IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Experimental Analysis of Nano Powder Mixed Coolant Performance on Heat Transfer of Car Radiator

[1] C. Limbadri, [2]R.S. Pawar

[1] Assistant Professor, [2] M Tech Student,

[1]Department of Mechanical Engineering,

[1]G.H. Raisoni College of Engineering and Management, Pune, India

Abstract: The scope of work is to investigate thermal analysis of automobile radiator and also to check the influence of working conditions as well as physical parameters on the performance of radiator with the help of developing a test setup wherein checking the heat transfer rate in the radiator for different inlet mass flows of coolant, different air flow rate and different mass % of al2o3 nano powder mixed in water. To accomplish this, we used Al2O3-nanofluid to study the heat transfer of a car radiator at temperatures ranging from 40 to 75 degrees Celsius and concentrations of 0.5 to 1% nanoparticles. (vol.).

Index Terms **- Nano fluid, Al2o3, Car radiator, thermal analysis, experimentation**

I. Introduction

Heat transfer is an important part of the mechanical engineering curriculum for undergraduates. It is the transfer of heat from one object or material to another across a temperature gradient. This study aims to investigate experimental solutions to practical heat transfer problems. A great deal of effort has gone into developing innovative methods for increasing heat transmission from a finer surface to the surrounding moving fluid. Power densities of electronic component increased due to requirement of smaller and powerful products in electronic industry. The maximum temperature of an electronic component determines its reliability. Many innovative inventions have become symbols of modern existence. Thermal management is a major issue in the electronic industry, and its relevance will expand in the next years. In necessary for modern inventions like the computer, the car, and the use of electricity to be functional, a heat sink is necessary. The most frequent application of thermal control in electronic packaging is the heat sink. The performance of the heat sink is influenced by the material, surface area, flatness of contact surfaces, design, and fan requirements. Due to its high conductivity (205 W/mK), low weight, low price, and ease of manufacturing, aluminium is the most commonly used material. Copper has a high conductivity (400 W/Mk), yet it has drawbacks such as weight and cost. Heat sinks built of aluminum and copper linked together can combine the advantages of both Aluminum and Copper. For these many technologies, heat sink technology is applied in a variety of ways, but in cars, it takes the form of a radiator. The heat sink is made to allow effective heat transfer from the heat source to the fins while also allowing cooling fluid to reach all cooling fins. The type of fluid moving equipment employed also affects heat sink effectiveness since air flow rates have a direct impact on enhancing properties. Heat exchangers are a more technical term for radiators, but the main assumptions are the same. The combustion process heats the water that is forced through the internal combustion engine, keeping it warm enough to function properly. The water then enters the radiator and travels via a number of smaller tubes that connect to the radiator's various fins. The radiator's surface area is increased by the rows of fins, which improves the air's ability to cool itself as it passes through. The fan and motion of the car force air through the radiator's fins and around its tubes. With the help of this flowing air heat is removed from the water running through the pipesThe car radiator has lowered fins with flat cross-sectional areas and 32 flat, vertical Aluminum tubes. Rows of perpendicular aluminium fins were integrated to fill the space between the tubes. An axial force fan (6000 rpm) is installed on the air side, close to the radiator's axis line. For conversion of AC to DC used

DS power supply adaptor. The working fluid was heated with a 2000-watt electric heater and the temperature was controlled with the help of controller to remain between 40 and 80 degrees Celsius. Two thermocouples are inserted in the radiator to measure the wall temperature, and two thermocouples are mounted on the flow line to record the temperatures at the radiator's inlet and outlet.

1.1 NANO FLUID

To evaluate their superiority over the base fluid, the numerical research of a three-dimensional laminar flow and heat transfer utilising two different nano-fluids, Al2O3 and a water mixture, travelling through the flat tubes of an automobile radiator may also be conducted. A liquid (often water) is cooled by air in radiators, which are critical components in the control of engine temperature in automobiles. The liquid travels through flat tubes, whereas the air travels through channels created by fin surfaces. Nanometer-sized materials offer unique optical, electrical, and thermal properties and are now often used in traditional industries as a result of recent advancements in nanotechnology. Recently, it has been discovered that nanoparticles can disperse in typical heat transfer fluids like water, ethylene glycol, and engine oil. It develops a new class of very effective heat exchange fluids called nanofluids. Many practical and theoretical studies have been conducted, and it has been determined that these new heat exchanger coolants are outstanding.

II. EXPERIMENTAL SETUP

The test rig used to note heat transfer rate at variable operating conditions of engine cooling system / radiator So that outcome data will be helpful to modify or redesign the radiator in future. Plastic reservoir, heater, pump, flow metre, valve, fan, DC power source, and thermometer for temperature measurement are all included in this experimental set-up. To represent the engine an electrical heater of (2000 W) is used inside a plastic storage tank. The radiator's input temperature is maintained between 65 and 75 degrees Celsius using a voltage regulator (0-220 V). The flow rate is measured and managed using two valves and a flow metre. To measure the temperatures at the input and outflow, two thermocouples were mounted in front of the fan and on the opposite side of the radiator.

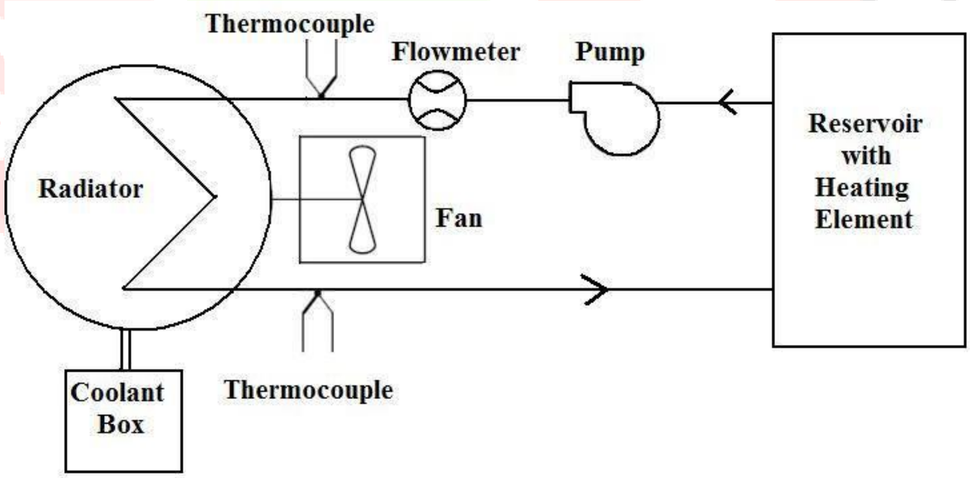

Fig.1.1 EXPERIMENTAL SETUP

2.1 NANO FLUID PREPARATION

A fluid known as a nano fluid has particles suspended in it that are smaller than a nanometer. When compared to larger particles of the same material, nanoparticles are a class of materials with unique physical and chemical properties. Experiments remain the most dependable source of knowledge when dealing with complex flow situations like multiphase flows, boiling, or condensation. In order to create Nano fluids, the two-step method employs a two-stage process in which Nanoparticles are first prepared as a dry powder and then dispersed into a base fluid in a subsequent processing phase. Although some agglomeration may happen during the production, storage, and dispersion of nanoparticles, it is well known that these agglomerates can be broken up into smaller pieces with comparatively little energy. Because of this, even agglomerated Nano crystalline powders can be successfully dispersed in fluids and display desired qualities. This two-step process is effective in various applications, particularly for oxide and nonmetallic nanoparticles. In this experiment, the Nano fluid was made utilising a two-step process. The nanoparticle was taken in a precise quantity. A mechanical stirrer was used to make sure that it was well combined with the water. To lessen the agglomeration issue, it was put in a sonicator and subjected to vibrations. The nanofluid was kept still for two days to check for sedimentation. After two days, there was no noticeable sedimentation, and the most important fact is that when it was stirred once again, it changed into a homogenous fluid with evenly suspended nanoparticles.

2.2 SPECIFICATION OF MATERIAL USED FOR EXPERIMENTATION

1.Radiator	Type	Radiator of 4 stroke 4cylinder petrol engine with range of 0-600 oC coupled with 4 thermocouples.
	Make	Maruti 800
	Volume of Coolant	3.5 litre.
	Radiator Size	335 mm X 300 mm X 17 mm
	Tube Side Area	330905.3 mm2
	Fin Side Area	2310000 mm2
2.Nano Particles	Al_2O_3 nano powder that mixes with water	
3.Blower	Type	Three speed axial fan
	Purity	80 %
	Water Dispersibility	Greater than 95 %

III. RESULTS AND DISCUSSION

3.1 Effect of change of flow rate of coolants at constant air flow rate 6.2 m/s.

Table 3.1 Rate of change in heat transfer at constant air flow rate.

When pure water used as a coolant			
Coolant flow rate lph	Air flow rate m/s	Temp diff. degree Celsius	Rate of heat transfer qc=mc(ti-to) j/s
50	6.2	4	232.7003
100	6.2	6	698.101
150	6.2	9	1570.727
200	6.2	10	2327.003
When 0.5% al2o3 nano powder mixed in Pure water			
50	6.2	7	394.5305
100	6.2	9	1014.507
150	6.2	11	1859.93
200	6.2	12	2705.352
When 1% al2o3 nano powder mixed in Pure water			
50	6.2	9	492.412
100	6.2	11	1203.674
150	6.2	13	2133.785
200	6.2	15	3282.747

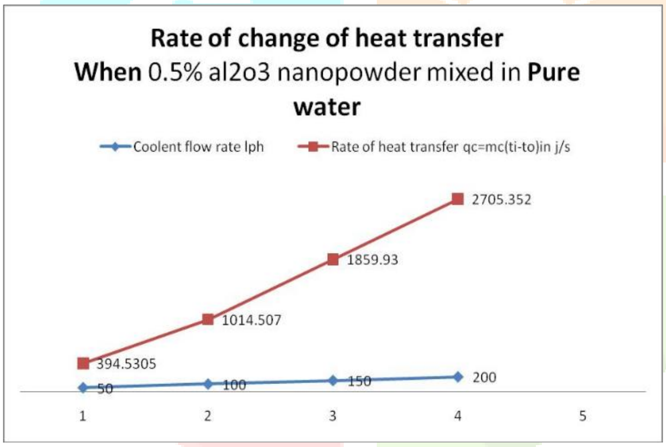

Fig. 3.1Rate of Change of heat transfer when 0.5% al2o3 is mixed in pure water

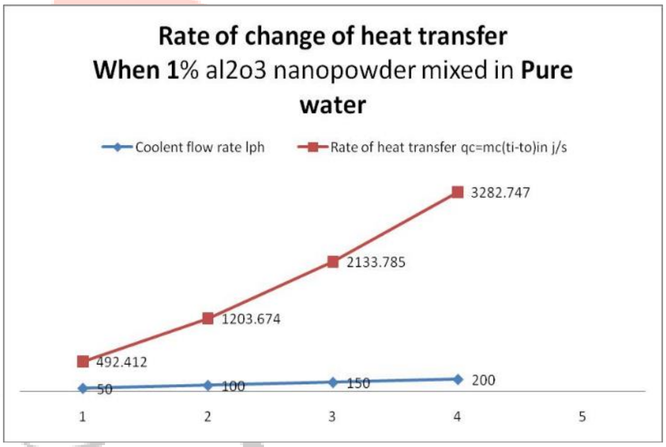

Fig. 3.2 Rate of Change of heat transfer when 1 % al2o3 is mixed in pure water

As seen from fig 3.1 and 3.2 the rate of heat transfer increases as coolant flow rate increases while air flow rate remains constant. For example, it was discovered that when coolant flow increased from 50 lph to 200 lph using 0.5 percent al2o3 nano powder mixed in pure water, the rate of heat transfer increased from 394.53 w/mK to 2705.35 w/mK. In the same case, it was discovered that using 1 percent al2o3 nano powder mixed in pure water caused the rate of heat transfer to increase from 492.4 w/mK to 3282.74 w/mK

Additionally, we can see from fig 3.1 and 3.2 that the rate of heat transfer is higher when using 1 percent al203 nano powder in pure water than when using 0.5 percent al2o3 nano powder in pure water. For example, the rate of heat transfer for pure water mixed with 0.5 percent al203 nano powder at 50 lph coolant flow rate and 6.2 m/s air flow rate is 394.53 w/mK, and for the same case with pure water mixed with 1 percent al2o3 nano powder at 50 lph coolant flow rate and 6.2 m/s air flow rate is 492.41w/mK.

3.2 Effect of change of air flow rate at constant coolant flow rate 200lph on heat transfer.

Table 3.2 Rate of change of heat transfer at constant coolant flow rate.

When pure water used as a coolant			
Coolant flow rate	Air flow rate	Temp diff.	Rate of heat transfer qc=mc(ti-to)
lph	m/s	degree Celcius.	j/s
200	3.8	7	1628.902
200	4.9	8	1861.603
200	6.2	10	2327.003
When 0.5% al2o3 nano powder mixed in Pure water			
200	3.8	8	1803.568
200	4.9	10	2254.46
200	6.2	12	2705.352
When 1% al2o3 nano powder mixed in Pure water			
200	3.8	12	2626.197
200	4.9	13	2845.047
200	6.2	15	3282.747

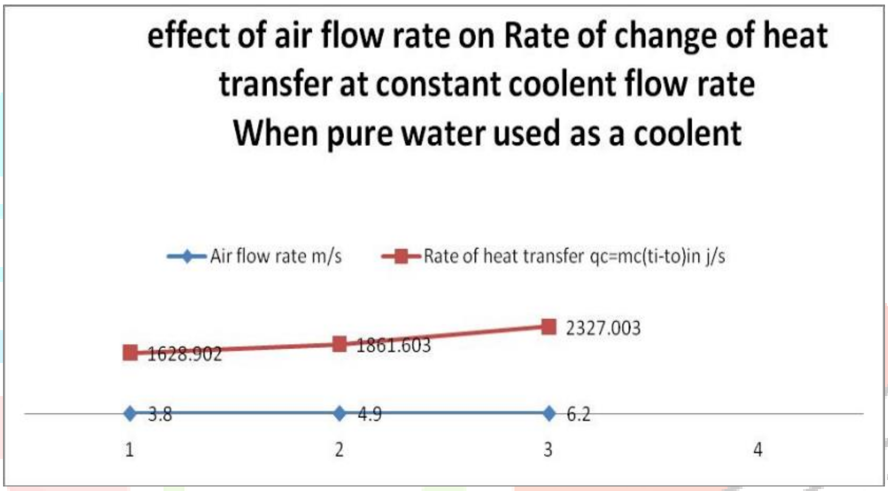

Fig.3.3 Rate of change of heat transfer at constant coolant flow rate when pure water used as coolant

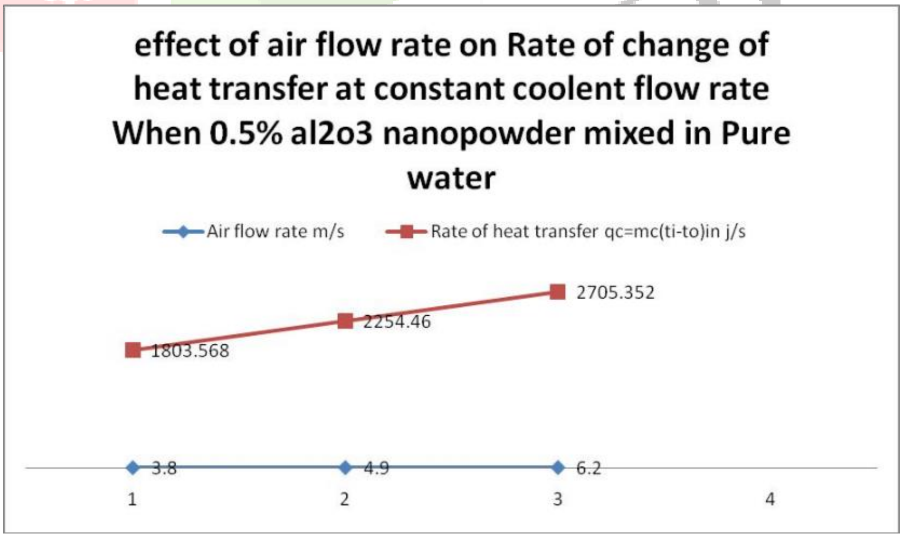

Fig.3.4 Rate of change of heat transfer at constant coolant flow rate when 0.5% al2o3 nano powder mixed in coolant

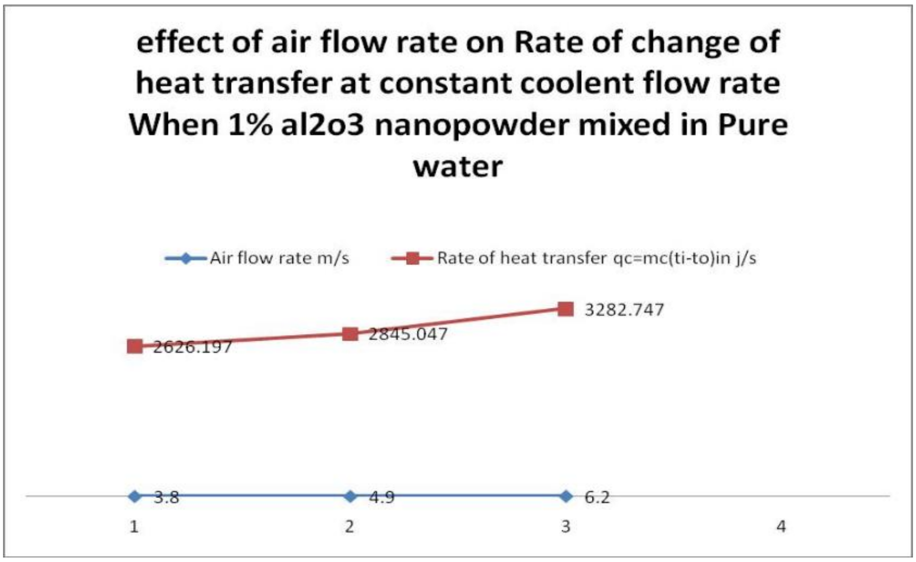

Fig.3.5 Rate of change of heat transfer at constant coolant flow rate when 1% al2o3 nano powder mixed in coolant

Figures 3.3,3.4, and 3.5 demonstrate that the rate of heat transfer rises with increasing air flow rate at constant coolant flow rate. For example, when pure water is used as a coolant at a coolant flow rate of 200 lph and the air flow rate increases from 3.8 m/s to 6.2 m/s, the rate of heat transfer increases from 1628.90 w/mK to 2327 w/mK; when 0.5 percent of al2o3 nano powder are mixed in pure water for the same case, the rate of heat transfer increases from 1803.5 w/mK to 270 and when 1 & l2o3 nano powder mixed in pure water for same case rate of heat transfer increases from 2626.2 w/mK to 3282.7 w/mK hence it was seen from above results that rate of heat transfer increases.

Additionally, it can be observed from fig 3.3, 3.4, and 3.5 that the rate of heat transfer is higher when using 1 percent al2o3 mixed in pure water than when using 0.5 percent al2o3 mixed in pure water and pure water used as coolant. For example, when using pure water as the coolant at a coolant flow rate of 200 lph with an air flow rate of 3.8 m/s, the rate of heat transfer is 1628.90 w/mK. In the same scenario, when 0.5 percent al2o3 is mixed with pure water, the rate of heat transfer is 1803.5 w/mK, and when 1 percent al203 is mixed with pure water, the rate of heat transfer is 2626.2 w/mK. Thus, it was observed that rate of heat transfer greater when using 1% al2o3 nano powder mixed in pure water.

IV.CONCLUSION

1) The rate of heat transfer in a car radiator is increased by 11% by adding 0.5 percent al2o3 nano powder of 100nm size to pure water at a constant coolant flow rate of 200LPH and a constant air flow rate of 6.2 m/s.
2) The rate of heat transfer in a car radiator is increased by 41% by adding 1% al2o3 nanopowder of 100nm size to pure water at a constant coolant flow rate of 200LPH and a constant air flow rate of 6.2 m/s.
3) When the air flow rate remains constant, the rate of heat transfer rises as the coolant flow rate rises.
4) When the flow of cooling air is increased while the flow of coolant remains constant, the rate of heat transfer increases.

REFERENCES

[1] Adnan. (2016). Numerical study on turbulent forced convective heat transfer using nano fluids TiO2 in an automotive cooling system. case studies in thermal engineering.
[2] Ali, H. M. (2015). Experimental investigation of convective heat transfer augmentation for car radiator using ZnO-water nano fluids. Elsevier, 317-324.
[3] Delavari, v. (2014). CFD simulation of heat transfer enhancement of Al2O3/water and Al2O3/Ethylene Glycol nano fluids in a car radiator. Applied thermal engineering, 378- 388.
[4] Goudarzi, K. (2017). Heat transfer enhancement of Al2O3- EG nano fluid in a car radiator with wire coil inserts. Guilherme. (2016). Experimental study on the heat transfer of MWCNT/water nano fluid flowing in a car radiator.
[5] Applied thermal engineering, 26.
[6] Naraki, M. (2013). Parametric study of overall heat transfer coefficient of CuO/water nano fluids in a car radiator.

[7] International journal of thermal sciences, 82-90.
[8] Saidur, R. (2011). A review on applications and challenges of nano fluids. Elsevier, 1646-1668.
[9] Sandhya, D. (2016). Improving the cooling performance of automobile radiator with ethylene glycol water based TiO2 nano fluids. Elsevier, 6.