

PERFORMANCE ANALYSIS OF HEAT DISSIPATION IN RADIATOR TUBE WITH NANO COATING

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Abstract: Radiators are a type of heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating. Upwards of 33% of energy generated by the engine through combustion is lost in heat. Insufficient heat dissipation can result in the overheating of engine, which leads to the breakdown of the lubricating oil, metal weakening of engine parts, and significant wear between engine parts. To minimize the stress on the engine as a result of heat generation, automotive radiators must be redesigned or material changing to be more compact while still maintaining high level of heat transfer components. This is lead to the increased demand on the power packed radiators, which can dissipate maximum amount of heat for any given space. This project aims to do a comparison between ordinary radiator tube material and a new radiator tube material with the nano coating. The existing material for the radiator tube such as aluminum alloy and copper alloy is replace by brass material with nano coating material such as Al_2O_3 .

Keywords— *Radiator, engine parts, nano coating material*

I. INTRODUCTION

It is theoretically approved that using Nano particles would improve the performance of the heat transfer. This project is to investigate the concept of using nanofluid in heat exchangers experimentally. Nanofluids are engineered colloids made of a base fluid and nanoparticles (1-100 nm). Nanofluids have higher thermal conductivity and single-phase heat transfer coefficients than their base fluids. The concept of Nanofluids refers to a new kind of heat transport fluids by suspending Nano scaled metallic or nonmetallic particles in base fluids.

II RADIATOR

Cooling is one of the top technical challenges to obtain the best automotive design in multiple aspects (performance, fuel consumption, etc.). Automotive radiator is an important part of the engine cooling system. Radiator is a heat exchanger that removes heat from engine coolant passing through it. Heat is transferred from hot coolant to outside air. Radiator assembly consists of three main parts core, inlet tank and outlet tank as shown in fig.1. Core has two sets of passage, a set of tubes and a set of fins. Coolant flows through tubes and air flows between fins. The hot coolant sends heat through tubes to fins. Due to limited space at the front of the engine, the size of the radiator is restricted and cannot be essentially increased. Nano fluids are dilute liquid suspended

nanoparticles which have only one critical dimension smaller than ~100nm. Much research work has been made in the past decade to this new type of material because of its high rated properties and behaviour associated with heat transfer (Masuda et al. 1993; Choi 1995), mass transfer (Krishnamurthy et al. 2006, Olle et al. 2006). The thermal behaviour of nano fluids could provide a basis for an huge innovation for heat transfer, which is a major importance to number of industrial sectors including transportation, power generation, micromanufacturing, thermal therapy for cancer treatment, chemical and metallurgical sectors, as well as heating, cooling, ventilation and air-conditioning.

III LITERATURE SURVEY

Today the Nano Technology Integrated next generation Automotive Radiator is one of the most active areas in automobile cooling system. Most of the early investigations are reviewed by Choi & Eastman have tried to suspend various metal and metal oxide nanoparticles in different fluids. Vasu et al. have used aqueous alumina as a coolant on automobile flat tube plain fin compact heat exchanger. Tzeng et al. investigated the temperature distribution of rotary blade coupling transmission used in four wheel drive vehicles. They concluded that use of nano fluids in the transmission has a clear advantage from the thermal performance view point. Ravikanth et al. used the nano fluids in radiator to study the heat transfer performance. They used the CuO and Al₂O₃ for their study.

Li and Xuan, Xuan and Li and Pak and Cho experimentally showed the convection heat transfer and pressure dropping for nano fluid tube flows. Their results show that heat transfer coefficient was greatly incremented and it depends upon factors like Reynolds number, particle size and shape, and particle volume fraction. They also found that nano particles did not cause an extra pressure drop.

Mushtaq et al. investigated the effect of channels geometry (the size and shape of channels) on performance of counter flow micro channel heat exchanger and used liquid water as a cooling fluid. They found that the effectiveness of heat exchanger and pressure drop were increased by decreasing the size of channels and claimed depending on the application of which type of heat exchanger is used.

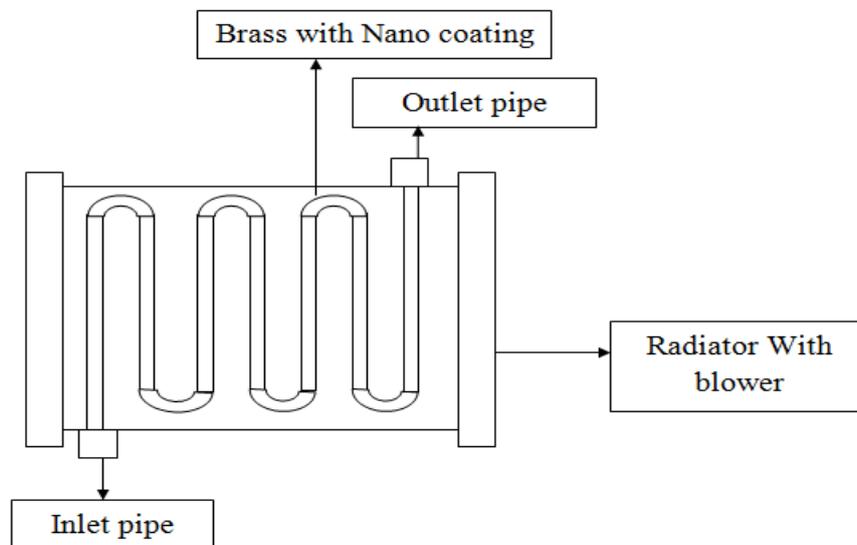


Fig 1 Block Diagram of Radiator Tube

IV LIST OF MATERIALS

A) RADIATOR WITH BLOWER

Radiators are installed in automobiles to remove heat from under the hood. When driving a car, the engine produces intense heat which must be dissipated or the engine will overheat. The use of higher output engines with tightly compacted underhood packaging, the addition of new emission components, and aerodynamic front end styling with narrower openings are creating a hostile thermal environment in the engine compartment.

Table 1 Radiator Specifications

Sl. No	Parameters	Specifications
1	Inlet Temperature of Water (Th1)	85°C
2	Inlet Temperature of Air (Tc1)	35°C
3	Dimensions of inlet & outlet tanks (mm)	50 × 60 × 354
4	Length of tube	250 mm
5	Number of tubes	8
6	Distance between two tubes	30 mm
7	Length of the fin on tube	5 mm
8	Thickness of fin on tube	1 mm
9	Length of fin between two tubes	30 mm
10	Thickness of fin	0.5 mm
11	Distance between two fins	2.85 mm

IV RADIATOR SPECIFICATIONS

A) BLOWER

Blowers are mechanical or electro-mechanical devices used to induce gas flow through ducting, electronics chassis, process stacks, etc.--wherever flow is needed for exhausting, aspirating, cooling, ventilating, conveying, and so on. Motors usually drive blowers, though they can be powered by other means such as engines.

Table 2 Blower Specifications

Sl. No	Specifications	Parameters
1	Pressure	2 bar
2	Inlet diameter	100 mm
3	Outlet diameter	50 mm

B) BRASS

Brass is a metallic alloy that is made of copper and zinc. The proportions of zinc and copper can vary to create different types of brass alloys with varying mechanical and electrical properties. It is a substitutional alloy: atoms of the two constituents may replace each other within the same crystal structure.

Table 3 Brass specifications

Sl. No	Distribution	Values	
		1	Temperature (Centigrade)
		Min	25.797
2	Total heat flux (W/mm ²)	Max	2.1129
		Min	0.00101
3	Total deformation (mm)	Max	1.59
		Min	0
4	Equivalent stresses (Mpa)	Max	56.85
		Min	0.2837

C) NANO FLUID

Aluminium oxide is a chemical compound of aluminium and oxygen with the chemical formula Al₂O₃. It is the most commonly occurring of several aluminium oxides, and specifically identified as aluminium (III) oxide. It is commonly called alumina, and may also be called aloxide, aloxite, or alundum depending on particular forms or applications. It occurs naturally in its crystalline polymorphic phase α -Al₂O₃ as the mineral corundum, varieties of which form the precious gemstones ruby and sapphire. Al₂O₃ is significant in its use to produce aluminium metal, as an abrasive owing to its hardness, and as a refractory material owing to its high melting point.

Table 4 Thermal properties of Nano coolant

Sl. No	Properties	Values
1	Density (Kg/m ³)	3950
2	Specific heat capacity J/Kg K)	873.336
3	Thermal conductivity	31.922

Table 5 Temperature distribution of different alloys

Sl. No	Length	Copper	Steel	Brass
1	0.25	294.77	215.69	282.08
2	0.50	321.18	241.64	308.76
3	0.75	386.13	311.9	375.27

Table 6 Heat flux of different alloys

Sl. No	Length	Copper	Steel	Brass
1	0.25	8883.2	2933.4	1591.5
2	0.50	61224	3257	18026
3	0.75	109380	6205.9	32909

Table 7 Thermal properties of nano coolant (Al_2O_3)

Sl. No	Properties	Values
1	Density (Kg/m ³)	3950
2	Specific heat capacity J/Kg K)	873.336
3	Thermal conductivity	31.922

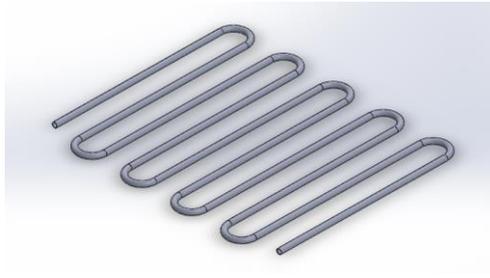


Fig 2 Radiator tube

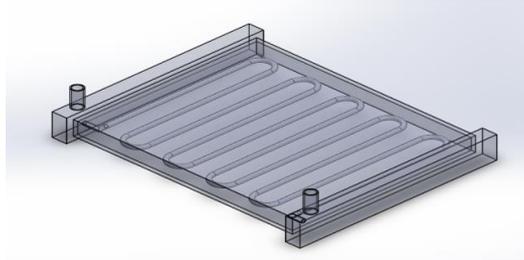


Fig 3 Radiator assembly

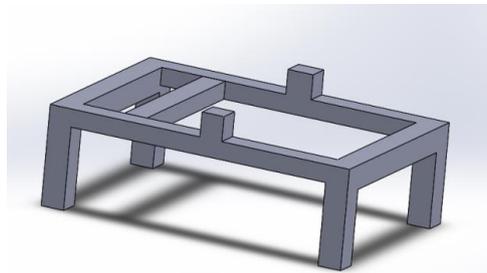


Fig 4 Frame

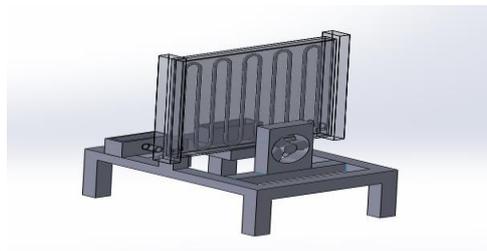


Fig 5 Assembly

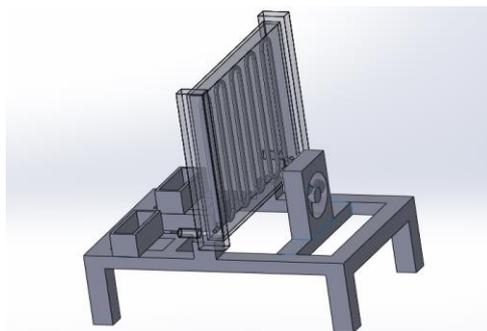


Fig 6 Radiator assembly

V WORKING PROCEDURE

The effect of EG addition is studied using two proportions of water–EG, i.e., 90:10 and 80:20 (by volume). For experiments with Al₂O₃/water–EG nanofluids, 80:20 water–EG mixture and 0.1% (vol.) of Al₂O₃ are used. The study is carried out with a constant flow rate of coolant and at different coolant temperatures (at the radiator inlet) varying from 30⁰C to 60⁰C. The rate of flow of the coolant was measured manually using a litre jar and a stop watch. The time taken to fill one litre was noted down and thus the flow rate was obtained. The procedure was repeated 5 times and the average flow rate was taken.

The setup is a closed loop system and the coolant line consists of a storage tank, an electrical heater, a pump, and a radiator. The components are connected using pipes of 1” diameter. The storage tank has a capacity of 80 liters. The coolant is heated in the storage tank using two 1 kW electrical immersion heaters and it maintains coolant temperatures between 30⁰C and 60⁰C A 0.2 hp centrifugal pump with a rated flow rate of 40 litres per minute and a rated head of 15 m drives the coolant through the loop. The radiator is a commercial aluminium plate fin type automobile radiator of size 517 mm × 380 mm × 24 mm. The radiator is cooled by forced convection using an electrical fan. The experiments are carried out with a constant flow rate of 0.13 kg/s. Thermocouples are used to measure the air and coolant temperatures. These are measured using a digital thermometer with an accuracy of ±1 ⁰C. As the heating of air is not uniform across the surface of the radiator at the exit, measurements are made at 15 points. These points are located across the vertical and horizontal centre line as shown in Figure. The average value of the temperatures measured at these points is taken for the analysis.



Fig 7 Radiator tubes with coated material



Fig 8 Radiator tubes with coated material



Fig 9 Radiator tubes with coated material

VI CONCLUSION

The project was intended to design an experiment to study the enhancement of heat transfer rate in radiator systems using nanoparticles. The main aim of this project is to prove experimentally what already has been proved theoretically that Nanofluids increase the heat transfer rate with no pressure drop.

Experiments were carried out under turbulent flow conditions and with three concentrations of Al₂O₃+CuO-Conventional coolant Nanofluid viz. 0.25%, 0.5% and volume concentration. The effects of particle concentrations and Reynolds number on the overall and convective heat transfer coefficients of Nanofluid are determined. Important conclusions have been obtained and are summarized as follows:

At a volume concentration of 0.25%, the use of Nanofluid increases convective heat transfer coefficient up to 35% and overall heat transfer coefficient up to 16% than that of conventional coolant at same flow conditions. Also at a particle concentration of 0.5%, Nanofluid increases convective heat transfer coefficient up to 30% and overall heat transfer coefficient up 8% to than that of conventional coolant at same flow conditions.

2. Nusselt number of the flow also increases from 1.3% to 7.31% for Hybrid Nanofluid for volume concentration 0.5 % to 1.5%. 3. It seems that the increase in the effective thermal conductivity and the variations of the other physical properties are not responsible for the large heat transfer enhancement. Brownian motion of nanoparticles maybe one of the factors in the enhancement of heat transfers. Although there are recent advances in the study of heat transfer with nanofluids, more experimental results and theoretical understanding of the mechanisms of the particle movements are needed to explain heat transfer behavior of nanofluids.

This new working fluid (Nanofluid) with higher heat transfer performance would promote the car engine performance and would reduce fuel consumption

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