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Design and Thermal Analysis of IC Engine Fins for Effective Heat Transfer by Modifying Material and Geometry

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Abstract: The work is set to analysis the heat dissipation of fins by deviate its geometry in both uniform and non-uniform types, with different material compositions. The models are generated by varying the geometry such as rectangular and triangular. The models were created by using the software 3D Experience. The analysis was carried out by using ANSYS 18.1. The conventional Material used for manufacturing fin body is generally Aluminium Alloy 204 and Aluminium Alloy 6061.We Analysed Aluminium Alloy 6063 which has a higher thermal conductivity of 201-218 W/m-ºC. After analysis, the performance parameters are compared with all types of geometries of different material compositions in Aluminium 6063.

Keywords: Fins, Natural convection, Thermal analysis, Effectiveness.

Introduction

Now a days the need in increasing the technology leads to developing the new materials, which will exhibits the noble characteristics. Developing the new materials is not an easy process to fulfil the technology requirements. Precisely the heat dissipation phenomenon in air cooled internal combustion engines will carries out accurately by the material type of the cooling fins and its geometry. The heat dissipation from the engine body can be raised by expanding the surface area of fins. The heat dissipation through the body of fins can be raised by increasing the surface area of fins. The hike in surface area is done by establishing holes of dissimilar sizes on the extended surface of fins [1]. A simulation was carried out to study the heat transfer situation through various finned surfaces of varying geometries and material using ANSYS Workbench®, to better approach the factors affecting heat transfer along the length of the fin [2]. The objective of this work is set to discover the heat dissipation rate, heat flux and the thermal gradient of the fins of an air cooled IC Engine can be analysed by changing the material composition and geometry of the fins.

Objectives

This research is focused on

- To analyse and measure effectiveness of separate kinds of fins.
- To examine steady state thermal properties of unlike geometries.
- To wrap up which type is most efficient.

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- To suggest which type of material composition should prefer for effective heat transfer.

Problem Definition

To increase the heat dissipation rate through the fins, different types of methods can be employed. By modifying the geometrical parameters such as surface area, length, shape, perimeter, the heat transfer rate can be estimated and the material composition also plays an important role to increase the heat dissipation rate through the fins. The objective of this work was set to determine the properties like the heat distribution and the heat dissipation of hero Honda air cooled 100cc engine can be estimated by modifying the material composition and geometric parameters such as thickness, length, width, shape etc.

Literature Review

The heat dissipation from the engine body can be raised by expanding the fins surface area. The hike in surface area is done by establishing holes of dissimilar sizes on the fins surface. The temperature of fins can be reduced by creating holes on fins. It also known that the increasing the turbulence of air also gets increased by creating the pits on the fins [1].

The main objective of the project is to analyse the performance of fins with different geometries. Fins with different geometries exhibits a major role in heat dissipation through the fins. Different kinds of fin geometries such as rectangular, circular and trapezoidal were used. The models were developed to examine which geometry is most efficient. The results were obtained by changing the orientation of different fin geometry [3].

Methodology

To examine the nature of heat transfer incidence through different finned surfaces of different geometries and material using ANSYS Workbench, the models of the different shapes were developed through 3D Experience and finally the models were rendered and subjected to simulation, with varying operating conditions and parameters.

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Modeling of fins

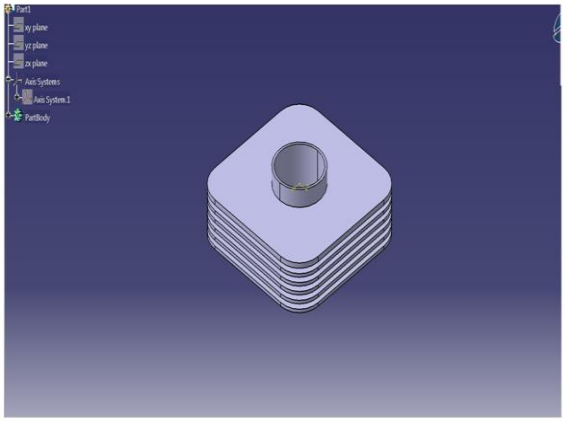

Figure 1. 3D Model of Rectangular Fin

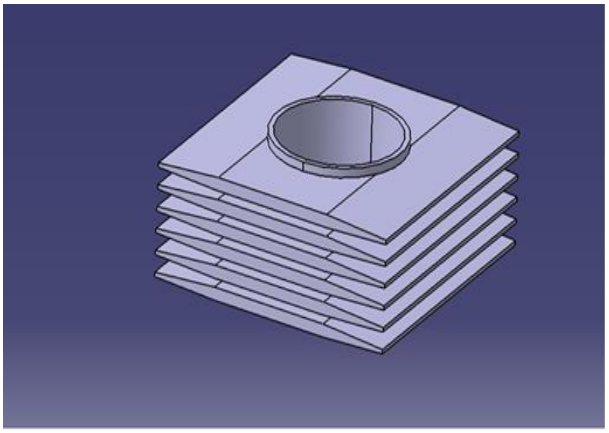

Figure 2. 3D Model of Triangular Fin

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Pg: -12-22

constituents of proposed materials

Table 1. The chemical composition of the materials.

Constituents	AL 6063 (%)	AL 6063 T5 (%)	AL 6063 T6 (%)
Si	0.2-0.6	0.2-0.6	0.4-0.8
Fe	0.35	0.35	0.7
Cu	0.10	0.10	0.15-0.4
Mg	0.45-0.9	0.45-0.9	0.8-1.2
Cr	0.10	0.1	0.1
Zn	0.10	0.1	0.25
Ti	0.10	0.1	0.15
Mn	0.10	0.10	0.15
Others	0.05-0.15	0.05-0.15	0.15
AL	97.6 – 99.30	97.5 – 99.30	97.6 – 99.30

Analysis on fins

The all generated models of two geometries in 3D experience software were simulated with three deferent material compositions i.e in Aluminum Alloy 6063, Alloy 6063 T5 and Alloy 6063 T6.The experimentation was carried out on all material composition by considering the below tabulated values.

Table 2. The Engine particulars.

1	Engine Linear Speed (KM / Hr)	50
2	Temperature of surrounding (Ambient)	50 ˚ C with 40 % RH
3	Geometrical Altitude	1000 Meter Above mean sea Level

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Pg: -12-22

4	Heat transfer coefficient w / m² K	10
5	Thermal conductivity w / m K	400
6	Nominal Wind Speed (m / Sec)	10.45

Analysis on rectangular fins

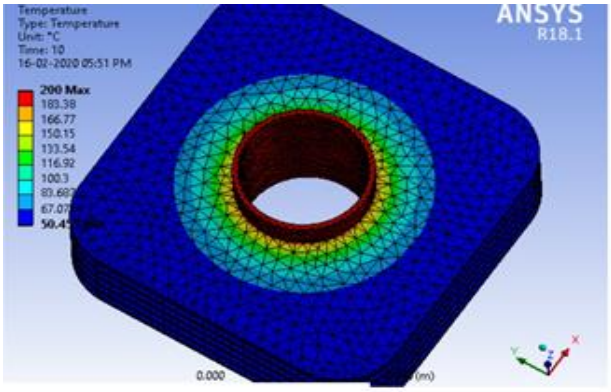

Figure 3. Analysis results on Rectangular fin Aluminum Alloy 6063

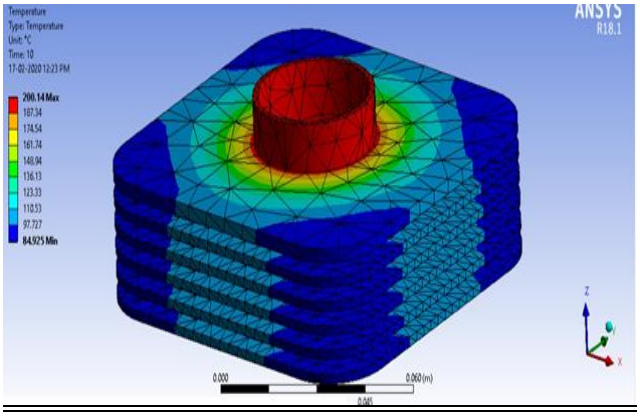

Figure 4. Analysis results on Rectangular fin Aluminum Alloy 6063 T5

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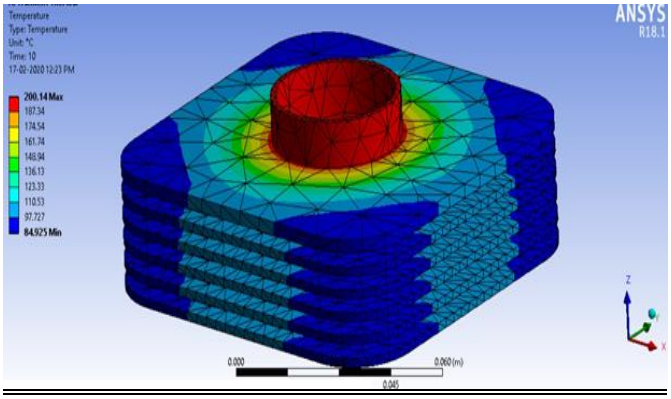

Figure 5. Analysis results on Rectangular fin Aluminum Alloy 6063 T6

Analysis on triangular fins

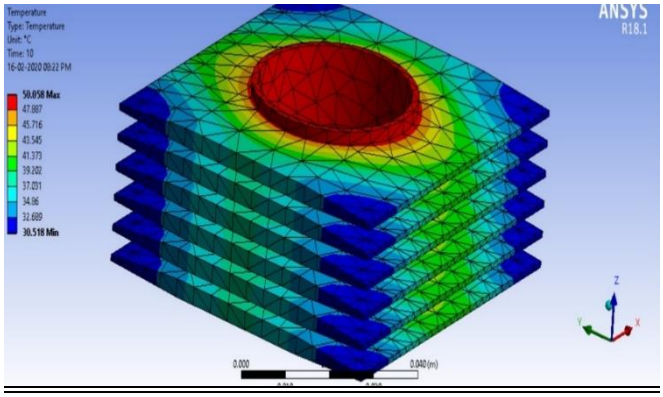

Figure 6. Analysis results on Triangular fin Aluminum Alloy 6063

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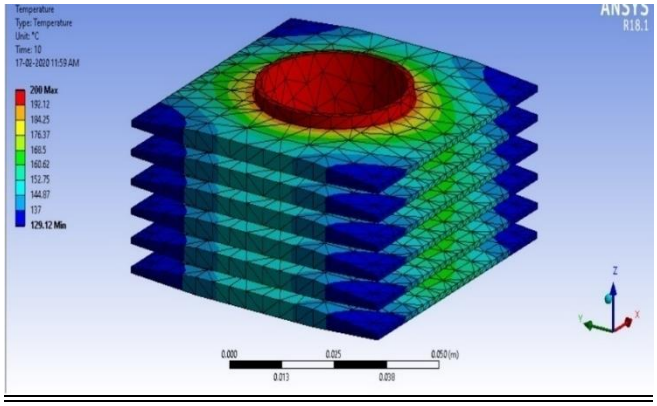

Figure 7. Analysis results on Triangular fin Aluminum Alloy 6063 T5

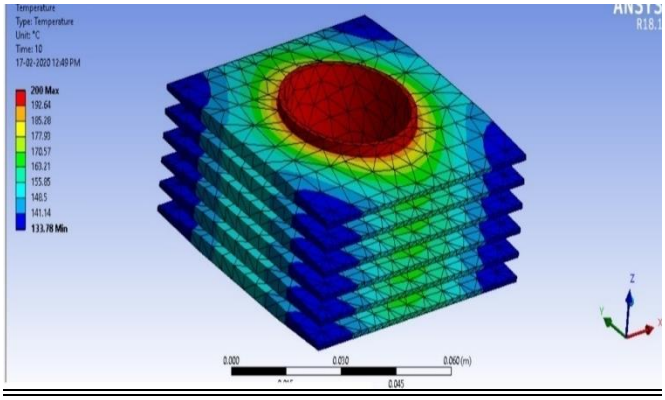

Figure 8. Analysis results on Triangular fin Aluminum Alloy 6063 T6

Results and Discussions

After the analysis, we have the clear report on the fins which we have designed has the following values which are tabulated below**.**

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Vol.8 Issue 6,
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Pg: -12-22

Rectangular fin

Table 3. Results of rectangular fin

FACTORS	AL 6063	AL 6063T5	AL 6063T6
Ambient temp ˚ c	50	50	50
Heat loss (w)	139.43	142.25	118.23
Thermal flux (w/mm2)	0.463	0.656	0.365
Thermal Gradient (K/mm)	4.172	4.85	4.128

Triangular fin

Table 4. Results of triangular fin

FACTORS	AL 6063	AL 6063T5	AL 6063T6
Ambient temp ˚ c	50	50	50
Heat loss (w)	145.33	144	120.62
Thermal flux (w/mm2)	1.753	1.91	1.744
Thermal Gradient (K/mm)	14.608	10.612	12.65

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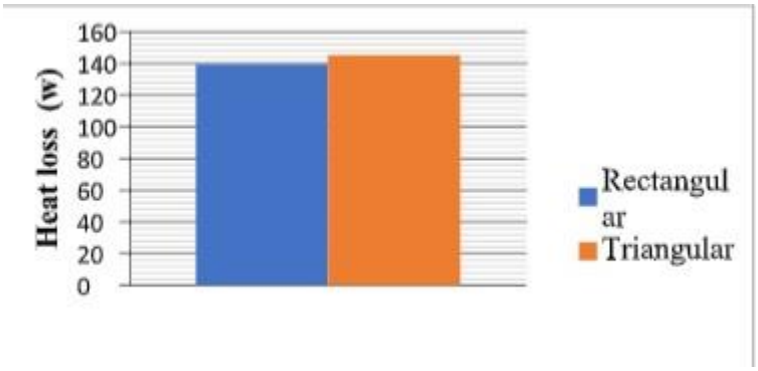
Comparison of Heat loss, Thermal Gradient and thermal flux

Heat loss

Figure 9. Heat loss of all Alloys in all geometries.



Thermal gradients

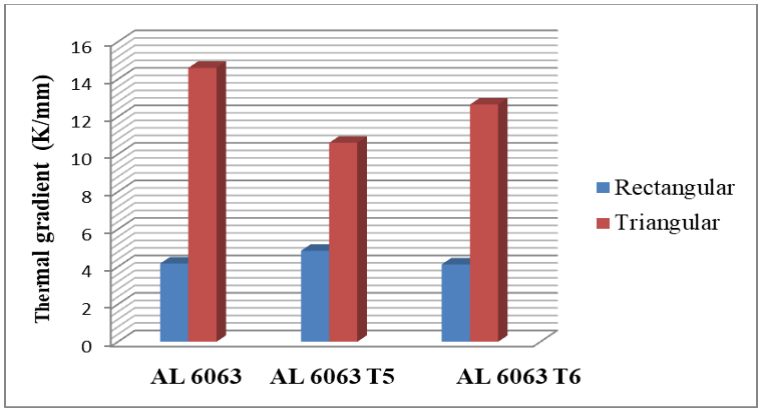


Figure 10. Thermal gradients of all Alloys in all geometries.

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Thermal flux

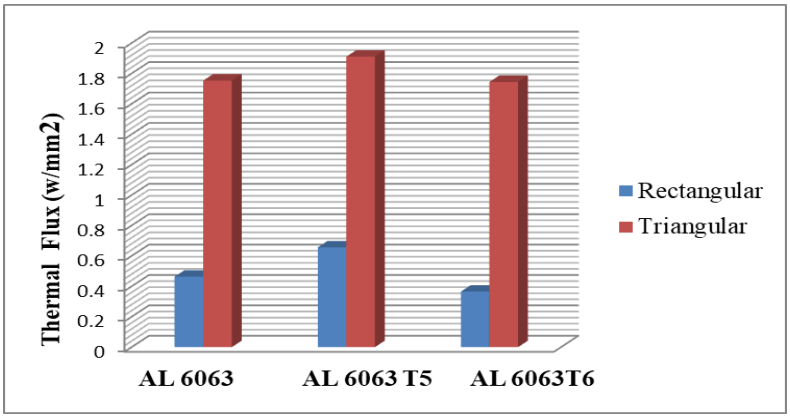

Figure 11. Thermal flux of all Alloys in all geometries.

Conclusions

- From the above detailed investigation of the Analysis surmise that the geometry and the cross sectional area of the fin are the most important parameter that decides the efficiency of the fin.
- The thermal analysis of fins by changing its parameters such as geometry and material composition has been completed.
- The thermal gradient or the rate of heat flow per unit length is observed more in the triangular fins than in Rectangular fins.
- From this analysis it has been noticed that the thermal flux through the Triangular fins is more when compared with Rectangular shape in AL 6063, AL 6063 T5 and AL 6063 T6 at same thickness.

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