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A Review on Nanofluids the next Super Coolant for Radiator

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***Abstract*—A radiator which is commonly found in automobiles, buildings and electronics is a type of heat exchanger for heat transfer application. It serves the purpose of heating and cooling of systems by convection, conduction and by radiation. The radiator is used to heat the environment or to cool the fluid or coolant supplied, which always acts as a source of heat to its environment, for example automotive engine cooling and HVAC dry cooling towers. Due to ever-rising demands for higher efficiency and effectiveness, there is a need to enhance the performance of automobile radiators for obtaining an overall improvement in performance of the functioning of IC engines. A possible solution to increase the heat transfer rate of radiators is by using nanofluids as a coolant, which will pass through it. These conventional fluids are specially synthesized fluids in which the particles size varies from 1-100 nm. Nanofluids are engineered colloidal suspensions of nanoparticles in a base fluid. The nanoparticles generally used are metals, oxides, carbides or carbon nanotubes. Base fluids include water, ethylene glycol or oil.**

Keywords—* *Radiator, Heat Exchanger, IC engine, Nanofluids, HVAC, Ethylene Glycol.

I. INTRODUCTION

Energy is a critical quantitative property that must be transferred before any system can do work. Energy can be transferred using either work or heat. When there is a temperature difference between two systems, heat is transferred from one to the other and travels from high to low temperatures. Heat transfer is the science that describes the way and rate at which thermal (heat) energy is transferred. In our daily lives, we encounter heat transfer applications; the human body, for example, is constantly emitting heat, and humans adjust their body temperature to suit environmental conditions by wearing clothing. Heat transfer is also used to regulate temperature in our buildings and is required for cooking, refrigeration, and drying. This concept is also in use in automobile radiators to control the temperature of electronic devices and IC engine. Heat transfer enhancement is a major concern in the field of thermal engineering. Therefore, efforts need to be put to improve the heat transfer performance of thermal devices used in many engineering applications.

Heat transfer improvement can be made by increasing:

(i) Heat Transfer Area,
(ii) Temperature difference,
(iii) Heat transfer co-efficient.

However, technologies have already reached their limit for the first two cases. Recently many researchers found that dispersing nanosized particles into the liquids result in higher heat transfer co-efficient. These newly developed fluids are known as nanofluids compared to the traditional liquids. Heat transfer is used in solar thermal collectors to convert solar energy to heat and power, as well as in spacecraft thermal control elements. Many of these devices require rapid heat dissipation to ensure effective operation and maximum efficiency within the system. As technology advances, devices become smaller, necessitating improved thermal management. Essentially, the smaller the size, the greater the need for effective cooling technology. As a result, heat transfer enhancement is a critical area in thermal engineering.

Rising petroleum prices and energy-saving awareness have focused attention on the issue of how to enhance vehicle fuel efficiency. Numerous mechanical experts are committed to develop a new type of engine or vehicle to enhance the performance of a vehicle's heat dissipation system, to reduce the weight of the cooling equipment to save fuel for vehicles. The use of a coolant with a high heat dissipation performance to enhance the cooling efficiency is the easiest method for enhancing the heat dissipation performance. Numerous researchers have added nanomaterials to the working fluid to form a stable suspension and called this stable suspension as "nanofluids", the purpose of which is to obtain excellent thermal conductivity and heat transfer performance.

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Therefore, using nanofluids with a high thermal performance in a vehicle cooling system is worthy of research. Several techniques have been investigated in order to improve the heat transfer coefficient between the working fluids and the fluid contact surfaces. Water, thermal oils, and ethylene glycol/water are examples of traditional heat transfer fluids and have some limitations because their thermal properties are much lower than those of solids. The addition of nanoscaled particles to improve the thermal properties of these fluids has resulted in an evolution in the study of heat transfer fluids. The suspension of these solid particles in the base fluid improves energy transmission in the fluid, resulting in improved thermal conductivity and heat transfer properties. Choi and Eastman were the first to coin the term "nanofluid."[1]. Nanofluids are colloidal suspensions of nanoscaled particles (1–100 nm) in a base fluid. These particles are typically made up of metals, metal oxides, or other carbon-based elements. Maxwell was the first to discuss the suspension of micro-scaled particles in a fluid over a century ago. [1] However, microparticles settled quickly in the fluid, causing abrasion and clogging of the flow channel and limiting future research into fluid suspensions. Furthermore, the significant enhancement seen today with the use of nanofluids is not being observed with these fluids. The use of nanoparticles has allowed for more research into colloidal dispersion in fluids. When nanoparticles are dispersed in fluids, they become more stable and tend to improve the thermal properties of the fluids. Other properties of nanofluids that make them suitable heat transfer fluids include particle Brownian motion, particle/fluid nanolayers, and lower pump power when compared to pure liquids to achieve intensified heat transfer.

Modern material technology helps us to produce nanometer-sized particles and their thermophysical properties are different from those of the parent materials. Recently, there has been interest in using nanoparticles to modify heat transfer performance of suspensions. Nanofluids are stable suspension of nanometer-sized particles (smaller than 100 nm in at least one dimension) in conventional heat transfer fluids. Nanofluids are suitable for engineering applications and show several potential advantages such as better stability, dramatically high thermal conductivity and no extra pressure drop compared to other suspensions.

II. ESTABLISHED WORK

The usage of TiO_2-water nanofluid's as a cooler in car engine radiator was studied. Based on the experimental results, TiO_2-water nanofluid offers a better overall performance than base fluid. The overall heat transfer coefficient of TiO_2 nanofluids in an automobile radiator was experimentally measured as a function of concentration and temperature. It was found that the presence of TiO_2 nanoparticle can significantly enhance radiator's heat transfer rate in a manner dependent on nanoparticle quantity added to the base fluid. Heat transfer coefficient significantly improves for 0.2% nanoparticle concentration as compared to pure water. This is due to the fact that TiO_2's greater thermal conductivity, aspect ratio, lower specific gravity, thermal resistance and larger specific area as compared to pure water. [2]

The thermal conductivity of Cu/Water nanofluid is increasing significantly with nanoparticle volume fraction of 1 % to 10 % but decreasing with the increment of particle size. The suspension of nanoparticles has increased the heat transfer coefficient of the nanofluid significantly up to 26000 W.m-2K-1 with the percentage enhancement is about 92 %. The overall heat transfer rate of louvered-fin and flat tube radiator shows the percentage enhancement is approximately 0.03 % as considering both types of coolants; the nanofluids and air. [3]

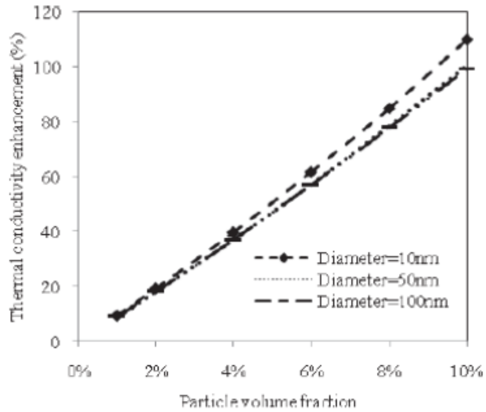

Fig. No - 1 Nanofluid thermal conductivity as a function of nanoparticle volume fraction.

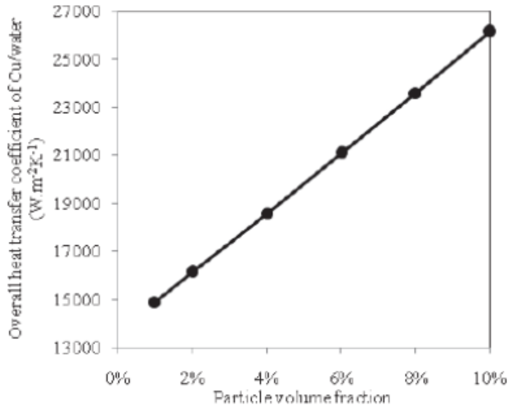

Fig. No. - 2 Overall heat transfer coefficient as a function of nanoparticle volume fraction.

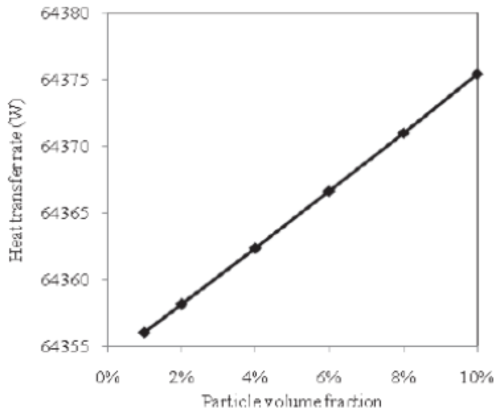

Fig. No. 3 – Heat transfer rate of a lovered-fin and flat tube radiator

The heat transfer and performance analysis of an automotive radiator have been done using aluminum

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nanofluids as coolant. At lower engine speed, superior nanofluid performance is obtained. Based on the results and discussions, the following conclusions can be made: -

1. The temperature depends on the volumetric concentrations of nanoparticles and speed of the engine; however, the difference between nanofluid and EG/W is rather similar [4]
2. In all cases studied, aluminum nanofluid has higher heat transfer of 2% as compared to EG/W. The maximum value of heat transfer rate is equal to 43.58 kW for φ=6% and low engine speed [4]
3. The same scenario it is possible to note the pumping power trend. The maximum value of the pumping power is equal to 1.15 kW for φ=6% and low engine speed; Due to the higher pumping power needed to pump nanofluids, the performance index of nanofluids has values smaller than the performance index of EG/W [4]

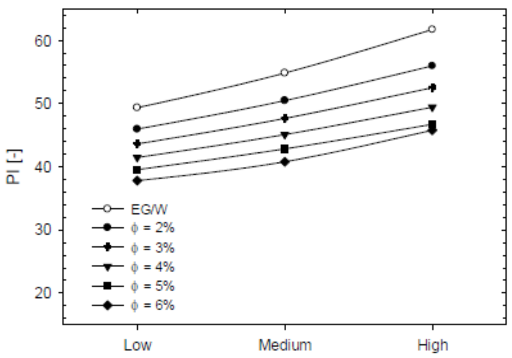

Fig. No. 4 – Performance index as a function of engine speed.

III. CONCLUSION

From the established work done we can conclude that Titanium dioxide is not preferable because of its cost. Whereas thermal conductivity of Cu/Water nanofluid is increasing significantly with nanoparticle volume fraction of 1 % to 10 % but decreasing with the increment of particle size. [3]

In case of Aluminum oxide at lower engine speed, superior nanofluid performance is obtained with a particle volume fraction of 6%. [4]

IV. FUTURE SCOPE

Since the former two nanofluids have certain limitations, experiments can be performed on aluminum oxide by increasing the particle volume fraction beyond the aforementioned value. Other parameters such as Flow rate of nanofluid through the radiator, size of nanoparticles, purity of the nano material can also be varied. By changing the mentioned parameters the results that can be obtained will be more precise and accurate.

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