A REVIEW STUDY ON THE THERMAL PERFORMANCE OF ENGINE CYLINDER WITH FINS

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Abstract: One of the main engine components is the engine cylinder, which is subject to unnecessary variations in temperature and thermal stress. Fins are put on the cylinder surface to increase the quantity of convection-rejected heat. The current research outlined the heat dissipation enhancement assessments and the corresponding stress reduces in distinct motor cylinder forms over a flat surface in order to optimize the heat transfer rate enhancement. Multiple thermal efficiency characteristics are heat resistance. The conclusions of geometric limitations, fin length, fin area and material of fin with base temperature to ambient temperature variation on the heat transfer performance of fin arrays and the optimum fin separation value has been optimized. The effect of fin density on the heat transfer behaviour is examined Heat transfer also increases with the thermal conductivity of the material and with the pin shapes.

Keywords: heat transfer, Extended surfaces, Thermal analysis, FEM, Analysis, Analysis and Heat transfer enhancement.

I. Introduction

The engine cylinder is one of the main parts of the automobile, subject to elevated differences in temperature and thermal stress. In an internal combustion engine combustion chamber, combustion occurs at elevated temperature and stress, which may affect likelihood of piston seizure, overheating, piston ring opportunities, compression ring, oil ring, etc. Excess temperature may also harm the fabric of the cylinder. Also happens because of overheating likelihood of pre-ignition. In air-cooled motorcycle motors, heat is released by forced convection into the atmosphere. The velocity of heat transfer depends on wind speed, geometry of the motor surface, internal surface area and temperature of the environment. Wind speed is not considered in this work on motor block fins considering heat inside through conduction and convection in this job evaluation. Motorcycle engines are generally designed to function at a particular atmospheric temperature, but cooling above the optimum limit is also not considered as it may reduce overall efficiency. It can be noted, therefore, that only adequate cooling is necessary. The air-cooling system building is much simpler. In order to achieve standardized temperature in the engine cylinder, it is therefore essential for an air-cooled engine to use the fins efficiently. An internal combustion engine is a motor in which a gas is combusted in a combustion chamber. The development of combustion-generated high-temperature and high-pressure air adds immediate power to motor components such as pistons, turbine blades or a nozzle. This power moves the element, producing helpful mechanical energy over a range. Air-cooled engines are substituted by water-cooled engines that are more effective, but all two wheels use air-cooled motors because air-cooled engines require less weight and less requirement.

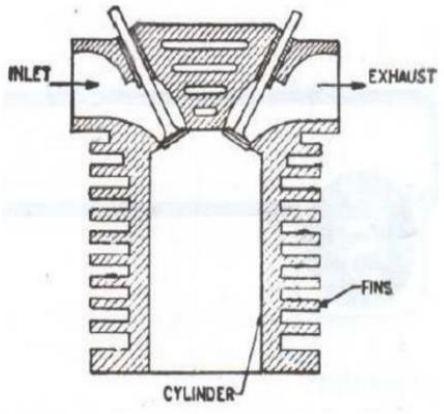

Figure 1: Engine cylinder [18]

II. Literature Review on Engine Cylinder thermal behaviour

Different research completed in past decade demonstrates that heat rejection engine cylinder by various shapes of fins, fin pitch, fin configuration, wind speed, material and atmosphere conditions. distinctive literature overviews that how heat exchange through broadened surfaces and the heat exchange coefficient influenced by evolving cross-area this examination is helpful to know the better geometry and material for the fins for better engine cooling.

Arjun Vilay et. al. (2018) The purpose of the study was to determine the optimal size and shape of the rectangular longitudinal fins, Cylindrical Pin Fin, including horizontal thermal conductivity. This analysis has been completed the calculated maximum heat transfer rate of the fin surface and minimum pressure loss in the pipeline as a result of the shape of the change. The results of various calculations of different Nusselt no for Laminar and turbulent. After solving the problem of post-processing after the completion of the discovery of different results as outline figure, the X-Y plot and vector drawing the Laminar and turbulent flows including the heat transfer rate and pressure loss. In the light of the discussions on the basis of the results, print data concluded that heat transfer is the smallest rectangle shaped fins on the surface and the large round Pin Fin surface and pressure loss is the minimum piping, round the fins to enable it to make better use of the maximum heat transfer rate is required.

D. Madhavi et. al. (2018) Using these cooling fins is primarily intended to cool the 220cc engine cylinder by any air. As the heat dissipation speed can be increased by raising the surface area of the fin per research, it is very hard to design such a big complicated 220cc engine. To forecast the heat conduct, a parametric model of piston bore fins was created. In 3D modeling software Solid functions, the parametric model is developed. In order to determine variability in temperature distribution over moment, thermal analysis is performed on the fins. The analyzes are carried out using ANSYS. Analysis is carried out using different materials. Cast Iron is currently the material used to manufacture the fin body. It is substituted in this thesis with aluminum alloy 6082. Total heat flux for aluminum alloy 6082 is more than the surviving aluminum alloy 6082, zinc alloy fabrics for condenser and evaporator, by watching the outcomes of the study. For cylindrical fins, aluminum alloy would be superior.

Mahendra Kumar Ahirwar et. al. (2018) The project's primary objective is to explore and compare the heat characteristics by different design, content and density with 100 cc Hero Honda Motorcycle fins. To forecast the temporary heat conduct, parametric cylinder designs with fins were created. Currently, the aluminum alloy 6063 used in the manufacture of the designs has a thermal conductivity of 200W / mk. Analysis of the designs intended by getting 1000 oC heat temperature. An internal combustion engine's power flows from the combustion chamber are dissipated in three distinct forms. Transient thermal analyzes for the actual and proposed design of the engine cylinder were performed to optimize geometric parameters and improve heat transfer from the IC engine. The outcome reveals that the suggested layout of the IC engine has stronger efficiency and heat transfer rate from the cooling area in the IC engine, which is why the outcome of this job is more focused on it and also suggested substitution of the current model with the use of ANSYS 17.0 software.

Pradeep Kumar et. al. (2018) Thermal analysis of the engine block with fins was evaluated in this study. Knowing the heat dissipation inside the cylinder is useful by performing thermal analysis on cylinder block caps. Fins are essentially mechanical elements used by the convection method to cool different buildings. Most of their layout is essentially restricted by system layout. However, certain parameters and geometry could still be changed to improve heat transfer. Simple fin design such as rectangular fins and curved fins is chosen in most situations. Many experimental work has been carried out to enhance the heat discharge of the internal combustion engine cylinder and to enhance the finishing effectiveness. The engine block fins model was created in ANSYS 14.5 3D software and continuous thermal analysis is performed on the fins and block to determine the transient state temperature variability with gaps. Use of ANSYS software to perform thermal analysis.

S. Karthik et. al. (2018) This research summarizes the selection of finish products for various apps. Fins have various apps like economizers, heat exchangers, etc. Cylinder portion is the core of the engine in internal combustion engines and this cylinder block forms the wall of a combustion chamber where air fuel mixture is burning. The cylinder wall is subjected to elevated temperature and heat transfer through the cylinder blades due to the ongoing combustion cycle. If the heat is not correctly absorbed then the engine's operating effectiveness will be reduced. Mostly the speed of heat transfer through the fin fabric relies on the thermal conductivity of the fabric selected and other characteristics. The normal Pin-Fin sample is regarded for assessment. By validating the ANSYS 16.1 operation. We can acquire the necessary material characteristics of metals by offering the evaluation output as the input for Artificial Neural Network. This system is very helpful in selecting the finishing products for various apps.

Raviulla et. al. (2018) The primary objective of the study is to assess by distinct geometry the heat features of cylinder fins. When filters operate with large temperature differences between the fine base and the surrounding fluid, the effect of the temperature-dependent thermal conductivity of the fine material must be included in the evaluation in order to correctly assess its heat production. Three aluminum alloys (A380, B390 and C443) are used in this research. The different parameters (i.e., cap shape and size) are regarded in the research, shape (circular and rectangular), and density (3 mm) by altering the fin shape to triangular form, thereby reducing the fin body weight to increase the heat transfer rate and cap effectiveness.

M. Rajesh (2017) The study's primary objective is to evaluate heat characteristics through different geometry, material (Cu and Al alloy 6082), distance between the fins and density of cylinder seals. For both geometries, the Fins designs are developed by changing the linear geometry and also by variable fins density. Pro / Engineer & Unigraphics is the 3D design tools used. Thermal analysis is performed on the cylinder blades to determine the distribution of variation temperature over moment. The analyzes are carried out using ANSYS. Knowing the heat dissipation inside the cylinder is useful by performing thermal analysis on the engine cylinder caps. The concept applied in this paper is to raise the level of heat dissipation by using the unseen working fluid, only air. All products show a linear temperature distribution alongside the fins duration. The circular propellers also improve the engine's effectiveness by decreasing the engine's weight.

Sagar et. al. (2017) The fundamental intention of the reward work is to analyses the thermal houses like Directional warmness Flux, whole warmth Flux and Temperature Distribution by way of various Geometry (circular, Rectangular), material and thickness of Fin (3mm, 2mm) of an approximately rectangular cylinder model all set in SOLIDWORKS-2013 which is imported into ANSYS WORKBENCH-2016 for Transient Thermal evaluation with an normal inner Temperature and Stagnant Air-Simplified case as Cooling medium on Outer floor with affordable film switch Coefficient as Boundary stipulations. By way of growing the outside discipline, we can increase the heat dissipation rate, so designing this type of massive difficult engine could be very difficult. The more than a few parameters (i.e., geometry and thickness of the fin) are viewed, with the aid of lowering the thickness and also

with the aid of altering the form of the fin to circular form from the traditional geometry i.E. Rectangular, the weight of the fin physique reduces there by growing the warmth switch expense and efficiency of the fin.

Kummitha et. al.(2017) In this research, an attempt was produced to figure out by using ANSYS the thermal analysis of cylinder block with fins for distinct metals, and the findings were evaluated to discover the finest material that provides the stronger heat transfer rate and comprises of light weight. From the outcomes of the thermal analysis, it should be noted that both gray cast iron and magnesium alloys are the finest two composite materials which, owing to their higher density, provide a stronger heat transfer rate. Most of the heavy vehicle cylinder blocks are produced with these components in practical apps. However, owing to its greater weight, these plastics are not very appropriate for light cars, so there is a growth of light aluminum alloys, so some aluminum alloys are also regarded for thermal analysis in this document and contrasted all the outcomes for the best one. From all the nodal temperature contours mentioned above and from the column graphs, it should be noted that A380 had the stronger heat transfer frequency and more resistance relative to other alloys regarded.

Pulkit Sagar et. al. (2017) The inquiry addressed determining the impact on heat transfer of the geometry, distinct size, and surface roughness of the propellers. The project's primary goal is to analyze the frequency of heat transfer by variable fins ' form and surface roughness. The model is developed by differentiating fin form and roughness in AUTODESK INVENTER 2015and displayed in AUTODESK NASTRAN 2015. The primary objective of this article is to explore by altering the geometry following impacts on heat transfer by fins in motorcycle and other motor vehicles. It also concludes that geometry changes can boost and reduce the specific heat, temperature flow implemented, heat flux, etc.

Sandeep Kumar et. al. (2017) The present work aims to increase the heat transfer rate from the heating zone in the IC engine, for which transient thermal analysis was carried out on the actual design of the 125 CC single cylinder engine bajajaj discover. Transient thermal analyzes for the actual and proposed design of the engine cylinder were performed to optimize geometric parameters and improve heat transfer from the IC engine. The outcome is that the suggested model -2 of the IC engine has stronger efficiency and heat transfer rate from the cooling area in the IC engine, which is why the outcome of the current job is more focused on it and the substitution of the current model is also suggested. The result of transient thermal analysis of actual design of engine cylinder at ambient temperature 25 ^{o}C indicates the maximum temperature is 650 ^{o}C and minimum temperature is 92.091 ^{o}C, Maximum Total heat flux generated is 16.2 W/mm^2 and minimum heat flux generated is 00332 W/mm^2, The maximum directional heat flux in X-direction generated is 12.35 W/mm^2 and minimum Directional heat flux generated is -10.108 W/mm^2.

A Sathishkumar et. al. (2016) The aim of this inquiry is to examine the heat characteristics using Ansys work bench by varying design, content and angle of cylinder fins, and the designs are produced by altering the geometry such as rectangular, circular, angular and bent formed fins. Transient thermal analysis demonstrates temperature variation over moment and accurate heat simulation is very helpful in identifying layout parameters for enhanced lives. The purpose of this investigation is to examine the heat features using Ansys working table by different structure, material and angle of cylinder fins, and models are created by changing the geometry such as rectangular, circular, angular and curved fins. Transient thermal analysis shows variability in temperature over time and precise simulation of heat is very useful in defining design parameters for improved life.

Richard et. al. (2016) The objective of this inquiry is to evaluate cylinder blocks of 4S SI Engines of two wheelers from three distinct firms namely; HONDA, TVS, YAMAHA, in order to determine the thermal impacts of fuel substances on them with regard to temperature and heat flux changes throughout the evaluation period, and also to compare the three blocks. These pieces are each replicated first using SolidWorks layout software. These blocks are then evaluated using Ansys software to determine the heat impacts when the engine runs at elevated velocity, average velocity, poor velocity and when the engine is subjected to variable atmospheric circumstances in Greater Noida for 25 minutes during the summer and winter. It was deduced from the study that Honda Activa always has a greater quantity of heat wasted over moment than TVS Wego and Yamaha Ray Z, but dissipates at least in the summer season, demonstrating that temperature is a important variable in heat dissipation regardless of the variation in thermal characteristics.

Narayan et al. (2016) The primary objective of this research is to evaluate the heat characteristics using Ansys job bench by changing the structure of cylinder caps. The 3D geometry model is developed using SOLIDWORKS 2016 and its heat characteristics are evaluated using Ansys R 2016 workbench. In many apps, such as convection, the variability in temperature distribution over moment is of concern. Precise heat simulation could allow the identification of critical design parameters for improved lifes. Aluminum alloy AA 6061 which has a heat conductivity of 160 – 170 W / mk is currently the material used for the manufacture of car fin heads. Analysis for cylinder fins using this material is currently being carried out.

Manir Alam et. al. (2016) The primary aim of using these refrigerating fins is to air-cool the engine cylinder. Cast Iron is currently the material used to manufacture the fin body of the cylinder. Copper and aluminum alloy 6082 products are also evaluated in this thesis. Thermal analysis is carried out using all three materials by changing geometries, distance between the fins and thickness of the fins for the actual model of the fin body of the cylinder. For Aluminum alloy 6082 density is lower compared to other two materials, so the weight of the fine body is lower with Aluminum alloy 6082. For copper, thermal conductivity is more than two other metals. Thermal flux is more for aluminum alloy than other two products by watching the outcomes of the thermal analysis and also by using aluminum alloy its weight is lower, so it is easier to use aluminum alloy 6082.

Ramesh Kumar et. al. (2016) The heat transfer efficiency of the engine cylinder cap is evaluated in this research by designing fines with different shapes such as rectangular, trapezoidal, triangular and circular segmental extensions. These are likened to the fine without extensions and the thermal transfer frequency is discovered to boost by 5-13%. The fundamental principle behind this idea of offering extensions on finned substrates is to raise the surface area of the end in touch with the fluid / coolant that flows around it, thereby improving the heat transfer rate. It is very evident from the outcomes that the use of fine extensions offers both

efficient and effective heat transfer. Fin with extensions provide approximately 5 to 13 percent more heat transfer than fines without extensions.

Ashok Reddy et. al. (2015) Using the SOLIDWORKS software, the main objective of our project is to design the cylinder head using standard formulas and modelling. Using ANSYS software, the stable thermal analysis is carried out. In this scheme we analyse the different heat characteristics of the cylinder head (Rectangle and Circular) for different geometric forms and further correlate the numerical values of the cylinder heads with the finite element numbers. From the above outcomes it can be seen that the circular fin is more appropriate than rectangular fins because in this venture we built a cylinder fin body used in a motorcycle and built in Solid Works parametric 3D modelling software. The fin form is curved and triangular.

Chaitanya et. al. (2014) The primary objective of this article is to evaluate the heat characteristics using Ansys Work Bench by using different design, material and density of cylinder fins. Transient heat assessment determines time-varying temperatures and other heat amounts. In many apps, such as convection, the variability in temperature distribution over moment is of concern. Precise heat simulation could allow the identification of critical design parameters for enhanced lives. Aluminum alloy A204, which has a thermal conductivity of 110-150W / mk, is currently the material used for the manufacture of cylinder fin body. Analysis for cylinder fins is currently carried out using this material and also using aluminum alloy 6061 with greater thermal conductivity.

G. Babu et. al. (2013) The project's primary objective is to evaluate the heat characteristics of cylinder fins by different design, content and density. Parametric cylinder designs were created with fins to forecast the temporary heat conduct. The designs are developed by adjusting the geometry, rectangular, circular and bent formed fins as well as the fins ' width. Pro / Engineer is the 3D modeling software used. The analyzes are carried out using ANSYS. Currently Aluminum Alloy 204, which has a thermal conductivity of 110-150W / mk, is the material used for the manufacture of cylinder fin heads. Using this product, we analyze the cylinder caps and use aluminum alloy 6061 and magnesium alloy with greater thermal conductivity.

III. Conclusion

One of the vital engine parts is the engine cylinder, which is subjected to excessive changes in temperature and hot burdens. Fins are laid on the bottom of the heat source layer to enhance heat exchange by convection on the outer layer of the engine cylinder. This study showed the heat exchange studies and the relative weight dropped over a level ground. Highlights of the different heat execution are the thermal resistance. The effects of geometric limitations, temperature generation inside the cylinder and heat dissipation structure in model with adjacent temperature range in the execution of fine designs heat exchange and the optimal final partition value were addressed. The effect of cylinder material on the results of the heat exchange is analyzed Heat exchange increases with the material's thermal conductivity and the cylinder model.

References

1. Arjun Vilay, Prem Shankar, Vivek Tiwari, "CFD analysis of engine cylinder fin with various materials", International Journal of Advance Research, Ideas and Innovations in Technology, Volume 4, Issue 3, 2018.
2. D. Madhavi, D. Dev Singh, "Design and Thermal Analysis on Engine Cylinder Fin by Varying Fin Material", International Journal & Magazine of Engineering, Technology, Management and Research, July 2018.
3. Mahendra Kumar Ahirwar, Ravindra Mohan, Jagdish Prasad, "I.C. Engine Cylinder Fins Transient Thermal Analysis by Using ANSYS Software", International Research Journal of Engineering and Technology (IRJET), Volume 05, Issue: 02, Feb-2018.
4. Pradeep Kumar, Animesh Singhai, "Transient Thermal Analysis of Cylinder Fins with Holes by Using Different Materials", IJIRT, Volume 5, Issue 1, June 2018.
5. S. Karthik, K. Muralidharan, B. Anbarasan, "material selection for fin based on Thermal analysis using Ansys and ANN", International Journal of Mechanical Engineering and Technology (IJMET), Volume 9, Issue 11, November 2018, pp. 560–567.
6. Raviulla, Ashish Muchrikar, "Heat Transfer Analysis of Engine Cylinder Fins of Varying Geometry with different Materials", International Journal of Science and Research (IJSR), Volume 7 Issue 1, January 2018.
7. M.RAJESH, "Design and optimization of engine cylinder fins by varying Geometry and material with thermal analysis", International Journal of Core Engineering & Management, Special Issue, NCETME -2017.
8. Mulukuntla Vidya Sagar, Nalla Suresh, "Thermal Analysis of Engine Cylinder with Fins by using ANSYS Workbench", International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 06, June - 2017.
9. Obula Reddy Kummitha, B.V.R. Reddy, "Thermal Analysis of cylinder block with fins for different materials using ANSYS", Materials Today: Proceedings,2017, 8142–8148.
10. Pulkit Sagar, Puneet Teotiu, Akash Deep Sahlot, "Heat transfer analysis and optimization of engine fins of varying geometry", Materials Today: Proceedings, 2017, 8558–8564.
11. Sandeep Kumar, Nitin Dubey, "Investigation and Thermal Analysis of Heat Dissipation Rate of Single Cylinder SI Engine", IJEDR, Volume 5, Issue 2, 2017.
12. Sathishkumar, MD KathirKaman, S Ponsankar, "Design and thermal analysis on engine cylinder fins by modifying its material and geometry", Journal of Chemical and Pharmaceutical Sciences, Volume 9, Issue 4, 2016.
13. Chidiebere Okeke-Richard, Sunny Sharma, "Thermal Analysis and Comparison of Cylinder Blocks of 4S, SI Two-Wheeler Engine Using Ansys", International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 5, May 2016.
14. L. Natrayan, G.Selvaraj, N.Alagirisamy, "Thermal Analysis of Engine Fins with Different Geometries", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5, May 2016.
15. Ramesh Kumar, Nandha Kumar.S, "Heat Transfer Analysis of Engine Cylinder Fin by Varying Extension Geometry", April 2016.
16. Mr. Manir Alam, M. Durga Sushmitha, "Design and Analysis of Engine Cylinder Fins of Varying Geometry and Materials", International Journal of Computer Engineering In Research Trends, Volume 3, Issue 2, February-2016, pp. 76-80.
17. K. Ashok Reddy, T. V. Seshi Reddy, S Satpagiri, "Heat Flux and Temperature Distribution Analysis of I C Engine Cylinder Head Using ANSYS", International Journal of Advanced Research Foundation, Volume 2, Issue 5, May 2015.
18. P. Sai Chaitanya, B. Suneela Rani, K. Vijaya Kumar, "Thermal Analysis of Engine Cylinder Fin by Varying Its Geometry and Material", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Volume 11, Issue 6, 2014.