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Investigation of Fin Thickness on Heat Transfer Characteristics of Engine

Ankita Taur[1], Dhanashri shinde[2], Avinash Taur[3], Prashant Deore[4], Jitendra Satpute[5]

[1,2,3,4] UG Students, Department of Mechanical Engineering, Suman Ramesh Tulsiani Technical Campus - Faculty of Engineering, Khamshet, Pune, Maharashtra
[5] Assistant Professor, Department of ME, Suman Ramesh Tulsiani Technical Campus - Faculty of Engineering, Khamshet, Pune, Maharashtra

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Abstract – Fins are one of the important key cooling elements. The main purpose of pin fins is to increase the rate of heat transfer to the surroundings by improving convection. The transferred heat will exist in the form of conduction, convection and radiation. If the temperature coefficient of heat transfer increases, the cooling rate will also increase. The main objective of our project is to increase the rate of heat transfer in different types of fins with different shapes.3D models were designed in Catia and tested in Ansys. Use the developed fins in various applications.

Index Terms—About four key words or phrases in alphabetical order, separated by commas.

1.INTRODUCTION

Heat transfer is a subject of general interest to students of engineering courses, practicing engineers and technicians engaged in the design, construction, testing and operation of the many forms of heat exchange equipment. heat required in science and industrial technology. Electrical engineers apply their knowledge of heat transfer to the design of cooling systems for automobiles, generators and transformers. Chemical engineers deal with the evaporation, condensation, heating, and cooling of liquids. Understanding the laws of heat transfer flux is important for civil engineers who construct dams and structures, and for architects who design buildings. Mechanical engineers deal with heat transfer in internal combustion engines, steam generation, refrigeration, heating, and ventilation.

In order to estimate the cost, feasibility and size of the equipment needed to transfer a given amount of heat for a given duration, a detailed heat transfer analysis must be performed. The size of boilers, heaters, refrigerators and heat exchangers depends not only on the amount of heat to be transferred, but also on the rate at which it can be transferred under given conditions. Proper operation of equipment components such as turbine blades and gas turbine combustor walls depend on the ability to cool certain metal components by removing heat from surfaces in rapid succession. These various examples show that in almost all branches of engineering, one encounters heat transfer problems that cannot be solved by thermodynamic reasoning alone, but require analysis based on the science of heat transfer.

• Selection of Material:

Aluminum was chosen as the fin material for further analysis by ANSYS. Aluminum is a very light metal with a specific weight. The use of aluminum in vehicles reduces dead weight and energy consumption while increasing load capacity. Aluminum is a good reflector of visible light and heat.

The main function of the fins is to dissipate the heat generated by the engine, essentially an engine cooling technique.
In terms of material selection, a material that can absorb engine heat at a higher rate and quickly dissipate it to the air passing through it would be preferred. Aluminum is an ideal material with this quality. It has excellent thermal conductivity, heat dissipation and heat dissipation performance.
The most common heatsink material is aluminum alloy, which has one of the highest thermal conductivity values at 229 W/mK but is mechanically more flexible.
copper has approximately twice the thermal conductivity of aluminum and absorbs heat faster and more efficiently.
But it is more expensive than aluminum. The thermal conductivity of copper decreases with increasing temperature, but in the case of aluminum, the thermal conductivity increases with increasing temperature. It is cheap and easy to extrude into fin extensions. Aluminium is good and efficient. Now a days, widely used material is Aluminium. Aluminium is quite light weighted than copper.

- Properties of aluminium are as follows:
- Good heat conductivity
- Malleability is high
- Easily casted
- Corrosion resistance
- Light weight than other metal
- Abundant availability
- Easily recyclable

2. LITERATURE REVIEW

1. Computational Analysis of Heat Transfer through Fins with Different Types of Notches, K. Sathishkumar, K. Vignesh, N. Ugesh, P. B. Sanjeevaprasath, S.

In this paper it represents the Engine as one of the important components in an automobile which is subjected to high temperature and thermal stresses. In order to cool the engine, the fins are another component which are used to dissipate the heat from the Engine. Fins are generally used to increase the heat transfer rate from the system to the surroundings.

2.Analysis of Varying Geometry Structures of Fins using Radiators K. Chinnarasu1, M. Ranjithkumar, P. Lakshmanan, K. B. Hariharan, N. K. Vigneshwaran and S. Karan

In this literature it presents as radiators are heat exchangers used to transfer thermal energy from one medium to another medium. In the existing plain fins type radiator are commonly used, which are usually set up in a crossflow arrangement made up of aluminum and copper alloy. Powerful fan and water pump is accompanied in this to greatly improve heat dissipation rate. For higher cooling capacity of radiator, addition of fins is one of the approaches to increase the cooling rate of the radiator.

3.Finite Element Thermo-Structural Methodology for Investigating Diesel Engine Pistons with Thermal Barrier Coating, Paolo Baldissera, Cristiana Delprete, Politecnico di Torino

In this paper it presents a combustion engine application, metallic materials have been widely employed due to their properties castability and machinability with accurate dimensional tolerances, good mechanical strength even at high temperatures, wear resistance, and affordable price. However, the high thermal conductivity of metallic materials is responsible for consistent losses of thermal energy and has a strong influence on pollutant emission. A possible approach for reducing the thermal exchange requires the use of thermal barrier coating (TBC) made by materials with low thermal conductivity and good thermo-mechanical strength.

4. J.-J. Shu, I. Pop, "Thermal interaction between free convection and forced convection along a vertical conducting wall, "International Journal of Heat and Mass Transfer

In this journal it presents the conjugate heat transfer across a vertical finite wall separating two forced and free convection flows at different temperatures. It is assumed that the heat conduction in the wall is only in the transversal direction. He also assumed that countercurrent boundary layers are formed on both sides of the wall. The governing equations of this problem and their corresponding boundary conditions are all cast into a dimensionless form by using a non-similarity transformation. These resulting equations, which are singular at the points nc. 0 and 1, are solved numerically using a very efficient singular perturbation method. The effects of the resistance parameters and of the Prandtl numbers on heat transfer characteristics are investigated.

5.Wei Du, Lei Luo, Songtao Wang, Xinghong Zhang 'Effect of the dimple location and rotating number on the heat transfer and flow structure in a pin finned channel',

The problem of natural convection heat transfer from fin arrays with inclination is studied experimentally and theoretically to find the effect of inclination of the base of the fin array on heat transfer rate.

6.Heat Transfer Analysis by CFD Simulation for Different shapes of Fins, Mohsin A. Ali and Prof. (Dr.) S.M Kherde

In this article it represents an air-cooled motorcycle engine releases heat to the atmosphere through the mode of forced convection to facilitate this, fins are provided on the outer surface of the cylinder. The heat transfer rate depends upon the velocity of the vehicle, fin geometry and the ambient temperature. Insufficient removal of heat from engine will lead to high thermal stresses and lower engine efficiency. The cooling fins allow the wind to move the heat away from the engine. Low rate of heat transfer through fins is the main problem of air-cooling system.

3.PROCEDURE FOR PAPER SUBMISSION

A. Review Stage

- Find out research papers and develop the literature on the engine overheating issue.
- Finalize the 3 designs of the engine fins to perform the analysis.
- Develop the different types of CAD model using 3D design software with different thickness.
- Perform the Computational Fluid Dynamics on the engine fins with existing thickness.
- Find out the heat transfer coefficient of the engine fins.

B. Final Stage

- Perform the CFD analysis on the other 2 model to find out difference between them.
- Check out the result using CFD post tool and compare the result and characteristics.
- Finalize the optimized model.

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C. Figures

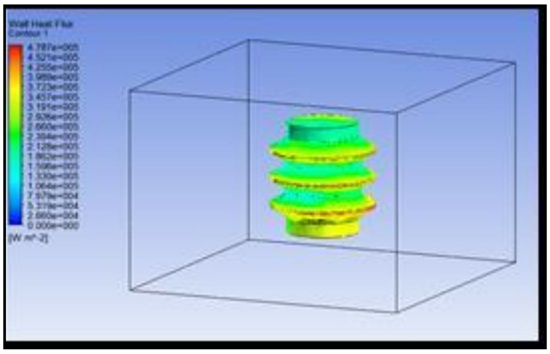


Fig. 1. Parabolic fin CFD analysis

4. MODAL SELECTION

Aluminium is selected as a fin material for further analysis by ANSYS. Aluminium is a very light metal with a specific weight. The use of Al in vehicle reduces dead weight and energy consumption while increasing load capacity. Al is a good reflector of visible light as well as heat.

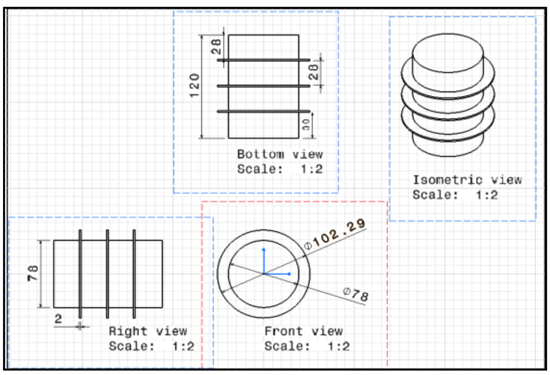


Fig. 2. Dimensions of circular fins

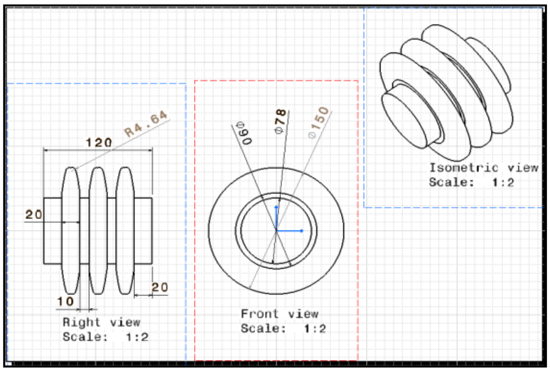


Fig. 3. Dimensions of triangular fins

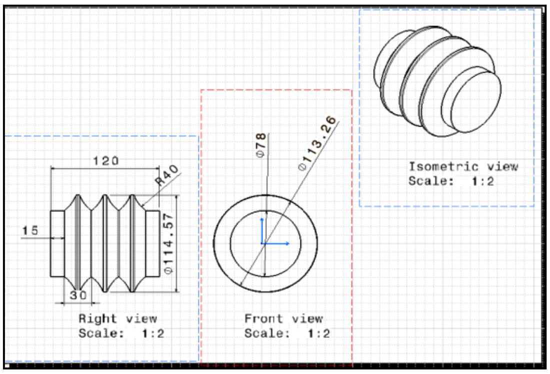
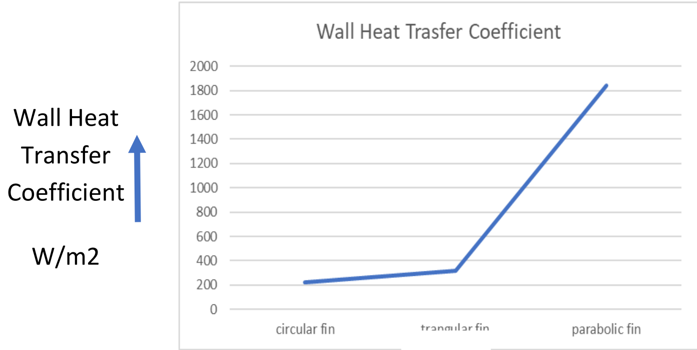


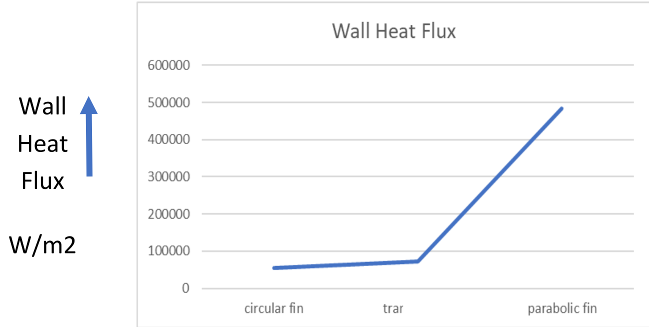
Fig. 4. Dimensions of parabolic fins

•During CFD simulation following steps are performed.
•Selection of k epsilon model with wall scalable function along with material as air as fluid and base material for model are selected.
•Inlet velocity of 12 m/s is defined with initial temperature and engine surface temperature as 300 degrees Celsius for solution initialization hybrid is selected.
•Number of iterations of approx. 200 is provided and calculation is performed.

Type of Fin	Wall Heat Flux (W/m2)		Wall Heat Flux Coefficient (W/m2K)	
	Min	Max	Min	Max
Circular	0	55631	28.518	221.305
Triangular	0	72216.1	38.3092	320.722
Parabolic	0	483152	57.0603	1840.58

•In above plot it is observed that triangular fin has maximum heat (flux) transfer rate as 483152 W/m2 and heat transfer coefficient as 1840.58 W/m2k.
•As per results we found that parabolic fin has more wall heat flux and high wall heat transfer coefficient. So, we have finalized parabolic fins.





Mesh Metric	Value
Skewness	0.24226
Orthogonality	0.75585

As per results we found that parabolic fin has more wall heat flux and high wall heat transfer coefficient. So, we have finalized parabolic fins.

Skewness is a measure of the asymmetry of a distribution. A distribution is asymmetrical when its left and right side are not mirror images. A distribution can have right (or positive), left (or negative), or zero skewness. A right-skewed distribution is longer on the right side of its peak, and a left-skewed distribution is longer on the left side of its peak.
Orthogonality, a property synonymous with perpendicularity when applied to vectors but applicable more generally to functions.

We have got above values for Skew ness and Orthogonality.

3. CONCLUSIONS

1. In this study, CFD simulations were performed on different fins to obtain an optimized model. Initially, CFD simulations were performed to obtain the best and most efficient shapes to list circular, triangular and parabolic fin targets around the engine.

2. It was observed from CFD simulations that the parabolic fins were the most efficient design in the current study, with greater heat dissipation and the standard design size material that was ultimately used for design purposes. manufacturing and testing.

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