© July 2019 | IJIRT | Volume 6 Issue 2 | ISSN: 2349-6002

"A Review on Thermal Analysis of Engine Cylinder Block with Fin using modified geometry"

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***Abstract*- The Engine barrel is one of the significant car segments, which are exposed to high temperature varieties what's more, warm anxieties. So as to cool the barrel, blades are given on the outside of the chamber to expand the rate of Warmth exchange. By doing warm examination on the motor chamber and balances around it, It is useful to know the warmth dispersal rate and Temperature Distribution inside the barrel. We realize that, By expanding the surface region we can increment the warmth dispersal rate, so planning such a vast complex motor is exceptionally troublesome.**

The principle point of the present investigation is to break down the warm properties like Directional Heat Flux, Total Heat Flux and Temperature Distribution by differing Geometry(Circular, Rectangular), material (Aluminium Alloy)and thickness of Fin (3mm) of a roughly circular barrel display arranged in CATIA V5 which is brought into ANSYS WORKBENCH-2014 for Transient Thermal examination with an Average Internal Temperature and Stagnant Air-Simplified case as Cooling medium on Outer surface with sensible Film Transfer Coefficient as Boundary Conditions.

Index terms- Dissipation, Thermal conductivity, Film transfer coefficient, Internal Temperature, Stagnant Air- Simplified case, Boundary Conditions, CATIA-V5, ANSYS WORKBENCH-2014

I. INTRODUCTION

1.1 Engine cylinder & Combustion Chamber:

We realize that if there should be an occurrence of Internal Combustion motors, burning of air and fuel happens inside the motor barrel and hot gases are created. The temperature of gases will be around 2300-2500°C. This is an extremely high temperature and may result into consuming of oil film between the moving parts and may bring about seizing or welding of same that is odds of cylinder seizure, possibilities of cylinder ring, pressure ring, oil ring and so on can be influenced. Overabundance temperature can likewise harm the barrel material. So this temperature must be diminished to around 150-200°C at which the motor will work generally effectively. As well much cooling is additionally not alluring since it diminishes the warm effectiveness. Thus, the object of cooling framework is to keep the motor running at its most productive working temperature. It is to be noticed that the motor is very wasteful when it is cold and subsequently the cooling framework is planned so that it avoids cooling when the motor is heating up and till it achieves most extreme effective working temperature, at that point it begins cooling. To abstain from overheating, and the ensuing sick impacts, the heat exchanged to a motor segment (after a certain level) must be evacuated as fast as could be allowed and be passed on to the climate. It will be appropriate to state the cooling framework as a temperature direction framework.

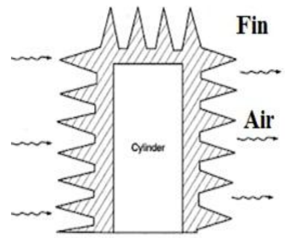
It ought to be recollected that deliberation of warmth from the working medium by method for cooling the motor segments is a direct thermodynamic misfortune. The rate of warmth exchange relies on the breeze speed, geometry of motor surface, outside surface region and the surrounding temperature. In this work examination is done on motor square balances thinking about temperature inside by methods of conduction and convection, air speed isn't consider in this work. Motorbikes motors are typically intended for working at a specific air temperature, be that as it may cooling past ideal point of confinement is likewise not considered since it can diminish by and large effectiveness. Therefore it might be seen that just adequate cooling is alluring. Air-cooled motors by and large utilize singular cases for the barrels to encourage cooling. Inline bike motors are a special case, having two-, three-, four-, or indeed, even six-barrel air-cooled units in a typical square. Water-cooled motors with just a couple of barrels may likewise utilize singular chamber cases, however this makes the cooling framework increasingly mind boggling. The Ducati bike organization, which for quite a long time utilized air-cooled engines with singular barrel cases, held the essential plan of their V-twin motor while adjusting it to water-cooling.

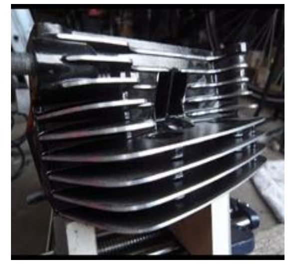
1.2 Cooling of engine cylinder:

(a) Air cooling in typical reason, bigger parts of a motor stay presented to the barometrical air. At the point when the vehicles run, the air at certain relative speed encroaches upon the motor, and ranges away its warmth. The warmth diverted by the air is because of regular convection, thusly this technique is known as Natural air-cooling. Motors mounted on 2-wheelers are for the most part cooled by regular air. As the warmth dispersal is an element of frontal cross-sectional region of the motor, along these lines there exists a need to extend this zone. A motor with broaden territory will winds up cumbersome and thusly will likewise decrease the power by weight proportion. Thus, as an elective course of action, blades are built to upgrade the frontal cross-sectional zone of the motor. Blades (or ribs) are sharp projections given on the surfaces of chamber square and barrel head. They increment the external contact territory between a chamber and the air. Blades are, by and large, threw indispensably with the barrel. They may likewise be mounted on the chamber.

A Fin is a surface that reaches out from an item to expand the rate of warmth exchange to or from nature by expanding convection.

The measure of conduction, convection, radiation of an item decides the measure of warmth it exchanges. Expanding the temperature contrast between the item and the earth, expanding the convection heat exchange coefficient, or expanding the surface territory of the article builds the Heat exchange. In some cases it isn't prudent or it isn't doable to change the initial two alternatives. Adding a balance to the item, be that as it may, expands the surface region and can now and then be conservative answer for warmth exchange issues. Circumferential blades around the chamber of an engine cycle motor and balances appended to condenser containers of an icebox are a couple of commonplace models.





II. LITERATURE REVIEW

The conclusion result are obtain by analysis of following research paper Mulukuntla Vidya Sagar,Nalla Suresh et al. (2017,)[1]

The Engine cylinder is one of the major automobile component, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of Heat transfer. By doing thermal analysis on the engine cylinder and fins around it, It is helpful to know the heat dissipation rate and Temperature Distribution inside the cylinder. We know that, By increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim of the present project is to analyse the thermal properties like Directional Heat Flux, Total Heat Flux and Temperature Distribution by varying Geometry(Circular, Rectangular), material (Aluminum Alloy, Magnesium Alloy) and thickness of Fin (3mm,2mm) of an approximately square cylinder model prepared in SOLIDWORKS-2013 which is imported into ANSYS WORKBENCH-2016 for Transient Thermal analysis with an Average Internal Temperature and Stagnant Air-Simplified case as Cooling medium on Outer surface with reasonable Film Transfer Coefficient as Boundary Conditions.

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University, Tehran, Iran[2] has stated that heat transfer in a straight fin with a step change in thickness and variable thermal conductivity which is losing heat by convection to its surroundings is developed via differential transformation method (DTM) and variation iteration method (VIM). In this study, we compare DTM and VIM results, with those of homotopy perturbaion method (HPM) and an accurate numerical solution to verify the accuracy of the proposed methods. As an important result, it is depicted that the DTM results are more accurate in comparison with those obtained by VIM and HPM. After these verifications the effects of parameters such as thickness ration, α, dimensionless fin semi thickness, δ, length ratio, λ, thermal conductivity parameter, β, Biot number, Bi, on the temperature distribution are illustrated.

Ajay Paul et.al.[3] Carried out Numerical Simulations to determine heat transfer characteristics of different fin parameters namely, number of fins, fin thickness at varying air velocities. A cylinder with a single fin mounted and explained it was tested experimentally. The numerical simulation of the same setup was done using CFD. Cylinders with fins of 4 mm and 6 mm thickness were simulated for 1, 3, 4 & 6 fin configurations. They concluded that 1. When fin thickness was increased, the reduced gap between the fins resulted in swirls being created which helped in increasing the heat transfer. 2. Large number of fins with less thickness can be preferred in high speed vehicles than thick fins with less numbers as it helps inducing greater turbulence and hence higher heat transferrin.

Babe and M. Lava Kumar[4] analysed the thermal properties by varying geometry, material and thickness of cylinder fins. The models were created by varying the geometry, rectangular, circular and curved shaped fins and also by varying thickness of the fins. Material used for manufacturing cylinder fin body was Aluminum Alloy 204 which has thermal conductivity of 110-150W/me and also using Aluminum alloy 6061 and Magnesium alloy which have higher thermal conductivities. They concluded that by reducing the thickness and also by changing the shape of the fin to curve shaped, the weight of the fin body reduces thereby increasing the efficiency. The weight of the fin body is reduced when Magnesium alloy is used and using circular fin, material Aluminum alloy 6061 and thickness of 2.5mm is better since heat transfer rate is more and using circular fins the heat lost is more, efficiency and effectiveness is also more.

Phani Raja Rao et.al [5] Analyzed the thermal properties by varying geometry, material and thickness of cylinder fins. Different material used for cylinder fin were Aluminum Alloy A204, Aluminum alloy 6061 and Magnesium alloy which have higher thermal conductivities and shown that by reducing the thickness and also by changing the shape of the fin to circular shaped, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The results shows, by using circular fin with material Aluminium Alloy 6061 is better since heat transfer rate, Efficiency and Effectiveness of the fin is more.

Fernando Allan[6] simulated the heat transfer from cylinder to air of a two-stroke internal combustion finned engine. The cylinder body, cylinder head (both provided with fins), and piston have been numerically analysed and optimized in order to minimize engine dimensions. The maximum temperature admissible at the hottest point of the engine has been adopted as the limiting condition. Starting from a zero-dimensional combustion model developed in previous works, the cooling system geometry of a two stroke air cooled internal combustion engine has been optimized in this paper by reducing the total volume occupied by the engine. A total reduction of 20.15% has been achieved by reducing the total engine diameter D from 90.62 mm to 75.22 mm and by increasing the total height H from 125.72 mm to 146.47 mm aspect ratio varies from 1.39 to 1.95. In parallel with the total volume reduction, a slight increase in engine efficiency has been achieved.

III. METHODOLOGY

The primary point this task is to build the warmth dissemination rate of the given motor barrel and to investigate dispersion of various properties like Temperature, Total warmth motion and Directional warmth transition by fluctuating the material utilized for the chamber, Geometry of the Cylinder and Linear Dimensions. There are two different ways to expand the rate of Heat exchange for dissemination of Heat from the Cylinder dividers

1. Expanding the Surface Heat exchange coefficient,
2. Expanding the Outer surface region of the Component (Cylinder) which is in contact with the surrounding barometrical air.

3.1Problem Definition:

In the present Project examination on warm issues on car blades were completed. Examination yields the temperature conduct and Total Heat transition and

Directional heat motion of the Cylinder blades because of high temperature in the burning chamber.
The investigation is improved the situation diverse models of just about a circular motor and a correlation is accordingly settled between them by evolving geometry.

3.2 ANSYS Workbench
The ANSYS Workbench Toolbox shows the kinds of information that you can add to your undertaking. The Toolbox is setting delicate; as you select distinctive things in the Project Schematic or different workspaces, the substance of the Toolbox may change to mirror the segments and activities accessible to you. When working in different workspaces, for example, Engineering Data or Parameters, you can come back to the Project Workspace by tapping the Return to Project catch on the Toolbar.
Assumptions for analysis:

- The temperature of the surrounding air does not change significantly.
- Constant heat transfer coefficient is considered at the air side.
- The heat generation is neglected.
- Loads are constant.
- Most of physical properties are constant

IV. GEOMETRY DETAIL

The geometrical modal is divided into two parts
1) Main geometrical modal
2) Modified geometrical modal

1) Main geometrical modal:-
1. Understand the given model's best and textual style sees plainly and their measurements,
2. Adjust the Unit system in CATIA V5 as SI system.
3. Draw one side of front view with assumed dimensions.
4. Draw the fin length, groove length, upwards projection of cylinder and Projection distance from centre line.
5. The internal and external diameter of the cylinder are fixed,
6. Then by using revolute command revolute the drawn section,
7. Now the geometrical modal is ready.

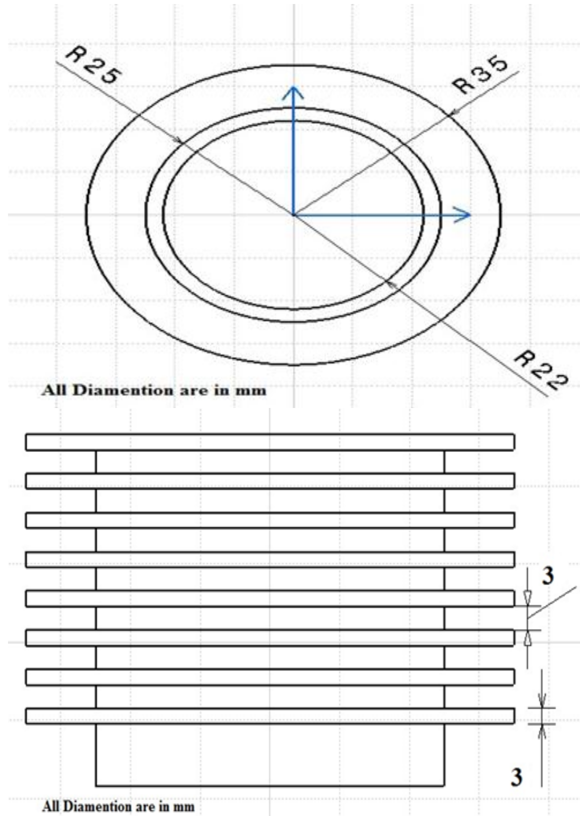


Fig. 3.1 geometrical modal of cylinder barrel

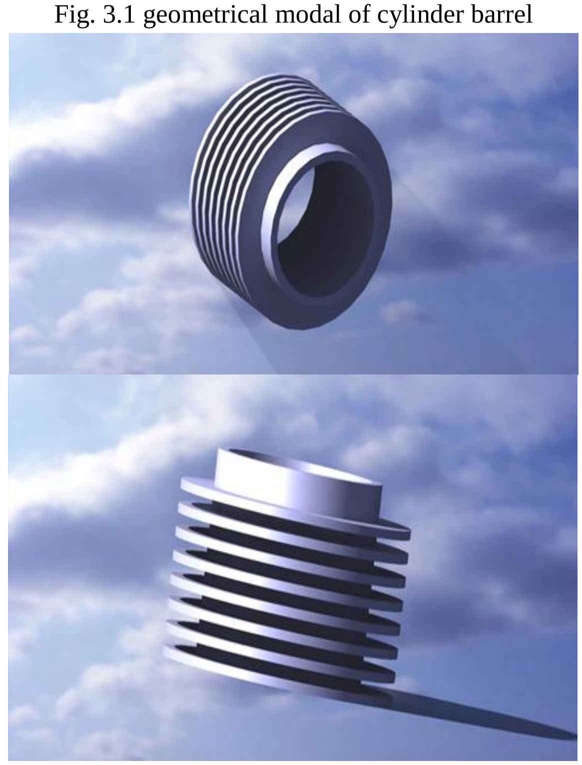
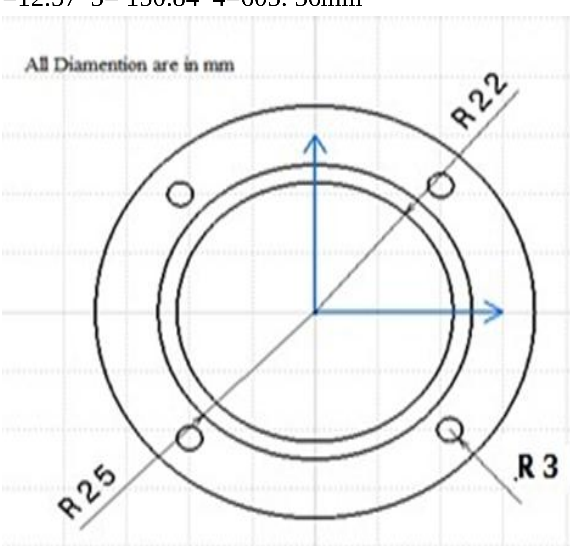


Fig. 3.2 geometrical modal of cylinder barrel in CATIA V5

2) Modified geometrical modal
1. Draw the same modal as old model.
2. 2. Now draw the modified geometry on the top view of the cylinder barrel.
3. Select the necessary commend &draw the modified modal.

2.1 surface geometry:-
If we consider single circular fin, then total area of the fin is
Area of the fin (a)
$a = \pi(35)^2 - \pi(25)^2$
= 3848.451 – 1963.495
= 1884.956 mm^2
Surface area of the thickness of the fin
$2\pi r = 2\pi(35)$
=219.91*3
=659.73 mm^2
Total surface area (A)
= 1884.956+ 659.73+1884.956
A = 4429.642 mm^2
After creating a hole of 2 mm radius at 4 times then we have lost some area but also we can get some extra surface area.
We lost some area
$= \pi r^2$
$= \pi(2)^2$*2=25.14
= 25.14*4= 100.56mm^2
And we are getting more area
$= 2\pi r$
= $2\pi(2)$ = 12.57
=12.57*3= 150.84*4=603. 36mm^2



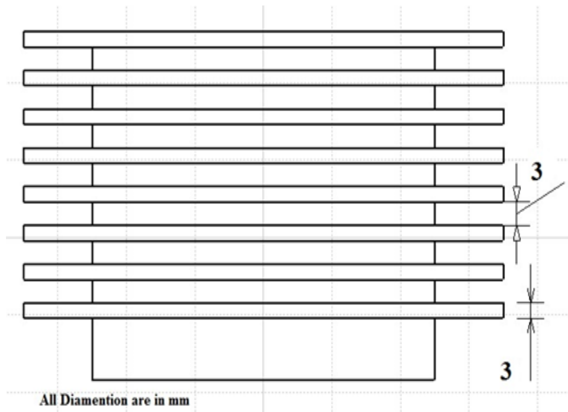


Fig 3.3 geometrical modal of modified cylinder barrel

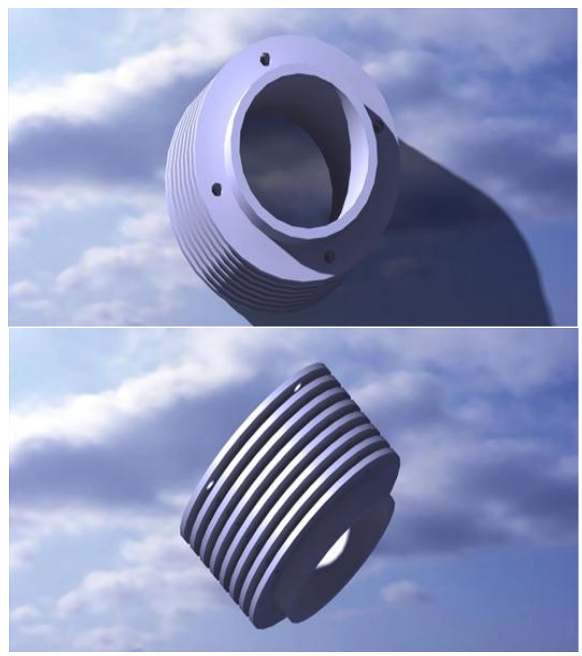


Fig 3.4 geometrical modal of modified cylinder barrel in CATIA V5

V. EXPERIMENTAL DETAIL

4.1 BOUNDRY CONDITION

S.N.	LOADS	UNITS	VALUE
1	Inlet temperature	K	1073
2	Film coefficient	W/m^2K	5
3	Ambient temperature	K	303
4	Material		Aluminium Alloy,

4.2. MATERIAL DATA:
Aluminium Alloy:

Density	2770 kg m^-3
Coefficient of Thermal	2.3e-005 C^-1

Expansion	
Specific Heat	875 J kg^-1 C^-1

Now we analyse both models in the ANSYS software. First we insert both models in ANSYS software &after that we mesh the model & calculate the result.

VI. MESHING OF THE MODEL

Meshing is defined as the process of dividing the whole component into number of elements so that whenever the load is applied on the component it distributes the load uniformly called as meshing.

Meshing is just a tool used in the designing software to divide the whole component into finite no. of small elements as per requirement. The size of the divided element must be as small as possible so that the total no. of of elements divided must be large as possible, which helps the the results to be accurate.

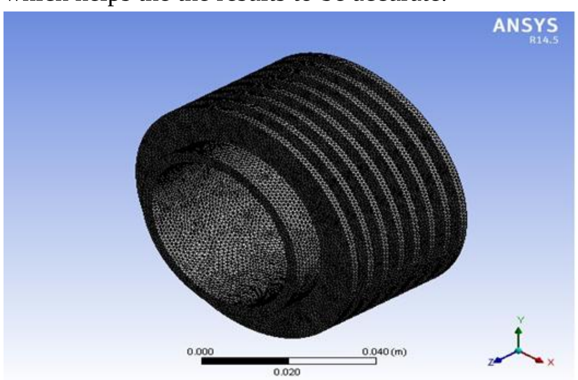


Fig 5.1 Meshing of main cylinder model

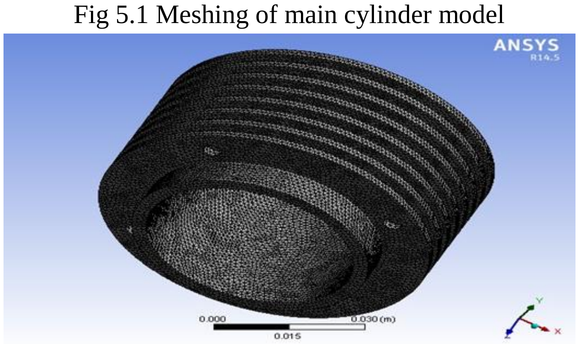


Fig 5.2 meshing of the modified geometry model

VII. RESULT & DISSCUSION

In the present analysis we will analyse both Heat flux and heat transfer distribution. In both the analyses we will see what happens in the Heat flux and heat transfer; instead we are improving the engine surface area of the cylinder.

In this analysis, we will also look at the two types of analysis.

(1) Steady state analysis,

(2) Transient state analysis.

In Transient state analysis, we take some time to analyse the interval in the analysis and see what the difference in heat distribution & heat flux and how much heat distribution is done over time. In this analysis, we have made the cylinders of aluminium alloy, if we change it, and then take another material, and then what difference does it take?

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