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Performance analysis of two-wheeler bike fins using Ansys.

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Abstract*: The Engines Cylinder is one of the important parts of an automobile component, which is subjected to high-temperature variations and thermal stresses. To cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. An air-cooled motorcycle engine releases the heat to the atmosphere through the mode of forced convection, fins are provided on the outer surface of the cylinder block of the engine. The fins allow the cooling wind over its surface and transfer heat from the fins surface to the air. The main aim of the project is to analyze the thermal properties like Directional heat flux, total heat flux, the steady-state thermal analysis used to determine temperature distribution. To improve the rate of heat transfer thermal analysis of designs providing slots, reducing the fin thickness and increasing no. of fins. The fins model prepared in SOLIDWORKS2020SP0 and doing the thermal analysis of cylinder block with fins for different materials by using ANSYS2021R1and to find out the best material that gives the better heat transfer rate.*

Keywords *-Analysis, Fins, Thermal, Two-wheeler, Heat-Transfer.*

I. INTRODUCTION

1.1 Introduction of fins.

Fins are thin extrusions or appendages attached to a larger structure or a component. Normally fins are used for either of the two purposes: The fins act to produce lift and thrust are in turbines and propellers, these components use rotating fins, also called foils or blades, to generate rotating motion. Fins are also used to increase the surface area to accelerate heat transfer. The fins in the motorcycle engines are used for dissipating the heat generated in the engine. Fins provide a larger surface area over which the air can circulate and take away the heat. In a motorcycle engine, the air-fuel mixture gets combusted and produces the energy required for the functioning of a motorcycle. Heat is also generated in the combustion chamber, the temperature in the combustion chamber increases rapidly. Now the engine to function smoothly and to last longer, the temperature needs to be brought down to lower levels. The heat generated needs to dissipate as fast as possible. If at all, the heat is not dissipated, the effects on the engine can include overheating, knocking, misfiring, pre-ignition, etc. Even the piston rings, cylinder walls, engine valves could be damaged. To dissipate the heat generated and bring down the temperature, motorcycles have cooling systems. There are mainly 2 types of cooling systems used: Air Cooling System And Liquid Cooling System.

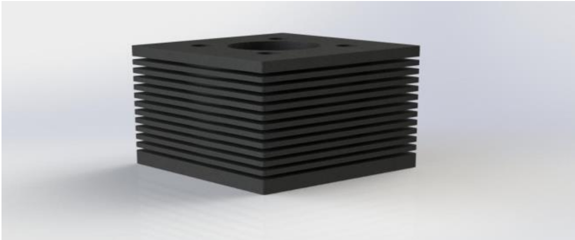

Fig. 1.1: Image of two-wheeler bike fins.

1.2.Background.

In this project, we are going to test the performance of two-wheeler bike engine fins for increasing the heat transfer rate using three different types of materials and design the most optimum fins by testing out various types of thermal properties like Directional heat flux, total heat flux, temperature distribution.

II. LITERATURE REVIEW

Shankar Durgam*, Aniket Kale, Nikhil Kene, Akshay Khedkar, Sanket Palve, and Nikita M.Gawai, "Thermal analysis of fin materials for engine cylinder heat transfer enhancement", 2021. Department of Mechanical Engineering, College of Engineering Pune. Studies on thermal analysis of engine cylinder having fins of different materials for heat transfer enhancement, and to find out the best material among the selected materials following conclusions were made. From the thermal analysis which is done by using ANSYS, it is clear that Aluminum alloys are better compared to the Gray cast iron and copper alloys. We also used the weighted point method to select the best material among them. By doing the calculations according to the weighted point method we made the final table which depicts that Aluminum alloy 356 is the best among the 4 materials. This method also gives us the selection preferences of the materials to be chosen. The results obtained from ANSYS analysis and weighted point method are complementary to each other and both show us that Aluminum alloy 356 has the better combination of required properties to be chosen as fin material.

A.N.Mohan Das, G. Harish, D. Purrab, J. Sachinand G. Suraj. Departmet of Mechanical Engineering, Dayanand Sagar College of Engineering, Bengaluru-560078, India. January-June 2021 “Transient thermal analysis of different types of IC engine cylinder fins by varying thickness and introducing slots”. 3D modeling of the different fin geometries using AUTODESK FUSION 360 software. The geometries included rectangular and circular fins. the next stage of the simulation was done in ANSYS WORKBENCH 2020 ACADEMIC software, wherein the transient thermal analysis was carried out on the modeled fins. The material used was Aluminium alloy 6061. The data are contained in the literature surveys; many studies were subjected to steady-state heat transfer analysis and plot corresponding temperature distribution. However, the method followed here was to conduct transient thermal analysis and thereby obtain their temperature and total heat flux dispersal. Another important aspect of this study was introducing slots and examining their effect on temperature distribution, thus recommending the most optimal engine fin model for heat dissipation

III. PROBLEM DEFINITION

3.1 Problem Statement.

In a Two Wheeler Bike Engine, we can see high-temperature variations and thermal stresses which can affect a two-wheeler bike engine and can cause overheating. To cool the Engine cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine fins around it, it is helpful to know the heat dissipation rate and temperature distribution inside the cylinder. By choosing different types of materials we can reduce the temperature variations and thermal stresses.

3.2 Objectives:

• To study the effect of fins with different parameters for it.
• To study the behavior of fins using three different materials.
• Optimisation of the different parameters for optimal result i.e. height, thickness, number of fins for a two-wheeler bike engine and to increase the rate of heat transfer.
• To study the thermal properties like Directional heat flux, total heat flux, temperature distribution.

IV. PROPOSED METHODOLOGY

4.1 Methodology.

The main objective of our project is to increase heat transfer by using three different materials. To achieve the above-stated objectives various calculations, Solid Modeling, Analysis has to be done.

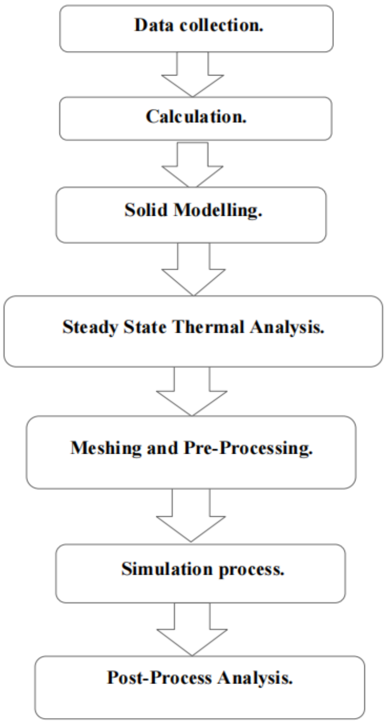

Fig. 4.1: Block diagram of Methodology.

V. TECHNICAL SPECIFICATIONS

In this research, we have bought a cylinder head of a two-wheeler from the market and measured all its dimensions with the help of measuring instruments, and all the information about the material and boundary conditions of this cylinder block is taken from research, the technical specifications are given below.

Sr.No	Specifications		Properties	
1.	Engine Capacity	100CC, air-cooled	Density	7.2e-009 tonne/mm^3
2.	Production	April 1994	Thermal conductivity	52 w/m-k
3.	Swept volume	97.2mm^3	Young's modulus	110 Gpa
4.	Stroke	50 mm	Poissons ratio	0.28
5.	Bore	100mm	Bulk modulus	8.33x10^10 Pa
6.	Fin material	Cast iron	Shear modulus	4.2969x10^10 Pa
7.	Fins type	Rectangular	Tensile ultimate strength	2.4x10^8 Pa
8.	No. of fins	11	Compressive ultimate strength	8.2x10^8 Pa

9.	Fin thickness	4mm	Specific heat	447 J/kg-°c
10.	Fin gap	6mm	Coefficient of thermal expansion	11x10^-6 (1/k)
11.	Fin length	25mm		

5.1 Engine model used in the project: Hero honda splendor Material properties of fins (cast iron) :

Table.5.1 Technical specification.

Boundary conditions.
Base temperature-150°c, Ambient temperature-35 °c, Film coefficient - 5e^-6 w/mm^2 °c
Higher temperature - 1000°c

VI. DESIGN AND ANALYSIS.

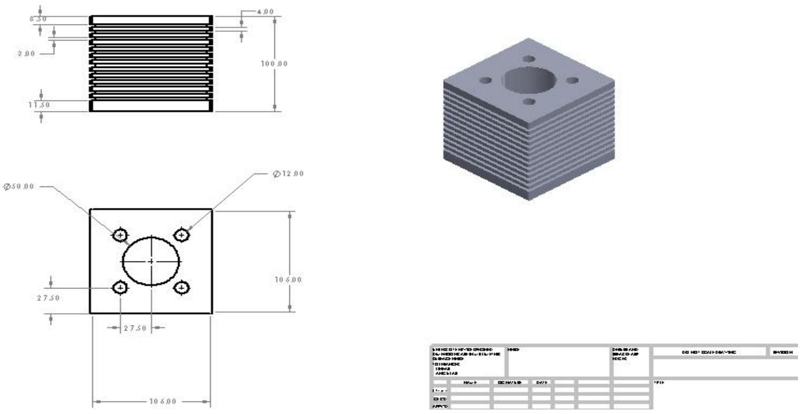

Fig.6.1 2D Sketch of fins model.

6.1 Materials used for analysis :

6.1.1.cast iron :

Properties:
Density- 7.2e-009 tonne/mm^3
Thermal conductivity- 52 w/m-k
Young's modulus- 110 Gpa
Poissons ratio - 0.28
Bulk modulus- 8.33x10^10 Pa
Shear modulus- 4.2969x10^10 Pa
Tensile ultimate strength- 2.4x10^8 Pa
Compressive ultimate strength- 8.2x10^8 Pa
Specific heat- 447 J/kg-°c
Coefficient of thermal expansion- 11x10^-6 (1/k)

Chemical composition:

Elements	Weight% Balance
Carbon -	2-4
Other alloys -	2-4
Silicon -	1-3

6.1.2.Magnesium Alloy AE44 :

Properties:
Density- 1.82 g/cm^3
Thermal conductivity- 85 w/m-k
Young's modulus- 45 Gpa
Poissons ratio- 0.35
Elastic modulus- 45 Gpa
Hardness (Brinell)- 62
Tensile ultimate strength- 245 Mpa
Yield strength- 142 Mpa
Specific heat- 1.02 kJ/kg.k

Chemical composition:

Elements	Weight% Balance
Aluminum-	3.98
Manganese-	0.35
Zinc (Zn)-	0.2
Rare earths (RE)-	3.95
Magnesium-	Balance

Coefficient of thermal expansion- 26x10^-6 (1/k).

6.1.3.Aluminium Alloy 6061 :

ASTM (American society for testing and materials) Standard. Alloy 6061 - The 1st 6 indicated that it is alloyed with magnesium and silicon. The 2nd digit is a 0, like this case, which means it is a standard alloy and its composition has not to be modified. Finally, the last two-digit (61) stands for specific alloy.

Properties:

Density- 2.70 g/cm^3
Thermal conductivity- 180 w/m-k
Young's modulus- 68 Gpa
Poissons ratio - 0.33
Shear modulus- 3.80 Gpa
Tensile ultimate strength- 124-290 Mpa
Compressive ultimate strength- 142 Mpa
Specific heat- 897 J/(kg.k)
Coefficient of thermal expansion- 2.32x10^-5 (1/k)

Chemical composition:

Elements	Weight% Balance
Manganese (Mn) -	0.15
Iron (Fe)-	0.70
Magnesium (Mg) -	0.80-1.20
Silicon (Si) -	0.40-0.80
Copper (Cu) -	0.15-0.40
Zinc (Zn) -	0.25
Titanium (Ti) -	0.15
Chromium (Cr) -	0.04-0.35
Other (Each) -	0.05
Others (total) -	0.15
Aluminum (Al) -	Balance

VII. RESULTS AND DISCUSSION

7.1 Cast Iron

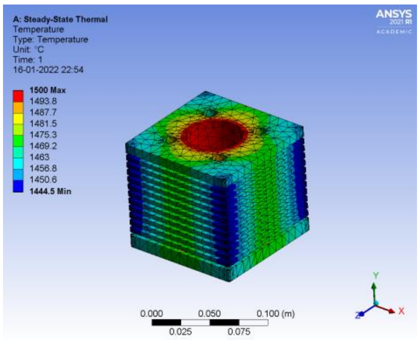

Fig.7.1.1 Temperature.

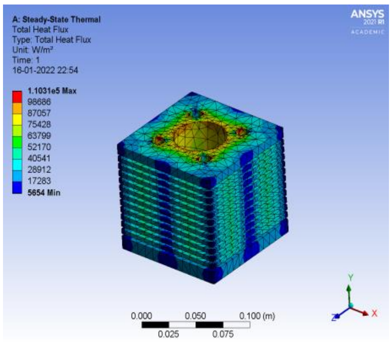

Fig.7.1.2 Total Heat Flux.

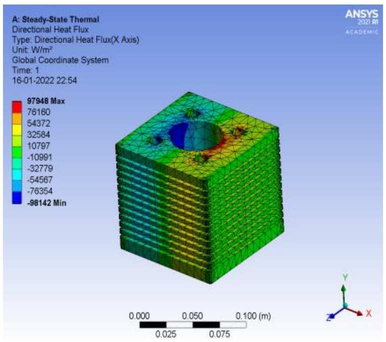

Fig.7.1.3 Directional Heat Flux.

7.2 Magnesium Alloy

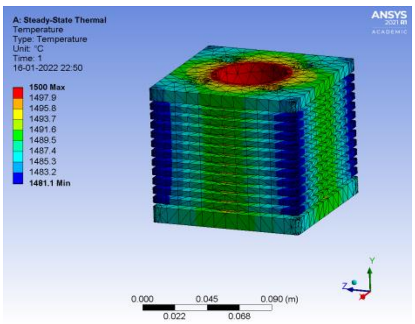

Fig.7.2.1 Temperature.

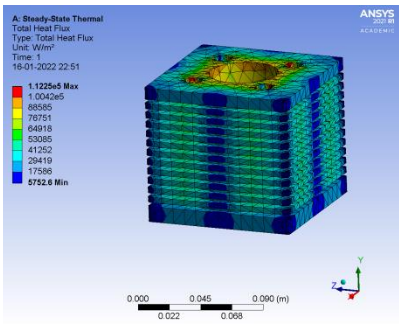

Fig.7.2.2 Total Heat Flux.

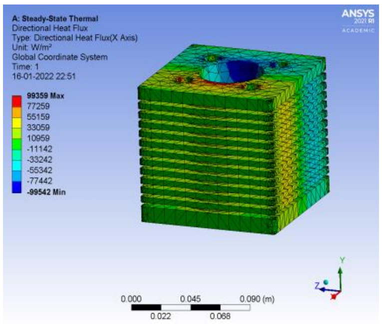

Fig.7.2.3 Directional Heat Flux.

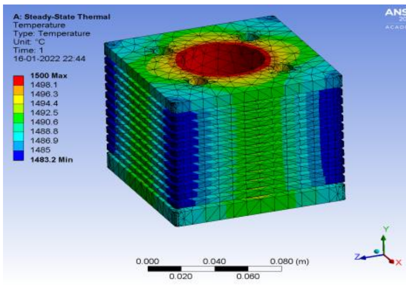

Fig.7.3.1 Temperature.

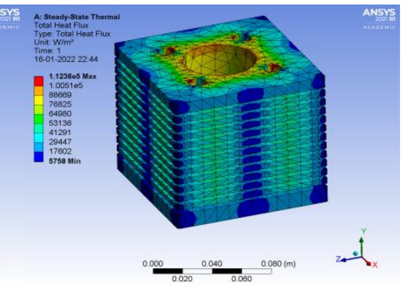

Fig.7.3.2 Total Heat Flux.

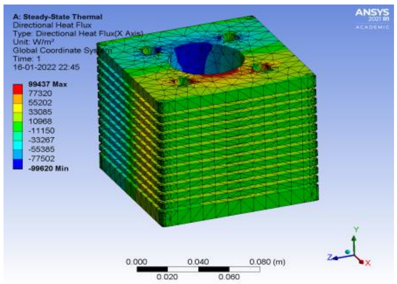

Fig.7.3.3 Directional Heat Flux.

7.4 Result

Table.7.4 Result Table.

In the above analysis of the model, we have got the results as temperature distribution over the fins, total heat flux, directional heat flux in the ANSYS software. The table gives data of results from ANSYS simulation. The maximum and minimum temperature in each case is mentioned. The material which has a higher value of minimum temperature is a clear indicator of better material in terms of its thermal properties. So this analysis carried out in which Aluminium alloy gives us a high heat transfer rate as compared to cast iron and magnesium alloy.

VIII. CONCLUSION

In this project, we are trying to use three different materials for the fins for temperature reduction and engine efficiency. In this project, we are planning to achieve it by changing the materials of the fins and adding the number of fins. After carrying out the analysis we will be able to choose the most optimum parameters for fins, which will also help to study the flow of heat transfer in two-wheeler bike engine fins that would improve the heat transfer characteristics which helps with the better cooling process. Fins will cause more heat transfer and the cool engine more effectively. As we increase the area under the convection the cooling of the engine improves and due to which engine cools effectively.

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