DESIGN AND ANALYSIS OF CYLINDER HEAD OF AN ENGINE

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Abstract— *Cylinder head is a critical part of an I C engines cylinder head is used to seal the working ends of the cylinder and accommodates combustion chamber in its cavity, spark plug and valves. The heat generated in combustion chamber is highly dynamic and allows very little time (few micro seconds) to transfer the heat if not distributed will lead to squeezing of piston due to overheating. Hence an effective waste heat distribution through cylinder head plays a very important role in smooth function of I C engine. Heat Transfer through cylinder head consists of conduction through walls and convective heat transfer due to surrounding air flow. As the shape of cylinder head is complex and temperature within the combustion chamber is still fairly unknown. Conventional methods of evaluating heat transfer are very complex this project aims at evaluating heat transfer through cylinder head using finite element analysis as well as the structural analysis. Geometrical models of Cylinder head with and without fins are developed in Auto CAD software .Thus developed models are exported to ANSYS software, and finite element model for thermal analysis done in ANSYS. Effect of fins on heat transfer through cylinder is evaluated. The proficiency of any automobile engine is deals with the structural strength of its cylinder and cylinder head. Cylinder and cylinder head are most important parts of an engine because the piston moving inside the cylinder, so friction between cylinder wall and piston is very higher and due to this the mechanical load or fatigue load acting on the cylinder. So that structure of cylinder should be stronger. 3Dmodel of cylinder and cylinder head were created using Pro/Engineer software and ANSYS was used to analyze the thermal and structural analysis. So finally design considerations, material specifications, failure analysis, these all are reviewed successfully over here.*

***Keywords — Cylinder Head, I C Engines, Heat Transfer, Cylinder, cylinder head, FEM, Pro/Engineer, Fatigue Load, Thermal Load, Structural Strength*.**

I. INTRODUCTION

Cylinder head is the very important part in the automobiles. The top of cylinder is covered by a separate cast piece known as the cylinder head. The cylinder head is bolted to the top of cylinder block. It contains combustion chamber, spark plug, and sometimes valves are mounted on it. It incorporates passages for flow of cooling air. The main purpose of cylinder head is to seal the working ends of the cylinder and not to permit entry and exit of the gasses on overhead valve engines. The inside cavity of head is called the combustion chamber in to which the mixture is compressed for firing. Its shape controls the direction and rate of combustion. So the performance of an I.C engine depends on the effective utilization of heat liberated during the combustion. Heat generated during the combustion is converted to mechanical power on to the crankshaft and part of it is wasted as heat losses through exhaust gases and heat transfers to the surroundings. This project aims to determine the heat transfer through the cylinder head for various configurations that is without fins and with fin. The peak temperatures of burning gases inside the cylinder of diesel engines are of the order of 2500 K. To prevent overheating, the maximum temperatures of the metal surfaces enclosing the combustion chamber are limited to much lower values and, therefore, cooling must be provided for the cylinder, cylinder head and piston. The substantial heat fluxes and temperature no uniformities arising from these conditions lead to thermal stresses, which further escalate the otherwise significant mechanical loading from combustion pressures. The design must take into account all these considerations to ensure trouble-free operation of engines, which, especially in the case of parts of complex design, requires an extended analysis based on detailed information of all the processes involved.

II. THE ROLE OF CYLINDER HEAD

Cylinder heads need to be robust. They have to withstand huge pressures and very high temperatures, while retaining their shape and form to seal the cylinder block via the head gasket. They're key to controlling air flow in and out of the cylinders and fuel deployment. The cylinder head also holds the injectors and valves – and contains more moving parts than any other part of the engine. Although largely unnoticed, the cylinder head plays a key role in your engine. It's a solid item that sits at the top of your unit and covers its workings. It's sealed in place with the head gasket. The inside of the cylinder head contains a number of passages – known as ports or tracks – and the air mix travels along these to the inlet valves. Other tracks inside the cylinder head are the route by which the exhaust gases travel when leaving the main engine block. In all engines cooled by water – this applies to all Perkins engines – the cylinder head also contains ducts and passages. These allow the coolant, comprising water and antifreeze, to flow and transfer excess heat away from the main body of the engine to the radiator, preventing the risk of overheating and damage. Not surprisingly, the cylinder head is subjected to extremes of temperature, which it has to resist.

III. LITERATURE SURVEY & REVIEW

G.BahadurVali& Krishna Veni [1] in this project they have design an assemble cylinder and cylinder head. They used two different Aluminum alloys 6061 and 7475.

Abhishek Mote at el [2] they analyze of heat transfer crosswise finned surfaces using CFD software. they thought that experiment based research done by different researchers in the past is a time consuming process.

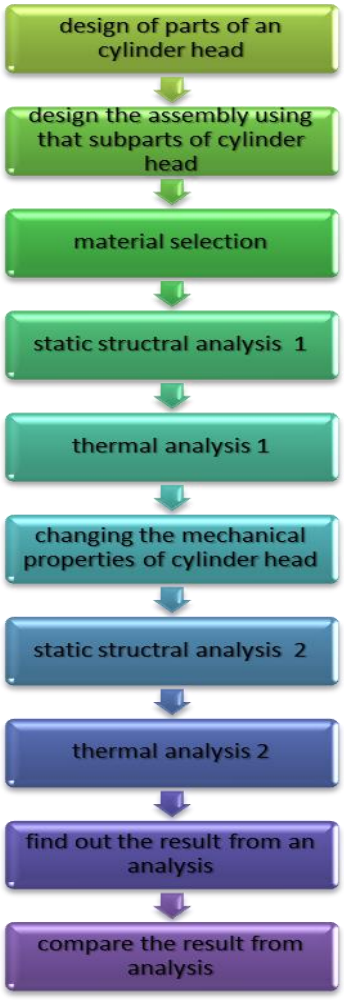
Shubham Shrivastava & Shikar Upadhyay [3] investigate the cylinder block made in 3D software Solid works in which perpendicular fins are mounted. they modify the engine cylinder block fins, and its thickness reduced from 3 mm to 2 mm.

Vinay Kumar Attar & Himanshu Arora [4] they investigate Piston skirt which appear deformation at work usually causes crack on the upper end of piston head.

ChidiebereOkeke-Richard & Sunny Sharma [5] They analyze cylinder blocks of 4Stroke SI Engines of two wheelers from three different companies like HONDA, TVS, YAMAHA, to find out the thermal effects of combustion gases with respect to change in temperature and heat flux.

KM Sajesh, Neelesh Soni and Siddhartha Kosti [6] they perform CFD analysis of rectangular fins of engine. They choose two wheeler bike engine (e.g. Unicorn bike engine) and geometry is designed in Design Modeler in ANSYS 16.0.they used for is Al 6063 which was a thermal conductivity of 200 W/mK.

IV. METHODOLOGY



V. TOOLS/ PLATFORM

The tools used for the design the cylinder head of an engine are like Catia Software. On the basis of Catia software all the designing data will be covered as well as the drafting is also done on this software. The secondary part of a project is an analysis of an designed part of cylinder head in done on the Ansys software. On this software the all type of the analysis of the cylinder head is done like structural, static, thermal etc. analysis is done by using the Ansys software.

VI. DESIGN/ IMPLEMENTATION/MODELING

Choosing the "right" cylinder heads for an engine build can make all the difference in an engine that delivers and one that falls short of its potential. Horsepower, torque and throttle response all depend on how well the cylinder heads, camshaft and induction system work together. Choose the right combination and you'll build a winner. Choose the wrong combination and you'll end up with a mismatch that never achieves what you set out to achieve. Choosing a set of aftermarket performance cylinder heads is not as simple as it sounds because there are so many different heads from which to choose. Comparing heads from various suppliers isn't exactly a straight-forward process because numbers can be very misleading. One thing is certain. There is way too much emphasis on peak airflow numbers. "The first thing a customer usually asks when they call about a set of heads is how much air do they flow? Or what's the port volume? None of these numbers will tell you how much horsepower a set of heads will actually make because the power output depends on the combination of parts in the motor and the application," said one head supplier.

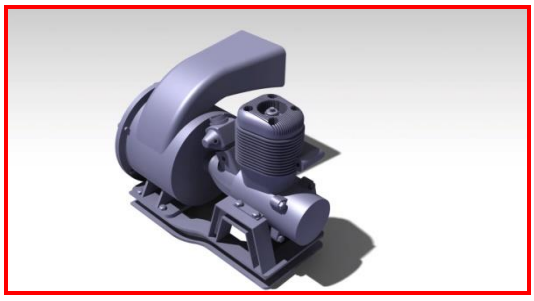


Fig. No. 1 Assembly of Engine Blower

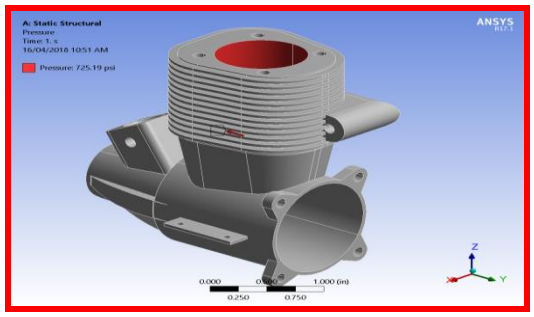


Fig. No. 2 Pressure Applied for Engine Blower

Table No. I Meshing Properties of Engine Blower

Object Name	*Solution (A6)*
State	Solved
Adaptive Mesh Refinement	
Max Refinement Loops	1.
Refinement Depth	2.
Information	
Status	Done
MAPDL Elapsed Time	8. s
MAPDL Memory Used	152. MB
MAPDL Result File Size	11.688 MB
Post Processing	
Calculate Beam Section Results	No

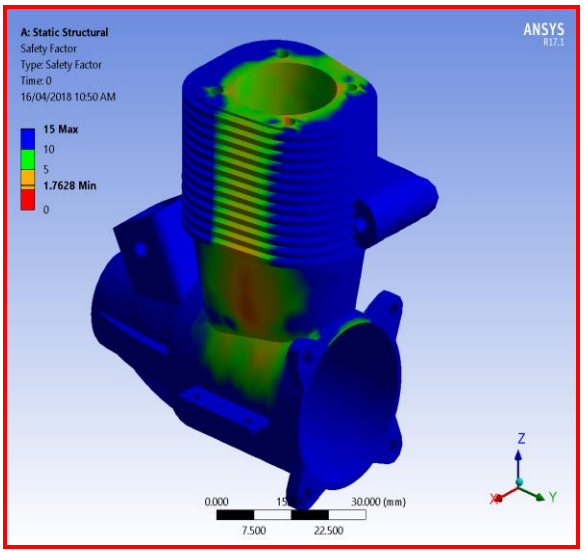


Fig. No. 3 Safety Factor of Engine Blower

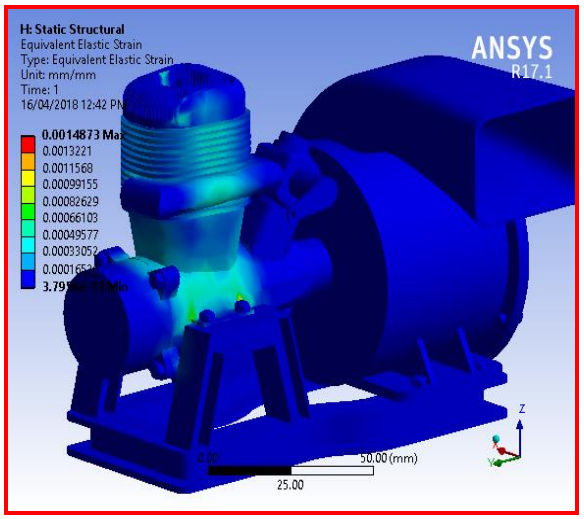


Fig. No. 4 Equivalent Elastic Strain for Engine Blower

VII. RESULTS & CONCLUSION

After design and analysis of the engine blower the result found from the ansys software are as follows:

Pressure Applied to Engine Blower is 725 PSI

1. Static Structural

Table No. II Static Structural

Object Name	Equivalent Stress	Equivalent Elastic Strain	Total Deformation
Minimum	7.9715e-003 MPa	6.3084e-008 mm/mm	0. mm
Maximum	48.9 MPa	2.604e-004 mm/mm	4.8629e-003 mm

2. Thermal Stress

Table No. III Thermal Stress

Object Name	Equivalent Stress	Equivalent Elastic Strain	Total Deformation
Minimum	0. mm	3.7956e-011 mm/mm	1.5337e-006 MPa
Maximum	6.4531e-002 mm	1.4873e-003 mm/mm	269.56 MPa

From this paper we are conclude that the design and analysis of the engine blower is done and the static and thermal analysis also, from this analysis the material selection should be very critical part, the maximum deformation on the edge of the cylinder blower is around 269.56MPa.

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