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Study about the Fins of 4-Stroke Bike Fins using cfd Method

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Abstract- **Cooling plays vital role in optimum performance of internal combustion engine. The two widely used methods of thermal management of the engine are air cooling and liquid cooling. The air cooling method is the effective way of cooling for two-wheeler engines as its cost is less and it requires less space. The weight of air cooled engine is less than liquid cooled engines. The Heat is conducted from cylinder inside wall to the engine fin surface. The purpose of this experimental work is to study the forced conjugate heat transfer process taking place in engine cylinder block with varying wind speeds ranging from 40 km/hr to 100km/hr, varying environmental conditions, various fin pitch and fin width. The environmental conditions of India have vast variation. In present study, first the 3D model of the actual engine cylinder block of two-wheeler with 4-stroke Engine has been drawn in Ansys 15.0. The Average heat transfer coefficient for the surface of the engine cylinder block has been calculated with the help of commercially available CFD tool ANSYS Fluent. It is observed that wind velocity, environmental temperature, Fin Pitch and Fin width have significant effect on heat transfer from the engine.**

Keyword-: **cooling System, Fins, CFD, Heat transfer rate, Wind Speed, Convection.**

I. INTRODUCTION

In internal combustion engine the combustion of fuel take place with an oxidizer in a combustion chamber. In an I.C. engine, the expansion of the high temperature and high-pressure gases generated by combustion which applies direct force to various component of the engine, i.e. pistons. This force moves the component i.e. piston over a distance, generated mechanical energy in the form of rotation.

Air cooled engines in heavy vehicles and cars are phased out and are replaced by water cooled engines which are more efficient, but almost all two wheelers use Air cooled engines, because Air-cooled engines are only option due to some advantages like lighter weight, lesser space requirement and lesser maintenance.The heat generation from combustion in IC engine should be maintained at higher level to increase thermal efficiency, but to prevent the thermal damage to the engine geometry some heat should be removed from the engine [1].

Fins are one of the heat transferring devices which are used to increase the heat transfer on engine cylinder walls. Therefore, it is necessary to study the heat transfer rate of the fins. The research has been done to increase fin efficiency by Changing fin material and fin geometry. The fins are generally extended surfaces of projections of materials on the Cylinder block and head. The fins are usually used to increase the heat transfer from the Cylinder to the surroundings air by increasing the heat transfer surface area[3, 4].

The heat transfer rate depends upon the velocity of the vehicle and fin geometry and temperature of cylinder. The heat transfer also depends on air velocity and environmental temperature. If the surrounding temperature is low and wind velocity is high, it can result in overcooling of the engine, which can overcome the thermal efficiency of the engine. Whereas, If the surrounding temperature is high and wind velocity is low it can result in over heating of the engine, which can cause distortion of the engine geometry and breakdown of the engine functioning. Various experimental methods are available in literature to study the effect of that factors on the heat transfer rate[5].

In the rest part of our research work, literature survey described in section II, surface heat transfer discussed in section III, difficulties in heat transfer introduced in

section IV and finally, conclusion and future work discussed in section V.

II. LITERATURE SURVEY

K. Shahril, Nurhayati Binti Mohd Kasim and M.Sabri Et al. [1] in this research, Motorcycle engine releases heat to the atmosphere through the mode of force convection. To solve this, fins are provided on the outer of the cylinder. The heat transfer rate is defined depending on the velocity of vehicle, fin geometry and the ambient temperature. This simulation is proving that the wind velocity is one important part that can affected the total of heat transfer and the value of heat transfer coefficient.

K. Sathishkumar, K. Vignesh, N. Ugesh, P. B. Sanjeevaprasath and S. Balamurugan Et al. [2] Fins are generally used to increase the heat transfer rate from the system to the surroundings. The fins with various configurations were modeled using CREO 2.0 and analyses are done by using CFD Fluent in order to find out the heat transfer rate. It is clear that the results from software and theoretically says that the fins with rectangular notch have greater heat transfer rate compared to that of the fins without holes, fins with holes and V shaped fins.

Mohsin A. Ali and S.M Kherde Et al. [3] Engine life and effectiveness can be improved with effective cooling. 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. 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.

S Chandra sekhar, P Satish Reddy and Ch.Chandra Rao Et al. [4] An air-cooled motorcycle engine releases heat to the atmosphere through the mode of forced convection. To facilitate this, fins are provided on the outer surface of the cylinder. The heat transfer rate depends upon the velocity of the vehicle, fin geometry and the ambient temperature. Many experimental methods are available in literature to analyze the effect of these factors on the heat transfer rate. In the present paper an effort is made to study the effect of fin parameters on fin array performance which includes variation in pitch, thickness and fin material. An expression of average fin surface heat transfer coefficient in terms of wind velocity is obtained. Heat transfer is taken as input for structural analysis. Finally obtained temp distribution, heat flux, thermal stresses and deformation for three types of materials like aluminium, cast iron and copper.

G. Angel and N. Sambasiva Rao Et al. [5] An air-cooled motorcycle engine releases heat to the atmosphere through the mode of forced convection to facilitate this, fins are provided on the outer surface of the cylinder. These fins are used for air cooling systems for two wheelers. In present work, Aluminium alloy 6061 and Zinc alloy at different thickness has been studied. The various parameters (i.e., materials and thickness of the fin) are considered in the study, materials (Aluminum and Zinc alloys), thickness (3 mm and 2.5 mm). By varying the thickness of the circular fin, aluminum alloy shows better results compared to Zinc alloy, since heat transfer of the circular fin is more.

Gokul Karthik A and Dinesh R Et al. [6] The main aim of the project is to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Parametric models of cylinder with fins have been developed to predict the transient thermal behavior. The 3D modeling software used is Pro/Engineer. The analysis is done using ANSYS. Presently Material used for manufacturing cylinder fin body is Aluminum Alloy 204 which has thermal conductivity of 110- 150W/mk. They can conclude that using material Aluminum alloy 6061 is better, reducing thickness to 2.5mm is better and using fin shape circular by analysis and fin shape curved by weight is better. they have also done theoretical calculations to determine the heat lost, effectiveness and efficiency of the fins.

P. Harish, B. Ramakrishna Reddy, G. S. Md. Waseem Akram, K.MD. Hanief and Kumair Naik Et al. [7] A cylinder fin body for Passion Plus 100cc motorcycle is modeled using parametric software Pro/Engineer. The original model is changed by changing the geometry of the fin body, distance between the fins and thickness of the fins. Present used material for fin body is Cast Iron. In this thesis, thermal analysis is done for all the three materials Cast Iron, Copper and Aluminum alloy 6082. By observing the thermal analysis results, thermal flux is more for Aluminum alloy than other two materials and also by using Aluminum alloy its weight is less, so using Aluminum alloy 6082 is better.

Prof. Arvind S. Sorathiya, Hiren P. Hirpara and Prof. Dr. P.P. Rathod Et al. [8] to 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/three 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.

M. Rajesh, S. Rahamathullah, and Dr. G Naga Malleswara Rao Et al. [9] The main aim of the Paper is to analyze the thermal properties by varying geometry, material (Cu and Al alloy 6082), distance between the fins and thickness of cylinder fins. The Fins models are created by varying the geometry circular and also by varying thickness of the fins for both geometries. The 3D modeling software used is Pro/Engineer & UniGraphics. All the materials are showing linear distribution of temperature alongside the length of fins. The observations from the present research work are, Aluminium 2014 Alloy showing 17 % higher temperature distribution compared to that of Aluminium Alloy 204 due to its material composition and higher thermal conductivity.

G. Babu and M. Lavakumar Et al. [10] In this project they have designed a cylinder fin body used in a 100cc Hero Honda Motorcycle and modeled in parametric 3D modeling software Pro/Engineer. Present used material for fin body is Aluminum alloy 204. they are replacing with Aluminum alloy 6061 and magnesium alloy. The shape of the fin is rectangular; they have changed the shape with circular and curve shaped. The default thickness of fin is 3mm; they are reducing it to 2.5mm. By reducing the thickness and also by changing the shape of the fin to curve shaped, the weight of the fin body reduces thereby increasing the efficiency. So, they can conclude that using material Aluminum alloy 6061 is better, reducing thickness to 2.5mm is better and using fin shape circular by analysis and fin shape curved by weight is better. they have also done theoretical calculations to determine the heat lost, effectiveness and efficiency of the fins. By observing the results, using circular fins the heat lost is more, efficiency and effectiveness is also more.

Mr. Mehul S. Patel and Mr. N. M. Vora Et al. [11] they know that, by increasing the surface area they can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. The main aim is the project is to analysis thermal properties by varying geometry, material and thickness of cylinder fins. Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal

simulation could permit critical design parameters to be identified for improved life.

Deepak Tekhre and Jagdeesh Saini Et al. [12] The heat transfer effect may be varied by changing material of different thermal conductivities, improvising engine geometry, increasing cross section area of fins, using perforations on fin and on CFD analysis of fins. Hence the aim of this paper is to study from different literature surveys that how heat transfer through extended surfaces and the heat transfer coefficient affected by changing cross-section this study is useful to know the better geometry and material for the fins for better engine cooling.

III. SURFACE HEAT TRANSFER

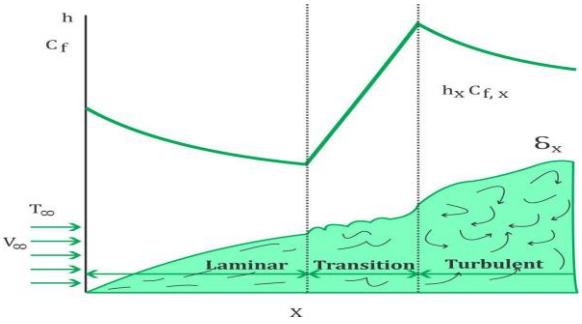

Figure 1. Variation of heat transfer coefficient over flat plate in different flow regime.

From the above it is observed that, Heat transfer coefficient purely depends on the fluid velocity, fluid temperature and surface reference temperature. If the fluid temperature is low heat transfer coefficient will be huge and vice versa. If the fluid velocity is high the heat transfer will be high which is called as forced convection. If the wall surface temperature is low the heat transfer coefficient will be low. The heat transfer coefficient also relies on the flow regime. figure shows the flow over a flat surface[2, 6].

The intense mixing of the fluid in turbulent flow as a result of rapid fluctuation enhances heat and momentum transfer between fluid particles, which increases the friction on the surface and convection heat transfer rate. It also causes the boundary layer to enlarge. Both the friction and heat transfer coefficient reach maximum value when the flow becomes fully turbulent. So, it will become no surprise that a special effort is made in design of heat transfer coefficient

associated with turbulent flow. The flow fields and geometries for most external flow problems are too complicated to be solved analytically, and thus we have to rely on correlation based on experimental data. The availability of high-speed computers has made it possible to conduct series of "numerical experimentations" quickly by solving the governing equations numerically, and to resort to the expensive and time-consuming testing and experimentation only in the final stages of design [8].

IV. DIFFICULTIES IN HEAT TRANSFER

After the consideration of all related research work, we have to conclude some difficulties. These several difficulties to face in heat transfer form a motorbike fins that's affected the performance of cooling system [8-11].

- The heat flow in the fin and its temperatures remain constant with time.
- The fin material is homogeneous, its thermal conductivity is the same in all directions, and it remains constant.
- The convective heat transfer on the faces of the fin is constant and uniform over the entire surface of the fin
- The temperature of the medium surrounding the fin is uniform.
- The fin thickness is small, compared with its height and length, so that temperature gradient across the fin thickness and heat transfer from the edges of the fin may be neglected.
- The temperature at the base of the fin is uniform.
- Heat transfer to or from the fin is proportional to the temperature excess between the fin and the surrounding medium.
- Radiation heat transfer from and to the fin is neglected.

IV. CONCLUSION AND FUTURE WORK

This work is done to study the heat transfer from the engine cylinder block of motorbike. Here we finally conclude the according to the analysis the modelling of an automotive air-cooled engine cylinder block is done. The effect of surrounding environment temperature and wind velocity on heat transfer through the extended surfaces is analysed with computational package. It is observed that the surface heat transfer coefficient increases as the wind velocity increases. Reduction in surrounding environmental temperature also results in excessive convective heat loss. The turbulence of wind flow increases with higher wind speed, which results in higher convection. The turbulent kinetic energy is also calculated. To increase the cylinder cooling, the cylinder should have a greater number of fins. However, the cylinder cooling decreases with an increased number of fins if the fin spacing is too narrow. Because the air does not flow well between the fins, overlapping of thermal boundary layers occurs on the upper and lower fin surfaces.

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