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THERMAL ANALYSIS OF I.C. ENGINE FINS BY VARIATION IN GEOMETRY FOR DIFFERENT MATERIALS

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Abstract: **The main aim of this project is to analyse the heat dissipation rate from the fins by varying the geometry and for different materials. In this case, we have considered an air-cooled IC engine. Modelling cylinder block with fins is done by using SolidWorks. Internal combustion engine design specification is taken from the Honda CB Shine 125CC. Finite Element analysis is performed using ANSYS considering the steady-state thermal setup and overall heat flux distribution and temperature distribution are obtained. The same analysis is carried out for two more materials and the results are compared.**

IndexTerms -: **Fins, FEA, Ansys**

I. INTRODUCTION

Internal combustion engines (IC engines) plays a key role in the transportation industry, powering the vehicles that are the foundation of our modern societies. Increasing the efficiency of these engines is necessary to meet the requirements for better fuel consumption and reduced environmental impact. One of the key aspects affecting the performance of internal combustion engines is the thermal management system, particularly the design and material composition of heat-dissipating components such as fins.

The fins in an internal combustion engine are essential for the efficient removal of excess heat generated during combustion. The choice of material for these fins significantly affects their thermal conductivity, heat dissipation capabilities, and overall performance. The quest to optimize these factors has led researchers to explore advanced computational tools for in-depth thermal analysis. In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction flow, convection flow, or radiation in an object determines the amount of heat transfer. An increase in the temperature gradient between the object and its surroundings, an increase in the convection heat transfer coefficient, or an increase in the surface area of the object all increase heat transfer. Sometimes it is not possible or economical to change the first two options. So, adding a fin to an item increases the surface area and can sometimes be an economical solution to heat transfer problems. Fins are widely used in various engineering industries as a device to increase the rate of heat transfer from the surface. A fin is an area that widens from a part to increase the amount of heat switched in or out near the rising convection. To increase the temperature difference between the object and the environment, increasing the coefficient of the convective thermal switch or increasing the surface area of the object increases the heat dissipation. However, adding a fin to the object increases its surface area and can still be an opportunity for an affordable approach to heat transfer problems. The most commonly used materials for Fins are aluminum and its alloy, copper and its alloy, and brass. There are exceptional types of fin shape and length used in engineering applications to increase heat transfer rates. They are: rectangular fins, triangular fins, trapezoidal fins, circular segment fins, and square fins.

In this context, this study focuses on the thermal analysis of IC Engine fins using the powerful finite element analysis software ANSYS. The primary objective is to investigate the effect of different fin materials on heat dissipation efficiency. Understanding how different materials affect thermal performance can provide valuable insights for engineers and designers looking to improve the overall efficiency and reliability of internal combustion engines.

The paper is structured as follows: Section 2 provides a comprehensive review of related literature, highlighting previous research efforts and advances in the field of internal combustion engine thermal management. Section 3 describes the methodology and details the numerical simulations performed using ANSYS software. Section 4 presents the results of the thermal analysis, discussing the effects of material changes on fin performance. Section 5 concludes the paper with a summary of key findings, implications and avenues for future research.

The goal of this research is to contribute to the ongoing effort to optimize internal combustion engine efficiency and provide a basis for informed decision-making in the selection of materials for heat sink components. By using ANSYS, this study tries to bridge the gap between theoretical knowledge and practical applications in the field of thermal management of internal combustion engines.

II.LITERATURE SURVEY

1) Kirubadurai. B, Magesh. G, Rajkumar. G, Suresh Kumar. K, found that thermal efficiency of an Engine increases as the rate of heat transfer from the engine block to the atmosphere increases, an external surface is needed to increase the rate of heat transfer from the engine block. The segmentally constructed fins with some were analyzed.

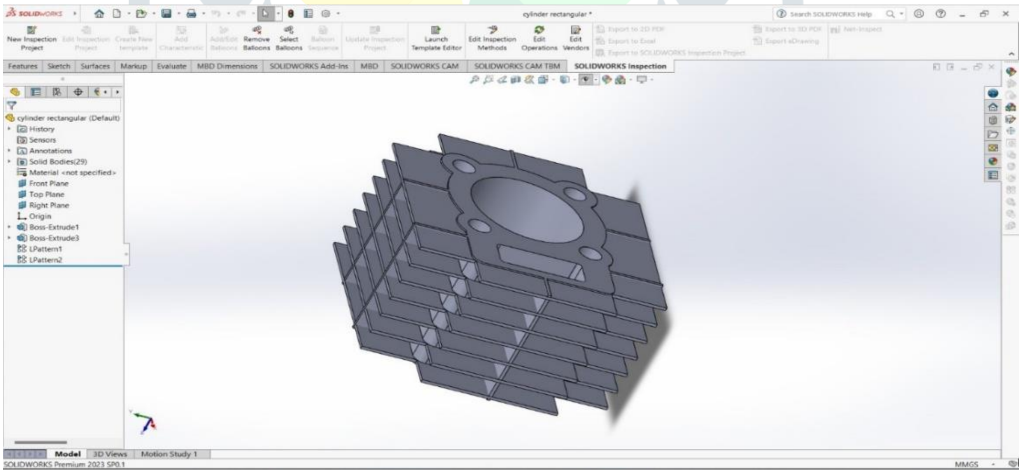
2) Prof. Arvind S. Sorathiya, Hiren P. Hirpara, Prof. Dr. P.P. Rathod found that the heat released from the cylinder does not improve when the cylinder had more fins having narrow fin spacing at lower wind speeds because air has difficulty flowing into the narrow spaces between the fins. The optimized spacing of the fins with the greatest effective cooling is 20 mm for immobile and 8 mm for mobile. Increasing the rate of heat transfer in permeable fins of the same dimensions as a fixed fin. Fin material costs are 10-30% lower for permeable fins compared to solid fins for the same heat transfer rate.

3) D.G.Kumbhar, concluded that the use of fins with extension ensures both efficient and effective heat transfer. Fins with extensions provide almost 5% to 13% more heat transfer compared to fins without extensions. Fin heat transfer with rectangular cross section is higher than fins with other type of cross sections. The temperature at the end of the fin in rectangular extensions is minimal compared to the other fins. Fin efficiency with a rectangular cross section is higher than other fins.

4) Miss. Kumud V. Deshmukh, Prof. Prashant R. Walke simulated the heat transfer from the cylinder to the air of a two-stroke internal combustion engine with the fins. The cylinder body, cylinder head (both equipped with fins) and piston were numerically analyzed and optimized to minimize engine dimensions. The maximum allowable engine temperature at the hottest point was taken as a limiting condition. Starting from the zero-burn cooling model geometry of the two-stroke air-cooled internal combustion engine developed in the previous sections, the engine in this paper has been optimized by reducing the overall volume occupied by the engine. An overall reduction of 20.15% was achieved by reducing the overall engine diameter D from 90.62mm to 75.22mm and increasing the overall height H from 125.72mm to 146.47mm. The aspect ratio changed from 1.39 to 1.95. In parallel the overall reduction in volume achieved a slight increase in engine efficiency.

III.PROBLEM DEFINITION

In this research we have designed a cylinder which is used in Hero Honda Motorcycle and modelled in SolidWorks. The analysis is carried on using ANSYS. From the analytical solution, thermal analysis and flow simulation, we find that the heat transfer to the atmosphere is less without fins from the cylinder to the atmosphere. This is why fins are added top increase the heat transfer rate. Three different fin geometries are used for the same boundary conditions and the results are compared. Also effect of material change is also depicted from the same.



Modelling of Fins

FIG.3.1. RECTANGULAR FINS

FIG.3.2. TRIANGULAR FINS

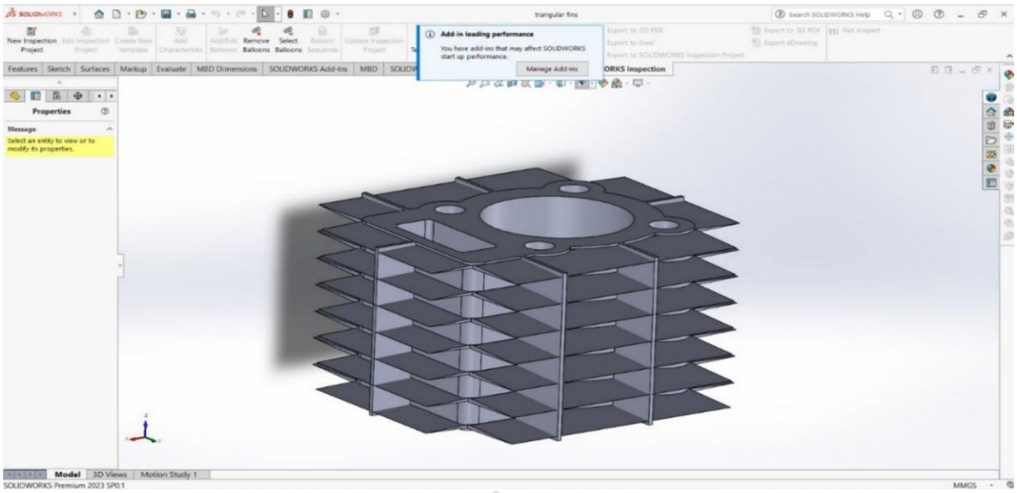
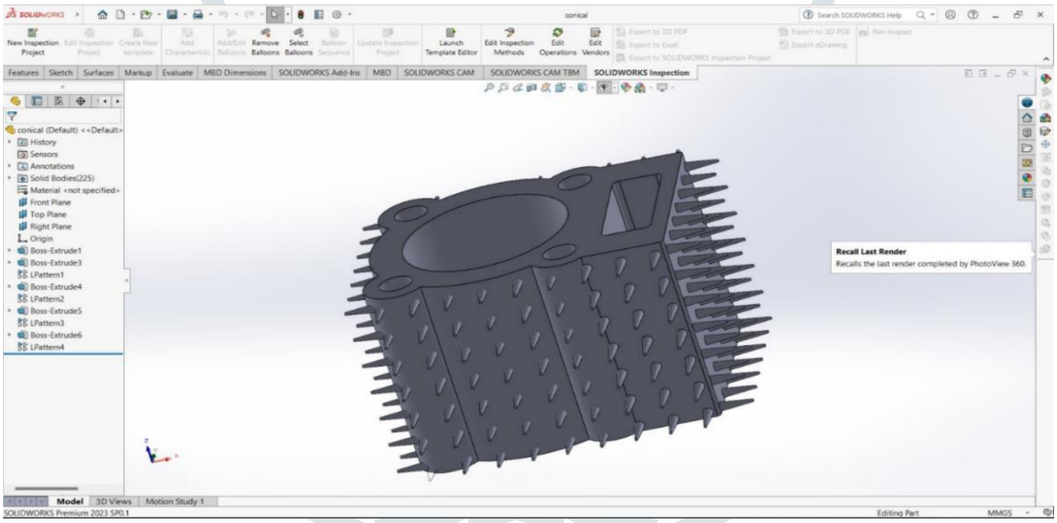


FIG.3.3. CONICAL FINS



IV.METHODOLOGY

Firstly, the Engine is modelled using Solid works of standard dimensions. This Engine is added with the Rectangular fins on cylinder head. The geometry is imported in ANSYS. Meshing is done to obtain the discretization. Boundary Conditions are setup in the solver. After complete simulation the results are obtained in the form of Temperature distribution and heat dissipation contours. The material selected is Aluminum Alloy. The same process is repeated for Copper alloy and Magnesium alloy. After the rectangular fins Triangular Fins & Conical Fins were incorporated and the process is repeated. All the results obtained are analyzed and compared.

MATERIAL	TENSILE STRENGTH	YIELD STRENGTH	MODULUS OF ELASTICITY	THERMAL CONDUCTIVITY
Aluminum Alloy	186 MPa	145 Mpa	68.9 Gpa	209 W/mK
Copper Alloy	170 Mpa	83.0 Mpa	117 Gpa	398 W/mK
Magnesium Alloy	260 Mpa	200 Mpa	44.8 Gpa	51 W/mK

TABLE 1: MATERIAL PROPERTIES

V. RESULTS AND DISSCUSSIONS

1) RECTANGULAR FINS

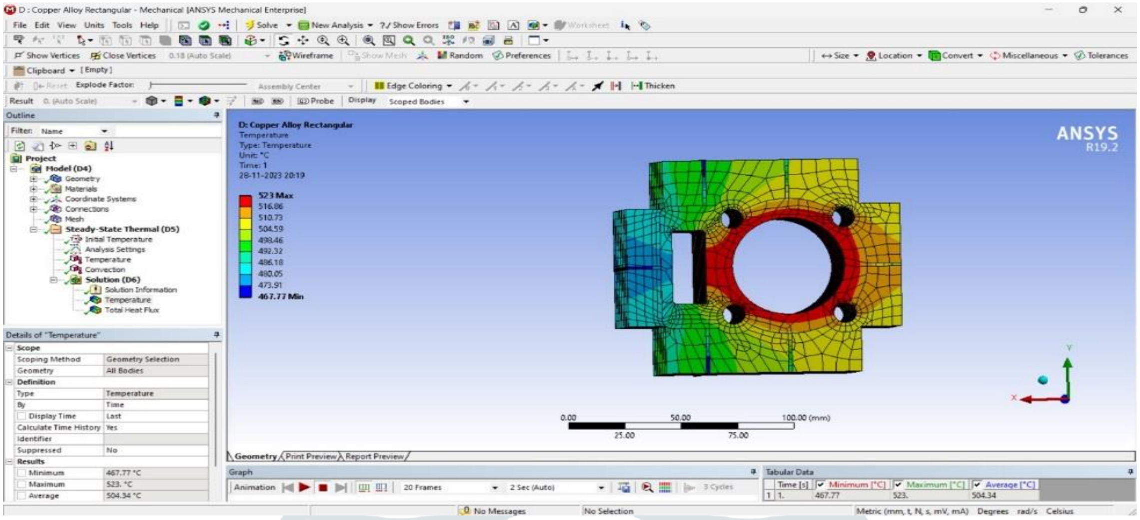


FIG.5.1.1 ALUMINIUM ALLOY, TEMPERATURE DISTRIBUTION

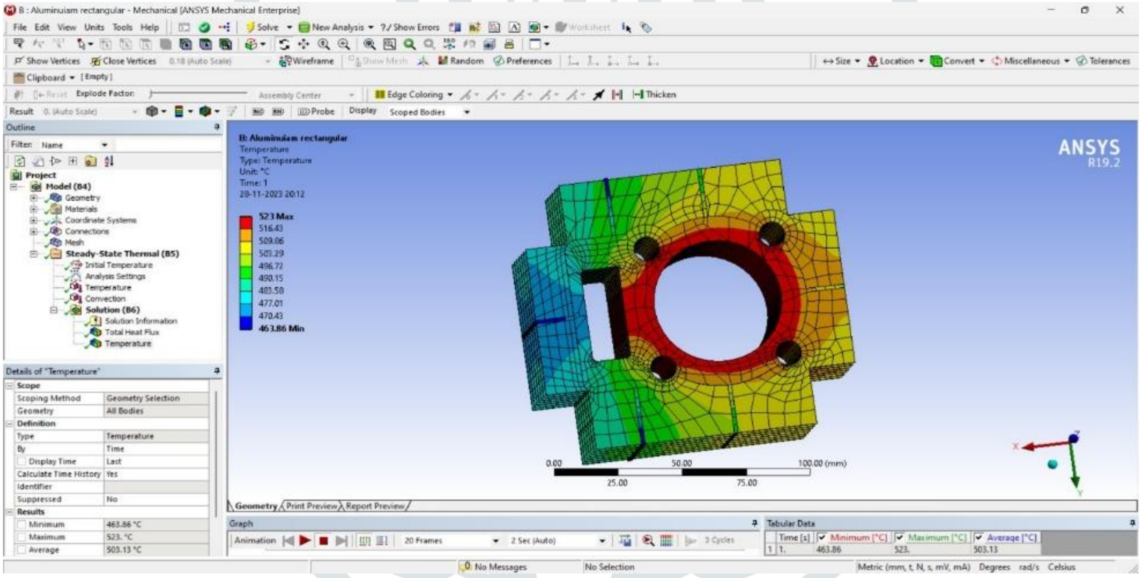


FIG.5.1.2 COPPER ALLOY, TEMPERATURE DISTRIBUTION

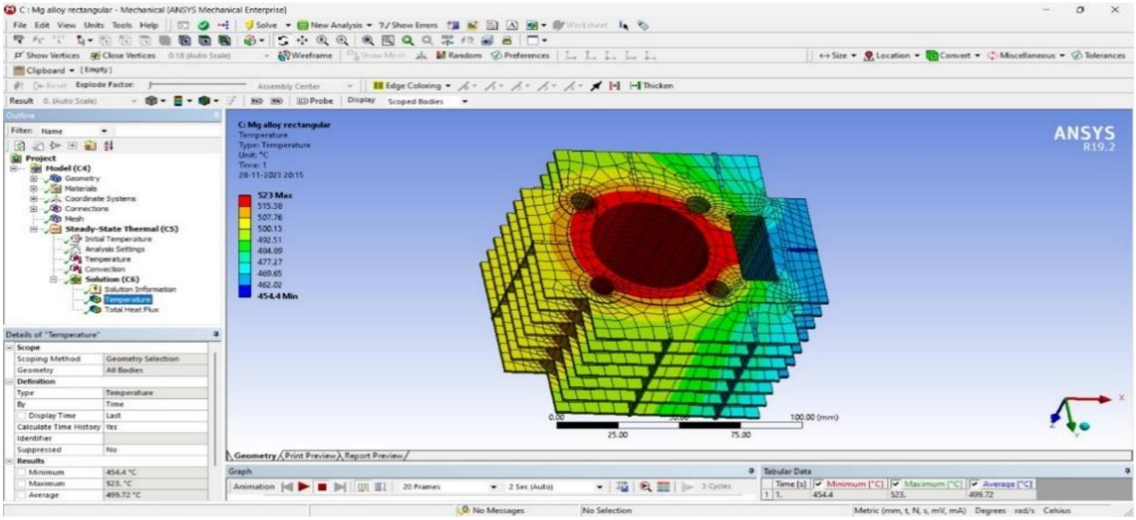


FIG.5.1.3 MAGNESIUM ALLOY, TEMPERATURE DISTRIBUTION

Similar Contours are obtained for

Temperature Distribution of Triangular fins for Aluminum Alloy, Copper Alloy & Magnesium Alloy.

Heat Flux of Triangular fins for Aluminum Alloy, Copper Alloy & Magnesium Alloy.

Temperature Distribution of Conical fins for Aluminum Alloy, Copper Alloy & Magnesium Alloy.

Heat Flux of Conical fins for Aluminum Alloy, Copper Alloy & Magnesium Alloy.

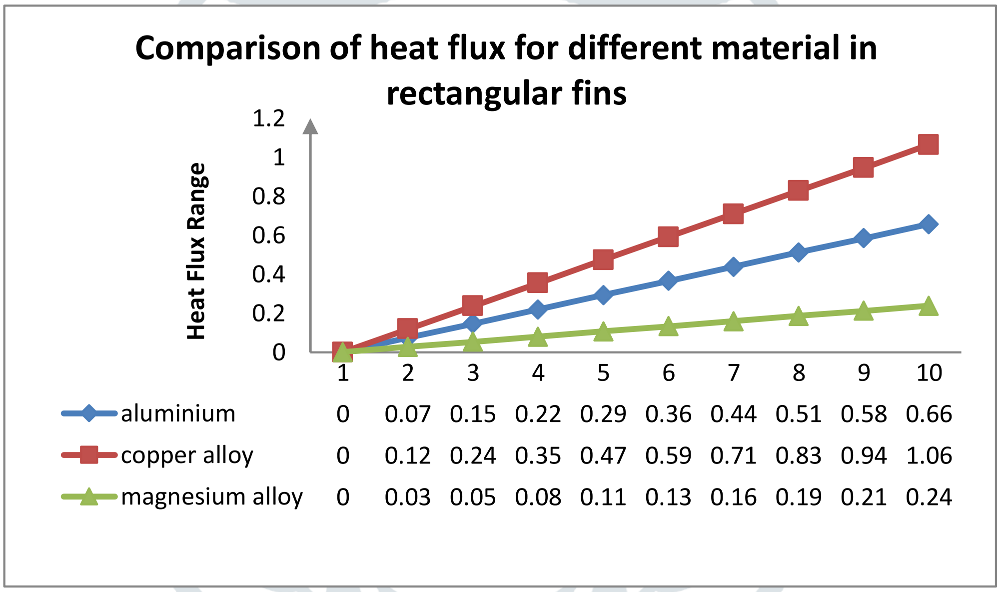


FIG.5.4.1 GRAPH OF DIFFERENT MATERIAL HEAT FLUX IN RECTANGULAR FIN

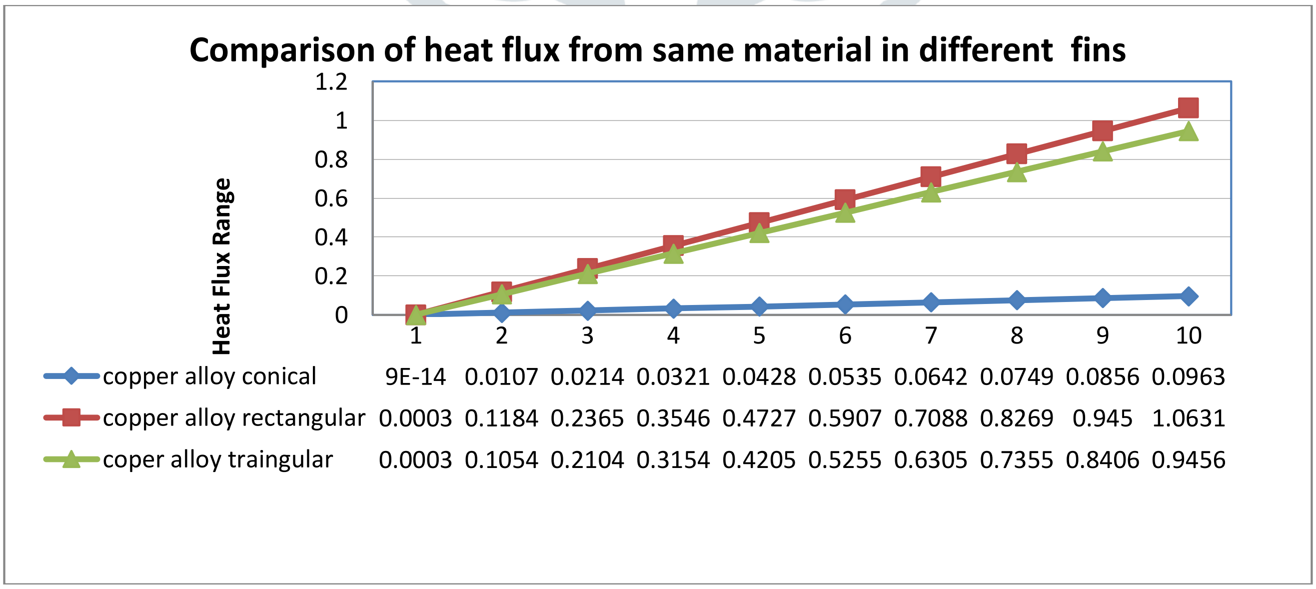


FIG.5.4.2 GRAPH OF SAME MATERIAL IN DIFFERENT FIN

COMPARISON TABLE

MATERIAL	TYPE OF FIN	TOTAL HEAT FLUX
COPPER ALLOY	RECTANGULAR	1.0631
ALUMINIUM ALLOY	RECTANGULAR	0.65641
MAGNESIUM ALLOY	RECTANGULAR	0.23801

TABLE. 6.1.1 COMPARISON OF DIFFERENT MATERIAL HEAT FLUX IN RECTANGULAR FIN

MATERIAL	TYPE OF FIN	TOTAL HEAT FLUX
COPPER ALLOY	RECTANGULAR	1.0631
COPPER ALLOY	TRIANGULAR	0.94559
COPPER ALLOY	CONICAL	0.096252

TABLE.6.1.2 COMPARISON OF SAME MATERIAL HEAT FKUX IN DIFFERENT TYPE OF FIN

VI. CONCLUSION

When applying a temperature of 523 K material AL6061 showed a minimum temperature of 463 K, minimum heat flux 0.00034 W/$m2$ and maximum heat flux 0.65641 e5 W/$m2$. Material Copper alloy showed a minimum temperature 467.77 K, minimum heat flow 0.000321 W/$m2$ and a maximum heat flux of 1.0631 e5 W/$m2$. The Magnesium alloy material showed a minimum temperature 454.4 K, minimum heat flux 0.0004090 W/$m2$ and a maximum heat flux of 0.23801 e5 W/$m2$.
From the analysis we can say that the temperature is the minimum for aluminum and the heat flux is maximum for copper alloy. we can say that Copper alloy is the most preferred material for ribs on the cylinder block.

VII. FUTURE SCOPE

In present work we studied the thermal effect of different material of fins, so there is scope to work on the structural effect analysis on working of cylinder block on different materials. We can also use CFD tools and CFD analysis to study the fin performance and we can also work on weight reduction factors according to fin types and their different materials.

REFERENCES

[1] Kirubadurai.B, Magesh.G, Rajkumar.G, Suresh Kumar.K, "Thermal Performance Analysis of IC Engine Fins" International Journal of Innovative Research in Science, Engineering and Technology, Vol V Issue VIII, August 2016.

[2]. Prof. Arvind S. Sorathiya, Manankumar B. Joshi,Prof. (Dr.) Pravin P. Rathod : "Heat Transfer Augmentation of Air Cooled 4 stroke SI Engine through Fins." IJREAT International Journal of Recent advances in Engineering & Advanced Technology, Volume 2, Issue 1, Feb-Mar, 2014.

[3]. D.G. Kumbhar, et al. "Finite Element Analysis and Experimental Study of Convective Heat Transfer Augmentation from Horizontal Rectangular Fin by Triangular Perforations", Proceedings of the International Conference on Advances in Mechanical Engineering (2009).
Dr. Kirpal Singh, 2004, Automobile engineering vol. II, Standard Publishers Distributors, Delhi.

[4]. Miss. Kumud V. Deshmukh, Prof. Prashant R. Walke, "Analysis of Engine fin body by Varying Geometry & Materials" International Research Journal of Engineering and Technology, Vol VI, Issue VII, July 2019.

[5] Prof. R.K. Rajput, "Heat and Mass Transfer", S. Chand Publications.