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Thermal Analysis of Cylinder Head by Changing Its Fin Thickness

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ABSTRACT: A cylinder head is an integrated structure comprising the cylinder of a reciprocating engine and often some of their associated surrounding structures like coolant passages, intake passages, exhaust passages, ports and crankcase. The term engine block is often used synonymously with "cylinder block". In an internal combustion engine, the cylinder head (often informally abbreviated to just head) sits above the cylinder block. It closes in the top of the cylinder, forming the combustion chamber. This joint is sealed by a head gasket. In most engines, the head also provides space for the passages that feed air and fuel to the cylinder, and that allow the exhaust to escape. The head can also be a place to mount the valves, spark plugs, and fuel injectors. Cylinder head is designed according to the specified dimensions using CATIA v5. After designing, the model is exported to ANSYS. In ANSYS mesh module, the geometric model is converted into finite element model. On that finite element model loads and boundary conditions are applied. Finite element analysis of the Cylinder head is done using mechanical APDL (ANSYS Parametric Design Language) to find temperature distribution and heat flux on the Cylinder head by increasing and decreasing the fin thickness. Hence concluded that by decreasing the thickness of fins temperature distributions is good and heat flux is decreased.

KEY WORDS: Cylinder Head Fins, CATIA V5 Module, Finite Element Method, ANSYS.

I. INTRODUCTION

The first successfully working internal combustion engine used in an automobile was built by Siegfried Marcus in approximately 1864. It was an upright single-cylinder, two-stroke petroleum-fuelled engine that also utilized a carburetor to deliver fuel to the engine. The engine was placed on a cart with four wheels and successfully ran under its own power.

Today's engines are an integral component of an automobile that are in a number of configurations and are considerably more complex than early automotive engines. Technological innovations such as electronic fuel injection, drive-by-wire (i.e., computer -controlled) throttles, and cylinder-deactivation have made engines more efficient and powerful. The use of lighter and stronger engineering materials to manufacture various components of the engine has also had an impact; it has allowed engineers to increase the power-to-weight of the engine, and thus the automobile.

Cylinder head

The head gasket is the most highly stressed static seal in an engine and was a source of considerable trouble in early years. The monobloc cylinder head forms both cylinder and head in one unit, thus avoiding the need for a seal. Along with head gasket failure, one of the least reliable parts of the early petrol engine was the exhaust valve, which tended to fail by overheating and burning. A monobloc head could provide good water cooling, thus reduced valve wear, as it could extend the water jacket uninterrupted around both head and cylinder.

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Computer-Aided Design (CAD):

It also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provides the user with input-tools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based environments.

Introduction to CATIA:

There are different modules in **CATIA** using which different tasks can be performed. The main window and modules of **CATIA** shown in below

Steps To Draw Cylinder Head In CATIA:

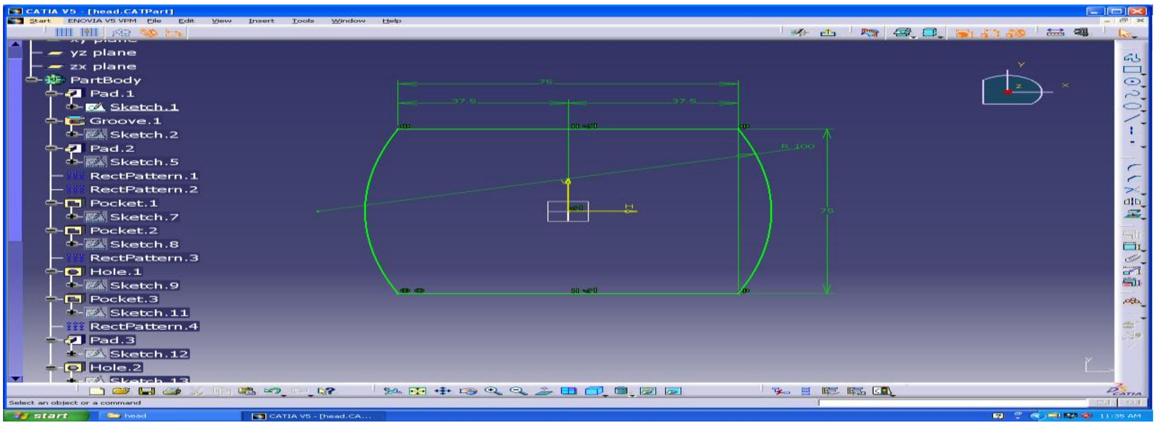

Fig.2 Cylinder head step 1

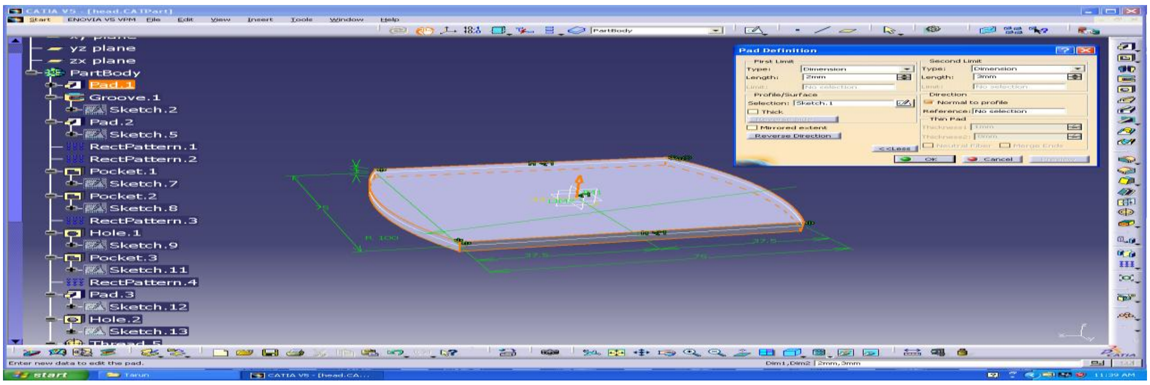

Fig.3 Cylinder head step 2

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Fig.4 Cylinder head step 3

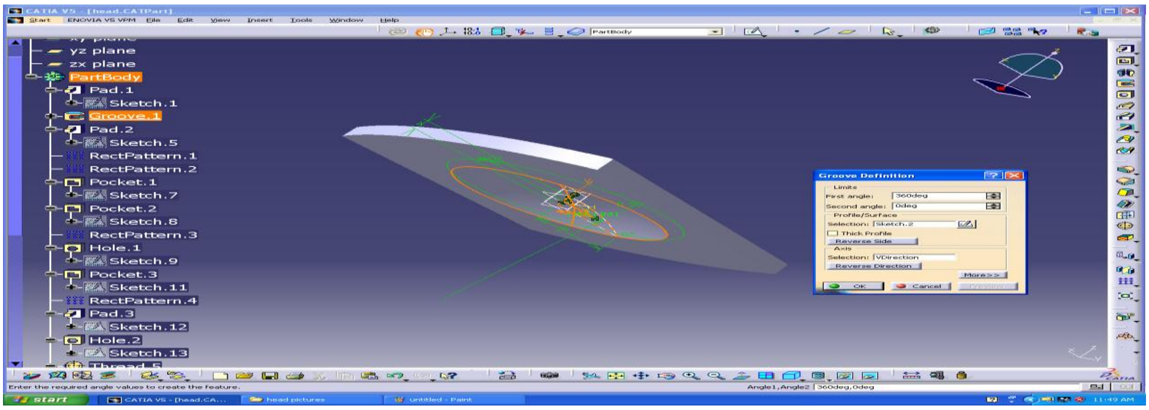

Fig.5 Cylinder head step

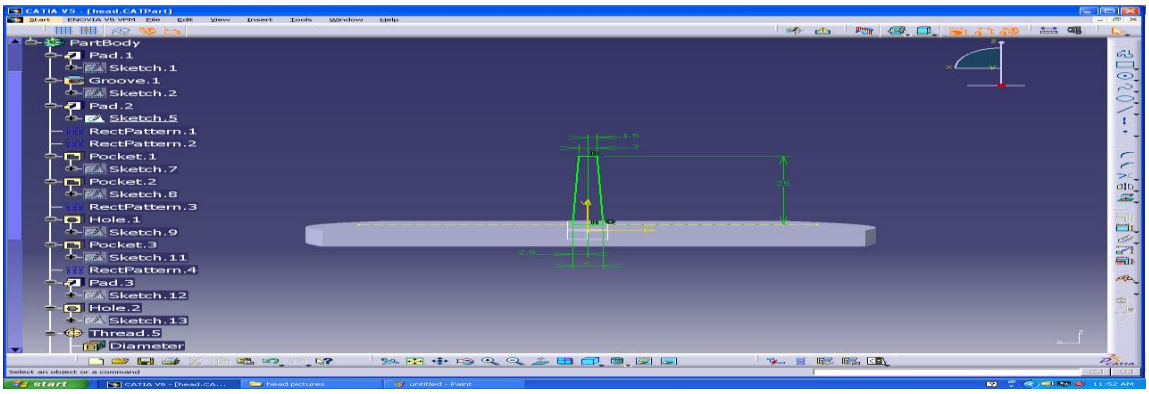

Fig.6 Cylinder head step 5

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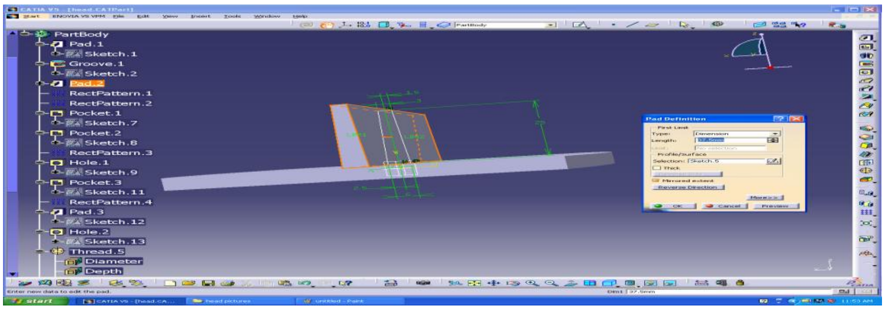

Fig.7 **Cylinder head step 6**

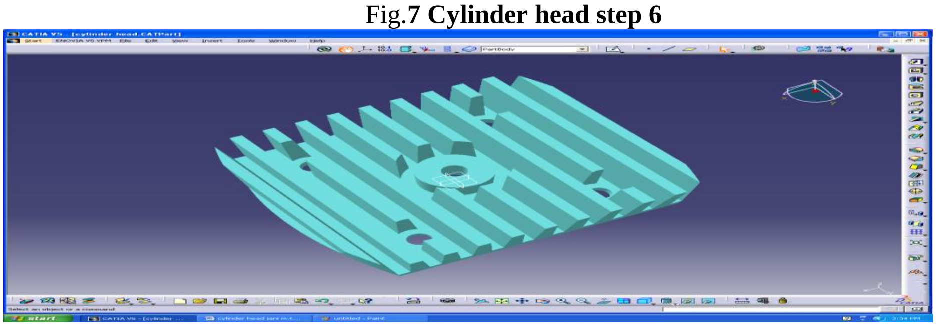

Fig.8 Cylinder head step 7

Fig.24 Final model of Cylinder head with fin thickness of 3mm at top 5mm at bottom

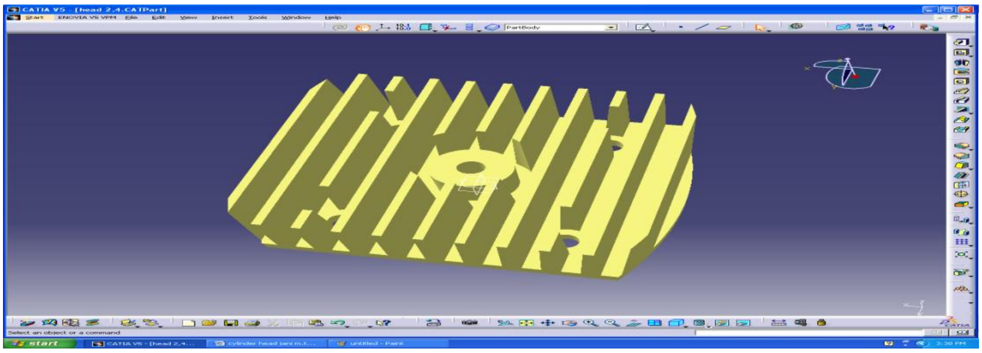

Fig.25 Final model of Cylinder head with fin thickness of 2mm at top 4mm at bottom

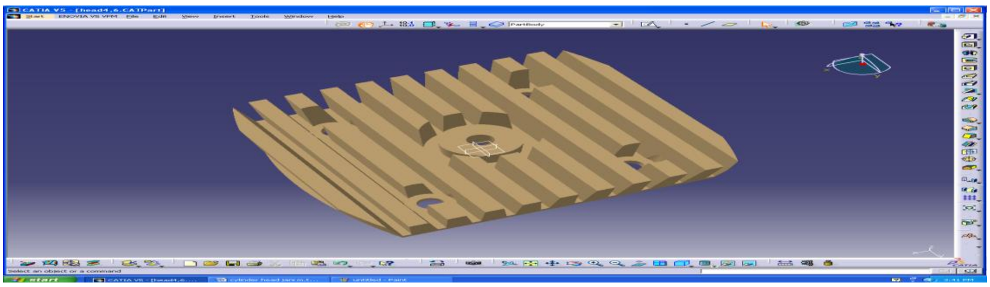

Fig.26 Final model of Cylinder head with fin thickness of 4mm at top 6mm at bottom

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Introduction To FEA:

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling.

Introduction to ANSYS:

The ANSYS Workbench platform is the framework upon which the industry's broad stand deepest suite of advanced engineering simulation technology is built. An innovative project schematic view ties together the entire simulation process, guiding the user through even complex multi physics analyses with drag-and-drop simplicityANSYS works on three principles; those are Penalty method, Lagrange method and augmented Lagrange method. These principles used in the process of contact analysis and non – linear analysis. In this project ANSYS 13.0 played a major role, all the analysis was done with the implementation of ANSYS. Mainly Modal ANSYS and Static Structural ANALYSIS was done in this Project.

Young's modulus	71Gpa
Poisson's ratio	0.35
Density	2700 kg/m^3
Thermal conductivity	237. W/m.°C
Specific heat	910. J/kg.°C

Table 1 Material properties of aluminium alloy

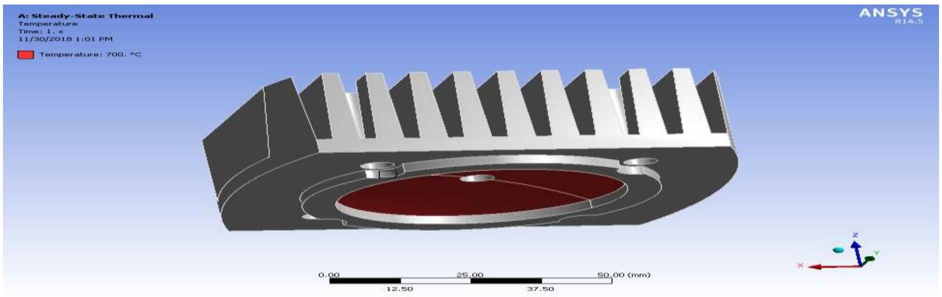

Fig.28 Temperature boundary condition of cylinder head

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Case 1 Fin thickness of 3mm at top and 5mm at bottom

Fig. 29 Temperature distribution in cylinder head

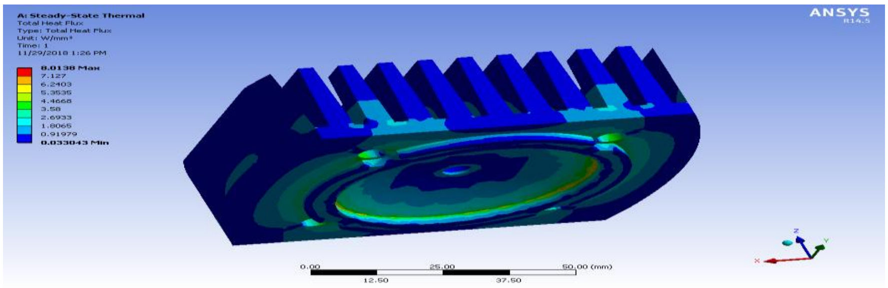
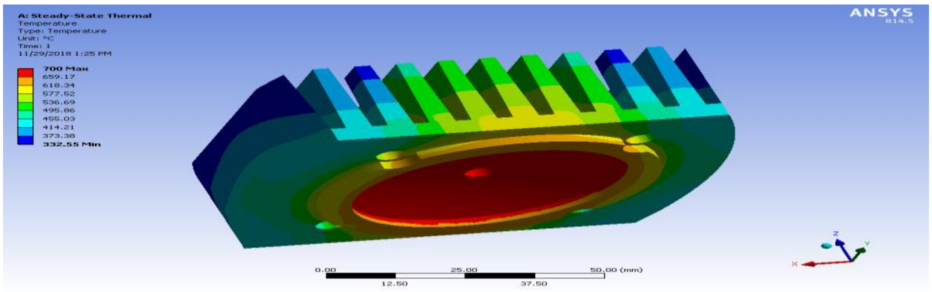
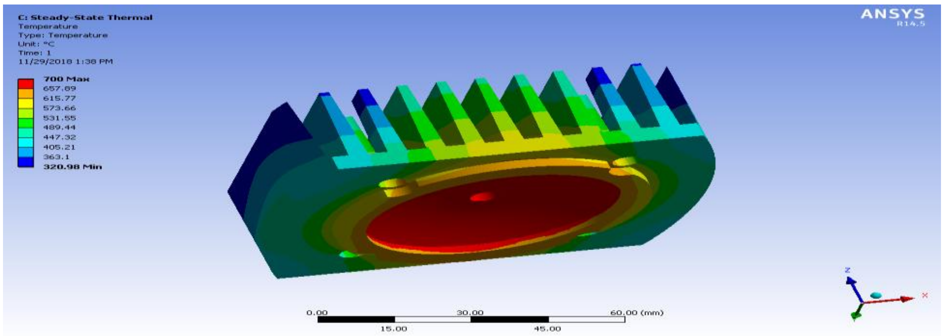


Fig.30 Heat flux of cylinder head



Case 2
Fin thickness of 2mm at top and 4mm at bottom

Fig. 31 Temperature distribution in cylinder head



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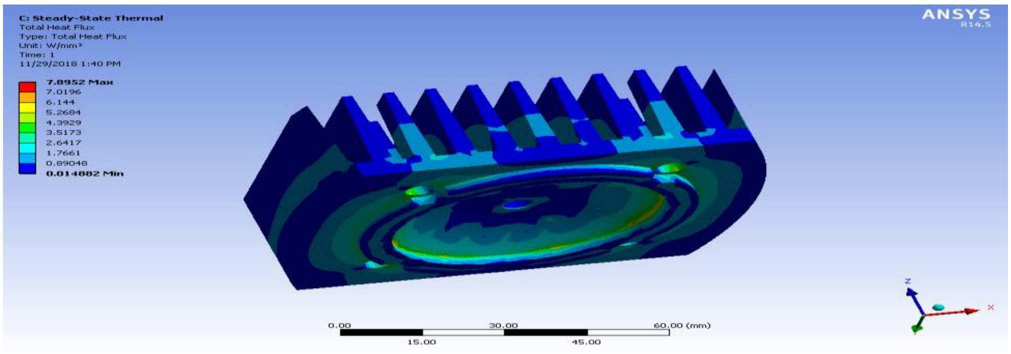

Fig.32 Heat flux of cylinder head

Case 3

Fin thickness of 4mm at top and 6mm at bottom

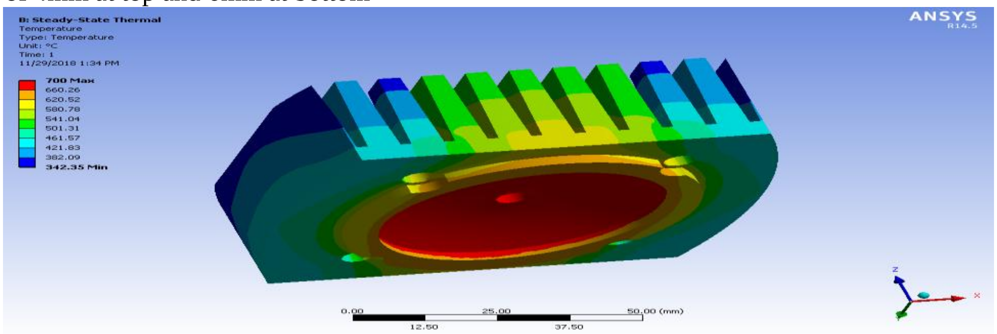

Fig. 33 Temperature distribution in cylinder head

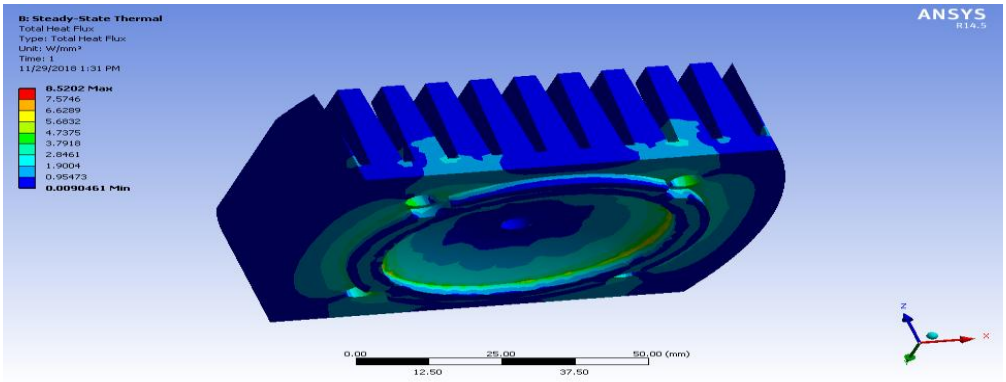

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Fig. 34 Heat flux of cylinder head

Fin Thickness	Temperature		Heat flux	
	Min	Max	Min	Max
2mm Top &4mm Bottom	320.98	700	0.014	7.895
3mm Top &5mm Bottom	332.55	700	0.033	8.013
4mm Top &6mm Bottom	342.35	700	0.0090	8.202

Table 2 Comparison table of cylinder head

II. CONCLUSION AND FUTURE SCOPE

Thermal analysis of cylinder head was done by varying fin thickness with the Aluminium alloy as a material. From the simulation, result obtained that the fin thickness model of 2mm at the top and 4mm at the bottom has maximum temperature distribution and heat flux is also less when compared with other models. So by decreasing the fin thickness we are getting good result. Future scope simulations can be done by varying the materials and transient thermal analysis to get location wise results.

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