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Thermal Analysis of IC Engine Bore Fins

Abhay Bele¹, Akash Chaurasia², Aniket Gavas³, Sarthak Khare⁴, Sandhya D. Jadhav⁵

U.G. Student, Department of Mechanical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, Maharashtra, India^{1,2,3,4}

Associate Professor, Department of Mechanical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, Maharashtra, India⁵

ABSTRACT: To study different research papers related to thermal analysis of extended surfaces or projections of materials on the system (engine) called fins of air cooled IC engines. The fins are used to increase the heat transfer rate from the system to the surrounding by increasing the heat transfer area. Fins 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. The heat transfer effect may be varied by changing material of different thermal conductivities, improving engine geometry, increasing cross section area of fins, using perforations on fin and on thermal 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.

KEYWORDS: solid works, Siemens nx, thermal analysis, fins, increase in the efficiency, increase in the heat transfer rate, etc.

I. INTRODUCTION

In IC engine the combustion process takes place inside the cylinder in which the chemical energy of the fuel converts into mechanical energy. Only 25 to 35 percent of the total generated thermal power converts into beneficial work and rest of its energy is rejected into the environment. The generated energy causes the engine temperature to go up to 600°C which may result into burning of oil film among moving elements and may result into seizing or welding. Hence this temperature needs to be maintained as much as secure temperature limits. The present study aims to investigate the heat dissipation effect of fins made of different geometries. Its importance is to analyse the heat transfer rate of fins. Study will lead to the different experiments which have been made to increase efficiency by means of changing fin efficiency by changing fin geometry, climatic conditions around fins, by use of perforations and notches in fins and fin geometry. The main thermal analysis device is Ansys workbench with the aid of computer modelling software. The fundamental observation is focused on a two wheeler engine (Kawasaki 125cc). 3D modelling of IC engine bore is done using 3-D modelling software Solid works and Siemens NX. Reverse Engineering is used to take the dimension of the bore IC engine and it's been redesigned again through converting the geometry of the bore. Thermal analysis of bore has been performed using ANSYS Simulation software. Actual boundary conditions were considered to have a detailed study of the simulation of the bore.

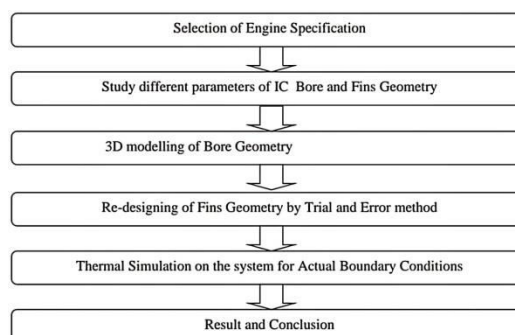
II. RELATED WORK

A. T. Pise and U. V. Awasarmol: performed the test to compare the rate of heat transfer with solid and permeable fins. Permeable fins are formed by modifying the solid rectangular fins with drilling three holes in keeping with fins inclined at one half of length of the fins of two wheeler cylinder block [1]. Pulkit Agarwal: They have concluded that overcooling also affects the engine performance because of overcooling excess fuel consumption happens. This necessitates the need for decreasing air velocity striking the engine surface to reduce the fuel consumption [2]. G. Babu, and M. Lavakumar: Designed rectangular fin body made of Al 204 replacing with Al 6061 and Mg Al, modified the form with round and curve formed. The default thickness of fin is 3mm; decreased it to 2.5mm. They had also done theoretical calculations to determine the heat lost effectiveness and efficiency of the fins [3]. Raju G: They examined maximization of heat transfer through fin arrays of an internal combustion engine cylinder, in one dimensional, steady state condition with conduction and free convection modes. They used non-traditional

optimization method[4]. Prof. Arvind S.S: In IC engine there are large amount of heat generated in combustion chamber so the heat is carried away by exhaust gases. The purpose of this review is to find out the effect of fin geometry and fin pitch on cooling of the engine. From the simulation they have concluded that a complete reduction of 20.15% has been accomplished by means of lowering the total engine diameter D and by increasing the total height H . The heat transfer should increase by providing different shapes of notches on the engine surface. So this is the different method to remove heat from the engine[5]. Abhishek Mote: There are four various types of fins (rectangular, triangular, trapezoidal, pin) are taken and compare on CFD. If the length of fins is increased in an excessive amount, convective thermal resistance would increase accordingly decreasing the heat transfer rate, fin efficiency and also; it adds unnecessary material and cost too and on the other hand, if the length of fins is too short, the heat transfer rate and fin efficiency will decrease again. Hence the length of fin needs to be in optimum in value[6]. KM Sajesh :had studied that the heat lost by the body can be increased by increasing the surface area. The increment in surface place is accomplished through creating holes of various sizes at the surface of fins. Increasing the diameter of hole created on the fin brings the overall temperature of the body lower than the lesser diameter model. By creating holes on fins the temperature of fins can be reduced. It also says that the turbulence of air also get increased via creation of holes[7]. . Deepak Gupta :have designed a cylinder fin body used in a 100cc Hero Honda Motorcycle and modelled in parametric three-D modelling software program Pro/Engineer. They have performed thermal analysis on the fin body through varying materials, geometry and thickness. By observing the analysis results, using the circular fins heat lost is more . The efficiency and effectiveness was also found to be increased[8]. Swati Saini & Kagdi Dhruvin Nileshekumar: they accomplished CFD simulation for the results obtained with the help of the experiments conducted via Thornhill and Yoshida . The heat transfer growth can be performed using the identical cylinder with varied fin profiles. The fin profile selected for heat transfer augmentation was developed using CAD software program and simulation was executed in similar way as performed for experimentally[9] P.T. Nitnaware & Prachi S. Giri : they look into the effect of fin geometries and coefficient of heat transfer coefficient and material they examine for the heat loss for air cooling for an IC engine. Heat transfer per unit weight of fin is greater for conical fin than the rectangular fins. That is why conical fins are preferred over rectangular cross section fins. The rate of heat transfer increases with increasing h . For small values of h , the Aluminium is the best material for designing fins for air cooled engines due to less weight, higher rate of heat transfer and lower cost[10].

III. METHODOLOGY

Selection of Kawasaki GTO 125 engine is done where we have studied parameters of IC Engine and also we have studied the geometry of fins. 3D modelling of IC Engine bore is done using 3D modelling software Solid works. It has been redesigned again by changing the geometry of the bore. Thermal analysis of bore is done using ANSYS Simulation software. Actual boundary conditions have been considered to study the simulation of the bore. Results and conclusions is tabulated



IV. DESIGN AND ANALYSIS OF IC ENGINE BORE FINS

The basic structure of the fin available in the current engine model of two wheelers is a Flat structured fin. Our idea is that to change the shape of the structure as a Sinusoidal structure and by adding holes through fins. Our main aim is to increase the heat transfer rate by increasing heat flux in the Engine. This is because we can cool the engine more easily and increase the thermal efficiency.

The new structure was modelled in Solidworks and Siemens NX and had it thermally simulated for temperatures 100 °C to 500 °C using Ansys workbench software, and the results were positive compared to that of conventional flat fin structures. Material is taken as Aluminium alloy A356.

1.DESIGN SPECIFICATION

Technical Specifications

Sr. No	Model Name	Kawasaki GTO 125cc
1	CC	125
2	Stroke(mm)	65mm
3	Bore(mm)	55mm
4	No. of Fins	7
5	Fin Thickness (mm)	3mm
6	Distance Between TwoFins(mm)	5mm
7	Fin Material	Aluminium Alloy A356
8	Position of fins w.r.t. Cylinder Axis	Horizontal
9	Position of Cylinder in Vehicle	Horizontal

Boundary Conditions

Boundary Condition		
Type	Temperature	Convection
Magnitude	500°C	
Suppressed	No	
Film Coefficient		Tubular data
Coefficient Type		Average Film Temperature
Ambient Temperature		22°C (ramped)
Convection mixture		Program Controlled
Edit Data For		Film Coefficient

Material Properties

Isotropic Thermal Conductivity	150 W/m-k
Density	2.6 g/cm ³
Specific Heat Constant Pressure	0.936 J/g-°C

2.DESIGNING OF EXISTING MODEL AND SINUSOIDAL MODEL

3D model of cylinder block with conventional fins and sinusoidal fins modelled on 3D modelling software which is shown in figures

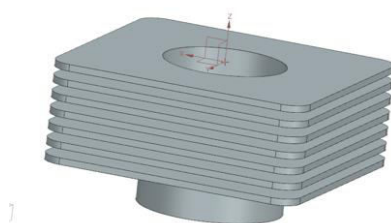


Figure 4.2.1 Engine Bore with normal fins

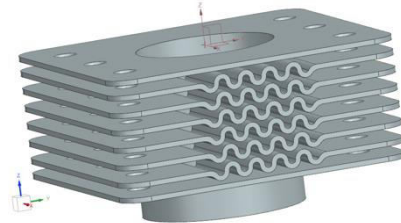


Figure 4.2.2 Engine Bore with Sinusoidal fins

3.THERMAL ANALYSIS

Both cylinder blocks are imported to the Ansys for the further thermal analysis.

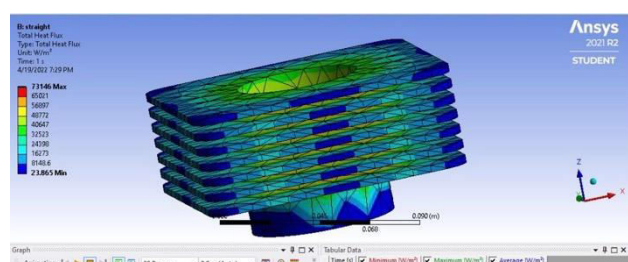
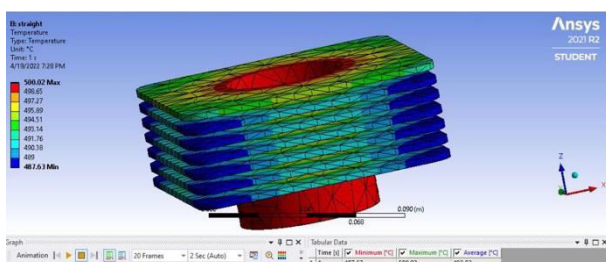


Figure 4.3.1 Static thermal analysis of engine bore with normal fins

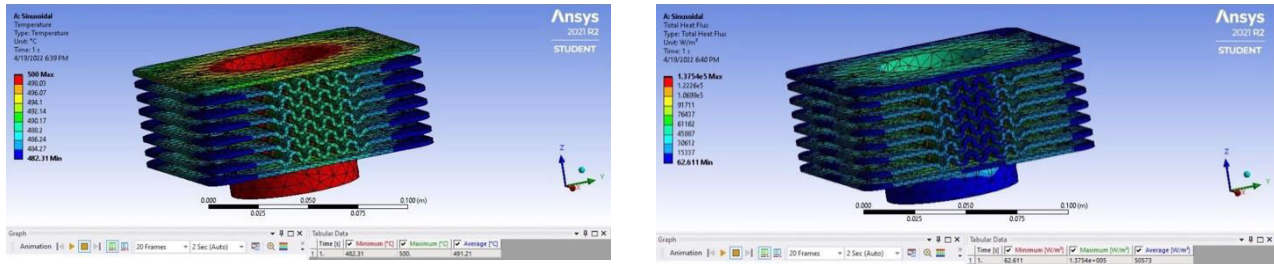


Figure 4.3.2 Static thermal analysis of engine bore with Sinusoidal fins

V.RESULT OF THERMAL ANALYSIS

Temperature inside Engine Bore	Temperature for Straight Fins		
	minimum	maximum	Average
100	97.98	100	98.99
200	155.39	200	1
300	292.8	300	296.4
400	390.22	400	395.11
500	487.63	500.02	493.82

Temperature inside Engine Bore	Heat Flux for Straight Fins		
	minimum	maximum	Average
100	3.894	11936	98.99
200	8.8871	27238	11071
300	13.88	42541	17290
400	18.873	57844	23510
500	23.86	73146	29729

Temperature inside Engine Bore	Temperature for Sinusoidal Fins		
	minimum	maximum	Average
100	97.113	100	98.56
200	153.41	200	196.73
300	289.71	300	294.89
400	386.01	400	395.11
500	482.31	500	451.21

Temperature inside Engine Bore	Heat Flux for Sinusoidal Fins		
	minimum	maximum	Average
100	10.217	22443	8252.6
200	23.316	51216	18833
300	36.41	79489	29413
400	49.513	1.0876*10 ⁵	39993
500	62.61	1.375*10 ⁵	50573

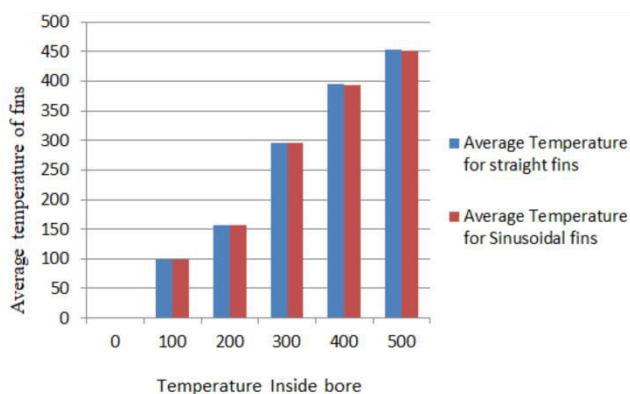


Figure 5.1: Temperature Distribution

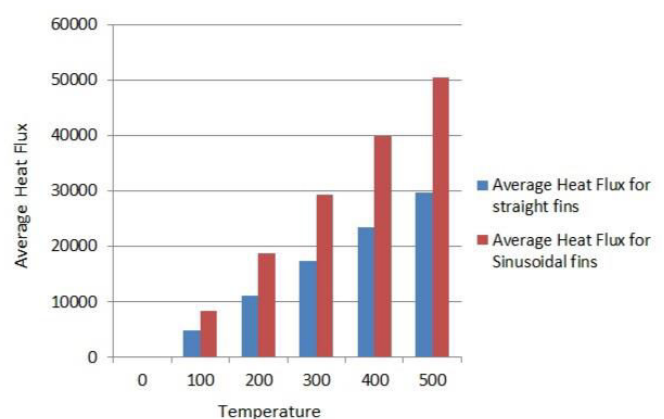


Figure 5.2: Total Heat flux

VI. CONCLUSION

In present work, a cylinder fin body is modelled and brief thermal analysis is done with the help of using ANSYS. These fins are used for air cooling structures for two wheelers. The various parameters (i.e, geometry and thickness of the fin) are considered for study. By changing the the thickness and also by changing the shape of the fin to the sinusoidal from the conventional geometry i.e. straight flat, the weight of the fin body reduces thereby increasing the heat transfer rate and performance of the fin.

Thus through converting the fin geometry from the flat fin to the sinusoidal wavy shape the heat transfer rate is substantially improved leading to less thermal stress. uniform cooling can be feasible in this sort of fin geometry. The engine efficiency and effectiveness is increased because of reduction of fin length. Due to the improvement of wavy fins with projection on the convex region of the fins more turbulence and vorticity is formed which in addition improve the heat transfer rate.

As comparing flat fins and sinusoidal wavy fins, it's observed that for applied 500 °C, the average temperature of engine is decreased from 494°C to 491 °C and average heat flux is increased from 29729 W/M² to 50573 W/M². i.e. Heat flux increased by 41 percentage.

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