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# Modeling and Analysis of Fin

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***Abstract: An Internal Combustion engine heats up and over-heating can cause engine seizure. To prevent this, Fins are provided anywhere basically for increasing the rate of heat transfer to the cooling media.***

***The objective of this project is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Different models of with fins have been developed to predict the transient thermal behavior. The models are created by varying the geometry such as tapered, rectangular, and circular and curved shaped fins and also by varying thickness of the fins, previously it is 3mm by modifying this to the 2.5mm fins for better efficiency. The modeling and analysis is done by SOLID WORS and COSMOS software. Currently material used for manufacturing of cylinder fin body is Aluminum alloy 204. This has thermal conductivity of 110-150 W/mK. We analyzed the cylinder fins using this material and also using Aluminum alloy 6061 and 7071 which have higher thermal conductivity more than previously using material.***

***Keywords: Fin, Engine Cylinder, Geometry, Material, Thermal Analysis.***

## I. INTRODUCTION

The internal combustion engine is an engine in which 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 which is very high and may result of oil film between the moving parts (seizing or welding of same). So this temperature must be reduced to about 150-200°C to work engine most effectively. More cooling is also not desirable since it reduces the thermal efficiency. The purpose of cooling system is to keep the engine running at its most efficient operating temperature.

The consequent ill effects, to keep way the overheating and the heat transferred to an engine component must be removed as quickly as possible and be conveyed to the atmosphere.

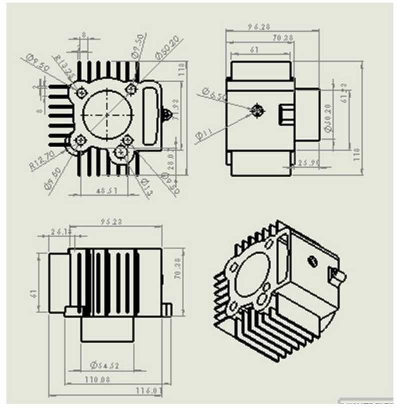
## II. DIMENSIONS AND PROPERTIES

*A.* Analysis type – Thermal
*B.* Material = Aluminum alloy ( Cu 4%, Si 9%, Mn 2% , Mg 0.009% )
*C.* Thermal Conductivity = 190 watt/m°C
*D.* Density = 2770 Kg/$m^3$
*E.* Specific heat = 900 J/Kg K
*F.* Length of fin = 130 mm
*G.* Width of fin = 130 mm
*H.* Thickness =2.5 mm

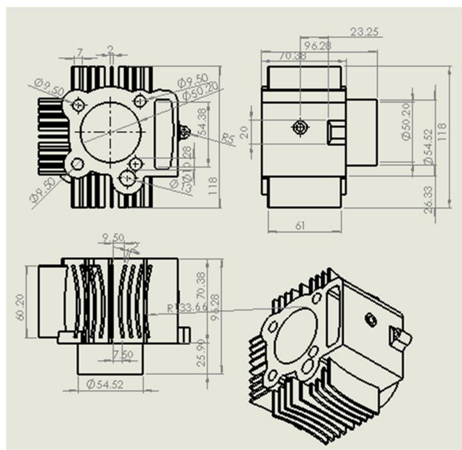
*1) Properties Of The Materials*

| Property | Al 2024 | Al 6061 | GCI |
|---|---|---|---|
| Density ( g/cc ) | 2.78 | 2.7 | 7.2 |
| Thermal conductivity ( W/m-K ) | 140 | 210 | 45 |
| Specific Heat ( j/Kg$^0$K ) | 800 | 0.896 | 510 |

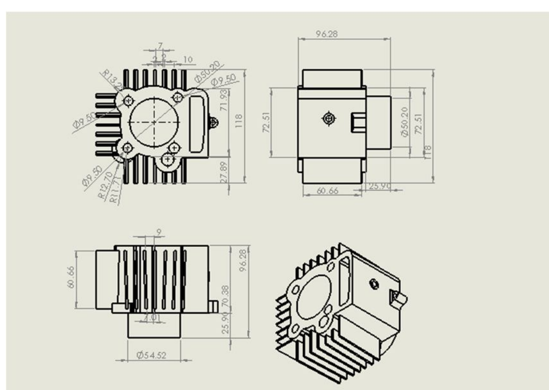
## III. MODELS – CYLINDER FINS



a. Cylinder with Rectangular Fin



b. Cylinder with Circular Fin



c. Cylinder with Taper Fin

## IV. Analysis

### *A. Original Models*

*1) Aluminum Alloy 2024*

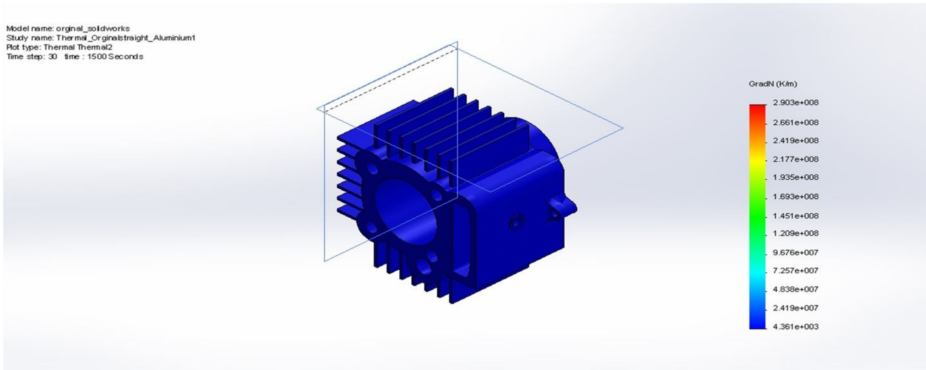
*a)* Thermal conductivity : 140 W/m-K

*b)* Specific Heat : 800 J/Kg-K

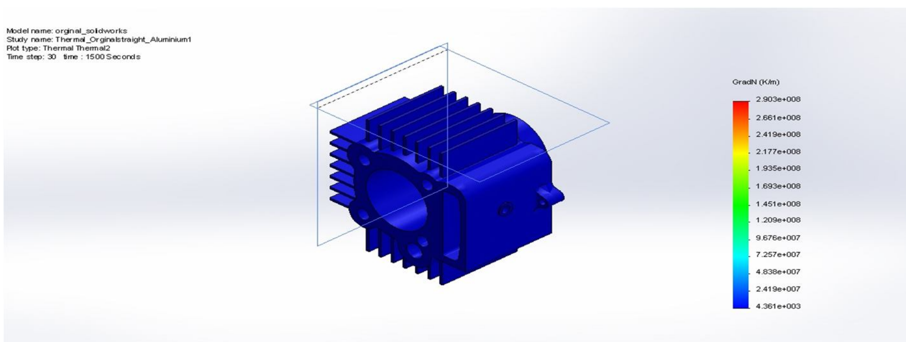
*c)* Density : 2.78 g/cc

Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant Temp Gradient at step no : 30 (1500 seconds ) | 4361.02 K/m<br>Node :333 | 2.90265e008K/m<br>Node : 11070 |



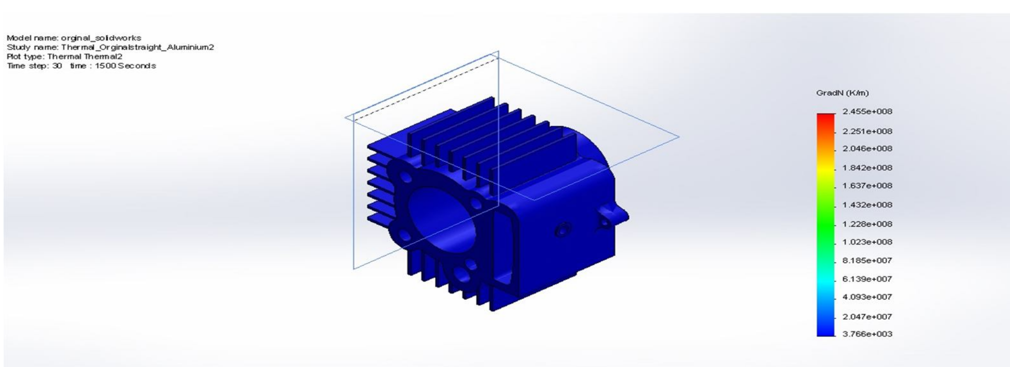

| | | |
|---|---|---|
| HFLUXN : Resultant Heat Flux at Step No : 30 ( 1500 seconds ) | 610543 W/m^2<br>Node : 333 | 40637100W/m^2<br>Node : 11070 |



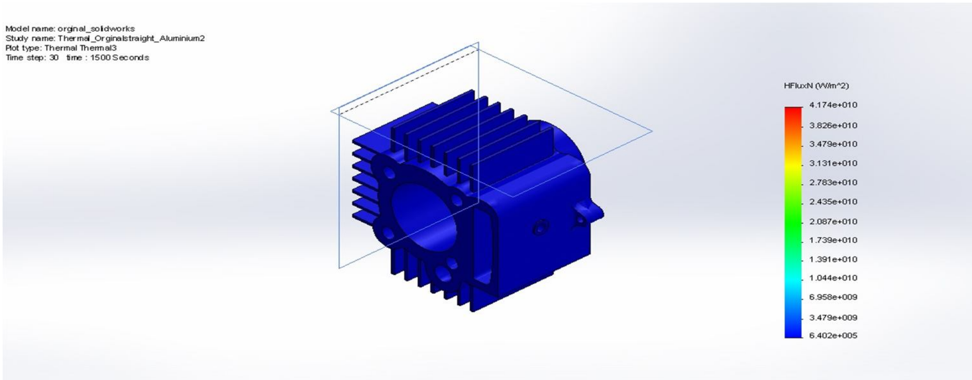

2) *Aluminum Alloy 6061*
a) Thermal conductivity : 170 W/m-K
b) Specific heat : 1300 J/Kg-K
c) Density : 2.7 g/cc

Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant Temp Gradient at step no : 30 ( 1500 seconds ) | 3765.66 K/M<br>Node : 333 | 2.45545e+008 K/m<br>Node : 11070 |



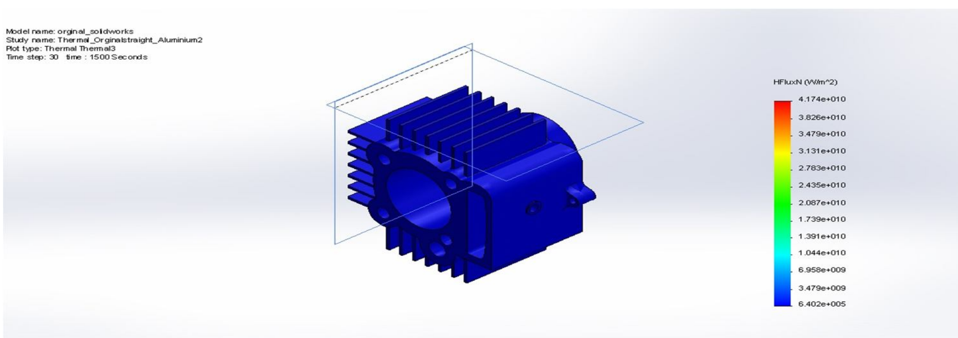
| | | |
|---|---|---|
| HFLUXN : Resultant Heat Flux at step no 30 ( 1500 seconds ) | 640162 W/ m^2<br>Node : 333 | 41742600 W/m^2<br>Node : 11070 |




3) *Grey Cast Iron*
a) Thermal conductivity : 45 W/m-k
b) Specific heat : 510 J/ Kg-K
c) Density : 7.2 g/cc

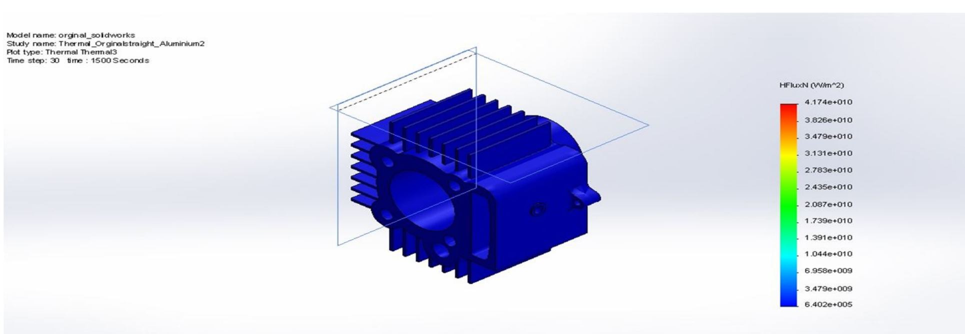
Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant Temp Gradient at step no :30 ( 1500 seconds ) | 12783.4 K/m<br>Node : 1321 | 6.73663e+008K/m<br>Nod : 11070 |




Thermal flux

| | | |
|---|---|---|
| HELUXN : Resultant Heat Flux at step no : 30 (1500 seconds ) | 575252 W/m ^2<br>Node : 1321 | 30314800 W/m^2<br>Node :11070 |



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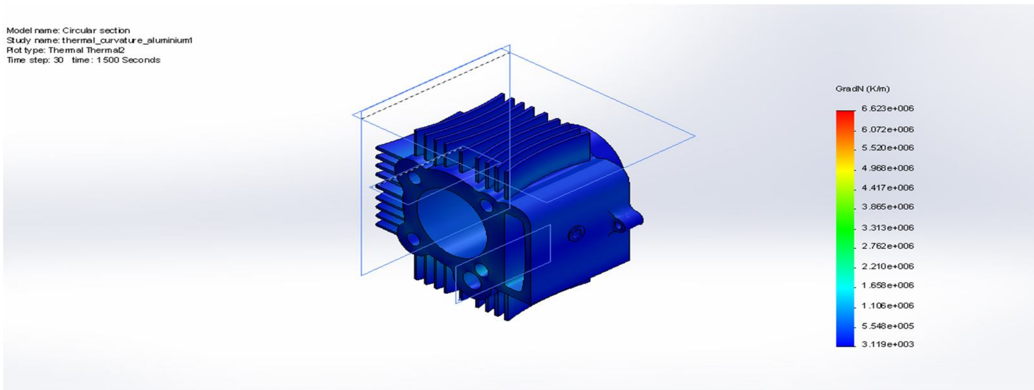
*B. Curvature Model*

*1) Aluminum Alloy 2024*

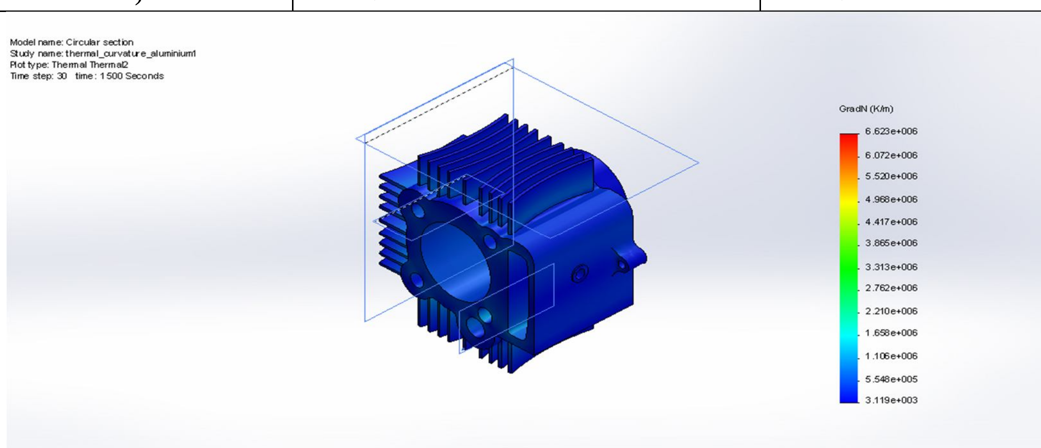
Temperature gradient

| | | |
|---|---|---|
| GRADN: Resultant Temp Gradient at Step No: 30(1500 Seconds) | 3118.64 K/m<br>Node : 14071 | 6.62334e+006 K/m<br>Node : 17124 |

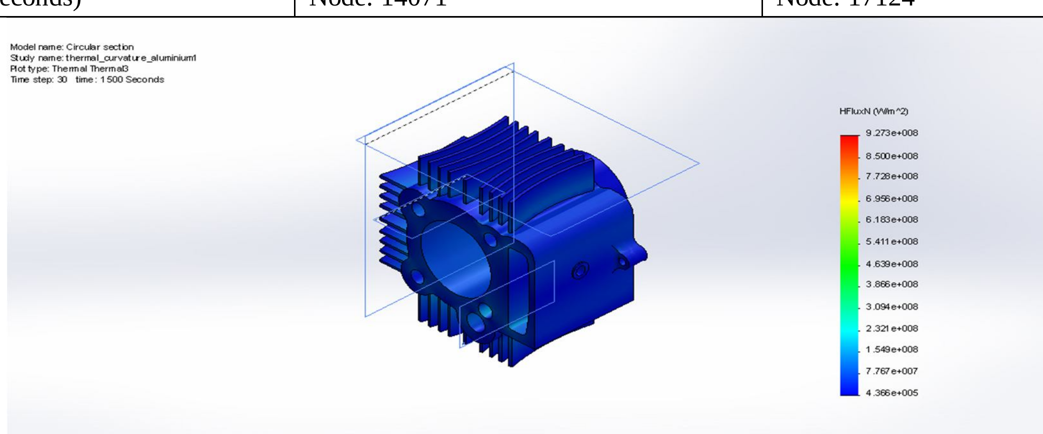



Thermal flux

| | | |
|---|---|---|
| HELUXN : Resultant heat flux at Step no : 30 (1500 seconds ) | 436609 w/M^2<br>Node : 14071 | 92726700 W/ m^2<br>Node : 17124 |




| | | |
|---|---|---|
| HFLUXN: Resultant Heat Flux at Step No: 30(1500 Seconds) | 436609 W/m^2<br>Node: 14071 | 92726700 W/m^2<br>Node: 17124 |



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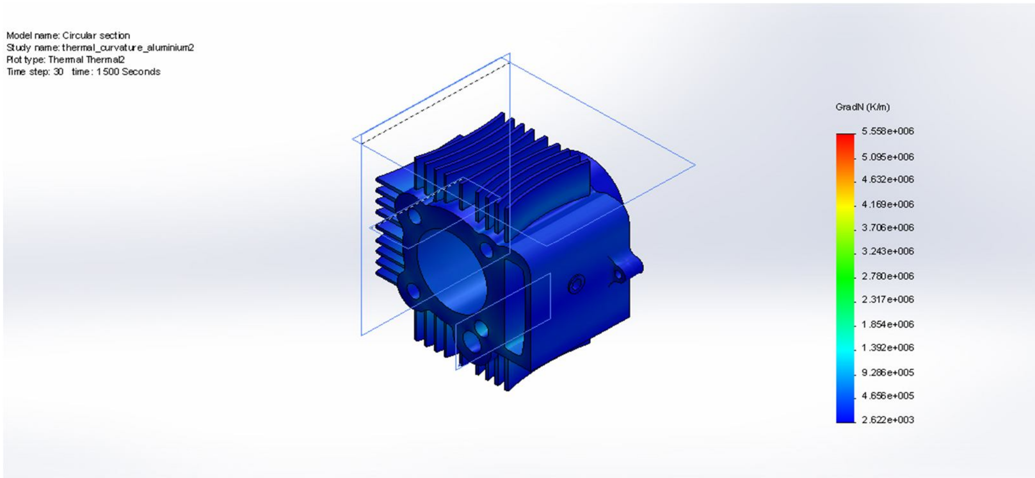
*2) Aluminium 6061*

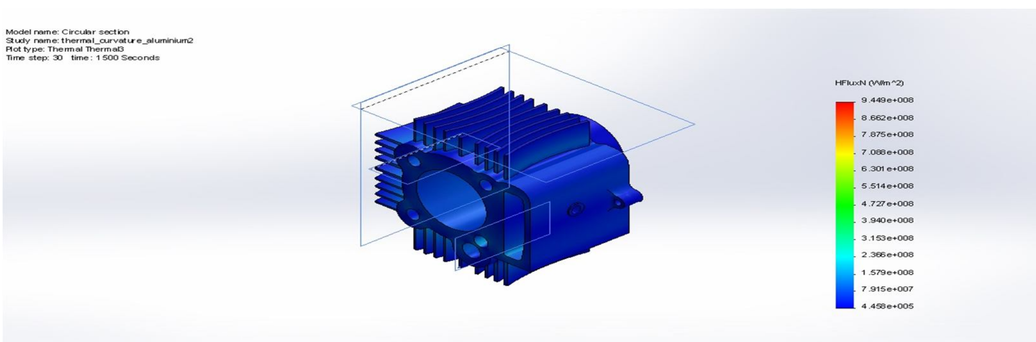
Temperature gradient

| | | |
|---|---|---|
| GRADN: Resultant Temp Gradient at Step No: 30(1500 Seconds) | 2622.45 K/m<br>Node: 14071 | 5.55825e+006 K/m<br>Node: 17124 |




Thermal flux

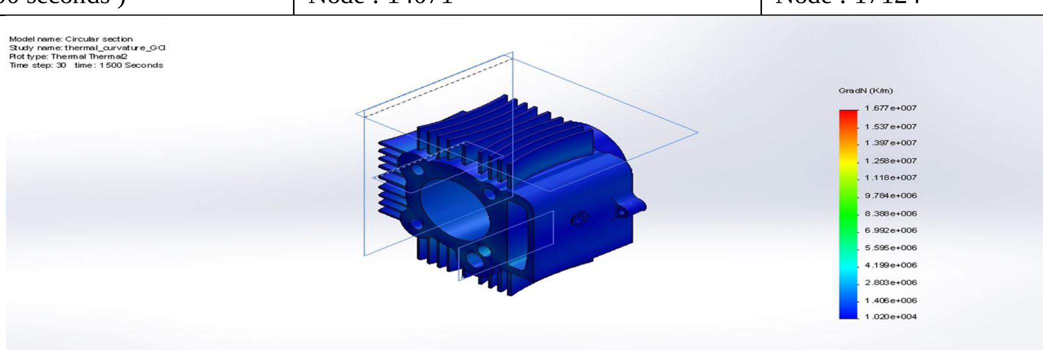
| | | |
|---|---|---|
| HELUXN : Resultant heat flux at step no : 30 (1500second ) | 445817 W/m^2<br>Node : 14071 | 94490300 W/ m^2<br>Node : 17124 |




*3) Grey Cast Iron*

Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant temp Gradient at step no 30 (1500 seconds ) | 10195.5 K/m<br>Node : 14071 | 1.67656e+007 K/m<br>Node : 17124 |



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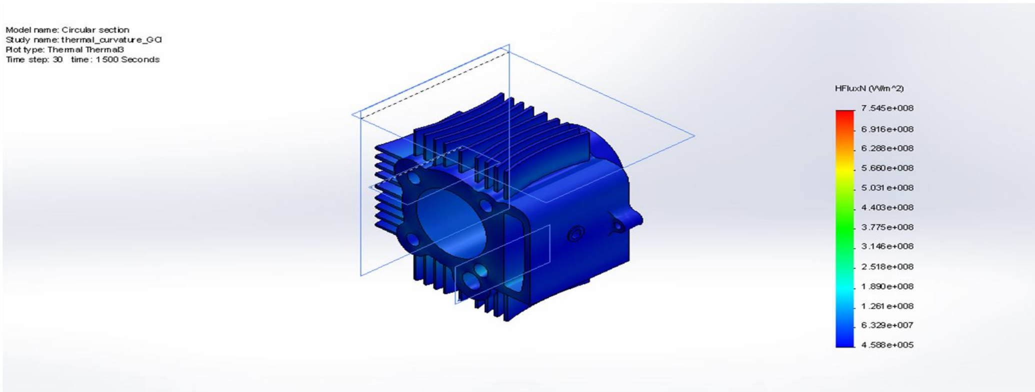
Thermal Flux

| | | |
|---|---|---|
| HFLXUN : Resultant heat flux at step no : 30 ( 1500 seconds ) | 458796 W/m^2<br>Node : 14071 | 75445200 W/ m^2<br>Node : 17124 |

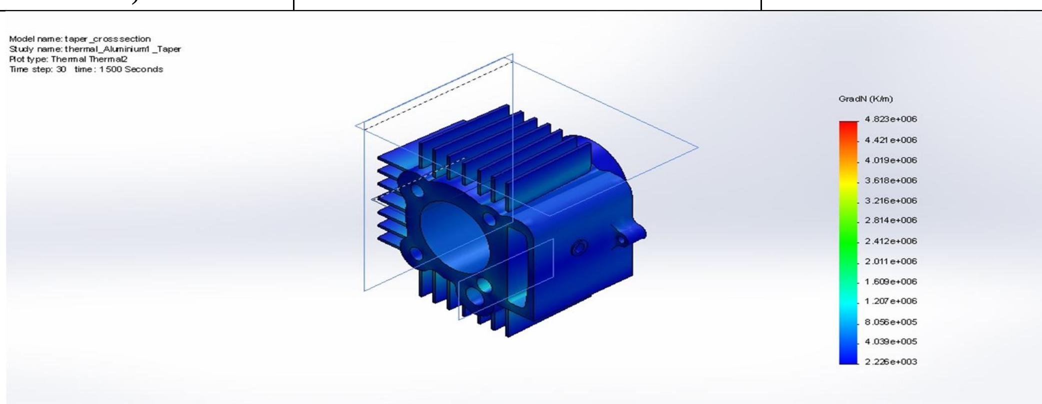



*C. Taper Model*

*1) Aluminium Alloy 2024*

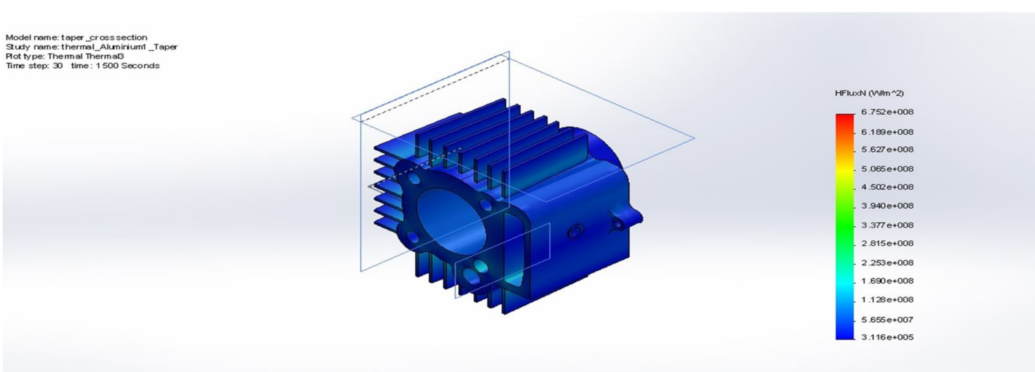
Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant Temp Gradient at step no : 30 (1500 seconds ) | 2225.8 K/m<br>Node : 21067 | 4.82265e+006 K/m<br>Node : 23241 |




Thermal flux

| | | |
|---|---|---|
| HFLUXN : Resultant heat flux gradient at step no : 30 (1500 seconds) | 311613 W/ m^2<br>Node : 21067 | 67517000 W/ m^2<br>Node : 23241 |



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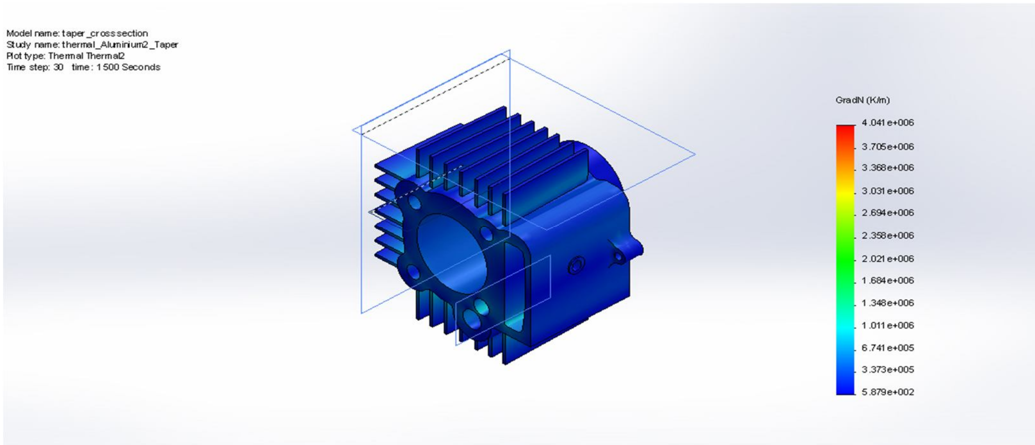
*2) Aluminium 6061*

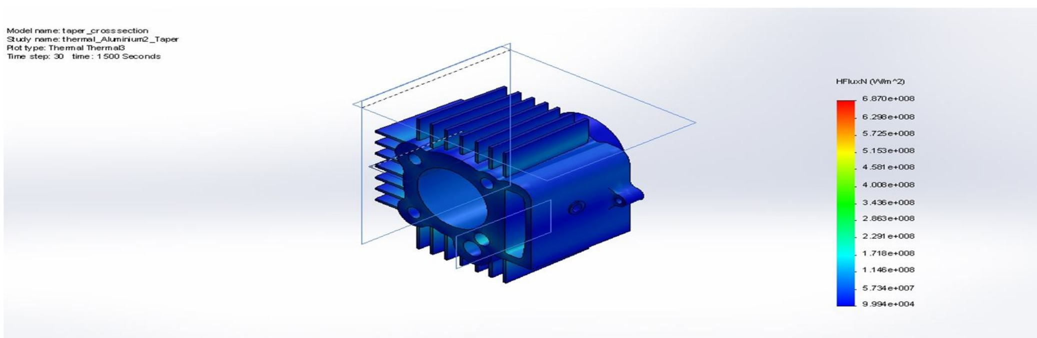
Temperature gradient

| | | |
|---|---|---|
| GRADN : Resultant temp gradient at step no : 30 (1500 seconds ) | 587.584 K/ m<br>Node : 21067 | 4.04136e+006 K/m<br>Node : 23241 |




Thermal flux

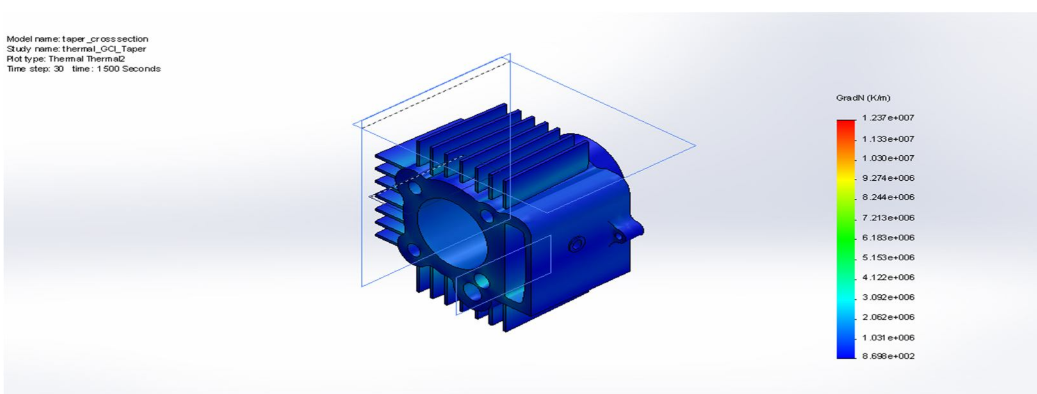
| | | |
|---|---|---|
| HFLUXN: Resultant Heat Flux at Step No: 30(1500 Seconds) | 99935.2 W/m^2<br>Node: 21067 | 68703200 W/m^2<br>Node: 23241 |




*3) Grey Cast Iron*

Temperature gradient

| | | |
|---|---|---|
| GRADN: Resultant Temp Gradient at Step No: 30(1500 Seconds) | 869.761 K/m<br>Node: 21067 | 1.2365e+007 K/m<br>Node: 23241 |



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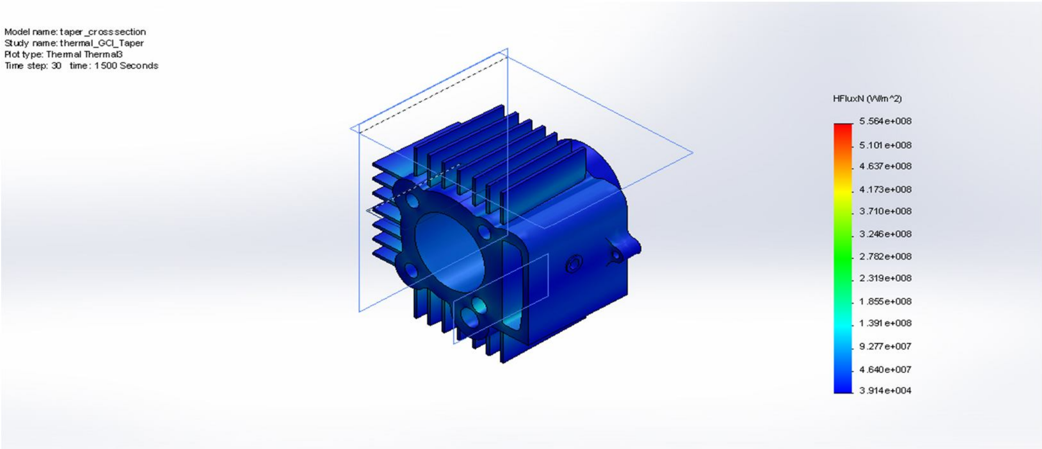
Thermal flux

| | | |
|---|---|---|
| HFLUXN: Resultant Heat Flux at Step No: 30(1500 Seconds) | 39139.2 W/m^2 Node: 21067 | 55642700 W/m^2 Node: 23241 |




## V. RESULTS

### A. Original Model

| Material | Temperature gradient (K/M) | Thermal flux(W/mm$^2$) |
|---|---|---|
| Aluminium 2024 | 2.90265e$^{+8}$ | 40.6371 |
| Aluminium 6061 | 2.45545 e$^{+8}$ | 41.7426 |
| Grey Cast Iron | 6.73663 e$^{+8}$ | 30.3148 |

### B. Taper Model

| Material | Temperature gradient (K/M) | Thermal flux(W/mm$^2$) |
|---|---|---|
| Aluminium 2024 | 4.82265 e$^{+6}$ | 67.51 |
| Aluminium 6061 | 4.04136 e$^{+6}$ | 68.70 |
| Grey Cast Iron | 1.2365 e$^{+7}$ | 55.64 |

### C. Curvature Model

| Material | Temperature gradient (K/M) | Thermal flux(W/mm$^2$) |
|---|---|---|
| Aluminium 2024 | 6.62334 e$^{+6}$ | 92.7 |
| Aluminium 6061 | 5.55825 e$^{+6}$ | 94.4 |
| Grey Cast Iron | 1.67656 e$^{+7}$ | 75.4 |

## VI. CONCLUSION

In this project we have calculated the thermal flux for the curvature mode by varying material Aluminium Alloy 2024, Aluminium 6061, and grey cast iron by mathematical approach. Thus we prepare 3D models by solid works software. Present using material for manufacturing is Aluminum 2024 alloy we modify that material to Aluminum alloy 6061 and grey cast iron. By the results we conclude that Aluminum alloy 6061 is more efficient for convecting heat from the surface of the body. Finally we have concluded that present material aluminum alloy 2024 is replacing with aluminum 6061 is good for further purpose.

## VII. FUTURE SCOPE

In this thesis , we conclude that using circular fins is better, but circular fin are mostly used in vertical engines than horizontal engines and also by using the weight of the fin body is also increases. By using curved fins, the fin body weight is less, so more experiments are to use curved fins for the fin body in future.

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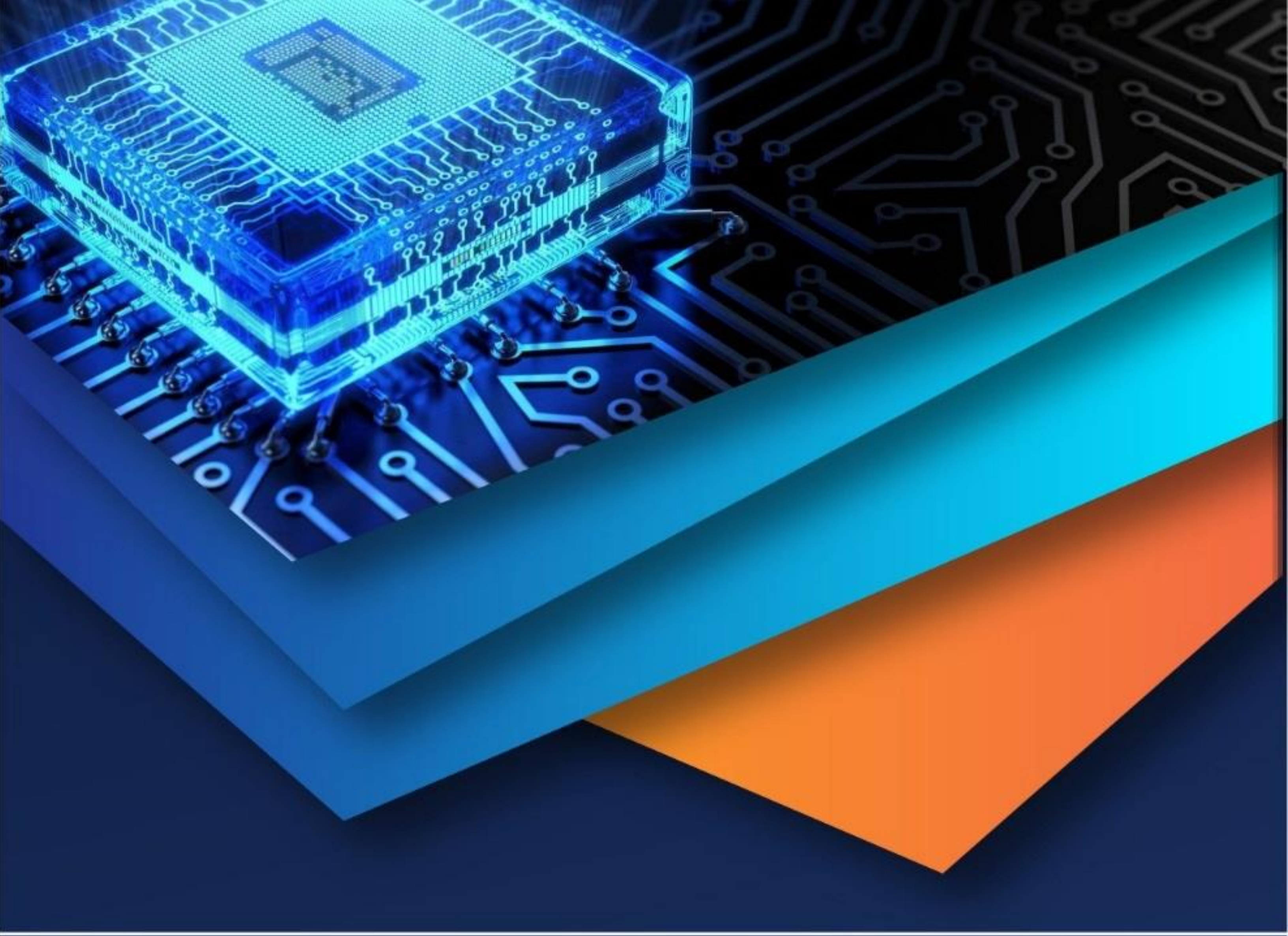


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