JOURNAL OF AERONAUTICAL MATERIALS
ISSN: 1005-5053

Vol. 43, Issue-01, 2023
pp. 1303-1311

HEAT TRANSFER ANALYSIS AND OPTIMIZATION OF ENGINE FINS OF VARYING GEOMETRY USING COMPOSITE MATERIAL

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ABSTRACT

The cylinder is one of the main parts and the heart of the engine. The cylinder of the engine is one of the key components of the vehicle and is prone to maximum temperature thermal stress. The cylinder fin is designed to cool the cylinder to improve the heat transfer rate. Thermal analysis is done on engine cylinder fins, it is very useful to understand the heat dissipation in the cylinder. The variation of Temperature distribution over time is of interest in many applications such as cooling. Fins are the extended surfaces that help to dissipate heat generated in the engine but these extended surface lengths are limited which limits the rate of heat dissipation. Heat transfer enhancement in fins can be increased by using porous fins. Various automobile industries work to increase this heat dissipation rate by which engine efficiency and the saving in the power supplied can be increased. The idea applied in this project is to increase the heat dissipation in the cylinder engine. In this paper, work has been done to increase the heat dissipation rate by varying the geometry of the fin using an ANSYS workbench. The 100cc engine cylinder fins are carried out to analyze the heat transfer rate in the engine cylinder. The material used for the fin body is Al6061. The result is compared to find the best geometry which gives the maximum heat flux.

Keywords: - Engine cylinder fin, Heat flux, Temperature distribution, ANSYS, Al6061

INTRODUCTION

IC engine is one of the most important machines made by humans. The main design of a combustion engine has not changed for many years. The performance of automobile vehicles depends on the performance of the engine. In this paper or experiment, the engine cylinder fin geometry is changed to get better output. Fins are extended surfaces, they are used to increase the rate of heat transfer[1][2][3]. In the engine cylinder heat dissipation should be greater than heat generation for better output. When the fuel is burned by starting the vehicle, 70% of the heat is lost into the atmosphere and 30% of the heat generated in combustion is utilized. If this heat does not dissipate properly, it may affect the engine cylinder. So, fins are used for proper heat dissipation in the engine cylinder and to prevent thermal damage. For this purpose, fin efficiency should be high. So, fin efficiency can be improved by changing the shape and geometry of fins. The present research analyzes the output of different geometry fins of the engine cylinder. This process is performed on ANSYS software [4][5][6].

Fins are stretched surfaces hanging from an object or surface, aiming to increase the heat transfer rate between the surface and the surrounding fluid by increasing the heat transfer area. Fins are modifications on the external surfaces of objects which, by increasing convection, Increase the rate of heat transfer with the material [7][8]. This is achieved by increasing the surface area of the body, and the increase in surface area increases the speed of heat transfer to a sufficient degree. This is an effective way to increase the rate because another way to do this is to increase the heat transfer coefficient (depending on the nature of the material used and the conditions of use) or the temperature gradient (depending on the Conditions of use). It is more convenient to adjust the shape of the body[9][7][2]. Therefore, to increase the heat transfer from the surface, fins are a very common solution and are widely used in various articles. Preferably, the fin content should have high thermal conductivity. In most applications, the heat sink is surrounded by the fluid in motion. Due to the large surface area, the fluid quickly heats or cools it, and then due to the increased thermal conductivity of the heat sink, heat is quickly transferred to or from the body. For a specific application, the size and shape of the heat sink must be determined to obtain the best heat transfer efficiency at the minimum cost[10][11][12].

Fins are usually used on the fixed surface to extend the surface as well as to increase the transfer rate. It is used to increase the heat transfer rate in the environment. The fins are usually located on the burning rate. The internal combustion engine can transfer heat from there. The fin can be classified into the following type [1].

1. Constant area straight fin
2. Variable area straight fin
3. Pin fin
4. Annular fin

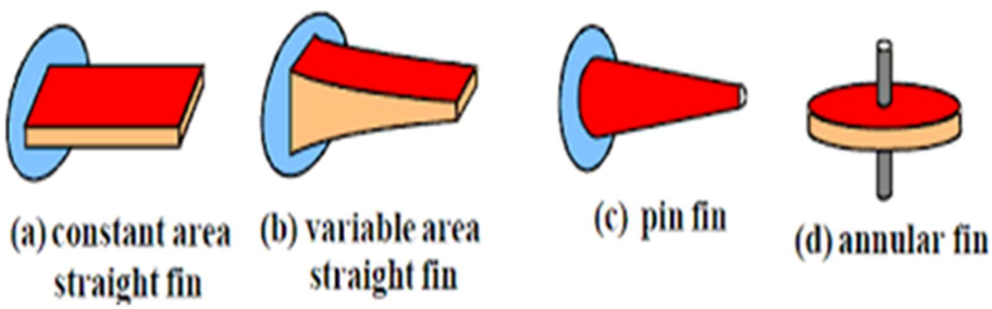

Figure 1. Types of fins [1]

Material and its properties

The strength and physical qualities of all metals improve when their composition is combined with the composition of other materials in little (or large) amounts. The use of materials with better conductivity improves the effectiveness of fins. Aluminium alloys containing silica are more thermally conductive than pure aluminium. The characteristics of Aluminium were applied to an existing model of an engine cylinder with various shape fins. Aluminium's structural and thermal characteristics are listed below[4].

Material = Al 6061

Thermal Conductivity = 180W/mk

Specific heat capacity = 0.896J/g^{o}C

Density = 2.7g/cc

Heat transfer coefficient (h) = 22W/mk2

Different geometry of engine cylinder fin

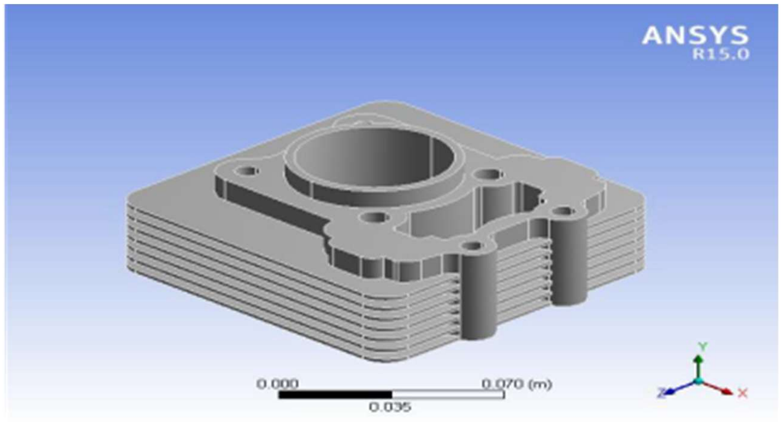

Figure 2. 3-D Model of engine cylinder with standard fin

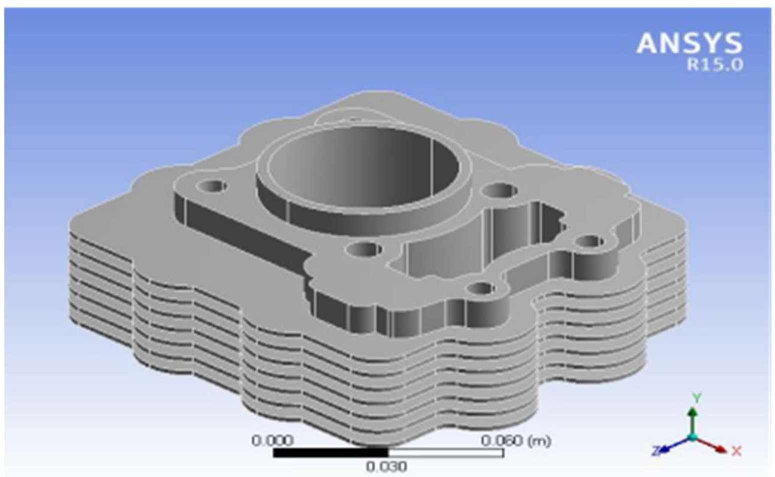

Figure 3. 3-D Model of engine cylinder with curve fin

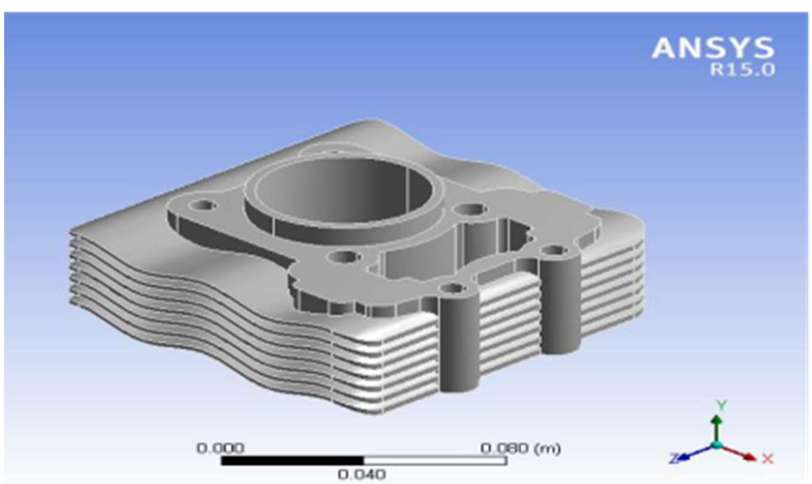

Figure 4. 3-D Model of engine cylinder with wave fin

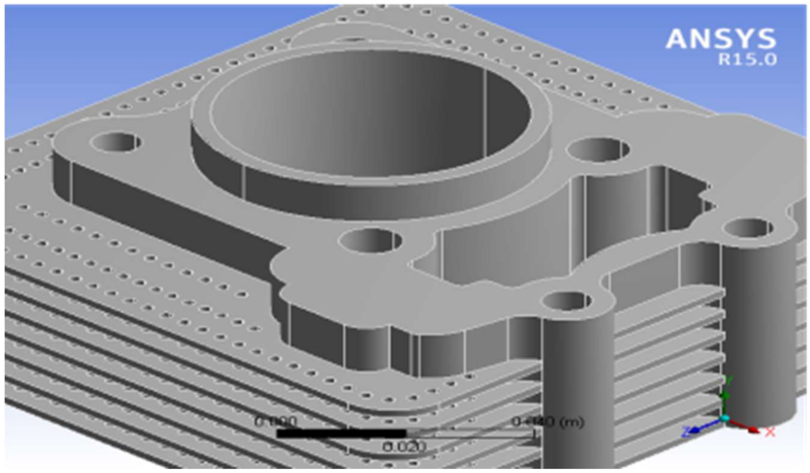

Figure 5. 3-D Model of engine cylinder with pin hole fin

Result and discussion

Completion of the process optimal outcome of solving process has culminated in the post-processor outcome. It has been seen from the result portion that the current one is a new design that has established the temperature of the total heat flux that has been measured. The design process focuses primarily on temperature and total heat flux. Thus, the results section of the various forms of fin geometry design shows the difference in temperature and heat flux according to the design. In each type of design, comprehension is often carried out to achieve an effective and efficient design for the optimum heat dissipation in the engine. The comparison results calculated the increase of the heat flux and temperature range in the new design.

A total of four-cylinder designs have been made to perform the thermal study. Their design variations are based on fins design which is mentioned below.

Temperature analysis of different geometry fins

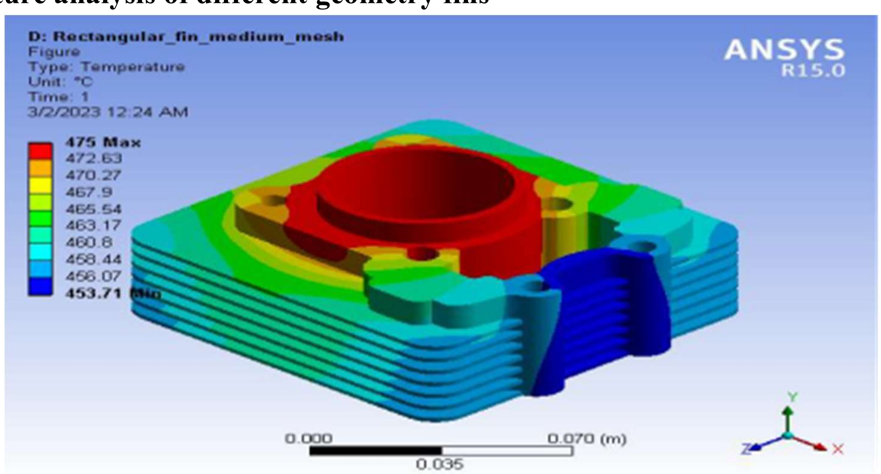

Figure 6. Temperature distribution for engine cylinder with standard fin

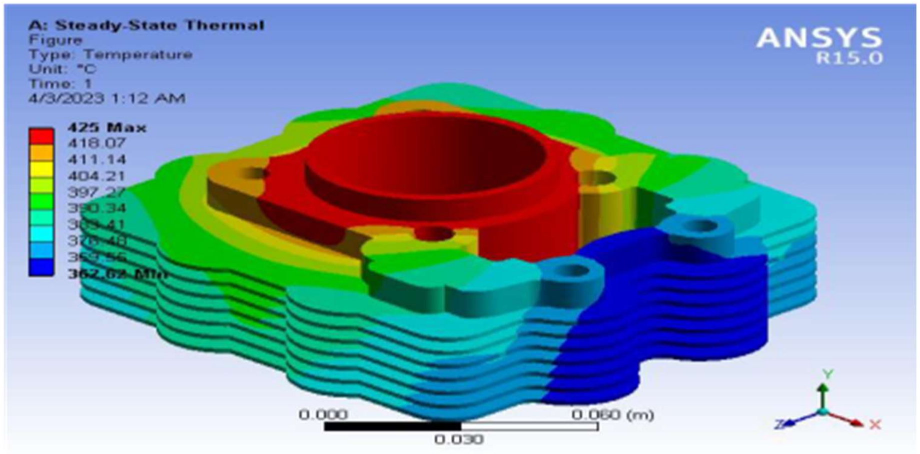

Figure 7. Temperature distribution for engine cylinder with curve fin

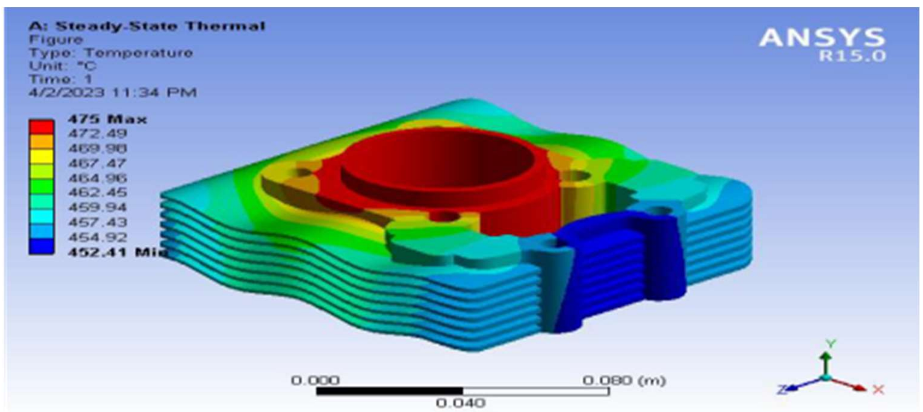

Figure 8. Temperature distribution for engine cylinder with wave fin

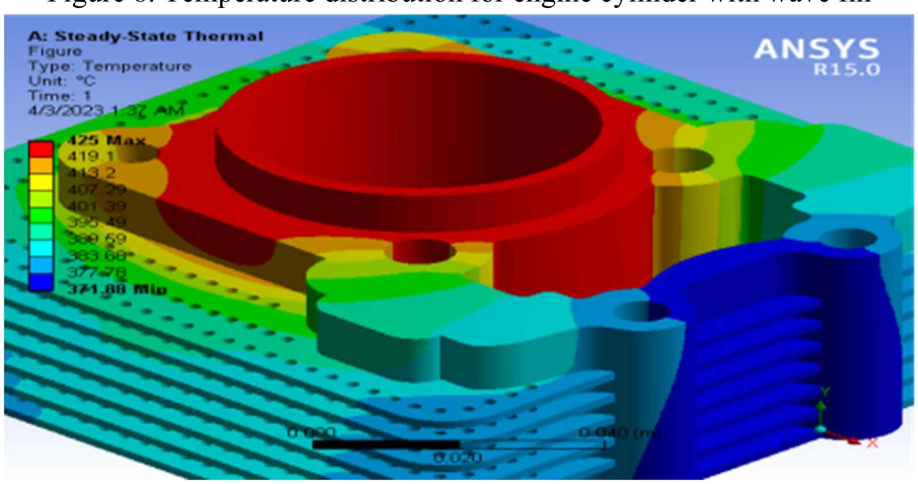

Figure 9. Temperature distribution of engine cylinder with pinhole

Table 1. Temperature distribution

S. No	Model	Maximum Temperature	Minimum Temperature	Change in min temp. compared to standard design
1.	Standard fin	475ºC	453.71ºC	_

2.	Curve fin	425ºC	362.62ºC	91.09ºC
3.	Wave fin	475ºC	452.41ºC	1.30ºC
4.	Fin with pinhole	425ºC	371.88ºC	81.83ºC

Heat flux analysis of different geometry fins

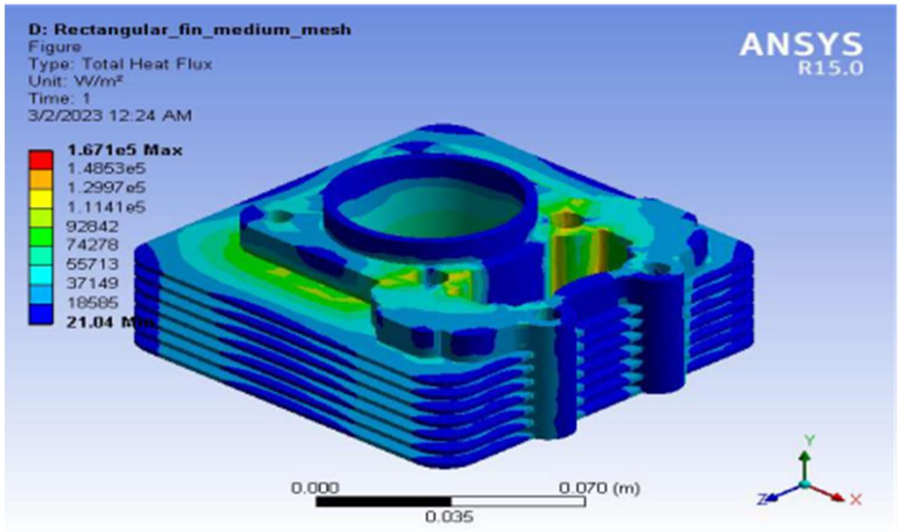

Figure 10. Total heat flux of standard fin

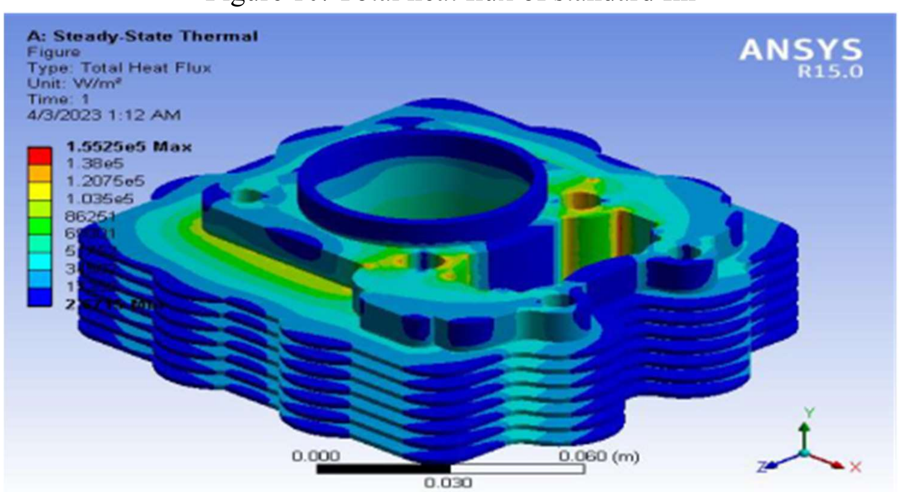

Figure 11. Total heat flux of curve fin

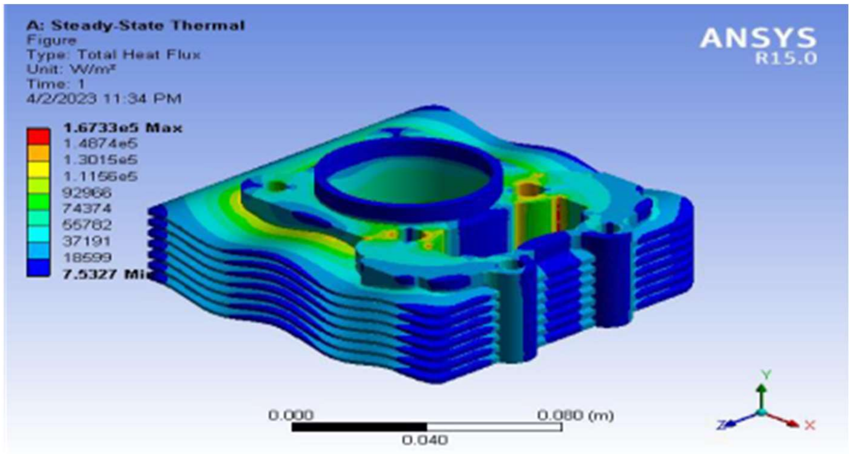

Figure 12. Total heat flux of wave fin

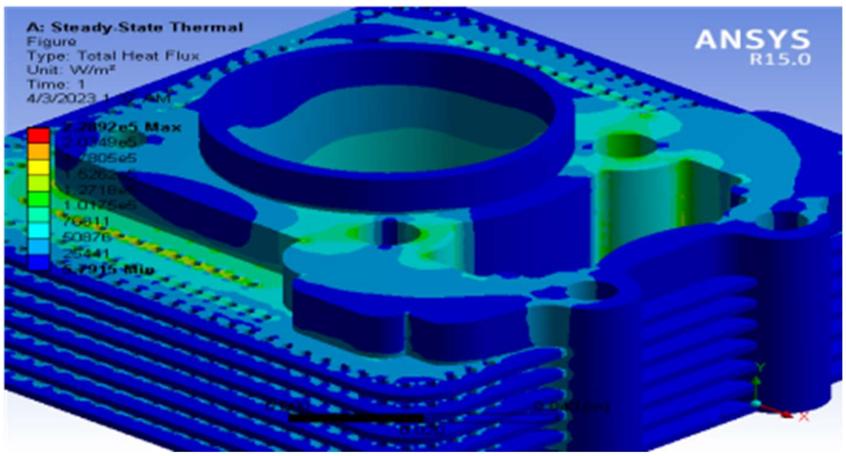

Figure 13. Total heat flux of pinhole

Table 2. Heat flux

S. N0	Model	Max. heat flux (KW/m^2)	Min heat flux (KW/m^2)
1.	Standard Fin	167.1	.2104
2.	Curve Fin	155.25	0.026715
3.	Wave Fin	167.33	0.075327
4.	Fin with pinhole	228.92	0.057915

Comparison Graph of heat flux and temperature of engine fins with varying geometry

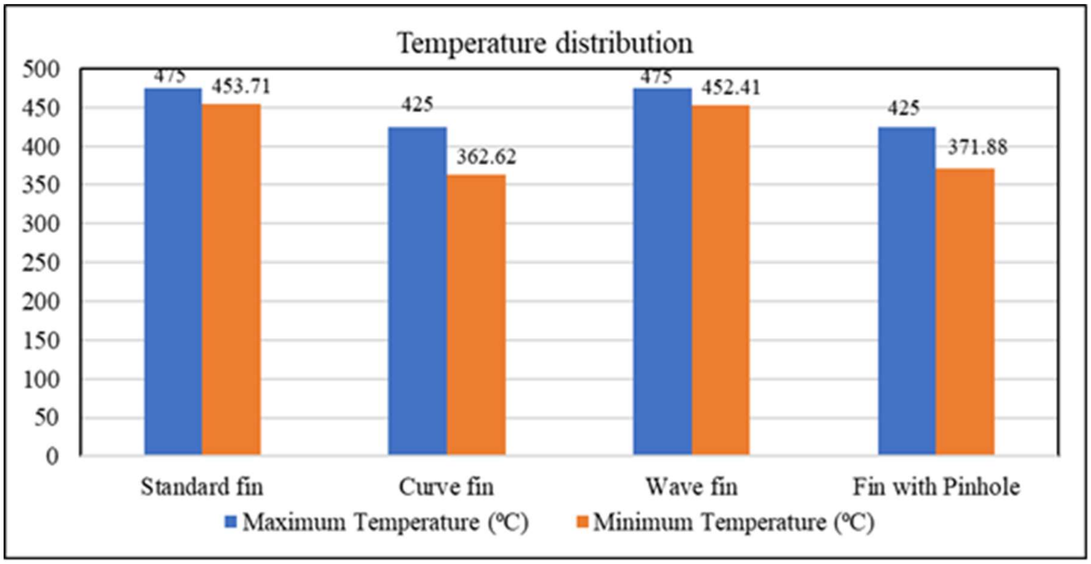

Figure 14. Maximum and minimum temperature for different geometry

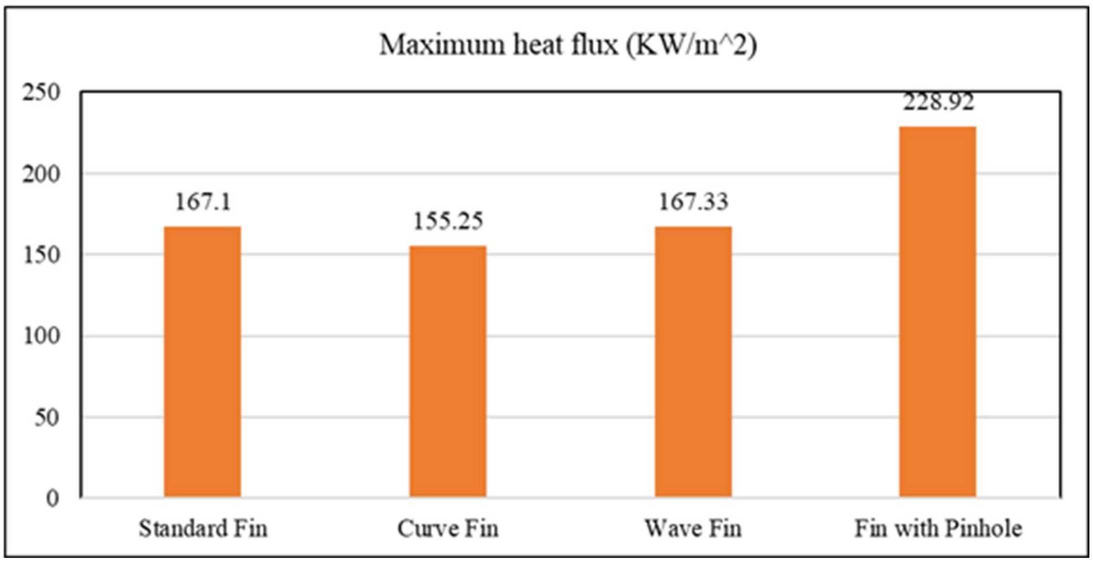

Figure 4.13: Maximum heat flux for different geometry

The result section of comparison and from the above graphical representation shows that different geometry gives the value of maximum heat flux and temperature range. From the above two graphs, it is shown that the maximum heat flux in the fin with pinhole is followed by tapered, rectangular, triangular. The temperature drop is highest for curve fin as compared to the other geometry rectangular, convex, and triangular.

Conclusion

In this paper, a cylinder fin body of two wheelers is modelled in parametric 3D modelling Software solid works. Steady-State thermal analysis was performed using ANSYS Software. The geometry used is curve fin, wave fin and pinhole. The material used for the fin body is Al6061. From the analysis, by observing the result it has been seen that the heat flux is maximum in pinhole. It is also seen that the maximum temperature distribution in Curve fin. It can also be concluded that the variation in geometry can increase and decrease the heat flux and temperature distribution. From the graph of the heat flux and temperature distribution, it is found that variation in maximum heat flux is more significant and varies to a higher numerical value as compared to the temperature drop, which is highest for curve fin.

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