Heat Extraction From Nano Fluid

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Abstract- *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 transport 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 Al2O3 /water/ethylene glycol based nanofluids are experimentally investigated. The volume fractions of nanoparticles used were 0.1%, 0.25%, 0.50% and 1.0%. The present work focuses on thermal conductivity and viscosity measurement of fluid mixture. This however, has not been addressed properly so far. Results show 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.*

I. INTRODUCTION

Our task is to design an automotive radiator to work in conjunction with advanced nanofluids. The new radiator design will be used in new General Motors hybrid vehicles. These hybrid vehicles have multiple cooling systems for the internal combustion engine, electric engine, and batteries. The popularity of these hybrid vehicles is on the rise due to the decreasing fossil fuel supply, increasing the importance of a new radiator design that can possibly replace these multiple cooling systems. Nanofluids are a relatively new classification of fluids which consist of a base fluid with nanosized particles (1-100 nm) suspended within them. These particles, generally a metal or metal oxide, increase conduction and convection coefficients, allowing for more heat transfer out of the coolant.

II. LITERATURE REVIEW

- **D. Tirupathi Rao , S. Ravi babu (2015)**,"Experimental investigation of cooling performance of an Automobile radiator using Al_2O_3 + Water + ethylene Glycol nanofluid".

They conclude that the presence of Al_2O_3 Nano particles in water + ethylene glycol can enhance the heat transfer rate of automobile radiator. The degree of heat transfer enhancement depends on the amount of the Nano particle added to water plus ethylene glycol. Ultimately, at the concentration of 0.08 vol. % the heat transfer enhancement around 48% compared to the pure water + ethylene glycol recorded.

- **Sayantan Mukherjee, Somjit Paria (2013)**,"Preparation and Stability of Nanofluids- A Review".

In this review article an attempt has made to cover all the important investigations performed on the preparation and stability of nanofluids. Preparation and stabilization of such fluids are indeed a matter of concern for better understanding. Nanofluids are colloidal suspension of ultra-fine metallic or non metallic particles in a given fluids. Despite all other properties, it is well known for its high thermal conductivity and better response as heat transfer medium. Nanofluids can be of two kinds such as metallic nanofluids and non metallic nanofluids.

- **Gaurav Sharma, Lal Kundan (2013),** "Experimental Investigation into Thermal Conductivity and Viscosity of Al_2O_3 Based Engine Coolant (Nano-coolant)".

In their study, the thermal conductivity and viscosity of Al_2O_3-engine Nano-coolant have been investigated. It is found that the volume concentration have significant effects on thermal conductivity and viscosity. Results indicate that thermal conductivity and viscosity increases with the increase of the volume concentration (%). Thermal conductivity and Viscosity characteristics should be considered before implementing nanoparticles in engine coolant. Thermal conductivity increases with temperature while viscosity decreases with temperature. The maximum improved thermal conductivity on 0.5% vol. concentration, by 5.7% at 40 ºC. The enhancement in viscosity on 0.5% vol. concentration, by 124% at 40 ºC. Viscosity increases with increase in the volume concentration of nanoparticles. It decreases with increase in temperature. It has been observed that decrease is sharper at higher temperature than the lowered value of temperature.

- **Pawan S. Amrutkar, Sangram R. Patil & S. C. Shilwant (2013),** "Automotive Radiator - Design And Experimental Validation".

It has been described radiator design validation through finite element analysis as well size and heat rejection validation by experimental test. In automotive, radiator is a base component of engine cooling system. It extracts heat from engine and keeps engine surface temperature at optimum level for better engine efficiency. Radiator development consists of its size and design aspects. Size provides heat rejection area and its performance. Design is related to its robustness. Radiator size is controlled by heat load and packaging space availability. The heat transfer performance of the radiator is analyzed for theoretical, simulation and experimental values. FE Analysis result shows radiator design is safe and stress level observed is below maximum stress criteria. Performance test result shows radiator is able to deliver required heat rejection. Simulation results are good approximations of the tested values found experimentally. The objective to design and validate the radiator is accomplished successfully.

III. METHODOLOGY

IV. EXPERIMENTAL SETUP

The experimental system used in this study it includes flow lines, a storage tank, a heater, a centrifugal pump, a flow meter, a forced draft fan and a heat exchanger (an automobile radiator). The pump gives a variable flow rate of 2-42 l/min. the flow rate to the test section is regulated by appropriate adjusting of a globe valve on the recycle line. The base fluid fills 30% of the storage tank whose total volume is 2 lit. The total volume of the circulating liquid is constant in all the experiments.

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V. CAD MODEL

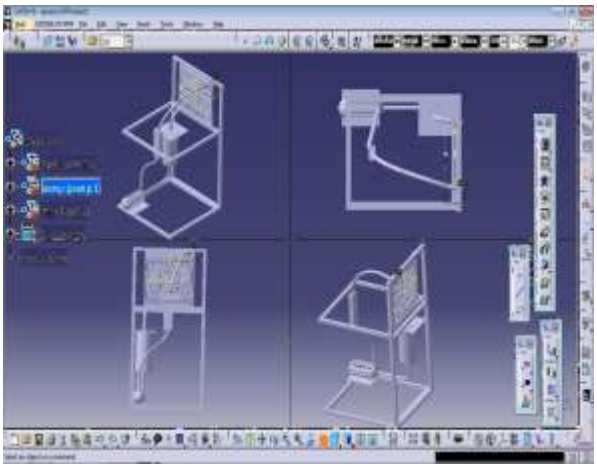

Fig. Different Views Of The Setup

The CAD modeling of the experimental setup with different views are shown in the figure. We have found out the actual dimensions needed during the design stage for purpose of manufacturing the experimental test setup

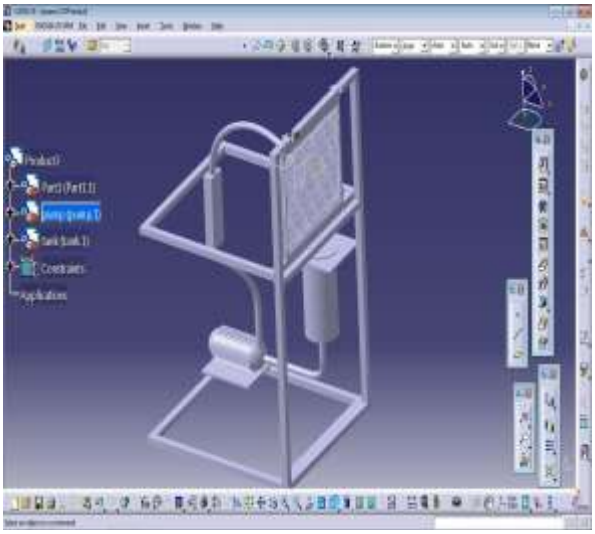

Fig. CAD Assembly

The fig 3.4 shows the isometric view of the entire experimental setup. The assembly of all the components with all its sequential connections is illustrated in this model.

VI. ESTIMATED COST OF PROJECT

SR. NO.	Parameter Components	Quantity	Cost
1	Nanoparticles (100gms)		8000
2	Radiator with fan	1	2000
3	Water pump	1	9000
4	Electric water heater	1	800
5	Collecting tank	1	650
6	Connecting hose pipes		2500
7	Mild steel frame		2000
8	Rotameter	1	5000
9	AC to DC Converter	1	1500
10	Digital temperature sensor	2	700
11	Sealing material		60
12	Welding Charges		500
TOTAL			32710

Cost Table

VII. RESULT

Sr. No.	Flow Rate (Lpm)	Water (Watt)	Water + Propylene glycol (Watt)	Nanofluid
1	10	739.29	542.50	589.23
2	9	730.93	551.30	560.25
3	8	698.57	570.89	588.52
4	7	716.81	532.71	550.74

Result Table

VIII. CONCLUSION

The experiment conducted on the Maruti Suzuki 800 radiator by replacing the conventional coolant by the modern nanocoolant proved comparatively effective. The results obtained so far is the evidence of increase in the efficiency of the radiator. The following inferences can be drawn by demonstrating the experiment successfully:

1. The heat transfer rate of nanofluid is greater than that of conventional coolant as the conductivity of the Alumina is higher than the simple coolant.
2. The size of the radiator is reduced in the case if we want same heat transfer rate as that of the conventional coolant.
3. Hence it becomes possible to improve the aerodynamic shape of the car which would reduce the air drag.
4. The reduced air drag, improved heat transfer rate, better engine cooling reducing the average fuel consumption.
5. The volumetric efficiency of the engine cylinder is also improved due to better and faster cooling.
6. The most important the Nox emission is also considerably reduced as the engine temperature is reduced below 1100^0C.

Thus we finally conclude that this experiment proved to be very beneficial in all-round aspects improving the overall vehicle performance covering all important aspects.

REFERENCES

[1] **D. Tirupathi Rao , S. Ravi babu (2015)**,"Experimental investigation of cooling performance of an Automobile radiator using Al_2O_3 + Water + ethylene Glycol nanofluid".

[2] **Sayantan Mukherjee, Somjit Paria (2013)**,"Preparation and Stability of Nanofluids- A Review".

[3] **Gaurav Sharma, Lal Kundan (2013),** "Experimental Investigation into Thermal Conductivity and Viscosity of Al_2O_3 Based Engine Coolant (Nano-coolant)".

[4] **Pawan S. Amrutkar, Sangram R. Patil & S. C. Shilwant (2013),** "Automotive Radiator - Design And Experimental Validation".

[5] **Andreea Kufner (2013) ,** " Design Parameters To Obtain Al_2o_3 Nanofluid To Enhance Heat Transfer".

[6] **Rahul A. Bhogare, B. S. Kothawale (2013),** "A Review on applications and challenges of Nano-fluids as coolant in Automobile Radiator".

[7] **Gupta H.K, Agrawal G.D, Mathur J (2012),** "An overview of Nanofluids: A new media towards green environment".

[8] **SM Peyghambarzadeh, SH Hashemabadi, M Seifi Jamnani, SM Hoseini (2011),** "Improving the cooling performance of automobile radiator with Al2O3/water nanofluid".

[9] **Ravikaanth S. Vijjha, Debendra K. Das, Praveen K. Namburu (2010),** "Numerical study of fluid dynamic and heat transfer performance of Al_2O_3 and CuO nanofluids in the flat tubes of a radiator".

[10] **K.Y. Leong, R. Saidur, S.N. Kazi, A.H. Mamun (2010),** "Performance investigation of an automotive car radiator operated with nanofluid-based coolants (nanofluid as a coolant in a radiator)".

[11] **Xiang- Qi Wang, Arun S. Mujumdar (2008),** "A Review On Nanofluids-Part I : Theoretical And Numerical Investigations".