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EVALUATING THE EFFICIENCY OF CAR RADIATORS THROUGH THE APPLICATION OF ALUMINUM OXIDE AND LEMON JUICE AS NANOFLUIDS

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ABSTRACT
Heat is a thermal energy which is transferred between two mediums. It actually spread over a boundary of thermodynamic system. The thermodynamic free energy is the one in which the amount of work that a thermodynamic system can perform is performed. The Enthalpy is a thermodynamic potential and energy

Keywords:
Aluminum oxide (Al2O3), Radiator, NanoFluids.

1.INTRODUCTION

Heat is a thermal energy which is transferred between two mediums. It actually spread over a boundary of thermodynamic system. The thermodynamic free energy is the one in which the amount of work that a thermodynamic system can perform is performed. The Enthalpy is a thermodynamic potential and energy. This is the sum of the internal energy of the system and the product of volume and pressure. The heat transfer is a process function of an opposed to functions of state. The amount of heat transferred in a thermodynamic process is that changes the state of a system depends on how that process occurs. The Thermodynamic and mechanical heat transfer is calculated with the heat transfer coefficient. Heat flux is a quantitative of the representation of the heat flow in a surface. In engineering the term heat is taken as synonymous to thermal energy of a system. Heat is generally transferred from higher temperature to lower temperature. It does not require any medium. The heat transfer has been involved in almost every sector of the engineering field. The heat transfer is classified into conduction, convection and radiation.

In an automobile fuel and air produce power within the engine through combustion. Only a portion of the total generated power actually supplied to the automobile with power, and the rest is wasted as heat. If this excess heat is not removed the engine temperature becomes too high and resulting in quicker wear, among the related moving parts. A cooling system is compulsorily need and to be used to remove the excessive heat. Automotive engine cooling system takes care of excess heat produced during engine in running. It regulates engine surface temperature for engine optimum efficiency. Mostly in an automotive engine cooling systems consist of the radiator, water pump, cooling fan, pressure cap and thermostat. Radiator is the prime component of the system. Radiator is a heat exchanger that removes heat from engine coolant passing through it. Heat is transferred from hot coolant to atmospheric. The radiator assembly consists of three main parts core, inlet tank and outlet tank. The Core has two sets of passage, a set of tubes and a set of fins. Coolant flows through tubes and air flows between the fins. The hot coolant fluid sends heat through tubes to fins. Outside air passing between fins and pickups and carries away heat. Heat transfer has been a great challenge for the industrial applications during various operations in order to achieve better performance and efficiency. The Nano fluids were developed recently by suspending solid particles in a base fluid. These fluids have displayed better thermal characteristics and exhibited excellent heat transfer properties even at low concentration of nanoparticles in base fluid.

1.1 literature review

The literature review presented in the thesis are classified into three major domains namely, thermal properties of nanofluids, heat transfer in single nanofluids, and heat transfer in hybrid nanofluids. The main aim of this research is to enhance the heat transfer rate in car radiator. Generally distilled water is mixed with ethylene glycol and used in the car radiator as cooling fluid. The distilled water has only minimum thermal conductivity value so that it can improve the heat transfer rate in a minimum level. But, the nanoparticles having more thermal conductivity value than the base fluid. It is proved by many literature surveys. The thermal conductivity of nanoparticles are multiple times greater than the base fluid. Recently the hybrid nanofluids having much higher heat transfer rate than the single nanofluids. The hybrid nanofluid is the combination of more than two nanoparticles. Hence it is also planned to analyze the effect of hybrid nanofluids in heat transfer rate. Finally, the study of thermal properties such as pH value, thermal conductivity, specific heat, dynamic viscosity, Reynolds number, Nusselt number, Prandtl number, heat transfer coefficient and density is much needed. Since the thermal properties may vary while adding nanoparticles with the base fluid. So that it also take part in this literature survey. Thermal

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properties of viscosity, thermal conductivity, heat transfer coefficient, heat transfer rate, reynold number, nusslet number, prandtl number were added. Suganthi et al. (2016) Spherical ZnO Nano liquids have been prepared. It is blended with water and propylene glycol. The het absorption performance of ZnO, Propylene Glycol (PG) and water was contrasted and the blend of water and propylene glycol under the same condition. The Nano molecule included blend indicated preferred heat assimilation warm limit over the water and PG blend. The ZnO, PG and water blend demonstrates that 16.55% expansion in the warm exchange rate for 2% volume fixation. Ilhan et al. (2016) Hexagonal Boron Nitride (HBN) Nano liquids are utilized as a part of this research. The measurement of the Nano molecule is 70 nm. Sodium Dodecyl Sulfate (SDS) and polyvinyl pyrolidone were utilized as surfactant. A volume grouping of 0.03% to 3% was used. The HBN Nano liquids preferred warm conductivity esteems over the base liquid. There was an overall improvement of 45% in the heat transfer found. This study also included the thermal properties. The thermal properties of nano fluids were found to be higher than the base fluid

Behabadi et al. (2016) the Multi Walled Carbon Nano Tubes (MWCNT) Nano liquids were utilized as a part of this research. It has been blended with water at weight grouping of 0.05, 0.1and 0.2.The MWCNT Nano liquids demonstrates preferred heat exchange rate over the base liquid while expanding the molecule concentration. Mean time the weight drop of the Nano liquids is somewhat higher than the base liquid.

Big deli et al. (2016) the thermo physical properties of various Nano liquids were conducted. The Nano liquids demonstrate preferred warm conductivity over the base liquid. Be that as it may, the materials sort, particles shape, size and volume focus were not altogether broke down in numerous writing review. The thermal conductivity of aluminium oxide was 33w/mk. The thermal conductivity of copper oxide nano fluid is 23w/mk. The size of the nano particles were measured as 34mm and 45mm respectively.

The viscosity of the aluminium oxide nano fluid is higher than the copper oxide nanofluid. It is also reported the density properties. Accordingly, the copper oxide nanofluid has got 33kg/m3, whereas the aluminium oxide nanofluids have reported the density of 31kg/m3. Devonian et al. (2016) the properties of different Nano liquids are talked about in this survey paper. The Nano liquids readiness and portrayal have been studied. The warm conductivity of Nano liquids relies upon the particles volume division, shape and size. The thermo physical properties of mixture Nano particles have not done by numerous specialists. The impact of surfactant of sodium dodecyl benzene sulfonate was examined. The security of Nano liquids has connection with warm conductivity and viscosity. The steadiness of Nano liquids are enhanced with an expansion in warm conductivity and reduction in consistency of Nano liquids.

Krishnam et al. (2016) Boron nitride (BN) Nano liquids are utilized as a part of this research. The size of Nano molecule is 80nm. The warm conductivity of Nano liquids have an increment of 16.5% than the base liquid is accomplished. The aluminium oxide nano fluid had an overall enhancement of 23% followed by copper metal powder which had 19% increases in heat transfer rate.

Muhammad et al. (2016) the utilization of Nano liquids in sun powered authority have been contemplated in this survey paper. The half breed Nano liquids increment the heat move in to abnormal state however restricted writing just available. The Nano liquids indicate great warm conductivity. They investigated the effect of clay and silt soil blocking the heat transfer area of the radiator and its effect on the engine coolant through experiments and a mathematical model. The results dictated that the area covered is in a proportional relation with the inlet and outlet temperatures of the coolant in the radiator. In both account, at 80% coverage of the heat transfer area of the radiator the engine vibrated excessively. It concluded that dirt on the surface of a radiator decreased the performance of the radiator.

Raja et al. (2016) this is an audit paper about Nano liquids attributes and applications. The strength of Nano liquid is a testing factor. The pumping power additionally assumes an imperative part and keeping in mind that there is a high increment in warm conductivity found. It is important to keep up the solidness without influencing the warm properties of Nano liquids is some quick discoveries for the future. The effect of using the Cu-EG nanofluid as a coolant in an automotive car radiator was investigated. They observed that the heat transfer enhancement of almost 3.8% could be achieved with adding 0.02 in volume copper nanoparticles to the base fluid; hence, they estimated 18.7% reduction of air frontal area of the radiator. However, additional 12.13% pumping power was needed for a radiator using the nanofluid with volume fraction of 0.02 % compared to that of the same radiator using only pure ethylene glycol coolant at the same coolant volumetric flow rate.

Su et al. (2016) Self rewetting Nano liquids is blended with Nano fluids. N-butanol liquor watery arrangement is utilized as self-rewetting Nano fluids. Similarly, graphene oxide. Nano particles are utilized to get ready Nano fluids. An swaying heat pipe is made and the heat exchange rate here is measured, an change of 16% heat exchange rate for rewetting Nano fluids than base liquid is found and keeping in mind that utilizing grapheme oxide Nano liquids it is discovered 12% increments than base liquid. The graphene nanofluids have reported the thermal conductivity of 35W/Mk which is higher than the base fluid.

Sun et al. (2016) in this examination Cu, Fe2O3, Al2O3 & MWCNT Nano liquids have been utilized as a part of a heat exchanger as cooling medium at a mass division of 0.1%, 0.3% and 0.5%. Sodium dodecyl benzene surfactant were added to enhance the stability. The convective heat exchange coefficient of coefficient of copper is having top level increments than the rest of the Nano liquids. Then if there should be an occurrence of security aluminum oxide have great soundness than outstanding Nano liquids.

2. METHODOLOGY AND EXPERIMENTAL SETUP

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the experimental details and procedure to study the heat transfer rate of a car radiator with nano fluids by varying the inlet temperature, mass flow rate and velocity are discussed. The heat transfer rate of car radiator with base fluid is also measured. The comparison of heat transfer rate while adding nano particles are also discussed. The experimental setup is made with radiator, heating coil, anemometer, Rotameter, and pump. The setup is made to analyze the effect of heat transfer rate in the car radiator. The nano particles and lemon juice have been added with the base fluid by the volumetric concentration of 0.03%, 0.06%, 0.09%, 0.12%, 0.15%, 0.18% & 0.21%. The mass flow rate of fluids varied in 10 lpm, 12 lpm, 14 lpm and 16 lpm. The inlet temperature is varied from 45° C to 80°C. The objective of research work.

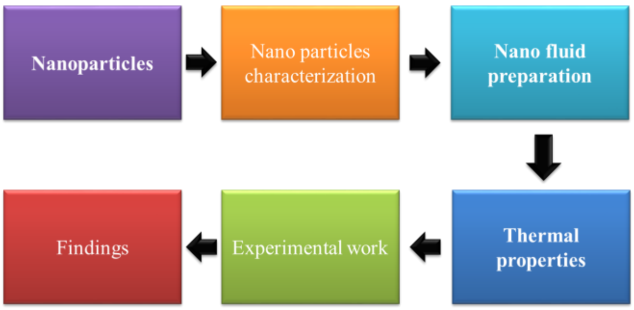

Fig. 1 The methodology of the research work

The main study to be carried out is to finding the heat transfer rate while adding nano fluids with the base fluid. Since the base fluid alone does not have heat transfer rate. Hence it is compulsory to have a new method which is to be studied in order to improve the heat transfer rate. Recently the heat transfer rate has been improving by adding nano particles with base fluid. Four different nano particles have been added with the base fluid. A different approach is planned and to be carried out. By adding lemon juice with base fluid is made an attempt in this research. Preparation of nano fluid and characterization of the same have been done. This methodology shall highlight the heat transfer rate. Similarly, the thermal properties also have been done. By analyzing various factors for the same have also been done. The uncertainty analysis of various factors like heat transfer coefficient, Nusselt number, Reynolds number, and specific heat and friction factor has been carried out. The method of mixing the nano particles with the base fluid. The experimental set up was fabricated for the water cooling system in the car radiator. The line diagram of test rig arrangement is as shown in Fig.2.
The test section is a cross flow heat exchanger (automobile radiator) consisting of finned-tube exchanger. Water flows downwards through the 54 vertical non circular. The car radiator has louvered fin and 32 flat vertical copper tubes with flat cross sectional area. The distances among the tube rows filled with thin perpendicular copper fins. Instrumentation is provided to measure the temperature of water at inlet and outlet. Two additional thermocouples were provided to measure the temperature of air that flows across the radiator. They were fixed at the air inlet and outlet of radiator. The flow lines are insulated to avoid heat loss.

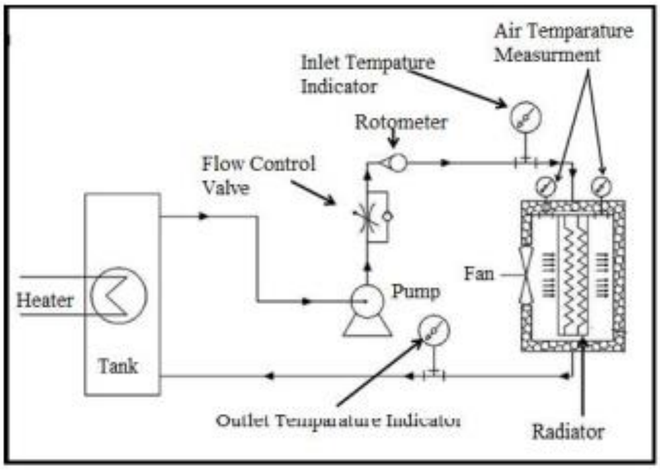

Fig. 2 ***Line diagram of test rig***

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Fig. 3 Experimental set up

A gate valve was provided to regulate the flow of water through the radiator. Three heaters with controllers were provided to heat the water to be sent to the radiator at steady state temperature at the inlet. The radiator was placed inside a duct to avoid the leakage of air in the radiator. A fan was used to provide the flow at two different speeds. The DC power supply (type Teletron10 12V) used to turn the axial fan instead of a car battery. The experiments were carried out for different flow rates of 10 lpm 16 lpm with increments of 2 lpm. Temperatures of the cooling fluid at inlet was varied from 40oC to 75oC. The thermocouple used to measure the temperature had an accuracy of ± 0.5oC. A pump of 0.5 HP was used to circulate the cooling fluid from the storage tank. An anemometer was used to measure the velocity of air through the duct. The readings were taken at four points and the operate average velocity was calculated. The pump gives a constant flow rate of 25 lpm (liters per minute) and takes the fluid from storage tank. By using a gate valve, the required flow rate of the fluid is passed to the flow meter that has an accuracy of ±2% of reading. A recycling line is also installed with the pump using a gate valve that is used to pass the extra fluid back to the tank to achieve the desired flow rate. Air flow rate was adjusted by varying the fan speed using an electronic speed regulator. All the measurements were made after reaching steady state conditions. The inlet and outlet temperatures and the flow rates for air and water were acquired for calculations. Before conducting experiments with nano coolant and coolant (water + EG mixture) experiments were conducted using de-ionized water as the working fluid and the obtained experimental data are used for benchmarking. The pH values before and after experimental tests referring to nano fluids stability were measured.

3. Results and dissuasion

In this work, there are three different fluids have been used as given below,
Base fluid (Distilled water & Ethylene glycol) (F1)
Base fluid & Lemon juice (F2)
Base fluid & Lemon juice & Aluminium oxide (F3)

First, the base fluid alone used to get the heat transfer rate. (1:1 ratio). Afterwards, the heat transfer rate for the different combination will be done. There are seven different combinations will be prepared in all cases 0.03%, 0.06%, 0.09%, 0.12%, 0.15%, 0.18% & 0.21% will be used.

3.1 Nusselt Number vs Mass Flow Rate

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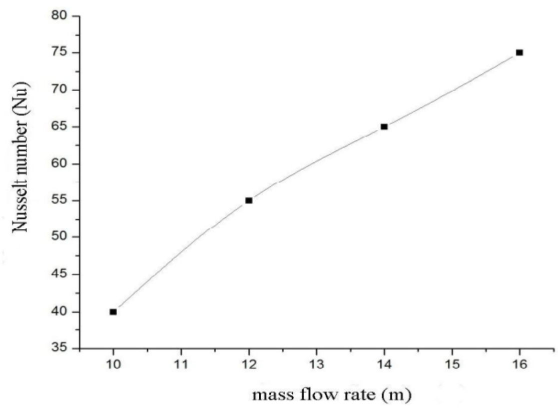

Fig. 4 Nusselt number vs Reynolds number

The outlet temperature is important in the car radiator experimental setup. The outlet temperature of the hot fluid mainly depends upon the inlet temperature and the mass flow rate. In this case also while increasing the mass flow rate the value of outlet temperature also increases. By varying the mass flow rate the required level of heat transfer can be achieved. The temperature difference between the inlet and outlet is one among the reason to further improve the heat transfer rate. This is done at point 3. The outlet temperature decreases while increasing the mass flow rate. Hence the study of the temperature difference between the hot and cold fluid is much changing.

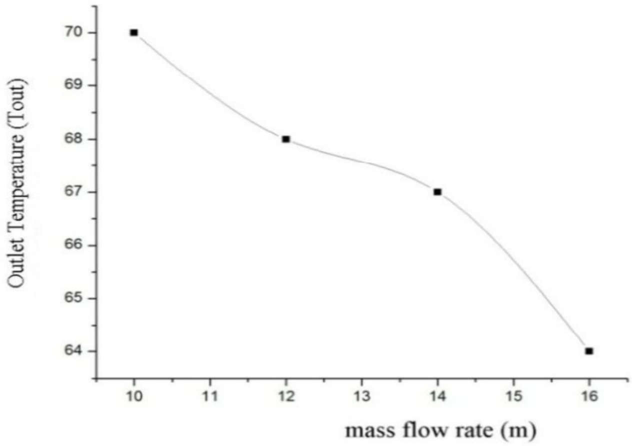

Fig.5 Outlet Temperature vs Mass Flow Rate

CONCLUSIONS

In the research of heat transfer analysis various fluids were used. A novel approach is applied. According to lemon juice added with the base fluid. Similarly, nanoparticles like aluminum oxide, magnesium oxide, multi-walled carbon nanotube and graphene are used along with the base fluid. Firstly, the base fluid is used in the experimental setup. The mass flow rate had been varied from 10 lpm to 16 lpm. Then the base fluid heated up to 80oC. Now it is cooled to 40oC by operating the fan. Then, the temperature at inlet and outlet of the hot fluid and cold fluid were measured.

It is concluded that the lemon juice have achieved higher heat transfer rate. The addition of lemon juice is done in systematic manner. None of the researcher have done and added lemon juice with base fluid. It clearly shows better results in the latest trend.

REFERENCES

[1] Abbaspoursani, K, Allahyari, M & Rahmani, M 2011, 'An improved model for prediction of the effective thermal conductivity of nanofluids', Journal of Engineering and Technology, vol.58, pp. 234-237.
[2] Akbarinia, A & Behzadmehr, A 2007, 'Numerical study of laminar mixed convection of a nanofluid in horizontal curved tubes', Applied Thermal Engineering, vol. 27, pp. 1327–1337.
[3] Akbarinia, A 2008, 'Impacts of nanofluids flow on skin friction factor and Nusselt number in curved tubes with constant mass flow', Int. Journal of Heat and Fluid flow, vol. 29, pp. 229-241, 2008.

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International Journal of Engineering Technology Research & Management
www.ijetrm.com

[4] Akoh, H, Tsukasaki, Y, Yatsuya, S & Tasaki, A 1978, 'Magnetic properties of ferromagnetic ultrafine particles prepared by vacuum evaporation on running oil substrate', Journal of Crystal Growth, vol. 45, pp. 495–500, 1978.
[5] Ali, ME 1998, 'Laminar natural convection from constant heat flux helical coiled tubes', Int. Journal of Heat Mass Transfer, vol. 41, pp. 2175.
[6] Anoop, K, Sundararajan, T & Das, SK 2009, 'Effect of Particle Size on the onvective Heat Transfer in Nanofluid in the Developing Region', Int. Journal of Heat Mass Transfer, vol. 52, pp. 2189-2195.
[7] ANSI/ASME 1986, 'Measurement Uncertainty', PTC. vol. 19, pp.1-1985.
[8] Ashutosh, U, Pimpalkar, Darshana, Miss, Pimpalkar, U, Rekha ,Miss, Rathod, S, Suraj, Prof, Bhivagade, P 2016, 'Advance water cooling system in two-wheeler bike engine: case study', International Organization of engineering Research & Development Journal (IOERD), vol. 1, no 2.
[9] Assael, MJ, Chen, CF, Metaxa, IN & Wakeham, WA 2004, 'Thermal Conductivity of Suspensions of Carbon Nanotubes in Water', International Journal of Thermo Physics, vol. 25, no. 4, pp. 971–985.103
[10] 10. Assael, MJ, Mataxa, IN, Arvanitidis, J, Christophilos, D &Lioustas, C 2005 'Thermal conductivity enhancement in aqueous suspensions of carbon multi-walled and double-walled nanotubes in the presence of two different dispersants", Int.J. Thermo phys. 26, 647–664.
[11] Assael, MJ, Metaxa, I, Arvanitidis, J, Christofilos, D, Lioustas, C 2005, 'Thermal conductivity enhancement in aqueous suspensions of carbon multi-walled and double-walled nanotubes in the presence of two different dispersants', Int. J.Thermophys, vol. 26, no. 3, pp. 647-664.
[12] STM D 5334-00 2000, 'Standard test methods for dermination of thermal conductivity of soil and soft rock by thermal needle probe procedure', Vol. 04.08, ASTM, 100 Barr-Harbor, West Conshocken, PA 19428-2059.
[13] Austin, LR & Seader, JD 1973, 'Fully developed viscous flow in circular coiled pipes', AICHE Journal, vol.19, no.1, pp.85-94.
[14] Avsec, J & Oblak, M 2007,'The calculation of thermal conductivity viscosity and thermodynamics', vol. 50, pp. 4331-4341K. Elissa, "Title of paper if known," unpublished.