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Effect of Thermal Loads on Cylinder Heads

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ABSTRACT:

A cylinder head is made of box type of section of considerable depth to accommodate ports of air and gas passages, inlet valve, exhaust valve and spark plug. The studs or bolts are screwed up tightly along with a metal gasket or asbestos packing to provide a leak proof joint between the cylinder and cylinder head. The cylinder head is subjected to temperatures due to combustion in cylinder and pressure on surface.

Optimal Design means the best of all feasible designs proposed in phase one, i.e., the conceptual design. Optimization is the processes of maximizing a desired quantity or minimizing an undesired one. Optimization theory is the body of mathematics that deals with the properties of maxima and minima, and how to find maxima and minima numerically.

1. ***These optimization are done by the following methods,***
   Optimization by Evaluation
2. ***Optimization by Trial-and-Error Modeling***
3. ***Optimization by Numerical Algorithm***
4. ***Optimization by Parameters***
5. ***Optimization by Material***

In this project, Optimization method is taken as Optimization by Parameters. In this project parameter Thickness is varied for different materials aluminum alloys LM6, LM24, LM25. By varying above parameters maximum optimal convection rate is determined. Thermal analysis is done. 3D modeling is done in Pro/Engineer and analysis is done in Ansys.

I. INTRODUCTION

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and high -pressure gases produced by combustion apply direct force to some component of the engine. This force is applied typically to pistons, turbine blades, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy. The first internal combustion engine was created by Étienne Lenoir.

The term internal combustion engine usually refers to an engine in which combustion is intermittent, such as the more familiar four-stroke and two-stroke piston engines, along with variants, such as the six-stroke piston engine and the Wankel rotary engine. A second class of internal combustion engines use continuous combustion: gas turbines, jet engines and most rocket engines, each of which are internal combustion engines on the same principle as previously described.

INTRODUCTION TO CYLINDER:

A cylinder is the central working part of a reciprocating engine or pump, the space in which a piston travels. Multiple cylinders are commonly arranged side by side in a bank, or engine block, which is typically cast from aluminum or cast iron before receiving precision machine work. Cylinders may be sleeved (lined with a harder metal) or sleeveless (with a wear-resistant coating such as Nikasil).

A cylinder's displacement, or swept volume, can be calculated by multiplying its cross-sectional area (the

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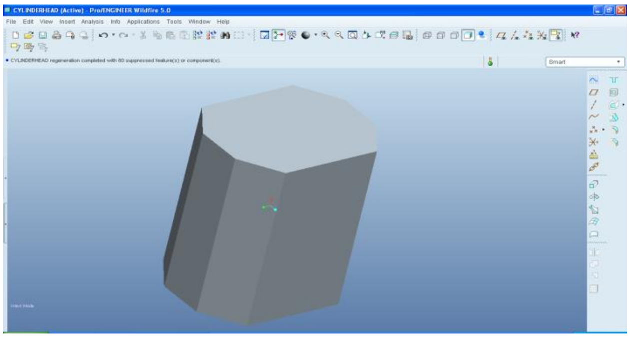
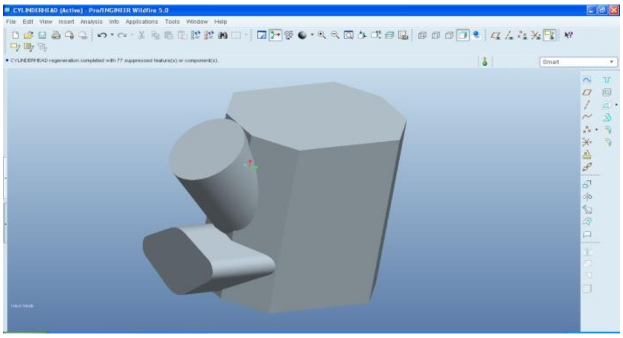
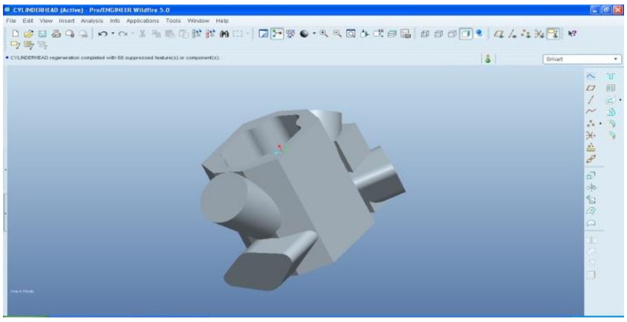
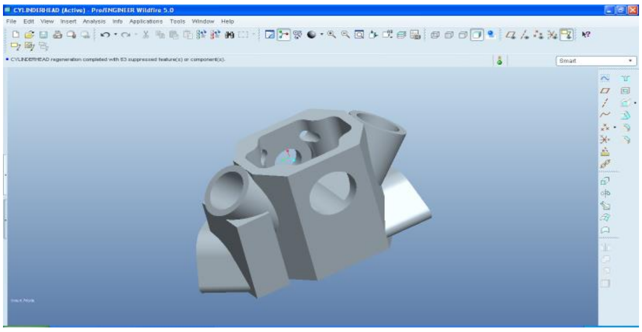
square of half the bore by pi) and again by the distance the piston travels within the cylinder (the stroke). The engine displacement can be calculated by multiplying the swept volume of one cylinder by the number of cylinders.

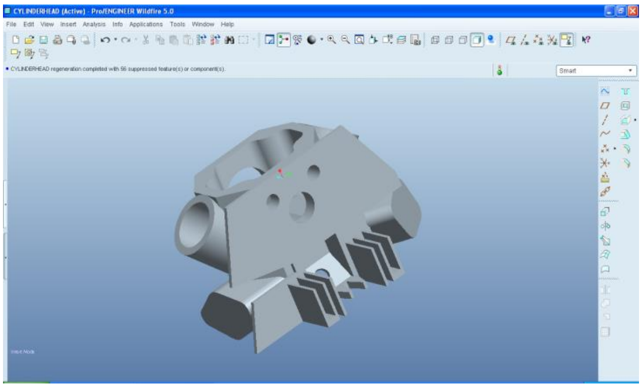
3D MODELS OF CYLINDER HEAD

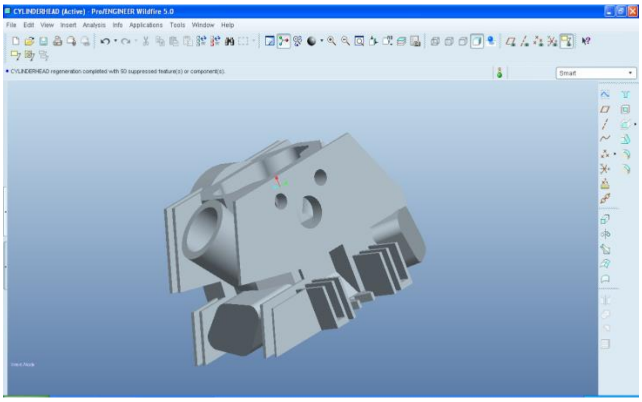


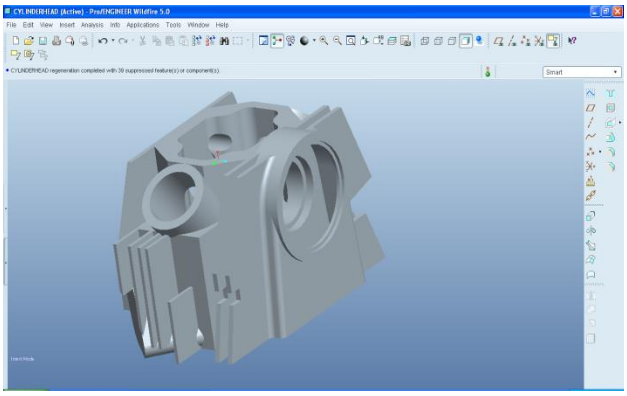


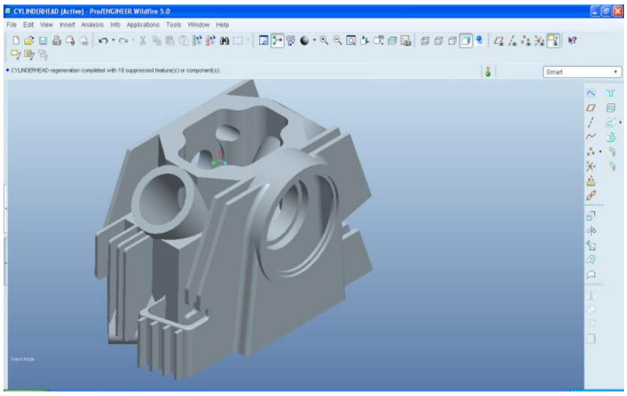


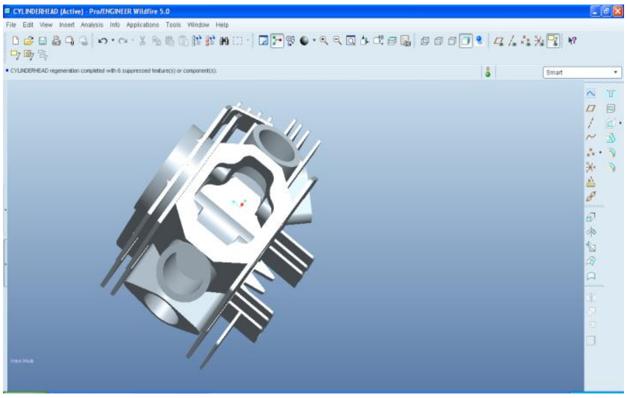


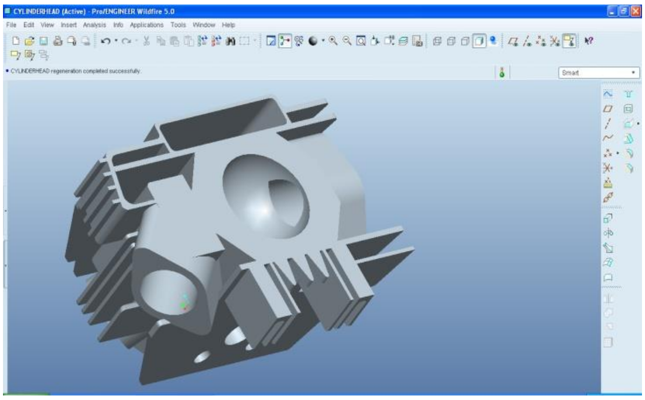


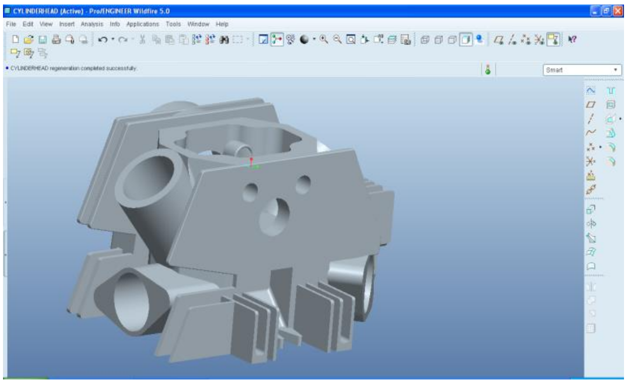


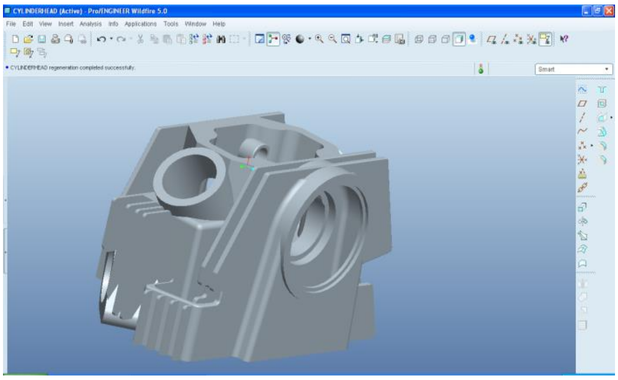






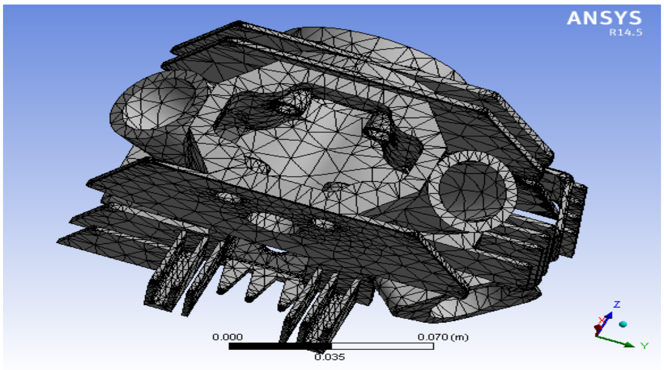




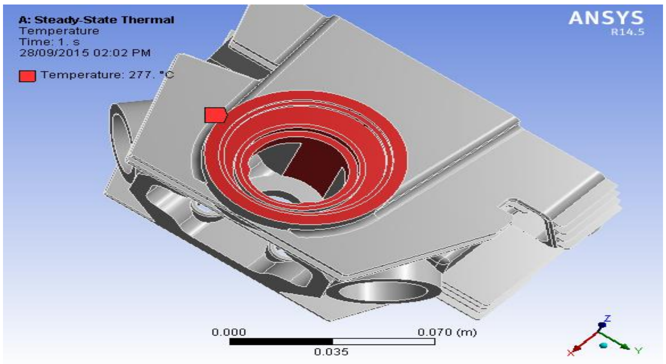


THERMAL ANALYSIS OF CYLINDER HEAD MATERIAL - LM 6

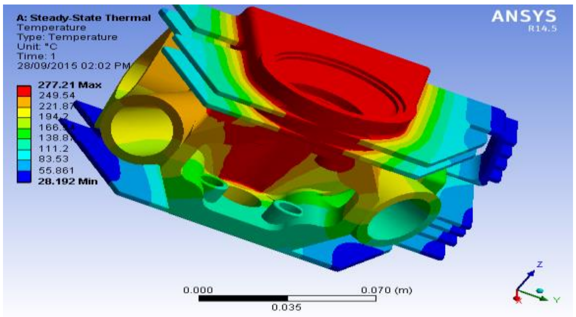
Meshed model



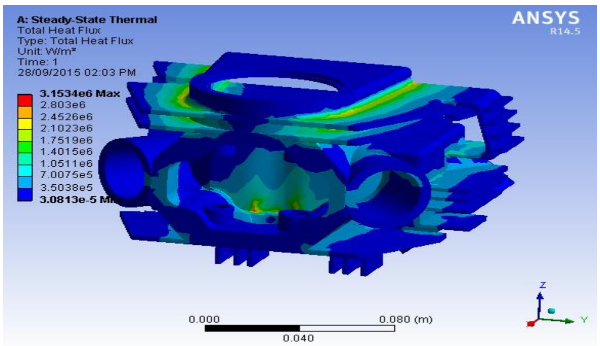
Temperature



Total temperature



Total heat flux



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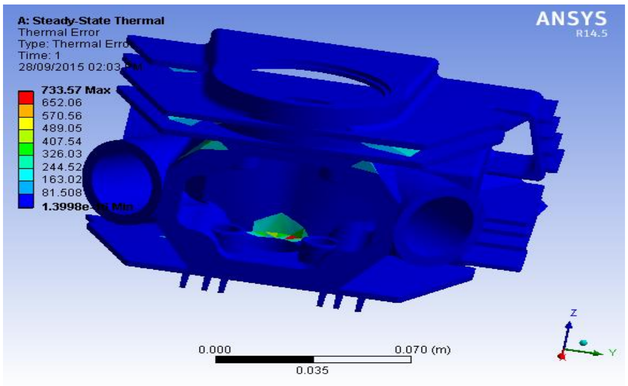
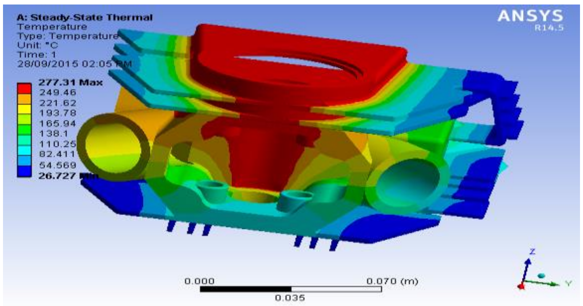
Thermal error

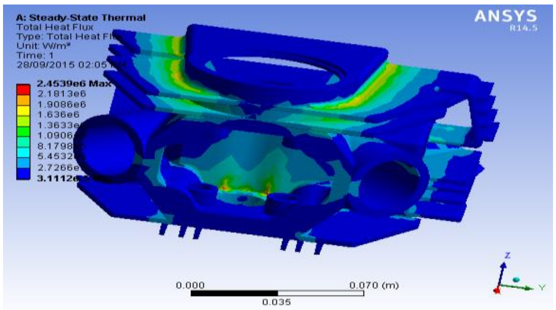


MATERIAL - LM 24

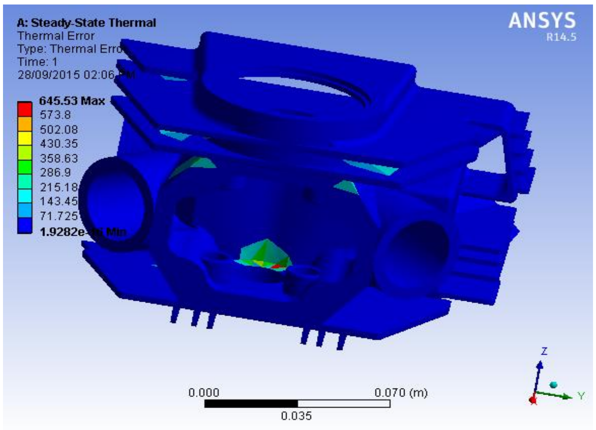
Total temperature



Total heat flux

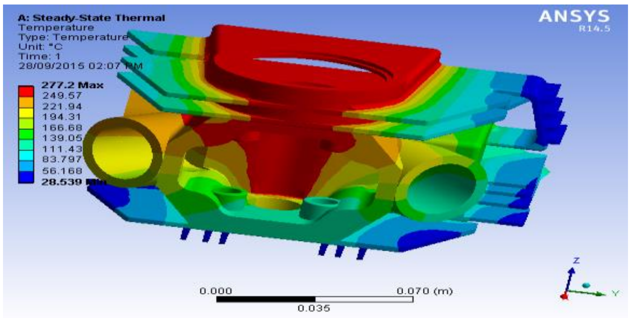


Thermal error

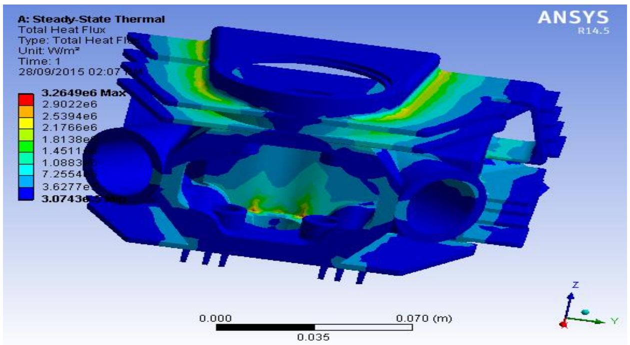


7.1.3 MATERIAL - LM 25

Total temperature



Total heat flux



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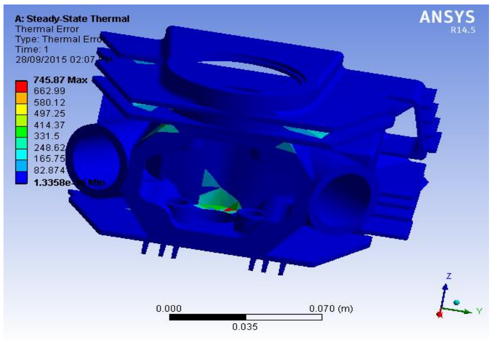
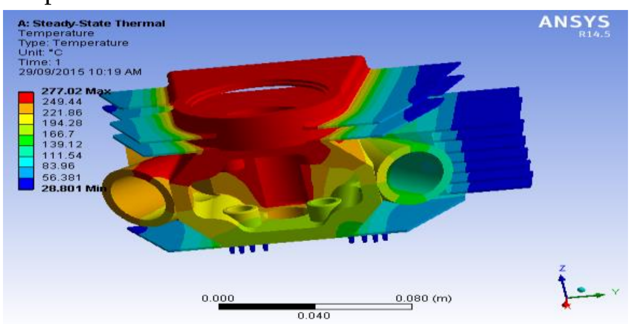


THICKNESS OF FINS- 1.5mm

MATERIAL - LM6

Temperature



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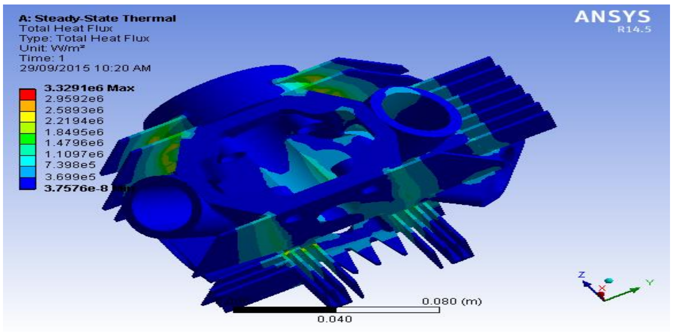
Heat flux



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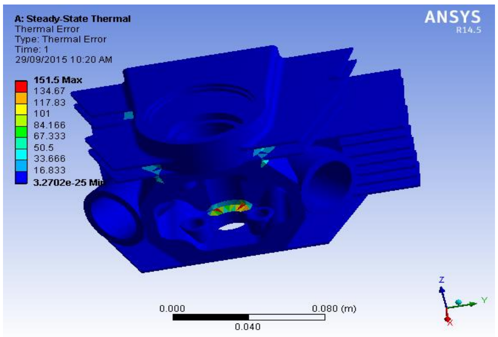
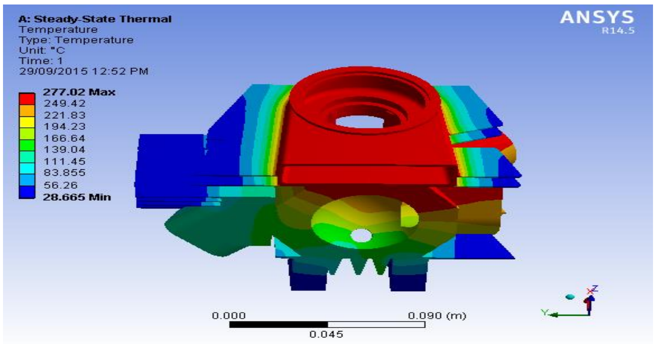


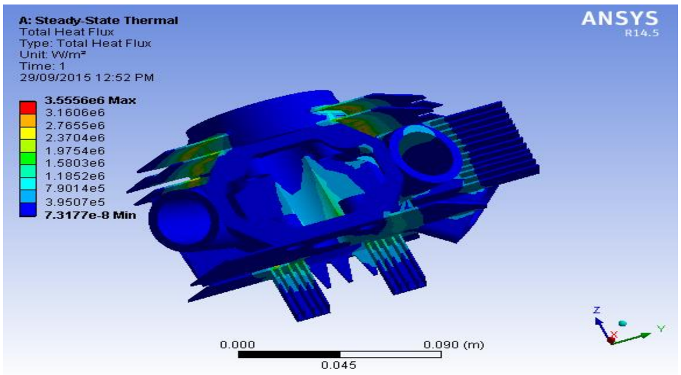
THICKNESS OF FINS - 1mm

MATERIAL - LM 6

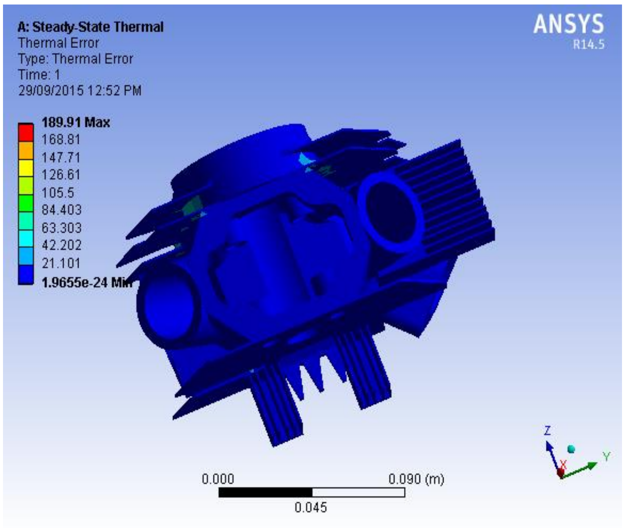
Temperature



Heat flux

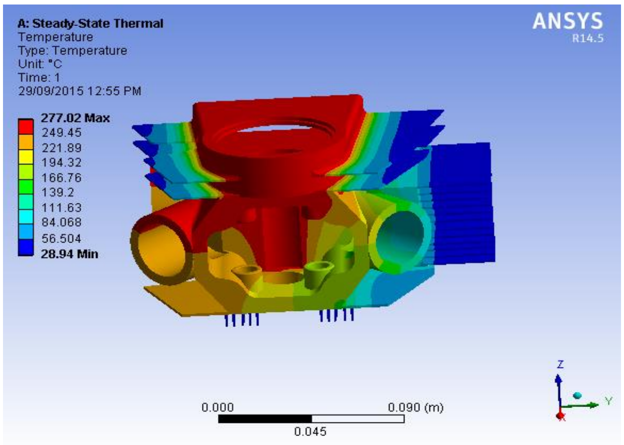


Thermal error

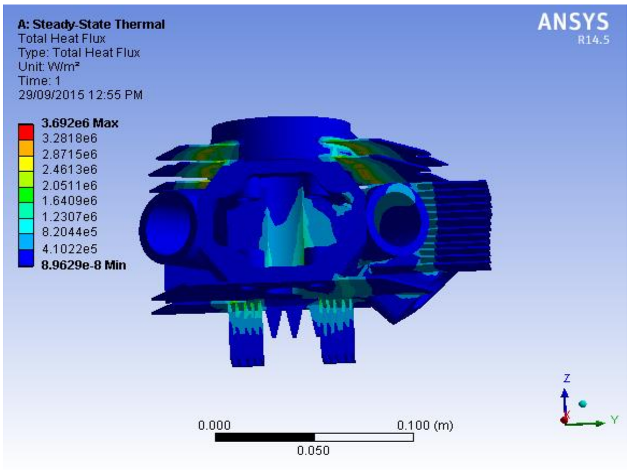


7.3.3 MATERIAL - LM 25

Temperature



Total heat flux



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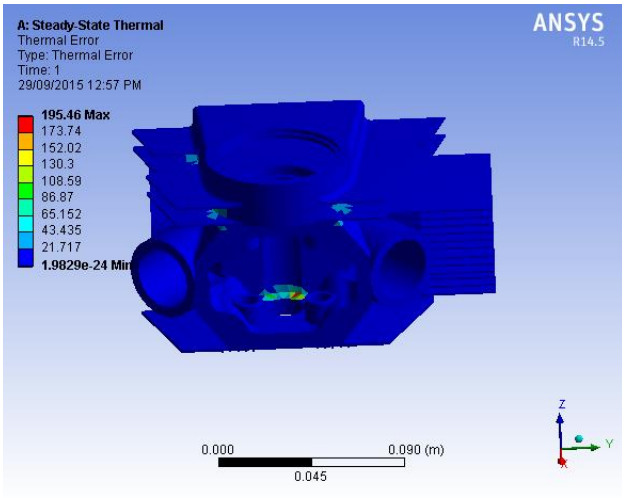
Thermal error



RESULTS TABLE

8.1) 1 mm THICKNESS OF FINS

	TEMPERATURE (°C)	HEAT FLUX(W/m²)	THERMAL ERROR
LM6	277.02	3.5556E6	189.91
LM24	277.02	2.7493E6	154.33
LM25	277.02	3.692E6	195.46

Table1 Thermal analysis for 1mm Thickness of Fins

8.2) 1.5 mm THICKNESS OF FINS

	TEMPERATURE (°C)	HEAT FLUX(W/m²)	THERMAL ERROR
LM6	277.02	3.3291E6	151.5
LM24	277.02	2.4935E6	338.09
LM25	277.02	3.3761E6	379.7

Table2 Thermal analysis for 1.5mm Thickness of Fins

8.3) 2 mm THICKNESS OF FINS

	TEMPERATURE (°C)	HEAT FLUX(W/m²)	THERMAL ERROR
LM6	277.21	3.1534E6	733.57
LM24	277.31	2.4539E6	645.53
LM25	277.2	3.2649E6	745.87

Table3 Thermal analysis for 2mm Thickness of Fins

CONCLUSION

In this thesis a cylinder head is optimized for its material and thickness using thermal analysis. Thicknesses observed are 2mm, 1.5mm and 1mm for different aluminum alloys LM6, LM24 and LM25.Modeling is done in Pro/Engineer and analysis is done in Ansys.

By observing the analysis results, heat flux is more for LM 25 aluminum alloy than other materials so heat transfer rate is more. The heat transfer rate is increasing by increasing the thickness of the fin. So using 2mm thickness is better than 1.5mm and 1mm.

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