A Review Report on Design and Analysis of Cylinder Fins

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Abstract: The key part of the engine that is subjected to extreme temperature variations and thermal strains in the cylinder. So, for overcome these temperature variations and speed up the heat transmission, expanded surfaces known as fins are attached to the cylinder walls of air-cooled internal combustion engines. If the only goal is to increase the heat transfer rate, the shape of the fins and material used for fabrication of fins plays a vital role in increasing the heat loss capacity of the cylinder block. The fin parameters like thickness, shape, fin number, length is having a great influence on heat transfer rate. The temperature of the fin surface and the outside wall was determined computationally and mathematically. Rectangular fins are taken into account for the study based on the literature review. Additionally, Gray cast iron and aluminium 6061, are chosen as material for comparison maximum heat transfer in both. SOLID WORKS 2020 was used to create the design of the engine cylinder and ANSYS 2023 R2 student version is used to analyse the designed model. The analysis's finding indicates that which material is better for the fins for the fabrication on cylinder outer walls.

Key words: Expanded surfaces, Fins, Gray Cast iron, Aluminium 6061, SOLIDWORKS 2022, ANSYS 2023 R1.

1. INTRODUCTION

There are two ways to use metal fins to cool heated surfaces: one involves transferring heat from the fin surfaces to the air stream, and the other involves transferring heat from the fin surfaces to the fin surface. A surface heat transfer coefficient is typically used to describe how quickly heat is transferred from a fin surface to an air stream. Except for bicycle engines, almost all modern motorcycle engines use liquid cooling. The building of an air-cooled engine is easier even though liquid cooling is more effective at cooling an engine. The fins in an air-cooled engine transport heat from the cylinder and away from it to the air. In order to effectively cool the engine and maintain a constant temperature throughout the circle of the cylinder, fins are crucial for air-cooled engines [1]. We are aware that in IC engines, the combustion of the fuel and air mixture occurs inside the engine cylinder, producing hot gases with a temperature range of 3000 to 10000 C. Fins help to lower the temperature by 1800–2500 C because the gasket or film burns at this high temperature. By increasing the engine's surface area through the use of metal fins, the cooling rate through convection is improved. The goal of the cooling system is to maintain the engine at its most efficient operating temperature because excessive cooling of the cylinder diminishes its thermal efficiency. It should be remembered that the engine is highly inefficient while it is cold, thus the cooling system is made to stop cooling while the engine is warming up and wait until the engine reaches its maximum effective working temperature before starting to cool. Numerous engineering concerns, such as cooling rate, overall mass, and geometry limitations, go into the construction of an air-cooled engine [2].

2. LITERATURE SURVEY

“Chandra Sekhar, P. Satish Reddy, and CH. Chandra Rao." had studied on “structural and thermal simulation of fins of an air-cooled engine cylinder” under varying speed condition and published on international journal that the main part of a car that experiences significant temperature changes and thermal strains is the engine cylinder. Fins are essentially mechanical devices that use convection to cool a variety of structures. The vehicle's speed, the fin's geometry, and the surrounding temperature all affect how much heat is transferred. Thermal data are incorporated into structural analysis, and transient couple field analysis is used to determine thermal stresses and deformation outcomes [3].

“A. Satish Kumar, MD. Kathir Kaman, S. Ponsankar, C. Balasuthagar” had published a international journal of sub-title “Design and Thermal Analysis On Engine Cylinder Fins by Modifying its Material and Geometry” as studied on the thermal properties by varying geometry, material and angle of cylinder fins and the models are created by changing the geometry like rectangular, circular, angular and curved shaped fins. The circular fins increase the efficiency of the engine by reducing the weight of the engine. Also, observed that the engine with curved fins is shown better efficiency due to its less weight [4].

“Pardeep Singh”- In this study, the heat transfer efficiency of fins is examined through the design of fins with various extensions, including rectangular, trapezoidal, triangular, and circular segmental extensions. Comparisons are made between the heat transfer capabilities of fins with the same geometry but different extension lengths. With these various fin extensions, approximately 5% to 13% more heat transfer can be accomplished compared to the same fin geometry without these extensions. With the aid of the programme AutoCAD, create designs with a variety of extensions. Fin performance was examined using the Autodesk Simulation Multiphysics programme. This thermal analysis examines temperature changes in relation to the distance at which heat flows through the fin. To enhance the surface area of the fin in touch with the fluid moving around it, extensions are employed on the surfaces with fins. In comparison to a fin without the extensions provided, the rate of heat transfer from the base surface increases as surface area increases due to the increased fluid contact. When compared to other extensions attached to finned surfaces with the same length and width, rectangular extensions provide on fin gives the greatest heat transfer [5].

“Fernando Illan” modelled the two-stroke internal combustion finned engine's heat transmission from the cylinder to the air. In order to reduce engine dimensions, the cylinder body, cylinder head (both of which are equipped with fins), and piston have all undergone numerical analysis and optimisation. As the limiting condition, the maximum temperature permitted at the engine's hottest point has been chosen. In this research, the cooling system design of a two-stroke air-cooled internal combustion engine has been optimised by lowering the overall volume occupied by the engine, starting from a zero-dimensional combustion model created in previous studies. By reducing the entire engine diameter D from 90.62 mm to 75.22 mm and increasing the total height H from 125.72 mm to 146.47 mm, a reduction of 20.15% overall has been made. The engine's aspect ratio ranges from 1.39 to 1.95. A minor improvement in engine efficiency has been attained concurrently with the reduction in total volume [6].

“Y. Tejeswar and S. Jamaal Reddy”. In this research, cooling fins are designed and thermally analysed while having different geometries and materials. The primary goal of utilising these cooling fins is to use air to cool the engine cylinder. By altering the geometry, material, and thickness of the cylinder fins, the project's primary goal is to examine the thermal qualities. Temperatures and other thermal parameters that change over time are determined using transient thermal analysis ZanWU. Increase in the heat transfer coefficient was achieved with perforated fins of 12mm perforation diameter of the Angle of orientation 45 degree, which shows about 32% enhanced heat transfer coefficient with saving 30% material. Natural convection heat transfer enhancement of perforated fin array with different perforation diameter 4-12mm and a different Angles of inclination (0-90) [7].

“D. Merwin Rajesh and K. Suresh Kumar” has submitted an article in the International Journal with the subtitle "Effect of Heat Transfer in A Cylindrical Fin Body by Varying Its Geometry and Material," The fins are subjected to thermal analysis to evaluate how the temperature distribution has changed over time. By taking into account their densities and thermal conductivity, the material for the original model is altered. According to the results of the thermal analysis, Beryllium has a higher thermal flux than other materials. The heat transfer rate is also increased by reducing the fin's thickness by 2.5 mm [8].

Mechanical and Thermal Analysis on Engine Cylinder Fin by Changing Material and Geometry is the subtitle of an article written by **“S. Ananth and S. Chaitanya”** for publication in the International Journal. In the current study, a parametric model of a cylinder with bodies made of trapezoidal, elliptical, and triangular fins was produced using the 3D modelling programme Pro/Engineer. The temperature distribution, total heat flux, and directional heat flux that are brought on by thermal loads that don't change over time are determined by doing steady state thermal analysis on the fins. Various materials are used to conduct analysis. The total heat flux for Triangular A356 is higher when compared to other Trapezoidal fin and Elliptical fin when employing both materials, according to the thermal analysis results [9].

“L. Prabhu”. the ANSYS Workbench analyses the fin's ability to transmit heat in several design configurations, including cylindrical, square, and rectangular. Comparing the heat transfer efficiency of fins with the same base temperature. Aluminium served as the basis metal for the fin material in this thermal investigation. The CATIA V5R16 design software is used to create fins. ANSYS 15.0 was used to analyse the performance of the fins [10].

3. ACKNOWLEDGEMENT

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