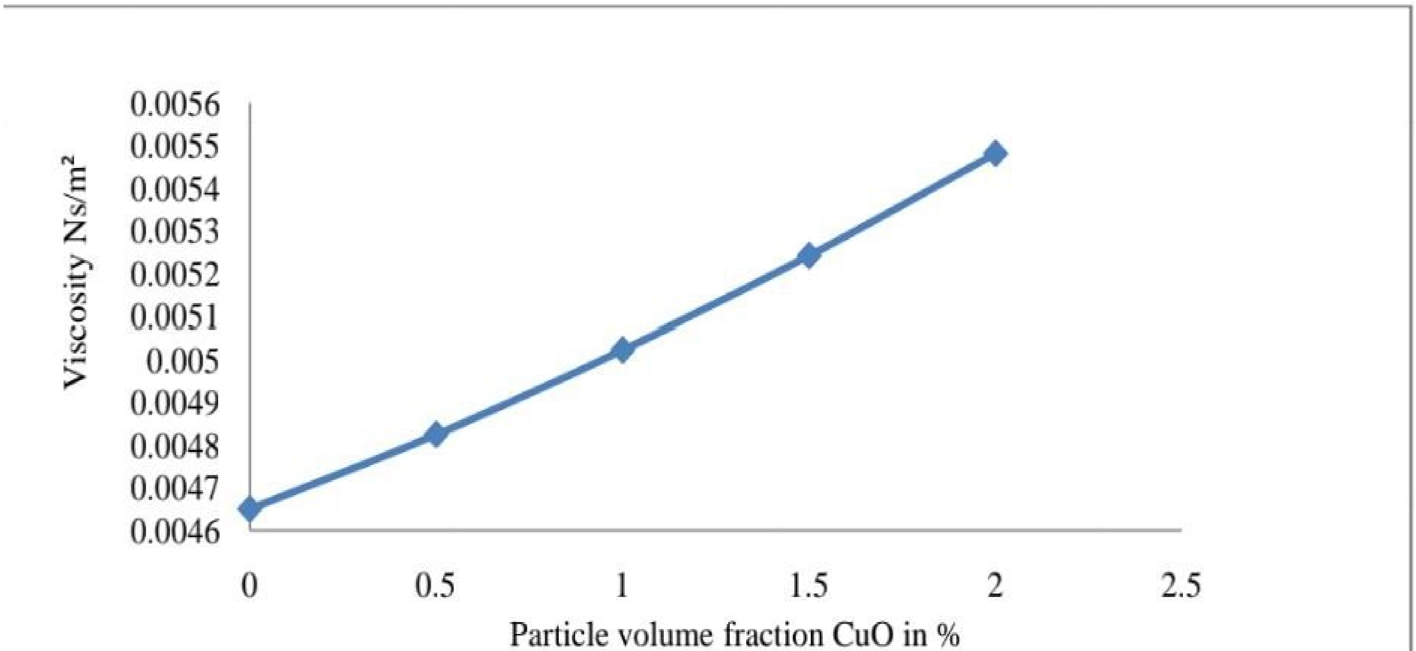

Figure 2: Variations of Viscosity for Nanofluid at different Particle fraction

In Shown Figure 2 we have taken particle volume fraction 0.5%,1%,1.5%,2% then we achieved maximum Viscosity 0.005481 Ns/m2.

B. Variation of over all heat transfer coefficient at different volume fraction.

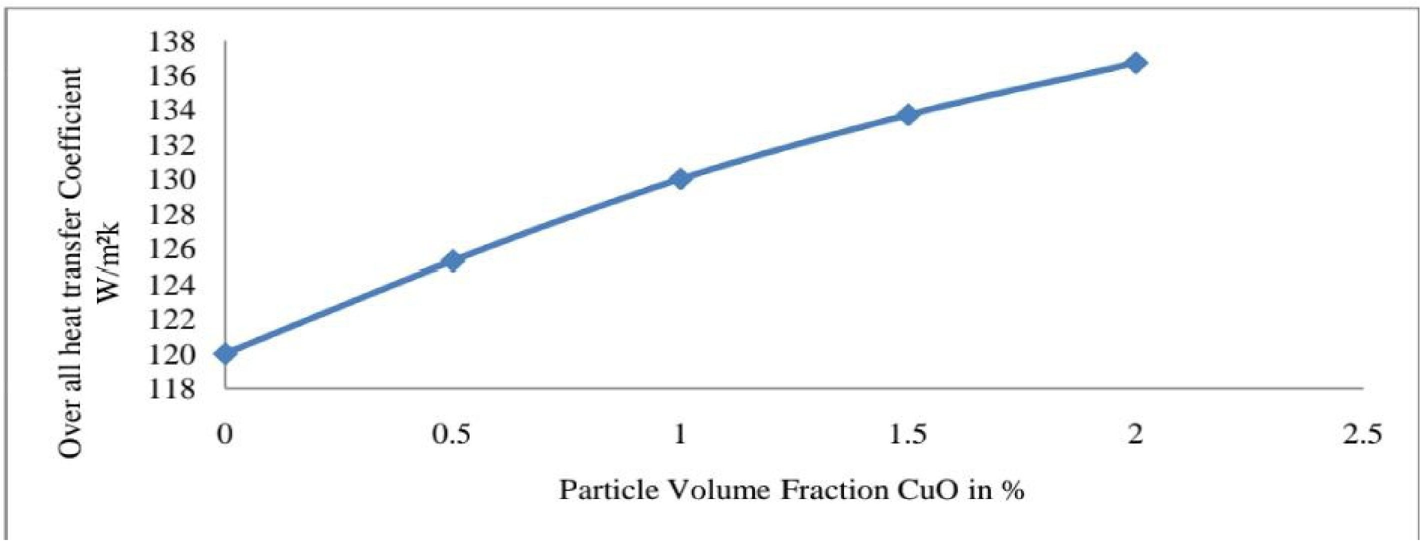

Figure 3: Variations of Overall heat transfer coefficient for nanofluid at different volume fractions.

Figure3 shows the overall heat transfer coefficient for CuO-water nanofluid coolant in an automotive radiator that has been calculated by Equation. In this analysis, Reynolds number of the nanofluid is 6000. As shown in this figure, the overall heat transfer coefficient is high when the probability of collision between nanoparticles and the wall of the flat tubes has increased under higher concentration conditions. It confirms that nanofluids have considerable potential to use in the automotive radiator. A further inspection of Figure 3 shows that the Overall heat transfer coefficient of the CuO-water nano-fluid for volume concentrations in the range of 0.5% to 2% is about 120.6 and 136.7 W/m2k, respectively.

C. Variation of over all heat transfer coefficient at different flow rate

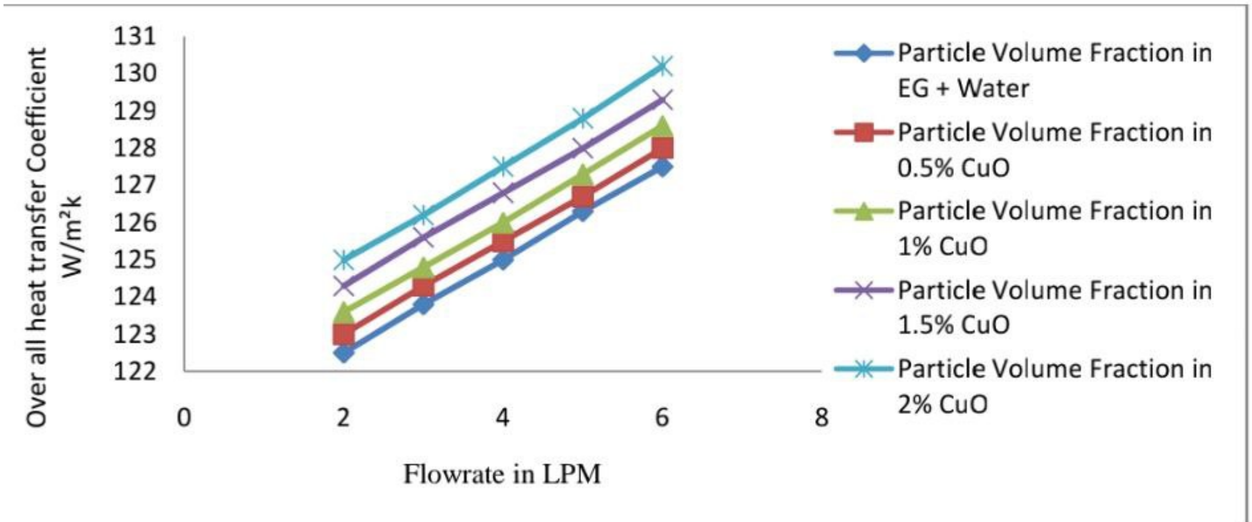

Figure 4: Variation of Overall heat transfer coefficient for nanofluid at different flowrate in (LPM).

Figure 4 shows Overall heat transfer coefficient on air side was increased with flow rate. Heat transfer enhancement was also observed with increase in mass flow rate of the coolant. But it cannot increase beyond certain limit because of constrains in size/flow area of the radiator tubes. We have taken flowrate 2,3,4,5 and 6 LPM then we achieved maximum over all heat transfer coefficient 130.2 W/m2K at 6 LPM flowrate.

D. Variations of pressure drop, pumping power for nanofluid at different volume fractions

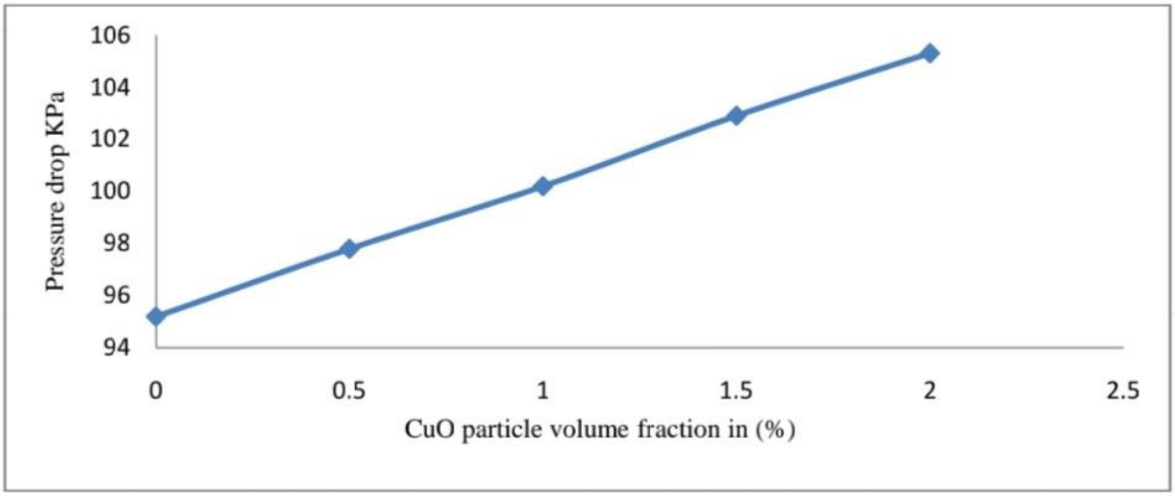

Figure 5: Variations of Pressure drop for nanofluid at different volume fractions.

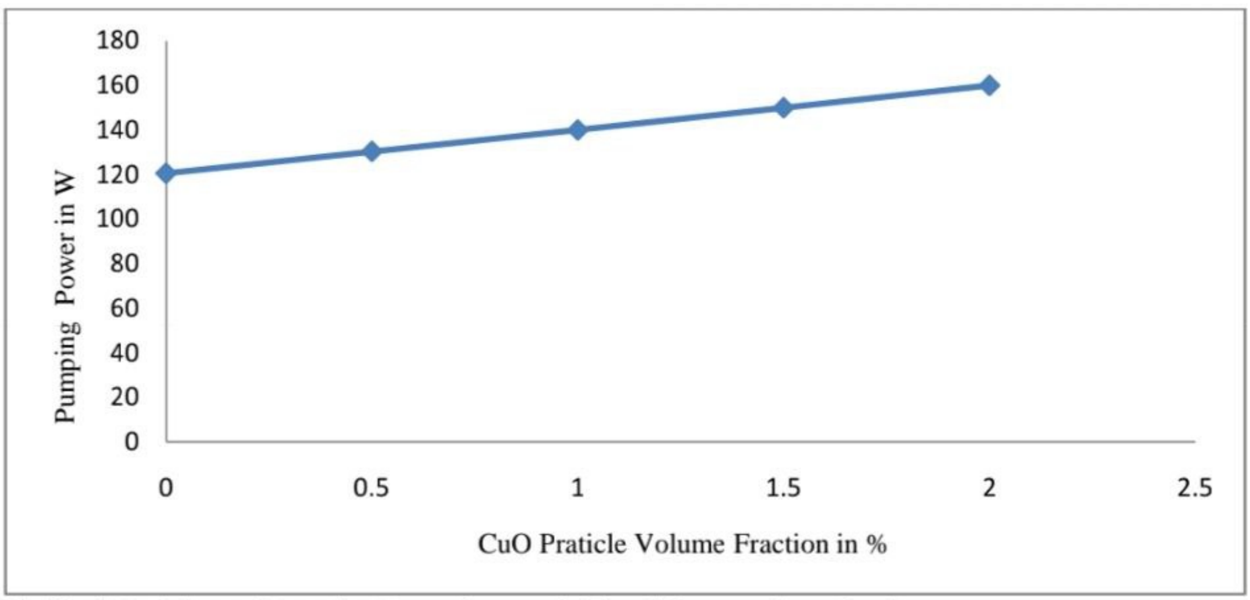

Figure 6: Variations of Pumping Power for nanofluid at different volume fractions.

In order to apply the nanofluids for practical application, in addition to the heat transfer performance it is necessary to study their flow features. With increasing nano- particles loading in the base fluid, viscosity and density of the nanofluids increase and therefore the friction factor and the pressure drop must be increased. Hence, nanofluids generally require the greater pumping power than their base fluid. In the present paper, the pumping power for CuOwater nanofluid coolant flowing in the flat tubes in the various ranges of the coolant Reynolds number.

CHAPTER THREE

APPLICATION

&

PROPERTIES

3.Uses of antifreeze :

An antifreeze is an additive which lowers the freezing point of a water-based liquid and increases its boiling point. An antifreeze quid an antifreeze mixture is used to achieve freezing-point depression for cold environments and also achieves boiling-point elevation ("anti-boil") to allow higher coolant temperature. Freezing ng-points and also and boiling points are colligative properties of ("anti-boil") to a solution, which depend on the concentratior of the dissolved substance. Because water has good properties as a coolant, water plus antifreeze is used in internal combustion engines and other heat transfer applications, such as HVAC chillers and solar water heaters. The purpose of antifreeze is to prevent a rigid enclosure from bursting due to expansion when water freezes. Commercially, both the additive (pure concentrate) and the mixture (diluted solution) are called antifreeze, depending on the context. Careful selection of an antifreeze can enable a wide temperature range in which the mixture remains in the liquid phase, which is critical to efficient heat transfer and the proper functioning of heat exchangers.(Das et al., 2006)

Other uses

The most common water-based antifreeze solutions used in electronics cooling are mixtures of water and either ethylene glycol (EGW) or propylene glycol (PGW). The use of ethylene glycol has a longer history, especially in the automotive industry. However, EGW solutions formulated for the automotive industry often have silicate based rust inhibitors that can coat and/or clog heat exchanger surfaces. Ethylene glycol is listed as a toxic chemical requiring care in handling and disposal. Ethylene glycol has desirable thermal properties, including a high boiling point, low freezing point, stability over a wide range of temperatures, and high specific heat and thermal conductivity. It also has a low viscosity and, therefore, reduced pumping requirements. Although EGW has more desirable physical properties than PGW, the latter coolant is used in applications where toxicity might be a concern. PGW is generally recognized as safe for use in food or food processing applications, and can also be used in enclosed spaces.(Nguyen et al., 2007)

Similar mixtures are commonly used in HVAC and industrial heating or cooling systems as a high-capacity heat transfer medium. Many formulations have corrosion inhibitors, and it is expected that these chemicals will be replenished (manually or under automatic control) to keep expensive piping and equipment from corroding.(Vajjha et al., 2010)

3.1 Application of antifreeze :

Antifreeze Special is free from amine, phosphate and nitrite etc. And uses as engine Antifreeze as well as coolant. This product is based on ethylene glycol. It contains a corrosion inhibitor, salts of organic acids and silicates (Si-OAT). It protects all metallic parts against corrosion and deposits in the cooling system.((Oliveira and Bandarra Filho, 2014)

3.2.Related product of antifreeze :

- Anti Corrosive Agent
- Antifreeze Agent
- Antifreeze Liquid
- Antifreeze Liquid 210 Ltrs
- Antifreeze Plus Corrosion Scale Inhibitor 25 Ltrs
- Antifreeze with Potassium Chromate

3.3 coolant properties:

Engine coolant is a fluid mixture that aids heat transfer plus ensures the optimum operating temperature of most fossil-fuel-powered engines.Its primary function is to keep the engine at a constant safe operating temperature but also, with the addition of other chemicals called inhibitors, to control the formation of scale and rust. Inhibitors also prevent cavitation, that is, oxidation from water passing through the cooling system. Anti-freeze / Anti-Boil coolants lower the freezing point of the coolant while raising the boiling point. Corrosion inhibitors have little or no Anti-Freeze / Anti-Boil properties and are used primarily to protect surface materials in the cooling system from corrosion.((Leong et al., 2010)

3.3.1.what type of coolant:

Type A and Type B are the two main categories of coolant. Type A has an Anti-Freeze Anti-Boil package included present as Ethylene Glycol or similar, an additive package which raises the boiling point of the water and lowers the freezing point. Type B does not have an Anti-Freeze Anti-Boil additive package added and are true corrosion inhibitors only with no or little AF/AB properties. There are different formulations of both Type A and Type B. Some are not compatible.

3.3.2.A good coolant provide the flowing:

- Good heat transfer.
- Protection against deposits.
- High-temperature protection.
- Safe to use with hard waters.
- Won’t damage and be neutral with internal components
- Reduced foaming tendency

3.3.3.Coolant Color:

Just because a coolant is colored doesn’t mean it’s an antifreeze anti-boil product or a corrosion inhibitor. The color in the coolant is a dye and should never be used to distinguish the type of coolant. Many OEM manufacturers add dye in their coolant mainly to aid in the identification of brand (specific to that make) or type of coolant. Aftermarket manufacturers usually use dye to differentiate the type. Type A or Type B should be clearly labeled on the packaging. The OEM manufacturer will indicate what is suitable for the vehicle and is usually found in the owner’s service appendix.(Kurhe et al., 2016)

3.4 Advantage of Coolant:

Certainly! Coolants offer numerous advantages across various applications:

1. Temperature Regulation: Coolants efficiently dissipate heat, preventing equipment from overheating and maintaining optimal operating temperatures.

2. Heat Transfer Enhancement: Coolants improve heat transfer efficiency, allowing for better performance and energy savings in systems such as automotive engines, electronics, and industrial machinery.

3. Freeze Protection: Coolants prevent freezing in cold temperatures, ensuring continuous operation in harsh environments and protecting equipment from damage.

4. Corrosion Inhibition: Many coolants contain additives that protect system components from corrosion, extending equipment lifespan and reducing maintenance costs.

5. Lubrication: Some coolants provide lubrication properties, reducing friction and wear on moving parts within the system.

6. Compatibility: Coolants are formulated to be compatible with various materials commonly found in cooling systems, minimizing the risk of damage or degradation.

7. Versatility: Coolants can be tailored to meet specific requirements of different applications, allowing for customization based on temperature range, performance needs, and environmental considerations.

8. Environmental Safety: Environmentally friendly coolant formulations are available, reducing the ecological impact and ensuring safer handling and disposal practices.

9. Efficiency Improvement: By maintaining optimal temperatures and improving heat transfer, coolants contribute to overall system efficiency, leading to energy savings and improved performance.

10. Reliability: Proper coolant management ensures consistent system operation, reducing downtime and the risk of equipment failure.

3.4.1.Disadvantage of Coolant:

While coolants offer numerous benefits, they also come with some disadvantages:

1. Environmental Impact: Traditional coolant formulations, especially those containing ethylene glycol, can be toxic to humans, animals, and the environment if not handled or disposed of properly. Accidental spills or leaks can contaminate soil and water sources, posing risks to ecosystems.

2. Health Risks: Exposure to certain coolant chemicals, such as ethylene glycol, can lead to adverse health effects if ingested, inhaled, or absorbed through the skin. This poses risks to individuals working with coolants or exposed to them in poorly ventilated areas.

3. Maintenance Requirements: Coolant systems require regular monitoring and maintenance to ensure proper levels, condition, and performance. Neglecting maintenance can lead to coolant degradation, corrosion, and reduced effectiveness, potentially causing damage to equipment.

4. Cost: Coolants can be relatively expensive, especially specialty formulations or those containing additives for specific applications. Additionally, the cost of disposal and environmental compliance adds to the overall expense of coolant management.

5. Performance Limitations: While coolants are designed to withstand a range of operating conditions, they may have limitations in extreme environments or under severe stress. In some cases, alternative cooling methods or supplementary cooling systems may be required to augment coolant performance.

3.5 Conclusion:

- The density and viscosity of nanofluid is increased with the addition of copper oxide nanoparticle from (0% to 2%) About at 10% nanofluid density & 19.35 viscosity is increased at 2% of CuO in linear way.

- Heat transfer rate is increased with increase in volume concentration of nanoparticle (0.5%, 1%, 1.5%, and 2%). In this study 4.2% heat transfer enhancement was reached with addition of 2% CuO nanoparticle at 6000-8000Reynolds number and constant flow rate 2-5 LPM.

- Extra 14.8% pumping power is requirement for the radiator using 2% CuO nanoparticles with Ethylene Glycol + Water combination (50:50) at 5 LPM coolant flow rate compared to that of using Base fluid same radiator.

- It is not justified to increase the volume concentration of nanoparticle beyond 2% as it will not only increase the pressure drop/pumping power but also increases the cost of the system although some increase in heat transfer coefficient also increases.

- It is not justified to increase the mass flow rate beyond certain limit because of fixed sizes/flow are of radiator tubes.

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حوکومەتی هەرێمی کوردستان-عێراق

وەزارەتی خوێندنی باڵا &تویێژینەوەی زانستی

زانکۆی سەلاحەدین- هەولێر

کۆلێژی زانست

بەشی کیمیا

باشترکردنی کارای سیستەمی ساردکردنەوەی بزوێنەر بە بەکارهێنانی نانۆشلەی ئۆکسیدی مس

پرۆژەی دەرچوونە

پێشکەش بە بەشی (کیمیا) کراوە، وەك بەشێك لەپێداویستەکانی بەدەستهێنانی بڕوانامەی بەکالۆریۆس لە زانستی (کیمیا ،)

ئامادەکراوە لەلایەن:

نور شاکر اسماعیل

بەسەرپەرشتی:

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نیسان،٢٠٢٤ نەورۆز،٢٧٢٤ ڕەمەزان،١٤٤٥