© 2018 IJSRSET | Volume 4 | Issue 7 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

# Parametric Study of Longitudinal Fins

**Sumit Dashore, Yamini Dewangan, Ashish Kumar Upadhyay**
Department of Mechanical Engineering, Shri Shankaracharya Institute of Professional Management And Technology Mujgahan, Raipur, Chhattisgarh, India

## ABSTRACT

Nowadays the fossil Fuel's consumption increases day by day, which will create major problem in upcoming years. Since all the vehicles run by fossil fuel only, so to reduce the consumption of fossil fuel, Fins (Extended Surface) plays a vital role. If the temperature of combustion chamber decrease, it will result in increasing the consumption of fuel or if the temperature inside the combustion chamber increases it will melt all the parts, so to transfer the sufficient amount of heat from the combustion chamber to the atmosphere at high rate, we will use the fins. The fins are generally extended surfaces or projections of materials on the system whose function is to transfer heat from the base to the atmosphere. In this we have done the analysis of fins using Finite Difference Method (FDM) and plot the graph. We are using Ansys for designing the fin, Ansys Fluent for Simulation and Microsoft for plotting the graph.
Keywords : Finite Difference Method, Ansys Fluent

## I. INTRODUCTION

Extended surface is known as fin, which is used to enhance rate of heat transfer from a surface or structures. The fin is used where heat transfer coefficient is low. In fin, heat transfer takes place by means of conduction and convection. The major heat transfer to the surface of fin takes place by conduction and by convection heat transfer from the surface of the fin to the surrounding. In current scenario the heat transfer is very important for any industry; we required better fins, which dissipate more and more heat from the primary surface. Now a day's fins are mostly used in the electronic industry to avoid the damaging effects of burning or overheating like normal computer or laptop used everything can be placed in small space. The design and selection of any particular type of fin is very important in engineering application, we choose those fins which give maximum heat transfer rate and it depends on the shape or geometry of fin and it is less difficult in manufacturing. The fin should be low cost and light weight and volume.

As the fossil fuel reserves are depleting day by day, increasing of fuel price raising the technology towards new inventions and research, which provides engines which are highly efficient and produces high specific power. Air cooled engines are phased out and are replaced by water cooled engines which are more efficient, but almost all two wheelers uses. Air cooled engines, because Air-cooled engines are only option due to some advantages like lighter weight and lesser space requirement. The heat generated during combustion in IC engine should be maintained at higher level to increase thermal efficiency, but to prevent the thermal damage some heat should remove from the engine. The fins are of following types:-

- ✓ Constant Area Straight Fin or Longitudinal Fins or Plate Fin
- ✓ Variable Area Straight Fin or Tapered Fin
- ✓ Pin Fin
- ✓ Annular Fins

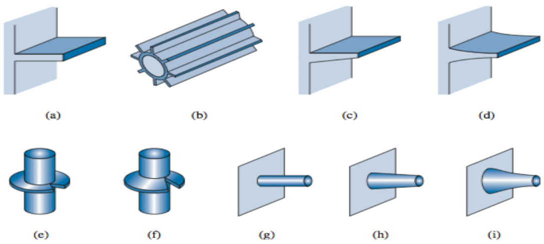

FIGURE 2.20 Schematic diagrams of different types of fins: (a) longitudi-

(a) Longitudinal fin – Rectangular profile
(b) Longitudinal fin – Rectangular profile
(c) Longitudinal fin - Trapezoidal profile
(d) Longitudinal fin - Concave parabolic
(e) Radial fin – Rectangular profile
(f) Radial fin – Triangular profile
(g) Pin fin – Cylindrical
(h) Pin fin – Tapered profile
(i) Pin fin – Concave parabolic

**Plate fin heat exchanger:**

Plate fin exchanger is a type of compact heat exchanger where the heat transfer surface area is enhanced by providing extended metal surface, interfaced between the two fluids and is called the fins. Out of the various compact heat exchangers, plate fin heat exchangers are unique due to their superior construction and performance. They are characterized by high effectiveness, compactness, low weight and moderate cost. As the name suggests, a plate fin heat exchanger (PFHE) is a type of compact exchanger that consists of a stack of alternate flat plates called parting sheets and corrugated fins brazed together as a block. Streams exchange heat by flowing along the passages made by the fins between the parting sheets. Separating plates act as the primary heat transfer surfaces and the appendages known as fins act as the secondary heat transfer surfaces intimately bonded to the primary surfaces. Fins not only form the extended heat transfer surfaces, but also work as structural supports against internal pressure difference. The side bars prevent the fluid from spilling over and mixing with the second fluid or leaking to outside. The fins and side bars are brazed with the parting sheets to ensure good thermal link and to provide mechanical stability. Figure 1.1 shows an exploded view of two layers of a plate fin heat exchanger. Such layers are arranged together in a monolithic block to form a heat exchanger.

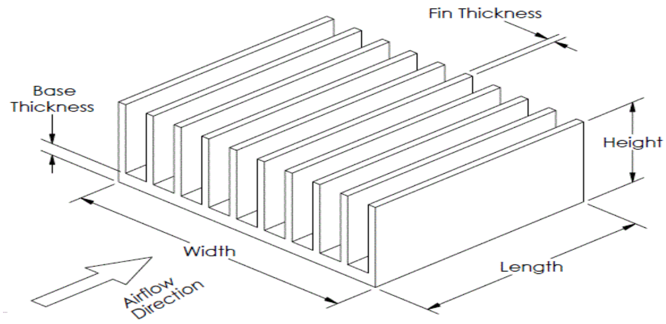

**Figure 3.** Plate fin heat Exchanger

**Advantage and Disadvantage:**

Plate fin heat exchangers offer several advantages over the other types of heat exchanger:

i) **Compactness:** Large heat transfer surface area per unit volume (typically 1000 m2/m3), is usually provided by plate fin heat exchangers. Small passage size produces a high overall heat transfer coefficient because of the heat transfer associated with the narrow passages and corrugated surfaces.

ii) **Effectiveness:** Very high thermal effectiveness more than 95% can be obtained.

iii) **Temperature control:** The plate fin heat exchanger can operate with small temperature differences. A close temperature approach (temperature approach as low as 3K) is obtained for a heat exchanger exchanging heat with single phase fluid streams. This is an advantage when high temperatures need be avoided. Local overheating and possibility of stagnant zones can also be reduced by the form of the flow passage.

iv) **Flexibility:** Changes can be made to heat exchanger performance by utilizing a wide range of fluids and conditions that can be modified to adapt to various design specifications. Multi stream operation is possible up to 10 streams.

v) **Counter flow**: True counter-flow operation (Unlike the shell and tube heat exchanger, where the shell side flow is usually a mixture of cross and counter flow) is possible in a plate fin heat exchanger.

The main disadvantages of a plate fin heat exchanger are:

i) The rectangular geometry used puts a limit on operating range of pressure and temperatures

ii) Difficulty in cleaning of passages, which limits its application to clean and relatively non-corrosive fluids, and

iii) Difficulty of repair in case of failure or leakage between passages.

iv) Relatively high pressure drop due to narrow and constricted passages.

**Applications:**

The plate-fin heat exchanger is suitable for use over a wide range of temperatures and pressures for gas-gas, gas-liquid and multi-phase duties. They are used in a variety of applications. They are mainly employed in the field of cryogenics for separation and liquefaction of air, natural gas processing and liquefaction, production of petrochemicals and large refrigeration systems. The exchangers that are used for cryogenic air separation and LPG fractionation are the largest and most complex units of the plate fin type and a single unit can be of several meters in length. Brazed aluminum plate fin exchangers are widely used in the aerospace industry because of their low weight to volume ratio and compactness. They are being used mainly in environment control system of the aircraft, avionics cooling, hydraulic oil cooling and fuel heating. Making heat exchangers as compact as possible has been an everlasting demand in automobile and air conditioning industries as both are space conscious. In the automobile sector they are used for making the radiators. The other miscellaneous applications are:

i) Fuel cells
ii) Process heat exchangers
iii) Heat recovery plants
iv) Pollution control systems
v) Fuel processing and conditioning plants
vi) Ethylene and propylene production plants
vii) Vehicle or Automobile.

And any surface where heat will be transfer from one medium the another medium and having some space for extended surface.

**Materials used for fin:**

The materials used for fins should be of high thermal conductivity, light weight and cheap. Silver, Copper and Aluminum have thermal conductivity of 410W/mK, 385W/mK and 225W/m K respectively. Aluminum selected for fin material because it is of low density, light weight, cheap price and non corrosive type.

## II. LITERATURE REVIEW

M.G. Sobamowo "**Analysis of convective Longitudinal Fin with temperature-dependent thermal conductivity and internal heat generation**", Alexandria Engineering Journal Received 10 December 2015; revised 7 March 2016; accepted 12 April 2016 Available online 22 September 2016.

This paper has done the analysis of heat transfer in a longitudinal rectangular fin (insulated tip) with temperature dependent thermal conductivity and internal heat generation was carried out using Finite Difference Method. The developed systems of non-linear equations that resulted from the discretization using finite difference scheme were solved with the aid of Matlab using fsolve. And this paper also shows various type of method which is used to do analysis on fins. This various methods are Homotype Perturbation Method – this method is used to calculated the efficiency of straight fins, Homotype Analysis Method – this method is also used to calculate the efficiency of straight fins, Variational Iteration Method – this method is used to do analysis of convective straight & radial fins, Adomian Decomposition Method, Finite Difference Method –

It can be used for solving any complex body by breaking the body into small domain, and many more are there for doing analysis on fins. The result of this paper is that the dimensionless temperature distribution falls monotonically along fin length for all various thermogeometric, thermal conductivity and convective heat transfer parameters. For large values of the thermogeometric parameter M, the more the heat convected from the fin through its length and the more thermal energy is efficiently transferred into the environment through the fin length. In the situation of negligible heat loss from the fin tip (insulated tip) to the environment, the fin temperature decreases along the fin length also, and the temperature decreasing rate is the same around the fin base area. After gone through this paper we get to know about the various methods of analysis and while going through this paper we are choosing the Finite Difference Method (**FDM**) for further analysis of fins in our research.

Hardik D. Rathod, Ashish J. Modi, Prof. (Dr.) Pravin P. Rathod "**Effect of Different Variables on Heat Transfer Rate of Four-Stroke SI Engine Fins- Review Study**", International Journal Of Mechanical Engineering And Technology (IJMET) , Volume 4, Issue 2, March - April (2013), pp. 328-333

This paper has done the analysis on the geometry of fins, in which they do analysis and comes to the optimal geometry of fins. They do analysis and plot the graph using Microsoft Excel. They show the following effect which will increase the heat transfer rate. These are the following effects to be considered while designing the fins:-

**1). EFFCT OF NUMBER AND THICKNESS OF FINS ON THE HEAT TRANSFER RATE:**

Heat release from the cylinder did not improve when the cylinder have the more fins and too narrow a fin pitch at lower wind velocities, because it is difficult for the air to flow in to the narrower space between the fins, so the temperature between them increased. The expression has been derived for the fin of the air cooled cylinder. The conclusion was that the optimized fin pitches with the greatest effective cooling area at 20mm for non-moving and 8mm for moving.

The variation of the heat Transfer with respect to velocity. The heat transfer was calculated directly from the fluent software. At zero velocity it is seen that the

Heat transfer from the 4mm and 6mm fins are the same. When the velocity is increased it can be seen that the heat transfer is increased with due to forced convection and also due to the swirl generated between two fins which induces turbulences and hence higher heat transfer. For a larger fin thickness, the corresponding fin spacing is comparatively small. As a consequence, the Generated swirled flow may mingle with the main flow and result in a higher heat transfer performance.

The heat transfer from 6mm fins is found to be the higher at high velocities. For high speed vehicles thicker fins provide better efficiency. When fin thickness was increased, the reduced gap between the fins resulted in swirls being created which helped in increasing the heat transfer. Large number of fins with less thickness can be preferred in high speed vehicles than thick fins with less numbers as it helps inducing greater turbulence.

**2). EFFECT OF PERFORATIONS, NOTCHES AND VARYING GEOMETRY ON HEAT TRANSFER RATE OF FINS:**

The analysis by ANSYS shows that thermal flux is more for the fins with perforations as compared to fin without perforations. Thus we can say that the heat transfer improves with the addition of perforations. It is also observed that the thermal flux increases with increase in perforation dimension increases up to certain dimension, then again it decreases. The analysis is also done for different materials of varying thermal conductivities, such as Mild steel & stainless

steel. Results shown are similar to that of Aluminum fin. They show that as thermal
Conductivity increases thermal flux increases. As the thermal flux is more the rate of heat transfer would be more for the fins.

It is observed that heat transfer rate increases with perforations as compared to fins of similar dimensions without perforations. It is noted that in case of triangular perforations optimum heat transfer is achieved. It is also concluded that heat transfer rate is different for different materials or heat transfer rate changes with change in thermal conductivity. The perforation of fins enhances the heat dissipation rates and at the same time decreases the expenditure for fin materials also. From this paper we are grasping the optimal thickness of fins and the optimal pitch of fin in our research.

Mr. Manir alam, Asst. Prof. "**Design and Analysis of fins of varying geometry and material**", International journal of computer engineering in research trends (IJCERT),Volume 3, Issue 2. Feb 2016

In this paper research - fin is one of the major components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the cylinder to increase the rate of heat transfer. By doing thermal analysis on the longitudinal fins it is helpful to know the heat dissipation inside the fins.

The principle implemented in this project is to increase the heat dissipation rate by using the invisible working fluid, nothing but air. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. Presently Material used for manufacturing cylinder fin body is Cast Iron. In this thesis, using materials Copper and Aluminum alloy 6082 are also analyzed. Thermal analysis is done using all the three materials by changing geometries, distance between the fins and thickness of the fins for the actual model of the cylinder fin body.

M. P Shah, K. S. Mehra, S.Gautam "**Transient and steady state analysis of fins using for different material**", International journal for research in applied science and engineering technology (IJRASET) Volume 2, Issue 6, June 2014 Fins are used to augment the rate of heat transfer. Generally, the material used for the application of fins is aluminum alloys. In this present work Thermal behavior of cylindrical fin is numerically investigated using Ansys APDL Software for different materials like Copper, AA1100, AA2011, and AA6083. Transient and steady state analysis is carried out for the cylindrical fin under the convection and a specified base temperature condition. The length, base thickness, and end thickness of the fin is specified. Thermal conductivity of the fin material is specified. A constant temperature condition is applied at the base of the fin convective boundary conditions applied at the tip of the fin. Comparative study is being done among the fin material here used to find out the best material under the conditions. Base heat transfer rate, time to reach steady state, temperature distribution at different times, steady state temperature distribution is investigated .

Fins are used to enhance convective heat transfer in a wide range of engineering applications, and offer a practical means for achieving a large total heat transfer surface area without the use of an excessive amount of primary surface area. Fins are commonly applied for heat management in electrical appliances such as computer power supplies or substation transformers. Other applications include IC engine cooling, such as fins in a car radiator. It is important to predict the temperature distribution within the fin in order to choose the configuration that offers maximum effectiveness. This exercise serves as a visualization tool for evaluating the effect of shape on fin effectiveness, efficiency, and temperature distribution. In many heat transfer applications, it is desirable to increase the surface area that is available for the heat transfer application. It is desirable to increase the surface area of fin.

P. S. Chaitanya, B.Suneela Rani, K. Vijay Kumar "**Thermal analysis of engine cylinder fin by varying its geometry and material**", IOSR Journal of mechanical engineering. (IOSR) Volume 2, Issue 6, Nov – Dec 2014

The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a fin is very difficult. The main aim of the present paper is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins using ansys work bench.

## III. SUMMARY

Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life. Presently Material used for manufacturing cylinder fin body is Aluminum Alloy A204 which has thermal conductivity of 110-150W/mk. presently analysis is carried out for cylinder fins using this material and also using Aluminum alloy 6061 which have higher thermal conductivities.

## IV. CONCLUSION

After have gone through all the research paper and doing some analysis we come to conclusions which are as follows:

**Material**: - It is very important factor. There are so many material which is suitable for making the fins but we want that material which is having higher value of h (convective heat transfer coefficient) and considering other parameters also we can get some of material and they are:-

- Aluminum
- Copper
- Carbon Steel

We will make the compound of these materials and will manufacture fins whose rate of heat transfer is high and having less weight and cheap.

## V. REFERENCES


[1]. M.G. Sobamowo "Analysis of convective longitudinal fin with temperature-dependent thermal conductivity and internal heat generation" , Alexandria Engineering Journal Received 10 December 2015; revised 7 March 2016; accepted 12 April 2016 Available online 22 September 2016

[2]. Sidramappa Alur "Experimental Studies on Plate Fin Heat Exchangers"

[3]. Saurav kumar, Prof. M.K. Singh "Comparative Analysis of Rectangular and Triangular Fin in Free and Forced Convection", 3rd International Conference on Emerging Trends in Engineering and Management Research 30th July 2017.

[4]. Hardik D. Rathod, Ashish J. Modi, Prof. (Dr.) Pravin P. Rathod "Effect of Different Variables on Heat Transfer Rate of Four-Stroke SI Engine Fins-Review Study", International Journal Of Mechanical Engineering And Technology (IJMET) , Volume 4, Issue 2, March - April (2013), pp. 328-333.

[5]. Mr. Manir alam, Asst. Prof. "Design and Analysis of fins of varying geometry and material", International journal of computer engineering in research trends.(IJCERT) Volume 3, Issue 2. Feb 2016

[6]. M. P Shah, K. S. Mehra, S.Gautam " Transient and steady state analysis of fins using for different material" , International journal for

research in applied science and engineering technology (IJRASET) Volume 2, Issue 6, June 2014

[7]. P. S. Chaitanya, B.Suneela Rani, K. Vijay Kumar "Thermal analysis of engine cylinder fin by varying its geometry and material", IOSR Journal of mechanical engineering. (IOSR) Volume 2, Issue 6, Nov – Dec 2014