EXPERIMENTAL INVESTIGATION ON ENGINE COOLING USING Al_2O_3WITH BASE FLUID AND LEMON JUICE

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ABSTRACT: ***The heat transfer enhancement for engine block by adding solid nanoparticles to liquid is significant topics recently. The nano materials have high heat transfer rate. Most of the researches have been conducted nanoparticles alone in the engine. It is the right time to have alternative materials including nanoparticles in the cooling media. The lemon juice is traditionally one of the best cooling medium. An attempt is made by adding lemon juice (natural) as an additional fluid with base fluid to investigate the heat transfer rate. Now it is planned to run the engine at different load conditions and at constant flow rate of coolant (Lemon juice+ Base fluid +Al_2O_3nano particles) to obtain the heat transfer rate. This work included the heat transfer rate by forced convection. The juice which is extracted from naturally available lemon and dispersed in the base fluid as the lemon is easily soluble. The different concentrations of lemon juice in the ratio of 1%, 1.5 % and 2 % by volume have been added with base fluid (70% water +30% Ethylene Glycol).***

KEYWORDS: Engine block, Forced convection heat transfer, Al_2O_3 nano fluid, Water + ethylene glycol (base fluid), lemon juice.

INTRODUCTION

It has been a keen interest of researchers for quite a long time to enhance the heat transfer in devices used in industries and in our daily life to increase their performance and efficiency. In past different techniques like free and forced convection, and extended surfaces were used for transferring heat at a higher rate. In the recent era, researchers are interested to find new ways to increase the heat transfer and as a result, today, we have come across a term known as nanofluids. Nanofluids are consisted of nanoparticles which are ranging of 10 nm to 100 nm, suspended in the base fluid. Accordingly, lemon juice has been identified to mix with base fluid. The naturally available lemon is traditionally used into reduce the heat of human body as lemon juice during summer season. It transfers the heat from the human body quickly. The lemon is easily available everywhere. Hence it is planned to add lemon juice with base fluids with Al_2O_3 and finding the heat transfer rate in the engine block.

[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 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 ($9\times103 < Re < 2.3\times104$). [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. [3] Nano fluids volumetric concentration 1.2% of Al2O3 Nano particles and base fluid water. Nano fluid is enhancing 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. [4]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%) and base fluid water. Fluid flow rate has been varied from 7 LPM to 11 LPM (Liter 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. [5]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.

NANOFLUIDS PREPARATION

Two-step method:

The sketch of two-step method is shown in Fig1. Currently, two-step method is the most commonly used method for the preparation of nanofluids. Generally, two procedures are involved in this method. The first procedure is the synthesis of nanomaterial, which is usually in the form of dry powder. The second procedure is the dispersion of nanomaterial in the base liquid such as water, ethanol and ethylene glycol. During this procedure, some measures, for instance, addition of dispersant or sonication, are generally carried out to enhance the stability of the resulting nanofluids.

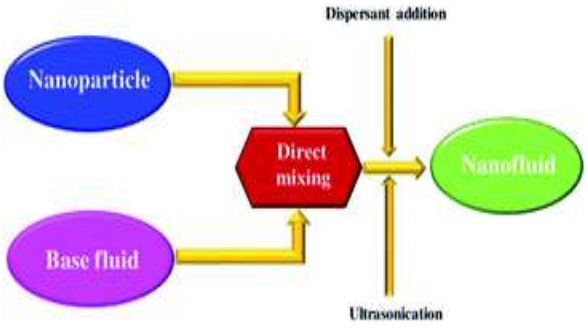

Fig.1Preparation process of nanofluids by two-step method

Fig. 2Nanoparticles

LEMON JUICE PREPARATION

The lemons had collected from former. From the collected leman, it is crushed to extract the juice. Four different coolants are prepared by adding lemon juice in the nanofluids (Base fluid + 0.2% of Al_2O_3 nano particles) in the ratio of 0%, 1%, 1.5%, 2% directly.

Fig.3 Extraction of lemon juice

EXPERIMENTAL TEST RIG AND PROCEDURE

1) Kiroloskar engine block
2) Fan
3) Water pump
4) thermocouples
5) pipes

Engine Specifications:

Make	: - Kiroloskar
Bore	: - 80mm
Stroke	: - 110mm
Rated speed	: - 1500rpm
Maximum Brake powder	: - three.7 k w (SHP)
Compression ratio	: - sixteen.5: 1
Orifice diameter	: - 30mm
Fuel type	: - Diesel
Density of Diesel	: - zero.827 gm/ml
Calorific worth of diesel	: - forty four.350 Kj/Kg
Brake drum diameter	: - zero.3m
Rope diameter	: - zero.015m
Equivalent diameter	: - zero.315m

TESTING PROCEDURE

In this process, first connect all the experiment process. Tank contains the coolant and the out let pipe is connected to the inlet of the pump and then pump out let is connected to inlet of the engine block. The out let after engine block is connected to the inlet of the radiator finally the out let of the coolant is connected to the tank. Thermocouple is placed in engine inlet and outlet to measure the temperature values with a digital meter.

Initially 3litres of 0% lemon juice (sample 1) poured in the tank. The engine is starts working and the coolant is circulated around the engine jacket with a constant flow pump. The pumped coolant absorbs heat from the engine and leaves the engine then it passes throw the radiator to the tank. This process is repeated and the temperatures are tablelated. At no load condition engine speed maintained at constant speed of 1000 rpm. At Full load condition engine speed maintained at constant speed of 970rpm.Same way remaining three samples are used to observe the temperature absorption by this process.

CALCULATION OF HEAT TRANSFER COEFFICIENT

To obtain heat transfer coefficient and corresponding Nusselt number, the following procedure has been performed.
Heat transfer rate can be calculated as follows

$Q = mC_p$ $Q = mC_p (T_2-T_1)$

Nu =Nusselt number for the whole radiator,

m = mass flow rate which is the product of density and volume flow rate of fluid,

Cp =specific heat capacity of fluid,

A = peripheral area of radiator tubes,

T in and Tout = inlet and outlet temperatures,

CALCULATIONS FOR NO- LOAD AND FULL LOAD CONDITION TEMPERATURE AVERAGES:

Table 1.No – load condition temperatures average: -

Sample	Water Percentage (%)	Coolant Percentage (%)	Nano particle percentage (%)	Lemon juice Percentage (%)	Temperature readings		Temperature Difference
					T1	T2	T=T2-T1
1	70	30	0.2	0	42	53	11
2	70	30	0.2	1	45	56	11
3	70	30	0.2	1.5	43	55	12
4	70	30	0.2	2	43	54	11

Table 2.Full – load condition temperatures average: -

Sample	Water Percentage (%)	Coolant Percentage (%)	Nano particle percentage (%)	Lemon juice Percentage (%)	Temperature readings		Temperature Difference
					T1	T2	T=T1-T2
1	70	30	0.2	0	60	46	14
2	70	30	0.2	1	60	46	14
3	70	30	0.2	1.5	59	43	16
4	70	30	0.2	2	59	44	15

RESULTS AND DISCUSSIONS

Heat transfer rate of different concentration on no load condition: heat transfer rate the different rage of coolant in order to check the reliability and accuracy of the experimental setup. Get 1.5% maximum Heat transfer rate.

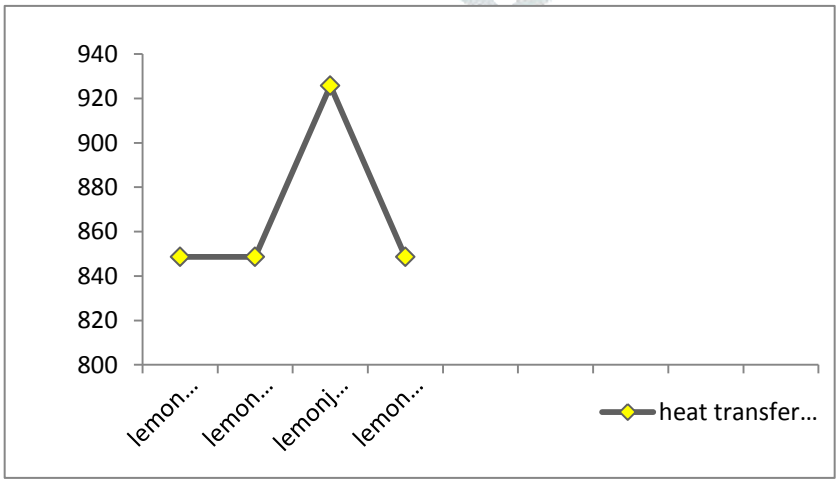

Fig. 5 Heat Transfer Rate

Temperature difference of different concentration on no load condition: Implemented coolants in different concentrations, i.e. 0%, 1%,

1.5%, 2%. Get 1.5% maximum Temperature difference.

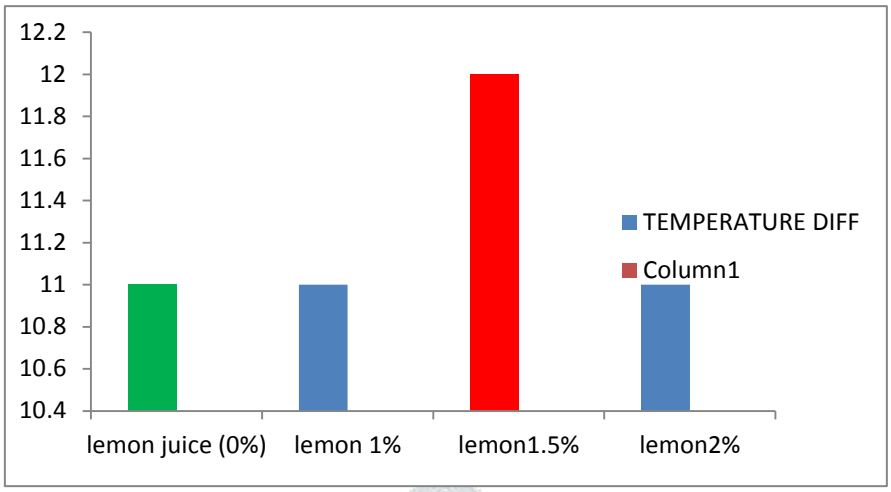

Fig. 6 Temperature Difference

Heat transfer rate of different concentration on full load condition: heat transfer rate the different rage of coolant in full load order to check the reliability and accuracy of the coolant. Get 1.5% maximum Heat transfer rate**.**

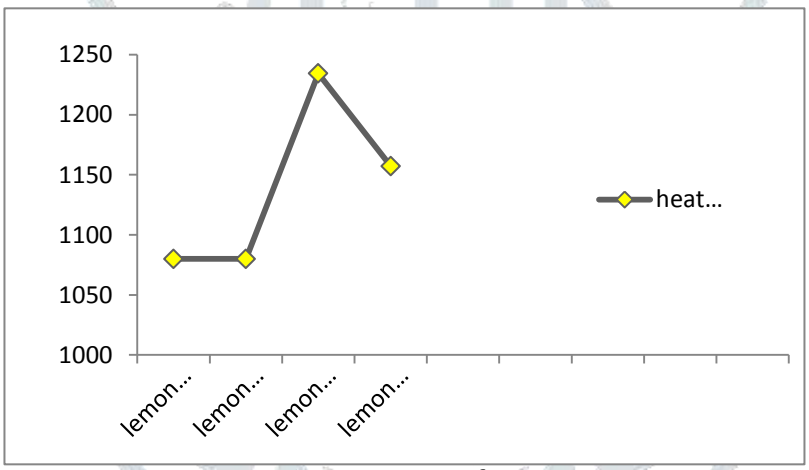

Fig. 7 Heat Transfer Rate

Temperature difference in different concentration on full load condition: In this process conduct experiment with pure water and then with ethylene glycol base fluid and Al_2O_3 in different concentration level 0.1%, 0.2%, 0.3% with the full load. Get 1.5% maximum Temperature difference.

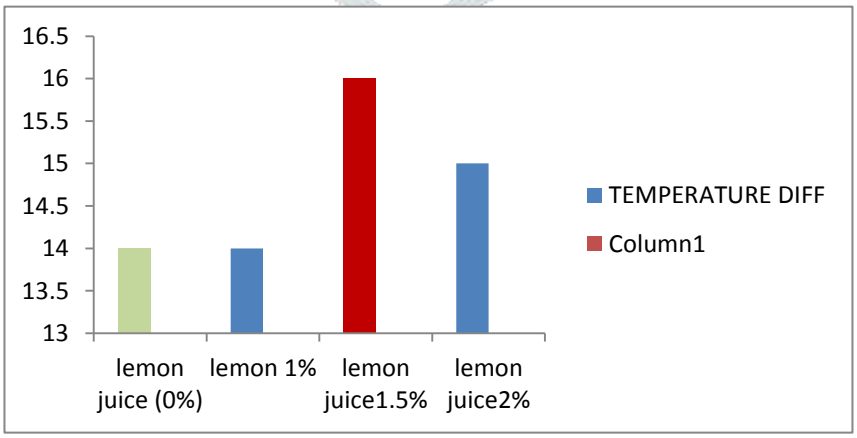

Fig. 8 Temperature Difference

CONCLUSION

The above experiment reveals that coolant (base fluid + nanofluid + lemon juice) range 0%, 1%, 1.5%, 2% increases heat transfer rate and temperature difference. By the addition of 1.5% lemon juice in nano fluid the heat transfer rate is increased when compared with nano fluid. It

seems that the increasing in the effective thermal conductivity and the variation of the other physical properties are not responsible to enhance heat transfer rate.

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