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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

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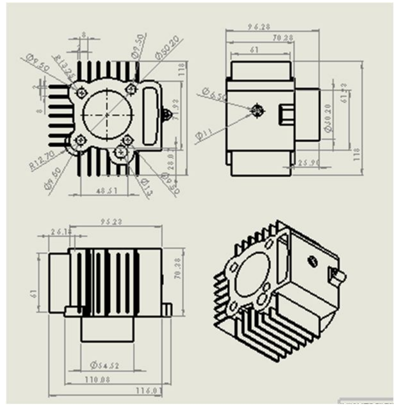
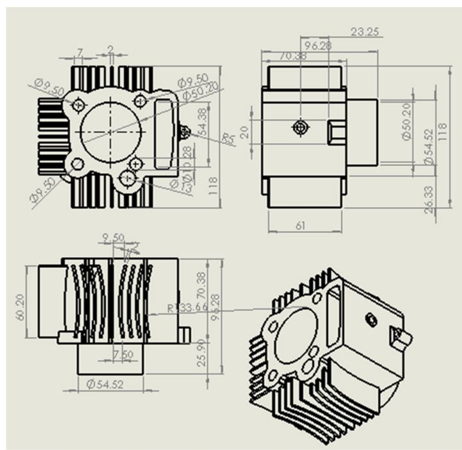
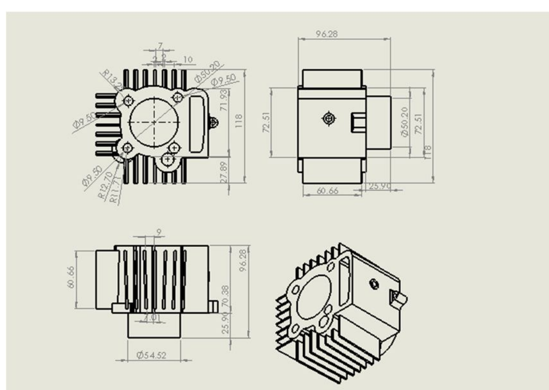
III. MODELS – CYLINDER FINS



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

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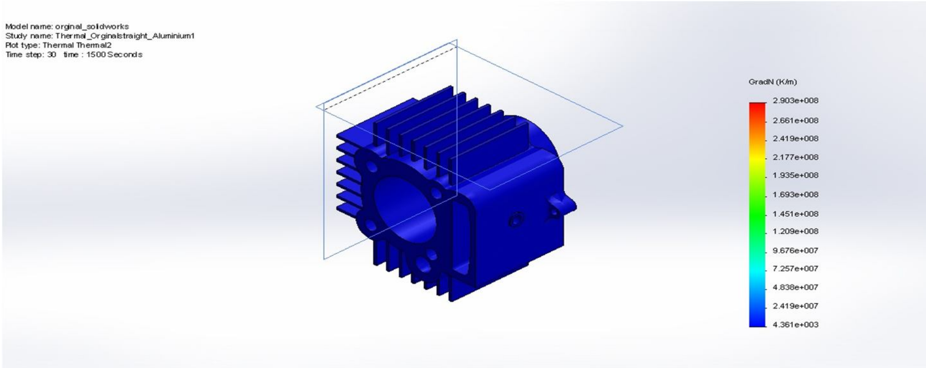
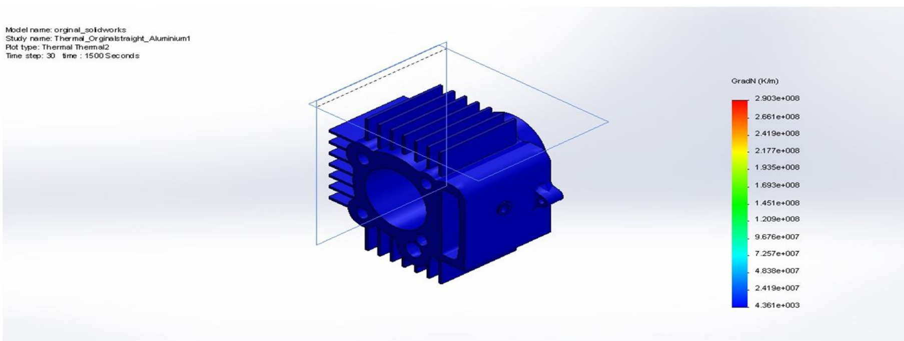
Temperature gradient

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



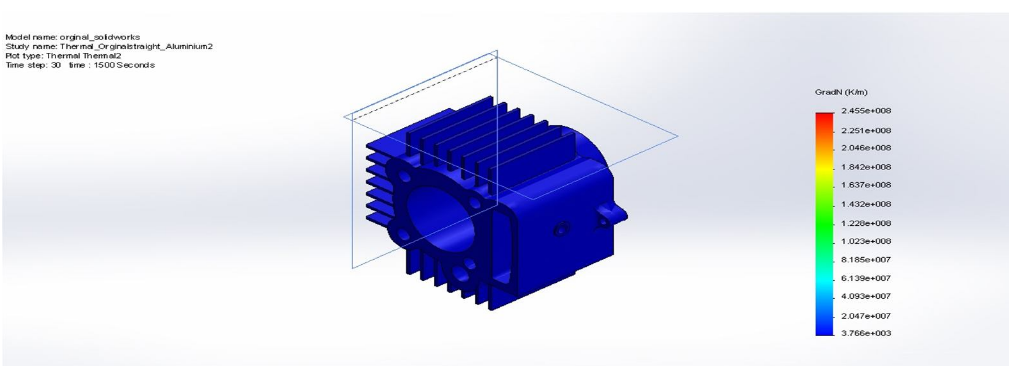
HFLUXN : Resultant Heat Flux at Step No : 30 (1500 seconds)	610543 W/m^2 Node : 333	40637100W/m^2 Node : 11070



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 Node : 333	2.45545e+008 K/m Node : 11070



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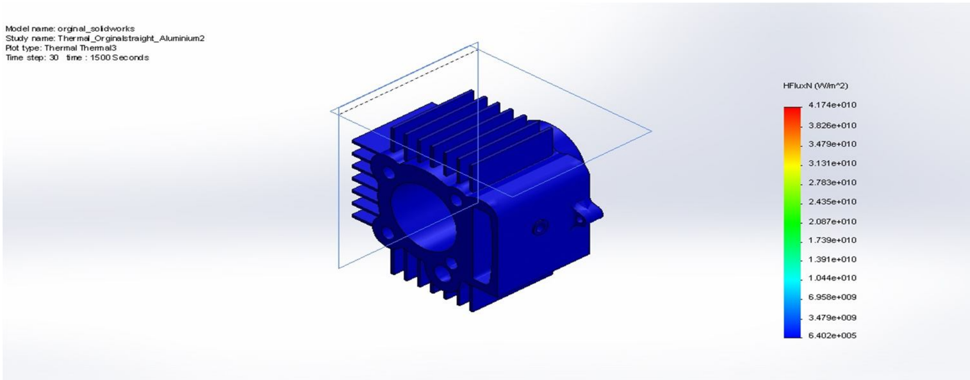
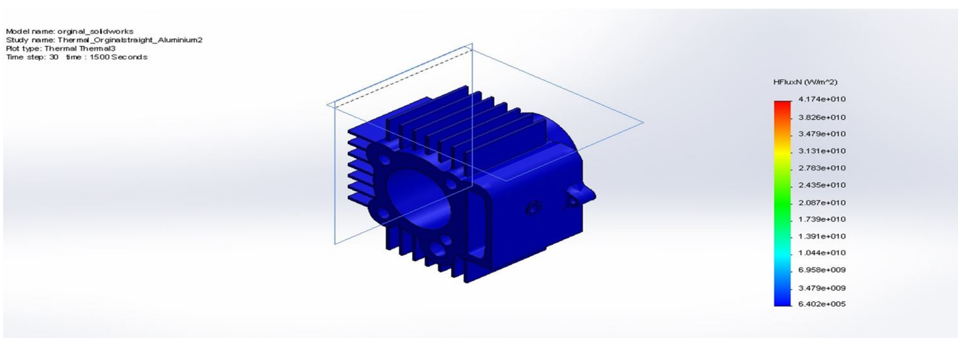
HFLUXN : Resultant Heat Flux at step no 30 (1500 seconds)	640162 W/ m^2 Node : 333	41742600 W/m^2 Node : 11070



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

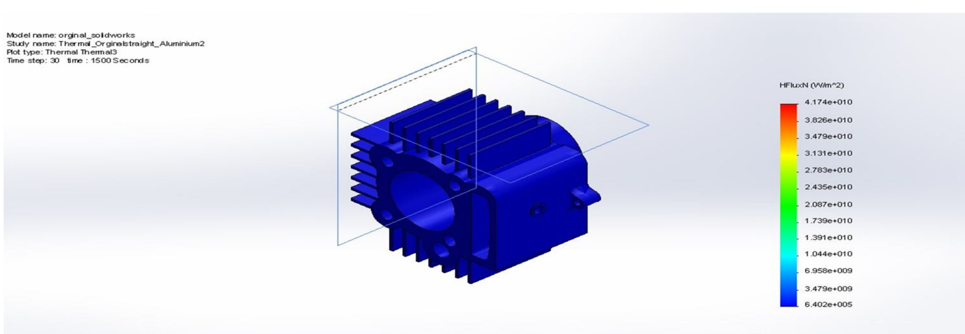
Temperature gradient

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



Thermal flux

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

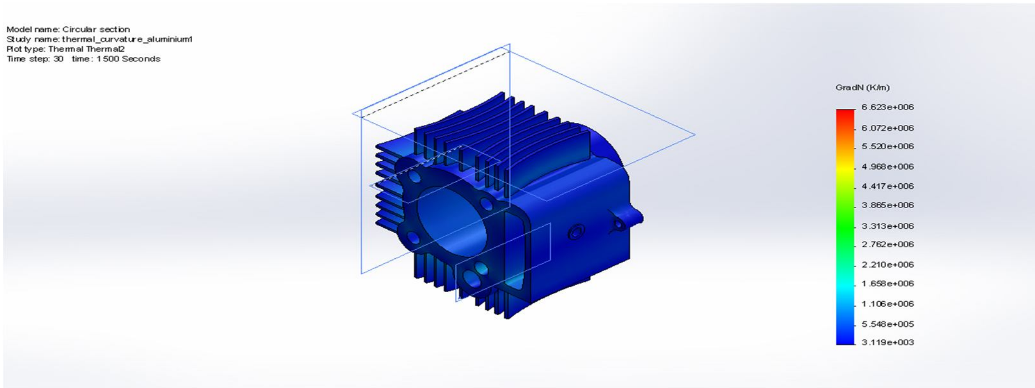


B. Curvature Model

1) Aluminum Alloy 2024

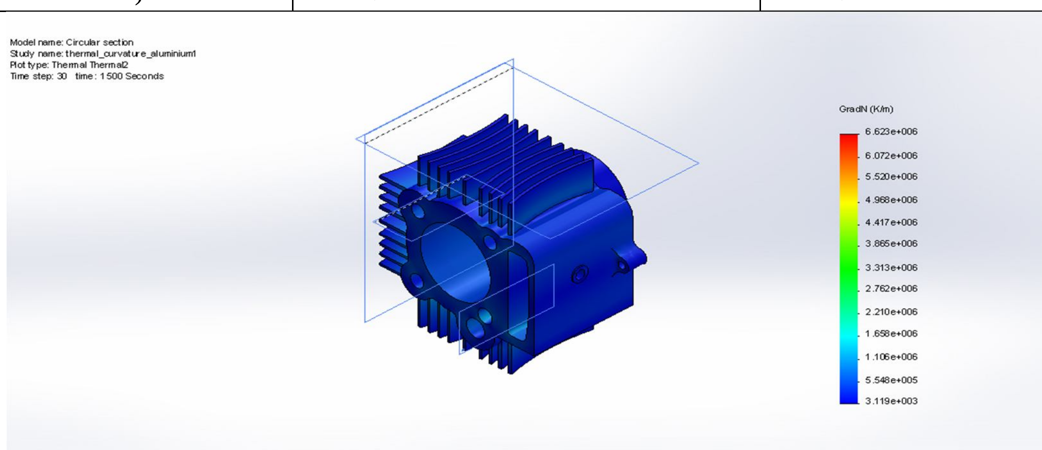
Temperature gradient

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

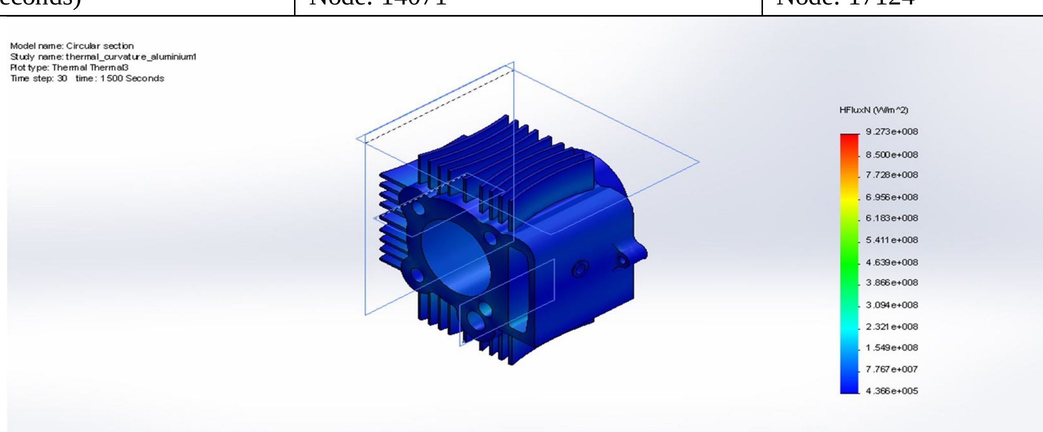


Thermal flux

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



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



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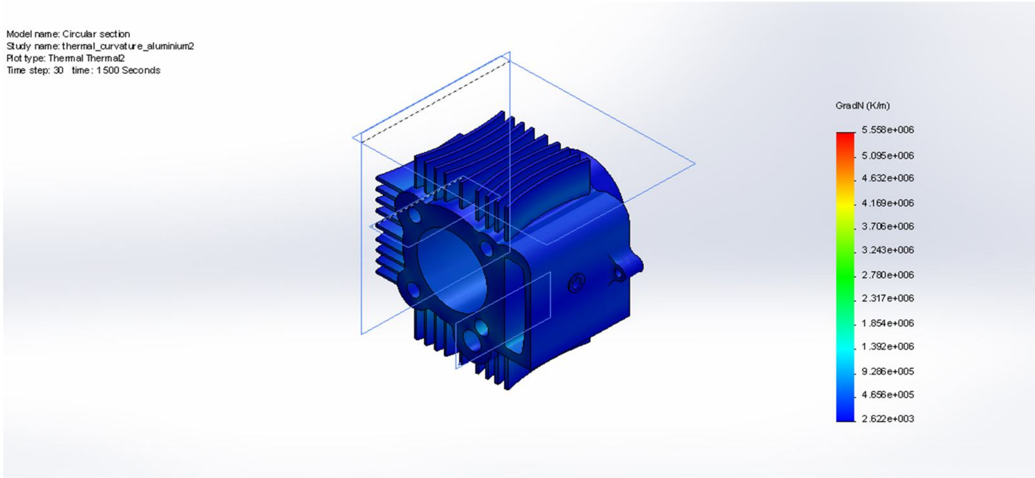
2) Aluminium 6061

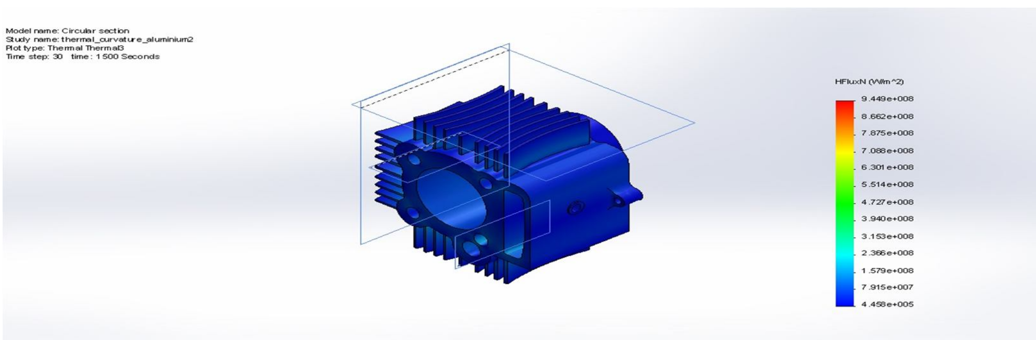
Temperature gradient

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



Thermal flux

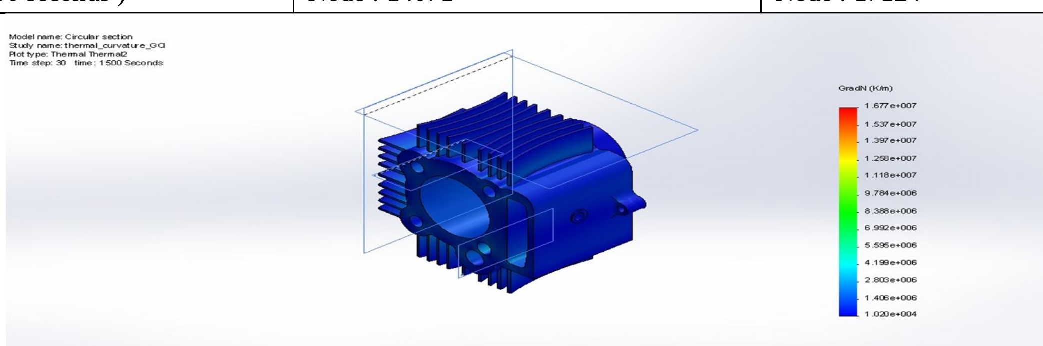
HELUXN : Resultant heat flux at step no : 30 (1500second)	445817 W/m^2 Node : 14071	94490300 W/ m^2 Node : 17124



3) Grey Cast Iron

Temperature gradient

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



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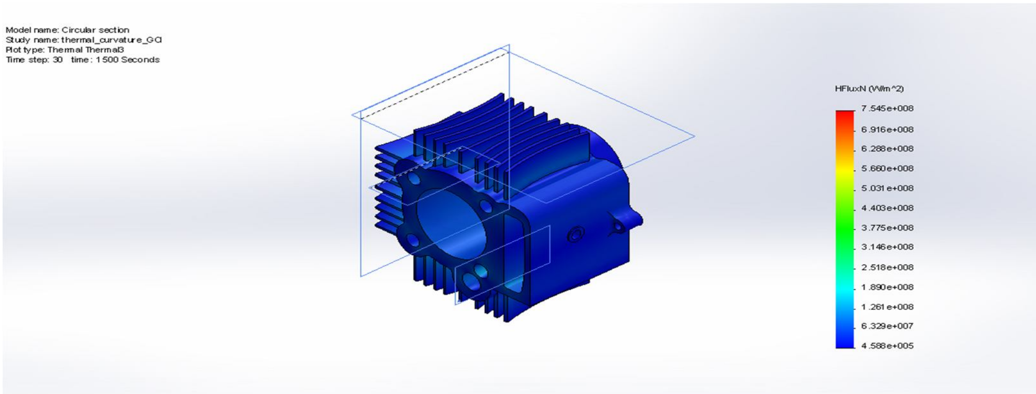
Thermal Flux

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

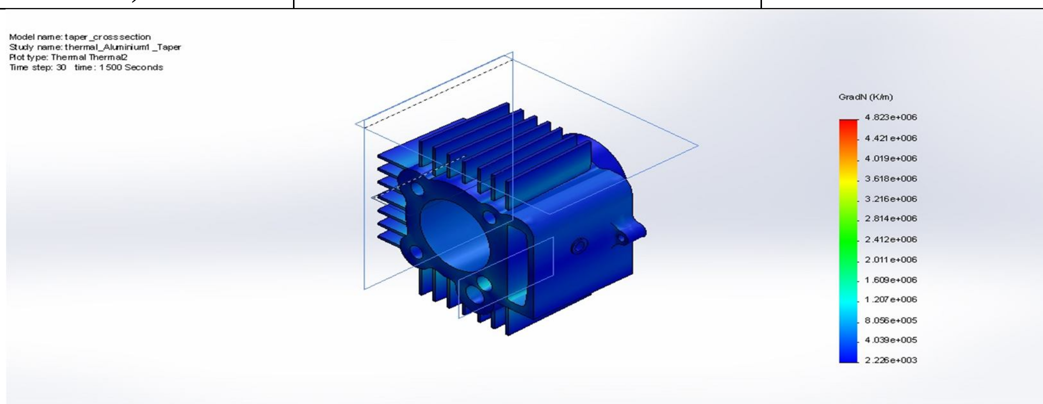


C. Taper Model

1) Aluminium Alloy 2024

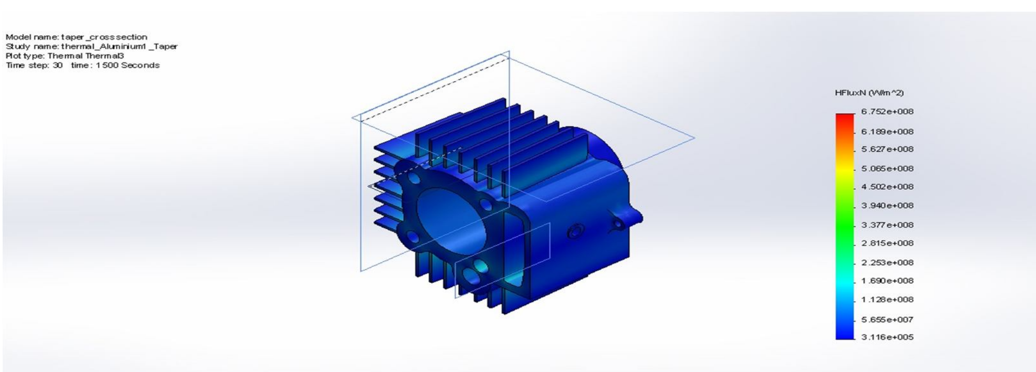
Temperature gradient

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



Thermal flux

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



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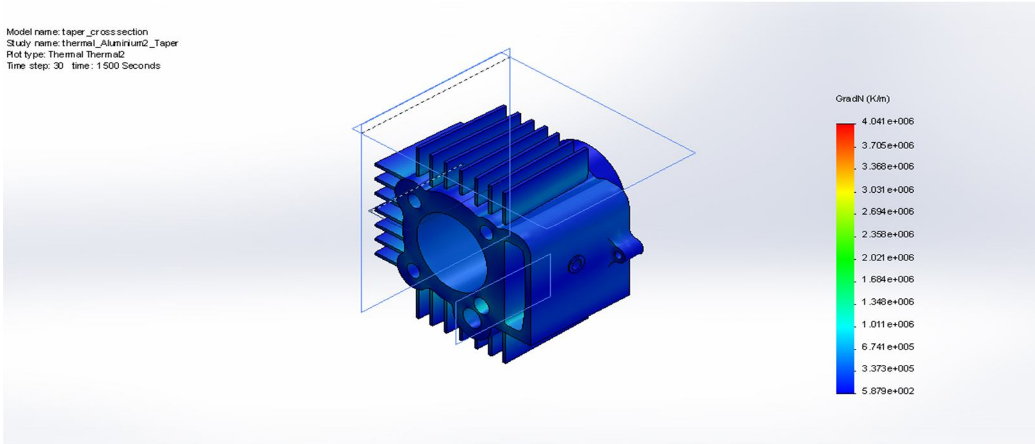
2) Aluminium 6061

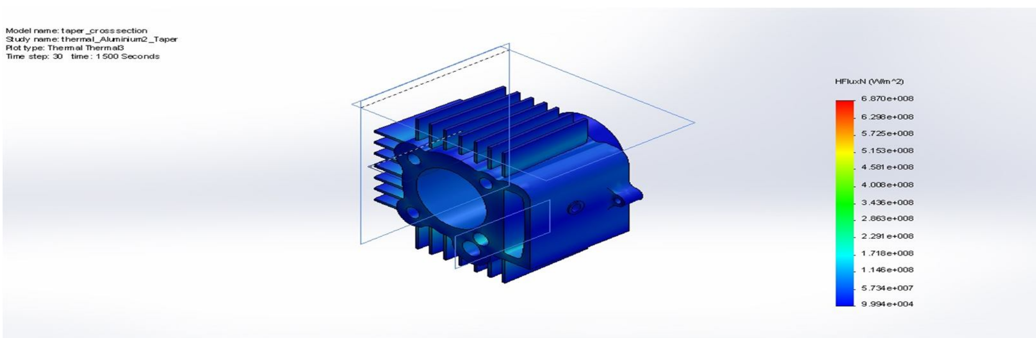
Temperature gradient

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



Thermal flux

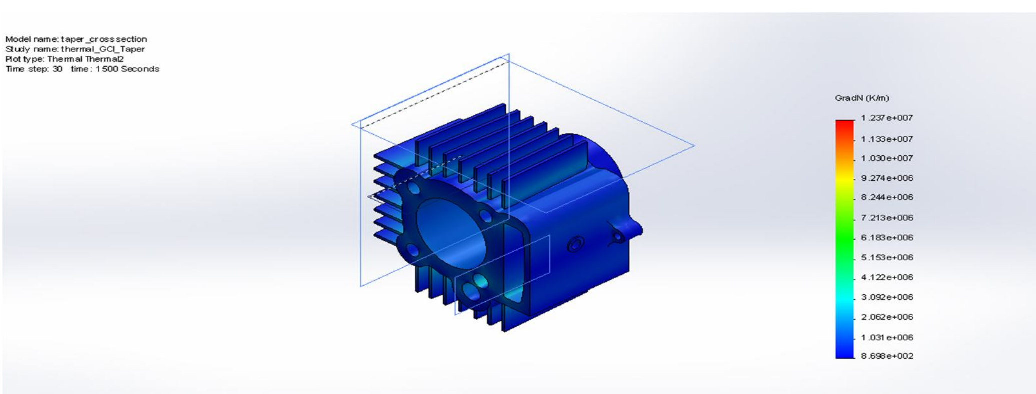
HFLUXN: Resultant Heat Flux at Step No: 30(1500 Seconds)	99935.2 W/m^2 Node: 21067	68703200 W/m^2 Node: 23241



3) Grey Cast Iron

Temperature gradient

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



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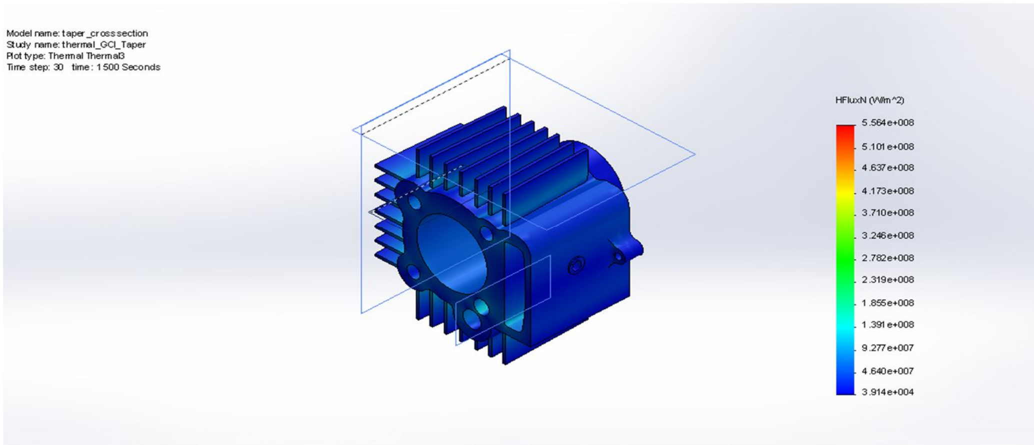
Thermal flux

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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