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Design and Analysis of Fins of Different Configuration and Shapes

[1] **Guide: Prof. Sachin Malave**

[2] Mr. Amol Khaire (Roll No 219), [3] Mr. Rohit Bagal (Roll No 373)

[4] Mr. Mayur Kharkar (Roll No 426), [5] Mr. Sushil Bhore (Roll No 130)

Smt. Kashibai Navale College of Engineering, Savitribai Phule Pune university

ABSTRACT :-

In today's industrial world there is a constant need for working with efficiency and carry out all the tasks quickly with accuracy. The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. It is know that, by increasing the surface area it can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim of the present thesis is to analyze the thermal properties by varying geometry of cylinder fins using Ansys workbench. The model of the geometries are created using SOLIDWORKS and its thermal properties are analyzed using Ansys workbench. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life. Presently Material used for manufacturing cylinder fin body is Aluminium Alloy AA 6082 which has thermal conductivity of 160 – 204.2 W/mk. Presently analysis is carried out for cylinder fins using this material.

I. INTRODUCTION

It is known that in case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result it seizing or welding of same. So, this temperature must be reduced to about 150- 200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. To avoid overheating, and the consequent ill effects, the heat transferred to an engine component (after a certain level) must be removed as quickly as possible and be conveyed to the atmosphere. It will be proper to say the cooling system as a temperature regulation system. It should be remembered that abstraction of heat from the working medium by way of cooling the engine components is a direct thermodynamic loss.

II. LITERATURE REVIEW

1. S. Padmanabhan, S. Thiagaranjan, A. Deepan Raj kumar, D. Prabhakaran, M. Raju [1] analyzes temperature distributions of fin profiles using analytical and CFD analysis. They used AA6082 as fin material and concluded that heat transfer rate is much higher for rectangular fins compared to triangular fins.

2. K. Sathishkumar, K.Vignesh, N. Ugesh, P. B. sanjeevaprasath, S. Balamurgun [2] analyzes heat transfer through fins with different types of notches. They used aluminium as fin material; they concluded from their experiment that heat dissipation rate is more in rectangular notch fin among all types of notches.

3. G. Babe and M. Lava Kumar [3] analysed the thermal properties by varying geometry, material and thickness of cylinder fins. Material used for manufacturing cylinder fin body was Aluminium Alloy 204 and Aluminium alloy 6061 and Magnesium alloy. They concluded that by reducing the thickness and also by changing the shape of the fin to curve shaped, the weight of the fin body reduces thereby increasing the efficiency.

4. Kumar, Devendra Singh, Ajay Kumar Sharma. [5] Carried out static thermal analysis on fins using ansys. They used aluminium alloy 1060 and carried research on plate fins, rectangular fins, circular fins, draft fins. They calculate heat flux for this all shapes and concluded that conical draft fins is better since temperature drop and heat transfer rate in it is much more compared to plate fins.

5. F. Khani, Abdul Aziz. [6] Thermal analysis of a longitudinal trapezoidal fin with temperature dependent thermal conductivity and heat transfer coefficient. They concluded that the performance of fin is affected by thermal conductivity parameter taper ratio and heat transfer coefficient parameter. The tip temperature increases much as 67% if the thermal conductivity at the base is 60% higher than its value at atmospheric temperature.

III.SUMMARY

Many people studied fins on cylinder but no one can explore different materials and shapes of fins so that we can increase their efficiency and it is possible to use best suitable fins. As in engine cooling of cylinder is most important. If we successful in increasing the cooling rate we can also increase efficiency of engine. There are different shapes by which we can reduced used of material in that way we reduced minimal cost required for material. So that overall performance improvement and cost cutting is done.

Software and hardware requirements :--

• Software - Solid works and ANSYS

• Hardware – Laptop

Scope :--

• Design: Construction of all parts and assembly followed by material application

• Analysis: Performing FEA analysis for different fins shapes

• Optimization: Cost cutting by selecting most efficient material for fins

Expected outcomes : --

By analysis and optimization, we would be able to choose best combination of fin shape, size and material for best efficiency.

Methodology : --

The methodology followed in the present work is given in flow chart showing the methodology used in the study :-

- PROBLEM
- DEFINATION SELECTION OF DIFFERENT MATERIALS
- THERMAL ANALYSIS IN ANSYS COMPARING
- THE RESULT
- CONCLUSION

Problem statement:--

Design and thermal analysis of fins of different shapes and size. In this project we Assume engine expansion temperature as base temperature and carried out analysis using ANSYS . In the present paper investigation on thermal issues on automobile fins were carried out. Investigation yields the temperature behavior and heat flux of the fins due to high temperature in the combustion chamber. Ansys work bench is utilized for analysis. The analysis is done for different models of fins that are commercially available now a days and a comparison is thus established between them. Also the material is changed so that better heat transfer rate can be obtained.

Selection of materials:

Table No. 1 showing material that is used during analysis and their respective thermal conductivities.

Table No. 1- Material and respective thermal conductivity

Material name	Thermal conductivity(W\mk)
Aluminium 6082	204.2
Aluminium 7068	190
Aluminium 204	120
Aluminum 6061	151
copper	397

Dimension specifications for fins with flat base:

Table No.2 showing the dimension specification of fins with flat base:

Table No. 2- Dimensional specification of fins with flat base.

Specifications	Dimension (mm)
Length of base	75
Breadth of base	55
Height of fins	50
Thickness/Dia. of fins	5
Pitch	5
No. Of fins in rectangular fin	7
No. Of fins in rectangular fin	42

Dimension specifications for fins on cylinder:

Table No.3 showing the dimension specification of fins on cylinder:

Table No. 3- Dimensional specification of fins on cylinder

Specifications	Dimensions (mm)
Cylinder inner diameter	66
Cylinder outer diameter	78
No. Of fins	8
Thickness off fins	2.5
Fins length	27
pitch	10
Length of cylinder	120

Analysis of fins:--

1 Boundary conditions Below are base parameters that we selected for analysis –

- Heat transfer coefficient = 30 w/m^2 k
- Ambient temperature = 28 °C for flat base
- 22 °C for fins on cylinder
- Expansion temperature = 1387.34 °C
- Heat flux to be applied = 1000 w/m^2

Steady state thermal analysis of cylindrical fins on cylinder with hole (AL204):--

Mesh diagram :

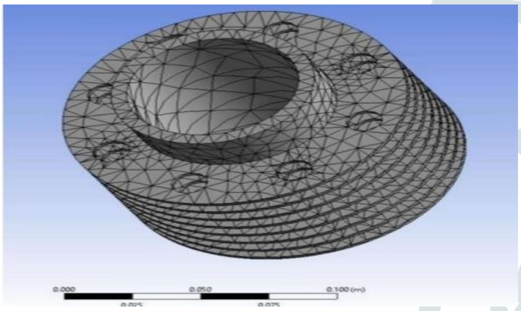
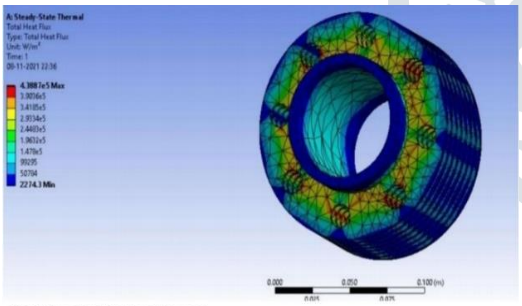


Fig.1 Mesh Diagram of Cylindrical Fins with Hole

figure 1 shows the mesh diagram for the cylindrical fins.

Heat flux distribution diagram:



Heat flux distribution diagram

Fig 2 Heat flux distribution diagram

figure 2 shows the heat flux distribution diagram for the cylindrical fins.

Steady state thermal analysis of square fins on cylinder with hole (AL204):--

Mesh diagram :

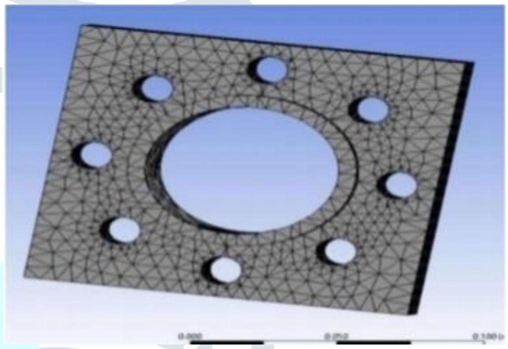


Fig 3. Mesh Diagram of square Fins with Hole

figure 3 shows the mesh diagram for the cylindrical fins with hole.

Heat flux distribution diagram:

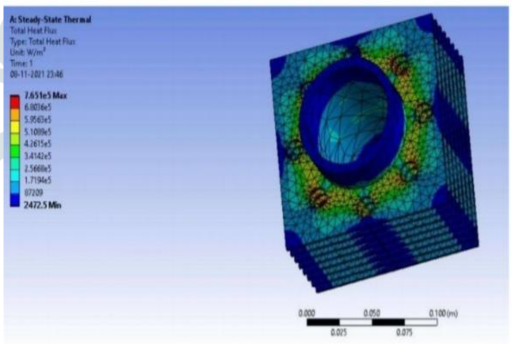


Fig 4 Heat flux distribution diagram:

figure 4 shows the heat flux distribution diagram for the cylindrical fins with holes.

Steady state thermal analysis of square fins on cylinder with notches(AL204):--

Mesh diagram :

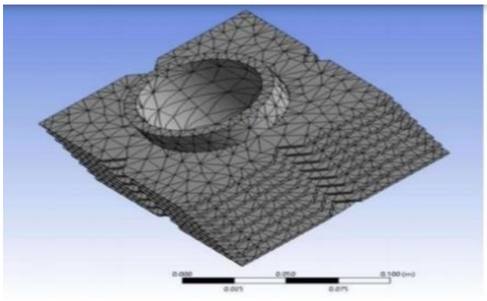


Fig 5 Mesh Diagram of Square fins with Notches

figure 5 shows the mesh diagram for the square fins with the notches.

Heat flux distribution diagram:

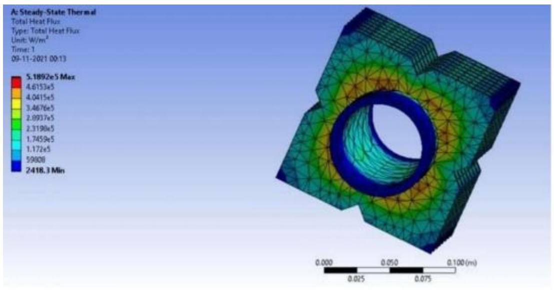


Fig 6 Heat flux distribution diagram

figure 6 shows the heat flux distribution diagram for the square fins with the notches.

Steady state thermal analysis of pin fins (AL204):--

Mesh diagram :

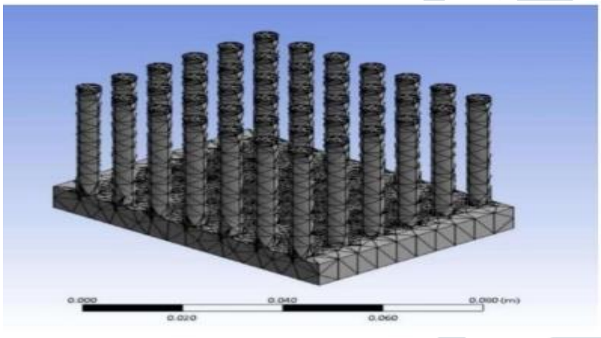


Fig 7 Mesh Diagram of Pin fins

figure 7 shows the mesh diagram for the pin fins

Temperature distribution diagram:

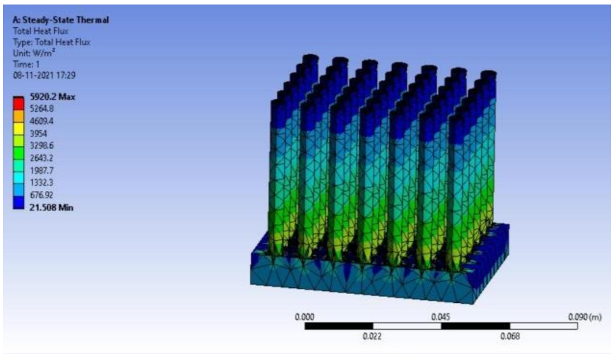


Fig 8 Heat flux distribution diagram:

figure 8 shows the heat flux distribution diagram for the pin fins

Steady state thermal analysis of Rectangular fins (AL204):--

Mesh diagram:

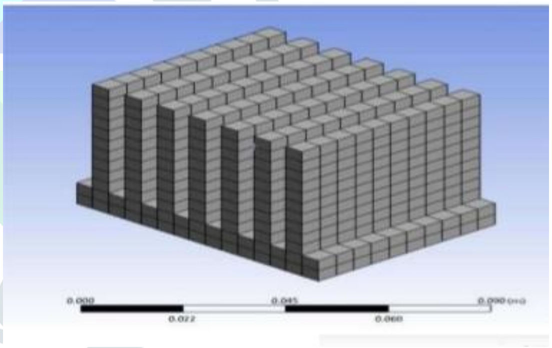


Fig 9 Mesh Diagram of Rectangular Fins with 2mm Thickness

figure 9 shows the mesh diagrams for the rectangular fins.

Heat flux distribution diagram:

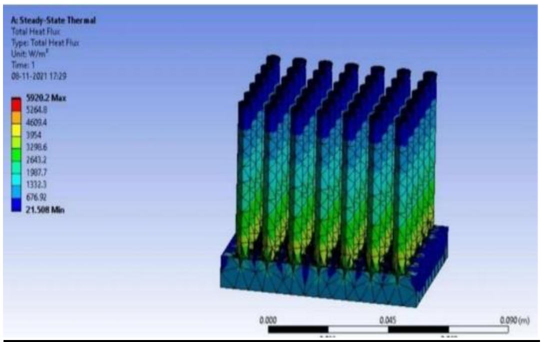


Fig 10 Heat flux distribution diagram:

figure 10 shows the heat flux distribution for the rectangular f

Results:--

Result obtained from analysis of various configuration is from table no.1 to 9

1 Cylindrical fins:

Table No.4 showing the analysis of the cylinder fins.

Table No.4 - Analysis of cylindrical fins

Material	Heat transfer rate (w/m^2)
Aluminium 6082	3.98e5
Aluminium 7068	3.97e5
Aluminium 204	3.91e5
Aluminium 6061	3.94e5
copper	4.02e5

2 Cylindrical fins with hole:

Table No.5 showing the analysis of the cylinder fins with hole.

Table No. 5- Analysis of cylindrical fins with hole

Material	Heat transfer Rate (w/m^2)
Aluminium 6082	4.49e5
Aluminium 7068	4.48e5
Aluminium 204	4.38e5
Aluminium 6061	4.43e5
copper	4.56e5

3. Square fins:

Table No.6 showing the analysis of the square fins.

Table No. 6- Analysis of square fins

Material	Heat transfer Rate (w/m^2)
Aluminium 6082	5.44e5
Aluminium 7068	5.42e5
Aluminium 204	5.27e5
Aluminium 6061	5.35e5
copper	5.5e5

4. Sqaure fins with hole:

Table No.7 showing the analysis of the square fins with hole.

Table No. 7- Analysis of square fins with hole.

Material	Heat transfer Rate (w/m^2)
Aluminium 6082	7.99e5
Aluminium 7068	7.95e5
Aluminium 204	7.65e5
Aluminium 6061	7.81e5
copper	8.25e5

5 Square fins with notches:

Table No.8 showing the analysis of the square fins with notches.

Table No. 8- Analysis of square fins with notches

Material	Heat transfer Rate (w/m^2)
Aluminium 6082	7.99e5
Aluminium 7068	7.95e5
Aluminium 204	7.65e5
Aluminium 6061	7.81e5
copper	8.25e5

6 Pin fins:

Table No.9 showing the analysis of the pin fins. Table

No. 9- Analysis of pin fins

Material	Heat transfer Rate (w/m^2)
Aluminium 6082	6030.9
Aluminium 7068	6018.7
Aluminium 204	5920.2
Aluminium 6061	5974.4
copper	6112.4

IV. CONCLUSION

- After performing all simulations we can come with a conclusion that by providing holes or notches on fins results in higher heat transfer rate.
- We get same conclusion from both analysis and calculation.
- By observing the analysis, we can easily say maximum heat transfer rate found in fins made of aluminium6082 and copper & minimum heat transfer rate seen in aluminium204.
- Among fins on cylinder maximum heat transfer rate seen in square fins with hole & minimum heat transfer rate in cylindrical fins.
- From rectangular & pin fins, pin fins shows higher heat transfer rate that rectangular.

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