DESIGN MODIFICATION AND ANALYSIS OF TWO WHEELER COOLING FINS-A REVIEW

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ABSTRACT
Engine life and effectiveness can be improved with effective cooling. The cooling mechanism of the air cooled engine is mostly dependent on the fin design of the cylinder head and block. Insufficient removal of heat from engine will lead to high thermal stresses and lower engine efficiency. 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. 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 and climate condition.

KEYWORDS: *cooling fins, Heat transfer, Convection & Thermal Stresses.*

I. INTRODUCTION

In Engine When fuel is burned heat is produced. Additional heat is also generated by friction between the moving parts. Only approximately 30% of the energy released is converted into useful work. The remaining (70%) must be removed from the engine to prevent the parts from melting. For this purpose Engine have cooling mechanism in engine to remove this heat from the engine some heavy vehicles uses water-cooling system and 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. In air-cooled engine, extended surfaces called fins are provided at the periphery of engine cylinder to increase heat transfer rate. That is why the analysis of fin is important to increase the heat transfer rate. Computational Fluid Dynamic (CFD) analysis have shown improvements in fin efficiency by changing fin geometry, fin pitch, number of fins, fin material and climate condition.

II. LITERATURE REVIEW

In the research of J. Ajay Paul and Sagar Chavan Vijay [2] Parametric Study of Extended Fins in the Optimization of Internal Combustion Engine they found that for high speed vehicles Engines thicker fins provide better efficiency. When fin thickness increases, the gap between the fins reduces that 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]
Author plotted the experimental results in figure 1, it shows the variation of the heat Transfer with respect to velocity. Ansys fluent software was used to predict the behavior or wind flow and analysis. 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. [2]

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]

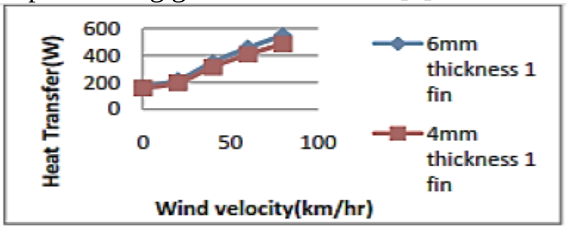

Fig.1. Heat transfer vs. air velocity for 6mm and 4mm thickness 1 no. of fin. [2]

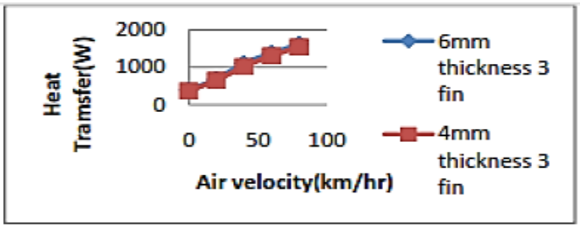

Fig.2. Heat transfer vs. air velocity for 6mm and 4mm thickness 3 no. of fin. [2].

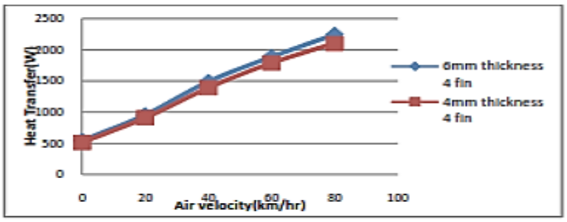

Fig.3. Heat transfer vs. air velocity for 6mm and 4mm thickness 4 no. of fin. [2].

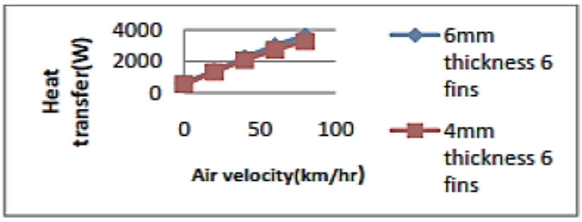

Fig.4. Heat transfer vs. air velocity for 6mm and 4mm thickness 6 no. of fin. [2].

Figure 1. Results of Analysis

In the research of J.C. Sanders et.al. [3] to find out overall heat transfer coefficient from the barrel he conducted experiment to of cooling tests on two cylinders, one with original steel fins and one with 1-inch spiral copper fins brazed on the barrel. The copper fins improved the overall heat transfer coefficient from the barrel to the air 115 percent. They also concluded that in the range of practical fins dimensions, copper fins having the same weight as the original steel fins will give at least 1.8 times the overall heat transfer of the original steel fins.

On the other hand Kumbhar D.G et.al. [4] Heat transfer augmentation from a horizontal rectangular fin by triangular perforations whose bases parallel and towards the fin base under natural convection has been studied using ANSYS. They have concluded that the heat transfer rate increases with perforation as compared to fins of similar dimensions without perforation. The perforation of the fin enhances the heat dissipation rates at the same time decreases the expenditure for fin materials also.

N.Nagarani and K. Mayilsamy, Experimental heat transfer analysis on annular circular and elliptical fins.[6]This other had analyzed the heat transfer rate and efficiency for circular and elliptical annular fins for different environmental conditions. Elliptical fin efficiency is more than circular fin. If space restriction is there along one particular direction while the perpendicular direction is relatively unrestricted elliptical fins could be a good choice. Normally heat transfer co- efficient depends upon the space, time, flow conditions and fluid properties. If there are changes in environmental conditions, there is a change in heat transfer co-efficient and efficiency also. [5]

To compare the rate of heat transfer with solid and permeable fins Ashok Tukaram Pise and Umesh Vandeorao Awasarmol [7] conducted the experiment. Permeable fins are formed by modifying the solid rectangular fins with drilling three holes per fins incline at one half lengths of the fins of two wheeler cylinder block. Solid and permeable fins block are kept in isolated chamber and effectiveness of each fin of these blocks were calculated. Engine cylinder block having solid and permeable fins were tested for different inputs (i.e. 75W, 60W, 45W, 30W, 15W). It was found that permeable fins block average heat transfer rate improves by about 5.63% and average heat transfer coefficient 42.3% as compared to solid fins with reduction of cost of the material 30%.

"Optimal Design of an I C engine cylinder fin array using a binary coded genetic algorithm" by G.Raju, Dr. Bhramara Panitapu, S. C. V. Ramana Murty Naidu. [8]This study also includes the effect of spacing between fins on various parameters like total surface area, heat transfer coefficient and total heat transfer .The aspect rations of a single fin and their corresponding array of these two profiles were also determined. Finally the heat transfer through both arrays was compared on their weight basis. Results show the advantage of triangular profile fin array. Heat transfer through triangular fin array per unit mass is more than that of heat transfer through rectangular fin array. Therefore the triangular fins are preferred than the rectangular fins for automobiles, central processing units, aero-planes, space vehicles etc… where weight is the main criteria. At wider spacing, shorter fins are more preferred than longer fins. The aspect ratio for an optimized fin array is more than that of a single fin for both rectangular and triangular profiles. [8]

R.P. Patil and H.M. Dange [9] conducted CFD and experimental analysis of elliptical fins for heat transfer parameters, heat transfer coefficient and tube efficiency by forced convection. The experiment is carried for different air flow rate with varying heat input. The CFD temperature distribution for all cases verifies experimental results. At air flow rate of 3.7 m/s, the heat transfer rate decreases as heat input increases. Also h is higher at above atmospheric temperature and lower at below atm. Temperature. At air flow rate of 3.7 m/s the efficiency, increases as heat input increases.

Magarajan U. , Thundil karrupa Raj R. , Elango T. "Numerical study on heat transfer I C Engine cooling by extended fins using CFD" [4]In this study, heat release of an IC engine cylinder cooling fins with six numbers of fins having pitch of 10 mm and 20 mm are calculated numerically using commercially available CFD tool Ansys Fluent. The IC engine is initially at 150 and the heat release from the cylinder is analyzed at a wind velocity of 0 km/h. It is observed from the CFD result that it takes 174.08 seconds (pitch=10mm) and 163.17 secs (pitch =20mm) for ethylene glycol domain to reach temperature of 423 K to 393 K for initially. The experiment results shows that the value of heat release by the ethylene glycol through cylinder fins of pitch 10mm and 20mm are about 28.5W and 33.90 W.[10]

Pulkit Agarwal et.al [11] simulated the heat transfer in motor-cycle engine fins using CFD analysis. It is observed that when the ambient temperature reduces to a very low value, it results in overcooling and poor efficiency of the engine. It is observed that when the ambient temperature reduces to a very low value, it results in overcooling and poor efficiency of the engine. They have concluded that overcooling also affects the engine efficiency because of overcooling excess fuel consumption occurs. This necessitates the need for reducing air velocity striking the engine surface to reduce the fuel consumption. It can be done placing a diffuser in front of the

Mr. N. Phani Raja Rao, Mr. T. Vishnu Vardhan. "Thermal Analysis of Engine Cylinder Fins By Varying Its Geometry And Material."[12] The principle implemented in the project to increase the heat dissipation rate by using the invisible working fluid nothing but air. The main aim of the project is to varying geometry, material. In present study, Aluminium alloy 6061 and magnesium alloy are used and compared with Aluminium Alloy A204. - The various parameters (i.e., shape and geometry of the fin) are considered in the study, shape (Rectangular and Circular), thickness (3 mm and 2.5 mm). By reducing the thickness and also by changing the shape of the fin to circular shaped, the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The weight of the fin body is also reduced when Magnesium alloy is used. The results shows, by using circular fin with material Aluminium Alloy 6061 is better since heat transfer rate, Efficiency and Effectiveness of the fin is more. By using circular fins the weight of the fin body reduces compare to existing engine cylinder fins.

S.M. Wange and R.M. Metkar [13] have done experimental and computational analysis of fin array and shown that the heat transfer coefficient is more in notch fin array than without notch fin array. Geometric parameters of fin affects on the performance of fins, so proper selection of geometric parameter such as length of fin, height of fin, spacing between fins, depth of notch is needed.

Heat Transfer Augmentation of Air Cooled 4 stroke SI Engine through Fins- A Review Paper. [14] The author had study number of research paper and concludes that the phenomenon by which heat transfer takes place through engine fins must frequently be improved for these reasons. Fins are extended surface which are used to cool various structures via the process of convection. Generally heat transfer by fins is basically limited by the design of the system. But still it may be enhanced by modifying certain design parameters of the fins. Hence the aim of this paper is to study from different literature surveys that how heat transfer through extended surfaces (fins) and the heat transfer co-efficient affected by changing cross-section, climatic conditions, materials etc. It is to be noted that heat transfer of the fin can be augmented by modifying fin pitches, geometry, shape, and material and wind velocity. As per available literature surveyed there is a little work available on the wavy fins geometry pertaining to current research area to till date. So there is a scope of research in the field of heat transfer study on wavy fins on cylinder head –block assembly of 4 stroke SI engine.

N.Nagarani and K. Mayilsamy, Experimental heat transfer analysis on annular circular and elliptical fins.[15]This other had analyzed the heat transfer rate and efficiency for circular and elliptical annular fins for different environmental conditions. Elliptical fin efficiency is more than circular fin. If space restriction is there along one particular direction while the perpendicular direction is relatively unrestricted elliptical fins could be a good choice. Normally heat transfer co- efficient depends upon the space, time, flow conditions and fluid properties. If there are changes in environmental conditions, there is a change in heat transfer co-efficient and efficiency also.[15]

2.1 Examples of Commercially Available Engines

Bajaj pulsar-150		Honda Shine-125		Hero Passion-110	
					
No Of Fins	12	No Of Fins	12	No Of Fins	8
Pitch (mm)	10	Pitch (mm)	10	Pitch (mm)	9
Thickness (mm)	2	Thickness (mm)	2	Thickness (mm)	2
Height (max/min) in (mm)	35/10	Height (max/min) in (mm)	22/7	Height (max/min) in (mm)	38/7
Fin Material	Al.alloy	Fin Material	Al.alloy	Fin Material	Al.alloy
Position of Fins W.R.T. Cylinder Axis	Perpindular	Position of Fins W.R.T. Cylinder Axis	Perpindular	Position of Fins W.R.T. Cylinder Axis	Parallel

Figure 1. Examples of Engines
Courtesy by KGN AUTOMOBILES, GACHIBOWLI, HYERABAD, AP, INDIA

III. CONCLUSION

The summary of the present literature review is as follows:
1. Design of fin plays an important role in heat transfer. The fin geometry and cross sectional area affects the heat transfer co efficient there is a scope of improvement in heat transfer of air-cooled engine cylinder fin if mounted fin's shape varied from conventional one.
2. From the all the research and experiment that covered in this paper it can be conclude that Contact time for the air flows over the fin is also important factor in heat transfer rate. If we can increase the turbulence of air by changing the design and geometry of the fins it will increase the rate of heat transfer and it is found that Curve and Zig-zag fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence of upcoming air. Improvements in heat transfer with new curve and Zig-Zag design fin can be compare with conventional one by CFD Analysis (Ansys Fluent).

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