International Journal of Research in Engineering, Science and Management
Volume-2, Issue-8, August-2019
www.ijresm.com | ISSN (Online): 2581-5792

Experimental Heat Transfer Analysis of Helical Fin with Parabolic Cross Section

M. A. Salve[1], T. A. Koli[2], V. H. Patil[3]
[1]Students, Department of Mechanical Engineering, Godavari College of engineering, Jalgaon, India
[2]Professor, Department of Mechanical Engineering, Godavari College of engineering, Jalgaon, India
[2]Professor & HoD, Department of Mechanical Engineering, Godavari College of engineering, Jalgaon, India

***Abstract*: 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 and modification on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. Air-cooling is used due to reduced weight and simple in construction of engine cylinder block. As the air-cooled engine builds heat, the cooling fins allow the wind and air to move the heat away from the engine. Low rate of heat transfer through cooling fins is the main problem in this type of cooling. An attempt will be made to simulate the heat transfer using helical fin with parabolic cross section and analyze effects on rate of heat dissipation from fins surfaces. The heat transfer surfaces of Engine are modelled in CATIA and simulated in ANSYS software. The experimental analysis is done for rectangular and helical fin with parabolic cross section. The main of aim of this work is to compare various characteristic between these two fins.**

***Keywords*: ANSYS, Helical fin, Heat transfer, Parabolic**

1. Introduction

In IC Engine quantity of heat given to the cylinder walls is considerable and if this heat is not removed from the cylinders it would result in the pre-ignition of the charge. Thereby causing the seizing of the piston. Excess heating will also damage the cylinder material and also following losses uncounted in engine:

1. Thermal efficiency is decreased due to more loss of heat to the cylinder walls.
2. The vaporization of fuel is less; this results in fall of combustion efficiency.
3. More piston friction is encountered, thus decreasing the mechanical efficiency.

Thus, in the present-day investigation on thermal issues on automobile fins are carried out. The main of aim of this work is to study various researches done in past to improve heat transfer rate of cooling fins by changing cylinder block fin geometry. We will change the cross-section of the fin to a parabolic one in an attempt to increase the flow velocity over the fin surface and hence facilitating more heat dissipation due to a proportional increase in heat transfer coefficient. Fins will have modeled over the cylinder in a helical orientation so as to accommodate more fin area than the conventional circular finned model over the cylinder with same dimensions.

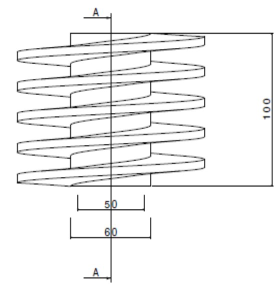

Fig. 1. CATIA model of parabolic fin

A. Development concept

A fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, radiation of an object determines the amount of heat it transfers. Increasing the temperature difference between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not economical or it is not feasible to change the first two options. Adding a fin to the object, however, increases the surface area and can sometimes be economical solution to heat transfer problems.

2. Literature review

"Review Paper on Effect of Cylinder Block Fin Geometry on Heat Transfer Rate of Air-Cooled 4S SI Engine" (2014) Arvind S. Sorathiya, et.al. says that, the design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Wavy fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be comparing with conventional one by CFD Analysis and Wind Tunnel experiment. [1]

"Design Modification and Analysis of Two Wheeler Engine Cooling Fins by CFD" (2015) S. M. Kherde, et.al. says that, models for three different shapes of fin and effects of wind

velocity and heat transfer coefficient values. An analysis is carried out in Ansys Fluent to find the effect of change in geometry of Fins in terms of HTC and air turbulence. Heat transfer rate increases after changing fin geometry and it is observed that HTC and turbulence are more in case of step shape fin model as compare to "S" shape Fin model. Due to non-uniformness in the geometry of Fins turbulence of flowing air increases which results in more heat transfer rate. [2]

"Thermal Analysis of Engine Cylinder Fin by Varying Its Geometry and Material'' (2014) P. Sai Chaitanya, et.al. says that, in the present work, a cylinder fin body is modelled and transient thermal analysis is done by using Pro/Engineer and ANSYS. These fins are used for air cooling systems for two wheelers. The various parameters (i.e., geometry and thickness of the fin) are considered in the study, by reducing the thickness and also by changing the shape of the fin to circular shape from the conventional geometry i.e. rectangular, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. By using circular fins the weight of the fin body reduces compared to existing rectangular engine cylinder fin [3].

"Heat Transfer Simulation by CFD from Fins of an Air Cooled Motorcycle Engine under Varying Climatic Conditions'' (2011) Pulkit Agarwal, et. al. says that, a model for an air cooled motorcycle engine was developed and effects of wind velocity and air temperature were investigated. The paper confirms the results of the experimental study of heat transfer dependence on different stream velocities. An analysis of heat transfer under different surrounding temperatures has also been carried out to reduce the overcooling of engines. The temperature and heat transfer coefficient values from fin base to tip are not uniform which shows the major advantage of CFD for analysis of heat transfer. The extra heat loss which takes place in the regions of subzero temperature has been found out. Using this data, the amount of fuel conserved can be easily calculated. A method of preventing this excessive heat loss is to use a diffuser in the path of air before it strikes the engine surface. This will help in reducing the air velocity and help in improving the efficiency of the engine [4].

"Optimization of Design Parameters of Various Geometries" (2000) Rong Hua Yeh says that, In his paper he find out the forgiven cylinder convex parabolic, conical, and concave parabolic fin profiles, the optimum dimensions and heat transfer characteristics of spines for various heat transfer modes and obtained with the aid of fin parameter and fin efficiency. It turns out the optimum base diameter, length, and heat duty is mainly a function of fin volume and base heat transfer coefficient. He illustrated different profiles and their relations [5].

3. Methodology

A. Material selection

Aluminium alloy (6061)

Thermal Properties

1. Co-Efficient of Thermal Expansion (20-100°C): $23.5x10^{-6}$ m/m.°C
2. Thermal Conductivity: 200 W/m.K
3. Typical composition of aluminium alloy 6061.

4. Experimental analysis

A. Experimental setup

1) Heater

Cylindrical cartridge heaters with 25 mm and nearby 100 mm length were used for heating purpose. A self-explanatory sketch of specimen cartridge type heater as shown in fig the power output of one heater was 300watts at 230v volts. Only one heater used in assembly.

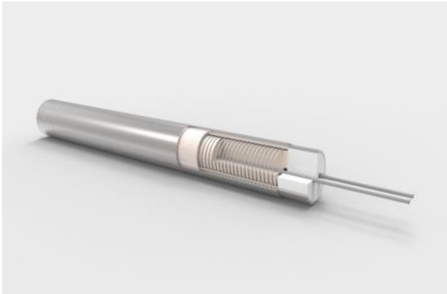

Fig. 2. Cartridge heater

2) Input power measurement

As supply was used for the heater through a dimmer stat so that the input can be varied. The input was measured with the help of wattmeter.

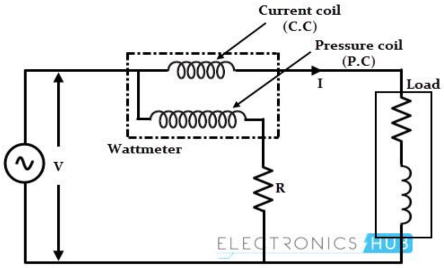

Fig. 3. Connection diagram for experimental setup

3) Temperature measurement

Multimeter was used to measure the average temperature of the helical and rectangular fin. They were connected in such way that whole fin length divided into some section they section 1 cm of 4 sections and connected each section and measure the temperature.

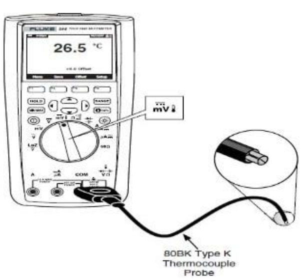

Fig. 4. Temperature measurement by using multimeter

IJRESM
International Journal of Research in Engineering, Science and Management
Volume-2, Issue-8, August-2019
www.ijresm.com | ISSN (Online): 2581-5792

4) Actual setup

Fig. 5. Actual setup

5. Experimental procedure

The assembled array was vertically suspended in the enclosure. The heaters were connected in electrically parallel circuit. Necessary electrical connection was made incorporating in a dimmer stat, a wattmeter for controlling and measurement purpose.

To carry out the experimental work following steps were followed:

1. Assembled of vertical parabolic fin array with 10 mm spacing suspended vertically in the enclosure.
2. All the necessary electrical connections were made.
3. AC supply was made to pass through the assembly.
4. The supply of 100 watt was adjusted with the help of dimmer stat and allowed the system to come to steady state.
5. Then the four junction temperature at four different junctions at the mid plane of fin array and ambient temperature were recorded by flunk multimeter of k-type probe.
6. Then the supply was changed from 100 W to 150,200,250 watts in four steps and for each assembly four junction temp. Of the fin array and the ambient temp. Were recorded at the steady state of the system.
7. In the next step supply was put off and assembly was taken out from the enclosure.
8. Then the above steps were repeated for equivalent rectangular fin array.

6. Various characteristic comparison

1) Effectiveness of fins

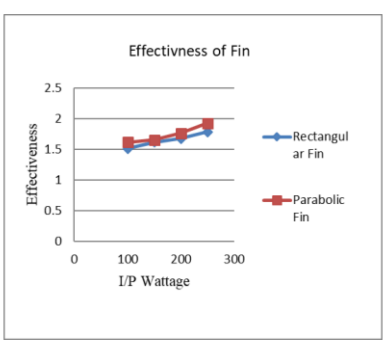

Fig. 6. Effectiveness vs. I/P wattage

From above graph, it is seen that effectiveness of parabolic fin is increased from 2.48%, 5.38%, 6%, and 7.68% at different wattage over rectangular fin. The effectiveness characteristics justifies the selection helical parabolic fin over rectangular for same dimension.

2) Weight

Table 1
Fins

Rectangular Fin	Parabolic Fin
2.15 Kg	1.44Kg

3) Temperature graphs

At 100-watt Reading

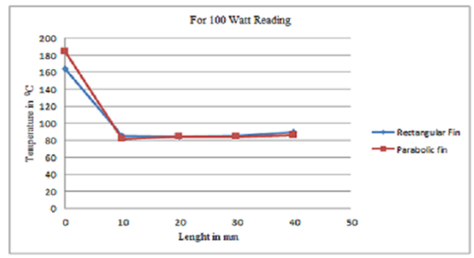

Fig. 7. Temperature distribution vs. length

At 250-watt Reading

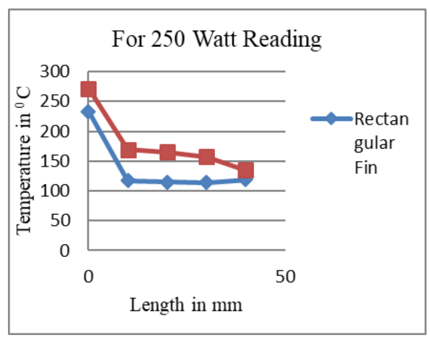

Fig. 8. Temperature distribution vs length

From above graphs, from above graph, it has been seen that at 100 w reading average surface temperature of parabolic is increased by 2.22% over rectangular fin. Similarly, at 250w reading it is increased by 34.78 %.

B. Convection gradient Θ(x) vs. length

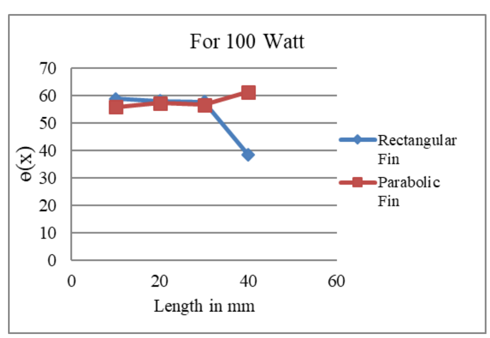

Fig. 9. Θ_x vs. length

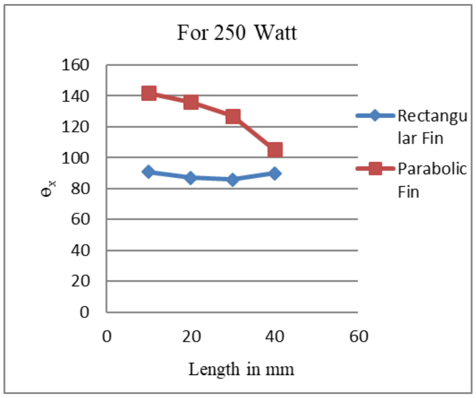

Fig. 10. Θ_x vs. length

Above graph represents the variation of convection gradient flux ϴ(x) w.r.t. lenght. From above graph, we observed convection gradient flux ϴ(x) is greater in parabolic fin than rectangular fin and it is increases with input wattage.

C. Heat transfer through fin (Q_{convec}) vs. length

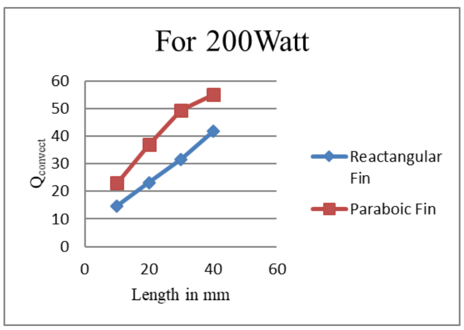

Fig.11. Qconvec vs. Length

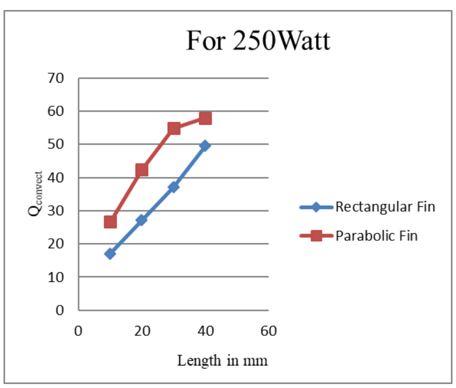

Fig.12. Q_{convec} vs. length

Above graphs indicate variation of convection heat transfer w.r.t length. It is seen that heat transfer is gradually increased in parabolic fin over rectangular fin with increase in wattage. It is observed that in parabolic fin Q_{conv} is increase 17%, 31% with input wattage 200w and 250w.

7. Conclusions

The important finding and observations from the present investigation are discussed below:

1. It is seen that heat transfer is gradually increased in parabolic fin over rectangular fin with increase in wattage. It is observed that in parabolic fin Q_{conv} is increase about 31% over rectangular fin.so it is more efficient to modelled parabolic fin.
2. Heat transfer efficiency of parabolic fin is increased about 4.1% over rectangular fin.
3. Effectiveness of parabolic fin is increased from 7.68% over rectangular fin. The effectiveness characteristics justifies the selection helical parabolic fin over rectangular for same dimension.
4. Percentage reduction in weight for parabolic fin is 42.62 %., so overall cost of system is reduced with such fins.
5. The experimental study undertaken revealed that the parabolic fins are more efficient over equivalent rectangular fin.

References

[1] A. S. Sorathiya, A. K. N. Parmar, and P. P. Rathod, “Review Paper on Effect of Cylinder Block Fin Geometry on Heat Transfer Rate of Air-Cooled 4S SI Engine,” *International Journal of Recent Development in Engineering and Technology*, vol. 2, no. 1, pp. 33-38, January 2014.

[2] M. A. Ali and S. M. Kherde, “Design Modification and Analysis of Two Wheeler Engine Cooling Fins by CFD,” *International Journal of Science, Engineering and Technology Research*, vol. 4, no. 2, pp. 367-371, February 2015.

[3] P. S. Chaitanya, B. S. Rani, K. V. Kumar, “Thermal Analysis of Engine Cylinder Fin by Varying Its Geometry and Material,” *IOSR Journal of Mechanical and Civil Engineering*, vol. 11, no. 6, pp. 37-44, Nov.-Dec. 2014.

[4] Pulkit Agarwal, et.al. “Heat Transfer Simulation by CFD from Fins of an Air Cooled Motorcycle Engine under Varying Climatic Conditions’’ *Proceedings of the World Congress on Engineering 2011 Vol III WCE 2011*, July 6-8, 2011, London, U.K.

[5] Rong Hua Yeh, “Optimization of Design Parameters of Various Geometries,” *Journal of marine science technology*, vol. 3, no.1, pp 11-17, 2000.