Design and Analysis on Engine cylinder Fins for variable Materials

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Abstract: The Engine cylinder is amechanical component, which is subjected to high temperature fluctuations and thermal stress. Fins are provided on the engine cylinder to reduce the heat inside the engine componentsand increase the heat transfer rate.fins are mainly used to cool the engine cylinder. By doing thermal analysis on the engine cylinder fins, we may know the heat dissipation inside the cylinder. The main principlein this project is to analyse the heat distribution and total heat flux by using the invisible working fluid, nothing but air under natural convection. so,manufacturingof such a large complex engine is very difficult. So, we can do model analysis. The parametric model is designed in 3D modelling software SOLIDWORKS 2020. The analysis is done using ANSYS 19.2 & SOLIDWORKS.Analysis is conducted by varying material and calculate the Temperature distribution, total heat flux and Directional heat flux. Presently Material used for manufacturing the fin body is Cast Iron. In this thesis, it is replaced by ALUMINIUM ALLOY and GRAY CAST IRON. Thermal analysis is done by using the dimensions of BAJAJ 150CC engine block.

KEYWORDS: Engine Cylinder, Heat Transfer rate, SOLIDWORKS 2020, ANSYS 19.2, Bajaj 150cc, Design & analysis, Aluminium Alloy, Gray Cast Iron.

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I. INTRODUCTION

Machines which generate power by utilizing some forms of energy are called prime movers or engines. Heat engine is a device which transform the chemical energy of a fuel into heat energy and utilizes this energy (heat energy) to perform useful work. Thus, heat engine converts heat energy into mechanical energy. The energy produced by heat engine may be used to produce electrical energy, to pump the water, to drive automobile and air crafts.Heat engines can be broadly classified into Internal combustion engines and External combustion engines. In Internal combustion engines (I.C engines) are those in which the necessary heat is produced inside the engine cylinder by combustion (burning) of fuel; whereas in external combustion engines (E.C. engines) the combustion takes place outside the cylinder. Ic engines offers the more compact and occupy less space and possess high thermal efficiency. Ic engine is simple in design and low initial cost. Ic engine require auxiliary equipments such as boilers and condensers. Only suitable for smaller capacity units. In CI engines operates on a very similar way as that of SI engines. The major differences are that the ignition occurs spontaneously due to the high temperature of the compressed air, and spark plug of SI engine (petrol engine) is replaced with fuel injector.Two-stroke cycle engine was invented by Dugald Clark (1878). For 2-stroke cycle engine all the events are completed in two-strokes of the piston. Thus, in a two-stroke engine suction and exhaust strokes are eliminated, and there is one power stroke for every revolution of crank shaft. Further, the valves of 4-stroke engine are replaced with three ports. These ports (inlet, exhaust and transfer ports) are covered (closed) and un-covered (opened) by the piston as it moves up and down in the cylinder.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives. In Section 2 we discuss literature review. In Section 3 we have the complete information about designing and experimental procedure.Section 4 shares information about analysis results. Section 5 tells us about the future scope and concludes the paper and references.

OBJECTIVES

In automobiles, the engine cylinder is subjected to high temperature variations and thermal stresses. So as to cool the engine cylinder, fins are mounted on the engine cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins you can know the rate of heat transfer inside the cylinder.

The main objective of the project is to analyze the thermal behavior of cylinder fins by varying materials. For designing purpose, we use Bajaj 150cc engine and designed in solidworks and analyzed in Ansys workbench

LITERATURE REVIEW

When the fuel is burnt in the engine cylinder, only about one-third of heat energy liberated is converted to mechanical energy, and rest of the heat goes to exhaust gases and heating of the combustion chamber which consists of cylinder head, cylinder and piston. The cooling system is necessary to remove the unwanted heat from the cylinder so as to prevent.Burning of lubricating oil may occurs. So, as to minimize the wear of the parts. Seizure of the piston because of excessive expansion. Overheating of spark plug and cylinder walls which leads to preignition in SI engines. Excessive stress in the parts due to unequal temperature, and to increase the life of the parts by controlling the temperature. An excessive heat removal from the engine reduces the engine power and increases the consumption of fuel. Thus, the over cooling of the engine is also undesirable as its overheating. Therefore, the cooling system provided must be such that it will remove unwanted heat from the cylinder and maintain normal running conditions of an engine.

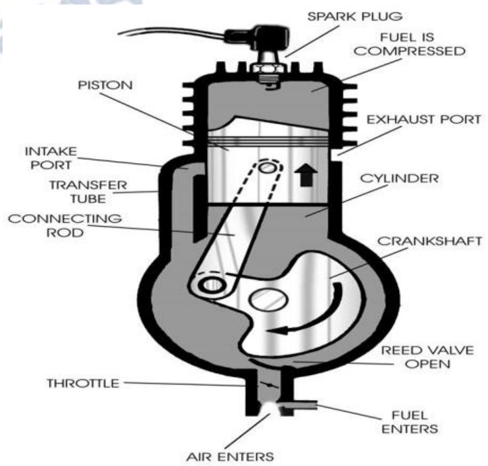

Fig.1 Engine cylinder

Liquid Cooling System

In water cooling system, water is continuously circulated through passage (water jackets) around the cylinder. The heat removal from the cylinder is affected by transfer of heat to circulating water. This system is more effective than air cooling and is used for the engines having larger capacity. Therefore, it is vital that the cooling system keep all parts at suitably low temperatures.

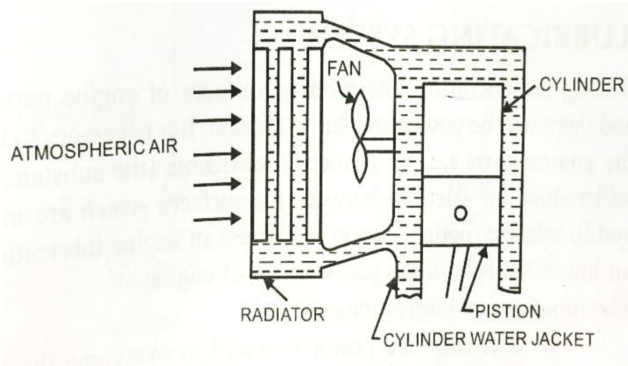

Fig.2 Water cooling system

Liquid-cooled engines usually have a circulation pump. According to the method of circulation of water, liquid cooling system is classified as gravity circulation (thermosyphon) system and forced circulation. In the thermosyphon system no need of pump to maintain circulation of water, and used for small engines. In the forced system the cooling is effective under all conditions of operation. But cooling is stopped as soon as the engine is stopped, and used for cooling large and medium size engines.

2. Air cooling system

In air cooling system the removal of heat is affected by inducing air to flow around the cylinders and their heads. To increase the surface heat transfer area, metallic fins are cast on the outer surface of cylinder and head. Small capacity engines obtain adequate circulation of the cooling air by convection. But high-capacity engines require a forced circulation. Forced circulation of air around the engine is provided by a rotary blower. Revolving with a high speed, the rotor forces the cooling air under sheet metal ducting that almost entirely enclose the engine. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air

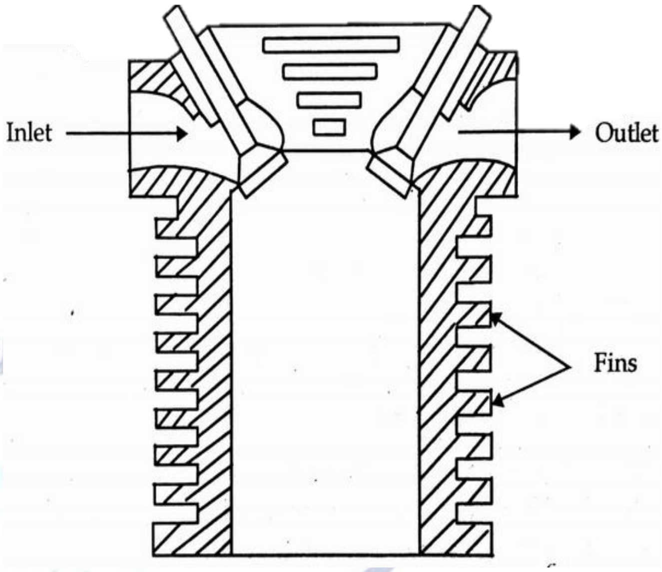

Fig.3 Air cooling system

In this air-cooling system water jackets are not required. Absence of radiator makes the system simpler and minimize the maintenance problem. And weight per given output is less. No danger of leakage and freezing of water in cold climate conditions. It is suitable only for small and medium size engines

DESIGN OF CYLINDER FIN BODY

Dimensions for fins and cylinder have been taken from the standard dimensions of Bajaj pulsar 150cc. this is designed using parametric softwareSolidworks.

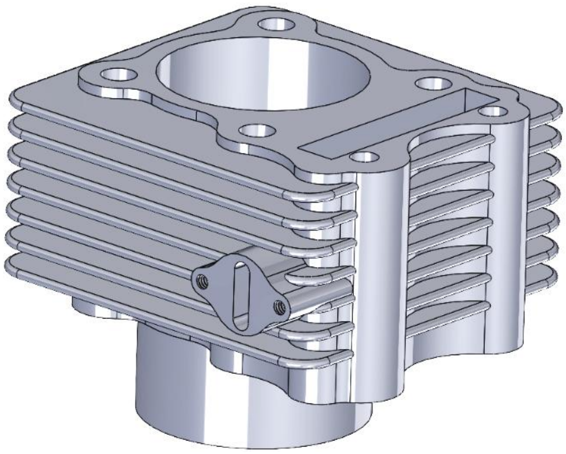

Fig.4 DESIGNED PART

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Table for Dimensions

Cylinder Inner Diameter	Día58mm
Cylinder Outer Diameter	Día 66mm
Thickness of Fin	2.60mm
Pitch of Fin	8mm
Length of Cylinder	100mm

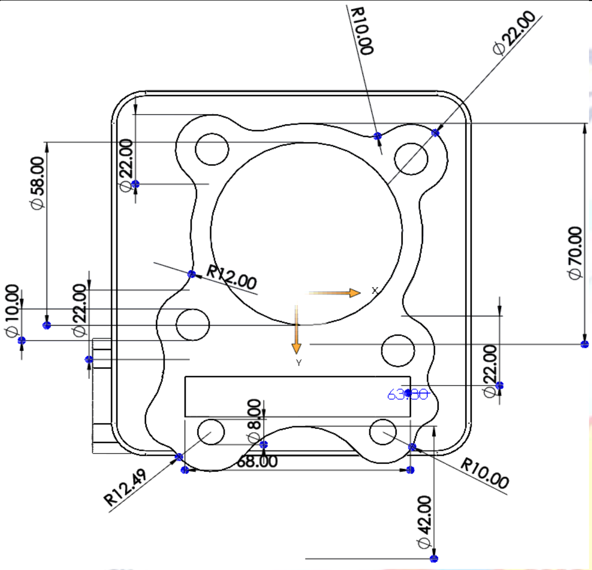

Fig.5 (2.60 Mm) Thickness Fin Body

EXPERIMENTAL PROCEDURE

1. Importing the designed body from solidworks.
2. Assigning material.
3. Applying temperatures and loads.
4. Meshing the model and running the study.
5. Visualizing the result.
6. Verifying the results.

In this project we use the solidworks 2020 for modeling and also verification of analysis results. After converting the model in to the IGES(*igs) format we have to open the ANSYS workbench 19.2 and assign the material to the model. Apply the temperature inside the cylinder is 2000-2500^{0}c. and add the convection to the all-exposed surfaces.

Add the Temperature Distribution, Total heat flux and Directional heat flux to the results.

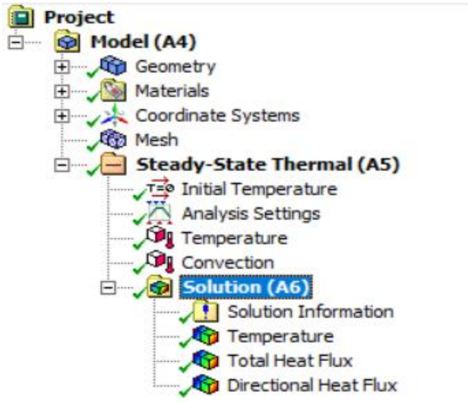

Fig.6Analysis Process

analysis determines temperatures and other thermal quantities.

Step: 1 Set Geometry

Construct a model and tested using the work plane coordinate system within ANSYS.

Step: 2Add Material Properties

Now that the part exists, define a library of the necessary materials.

Step: 3 Generate Mesh

In this process we break down the model into finite elements for getting good and accuracy result.

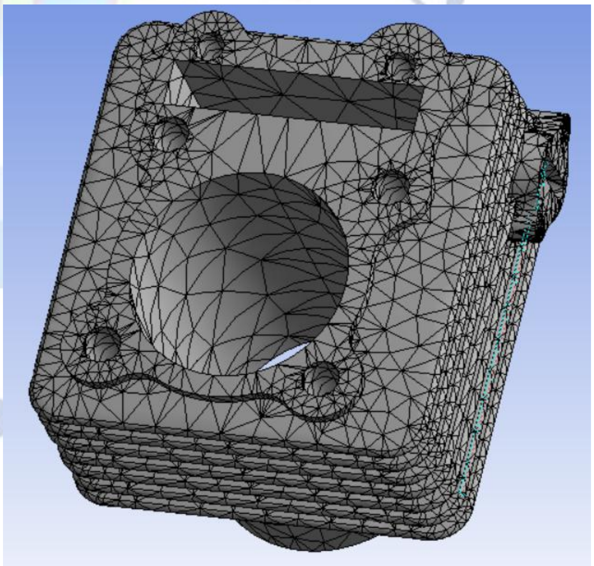

Fig.7Meshed model in ANSYS 19.2

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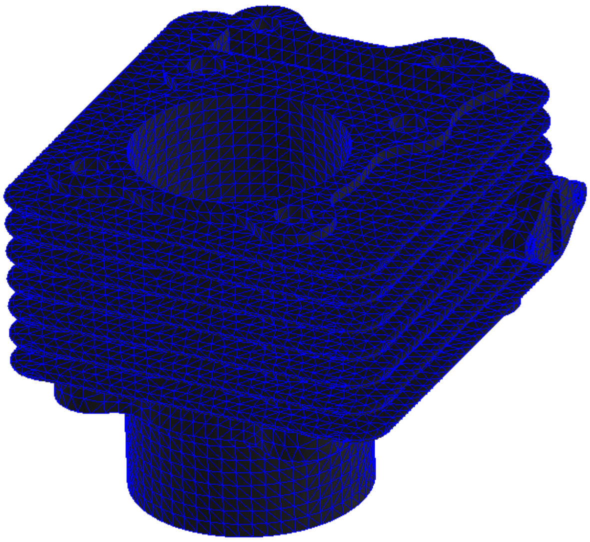

Fig.8 Solidworks Meshing

Step:4 Apply Loads

Apply the loads like static and thermal for the meshed model and also add the fixes and other task like burden the system with constraints, such as physicalloadings or boundary conditions.

Boundary conditions table

Film coefficient (or) Convective coefficient	10 w/ (m².k)
Bulk ambient temperature	298.15⁰k
Internal temperature	2500⁰c

Step: 5 Obtain Solution

Generate the to study the loads and boundary conditions the problem must be solved.

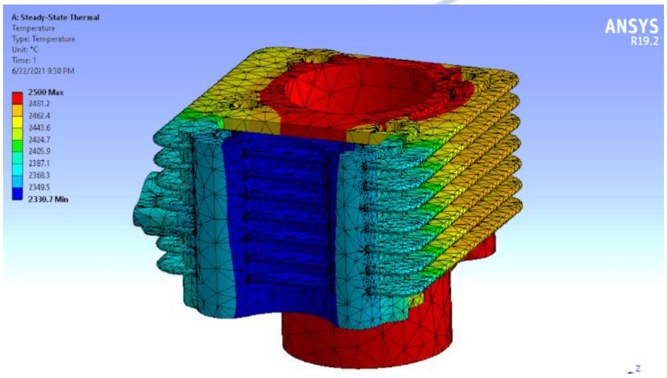

Fig.9 Temperature Distribution for Aluminium Alloy

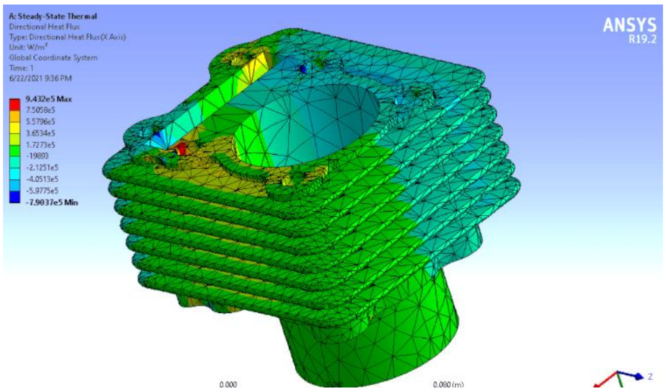

Fig.10 Directional Heat Flux for Aluminium Alloy

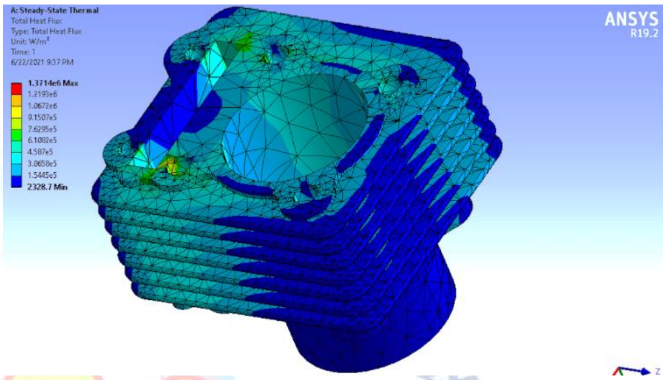

Fig.11 Total Heat Flux for Aluminium Alloy

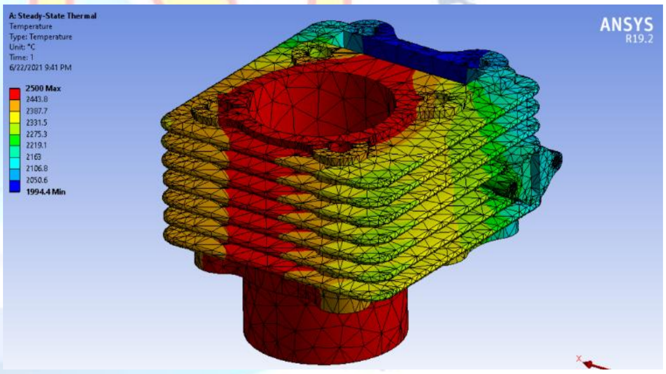

Fig.12 Temperature Distribution for Gray Cast Iron

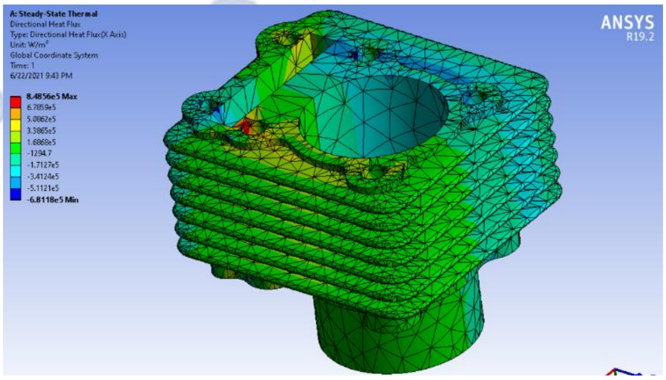

Fig.13 Directional Heat Flux for Gray Cast Iron

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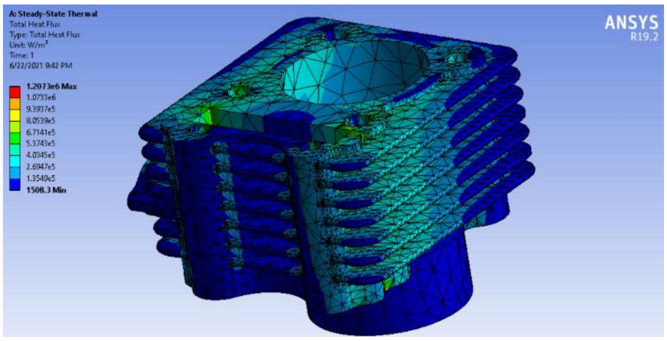

Fig.13 Total Heat Flux forGray Cast Iron

ANSYS Result: Temperature Distribution

Materials	Max Temperature	Min Temperature
Aluminium Alloy	2500^0c	2330^0c
Gray Cast Iron	2500^0c	1994.4^0c

Solidworks Result: Temperature Distribution

Materials	Max Temperature	Min Temperature
Aluminium Alloy	2500^0c	2326^0c
Gray Cast Iron	2500^0c	1983^0c

ANSYS Result: Total Heat Flux

Materials	Max Total heat flux	Min Total heat flux
Aluminium Alloy	1.3714e6	2328.7
Gray Cast Iron	1.20773e6	1508.3

ANSYS Result: Directional Heat Flux

Materials	Max Directional heat flux	Min Directional heat flux
Aluminium Alloy	9.432e5	-7.9037e5
Gray Cast Iron	8.4856e5	-6.8118e5

CONCLUSIONS

By doing thermal analysis on the bajaj pulsar 150cc engine cylinder fins, we get knowledge about heat distribution of the engine cylinder. From this study we apply the boundary conditions and get the heat distribution and heat dissipation along the cylinder wall and select suitable material. From above analysis we conclude that Aluminium alloy is the best material for engine fins.

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