Numerical Analysis of A Radiator Performance Using Aluminum Oxide Nanofluid

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Abstract- Most internal combustion engine to prevent overheating of the engine uses radiator as a heat exchanger to increase the heat transfer rate. The radiator are controls the engine temperature and thus increases engine efficiency .Liquid cooling requires the best exchange between the metal and the liquid for most efficient heat transfer. Cooling is one of the significant method of an automobile that affects the engine performance. The present study is to analyze numerically, the forced convection heat transfer of Aluminum oxide (Al_2O_3) nanoparticles dispersed in water as a base fluid circulating in the radiator. Three different concentrations of nanofluids 0.1%, 0.5% and 1% have beenused.The flow rate of water based nanofluid through the pipe is 0.138 kg/s to 0.555kg/s.The free stream temperature of air is varied from 20^0C to 40^0C.The simulation results shows that the presentation of Al_2O_3nanofluid with low concentrations can increase heat transferrate compared with purewater.

Keywords:Aluminum oxide nanofluid, temperature drop, Car radiator, Heat Transfer, Ansys.

1. INTRODUCTION

The radiators are used in water cooled automobile engines to keep water rotation in the Cylinder heads of engines at comparatively constant temperature and thus avoidhigh temperature of the engine. Liquid cooling involves the best conversation between the metal and the liquid for best efficient heat transfer. The coolant is generally water-based, with the addition of glycols to avoid freezing and other additives to minimisecorrosion, erosion and cavitations. However with the use of nanofluids, which are colloidal of nano sized particles suspended in base fluids like water etc., there is an enhancement of the radiator performance.The present studyis to simulate the effect of Aluminum oxide nanofluid used in a car radiatorinstead of water by using ANSYS. Researchers are carried out their work to improve the performance of the Radiator in different methods. Some of them have been mention below: V.Niveditha et.al. [1]Analyzed the performance of a radiator with Aluminum oxide, silicon oxide, ethylene glycol and copper oxide. They found that copper oxide nanofluid provided better performance properties for the improvement of radiator performance. Toure Ismael et.al.[2] Studied heat dissipation performance of five different geometry of radiators by varying the fin pitch wave distance, simulated them and then compared with that of the experimental results. The results presented thatas the fin phase is increased, the better performance will be achieved.JP Yadav et.al [3] presented anumerical parametric studies on automotive radiator using FDM and thermal resistance method. They compared the performance of radiator for variousmass flow conditions and two different coolants, in thisbase fluid is water and other fluid is propylene glycol–water mixture (40%-60%). From the observations the performance increases when the coolant is changed from water to mixture it is concluded that mixture coolant is best of its corrosive nature.Aditya Choure[4] carried out an experimental investigation for the improvement of automotive radiator performance of by using water and ethylene based Aluminum oxide nanofluid. It is establish thatnanofluids perform better than conventional fluids like water, ethylene glycol etc.P.Suganya et.al. [5] Carried out an experimental on water and copper oxide nanofluids in radiators using as cooling medium. The results showedthat copper oxide nanofluid offers more thermal conductivity and convective properties than compared to that of water. There is an improvement in Radiatorperformanceby 45% for copper oxide (CuO) nanofluidwhen compared to the water.P. Sai Sasank et.al. [6] tested an automotive Radiator with water and Aluminum oxide nanofluid at low volume concentrations of 0.025%,0.5% and 0.1%.From the obtained results heat transfer enhancement is found to be augmented when the concentration of the nano particles are increased. Tushar gaidhane et.al [7]hybrid nanofluid at concentrations of 0.5%, 1% and 1.5% as a coolant in the automobile radiator and compared to the hybrid nanofluid,heat transfer by experimentally conventional coolants like water and green coolant. These experimental values are again compared with the CFD values, there is an improvement in heat transfer coefficient up to 41% for hybrid nanofluid (Cuo+Fe_2O_3). J.R. Patel et.al. [8]Presented CFD simulation of a Maruthi van Radiator using commercial software CCM+. Investigation is carried out forwater+ethylene glycol solution, CUO/water and TI/water nanofluids. Comparative Investigation is carried out between these fluids and from the results, it showed that CuO / water nanofluid provides optimum results for the air temperatures.Paresh Machhar et.al. [9]Carried out an experimental for the enhancement of forced convective heat transfer in an Automobile radiator by using TiO_2 nanofluids and water as the cooling medium with concentrations of 0.1and 1%.The test section consisted of 34 tubes of elliptical cross section. The effect of inlet temperature on the radiator is analyzed on heat transfer rate.It shows that heat transfer increases with correspondingly increases the fluid rate. The use of nanofluid increased the rate of heat transferby an amount of 45%.

The objective of the present work is to simulate the radiator in CFD and to study the performance and the effect of Aluminum Oxide nanofluid as a coolant at different volume concentrations and compared with the water as a coolant.

2. MATHEMATICAL MODELING

Fig.1 depicts the model of the radiator chosen in the work. The radiator consists of 30 tubes of circular cross section, one inlet header and one outlet header. The length of the tubes being 584 mm.The inside and outside diameters of the tubes being 7mm and 9mm respectively. The dimensions of the radiator are shown in Table 1 and the properties of the water and nanofluid are shown in Table 2.

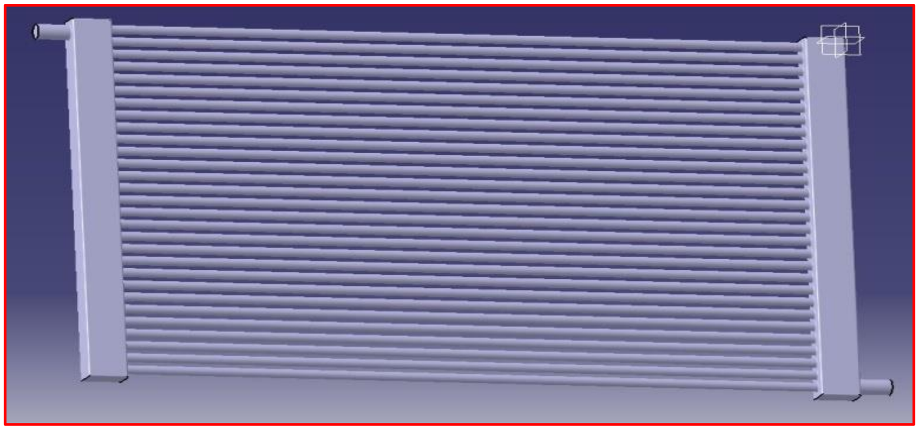

Fig.1 Model of the Radiator

Table 1 represents the dimensions of the Radiator for the analysis

Inner diameter	7mm
Outer diameter	9mm
Tube Length	584mm
Number of tubes	30
Width	30 mm
Height	360 mm
Length	644 mm

Table 2 represents the properties of water and nanofluid coolants

S.No	Properties	Water	Water+10%Al_2O_3
1	Density	998.2Kg/m^3	1243.17Kg/m^3
2	Viscosity	0.001003Kg/m^3	0.00125375Kg/m^3
3	Thermal conductivity	0.6W/m-K	1.30385W/m-K
4	Specific heat	4182J/Kg K	3197.47J/Kg-K
5	Molecular weight	18 gram/mole	101.96gram/mole

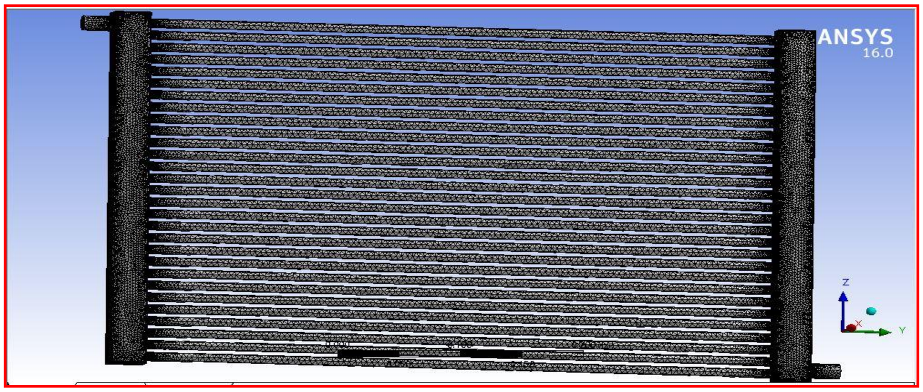

Fig.2 Depicts the meshed model of the radiator

3. RESULTS AND DISCUSSIONS

In the internal combustion engine case, due to heating the coolant is circulated through the engine where it passes through the engine block around the engine. Then the coolant flows towards radiator through the tubes. At the top of the radiator tank is present, which supplies the equal amount of coolant to radiator tubes. The fins are attached to these tubes to conduct the heat from tubes to adjacent air by convection. Then the coolant recirculates to the engine. The water circulates from the engine to the radiator from the top Header and flow through the tubes of the Radiator. Then water again enter into the engine from the bottom of the Radiator. The drop in the coolant temperature in the Radiator will decide the performance of the Radiator. In this work, comparative analysis has been carried out using Aluminum oxide Nanofluids at different concentrations (0.1%, 0.5% and 1%) and water at various mass flow rates of the coolant.

3.1 Temperature contours for water as coolant

The temperature contours are plotted for water and are represented in Fig. 3 to Fig. 6 with a mass flow rates of 0.138 Kg/s to 0.55 Kg/s.

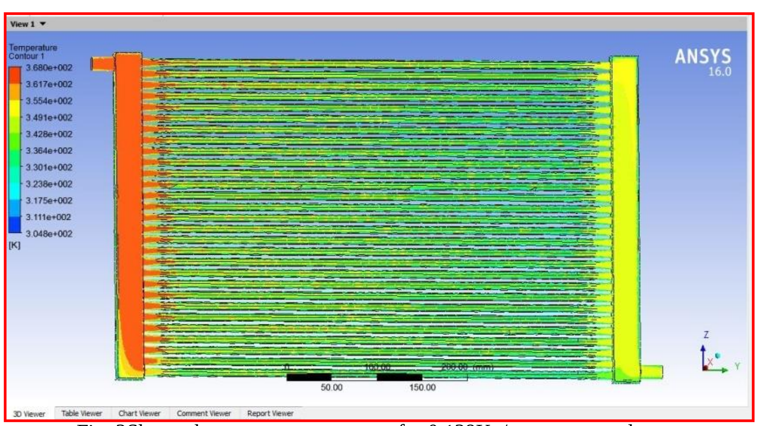

Fig. 3Shows the temperature contour for 0.138Kg/s water as coolant

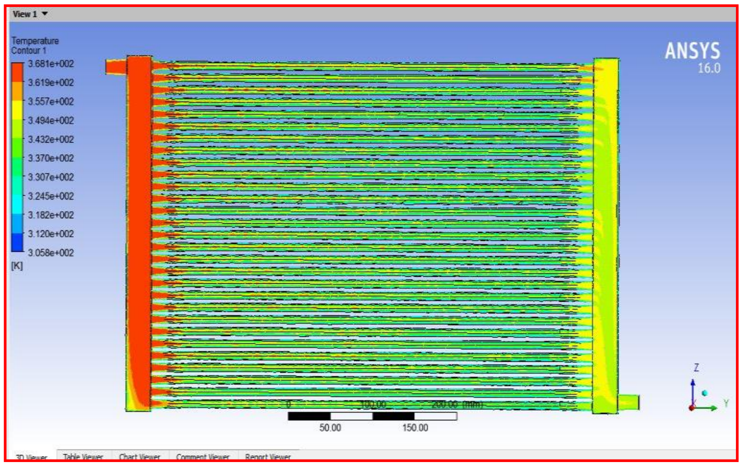

Fig. 4Shows the temperature contour for 0.277Kg/s water as coolant

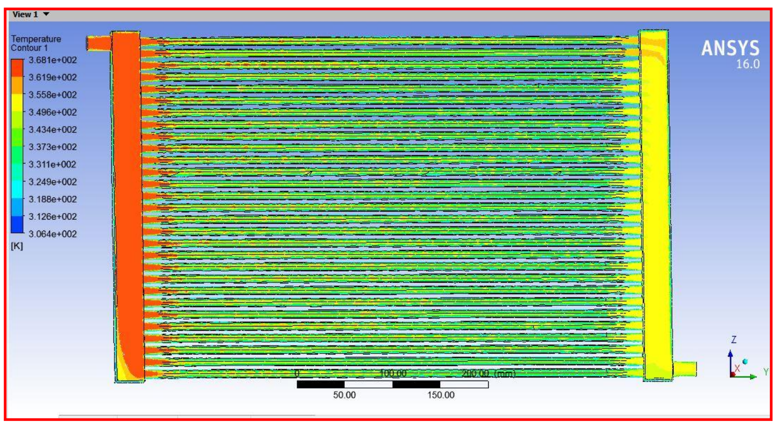

Fig. 5Shows the temperature contour for 0.416Kg/s water as coolant

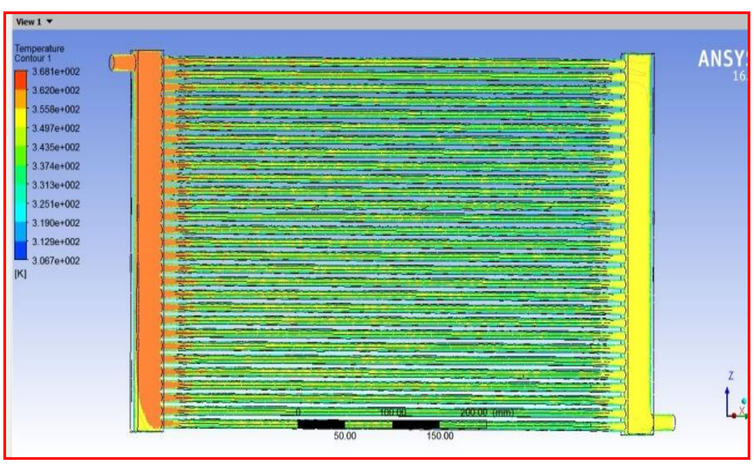

Fig. 6Shows the temperature contour for 0.55Kg/s water as coolant

3.2 Temperature contours for Aluminum oxide nanofluid as a coolant with 1% volume concentration

The temperature contours for Aluminum oxide nanofluid with 1% volume concentration are shown in Fig. 7 to Fig. 10 with a mass flow rates of 0.138 Kg/s to 0.55 Kg/s. From the analysis, it is observed that there is a significant increase in temperature drop. From the analysis, it is observed that there is a significant increase in temperature drop.

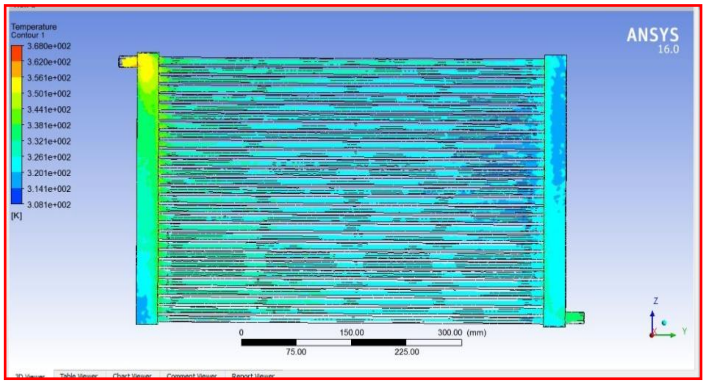

Fig. 7 Shows the temperature contour for 0.138Kg/s

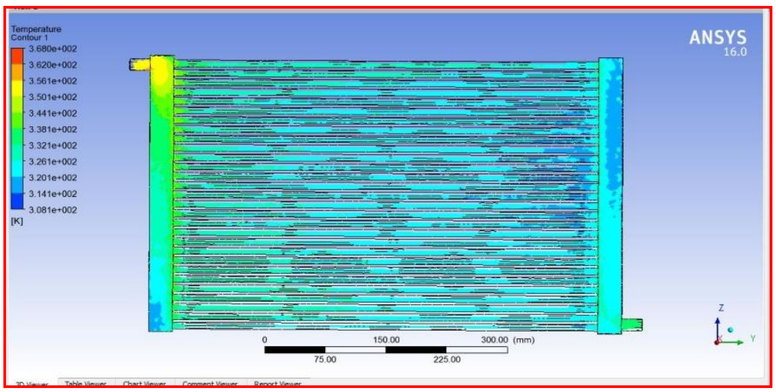

Fig.8Temperature contour for 0.277Kg/s

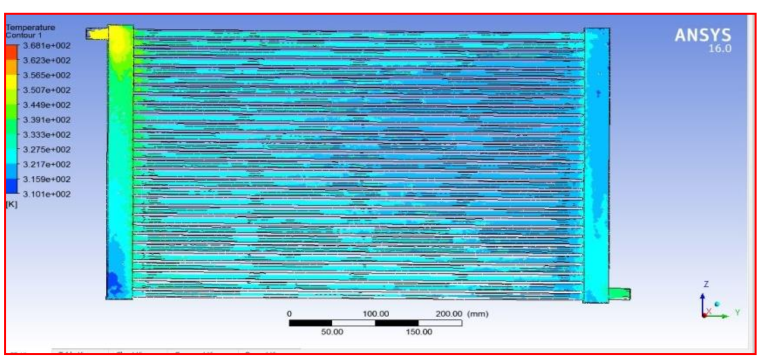

Fig.9 Temperature contour for 0.416Kg/s

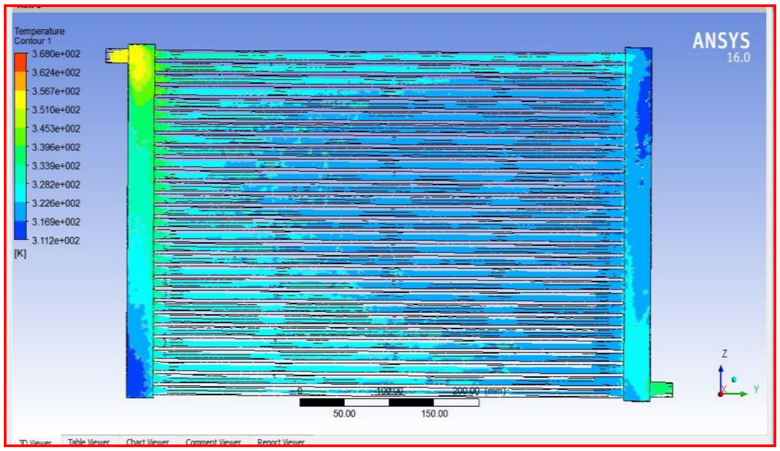

Fig. 10 Temperature contour for 0.55Kg/s

3.3 Comparison of radiator coolant outlet temperatures

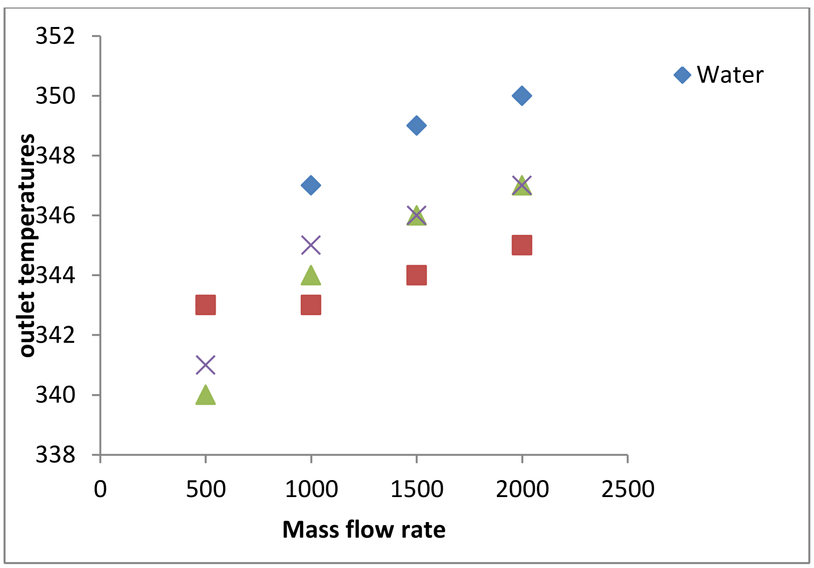

Fig.11 Comparison coolant temperatures of water and nanofluid at various concentrations

4. CONCLUSIONS

This paper presents the simulation of the radiator in CFD analysis and compared the performance of radiator as water and Aluminum Oxide nanofluid at different volume concentrations as a coolant. The results taken during the monitoring procedure. Nanofluid is the leading technique which has been widely used for enhancement of heat transfer rate in various applications.

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