Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

Experimental Investigation of Optimum Tubes Structure for Automobile Radiator Performance

Vishal V. Kulkarni
Department of Mechanical Engineering.
JSPM's Jayawantrao Sawant College of Engineering.
Savitribai Phule Pune University, Pune, India.

Prof. Suhas M. Shinde
Department of Mechanical Engineering
JSPM's Jayawantrao Sawant College of Engineering.
Savitribai Phule Pune University, Pune, India.

***Abstract*- Radiators are used for cooling internal combustion engines, piston engine aircrafts, railway locomotives, stationary gearing plants or any similar use in industrial and domestic applications. The proposed work focuses on geometrical aspects which are used in the core of radiators and their reflections on performance of radiator. The development of radiator prototypes based on existing tubes structure is described. Testing of these prototypes is carried out on standard experimentation setup using nanofliud as coolant with different concentrations of particles. The results showed that the performance of developed radiator prototype is giving satisfactory agreement with the performance of existing radiator. Also the heat transfer coefficient for both radiators increases as the concentration of nano particles increases.**

***Keywords- Radiator, Core, Tubes, Coolant flow, Nano Fluids*.**

I. INTRODUCTION

Radiator is the key component of engine cooling system. The coolant is pumped through the engine, then after absorbing the heat of combustion is circulated to the radiator where the heat is transferred to the atmosphere. The cooled liquid is then transferred back into the engine to repeat the process. Though there are large usages of radiator, difficulties and inconveniences arise while applying and installing them in particular applications. The problem of heat dissipation, overheating, chocking of water and energy losses are commonly occur in existing radiator and greatly reduce the engine efficiency. These are may be due to its geometric or performance parameters.

The changing of design parameter on Radiator fins, material, tube core and coolant flow arrangement may improve the heat transfer co-efficient and thermal conductivity of it. So, Radiator sizing is important factor while designing cooling system. Radiator size depends on heat load as well packaging space availability.

Mikk Maivel et.al.[1] presented work related to Laboratory measurements for the same size and type of radiator with parallel and serial connected panels for same conditions to calculate energy savings. Krunal Kayastha et.al. [2] proposed radiator having helical tubes structure and analyzed for two different pitches like 15mm and 20 mm. Two CAD models were compared at various mass flow rates like 2.3, 2.0, 1.0, 0.5 kg/sec in helical type tubes. C. Franklin [3] presented compact sized dual pass core radiator which involves arrangement of horizontal opposite flow with two directional pass having three tanks with flat tubes in the system. This resulted in increased area for heat transfer, splitting of pass direction and reduction in cooling time. Vahid Delavari et.al. [4] described the work related to use of flat tubes in radiator to carry out CFD simulation for heat transfer in nano fluids. The results gave idea about tube friction factor which increases as the concentration of nano particles in the nano fluid increased. A. Oliva et.al. [5] examined the effect of some geometrical parameters such as fin pitch, louver angle also the significance of coolant flow lay-out on the overall performance of radiator.

The proposed work consist study of geometric parameters of existing automobile radiator with its structure of tubes and core. Then development of prototype of radiator based on existing tube structure keeping basic dimensions of radiator constant. Finally, experimental evaluation of performance of these radiators on standard test rig.

II. DETAILS OF RADIATOR PROTOTYPES

The parametric studies presented in this paper have been performed on a existing car radiator of 800cc. Keeping basic dimension of existing radiator constant, prototype of radiator is developed having reduced number of rows and tubes in simplified way.

During development intention is clear that tubes volume become constant in radiator core part. Newly developed prototype gets reduced in number of rows and tubes. It is now having single row with 8 tubes.

Fig. 1: Existing Radiator Prototype

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

Table 1. Geometry description of Existing Radiator under study.

Core height	310 mm
Core width	320 mm
Core breadth	45 mm
Tube Rows	2
Total tubes	36
Tube cross section	circular
Tube height	310 mm
Tube diameter	6 mm
Tube thickness	1 mm

Volume of 36 tubes is equally converted into volume of 8 tubes. The calculation of geometrical parameters of developed prototype is as follows:

Volume of tube $V_1 = \pi r^2 h$

After substituting values,

For 36 tubes it gives $V_1 = 315541.57\ mm^3$

After concerning with few Radiator Manufacturers, available tube diameters are listed out for simplified radiator prototype. For converting it in 8 no. of tubes, volume of newly manufactured single tube is evaluated as

$$V_2 = 39442.69\ mm^3$$

Based on this volume, diameter of each tube is evaluated keeping initial and final height of tubes constant as follows;

$$r_2^2 = V_2 / (\pi h)$$

$$= 39442.69 / (\pi * 310)$$

$$= 40.5$$

Thus $r_2 = 6.36$ mm

and $d_2 = 12.73$ mm

In this way, new prototype of radiator 1 is prepared having single row with 8 tubes of 12.73 mm diameter of each tube. Considering the performance regarding temperature drop material selected for tubes in manufactured radiator is copper.

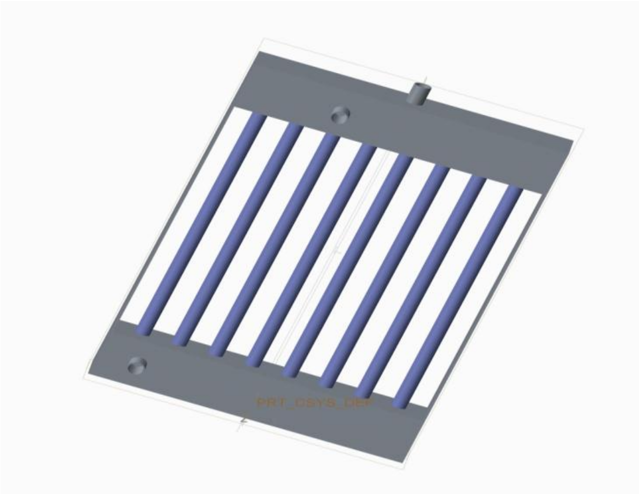


Fig. 2: CAD model of radiator 1 prototype.

Fig. 3: Fabricated prototype of Radiator 1

Table 2. Geometry description of radiator 1 prototype.

Core height	310 mm
Core width	320 mm
Core breadth	45 mm
Tube Rows	1
Total tubes	8
Tube cross section	circular
Tube height	310 mm
Tube diameter	12.73 mm
Tube thickness	1 mm

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

III. EXPERIMENTAL SETUP

The test rig shown in fig has been used to measure heat transfer coefficient and friction factor in the automotive engine radiator. This experimental setup includes a reservoir steel tank, electrical heater, a pump, a rotameter, hose pipes, flow control valves, a fan, Power supply, K type thermocouples for temperature measurement and automobile radiator.

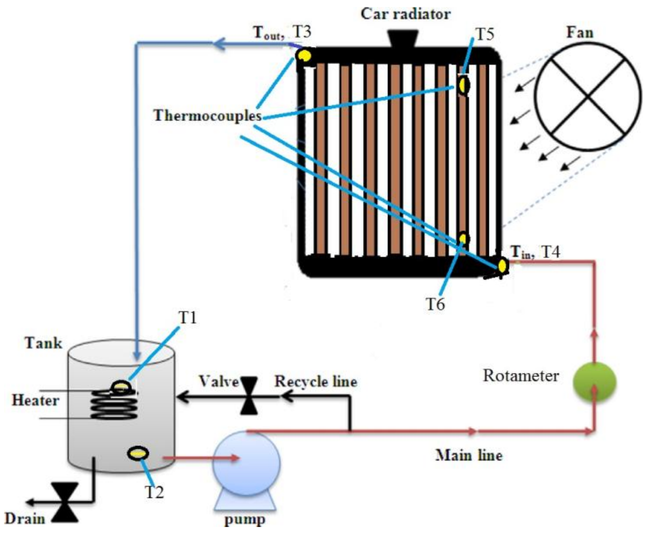


Fig. 4: Schematic of experimental set up.

An electrical heater (1000W) inside a steel storage tank of 12 ltr capacity (45cm height and 30 cm diameter) put to represent the engine and to heat the fluid. AC mains power supply provide the power to keep the inlet temperature to the radiator from 80 to 100°C. A rotameter (500–2500 LPM) and two flow control valves used to measure and control the flow rate. The fluid flows through hose pipes (0.5in.) by a pump (0.5 hp and 30-40 m head) from the tank to the radiator at the flow rate range 500-550 LPM. The total volume of the circulating fluid is 3lts and constant in all the experimental steps.

Out of two thermocouples of types K, one has been fixed on the heater (T1) and other is inserted in the fluid of the tank (T2). Then next two thermocouples are kept in the radiator inlet and outlet tank for recording the inlet (T4) and outlet (T3) fluid temperatures. Other two thermocouples have been fixed to one of the radiator tube surface to measure its surface temperature from inner tank side (T6) and outer side tank (T5).

For the air, a fan (1500-2000 rpm) is installed close on axis line of the radiator. The AC power supply is used to run the fan with incorporated voltage variable unit (0.5 amp, 3-12 V range).By means of this, rpm of fan made easy to vary.

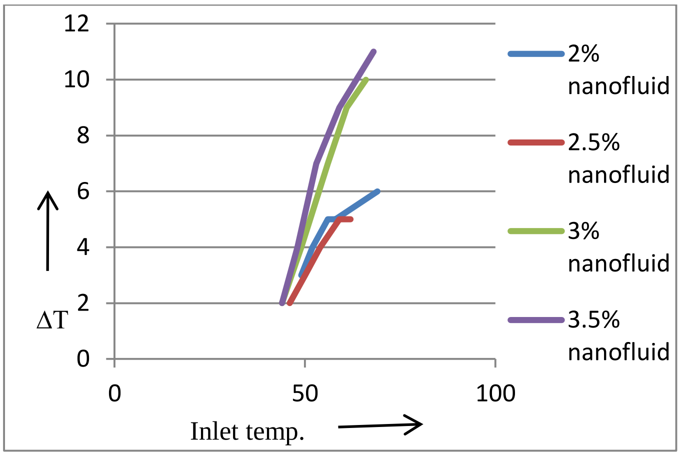
The coolants used during testing of radiators are nano fluid consisting of aluminium oxide as nano particles with different concentrations at water and ethylene glycol (50% + 50%) base.

Those are as follows:

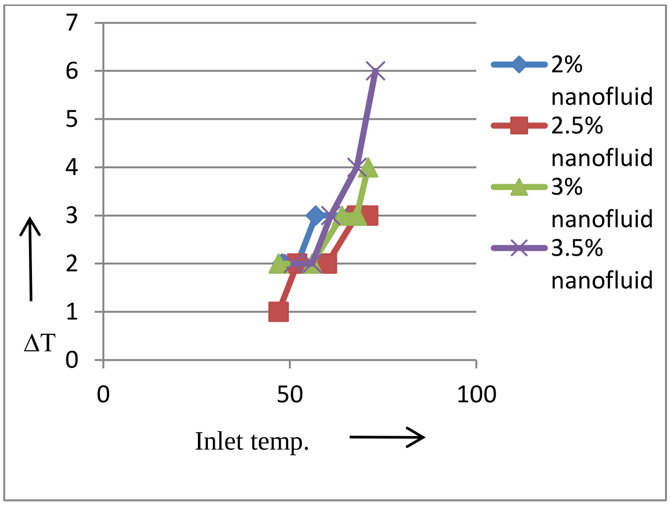
1. 2 % Al_2O_3 particles at glycol base.
2. 2.5 % Al_2O_3 particles at glycol base.
3. 3 % Al_2O_3 particles at glycol base.
4. 3.5 % Al_2O_3 particles at glycol base.

IV. RESULTS AND DISCUSSIONS

To evaluate the performance trials are conducted on existing radiator and radiator 1 prototype for different concentrations of nano fluids of Al_2O_3 particles.



Graph 1: ΔT vs. Inlet temp. for existing radiator.



Graph 2: ΔT vs. Inlet temp. for radiator 1 prototype

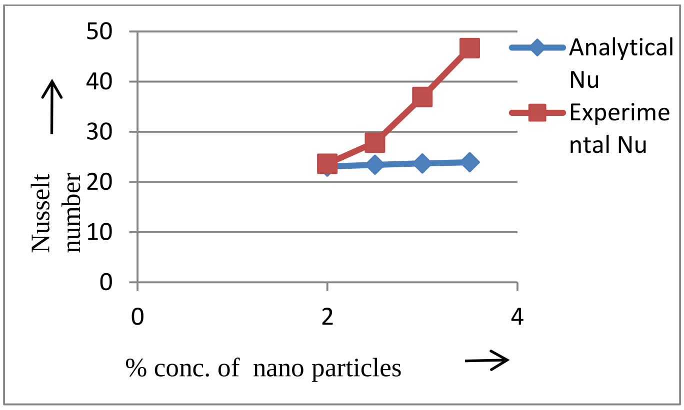
A] From the above graphs it can be seen that there is increment in ΔT values for both the radiators at the higher values of the inlet temperature.

B] Existing radiator is showing slightly higher values of ΔT than the developed prototype of radiator 1.

C] Also for both the radiators as the concentration of nano particles increases in the nano fluid, there is increment in the values achieved for ΔT.

Nusselt number and heat transfer coefficient

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 08, August-2016

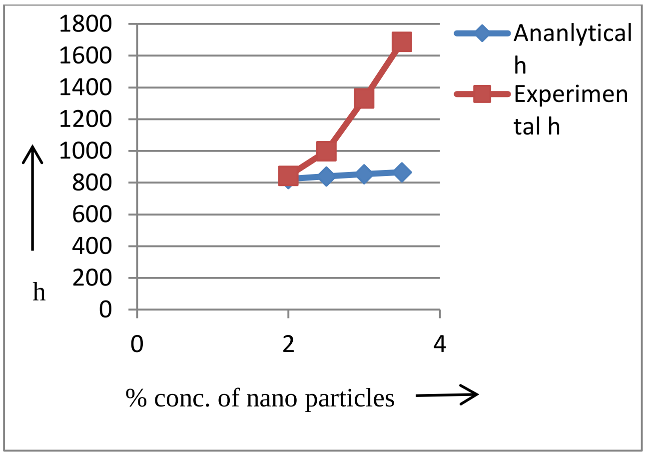


Graph3: Variation of Nusselt number with concentration of nano particles.

The above graph shows the experimental and analytical values of Nusselt number for the Radiator 1 prototype.

A] It can be seen that as the concentration of nano particles increases, there is increment in the Nusselt number values.

B] Nature of Graph also shows that experimental values are increasing more gradually then those of analytical values.



Graph 4: Variation of heat transfer coefficient with concentration of nano particles.

The above graph shows the experimental and analytical values of heat transfer coefficient for the Radiator 1 prototype.

A] It can be seen that as the concentration of nano particles increases there is increment in the heat transfer coefficient values.

B] Nature of Graph also shows that experimental values increasing more gradually then those of analytical values.

V. CONCLUSIONS

1] The results from Experimentation on Radiator 1 prototype and Existing radiator are describing ΔT curves generated and can be used to understand the small changes in temperature drop based on changes in tube geometry for different concentrations of coolant. For the two different tubes geometry of radiator, the temperature reduction is achieved with time. For particular steps of heater temperatures, radiator inlet and outlet temperatures are recorded for each case.

2] The developed prototype of radiator 1 is showing satisfactory agreement for ΔT and inlet temperature values with the existing radiator.

3] As the value of heat transfer coefficient h depends on the difference between inlet and outlet temperature (ΔT), so from the experimental readings it is found that as the inlet temperature of radiator increases, the value of ΔT increases for various concentrations of nano fluid. So at higher values of inlet temperatures, there is increment in heat transfer coefficient.

4] Experimental results of trials on developed prototype of radiator 1 shows there is significant increment in heat transfer coefficient values and Nusselt number as percent volume concentration of nano particles increases. So this radiator having geometrical changes in its tubes and core is showing favourable results in heat transfer with nano fluid as coolant.

REFERENCES

[1] Mikk Maivel et.al. ‘‘Energy performance of radiators with parallel and serial connected panels”, *Energy and Buildings* (2015), Vol. 86, pp.745–753.

[2] Krunal Suryakant Kayastha, “Simulation and Heat Transfer Analysis of Automobile Radiator using Helical Tubes”, *International Journal of Engineering Research and Development* (2015), Vol. 11, Issue 01, pp. 24-35.

[3] C. Franklin, D. B. Siva Kumar, “Design and Analysis of Dual Pass Core Radiator”, *International Conference on Energy Efficient Technologies for Automobiles* (2015), pp. 230-232.

[4] Vahid Delavari, Seyed Hassan Hashemabadi, “CFD simulation of heat transfer enhancement of Al_2O_3/water and Al_2O_3/ethylene glycol nano fluids in a car radiator”, *Applied Thermal Engineering* (2014) Vol. 73, pp. 380-390.

[5] C. Oliet, A. Oliva et.al. “Parametric studies on automotive radiators,” *Applied Thermal Engineering* (2007), Vol. 27, pp. 2033–2043.

[6] Adnan M. Hussein et. al. “Study of forced convection nanofluid heat transfer in the automotive cooling system”,*Case Studies in Thermal Engineering* (2014), Vol. 2, pp. 50-61.

[7] S.M. Hoseini et.al. “Experimental study of heat transfer enhancement using water/ethylene glycol based nanofluids as a new coolant for car radiators”, *International Communications in Heat and Mass Transfer* (2011), Vol. 38, pp. 1283-1290.

[8] K.Y. Leong et.al. “Performance investigation of an automotive car radiator operated with nano fluid-based coolants”, *Applied Thermal Engineering* (2010), Vol. 30, pp. 2685-2692.

[9] Cihat Arslanturk et.al. “Optimization of a central-heating radiator”, Applied Energy (2006), Vol. 86, pp. 1190–1197.

[10] A. Witry et.al. “Thermal performance of automotive aluminium plate radiator”, Applied Thermal Engineering (2005), Vol. 25, pp. 1207–1218.

[11] S.M.B. Beck et.al. “A novel design for panel radiators”, Applied Thermal Engineering (2004), Vol. 24, pp. 1291–1300.