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HEAT TRANSFER PERFORMANCE OF RADIATOR USING 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.In this thesis, different nano fluids mixed with base fluid water are analyzed for their performance in the radiator. These Nano fluids are the fluids that contain suspended nano particles such as metals and oxides. These nano particles keep suspended in the base fluid. The nano fluids are Aluminum Oxide, Silicon Oxide, Titanium carbide and Titanium nitride at two volume fractions 0.2, 0.3 are taken. Theoretical calculations are done to determine the properties for nano fluids and those properties are used as inputs for analysis.CFD analysis is done on the radiator for all nano fluids and volume fraction and thermal analysis is done in Ansys for two materials Aluminum and Copper for better fluid at better volume fraction from CFD analysis.

Keywords: *Titanium carbide, Titanium nitride, aluminium oxide, silicon oxide, aluminium, copper, heat transfer rate, radiator, aluminium oxide, silicon oxide, nanofluids.*

I. INTRODUCTION

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. Forced Convection Heat Transfer: Convection is the mechanism of heat transfer through a fluid in the presence of bulk fluid motion. Convection is classified as natural (or free) and forced convection depending on how the fluid motion is initiated. In natural convection, any fluid motion is caused by natural means such as the buoyancy effect,i.e. the rise of warmer fluid and fall the cooler fluid. Whereas in forced convection, the fluid is forced to flow over a surface or in a tube by external means such as a pump or fan.

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.

III. MODEL OF RADIATOR

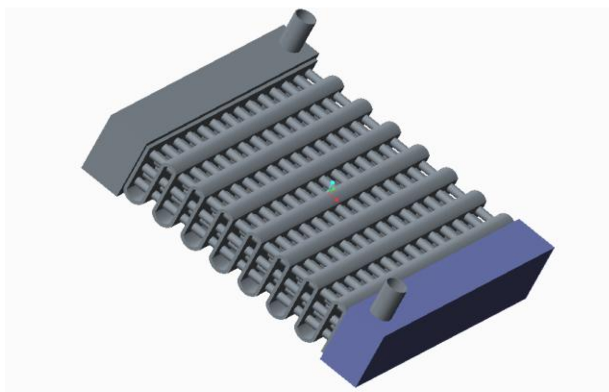

Fig1:3D model of radiator

2D DRAWING

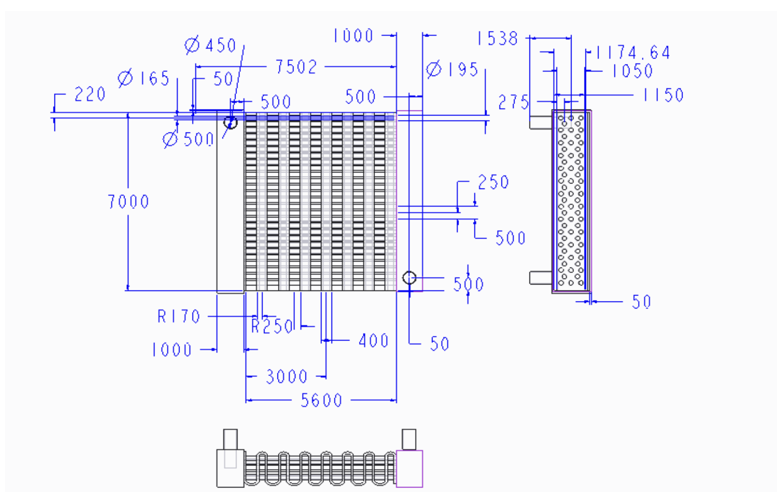

Fig2:2D drawing of radiator

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, titanium nitride ,titanium carbide and volume fraction 0.2& 0.3.

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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

CFD analysis is done on the radiator for all nano fluids Aluminum Oxide, Silicon Oxide, Titanium Carbide and Titanium Nitride & at different volume fractions 0.2, 0.3. The pressure, velocities are more for Silicon Oxide at volume fraction of 0.2 and mass flowrate is more for Silicon Oxide at volume fraction of 0.3. The heat transfer coefficient and heat transfer rate are more for Aluminum oxide at volume fraction of 0.3.

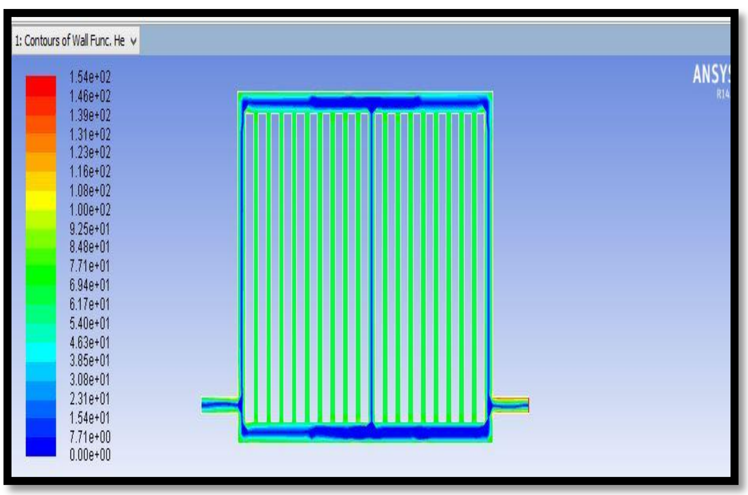

Fig:3 Heat transfer co-efficient of contour aluminium oxide

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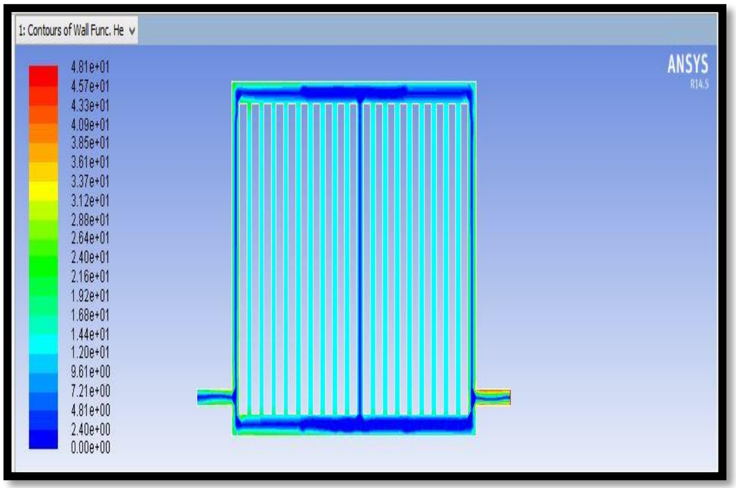

Fig:4 Heat transfer co-efficient of contour silicon oxide

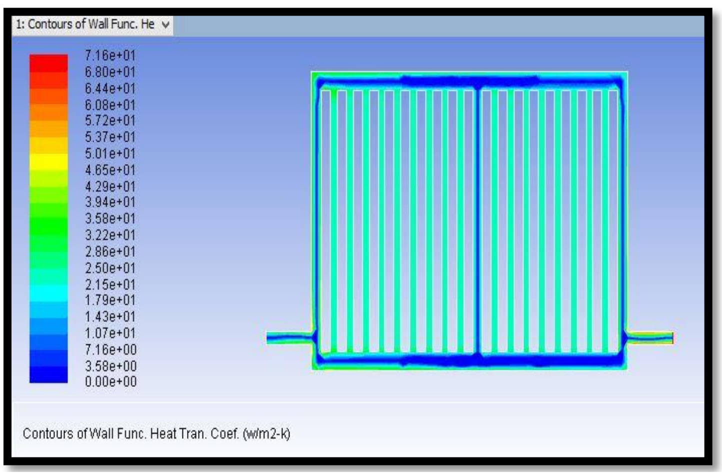

Fig:5 Heat transfer co-efficient of contour titanium carbide

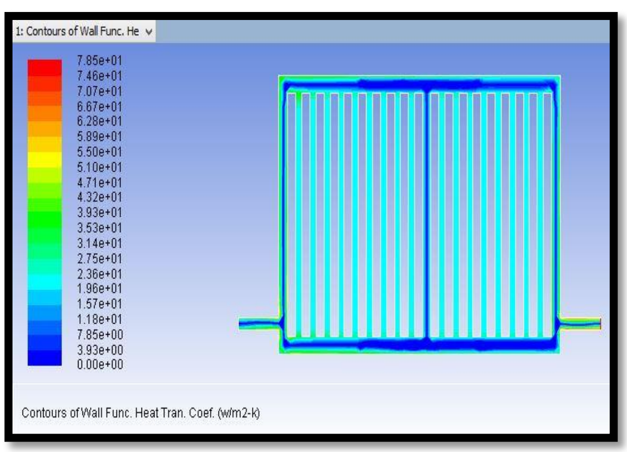

Fig:6 Heat transfer co-efficient of contour titanium nitride

Figure3,4,5,6 shows that Heat transfer co efficient of different Nano fluids that is aluminum oxide, silicon oxide, titanium carbide, and titanium nitride respectively for 0.3 volume concentration. Heat transfer co efficient when we compare to these Nano fluids aluminium oxide gives more maximum static Heat transfer co efficient that is 154.168.

VII. THERMAL ANALYSIS OF RADIATOR

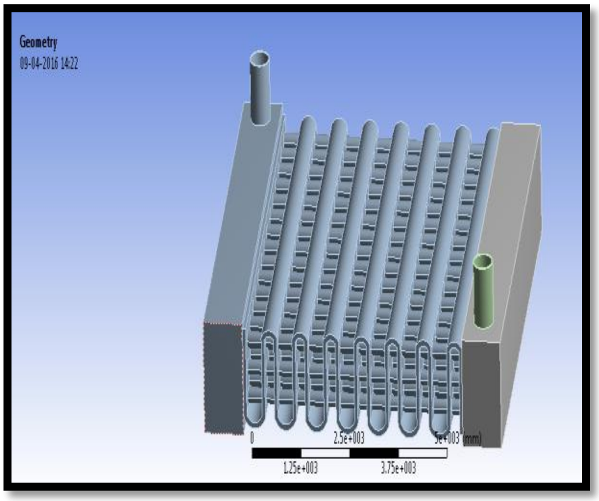

Fig7: Imported Model of Radiator

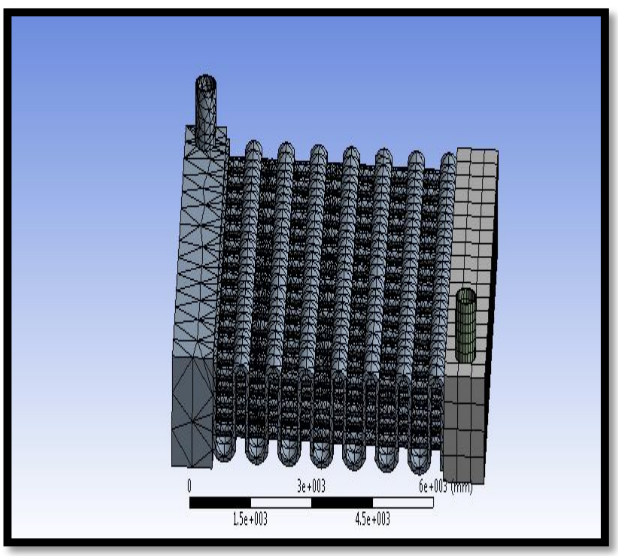

Fig8:Meshed Model of Radiator

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

A) Nano Fluid – aluminium Oxide At Volume Fraction – 0.3

1) Appemperature

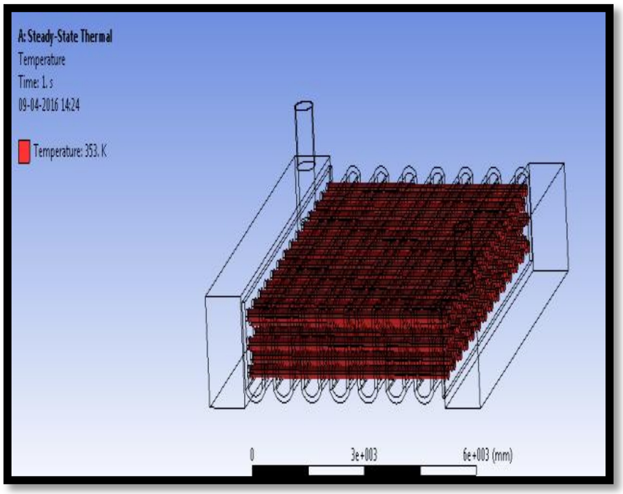

Fig9: Boundary condition 1: Applied Temperature

2) Applied convection

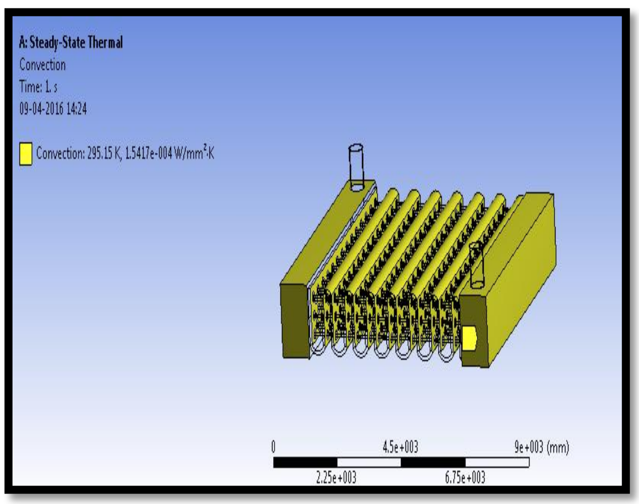

Fig10: Boundary condition 2: Applied convection

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B) Material- Copper

1) Temperature

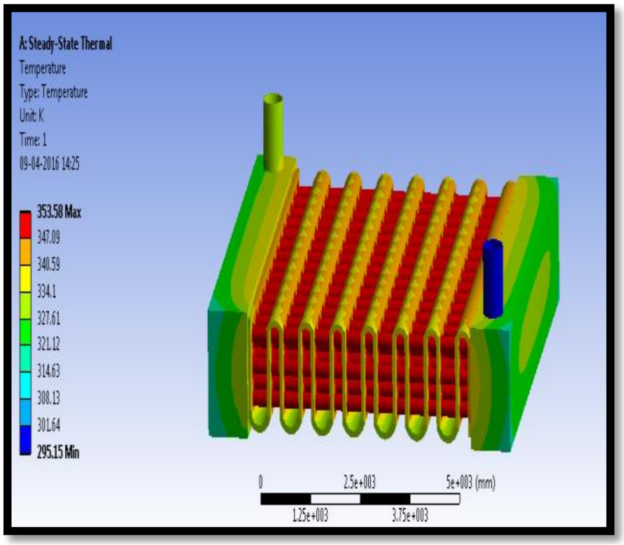

Fig 11: Temperature distribution of copper made radiator

2) Heat Flux

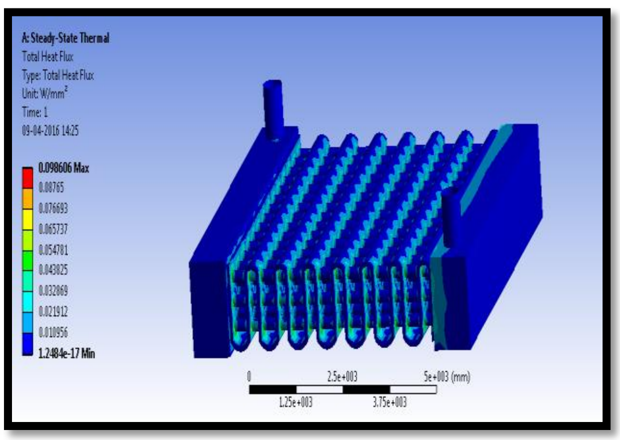

Fig:12: Heat Flux of copper made Radiator

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C) Material- Aluminum alloy

1) Temperature

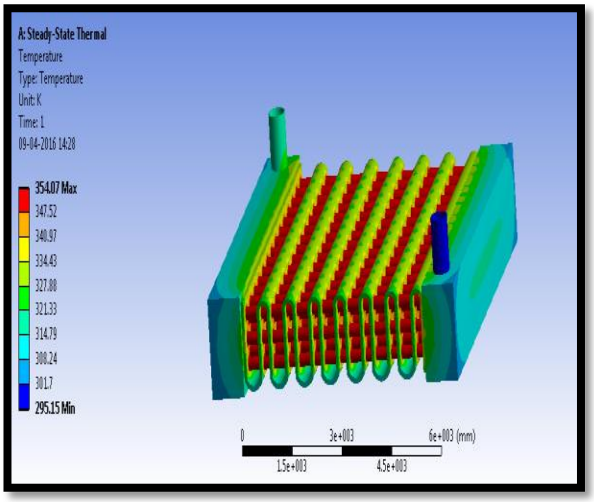

Fig 13: Temperature distribution of aluminium alloy made radiator

2) Heat Flux

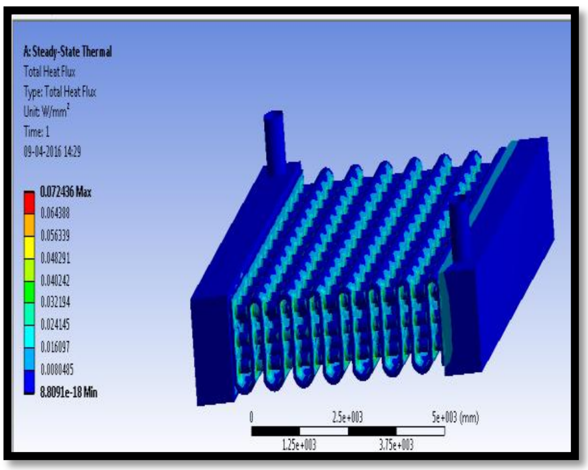

Fig 14: Heat flux of aluminum alloy radiator

Fig11 and Fig 12 Simulation results of the of the temperature and the heat flux for copper radiator. The maximum temperature 353.58 and heat flux was observed at 0.72436

Fig13,14 shows temperature and the heat flux for Aluminum alloy radiator. The maximum temp 354.07 and heat flux was observed at 0.098606. From above results copper radiator has more heat flux and distribution than aluminum alloy

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Material	Temperature(K)		Heat flux(W/mm^2)
	Min.	Max.	
Aluminum alloy	295.15	354.07	0.098606
Copper	295.15	353.58	0.72436

VIII. THERMAL ANALYSIS

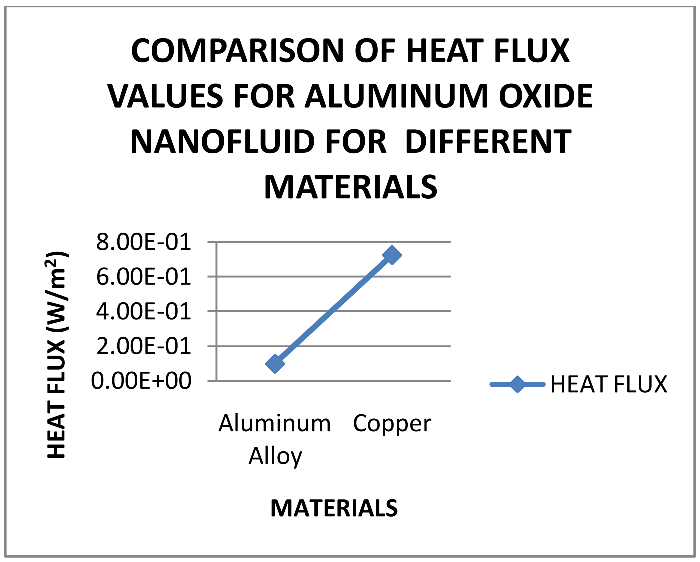

Fig 15: Comparison of heat flux values for aluminum oxide nanofluids for different materials.

IX. CFD ANALYSIS

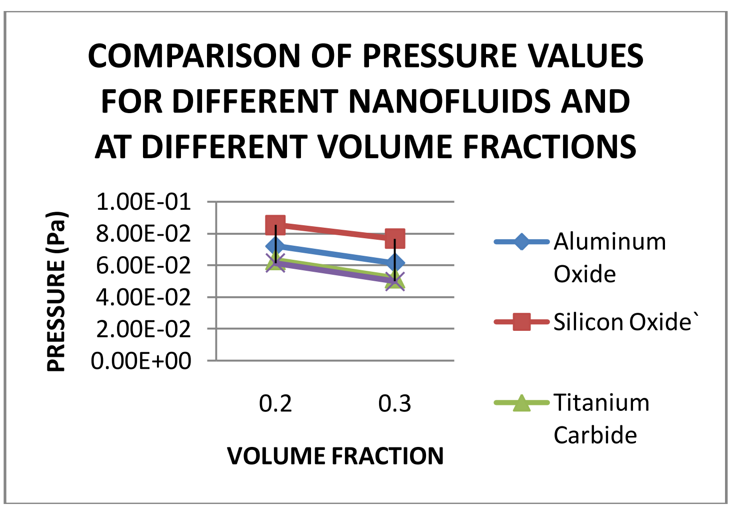

Fig 16: comparision of pressure values for different nanofluids and at different volume fractions

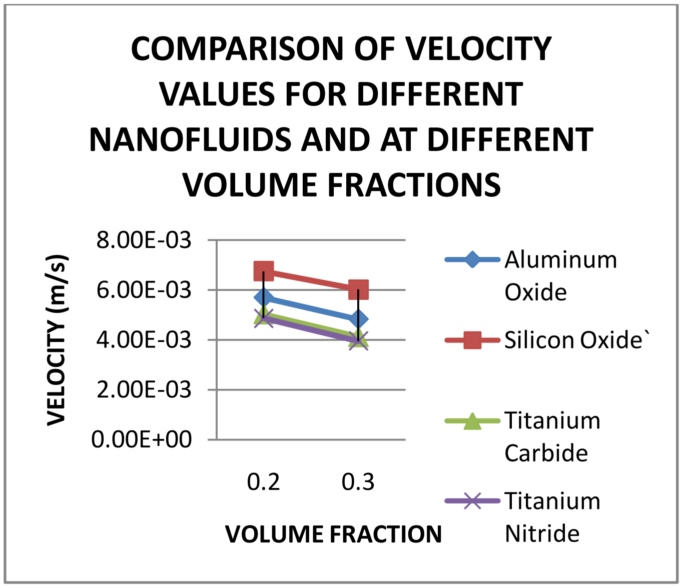

Fig 17:Comparison of velocity values for different nanofluids and at different volume fractions

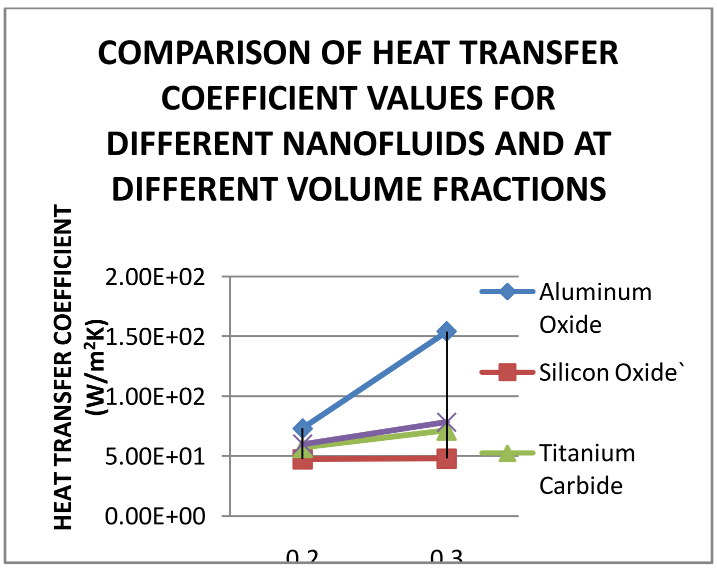

Fig 18: Comparison of heat transfer coefficient values for different nanofluids and at different volume fractions

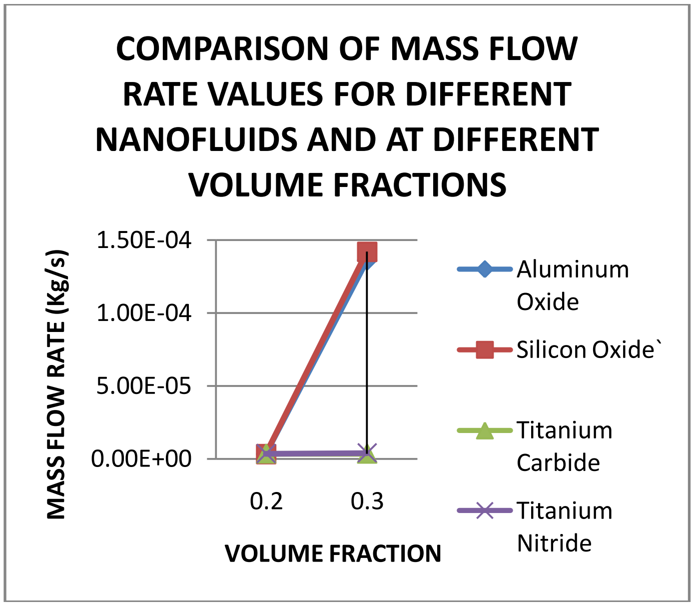

Fig.19: Comparison of mass flow rate values for different nanofluids and at different volume fractions

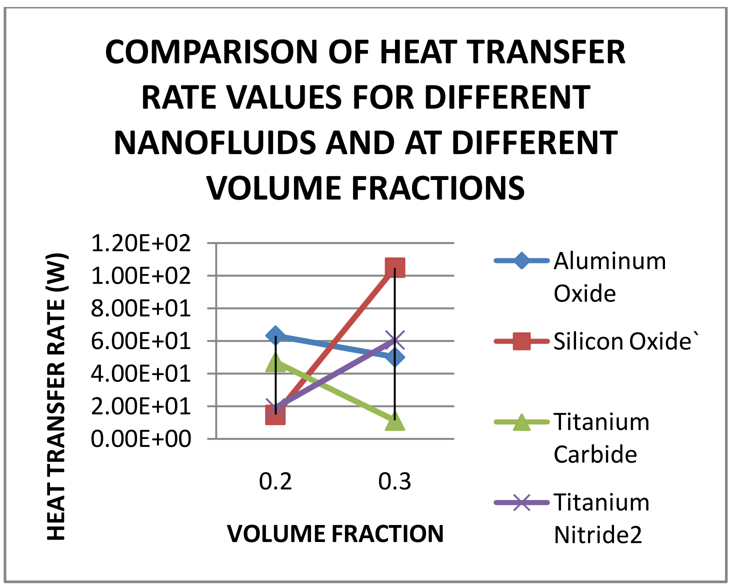

Fig.20: Comparison of heat transfer rate values for different nanofluids and at different volume fractions

X. CONCLUSION

3D model of the radiator is done in Pro/Engineer. CFD analysis is done on the radiator for all nano fluids Aluminum Oxide, Silicon Oxide, Titanium Carbide and Titanium Nitride and at different volume fractions 0.2, 0.3. According to obtained results the conclusion can be drawn as follows

1. The pressure, velocities are more for Silicon Oxide at volume fraction of 0.2 and mass flow rate is more for Silicon Oxide at volume fraction of 0.3.
2. The heat transfer coefficient and heat transfer rate are more for Aluminum oxide at volume fraction of 0.3.

3. Thermal analysis is done for two materials Aluminum and Copper taking heat transfer coefficient value of Aluminum oxide at 0.3 volume fractions from CFD analysis. By observing thermal analysis results, heat flux is more when Copper is used than Aluminum alloy.

REFERENCES

[1] *Performance Improvement of a Louver-Finned Automobile Radiator Using Conjugate Thermal CFD Analysis by Junjanna G.C*

[2] *Study on Performance Evaluation of Automotive Radiator by JP Yadav and Bharat Raj Singh*

[3] *Performance Investigation of an Automotive Car Radiator Operated With Nanofluid as a Coolant by Durgesh kumar Chavan and Ashok T. Pise Sahin*

[4] *Heat Transfer Enhancement of Automobile Radiator with TiO2/Water Nanofluid by Paresh Machhar, Falgun Adroja*

[5] *Yan, W.M., Sheen, P.J., Heat transfer and friction characteristics of fin and tube heat exchangers, International Journal of Heat and Mass Transfer, 43 (2000), pp.1651-1659.*

[6] *Wolf, I., Frankovic, B., Vilicic, I., A numerical and experimental analysis of neat transfer in a wavy fin and tube heat exchanger, Energy and the Environment (2006) pp.91-101.*

[7] *Tang, L.H., Zeng, M., Wang, Q.W., Experimental and numerical investigation on air side performance of fin and tube heat exchangers with various fin patterns, Experimental Thermal and Fluid science, 33(2009), pp.818-827.*

[8] *Wang, C.C., Lo, J, Lin, Y.T. Wei, C.S., Flow visualization of annular and delta winlet vortex generators in fin and tube heat exchanger application, International Journal of Heat and Mass Transfer, 45, (2002), pp.3803-3815.*

[9] *Fiebig, M., Valencia, A., Mitra, N.K.., Local heat transfer and flow losses in fin and tube heat exchangers with vortex generators: A comparison of round and flat tubes, Experimental Thermal and Fluid Science, 8(1994), pp.35-45.*

[10] *Leu, J.S., Wu, Y.H., Jang, J.Y., Heat transfer and fluid flow analysis in plate-fin and tube heat exchangers with a pair of block shape vortex generators, International Journal of Heat and Mass Transfer, 47 (2004), pp. 4327-4338.*