THERMAL ANALYSIS OF PISTON BLOCK USING FINITE ELEMENT ANALYSIS

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***Abstract*: Based on internal combustion engine block, using the finite element analysis software ANSYS to simulate and evaluate the thermal effect. Firstly, solid model created using CATIA and analysed using finite element model of engine block with different modified fin are established using relevant software, and the necessary simplify operation according to the needs of finite element analysis is carried out on the block. In this study, it has been observed that the cross section of the fin is the main factor for heat transfer, hence the analysis has been done for different fin cross section to minimize the loss and improve the efficiency of the engine. The better fin design has been reduced the heat flux. After analysis the present results are compared the thermal effect of block in literature.**

***Keywords*: Piton Block, Finite Element Analysis, ANSYS, Thermal Analysis.**

1. INTRODUCTION

In a combustion chamber of internal combustion engine, combustion occur at high temperature and pressure due to which chances of piston seizure, overheating, chances of piston ring, compression ring, oil ring etc can be affected. Excess temperature can also damage the cylinder material. Due to overheating chances of pre-ignition also occurs. In Air cooled motorcycle engines heat release to the atmosphere through forced convection. The rate of heat transfer depends upon the wind velocity, geometry of engine surface, external surface area and the ambient temperature. In this work analysis is done on engine block fins considering temperature inside by means of conduction and convection, air velocity is not considered in this work. Motorbikes engines are normally designed for operating at a particular atmosphere temperature, however cooling beyond optimum limit is also not considered because it can reduce overall efficiency. Thus, it may be observed that only sufficient cooling is desirable. Inside the cylinder the temperature of gases will be around 800-2000. This is very high temperature and may result into burning of oil film between the moving parts this temperature must be reduced to about 150-200 at which engine will work more efficiently.

1.1 Overview (Piston Block)

Cylinder is the one of the major components in Engine, which is subjected to high temperature variations and thermal stresses.

1.1 Piston

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. In some engines, the piston also acts as a valve by covering and uncovering ports in the cylinder

1.2 Types of piston

The types of piston are:
- Trunk pistons
- Crosshead pistons
- Slipper pistons
- Deflector pistons
- Racing Pistons

1.3 Thermal Analysis of piston block

The internal combustion engine is an engine in which the combustion of a fuel (a fossil fuel) occurs with an oxidizer (usually air) inside a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and pressure gases produced by combustion applies a direct force to the reciprocating piston thus producing the rotary motion of the crankshaft. This force moves the component over a distance, generating useful mechanical energy. All IC engines include five general processes:
- An intake process, during which air or a fuel–air mixture is inducted into the combustion chamber
- A compression process, during which the air or fuel–air mixture is compressed to higher temperature, pressure, and density

- A combustion process, during which the chemical energy of the fuel is converted to thermal energy of the products of combustion
- An expansion process, during which a portion of the thermal energy of the working fluid is converted to mechanical energy

1.4 Fins

In study of heat transfer, a fin is a surface that it is extends from an object to increase the rate of heat transfer. Fin act as the important part that help to reduce the distribution of overheat by the engine block. In Many thermal applications heats has to be removed from a small area to the surrounding (or) Environment to maintain it in a steady state condition.

2. PROBLEM IDENTIFICATION

In this field of design engineering, the main problem has been arrived in the piston due to its air dynamic conditions and weight of the piston head. In this study, it has been observed that the cross section of the fin is the main factor for heat transfer, hence the analysis has been done for different fin cross section to minimize the loss and improve the efficiency of the engine. The better fin design has been reduced the heat flux.

3. METHODOLOGY

In the present investigation, the finite element analysis has been considered for the done analysis and obtained the results.

In this work, the model of piston heat has been created using Catia 3D modeling software as shown in Figure 1. The Catia software is used for in field of 3D robust design. The part of Catia is export in Ansys analysis software, which provided the better results in different field like; Structure, Thermal, fluid etc.

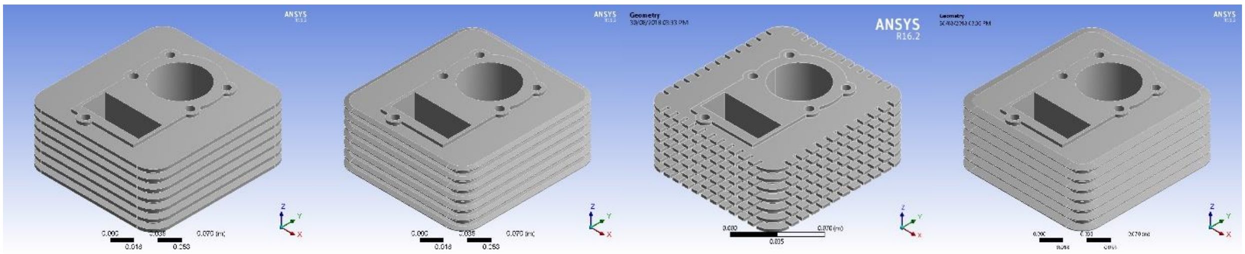

Figure 1. 3D Model of piston block for analysis (import into Ansys 16.2)

After modeling has been done, the model is imported in Ansys software. The Ansys tool follows the main three steps for done performed;

1. Pre-Processor:
2. Solution and Setup
3. Post-Processor

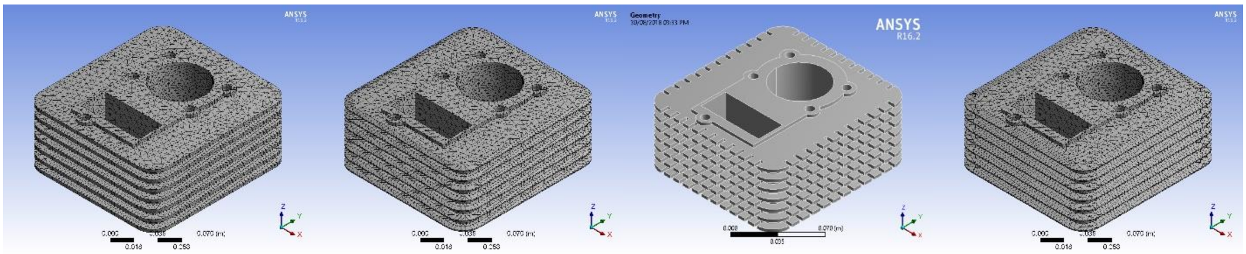

Figure 2. Meshed view of piston model (Plain fin, Equii chamfered fin, Cutted fin and Variable chamfered piston block)

In the first step, the model has been imported and apply meshing with unstructured fine meshing as shown in Figure 2. During meshing more than 100000 and 50000 nodes and elements are formed for all modified models.

In second step, the boundary conditions were applied like; temperature, convection etc. as shown in Figure 3.

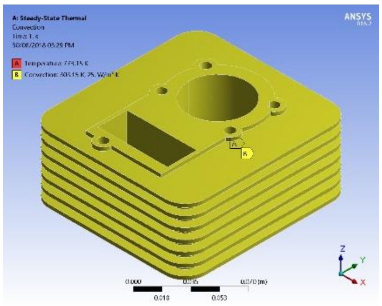

Figure 3. Boundary conditions applied in the piston block

In last, step, the various results are obtained in form of counters and graphs which are as shown in Figure 4 and Figure 5 and discussed in next section.

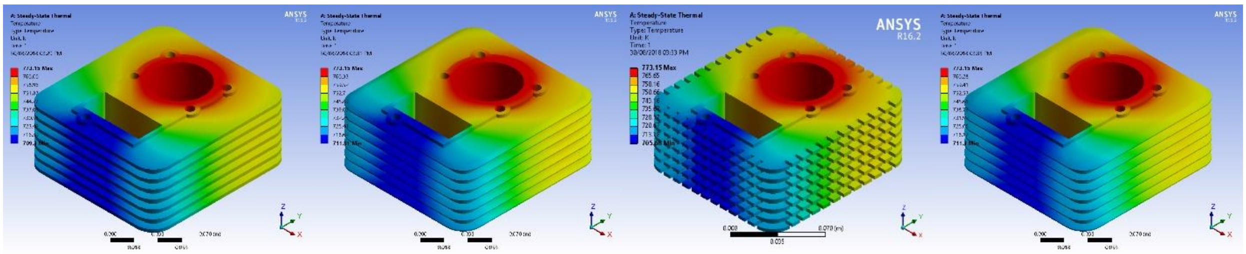

Figure 4. Temperature distribution of different piston block (Plain fin, Equii chamfered fin, Cutted fin and Variable chamfered piston block)

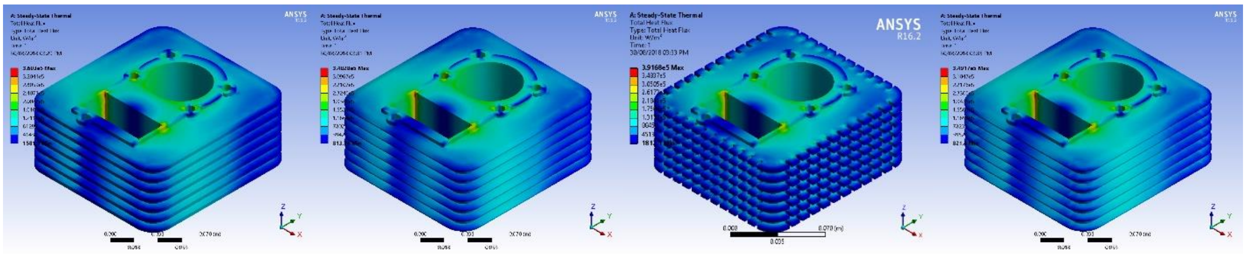

Figure 5. Total heat flux distribution of different piston block (Plain fin, Equii chamfered fin, Cutted fin and Variable chamfered piston block)

4. RESULTS AND DISCUSSIONS

In this section will discussed of obtained results from Ansys 16.2 with different modified design piston block.

Table 1. Results of maximum temperature distribution from the different types of piston block and existing or plain piston block.

Cases	Shrivastava and Upadhyay [1]	Present [Ansys]
1	773.15	709.3
2	-	711.81
3	-	705.68
4	-	711.3

Table 2. Results of total heat flux from the different types of piston block and existing or plain piston block.

Cases	Shrivastava and Upadhyay [1]	Present [Ansys]
1	0.8574	0.3603
2	-	0.34828
3	-	0.39168
4	-	0.34917

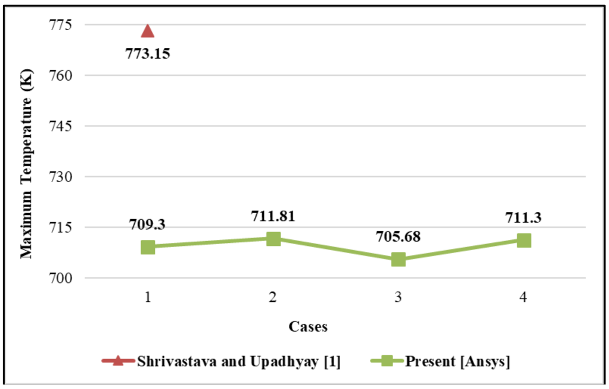

Figure 6. Graphical representation of maximum temperature in piston block

The Figure 6, indicates that the variation of maximum temperature distribution over the piston block with different modified design. In this figure it has clearly shows that the increases the maximum temperature of the piston block of variable chamfered piston block as compared to plain fin, equii chamfered fin and cutted fin.

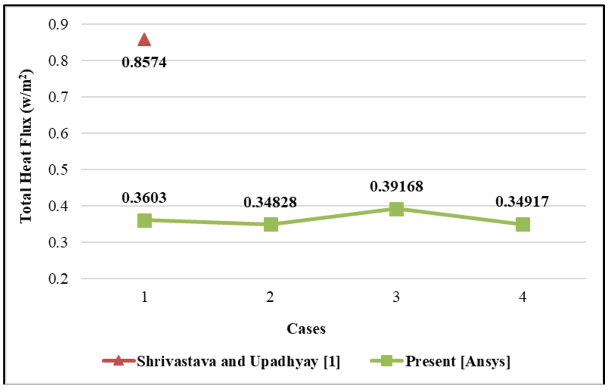

Figure 7. Graphical representation of total heat flux flow in piston block

The Figure 7, indicates that the variation of heat flux distribution over the piston block with different modified design. In this figure it has clearly shows that the decreases the heat flux of the piston block of variable chamfered piston block as compared to other three.

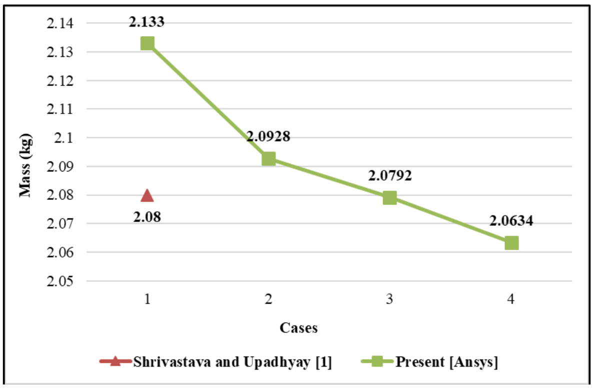

Figure 8. Graphical representation of mass reduction of piston block during modification

The Figure 7, indicates that the variation of mass of the piston block with different modified design. In this figure it has clearly shows that the mass of piston block has been gradually decreases of variable chamfered piston block as compared to other three with acceptable limit.

5. CONCLUSION

In this work it has been concluded that, firstly, solid model created using CATIA and analyzed using finite element model of engine block with different modified fin are established using relevant software, and the necessary simplify operation according to the needs of finite element analysis is carried out on the block. After analysis has been done the model is compared the thermal effect of block in literature. In this study, it has been observed that the cross section of the fin is the main factor for heat transfer, hence the analysis has been done for different fin cross section to minimize the loss and improve the efficiency of the engine. The better fin design has been reduced the heat flux.

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