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Thermal Analysis of Radiator with Different Nano Fluids

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Abstract: The advancement in automobile technology is increasing day to day. The efficiency of the engine depends on heat transfer rate of radiator in automobile and further it relays on flow capacity of fluids and material used in manufacturing of radiator. Mostly water is used as cooling fluid in automobile. The researchers were concentrated on different materials and found that copper and aluminium materials shows a higher heat transfer rate compare to other materials. The flow capacity and heat absorption of the fluid can be improved with the addition of Nano additives in radiator. In the current work the performance of the radiator is analysed with different Nano fluids using Pro-E and Ansys. Hence the present work is planned accordingly. Different Nano fluids i.e Aluminium Oxide, Silicon Oxide, Ethylene Glycol and Copper Oxide for volume fraction 0.3, are mixed with base fluid water are analysed for their performance in the radiator. Modelling of the radiator is done in Pro/E. The fluid flow characteristics are found using CFD analysis and with the same thermal analysis is done in Ansys for two materials Aluminium and Copper. Finally, it is concluded that the heat transfer co efficient is more for copper oxide at 0.2 volume fraction from CFD analysis. Thermal analysis is done for two materials Aluminum and Copper taking heat transfer coefficient value of aluminum oxide at 0.3 volume fraction from CFD analysis. By observing thermal analysis results, heat flux is more in Copper compared to Aluminum.
KeyWords: Aluminium, Aluminium oxide, copper, copper oxide, Ethylene Glycol, Silicon oxide Heat Transfer co efficient, Heat Transfer Rate, Nano fluid, Radiator

I. INTRODUCTION

CFD is a science that can be helpful for studying fluid flow, heat transfer, chemical reactions etc., by solving mathematical equations with the help of numerical analysis. CFD (Computational fluid dynamics) employs a very simple principle of resolving the entire system in small cells or grids and applying governing equations on these discrete elements to find numerical solutions regarding pressure distribution temperature gradients, flow parameters and the like in a shorter time at a lower cost because of reduced required experimental work. Automobile Radiator are becoming highly power-packed with increasing power to weight or volume ratio. Increased demand on power packed radiators, which can dissipate maximum amount of heat for any given space. Nano fluids give higher heat transfer rate than base fluids. This study involves CFD simulation of the mass flow rate of Nano fluid and heat exchanger (radiator) at various coolants (Nano fluids). In this paper, CFD used to simulate flow and heat transfer radiator (heat exchanger). Coolants flow through the tubes of the radiator, heat is transferred through tube walls to the air by conduction and convection. The radiator of car is analysed to get heat transfer rate at different volume fractions and coolants in this study. CFD analysis gives accurate and exact result.

II. WORKING OF AUTOMOBILE RADIATORS

Almost all automobiles in the market today have a type of heat exchanger called a radiator. The radiator is part of the cooling system of the engine as shown in Figure below. The radiator is just one of the many components of the complex cooling system. Coolant path and Components of an Automobile Engine Cooling System. The coolant flows from the inlet to the outlet through many tubes mounted in a parallel arrangement. The fins conduct the heat from the tubes and transfer it to the air flowing through the radiator. The tubes sometimes have a type of fin inserted into them called a tabulator, which increases the turbulence of the fluid flowing through the tubes. If the fluid flowed very smoothly through the tubes, only the fluid actually touching the tubes would be cooled directly. The amount of heat transferred to the tubes from the fluid running through them depends on the difference in temperature between the tube and the fluid touching it. So if the fluid that is in contact with the tube cools down quickly, less heat will be transferred. By creating turbulence inside the tube, all of the fluid mixes together, keeping the temperature of the fluid touching the tubes up so that more heat can be extracted, and all of the fluid inside the tube is used effectively. Radiators usually have a tank on each side, and inside the tank is a transmission cooler. In the picture above, you can see the inlet and outlet where the oil from the transmission enters the cooler.

The transmission cooler is like a radiator within a radiator, except instead of exchanging heat with the air, the oil exchanges heat with the coolant in the radiator.

III. MODELLING

In this modelling is done by using CRE-O software

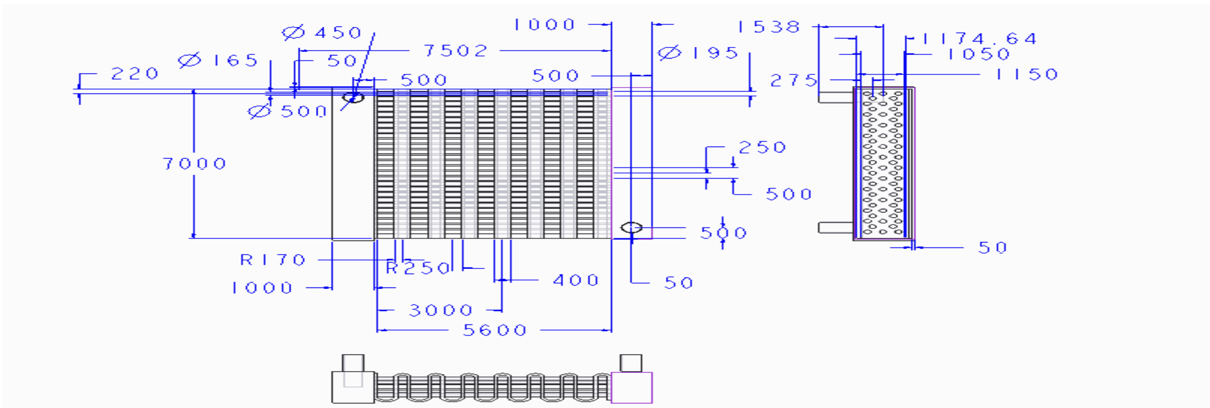

Fig1: 2D Drawing of Radiator

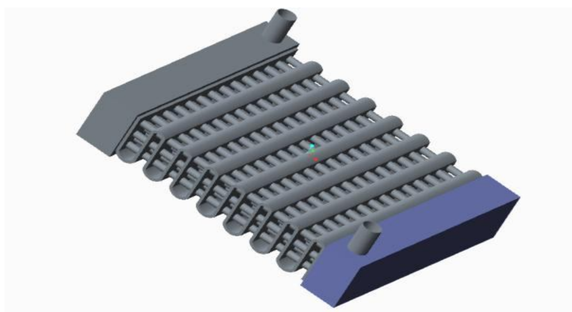

Fig2:3D model of radiator

IV. DATA AND RESULTS

In this, different Nano fluids mixed with base fluid water are analyzed for their performance in the radiator. The Nano fluids are Aluminum Oxide, Silicon Oxide, Ethylene Glycol and Copper Oxide volume fraction 0.3 Theoretical calculations are done to determine the properties for Nano fluids and those properties are used as inputs for analysis.

V. BOUNDARY CONDITIONS AND PHYSICS SELECTED

One of the most important operations of the fluid flow analysis of the radiator heat transfer is applying the boundary conditions to the geometric parts of the radiators. The conservation equations of mass, momentum, and energy are nonlinear and coupled systems, which are solved subjected to the following boundary conditions. At the inlet of the radiator properties of Nano fluid such as Thermal conductivity, density, specific heat, viscosity is prescribed. The inlet temperature and mass flow rate of the radiator have been taken as 353 K and 2 kg/s which is typical for automotive radiators. The mass flow rate at the inlet assumed in the present study is an idealization of the actual flow pattern because considerable flow non uniformities arising from the fluid entering the top of the radiator will be inevitable in the actual case. In Fluent the outflow boundary condition corresponds to fully developed mass flow rate and temperature profiles. For an automobile radiator, a realistic thermal boundary condition on the outside of the wall is a prescribed free stream temperature.

VI. SIMULATION RESULTS AND ANALYSIS

Simulation analysis of the car radiator done for 0.3 volumetric flow rate. After adding the Nano fluids to the base fluid enhanced heat transfer results are shown. In following heat transfer contours analysis results are given for 0.2 of Nano fluids at Mass flow rate 2 kg/s and temperature at 353k

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we simulate Nano fluids with base fluid with 0.2 concentrations. The simulation results for each Nano fluid have been observed. it was determined that for copper oxide, heat Transfer co efficient is more compare to other Nano fluids. And, the pressure, velocity, mass flow rate and heat transfer rate are more for Ethylene Glycol at volume fraction of 0.2

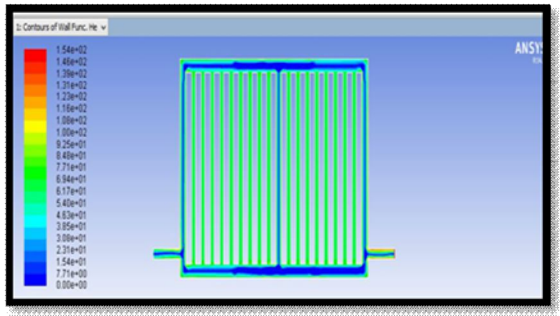

Fig 3: Heat transfer co efficient of contour of the Aluminum oxide

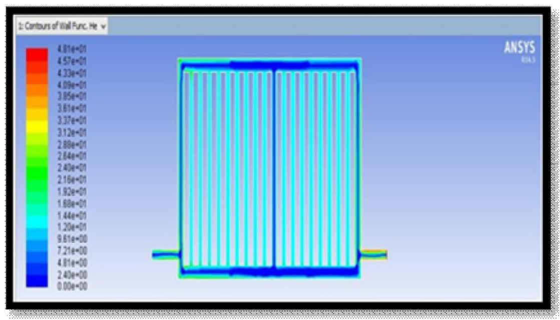

Fig4: Heat transfer co efficient of contour of the Silicon oxide

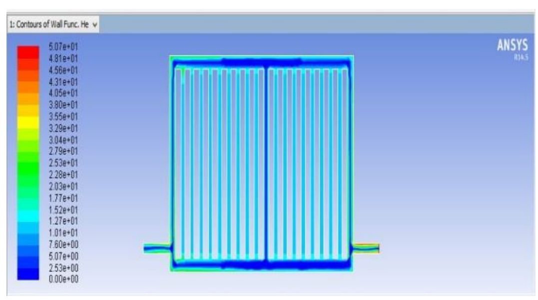

Fig 5: Heat transfer co efficient of contour of the Ethylene Glycol

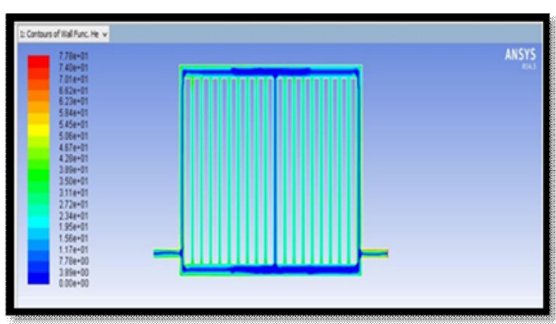

Fig 6: Heat transfer co efficient of contour of the Ethylene Glycol

Figure3,4,5,6 shows that Heat transfer co efficient of different Nano fluids that is aluminum oxide, silicon oxide, ethylene Glycol, and copper oxide respectively for 0.2 volume concentration. Heat transfer co efficient when we compare to these Nano fluids copper oxide gives more maximum static Heat transfer co efficient that is 75.178.

VII. THERMAL ANALYSIS OF RADIATOR

A) Nano Fluid – Coppr Oxide At Volume Fraction – 0.2

1) Imported Model

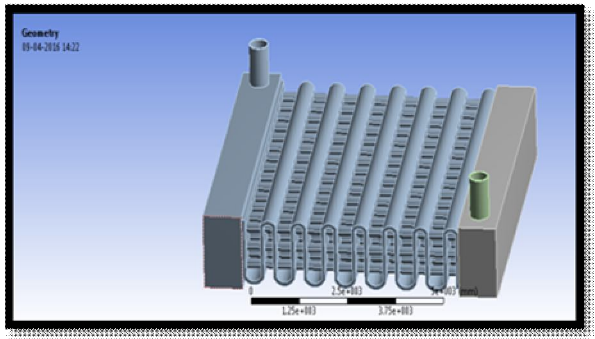

Fig7: Imported Model of Radiator

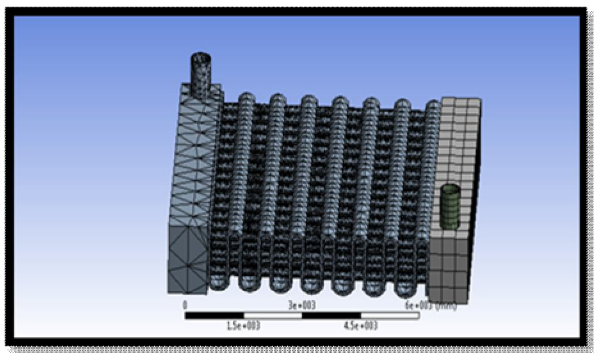

Fig8: Meshed Model of Radiator

Element type: Triangular element
Element size:100nm
No of elements:538371
Nodes:301030
BOUNDARY CONDITIONS
T_1 =353K

2) Applied Temperature

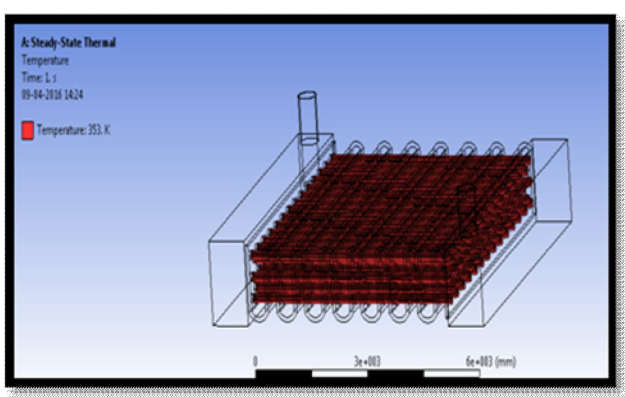

Fig9: Boundary condition 1: Applied Temperature

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3) Applied Convection

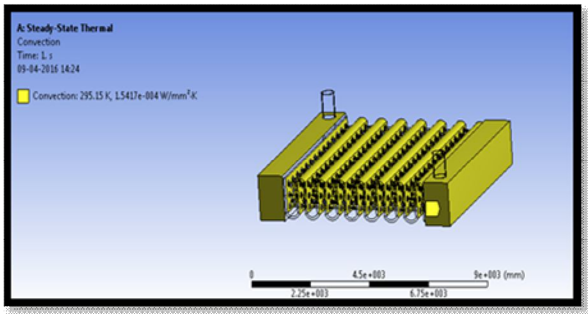

Fig10: Boundary condition 2: Applied convection

B) Material- Copper

1) Temperature

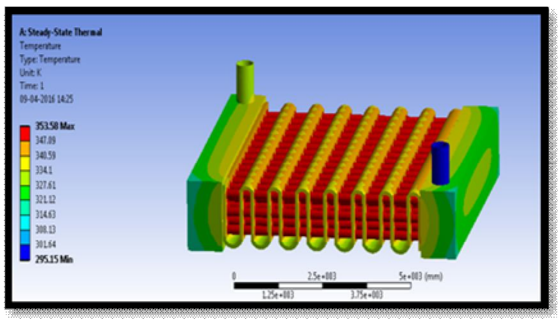

Fig 11: Temperature distribution of copper made radiator

2) Heat Flux

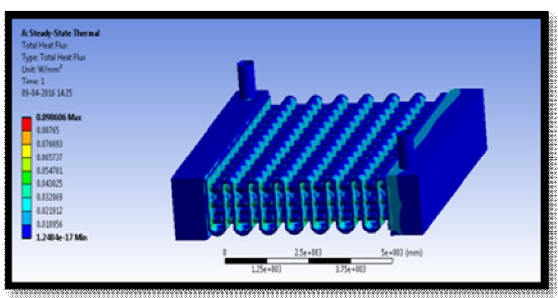

Fig:12: Heat Flux of copper made Radiator

C) *Material- Aluminum*

1) Temperature

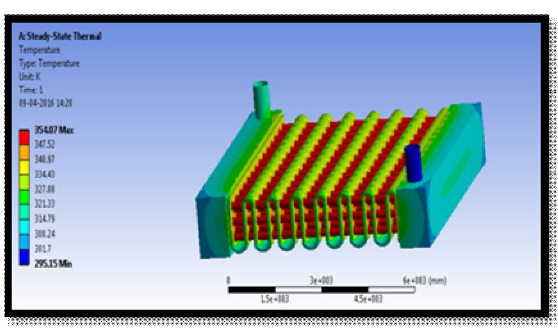

Fig 13: Temperature distribution of aluminum made radiator

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2) Heat Flux

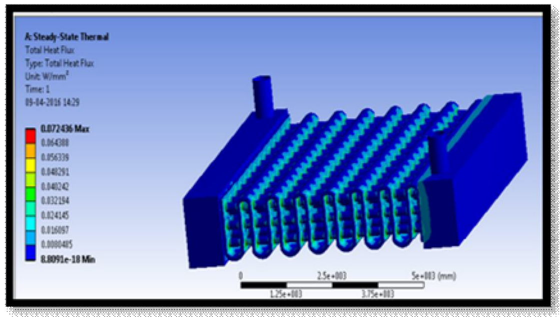

Fig 14: Heat flux of aluminum radiator

Fig11 and Fig 12 Simulation results of the of the temperature and the heat flux for copper radiator. The maximum temperature 353.37 and het flux was observed at 0.074926

Fig13,14 shows temperature and the heat flux for Aluminum radiator. The maximum temp 353.55 and het flux was observed at 0.064449. From above results copper radiator has more heat flux and distribution than aluminum

Table1: Thermal analysis Result Comparison of Radiator at 0.2 concentration

Material	Temperature(K)		Heat flux(W/mm^2)
	Min.	Max.	
Aluminum alloy	295.15	353.55	0.064449
Copper	295.15	353.37	0.074926

VIII. CONCLUSION

When we compared with all Nano fluids for 0.2 volume fraction in aluminum and copper radiator the variation of the fluid properties observed are Heat transfer rate is more for Aluminum Oxide Pressure, velocity and heat transfer rate is more foe ethylene Glycol

Thermal analysis is done for two materials Aluminum and Copper taking heat transfer coefficient value of copper oxide at 0.2 volume fractions from CFD analysis.

By observing thermal analysis results, heat flux is more when Copper is used than Aluminum alloy.

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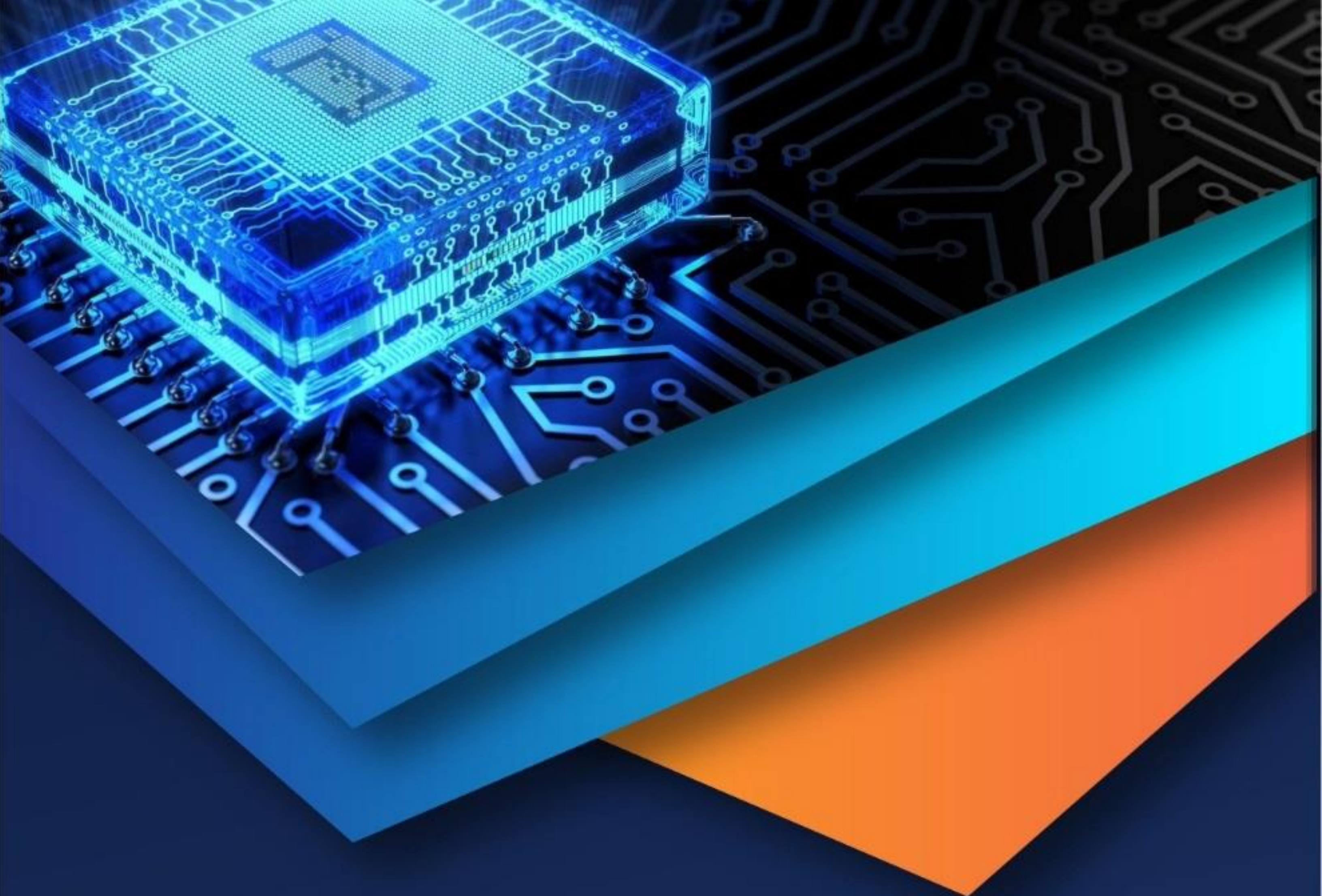

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