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# Design and Thermal Analysis of Engine Cylinder Fins by Varying Geometry

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## ABSTRACT

It is the engine cylinder that bears the brunt of high temperatures and thermal stress in automobiles. To improve heat transmission, fins are placed on the engine cylinders. The surface area of engine cylinder fins may be increased to increase heat rejection. This experiment aims to explore the thermal characteristics of cylinder fins by modifying the geometry of the fins, as well as the material, and angle of the cylinders, using the Ansys work bench. It is quite helpful to apply the accurate thermal simulation to find the design parameters that will increase life via the use of study state thermal analysis. Aluminum Alloy 2014 has a 17 percent greater temperature distribution than Aluminum Alloy 204, according to the findings of the current study. There is a linear temperature distribution along the fins for all materials. By lowering weight of the engine, the round fins improve the engine's efficiency.

**Keywords**:AISI 1010 STEEL, Gray Cast Iron, Structural Steel, CATIA V5, ANSYS

## 1. Introduction:

The combustion of air and fuel in an Internal Combustion engine generates hot gases within the engine cylinder. Gases will be very hot as a result of this. As a consequence, the oil coating between the moving components may be burned, which might cause the parts to seize or fuse together. As a result, the optimal operating temperature for the engine must be lowered. The thermal efficiency is also reduced by excessive cooling. As a result, the cooling system's primary goal is to maintain the engine working at its optimum temperature. It is important to remember that the engine is less efficient when it is cold, thus the cooling system is intended to keep the engine from overheating until it reaches its optimum working temperature. Much like a water wheel, which generates mechanical power from mass dropping across a distance, heat engines take energy from heat fluxes to do the same. Heat energy is lost as a byproduct of the inefficiency of engines, which results in waste heat that must be evacuated from the system. Cool intake air, hot exhaust gases, and engine cooling remove waste heat from internal combustion engines.

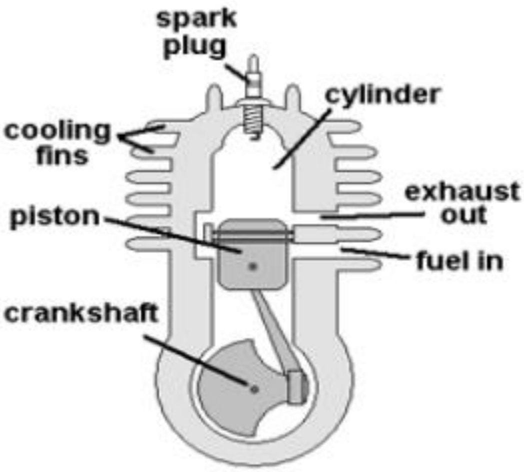


**Figure1:Engine Cylinder with fins**

## 2. LiteratureReview

**L.Prabhu [1]**ANSYS workbench analyses the fin's heat transfer performance when it is designed in different configurations, such as cylindrical, square, and rectangular. A comparison is made between the heat transfer properties of fins with the same operating temperature. Aluminium was the primary metal employed in the fins in this thermal investigation. CATIA V5R16 was used to design the fins. An ANSYS 15.0 analysis of fin performance was performed

**S.Jamala Reddy, Y.Tejeswar [2]**This work presents the design and thermal analysis of cooling fins with varied geometry and material. The primary function of these cooling fins is to cool the cylinders of the engine by the use of air. Changing the shape, material, and thickness of cylinder fins will allow us to better understand the thermal characteristics of the system. Temperatures and other thermal parameters that change over time are measured using transient thermal analysis

**ZanWU [3]**Natural convection heat transfer improvement was realised using perforated fin arrays of 12mm perforation diameter of the 45 degree angle of orientation, which displays a 32% increase in heat transfer coefficient and a 30% reduction in material consumption.

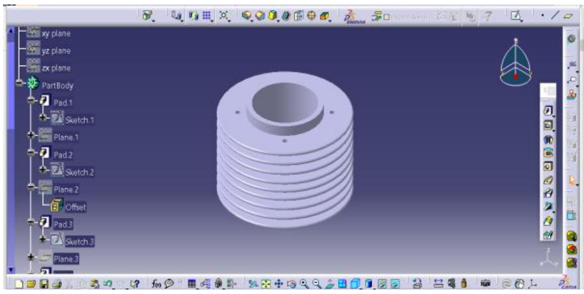
**Abdullah, H. Alessaet. al. [4]**A horizontal rectangular fin with equilateral triangular holes has been researched for its natural convection heat transfer increase. Comparing the perforated fin's heat dissipation rate to that of a solid counterpart. The influence of the perforated fin's geometrical dimensions and thermal qualities was thoroughly investigated. For specific values of triangle dimensions, they found that the perforated fin improved heat transmission. There is a direct relationship between a fin's thickness and heat conductivity. In addition to enhancing heat transfer rates, perforation of fins reduces the material consumption of the fin.

## 3. ProposedWork

1. Experiment on the rate of heat transfer in various scenarios to construct and use the various fin/perform geometries, content and edge extension to allow experimental data collecting.
2. To perform a finite element research to determine the heat conductivity of the fins.
3. The fins are made of aluminium alloys, as well.
4. Tail geometry is meant to demonstrate heat transmission characteristics.

## 4.Methodology

The FEA process involves CAD modeling of piston in CATIA V5 design modeler. The model is developed as shown in figure 2 below. The modeldevelopedinCATIA V5 Simulationdesignmodelerisimportedformeshing in ANSYS.



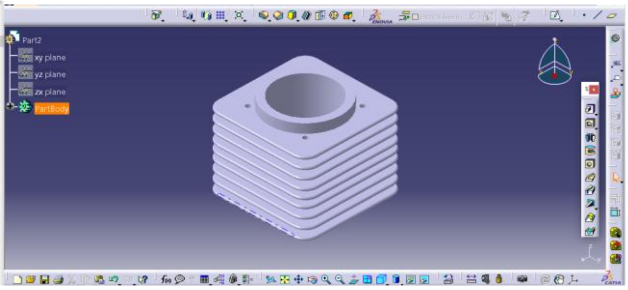


**Figure2:CADmodelofCrane Hook (Model-1)Figure4: CAD model of crane Hook (Model-2)**

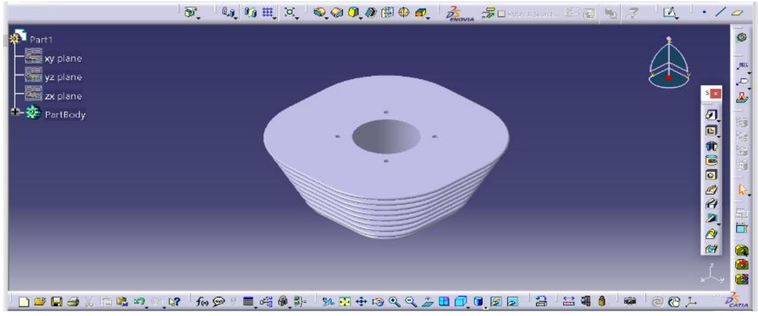


**Figure4: CAD model of crane Hook (Model-2)**

Tetrahedral elements and precise sizing with curvature effects are used to mesh the CAD model. As indicated in the diagram above, model-1 generates 38952 elements and 25734 nodes, whereas model-2 generates 56499 elements and 100622 nodes and model-3 generated 110034 node 50502 and element the figure depicts the shape of a tetrahedral element. It is made up of four nodes that are joined by a tetrahedral shape. After meshing, the CAD model of the suspension is applied with the required loads and boundary conditions.

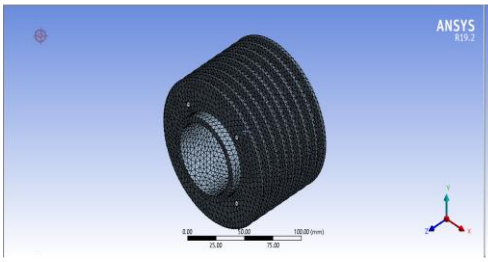


**Figure5: Model-1 Meshed**

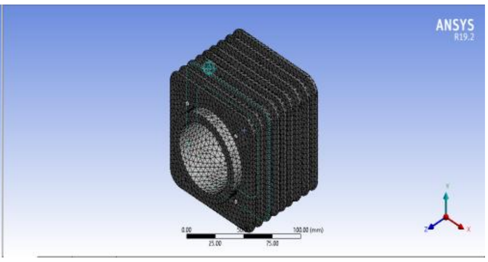


**Figure 6: Model-2 Meshed**

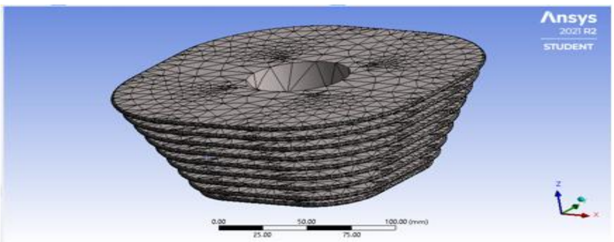
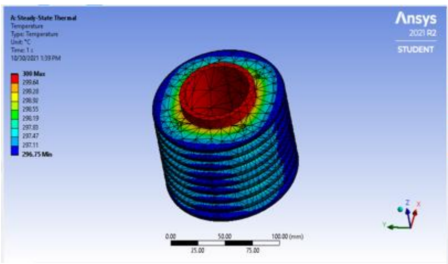


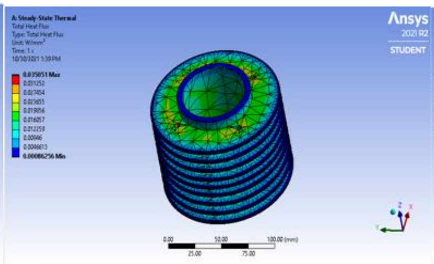
**Figure 6: Model-2 Meshed**

## 4. ResultsandDiscussion

Theresultsof FEsimulationaregenerated.Theradialstress andtangentialstressgeneratedonpistonis generatedas showninfigure6andfigure7below

**Model-1**





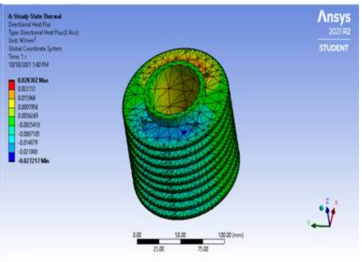
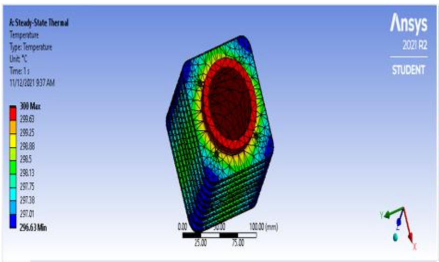
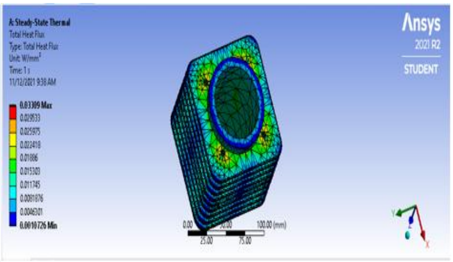


**Figure 7: Temperature Distribution Figure 8: Total Heat Flux Figure 9: Heat Flux Direction**

**Model – 2**





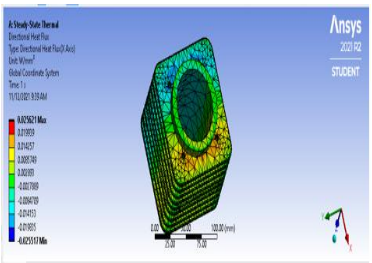
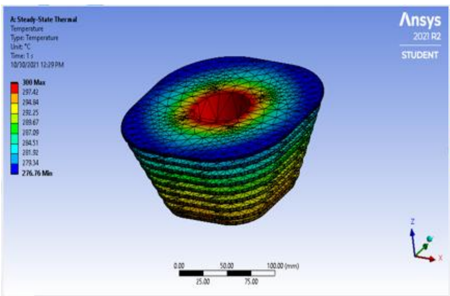
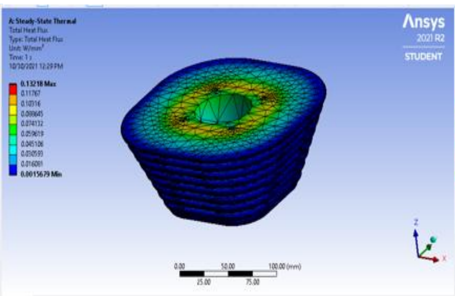


**Figure 7: Temperature Distribution Figure 8: Total Heat Flux Figure 9: Heat Flux Direction**

**Model-3**





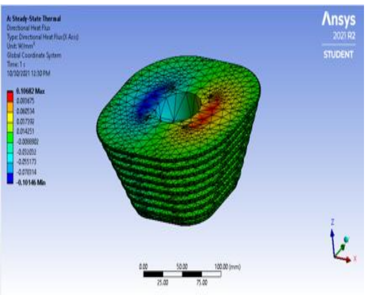
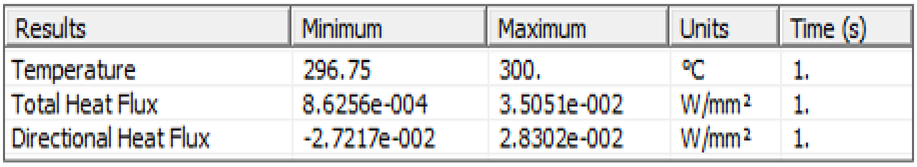


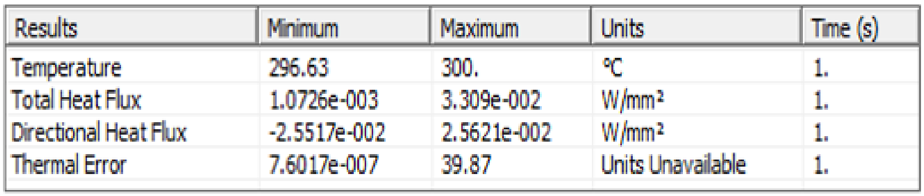
**Figure 7: Temperature Distribution Figure 8: Total Heat Flux Figure 9: Heat Flux Direction**

**Table 1: Model-1 Analysis Result**



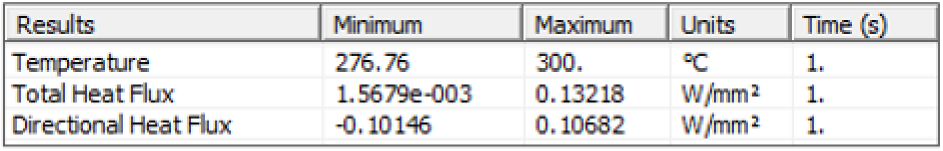
| Results | Minimum | Maximum | Units | Time (s) |
|---|---|---|---|---|
| Temperature | 296.75 | 300. | °C | 1. |
| Total Heat Flux | 8.6256e-004 | 3.5051e-002 | W/mm² | 1. |
| Directional Heat Flux | -2.7217e-002 | 2.8302e-002 | W/mm² | 1. |

**Table 2: Model-2 Analysis Result**



| Results | Minimum | Maximum | Units | Time (s) |
|---|---|---|---|---|
| Temperature | 296.63 | 300. | °C | 1. |
| Total Heat Flux | 1.0726e-003 | 3.309e-002 | W/mm² | 1. |
| Directional Heat Flux | -2.5517e-002 | 2.5621e-002 | W/mm² | 1. |
| Thermal Error | 7.6017e-007 | 39.87 | Units Unavailable | 1. |

**Table 3: Model-3 Analysis Result**



| Results | Minimum | Maximum | Units | Time (s) |
|---|---|---|---|---|
| Temperature | 276.76 | 300. | °C | 1. |
| Total Heat Flux | 1.5679e-003 | 0.13218 | W/mm² | 1. |
| Directional Heat Flux | -0.10146 | 0.10682 | W/mm² | 1. |

## 5. Conclusion

By doing steady state thermal analysis on circular, rectangular and gradually increasing cylinder fins we find temperature distribution over a body, total heat flux and directional heat flux. If we compare all three models result we find that model-3 shows the best performance low temperature range heat flux and heat flux direction if we calculate heat flux coefficient we found that model-3 has highest heat transfer coefficient.

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