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# Thermal Analysis of IC Engine cylinder fins using Ansys

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***Abstract**:* The fins of engine cylinder are one of the vital components of IC engine which is essential for dissipation of excess heat. The objective of current research is to evaluate the heat dissipation characteristics of engine cylinder with extended fin member. The thermal analysis of engine cylinder is conducted using techniques of Finite Element Analysis. The engine cylinder is designed in Creo parametric software and thermal analysis is conducted using ANSYS simulation package. The application of FEA tool enabled to investigate the thermal characteristics of engine cylinder with different designs. From the temperature distribution data, the intersection region between cylinder and fins has higher magnitude as compared to other regions. The high thermal gradient at the interface of engine cylinder and fins causes higher heat flux and thus higher heat dissipation rate. The second design with extended members has resulted in significant enhancement of heat dissipation rate as compared to first design.

***Key Words:** Engine cylinder, fins, thermal analysis*

## 1. INTRODUCTION

In an IC engine, the cylinder head is one of the vital component which is exposed to extreme pressure and temperatures. It comprises of various section as shown in figure 1. These are cylinder bores, mountings, bearing support etc.

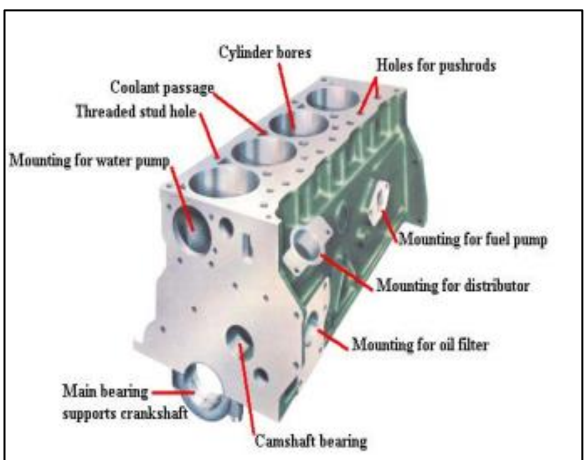


Figure 1: Cylinder Head [1]

The cylinder head is required to mount intake and exhaust valve ports which compromises its design. The overheating in various regions of cylinder heads causes failures like distortion. Various regions of engine cylinder experience high temperature and these regions are valve seats and narrow bridges between valves. These regions experience especially “severe thermal loading, as they receive heat not only from in-cylinder burning gases during the combustion period but also from burned gases flowing through the exhaust valve and along the exhaust-port walls during the exhaust” [1].

## 2. LITERATURE REVIEW

Ch. Venkata rajam et al (2013) [2] have conducted numerical investigation on piston using ANSYS FEA simulation package. The component analysed was piston made of high strength to weight ratio. The CAD modelling of piston is done using CATIA V5 software and the FEA results have enabled to identify the regions of high deformation and equivalent stress. The research also suggested the reduction in piston width by 25%.

Ekrem buyukkaya et al (2007) [3] investigated "thermal behaviour of uncoated piston made from Aluminium silicon alloy and with thermal coating of $MgO$-$ZrO_2$. The FEA analysis was conducted using ANSYS software to determine temperature distribution. The piston skirt region has highest temperature and with the use of coating the heat is retained at 326 °c for cast iron" [3].

Muhammet cerit et al (2010) [4] have conducted experimental investigation on IC engine using ceramic coating. The comparative analysis is conducted between coated and uncoated pistons. The research findings have shown piston temperature of 82.5$^o$C when coating of .35mm thickness is used.

Xiqun lu et al (2013) [5] have conducted investigation on diesel engine used in marine vessel. The FEA analysis conducted on the engine to determine heat transfer and temperature distribution. The experimental testing is also conducted on diesel engine and thermocouples are used to measure the temperature. The experimental results are validated with numerical results.

Isam jasim jaber et. al. (2014) [6] conducted FEA analysis on piston subjected to structural loads. The "piston taken for FEA analysis is 4-stroke petrol engine. The stress distribution plot showed that the regions underneath the piston crown has highest magnitude of stress and highest temperature is observed at centre region of piston top surface" [6].

Vaishali r. Nimbarte et. al. (2015) [7] have conducted research on evaluation of thermal behaviour of piston using techniques of finite element method. The regions of high thermal stress and equivalent elastic strain are determined from FEM results. The FEM results have shown that piston land region has maximum temperature and stresses.

## 3. OBJECTIVES

The objective of current research is to evaluate the heat dissipation characteristics of engine cylinder with extended fin member. The thermal analysis of engine cylinder is conducted using techniques of Finite Element Analysis. The engine cylinder is designed in Creo parametric software and thermal analysis is conducted using ANSYS simulation package.

## 4. METHODOLOGY

The FEA analysis is conducted on engine cylinder using 3 different stages i.e. pre-processing, solution and post processing.

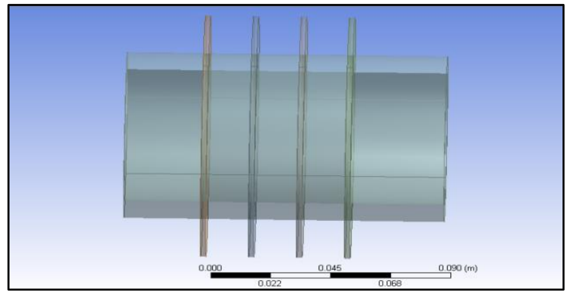


Figure 1: Design of engine cylinder without extended member

The model of engine cylinder with straight fins and fins with extended members is developed in 3D creo parametric design software. The engine cylinder model is then imported in design modeller module of ANSYS software.

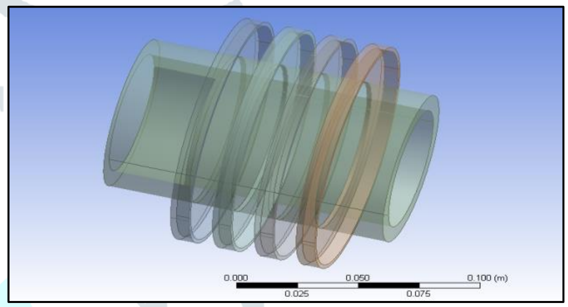


Figure 2: Design of engine cylinder with extended member

The first design of engine cylinder without extended member is shown in figure 1 and second design of engine cylinder with extended member is shown in figure 2. The first model of engine cylinder is meshed using hexahedral elements as shown in figure 3. The model is meshed using fine relevance of 80 and growth rate set to 1.1.

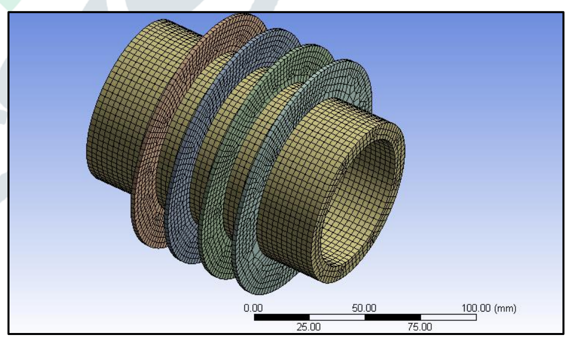


Figure 3: Meshed model of engine without extended member

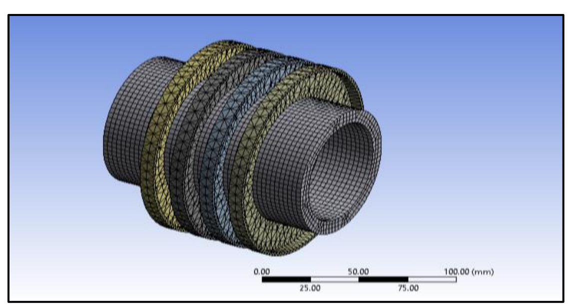


Figure 4: Meshed model of engine with extended member

The model with extended member is meshed with hexahedral and with tetrahedral elements. The hexahedral element is used for topologically consistent zone i.e. cylinder and the extended member is meshed with tetrahedral element type.

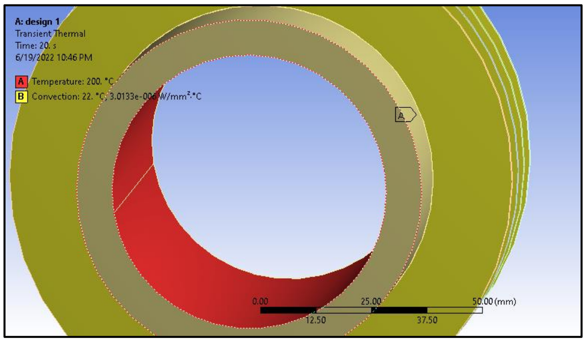

Figure 5: Loads and boundary condition on engine cylinder

After meshing, the thermal loads and boundary conditions are applied on the engine cylinder. The inner face of the cylinder is applied with the temperature as shown in red colour. The magnitude of temperature applied is $200^0$C and convective boundary is defined on other surface.

## 5. RESULTS AND DISCUSSION

The thermal analysis is conducted on the engine cylinder to determine temperature distribution and heat flux plot.

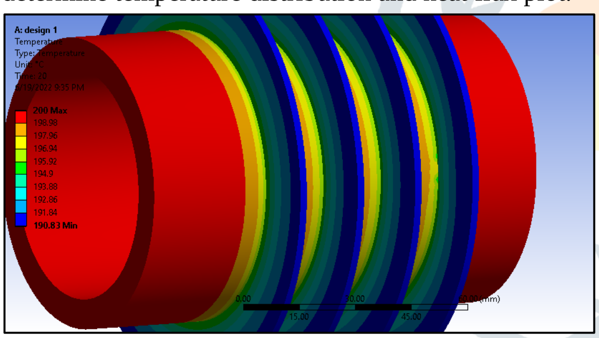

Figure 5: Temperature distribution plot for cylinder without extended member

The temperature on the inner side of the cylinder surface is maximum as shown in red coloured zone. The temperature reduces radially outwards and is nearly $190^0$C at the fin end.

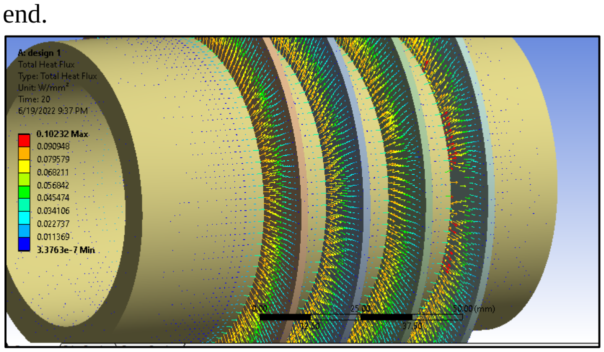

Figure 6: Heat flux vector plot for cylinder without extended member

The heat flux vector plot is generated for engine cylinder without fins as shown in figure 6 above. The maximum heat flux of .0909W/mm$^2$ is observed at the interface of fins and cylinder and the heat flux reduces radially outwards.

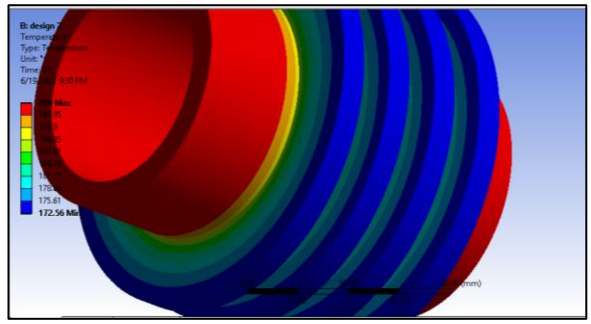

Figure 7: Temperature plot of cylinder with extended members

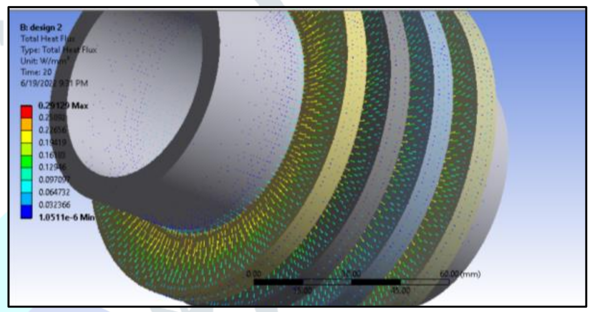

Figure 8: Heat flux vector plot of cylinder with extended members

The temperature distribution plot is generated for engine cylinder with fins having extended members as shown in figure 7 above. The temperature at the outer region of the fins is nearly $178^0$C. The heat flux vector plot is determined for the cylinder having fins with extended members. The heat flux at the interface region is more than .258W/mm$^2$.

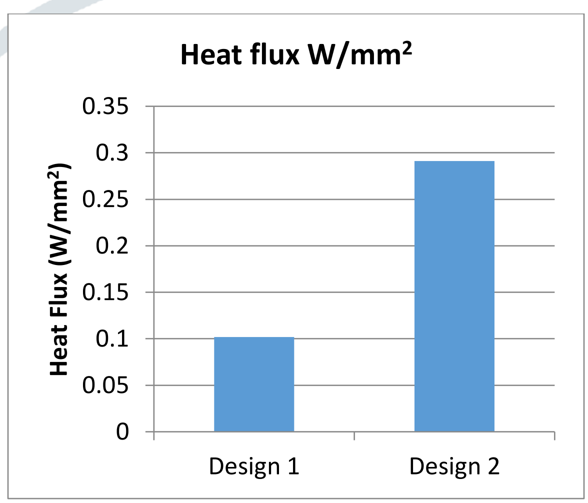


Figure 9: Heat flux comparison between designs

The heat dissipation rate is compared between both designs i.e. design 1 and design 2. As it's evident from figure 9 above, the heat dissipation achieved is higher for design 2.

## 6. CONCLUSION

The application of FEA tool enabled to investigate the thermal characteristics of engine cylinder with different designs. From the temperature distribution data, the intersection region between cylinder and fins has higher magnitude as compared to other regions. The high thermal gradient at the interface of engine cylinder and fins causes higher heat flux and thus higher heat dissipation rate. The second design with extended members has resulted in significant enhancement of heat dissipation rate as compared to first design.

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