ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DESIGN AND FINITE ELEMENT ANALYSIS OF TWO WHEELER ENGINE FINS

A.C.Deshpande*, Mohd. Razik
* Department of Mechanical Engineering B.N.C.O.E, Pusad
Department of Mechanical Engineering B.N.C.O.E, Pusad

ABSTRACT

In India, generally in two wheelers air cooled engines are used. For this purpose, extended surfaces i.e. fins are used, which are mounted on cylinder block and cylinder head. Though the efficiency of cooling in air cooled system is less as compared to the water cooled system still it is used because of less space available to keep accessories. In this project the extended surfaces i.e. fins of Honda Shine & Bajaj Discover two wheeler automotives are tested to investigate effect on heat transfer rate by changing the Cross-section, Fin Pitch, Fin Material and Fin Thickness. The vehicles considered have single cylinder air cooled engines with set of rectangular fins mounted on the cylinder block. Through experiments temperature generated at steady state condition have been measured from the fin surface and using the value as key parameter, heat dissipated and heat flux through fin is calculated using empirical formulations. The same data is then validated by using FEA approach.

KEYWORDS: Fin, Convection, Heat Transfer.

INTRODUCTION

In case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 800 to 1500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result into seizing or welding of the same. So, this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. It is also to be noted that:

- 20-25% of total heat generated is used for producing brake power (useful work).
- Cooling system is designed to remove 30-35% of total heat.

Remaining heat is carried away by exhaust gases. The aim of this project is to find out the effect of fin geometry and fin pitch on cooling of the engine. As the fossil fuel reserves are depleting day by day, the spiraling fuel price is pushing the technology towards it limit to provide engines which are highly efficient and produces high specific power. Air cooled engines are gradually phased out and are being replaced by water cooled engines which are far more efficient in dissipating heat, but in cases of two wheelers and certain other applications, air cooled engines are the only viable option due to space constraints. The heat which is generated during combustion in an internal combustion engine should be maintained at the highest level possible to increase its thermal efficiency, but in order to prevent the thermal damage to the engine components and the lubricants some amount of heat must be removed from the system.

EXPERIMENTAL SETUP

Fig.2.1 : Experimental setup.

Experimental setup is shown in figure 5.1 the setup simply consist of thermocouple rod placed on surface of fin of which temperature readings are to be taken. Thermocouple rod is attached to thermocouple temperature trainer kit which consist of digital display which will provide us actual readings directly. The k-type thermocouple is used in experiment. The readings are taken on stationary engine after reaching to steady state condition. Following observations are found.

Model name	Honda Shine
CC	125
Stroke(mm)	58
Bore(mm)	52
No. of fins	6
Fin pitch(mm)	10
Fin thickness(mm)	2.5
Fin material	Al alloy
Position of Fins w.r.t. cylinder axis	Perpendicular

Table: 2.1.1 Observation for temperature reading of Honda Shine

Sr. No.	**Fin No.**	**Temperature (^{0}C)**
1	1	129
2	2	126
3	3	121
4	4	120

5	5	119
6	6	115

Note: The time to reach steady state was 90 minutes there after the readings were taken.

Calculations for Peak Temperature Produced in Cylinder of Honda Shine
(Data taken from technical specification of automotive vehicle)

Initial temperature during suction, $T_1 = 30\ °C$

Initial pressure $P_1 = 1$ bar

Compression ratio, $r_c = 9.5$

Peak pressure produced, $P_3 = 35$ bar

$$P_2 = P_1 \times r_c^{\Upsilon} = 1 \times (9.5)^{1.4} = 23.378 \text{ bar}$$

$$T_2 = T_1 \times (r_c)^{\Upsilon-1} = 303 \times (9.5)^{1.4-1} = 745.64\ °K$$

$$T_3 = \frac{P_3}{P_2} \times T_2 = \frac{35}{23.378} \times 745.64 = 1116.32 \text{ K} = 843.32\ ^{O}C$$

Calculation for Heat Dissipated From Surface of Fins of Honda Shine

Assumptions made to calculate the heat dissipated or heat flux:-

1) Steady state one dimensional heat conduction.
2) Finite long fin and with negligible heat loss from fin tip.
3) Constant properties.

Considering, h = Heat transfer coefficient
A_c= Cross section area of fin
K = Thermal conductivity
L = Length of fin.
w = Width of fin
t = Thickness of fin
P= Perimeter of fin
T_0 = Fin temperature
T_∞ = Ambient temperature of air.

For fin no.1

$Ac = L \times t = 445 \times 2.5\times10^{-6} = 1112.5 \times 10^{-6}\ m^2$

$P = 445 \times 10^{-3}$ m

$$mL = \sqrt{\frac{h \times P}{K\times Ac}} \times w = \sqrt{\frac{30\times445\times10-3}{240\times1112.5\times10-6}} \times 0.024 = 0.169$$

$$Q_1 = \sqrt{h \times P \times K \times Ac} \times (T_0 - T_\infty) \times \tanh(mL)$$
$$= \sqrt{30 \times 0.445 \times 240 \times 0.001112} \times (129-30) \times \tanh(0.169)$$

= 31.29 W.

Similarly for other fins heat dissipated can be calculated

Q_2 = 29.52 W
Q_3 = 27.46 W
Q_4 = 26.01 W
Q_5 = 24.65 W
Q_6 = 23.24 W

Total heat transfer from fins, $Q_{Honda\ Shine}$=162.17 W

Heat flux Calculation:-

Calculation for fin no.1.

$$q_1 = \frac{Heat\ dissipated\ by\ fin}{Area\ of\ cross\ section\ for\ fin}$$

$$= \frac{Q_1}{A_c}$$

$$= \frac{31.29}{0.00112}$$

$$= 28125.84\ W/m^2$$

Similarly, heat flux can be calculated for other fins.

q_2 = 27270.207 W/m^2

q_3 = 25844.705 W/m^2

q_4 = 25562.653 W/m^2

q_5 = 25282.051 W/m^2

q_6 = 24145.45 W/m^2

VALIDATION BY USING ANSYS

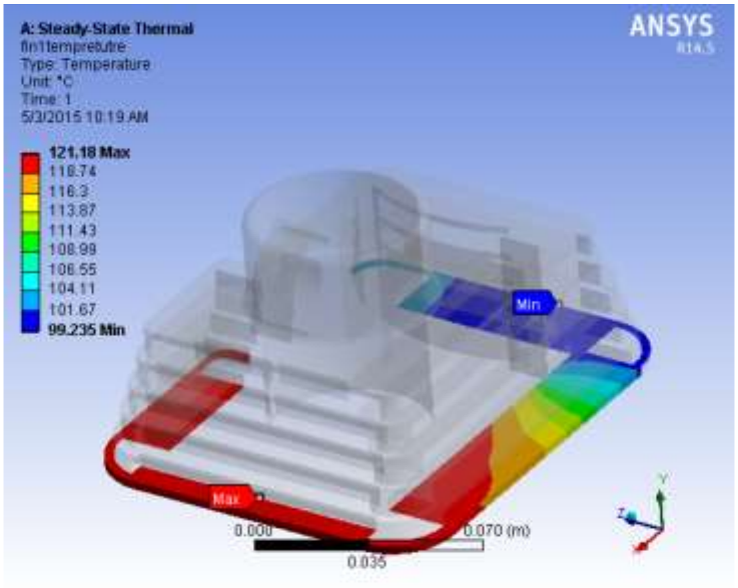

Fig.3.1 : Temperature for Honda Shine Fin 01

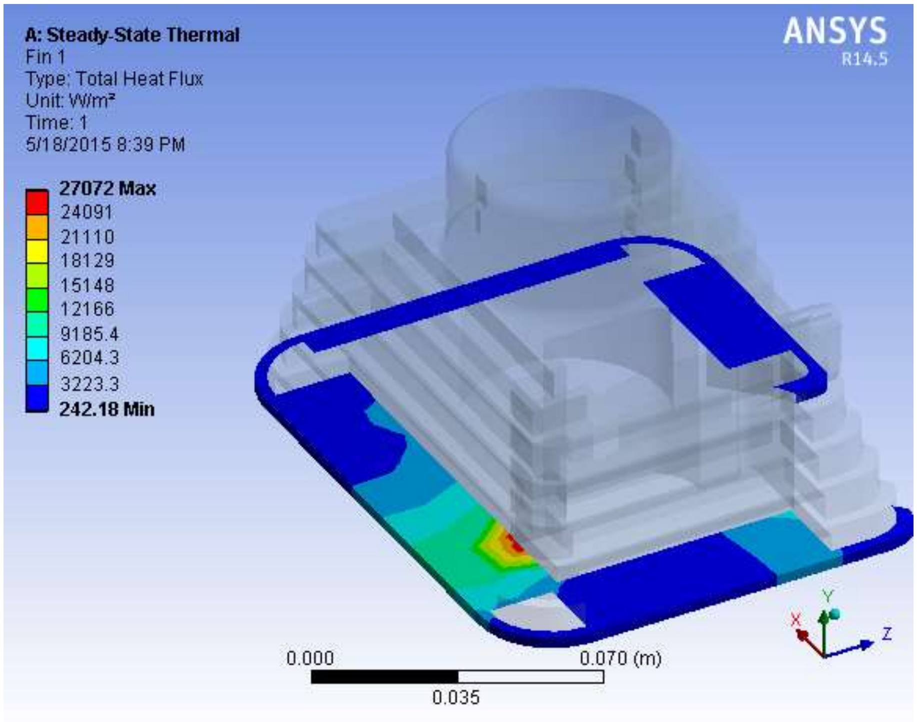

Fig. 3.2.: Heat flux for Honda Shine Fin 01

CONCLUSION

Design of fin plays an important role in heat transfer. The fin geometry and cross sectional area affects the heat transfer coefficient. There is a scope of improvement in heat transfer of air-cooled engine cylinder fin, if fin's is shape varied from conventional one. From this project after experiment values and FEA validation it can be concluded that contact surface available for the air to flow over the fin is also important factor in heat transfer rate.

If the turbulence of air is increased by changing the design and geometry (curved and corrugated shaped fins for cylinder block) of the fins, it will increase the rate of heat transfer. Due to non-uniformness in the geometry of fins, turbulence of flowing air increases which results in more heat transfer rate.

REFERENCES

1. Prof. Arvind S. Sorathiya, Hiren P. Hirpara, Prof. Dr. P.P. Rathod "An Effect of Different Parameters of Fins on Heat Transfer of IC Engine- Review Study" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 3 Ver. I (May- Jun. 2014), pp 63-71.
2. J.Ajay Paul, Sagar Chavan Vijay, U.Magarajan & R.Thundil Karuppa Raj" Experimental and Parametric Study of Extended Fins In The Optimization of Internal Combustion Engine Cooling Using CFD" International Journal of Applied Research in Mechanical Engineering (IJARME) ISSN: 2231 –5950, Volume-2, Issue-1, 2012.
3. Mohsin A. Ali, Prof. (Dr.) S.M Kherde " DESIGN MODIFICATION AND ANALYSIS OF TWO WHEELER COOLING FINS-A REVIEW" International Journal of Engineering and Applied Sciences Vol. 5. No. ISSN2305-8269, June. 2014, pp 30-33.
4. Prof. Arvind S.Sorathiya1, Ashishkumar N. Parmar2, Prof. (Dr.) Pravin 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 ISSN 2347 - 6435 Volume 2, Issue 1, January 2014.

5. Roody Charles, Chi-Chuan Wang" A novel heat dissipation fin design applicable for natural convection augmentation" International Communications in Heat and Mass Transfer Volume 59, December 2014, pp 24-29.
6. Cheng-Hung Huang, Yu-Hsiang Chen" An impingement heat sink module design problem in determining simultaneously the optimal non-uniform fin widths and heights" International Journal of Heat and Mass Transfer 73 (2014) pp 627-633.
7. Cheng-Hung Huang*, Yun-Lung Chung" The determination of optimum shapes for fully wet annular fins for maximum efficiency" Applied Thermal Engineering 73 (2014), pp 436-446.
8. Antonio Acosta-Iborra, Antonio Campo "Approximate analytic temperature distribution and efficiency for annular fins of uniform thickness" International Journal of Thermal Sciences 48 (2009), Received 4 February 2008; received in revised form 21 May 2008; accepted 22 May 2008 available online 20 June 2008, pp 773–780.
9. B. Kundu , P.K. Das "Performance analysis and optimization of elliptic fins circumscribing a circular tube" International Journal of Heat and Mass Transfer 50 (2007), Received 13 April 2005; received in revised form 15 June 2006 Available online 26 September 2006, pp 173–180.