THERMAL ANALYSIS OF AN AUTOMOBILE RADIATOR WITH AND WITHOUT LOUVERED FINS

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***Abstract**: Radiators are used to transfer thermal energy from one medium to another for the purpose of cooling. Radiators are used for cooling internal combustion engines, mainly in automobiles but also in piston-engine aircraft, railway locomotives, motorcycles, stationary generating plant. The radiator transfers the heat from the fluid inside to the air outside, thereby cooling the fluid, which in turn cools the engine.*

In this thesis, the computational analysis tool ANSYS is used to perform a CFD analysis on a radiator at different mass flow rates. The present model of radiator has no louvered fins, in this thesis the radiator is replaced with louvered fins. In this thesis CFD analysis is performed for radiator with and without louvered fins. Heat transfer analysis is performed to analyze the heat transfer rate. The material used for fins of radiator is Aluminum alloy 6061. Modeling is performed in Pro/Engineer and analysis is performed in ANSYS.

KEYWORDS: MODELING, ANALYSIS, SUGGESTION,FINS;

I. INTRODUCTION

Radiators are heat exchangers used to transfer thermal energy from one medium to another for the purpose of cooling and heating. The majority of radiators are constructed to function in automobiles, buildings, and electronics. The radiator is always a source of heat to its environment, although this may be for either the purpose of heating this environment, or for cooling the fluid or coolant supplied to it, as for engine cooling. Despite the name, radiators generally transfer the bulk of their heat via convection, not by thermal radiation, though the term "convector" is used more narrowly; see radiation and convection, below.

Junjanna described the performance improvement of automobile radiator using louvered fin [1]. Yadav described the performance analysis of radiator [2]. Durgesh described the performance of radiator with Nano fluids[3].

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. As you can see in the figure, the radiator is just one of the many components of the complex cooling system. Coolant path and Components of an Automobile Engine Cooling System Most modern cars use aluminum radiators. These radiators are made by brazing thin aluminum fins to flattened aluminum tubes. 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.

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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.

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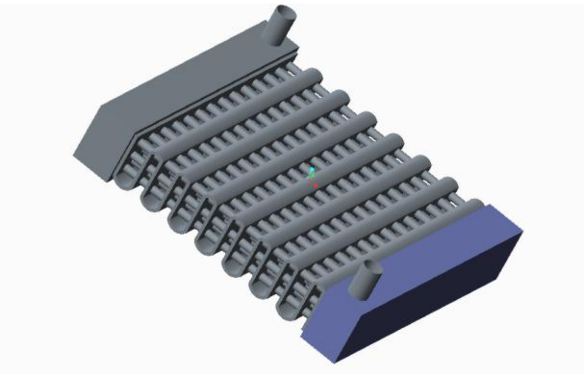


Figure1: Model Of Radiator

III MODELLING & ANALYSIS

In this modeling is done Auto Cad and analysis is made in Ansys using FEM.

A. DIFFERENT MODULES IN MODELING

- PART DESIGN
- ASSEMBLY
- DRAWING

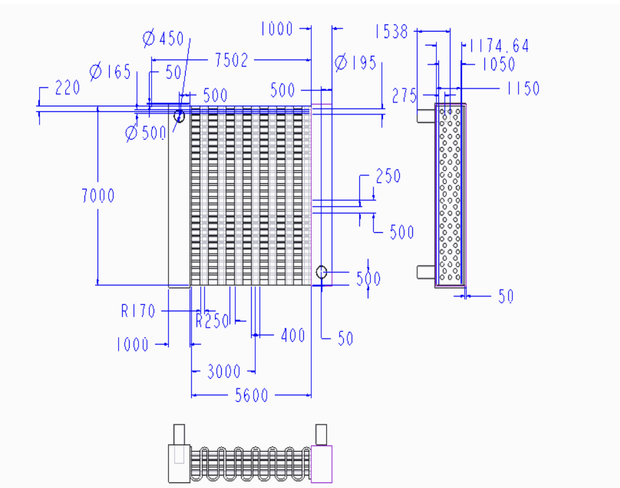


Figure2: 2d Drawing

B. FINITE ELEMENT METHOD

The finite element method (FEM) is used in structural analysis of solids, but is also applicable to fluids. However, the FEM formulation requires special care to ensure a conservative solution. The FEM formulation has been adapted for use with fluid dynamics governing equations. Although FEM must be carefully formulated to be conservative, it is much more stable than the finite volume approach. However, FEM can require more memory and has slower solution times than the FVM.

In this method, a weighted residual equation is formed:

$$R_i = \iiint W_i Q \, dV^e$$

where R_i is the equation residual at an element vertex i, Q is the conservation equation expressed on an element basis, W_i is the weight factor, and V^e is the volume of the element.

IV THERMAL ANALYSIS OF RADIATOR

Analysis is made with and without louvered fin for different mass flow rates.

A.WITH OUT LOUVERED FIN

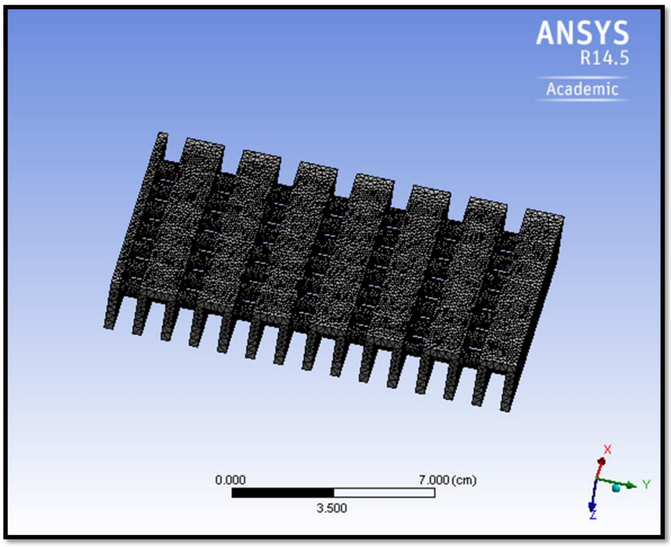


Figure3: *Model of Radiator without louvered fins*

BOUNDARY CONDITIONS

Water Flow Rate 1.4Kg/s
Inlet Temperature –353K
inlet pressure-10400pa
no of iterations = 50

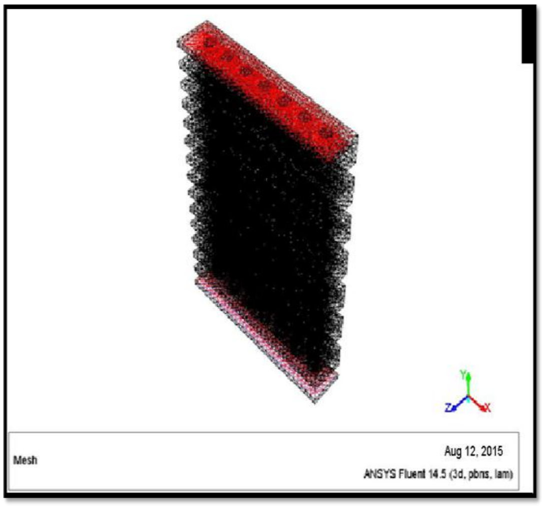


Figure4: *Model of Radiator without louvered fin*

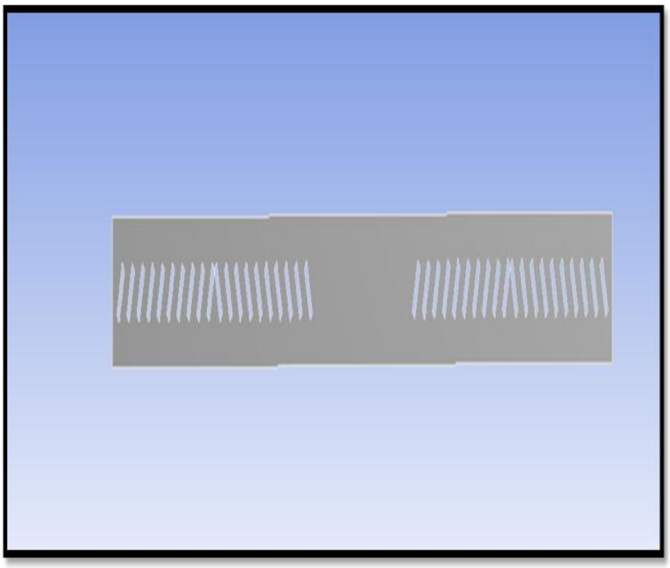


Figure5: *Model of Radiator with louvered fins*

B.WITH LOUVERED FIN

BOUNDARY CONDITIONS

Water Flow Rate =1.4Kg/s
Inlet Temperature=353K
Inlet pressure = 10400pa
No. of iterations = 50

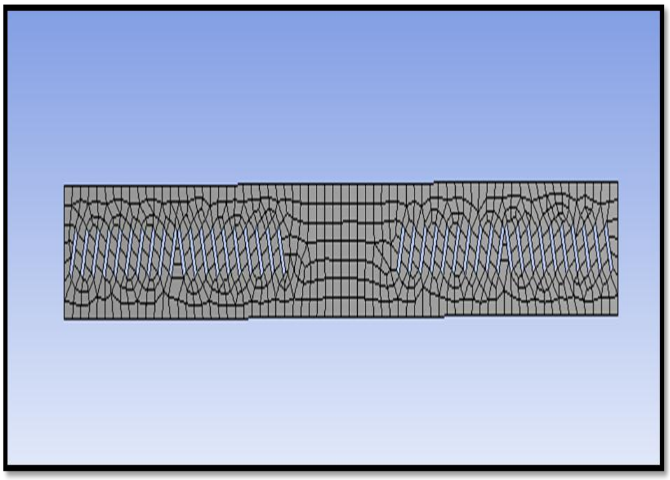


Figure6: *Model of Radiator with louvered fin*

IV.RESULTS

A.WITH OUT LOUVERED FIN

STATIC PRESSURE

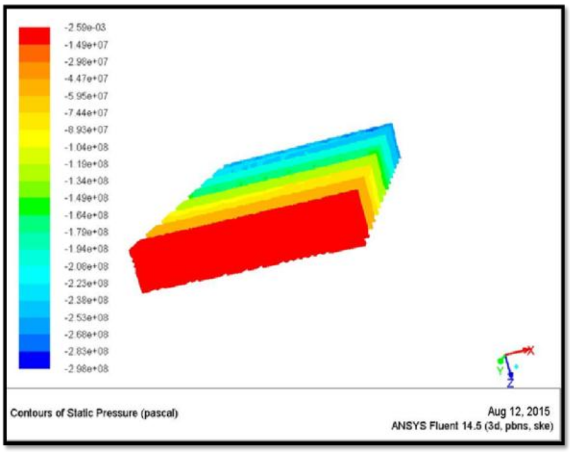


Figure7: *Model of Radiator without louvered fin*

STATIC TEMPUTATURE

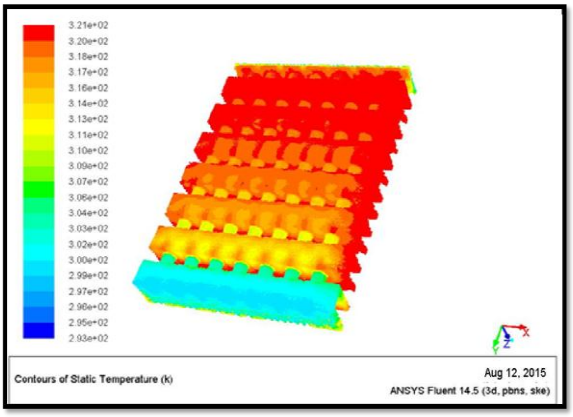


Figure8: *Model of Radiator without louvered fin*

B.WITH LOUVERED FIN

STATIC PRESSURE

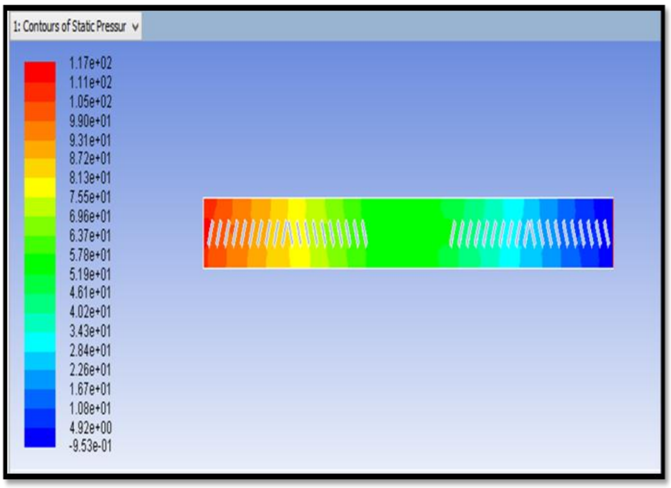
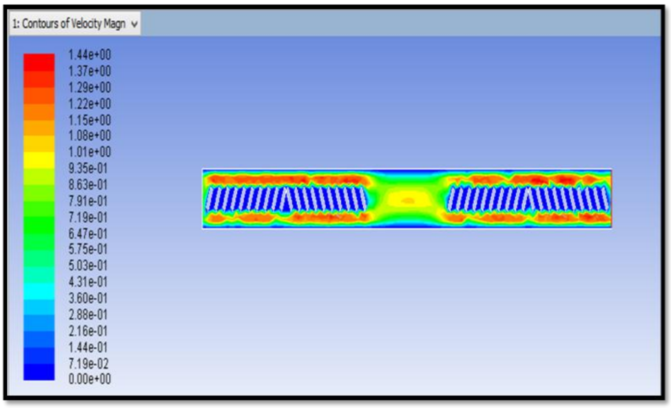


Figure9: *Model of Radiator with louvered fins*

STATIC TEMPUTATURE



C.RESULTS ANALYSIS

Table1 describes the pressure & temperature variations with ordinary fin for different mass flow rates.

	Mass flow rate (Kg/sec)			
	0.08 kg/sec	**0.140 kg/sec**	**0.210 kg/sec**	**0.280 kg/sec**
Pressure (Pa)	1.56e+01	2.82e+01	4.35e+01	5.94e+01
Velocity (m/s)	1.02e+00	1.77e+00	2.64e+00	3.51e+00
Temperature (K)	3.53e+02	3.53e+02	3.53e+02	3.53e+02
Mass Flow Rate (Kg/S)	1.147e-06	9.8341e-07	2.5331e-07	5.3644e-07
Total Heat Transfer rate at wall (W)	2749	3011	3149	3225

Table1: pressure & temperature variations with ordinary fin

WITH LOUVER FINS

Table2describes the pressure & temperature variations with louvered fin for different mass flow rates

	Mass flow rate (Kg/sec)			
	0.08 kg/sec	**0.140 kg/sec**	**0.210 kg/sec**	**0.280 kg/sec**
Pressure (Pa)	1.17e+02	2.14e+02	3.37e+02	4.68e+02
Velocity (m/s)	1.44e+00	2.50e+00	3.73e+00	4.94e+00
Temperature (K)	3.53e+02	3.53e+02	3.53e+02	3.53e+02
Mass Flow Rate (Kg/S)	4.616e-06	2.920e-06	2.840e-06	3.069e-06
Total Heat Transfer rate at wall (W)	5961	7463	8346	8872

Table2: pressure & temperature variations with louvered fin

RESULTS COMPARISON

THERMAL RESULTS

	With louvers	**Without louvers**
Temperature (^{0}C)	81.264	83.972
Thermal Error	1.5396e6	1.7557e6
Heat Flux (W/mm^2)	1.1418	0.98837

V CONCLUSION

In this project a radiator is designed without louver fins and with louver fins. The original radiator has no louver fins, it has been modified by specifying louver fins. 3D model is designed in Pro/Engineer.

The analysis tool ANSYS is used to perform CFD analysis on radiator at different mass flow rates. By observing the analysis results, the velocity is increased by 29.16%, pressure is increased by 86.66% and heat transfer rate at walls is increased by 53.88% for the modified model than the original that is the radiator with louvered fins.

Heat transfer analysis is performed to analyze the heat transfer rate to determine the thermal flux. The material taken is Aluminum alloy 6061 for thermal analysis. By observing the thermal analysis results, thermal flux is increased by 13.43% for the modified model.

So it can be concluded that modifying the radiator model with louver fins yields better results.

Ultimately it can be summarized that by providing louvers for the radiator and increasing the louver pitch helped in reducing the pumping power requirements with increase in heat transfer rate. This will help in increasing the power output per unit mass of the radiator. Hence it is recommended to increase the louver spacing for the geometry under consideration.

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VII REFERENCES

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