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Enhancement of Heat Transfer Rate in Automobile Radiator -Review Article

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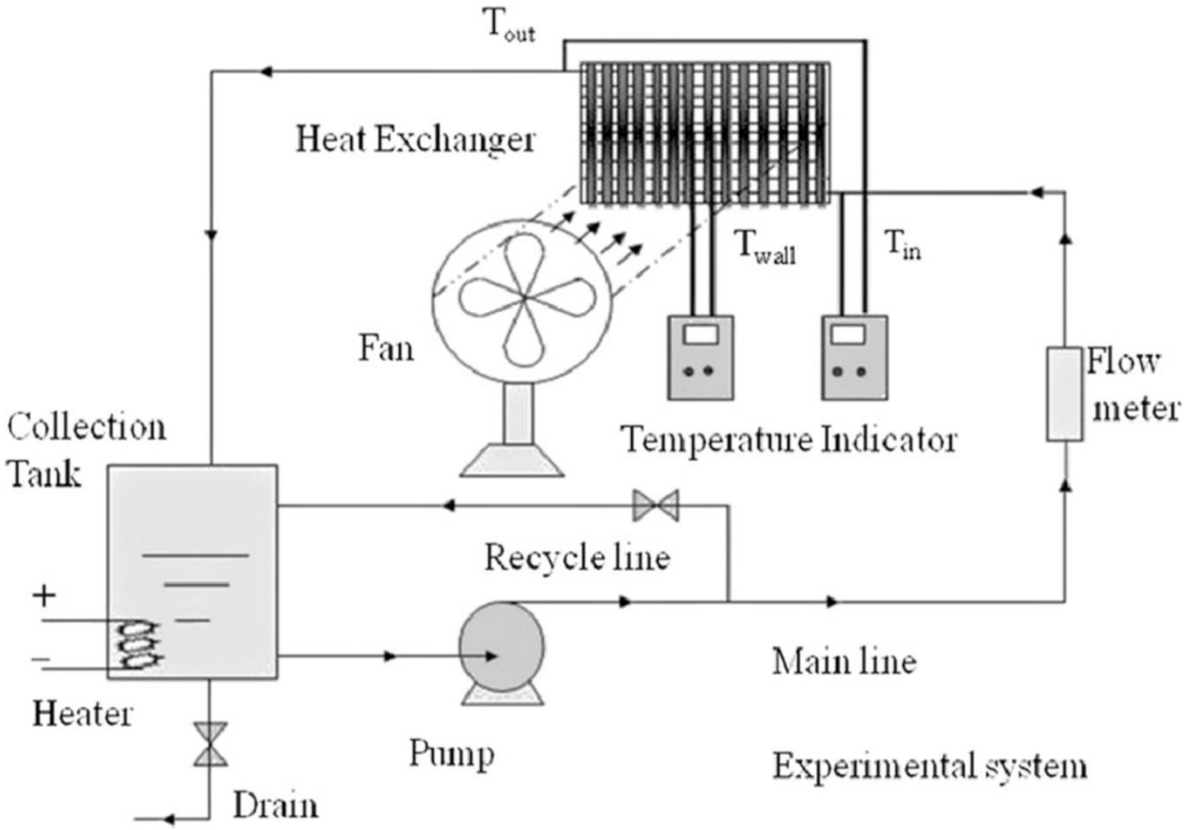
Abstract: Today the demand of vehicle is increasing with increasing in technologies. So, there is a challenge for automobile industry to give rise in efficiency and economy. The performance of car is affect by aerodynamic, fuel efficiency, engine cooling, transmission etc. So it becomes necessary to improve them while designing of vehicle for improve engine performance. Cooling system plays a big role in all over the structure among all. It has a responsibility to keep engine cool for all over the time. It also enhanced heat transfer and increase engine performance. Earlier water base coolants are used as a cooling of an engine. With the advancement of nanotechnology, the new era of heat transfer is "Nano fluids" have been developed and it offers higher thermal conductivity than conventional cooling fluid. The study of Nano fluid as a coolant in automobile radiator its application, merits, demerits have been issued and reviewed for automobile industry. The addition of nanoparticles enhanced the heat transfer performance by 37 %. All the experiments have been conducted at a constant0020coolant flow rate and coolant inlet temperatures varying from 40 oC to 70 oC.

Key words: Nano Fluid, Radiator, Heat transfer rate, Cooling Performance, Increase efficiency

Introduction: Continuous technological development in automotive industries has increased the demand for high efficiency engines. A high efficiency engine is not only based on its performance but also for better fuel economy and less emission. Reducing a vehicle weight by optimizing design and size of a radiator is a necessity for making the world green. Addition of fins is one of the approaches to increase the cooling rate of the radiator. It provides greater heat transfer area and enhances the air convective heat transfer coefficient. However, traditional approach of increasing the cooling rate by using fins and microchannel has already reached to their limit In addition, heat transfer fluids at air and fluid side such as water and ethylene glycol exhibit very low thermal conductivity. As a result there is a need for new and innovative heat transfer fluids for improving heat transfer rate in an automotive car radiator. Nanofluids seem to be potential replacement of conventional coolants in engine cooling system. Recently there have been considerable research findings highlighting superior heat transfer performances of nanofluids. Reported that about 15-40% of heat transfer enhancement can be achieved by using various types of nanofluids. With these superior characteristics, the size and weight of an automotive car radiator can be reduced without affecting its heat transfer performance. This translates into a better aerodynamic feature for design of an automotive car frontal area. Coefficient of drag can be minimized and fuel consumption efficiency can be improved. Therefore, this study attempts to investigate the heat transfer characteristics of an automotive car radiator using water based Aluminium Oxide nanofluids as coolants. Thermal performance of an automotive car radiator operated with nanofluids is compared with a radiator using conventional coolants. The effect of volume fraction of the Aluminium Oxide nanoparticles with basefluids on the thermal performance and potential size reduction of a radiator were also carried out. Aluminium Oxide nanoparticles were chosen in this study since it has higher thermal conductivity compared to other nanoparticlesSample paragraph, The entire document should be in cambria font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes. The entire document should be in cambria font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

Project setup: The project of using nanofluid include some nanofluids like aluminium oxide, titanium oxide, copper oxide and others. Specific components of this project are radiator for cooling of nanofluid, pump for transferring coolant, vehicle engine or a heater for heat purpose which is cool down by nanofluid, vibrating devices for mixing of nanoparticles in to the base fluid, different sensors to get reading of temperature for specific result. So these are the components of this project and some others at the time of manufacturing of this project.



Project procedure: This experimental setup includes a reservoir in the form of plastic tank, electrical heater, pump, a flow meter, flow control valves, fan, D.C power supply , temperature sensor, vibrating device and heat exchanger (automobile radiator).

Nano particles mixed with base fluid water called the Nano fluid fill in the coolant tank. Vibrating device continuously mix up those nanoparticles with water.

Then the cooling system start, Nano fluid goes into the wall of engine cylinder(Heater) through pipes which cools down the engine.

Two temperature sensors fitted with before engine and after engine and also for radiator at inlet and outlet. Which measure the temperature of engine. After that, Nano fluid goes into the radiator at which it is cooled down and cycle is repeated.

Project specification: In a heavy duty engine vehicle, 30 % of total energy is use to drive the vehicle. Another 30% is removed as heat energy by exhaust system. Remaining energy in form of heat is taken by engine coolant. This heat is removed by the coolant, which provide a heat balance in vehicle. This result is for a short duration of traveling but for a long duration of drive the overheating is a problem of deterioration of the oil and engine itself.

Physical characteristic of Al_2O_3 nanoparticle was used in this study.

Particle	Average Diameter (nm)	Superficial Density (Kg/m^3)	Actual Density (Kg/m^3)	C_P (J/kg K)	K (W/m K)
Al_2O_3	20	160–400	3700	880	46

The ability of nanofluids that exhibits enhanced thermal performance is acknowledged by researchers through studies since decades ago. However, the observation of thermal properties for nanofluids in water and ethylene glycol based is not fully explored yet. Hence, the thermal conductivity of water and ethylene glycol (EG) based Al2O3 nanofluid. The 36 nm sized Al2O3 nanoparticles were dispersed into three different volume ratio of water: EG such as 40:60, 50:50 and 60:40 using a two-step method. The measurement of thermal conductivity was performed using KD2 Pro Thermal Properties Analyzer at working temperatures of 30 to 70°C for volume concentration of 0.5 to 2.0%. The results indicate that the thermal conductivity increases with the increase of nanofluid concentration and temperature. While the percentage of ethylene glycol increase, the range of thermal conductivity decreases due to ethylene glycol properties. The measurement data of the nanofluids give maximum enhancement of thermal conductivity at condition 2.0% volume concentration, temperature of 70°C and for all base fluid.

Nano fluid	Base fluid	Size of nanoparticle (mm)	Enhancement of thermal property(%)
Al2o3	EG/WATER	36	9.8-17.9
Al2o3	EG	36	12.82
Al2o3	EG/WATER (20:80)	36	32.36
Al2o3	EG/WATER (40:60)	36	30.51

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LITERATURE REVIEW:

(1) Jaafar Albadr (2013) suggested that an experimental study on the forced convective heat transfer and flow characteristics of a nanofluid consisting of water and different volume concentrations of Al2O3 nanofluid (0.3–2)% flowing in a horizontal shell and tube heat exchanger counter flow under turbulent flow conditions are investigated. The Al2O3 nanoparticles of about 30 nm diameter are used in the present study. The results show that the convective heat transfer coefficient of nanofluid is slightly higher than that of the base liquid at same mass flow rate and at same inlet temperature. The heat transfer coefficient of the nanofluid increases with an increase in the mass flow rate, also the heat transfer coefficient increases with the increase of the volume concentration of the Al2O3 nanofluid, however increasing the volume concentration cause increase in the viscosity of the nanofluid leading to increase in friction factor.

(2) Dattatraya G. Subhedar, Bharat M. Ramani (2018): Implied that the heat transfer potential of Al2O3/Water-Mono Ethylene Glycol nanofluids is investigated experimentally as a coolant for car radiators. The base fluid was the mixture of water and mono ethylene glycol with 50:50 proportions by volume. The stable nanofluids obtained by ultra-sonication are used in all experiments. In this study nanoparticle volume fraction, coolant flow rate, inlet temperature used in the ranges of 0.2–0.8%, 4–9 l per minute and 65–85 °C. The results show that the heat transfer performance of radiator is enhanced by using nanofluids compared to conventional coolant. Nanofluid with lowest 0.2% volume fraction 30% rise in heat

transfer is observed. Also the estimation of reduction in frontal area of radiator if base fluid is replaced by Nanofluid is done which will make lighter cooling system, produce less drag and save the fuel cost

(3) K.P. Vasudevan Nambeesan, R. Parthiban (2015): said when an experimental study is carried out on heat transfer enhancement in an automobile radiator using Al2O3/water–ethylene glycol (EG) nanofluids is carried out. Heat transfer enhancement studies can help in the design of lighter and more compact radiators for the same given load, which in turn can improve the fuel economy of the automobile. A closed loop experimental setup is designed using a commercial automobile radiator for the study. The effect of adding EG to water on the overall heat conductance (UA) is studied using two mixtures of water–EG proportions, 90:10 and 80:20 (by volume). They showed a reduction in UA by 20% and 25% respectively. Experiments have also been done using Al2O3/water–EG nanofluids. The nanofluid was prepared using an 80:20 mixture and 0.1% (vol.) of Al2O3 nanoparticles. The addition of nanoparticles enhanced the heat transfer performance by 37 %. All the experiments have been conducted at a constant coolant flow rate and coolant inlet temperatures varying from 40 oC to 70 oC. The results showed that the heat transfer performance of the radiator reduced with the addition of EG and increased with the addition of nanoparticles to the water–EG mixture.

(4) Nandkumar Sadashiv Vele, Prof.(Dr.) R. K. Patil (2019) also mentioned that A colloidal mixture of nano-sized (<100 nm) particles in a base liquid called Nanofluid, which is the new generation of heat transfer fluid for various heat transfer applications where thermo-physical characteristics are substantially higher than the base liquid. In the present study, the effects due to temperature and concentration on thermo-physical properties (thermal conductivity, viscosity and density) for hybrid Nano fluids are discussed.The present work focuses on thermal conductivity and viscosity measurement of fluid mixture. This however, has not been addressed properly so far. It shows that thermal conductivity increases with nanoparticles concentration as well as with the temperature.Whereas,viscosity and density decreases with temperature and increases with nanoparticles concentration. Still more research is necessary to understand the mechanism behind the augmentation of heat transfer with hybrid nanofluids and to make use of hybrid nanofluids in real life applications.

(5) S. SENTHILRAJA, K. VIJAYAKUMAR, R. GANGADEVI (2015): mentioned in a study that the thermal conductivity of Al2O3/water, CuO/water and Al2O3 –CuO/water hybrid nanofluid were investigated experimentally. The two step method was adopted to prepare the hybrid nanofluid. Three different volume concentrations of nanofluids (0.05, 0.1 & 0.2%) were prepared by dispersing Al2O3 and CuO nanoparticles in water. The properties of single and hybrid nanofluids were measured by varying the temperature from 200C to 600C. The obtained results demonstrate that the thermal conductivity of nanofluids are the function of volume concentration and temperature. Also the experimental results showed that a maximum of 9.8 % enhancement of thermal conductivity was observed for 0.2% particle volume concentration. The experimental thermal conductivity values were compared with the theoretical thermal conductivity values.

(6)Devdatta P Kulkarni et al. [9] they performed the experiment on Diesel Electrical Generator using the water based Al2O3 nanofluids as a coolant in jacket cooling fluid. They used the nanofluids with various particle concentrations of 2%, 4% and 6%. The Reynolds number varies from 200-1400, and the fluid inlet temperature varies from 200-700 C. The investigation carried out by them, they shown that applying nanofluids resulted in reduction in cogeneration efficiency due to decrease in specific heat, which influences the waste heat recovery from the engine. From that, they concluded that efficiency of waste heat recovery heat exchanger was increased for nanofluids, due to its large convective heat transfer coefficient .

CONCLUSION: From the above study of nanofluids, following brief conclusions can be drawn. It has been seen that nanofluids can be considered as an effective fluid for an automobile application. Automobile radiators can be more efficient and compact by the use of nanofluid as a heat transfer application. Compact in size of radiator may result in decreasing aerodynamic drag, increasing fuel economy, and reduces the weight of the vehicle. The disadvantage is the mixing of particles can be solved putting vibrating devices in coolant passage. There are different challenges of nanofluids which should be identified and overcome for automobile radiators application. By solving the problem of above mention problems and cost, it is expected that nanofluids can make substantial impact as coolant in heat exchanging devices.

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