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

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Abstract: Study of different research papers related to the extended surfaces and effect on heat transfer rate by changing the cross-section, fin pitch, fin material, fin thickness, air velocity, and air exposed angle etc. and survey has been conducted on fin profile of various cylinder block of two wheelers automobiles available in India. The fins are generally used to increase the heat transfer rate by increasing the area of system. So it is necessary to study about effect of fin geometry on heat transfer rate. This review study is useful to know betterment of fin material and fin geometry.

Keywords: Cooling fins, Heat transfer, Free convection.

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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 2300-2500°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 review is to find out the effect of fin geometry and fin pitch on cooling of the engine

LITERATURE REVIEW:

1) Prof. Arvind S. Sorathiya¹, Ashishkumar N. Parmar², Prof. (Dr.) Pravin P. Rathod in the paper "Review Paper on Effect of Cylinder Block Fin Geometry on Heat Transfer Rate of Air-Cooled 4S SI Engine" wind tunnel experiments have shown improvements in fin efficiency by changing fins geometry, pitch, number of fins, fin material and climate conditions. Value of surface heat transfer coefficient varies mainly with air velocity and space between the fins. Cylinder body and head both provided with fins. Starting from a zero dimensional combustion model developed in previous works geometry of fins has been optimized.

2) J. Ajay Paul, Sagar Chavan Vijay, U. Magarajan & R. Thundil Karuppa Raj in the paper "Experimental and Parametric Study of Extended Fins In The Optimization of Internal Combustion Engine Cooling Using CFD" have mounted annular fins on a cylinder. Conducted experiments and all data was provided to the software. Found that particular thickness of fins gives better efficiency. Large number of fins with less thickness can be preferred in high speed vehicles than thick fins with less number. Future scope is provided by them heat transfer from outside portion was found less we can try to increase it by providing slits and holes.

3) Mohsin A. Ali, Prof. (Dr.) S.M Kherde "DESIGN MODIFICATION AND ANALYSIS OF TWO WHEELER COOLING FINS-A REVIEW" the fin geometry and cross sectional area affects the heat transfer co-efficient. Heat transfer can be increased by forced convection by increasing surrounding fluid velocity. Air contact time i.e. time between air inlet and outlet flow through fin is also important factor in heat transfer.

4) 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" in different papers they found that effects on heat transfer rate by changing the cross section, fin pitch, cross section, material, air velocity, air exposed angle. One of the author conducted experiments for different Reynolds number (5-200). From this he found that permeable fins offer more Nusslet number than solid once. One Japanese author conducted experiments with measuring temperature inside cylinder, surface of fins. Observed that heat transfer do not improved when cylinder have more fins, derived expression for that. Many authors have done CFD analysis by changing fin parameters.

5) Roody Charles, Chi-Chana Wang "A novel heat dissipation fin design applicable for natural convection augmentation" In this paper, a comparative study of heat sink having various fin assembly under natural convection is investigated. The fin pattern includes a rectangular, a trapezoidal and an inverted trapezoidal configuration. Tests were performed in a well-controlled environmental chamber having a heat load ranging from 3 to 20 W. From the test results, the heat transfer coefficient of the conventional rectangular fins is higher than that of the trapezoidal fins while the heat transfer coefficient of the inverted trapezoidal fins is higher than the trapezoidal one by approximately 25%, and it exceeds that of convectional rectangular fin by about 10%. The heat transfer improvements of the inverted trapezoidal fin are mainly associated with a larger temperature difference and inducing more air flow into the heat sink.

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" The Levenberg-Marquardt Method (LMM) is applied in the paper to determine the optimal fin widths and heights of an impingement cooling heat sink module using a general purpose commercial code (CFD-ACE+). In this optimal heat sink design problem, the non-uniform fin widths and heights are chosen as the design variables. The objective of the present study is to minimize the system thermal resistance (R_{th}) of the fin array and to obtain the optimal dimensions of heat sink. The results obtained by numerical experiments demonstrate that by utilizing the optimal heat sink and operating at the design condition $Re = 15,000$, R_{th} can be decreased by 3.10% and 1.20% when compared with the original and Yang and Peng's (2008) heat sinks, respectively. Nu and

COE can be increased by 3.20% and 3.20%, respectively, when compared with the original heat sink, and these parameters can be increased by 1.22% and 1.18%, respectively, when compared with the optimal heat sink proposed by Yang and Peng (2008). Consequently, the thermal performances of optimal impingement heat sink can be improved.

7) Cheng-Hung Huang, Yun-Lung Chung "The determination of optimum shapes for fully wet annular fins for maximum efficiency" A fin design problem to determine the optimum shapes of fully wet annular fins adhered to a bare tube based on the desired fin efficiency and fin volume is examined in the present study using an iterative regularization process with the conjugate gradient method (CGM). One of the advantages of applying the CGM in this design problem lies in that the optimal functional form of the fin shape does not need be given before the estimation, the optimal fin shape can be obtained automatically during the iteration process. It is assumed that the surrounding air has an assumed relative humidity of 100% and this will result in the condition of a fully wet annular fin. The results obtained from the numerical experiments using the CGM method are examined to justify the validity of the present inverse design problem. The numerical results show that when the Biot number, conductivity ratio and fin volume are varied, the optimum fin efficiency and the fin shape of the fully annular fin also change. Finally it is concluded that the optimal fin shapes can yield maximum efficiency and this implies that more heat can be dissipated into environment using the present optimal fins.

8) Antonio Acosta-Iborra , Antonio Campo "Approximate analytic temperature distribution and efficiency for annular fins of uniform thickness" The salient feature in the quasi one-dimensional differential equation for annular fins of uniform thickness is without question the presence of the variable coefficient $1/r$ multiplying the first order derivative, dT/dr . A good-natured manipulation of the variable coefficient $1/r$ is the principal objective of the present work. Specifically, the manipulation applies the mean value theorem for integration to $1/r$ in the proper fin domain extending from the inner radius r_1 to the outer radius r_2 . It is demonstrated that approximate analytic temperature profiles and heat transfer rates of good quality are easily obtainable without resorting to the exact analytic temperature distribution and heat transfer rate embodying modified Bessel functions. For enhanced visualization, the computed temperature profiles, tip temperatures and fin efficiencies of approximate nature are graphed and tabulated for realistic combinations of the normalized radii ratio c and the thermo-geometric fin parameter ξ of interest in thermal engineering applications.

9) B. Kundu, P.K. Das" Performance analysis and optimization of elliptical fins circumscribing a circular tube" in paper" The performance of elliptic disc fins has been analyzed using a semi-analytical technique. It has been shown that the efficiency of such

fins can also be predicted very closely using the sector method. However, the equivalent annulus method is not suitable for this fin geometry. A method for the optimum design of fins, using a constraint of either fin volume or rate of heat dissipation has also been suggested. Optimum elliptical fins dissipate heat at a higher rate compared to an annular fin when space restriction exists on both sides of the fin. Even when the restriction is on one side only, the performance of elliptical fin is comparable to that of eccentric annular fin for a wide parametric range.

CONCLUSION:

The summary of the present literature review is as follows:

1. 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.
2. The fin geometry and cross sectional area affects the heat transfer coefficient. In High speed vehicles thicker fins provide better efficiency. Increased fin thickness 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 and hence higher heat transfer.
3. Heat transfer coefficient can be increased by increasing the surrounding fluid velocity by forced convection. Heat transfer dependence on different stream velocities.
4. 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.
5. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Curve and Zigzag 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 compare with conventional one by CFD Analysis.

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