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Heat Transfer Rate Enhancement of an Air Cooled Four Stroke SI Engine by Geometrically Modified Fins-A Review

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Abstract: **The engine cylinder is one of the major I C engine components, which is subjected to high temperature variations and thermal stresses. 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. The main aim of the paper is to increase the heat dissipation rate by using the invisible working fluid of air. It is observed that, by increasing the surface area the heat dissipation rate increases, further the main purpose of using these cooling fins is to cool the engine cylinder by air. This paper presents a review to increase heat transfer rate in a four stroke S I engine by using geometrically modified fins**

Keyword: Thermal Analysis, Fins Geometry, Material, Velocity Variation and CFD

1. INTRODUCTION

In an internal combustion engines, the combustion of air and fuel takes place inside the engine cylinder, and hot gases are generated. The temperature of the gases is around 2300-2500 ° C. This is a very high temperature and can lead to the burning of the oil film between the moving parts. Therefore, this temperature must be lowered to 150-200 ° C, so that the engine will work as efficiently as possible. Too much cooling is undesirable because it reduces thermal efficiency. Thus, the purpose of the cooling system is to maintain the maximum effective operating temperature of the engine. Almost all two wheelers uses Air cooled engines, because Air-cooled engines are only option due twosome advantages like lighter weight and lesser space requirement. Internal combustion engines at best can transform about 25 to 35 % of the chemical energy in the fuel in to mechanical energy. About 35 % of the heat generated is lost in to the surroundings of combustion space, remainder being dissipated through exhaust and radiation from the engine. A fin is a surface which extends from a surface to increase the rate of heat transfer to the environment by increasing convection. Experiments has been made to increase fin efficiency by Changing fin material and fin geometry. The cooling mechanism of the air cooled IC engine is generally dependent on the fin design of the cylinder, cross-section area of fin, pitch of the fin, thickness of fin, air velocity, air exposed angle and weather conditions. The conduction heat transfer from inner wall to fin surface is given as:

$q = kA(T_w - T_{fin})$

The convection heat transfer from fin surface to atmosphere air by free and forced air is given as:

$q = hf\ (T_{fin} - T_{air})$

In air-cooled engine to increase the heat transfer rate, fins are provided at the periphery of engine cylinder so that the analysis of fin is important. Computational Fluid Dynamic (CFD) analysis and Wind tunnel experiments have shown improvements in fin efficiency by changing fin geometry, fin pitch, number of fins, fin material and climate condition. [1]It should be noted that the engine is very inefficient in the cold, and the cooling system is designed to prevent cooling, when the engine warms up, and then reaches the maximum operating temperature, starts to cool. It should also be noted that:

a) 20-25% of the total amount of heat released is used to create a braking power (useful work).

b) The cooling system is designed to dissipate 30 to 35% of the total heat The remaining heat is carried away by exhaust

gases. The purpose of this review is to reveal the influence of rib geometry and finning clearance on engine cooling.

2. LITERATURE REVIEW

Fernando Illan et.al [2] simulated the heat transfer from cylinder to air of a two-stroke internal combustion finned engine. The cylinder body, cylinder head and piston have been mathematically analyzed and optimized in order to minimize engine geometries. The maximum temperature allowable at the hottest point of the engine has been adopted as the restrict condition. Starting from a zero-dimensional ignition model developed in previous works, the cooling system dimension of a two-stroke air cooled internal combustion engine has been optimized in this paper by reducing the total volume occupied by the engine.

Yosidha Masao et.al. [3] investigated effect of number of fin, fin pitch and wind velocity on air-cooling using experimental cylinders for an air-cooled engine of a motor-cycle in wind tunnel. Heat release from the cylinder did not improve when the cylinder have the more fins and too narrow a fin pitch at lower wind velocity, because it is difficult for the air to pass into the narrow space between the fins, so the temperature is increased between them. They have concluded that the optimized fin pitches with the greatest effective cooling are at 20mm for non-moving and 8mm for moving.

B. Kundu and D. Bhanja[4] analyzed the thermal conductivity and convective heat transfer coefficient of fin material and its surface. The analysis for determining the optimum dimensions of fins satisfying either the maximization of rate of heat transfer for a given fin volume or the minimization of fin volume for a desired heat transfer rate. The performance of a contractual fin depends upon the base and ambient temperature. The fin performance increases with the increase in ambient temperature. The performance of thermal conductivity and convective heat transfer compared with existing results.

D.G.Kumbhar et.al. [5] carried out the 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.The consideration of fin parameters are thermal properties and geometrical dimensions. The perforated fin heat dissipation rate is compared to that of solid fin. They have concluded that the heat transfer rate increases with perforation as compared to without perforation fin. The perforation of the fin enhances the heat transfer rates at the same time decreases the expenditure for fin materials also.

N. Nagarani et.al. [6] Analyzed the heat transfer rate and efficiency for circular and elliptical annular fins for different environment conditions. Elliptical fin effectiveness is more than circular fin. If space limitation is there along one particular direction while the perpendicular direction is relatively unrestricted elliptical fins could be a best choice. Normally heat transfer co-efficient depends on the flow conditions and fluid properties. If there are changes in environment conditions, there is alteration in heat transfer co-efficient and efficiency also.

Ashok Tukaram Pise and Umesh Vandeorao Awasarmol [7] conducted the experiment to compare the rate of heat transfer with solid and permeable fins. Permeable fins are formed by altering the solid rectangular fins with drilling three holes per fins incline at one half length of the fins of two wheeler cylinder block. 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%.

G.Bahadur Vali & Krishna Veni [8] In this project they have design an assemble cylinder and cylinder head. they used two different Aluminum alloys 6061 and 7475. performed Thermal analysis on the cylinder to determine the thermal behavior for aluminum alloys for original model and also by changing the thickness of the cylinder head. They further explained that by reducing the thickness, the weight of the component reduces. By observing the thermal analysis results heat flux is more for the modified model than for original model. after comparing the result between two alloy, heat flux is more for Aluminum alloy 6061 than aluminum alloy 7475.

Abhishek Mote at el [9] they analyze of heat transfer crosswise finned surfaces using CFD software. they thought that experiment based research done by different researchers in the past is a time consuming process, hence CFD software was used to simulate the heat transfer across fins of an IC Engine and simulated results compared with experimental results.

Shubham Shrivastava & Shikar Upadhyay [10] investigate the cylinder block made in 3D software Solid works in which perpendicular fins are mounted. they modify the engine cylinder block fins, and its thickness reduced from 3 mm to 2 mm. so that weight reduced and also choose material which replace the existing materials , they analyzes Aluminium alloy 1050 for thermal analysis to evaluate the better heat transfer rate. they reduce the weight 13.2 %, of block due to modification and 2.1 % by change material without compromising with strength.

Vinay Kumar Attar & Himanshu Arora [11] They investigate Piston skirt which appear deformation at work usually causes crack on the upper end of piston head. they found that the situation becomes more serious when the

stiffness of the piston is not enough and the crack appeared which may gradually extend and even cause splitting along the piston vertically. they explained the stress distribution on the piston mainly depends on the deformation of piston in order to reduce the stress concentration..

Chidiebere Okeke-Richard & Sunny Sharma [12] They analyze cylinder blocks of 4Stroke SI Engines of two wheelers from three different companies like HONDA, TVS, YAMAHA, to find out the thermal effects of combustion gases with respect to change in temperature and heat flux From the analysis they conclude that Honda Activa always have higher amount of heat dissipated throughout the time than TVS Wego and also state that the Yamaha Ray Z, dissipates the least in the winter season irrespective of the difference in thermal properties.

Arvind S Sarothiya, Ashishkumar N Parmar et al[13] has done survey on Indian 2 wheeler market and various design of engines based on air cooling .As the air cooled engine builds heat ,the cooling fins allow the wind and air to move the heat away from the geometry. Based on this various parameters are considered for the changes in design using Ansys have been studied in this paper.

Vipul Shekhada, Dr. Shashi Jain et al [14] has done study on Ansys software in which they have compared the previous data and the current data of air cooled fins and validated upon the previous conditions and showed that the new fins have better heat transfer rate as compared to the existing one.

3. CONCLUSION

The outline of present literature review is as follows:

For a given thermal load, the fin material and fin array parameters is optimized in an exceedingly higher approach by numerical simulation ways. To extend the cylinder cooling, the cylinder ought to have a bigger number of fins. In High-speed vehicles thicker fins offer higher efficiency it can be seen that the swirls being created that helped in increasing the heat transfer. Contact time between air flow and fin is additionally necessary think about such heat transfer. Curve and Zig-zag fin formed engine block will be used for increasing the heat transfer from the fins by creating turbulence for future air. Heat transfer rate and heat transfer constant will be enhanced with the wind velocity so the heat transfer rate additionally increase by vary geometry of fins mounted on that.

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