International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 09 | Sep -2017 www.irjet.net p-ISSN: 2395-0072

Improving Performance in Engine Cooling System Using Nano fluids

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Abstract: *In this study mixture of water and ethylene glycol coolants has been widely used in an automobile radiator for many years. These heat transfer fluids offer lower thermal conductivity. The nanotechnology of the new generation of heat transfer fluids called, "Nano fluids". Nano fluids are higher thermal conductivity as compared to conventional fluids. This review paper focus on the various research papers to improve automobile radiator efficiency. Heat transfer performance of car radiator is enhanced by using Nano fluids. An effect of different volumetric concentration of the Nano fluids in heat transfer rate is investigated experimentally.*

INTRODUCTION

Heat transfer has been a great challenge for the automobile to achieve better performance and efficiency. Radiator is a main part of an engine. Radiators are heat exchangers used for cooling internal combustion engine and also used in aircraft, locomotives, etc. Normally it is used as a cooling system in an engine. Most of liquid cooling system consist of components like radiator, water pump, electric cooling fan, thermostat, storage tank. Generally water and ethylene glycol are used as a cooling medium. In current days to enhance heat transfer with advanced fluids to improve the flow and thermal characteristics. The latest technological advancement an emerging a new class of coolants called NANO FLUIDS (Nano particles with base materials). Compare to conventional fluid the Nano fluids have greater heat transfer, effective thermal conductivity, diffusivity and Brownian motion. Nano fluids used in the various application like microelectronics, transportation, manufacturing and bio engineering. Nano fluids is a fluid containing nanometre sized particles called nanoparticles. These particles are dispersed with the base fluids. Particles are further classified according to diameter coarse particles (10.00 to 2.50 nm), fine particles (2.50 to 100 nm), and ultrafine particles (1 to 100 nm). The Nano particles used in Nano fluids are made of metals, oxide and carbide. Solid particles are added they conduct heat much better than a liquid. Common base fluids include water, ethylene glycol and oil. Most of the research work done as Al_2O_3, CuO, TiO_2, $ZnFe_2O_4$.

LITERATURE SURVEY

S.M.Peyghambarzadeh [1] This paper is the forced convective heat transfer of Al_2O_3-Water based Nano fluid is experimentally compared to pure water in an automobile radiator. Five different volume concentration of nanoparticle in the range of 0.1-1 % in a water is investigated. The fluid is flow through the 34 vertical tubes in a radiator and fluid flow is changed in the range of 2-5 LPM under turbulent flow ($9\times10^3 < Re < 2.3\times10^4$). The fluid temperature is changed in the range of 37-49°C. At the volume fraction of 1% is giving 45% more heat transfer rate than that of pure water. Increasing the flow rate (or equal Re) enhances the heat transfer for both water and Nano fluid. While vary the inlet temperature of fluid slightly changes the heat transfer performance.

K.P. Vasudevan Nambeesan [2] In Al_2O_3/water-ethylene glycol (EG) Nano fluid is used. Overall heat conductance (UA) is studied using two mixture of water-ethylene glycol combination of ratio 90:10 and 80:20. They reduced UA in 20% and 25%.In ratio of 80:20 there is 0.1% of Al_2O_3 nanoparticles. Due to addition of Nano fluid there is increase in heat transfer performed in 37% of output. The significant increase in the Pr of the coolant with the addition of nanoparticles results in the increase of UA. With the addition of 0.1% of nanoparticles, the Pr of the water and 80:20 water–EG increased by 61% and 106% respectively.

D.Tirupathi Rao [3] This paper is the experimental study of forced convective heat transfer Al_2O_3-water+ethylene glycol Nano fluid in an automobile radiator. Addition of nanoparticles in the concentration of 0.08% in the base fluid is giving 48% more heat transfer than the base fluid. Increase of particle concentration that increase the thermal conductivity of Nano fluid and increase the cooling performance of engine. Increasing the flow rate (3LPM-15LPM) of both Nano fluid and also base fluid increase the heat transfer coefficient.

Sandesh S [4] In this paper they using the forced convective heat transfer performance of two different Nano fluid, Al_2O_3-water and CNT-water has been studied

experimentally in an automobile radiator. Four different concentrations of Nano fluid in the range of 0.15–1 vol. % were prepared by the additions nanoparticles into the water as base fluid. The coolant flow rate is varied in the range of 2l/min–5l/min. The heat transfer performance of CNT-water Nano fluid was found to be better than Al_2O_3-water Nano coolant. The maximum heat transfer performance for 1.0 vol. % Nanoparticle concentration were found to be 90.76% and 52.03% higher for CNT-water and Al_2O_3-water, compared with water. The CNT-water Nano fluid exhibited enormous enhancement in heat transfer compared to the Al_2O_3-water Nano fluid. This may be due to the fact that carbon nanotubes offer a high thermal conductivity, high aspect ratio, low specific gravity and low thermal resistance as compared Al_2O_3-water Nano fluid. The effective thermal conductivity of both CNT-water and Al_2O_3-water Nano coolant increases with the increase in nanoparticles concentration, consequently, increases the cooling performance in automobile radiator.

Aditya choure [5] Conventional coolants like water, ethylene glycol are not efficient enough to improve the car's performance. They development of new technology in the field of 'Nano-materials' and 'Nano-fluids'. Is effectively use these technologies in car radiators to improve engine efficiency, reduce weight of vehicle and size of radiator. They adding Al_2O_3 Nano fluid in car radiators. In this paper forced convective heat transfer of water and ethylene glycol based Nano fluid will be compared experimentally with water, water + ethylene glycol (60:40), water + ethylene glycol+ nanoparticles. An engine coolant is mixture of ethylene glycol and water in various ratios like 30:70, 40:60 and 50:50 respectively are mostly used in auto-mobiles. It is estimated that a higher temperature radiator could reduce the radiator size approximately by 30%. Nanoparticles with two different base fluids: ethylene glycol and pump oil. Results showed a 30 % & 40 %.Fluids for 5 vol. % of nanoparticles and the size of the nanoparticles used with both the fluids is 60 nm. It leading to perhaps a 10% fuel savings.

K. Sirisha [6] In this paper effective thermal conductivity for Al_2O_3 and ethylene glycol (EG) and water as a new generation of heat transfer fluids. They carried in the concept of pure water is mixed with glycol at standard proportions 70:30, 60:40 and 50:50 mixture is used in an automotive radiator. The performance comparison will be made between pure water and ethylene glycol tested in an automotive radiator. The heat transfer enhancement was about 4.56% for 0.025% ethylene glycol at 80ºc and this is about 12.4% for 0.1% ethylene glycol at 80ºc. That ethylene glycol has a high potential for hydrodynamic flow and heat transfer enhancement in an automotive radiator.

P.Prem Kumar [7] In this paper they do the enhancement of forced convective heat transfer rate of aluminium automobile radiator after using Al_2O_3 Nano fluid with ethylene glycol base fluid coolant. They consider volume fraction and the flow rate of coolant as parameters. They take volume concentration of Al_2O_3 nanoparticles in the range of 0.01 to 0.12 % and base fluid is 15 litres. They have chosen sonication process to mix Al_2O_3 nanoparticle with water using ultrasonic sonicate for 2 hours for getting stable suspension in water. Heat transfer rate were increased by increasing the volume concentration and flow rate .They observed that maximum heat transfer rate occurred at 0.08% volume concentration i.e. 45 % higher compared to water. After increasing the volume concentration heat transfer rate is just increased compare with previous heat transfer values. The coolant flow rate is varied from 3 LPM to 15 LPM. Al_2O_3 Nano particle in water + ethylene glycol base fluid (70:30) increases heat transfer coefficient and increase in flow rate (3-15 LPM) also enhance thermal performance of base fluid.

B.S kothawale [8] In this paper, they take Al_2O_3 nanoparticles were used to mixture (EG+water) in base fluid. Because of using nanoparticles the fuel consumption and decrease the pollution emission. Due to effects of fluids inlet temperature, nanoparticle volume fraction on heat transfer rate and the flow is taken. After this process, we get Nusselt number, effectiveness, heat transfer and overall heat transfer coefficient increase. In the ranging from 0% to 1% of volume concentration of nanoparticles. 40% heat transfer was taken in this experiment and adding of 1% of Al_2O_3 particles at 84391 air Reynolds number is obtained. The constant mass flow rate is 0.05 kg/s. overall heat transfer is increased in 36% and adding 1%of volume of Al_2O_3. 40% is increased in effectiveness of the radiator with adding 1% and volume fraction of Al_2O_3. Finally the constant mass flow rate and base fluid at constant air Reynolds number.

Datta N [9] This experimental study is discussed about thermal performance of car radiator using Al_2O_3 Nano fluid in the temperature range of (40-75°C) under different volume fraction of 0.5%, 1%, 1.5% .The size of nanoparticle is 100nm. The liquid flow rate is changed in the range of 50 to 200 LPH and air velocity in the range of 3.8 to 6.2 m/s. The inlet temperature of the fluid varying from 40 to 75°C. The results shows that increasing coolant flow rate and air velocity can improve the heat transfer performance. The volume fraction of 0.5%, 1%, and 1.5% of Al_2O_3 in a pure water is giving 19%, 33%, and 42% more heat transfer rate than the pure water at flow rate of 200 LPH with 6.2m/s. Addition of 0.5 to 1.5% of Al_2O_3 in a pure water gives 14% to 42% heat transfer rate than pure water.

Laxman P. Dhale [10] Nano fluids volumetric concentration 1.2% of Al_2O_3 Nano particles and base fluid water. Nano fluid is enhance the heat transfer rate up to 23% at constant mass flow rate. Heat transfer rate is increased with increase in volumetric concentration of nanoparticles ranging from 0% to 1%.Radiator effectiveness up to 24% volumetric at volumetric concentration of 1.2% Al_2O_3.

Navid Bozorgan [11] This paper is a numerical study of CuO-water Nano fluid in automotive diesel engine radiator. Nanoparticles (CuO) with size of 20nm and volume concentration up to 2% is investigated in a Chevrolet suburban diesel engine. The local convective and overall heat transfer co-efficient and pumping power for CuO-water is flow through the flat tubes with Re_{nf}=6000 at different volume concentration of 0.1 to 2% under turbulent flow at engine speed of 70km/hr is giving more than that of base fluid for given condition. The overall heat transfer for CuO-water at the volume concentration of 0.1-2% gives 122 & 134.27w/m^2k respectively. Increase the Reynolds number with Re_{nf}=8000 compared to Re_{nf}=6000 is giving more than 2.3%. The increase of pumping power 2% CuO-water Nano fluid at Re_{nf}=8000 is compared to Re_{nf}=6000 is 61.75%. The decrease in pumping power of 2% CuO-water Nano fluid at engine speed of 80km/hr is compare to speed of 60km/hr is 16.7%.

Amruta.P [12] This paper is the enhancement of heat transfer rate in a radiator using CuO Nano fluid. Increasing the inlet temperature of Nano fluid it decreases the overall heat transfer coefficient. The addition of nanoparticles to the base fluid in the volume fraction of 0.15 and 0.4% increases the overall heat transfer coefficient 6% and 8% compare to pure water. At certain range of fluid temperature the thermal conductivity increase due to increasing the temperature.

M. Naraki [13] In this paper they selected CuO/water as a Nano fluid. The laminar flow in this experiment is (100 < Re < 1000) in automobile radiator. The overall heat transfer coefficient is up to 8% of Nano fluid. The inlet temperature is 50 to 80 °c is decreases in Nano fluid. At the concentrations of 0.15 and 0.4 vol. % of CuO nanoparticles, the overall heat transfer coefficient enhancements compared with the pure water are 6% and 8%. The heat transfer coefficient is 94.11 W/m 2 k. 42% of air volumetric flow rate. There is increase of e 23%, 22% and 13% contribution in the overall heat transfer coefficient of CuO/water Nano fluid. This experiment was less cost and more particle in air flow rate to increasing.

K.Y. Leong [14] In this paper ethylene glycol and water are used as the conventional coolants in cars. In this concept they used ethylene glycol with copper Nano fluids in the car. The heat transfer coefficient and heat transfer rate is increased in this experiment. 3.8% of heat transfer is created by adding of 2% of copper particles. Reynolds number is 6000 and 5000 for air coolant. 42.7 % and 45.2% in heat transfer that observe ethylene glycol and 2% of copper nanoparticles. 18.7% reduction of air frontal area is achieved by adding 2% copper nanoparticles at Reynolds number of 6000 and 5000 for air and coolant. 12.13% pumping power is needed for a radiator using Nano fluid of 2% copper particles at 0.2 m3 /s coolant volumetric flow rate compared to that of the same radiator using only pure ethylene glycol coolant.

Hafiz Muhammad Ali [15] The heat transfer performance of the automobile radiator is evaluated experimentally by different Nano fluid (ZnO) volumetric concentrations (0.01%, 0.08%, 0.2%, and 0.3%).Base fluid water. Fluid flow rate has been varied from 7 LPM to 11 LPM (Litre per Minute). Reynolds number rage 17500 to 27600. Fluid inlet temperature maintained at 45° C to 55° C. The best heat transfer rate up to 46% in 0.2% volumetric concentrations. Further increased volumetric concentrations 0.3% decreased in heat transfer rate compared to 0.2% volumetric concentrations.

Ajay Tripathi [16] This Nano fluids based on Zinc ($ZnFe_2O_4$). Water and ethylene glycol as a coolants have been widely used in radiators. These heat transfer fluids was lower thermal conductivity. In this experiment focused on increased overall heat transfer coefficient and Preparation of Zinc based Nano fluids automotive cooling system along with mixture of ethylene glycol and water (50:50).Overall heat transfer coefficient and heat transfer rate increased with Nano fluids and base fluids (water and ethylene glycol) compared to base fluid (ethylene glycol) alone. Heat transfer rate increased 78% in addition of 1% Nano fluid. Reynolds number 84.4*10^3.

Devireddy Sandhya [17] The performance of water and ethylene glycol based Tio_2 Nano fluids as an automobile radiator is experimentally determined. Nano fluids were taking as water 40% and ethylene glycol 60% with volume concentrations 0.1%, 0.3% and 0.5% of TiO_2. Reynolds number rage was 4000 to 15000.Nanofluids flow through the elliptical cross section of radiator and constant airflow speed. Increase fluid circulation rate improve the heat transfer performance rate up to 37%.

V. Salamon [18] Heat transfer rate and overall reduction in size of the radiators. Heat transfer characteristics of water and propylene based TiO_2 experimentally analysed and compared with pure water and propylene glycol mixture. Two different volume concentrations 0.1% and 0.3%.The mixture of water and propylene glycol 70:30.This experiment conducted in different flow

rate between 3 to 6 lit/min for various temperature 50°C, 60°C, 70°C, and 80°C.Higher coolant flow rate, 0.3 Vol. % of TiO_2 Nano fluid enhances the heat transfer rate by 8.5%.

Eknath D. Kurhe [19] Nano fluid TiO_2 has been experimentally investigated in automobile radiator. Nano fluid size range from 10nm to 100nm.Increasing the flow rate and volumetric concentrations of Nano fluids enhance the overall heat transfer coefficient. High thermal conductivity of Nano fluids in radiators can reduction in frontal area up to 10%.

T. Ganesan [20] The heat transfer enhancement is used in automobile radiator by interact solid nanoparticles to liquid. The nanomaterials have high heat transfer rate. Nano sized particles cost is very high. We use different type additive is tried to add with base fluid for further improvement of heat transfer. Lemon juice is one of best cooing medium. So they take lemon juice is one of base fluid. It is planned to mix the lemon juice in the car radiator and conducting the experiments. By varying different input % and 1% respectively. The mass flow rate is varied from 10LPM, 12LPM, 14LPM and 16LPM. The input temperature varied from 400c, 450c, 500c, 550c, 600c, 650c and 700c.The HTR is 30% for 0.5 and 35% for 1.0 in 16 LPM.

N.Ummalsalmaan [21] This paper is experimental study of graphene Nano fluids as coolant in an engine radiator. Increasing the volume concentration of nanoparticles (ranging from 0 to 0.5%) that increases the heat transfer rate and effectiveness. Addition of graphene particles at constant mass flow rate of 3.45kg/s increases the heat transfer rate and effectiveness 61% and 50-70% increment in the total and overall heat transfer coefficient. Increasing the volume concentration of graphene particles in a water increases the thermal conductivity 61.05%.

Oliveira, G.A [22] This paper is the experimental study of thermal performance of silver-water Nano fluid in a radiator. The nanoparticles used in the size of 10nm and 80nm is investigated. The nanoparticles is dispersed in the distilled water by two step method. Addition of nanoparticles in the volume concentration of 0.3% giving 18% more heat transfer than the base fluid.

Muhammad Danish AZHAR [23] This paper is the heat transfer enhancement of aqua based magnesium oxide-water Nano fluid in an automobile radiator. Addition of MgO in the volume concentration of 0.12% in the water is giving 31% more heat transfer than the pure water at 8LPM. Increase the inlet temperature from 56-64°C is increase the heat transfer to 6%. Low flow rate resulted heat transfer rate is better than the high flow rates with same volume concentration of nanoparticles.

CONCLUSION

From this review, various ways of enhancing the heat transfer rate in a radiator by using different Nano fluids. We using the Nano fluids heat transfer rate is increased compared to water and ethylene glycol. Increasing the nanoparticles volume concentration, flow rate enhances the overall heat transfer coefficient. Overall heat transfer coefficient and heat transfer rate in cooling system increased with the usage of Nano fluids.

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