# Thermal Analysis Of Engine Fins Varying Different Geometry And Material

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## ABSTRACT

The Engine cylinder is one of the major automobile components, which is subjected to hightemperature variations. 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. We know that, by increasing the surface area we can increase the heat dissipation rate. The main purpose of using these cooling fins is to cool the engine cylinder by air. In this thesis, using materials and Aluminium alloy i.e. AL 6061, AL he15, 8011a-H111 are also analysed. Thermal analysis is done using all the three materials by changing geometries, for the actual model of the cylinder fin body. The analysis done by using ANSYS work bench. The 3D modelling software used is solid works. By using materials and Aluminum alloys which have higher thermal conductivities.

KEYWORDS: Engine Cylinder Fins, Materials, FEA, Solid Works, ANSYS.

## INTRODUCTION

Most modern internal combustion engines are cooled by a closed circuit carrying liquid coolant through channels in the engine block and cylinder head, where the coolant absorbs heat, to a heat exchanger or radiator where the coolant releases heat into the air (or raw water, in the case of marine engines). Thus, while they are no ultimately cooled by the liquid, because of the liquid-coolant circuit they are known as water-cooled. In contrast, heat generated by an air-cooled engine is released directly into the air. (Direct Cooled Engine) Typically this is facilitated with metal fins covering the outside of the Cylinder Head and cylinders which increase the surface area that air can act on. Air may be force fed with the use of a fan and shroud to achieve efficient cooling with high volumes of air or simply by natural air flow with well-designed and angled fins.

In all combustion engines, a great percentage of the heat generated (around 44%) escapes through the exhaust, neither through either a liquid cooling system nor through the metal fins of an air-cooled engine (12%). About 8% of the heat energy finds its way into the oil, which although primarily meant for lubrication, also plays a role in heat dissipation via a cooler

# LITERATURE REVIEW

**Fernando Illan**simulated the heat transfer from cylinder to air of a two-stroke internal combustion finned engine. The cylinder body, cylinder head (both provided with fins), and piston have been numerically analyzed and optimized in order to minimize engine dimensions. The maximum temperature admissible at the hottest point of the engine has been adopted as the limiting condition. Starting from a zero-dimensional combustion model developed in previous works, the cooling system geometry of a two-stroke air cooled internal combustion engine has been optimized in this paper by reducing the total volume occupied by the engine. A total reduction of 20.15% has been achieved by reducing the total engine diameter D from 90.62 mm to 75.22 mm and by increasing the total height H from 125.72 mm to 146.47 mm aspect ratio varies from 1.39 to 1.95. In parallel with the total volume reduction, a slight increase in engine efficiency has been achieved.

**G. Babu and M. Lavakumar**analyzed the thermal properties by varying geometry, material and thickness of cylinder fins. The models were created by varying the geometry, rectangular, circular and curved shaped fins and also by varying thickness of the fins. Material used for manufacturing cylinder fin body was Aluminum Alloy 204 which has thermal conductivity of 110-150W/mk and also using Aluminum alloy 6061 and Magnesium alloy which have higher thermal conductivities. 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. The weight of the fin body is reduced when Magnesium alloy is used and using circular fin, material Aluminum alloy 6061 and thickness of 2.5mm is better since heat transfer rate is more and using circular fins the heat lost is more, efficiency and effectiveness is also more.

## ALUMINIUM ALLOY

Aluminium is the stronger metal. The typical alloying elements are copper, magnesium, silicon and zinc. Aluminium alloys with a wide range of properties are used in engineering structures. Selecting the right alloy for given application entails consideration of its tensile strength, density, workability, and corrosion resistance, Aluminium alloys are used extensively in aircrafts due to their high strength-to-weight ratio. Whereas the pure aluminium metal is much too soft for such use and doesn’t have the high tensile strength that is needed for airplanes and helicopters

## AL 6061

Al 6061 is a Precipitation-hardened aluminium alloy containing magnesium and silicon as its major alloying elements. Al 6061 is one of the most versatile of the heat treatable alloys. 6061 is popular for its medium to high strength requirements, good toughness and excellent corrosion resistance.

## Properties

Density - 2.7 g/cc
Thermal conductivity -166 w/m.c
Melting point- 650 °c

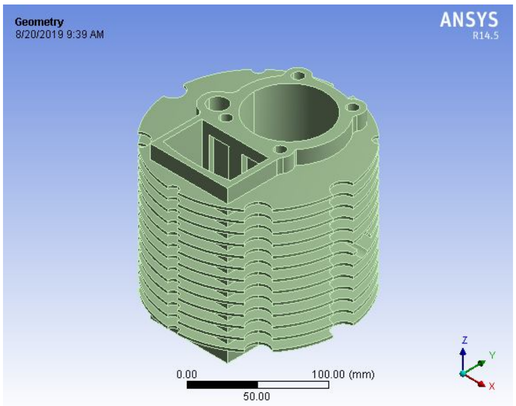
**AL HE15 (2014A)**
Aluminium Alloy 2014 HE15(2014 A) is a copper-based alloy with very high strength together with excellent machining characteristics. High strength alloys with excellent machinability widely used in aircraft. Have limited formability and only fair corrosion resistant in the heat-treated condition

**Properties**
Density - 2.8 g/cc
Thermal conductivity – 185 w/m.c
Melting point – 640°c

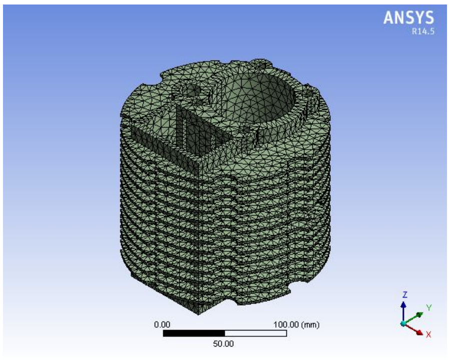
**Al 8011A-H111 (AlFeSi(A))**
8011a-H111 aluminium is 8011A aluminium in the H111 temper. To achieve this temper, the metal is strain hardened to a strength that is lower than what is permissible for H11 (1/8-hard).

**Properties**
Density – 2.65 g/cc
Thermal conductivity – 210 w/m.c
Melting point – 655°c

## Thermal analysis of circular modeled single cylinder engine using Al 6061
Imported file

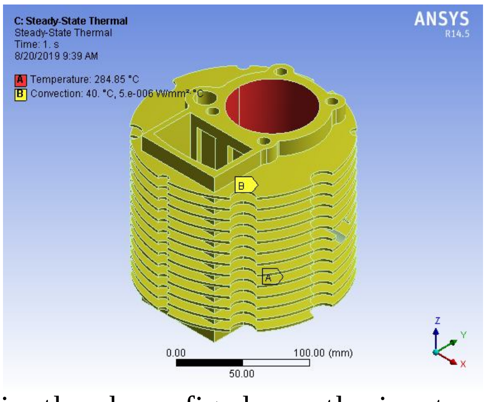



Here in the above fig we can see the imported file of geometry file in to ANSYS. As here we have imported igs format file in to ANSYS. The above fig is the circular modeled fins of a cylinder block
File – import external geometry file – select file from the location the computer – ok – generate.
Meshed file



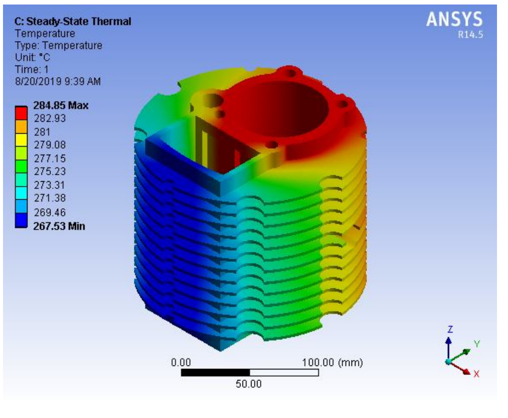

Here in the above fig we can observe the meshed file of the cylinder. Here there are different types of meshes in Ansys.
We have selected fine mesh with triangular mesh.
Select geometry – click on mesh – select sizing – change to fine mesh – select smoothing – click on high – click ok – generate mesh

Input boundaries



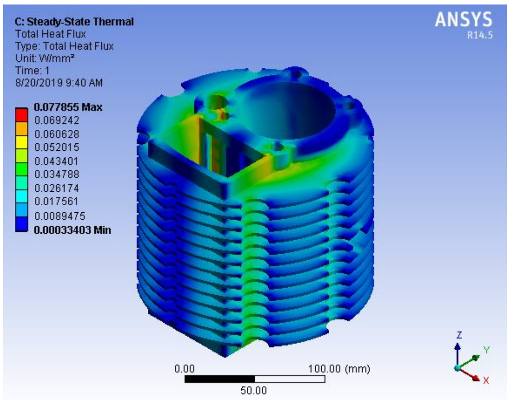

Here in the thermal analysis, the above fig shows the inputs even called as the boundary conditions for the project which we are going to do. Here the temperature is taken from the reference paper as 284.85°C. and the outside temperature is taken as 40°C.
Steady state thermal – select thermal conditions – temperature – ok select faces – apply temperature – select convection – apply the coefficients – click ok

Temperature



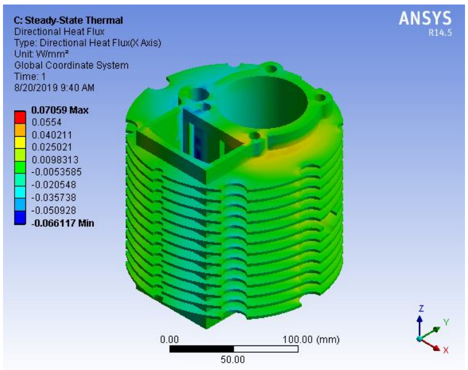
In the above figure we can find the temperature variations for the product from min to max. As here the estimation of temperature is shown in the result at the particular boundary conditions.

Total heat flux



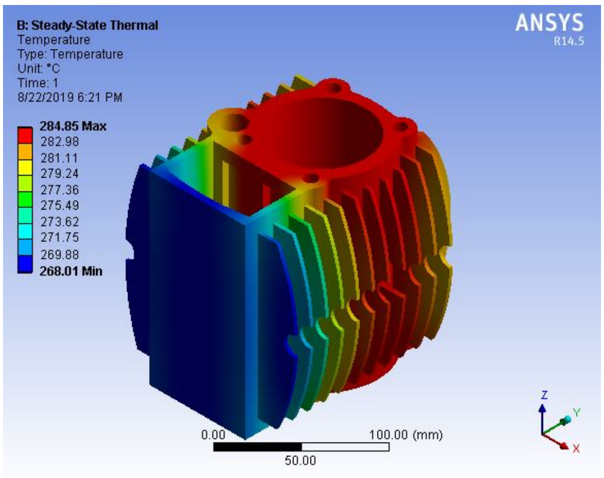

Total heat flux is known as the heat dissipated for the unit time for the unit surface area.
As here the above figure shows the flux distribution from min to max for the acquired temperature conditions. The units for the flux are given in $W/mm^2$.

Directional heat flux




## **Thermal analysis of curved modeled single cylinder engine using Al he 15**

Temperature



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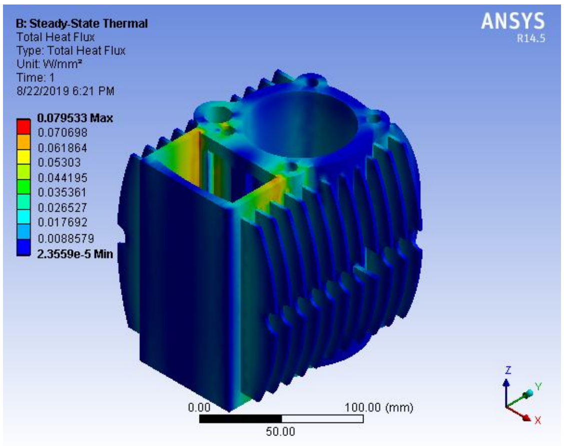
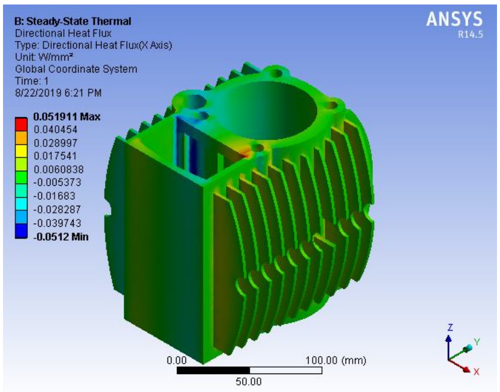
In the above figure we can find the temperature variations for the product from min to max. As here the estimation of temperature is shown in the result at the particular boundary conditions.

Total heat flux



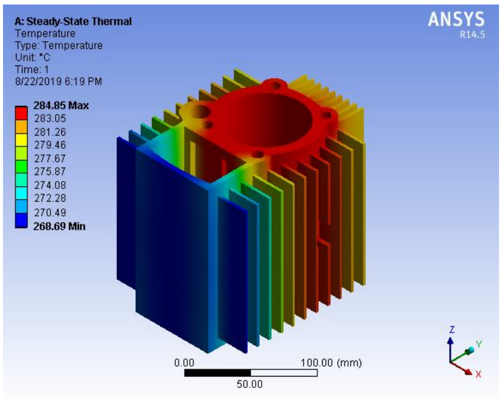

Total heat flux is known as the heat dissipated for the unit time for the unit surface area. As here the above figure shows the flux distribution from min to max for the acquired temperature conditions. The units for the flux are given in W/$mm^2$.

Directional heat flux



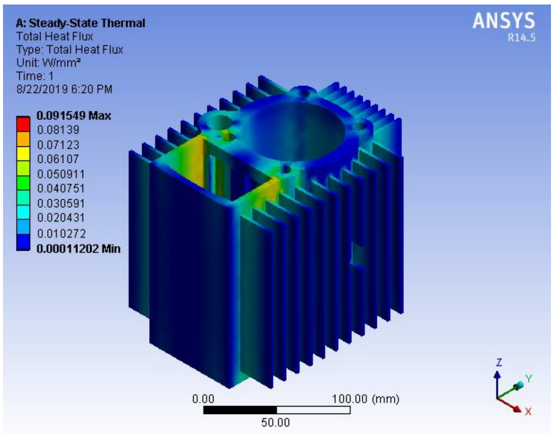

## Thermal analysis of spaced rectangular model single cylinder engine using Al 8011a-H111

Temperature



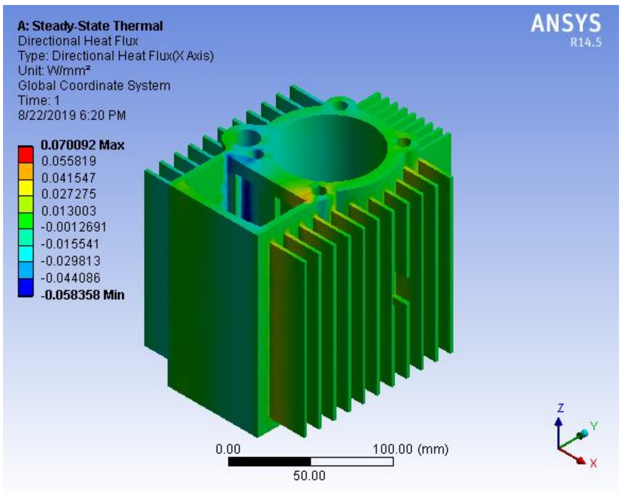

In the above figure we can find the temperature variations for the product from min to max. As here the estimation of temperature is shown in the result at the particular boundary conditions.

Total heat flux




Total heat flux is known as the heat dissipated for the unit time for the unit surface area. As here the above figure shows the flux distribution from min to max for the acquired temperature conditions. The units for the flux are given in $W/mm^2$.

Directional heat flux



## RESULTS

### Circular model

| MATERIAL | TEMPERATURE ($^{O}$C) | | TOTAL HEATFLUX (W/mm$^2$) | | DIRECTIONAL HEATFLUX (W/mm$^2$) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| AL 6061 | 267.53 | 284.85 | 0.00033403 | 0.077855 | -0.066117 | 0.07059 |
| AL he 15 | 267.98 | 284.85 | 0.00033401 | 0.077948 | -0.066197 | 0.070657 |
| AL8011a-H111 | 269.89 | 284.85 | 0.00033395 | 0.078349 | -0.066542 | 0.070945 |

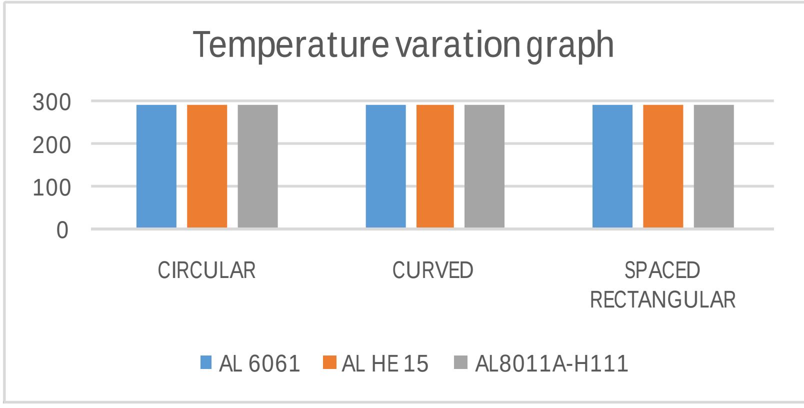
### Curved model

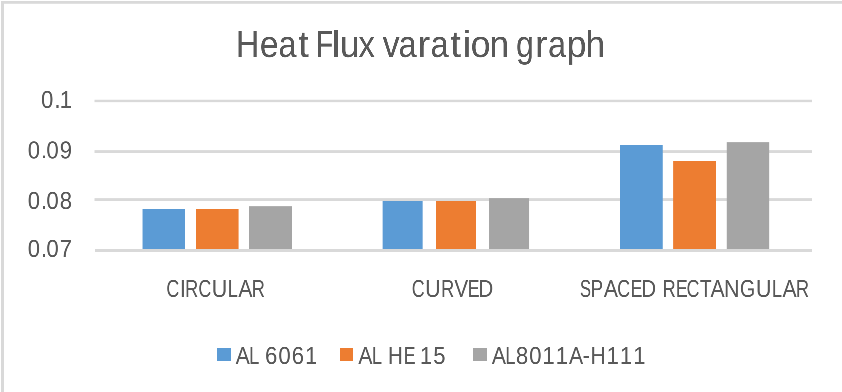
| MATERIAL | TEMPERATURE ($^{O}$C) | | TOTAL HEATFLUX (W/mm$^2$) | | DIRECTIONAL HEATFLUX(W/mm$^2$) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| AL 6061 | 267.57 | 284.85 | 2.3485e-5 | 0.079418 | -0.05114 | 0.051842 |
| AL he 15 | 268.01 | 284.85 | 2.3559e-5 | 0.079533 | -0.0512 | 0.051911 |
| AL8011a-H111 | 269.91 | 284.85 | 2.3879e-5 | 0.080026 | -0.051459 | 0.052211 |

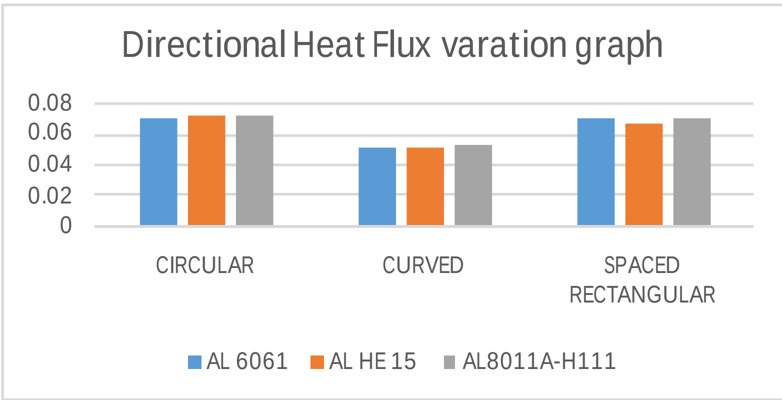
### Spaced Rectangular model

| MATERIAL | TEMPERATURE ($^{O}$C) | | TOTAL HEATFLUX (W/mm$^2$) | | DIRECTIONAL HEATFLUX (W/mm$^2$) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| AL 6061 | 266.17 | 284.85 | 0.00011355 | 0.09082 | -0.057963 | 0.069538 |
| AL he 15 | 255.44 | 284.85 | 0.00012025 | 0.087709 | -0.056277 | 0.067177 |
| AL 8011a-H111 | 268.69 | 284.85 | 0.00011202 | 0.091549 | -0.058358 | 0.070092 |

## GRAPHS




## CONCLUSIONS

In this thesis we have designed a single cylinder 4 stroke petrol engine with different fin profiles. Here we have designed an original model of circular fins and modified models of curved and spaced rectangular profiles. And even we have varied the materials of the geometry as Al 6061, AL he 15 and Al 8011a – H111. Using these materials we have analyzed at max optimum temperature levels.

As if we verify the results obtained in the above figures, all the results are tabulated in the tabular form and the comparison of the graphs are also done.

As per the output results obtained

- As if we verify the results obtained for the spaced rectangular fin profile model, here we can clearly observe that the Al 8011A-H111 meets the requirements when compared with others

As if we compare the all the three profiles we have obtained Al 8011A-H111 is the better material, but as if we compare in the fin profile, here the resulted graphs shows that the spaced rectangular fin has obtained the requirements and even if we consider the manufacturing process, this would be very easier and the time taken will be less when compared with other materials.

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