A review on Heat Transfer Enhancement of Cylinder Block with Fins for Various Materials And fin Geometries

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***Abstract*: The fins are used to increase the heat transfer rate from the system to the surrounding by increasing the heat transfer area. Generally heat transfer by fins is basically limited by the design of the system. Fins are used to cool various structures via the process of convection and conduction. The heat transfer effect may be varied by changing geometry and changing material for different thermal conductivities, using perforations on fin. CFD analysis on engine structure for examination done on CATIA model. The design of model is done in CATIA V5 software and for thermal analysis is done in ANSYS R19. Studying the different literature surveys for how heat transfer through extended surfaces and the heat transfer coefficient affected by changing design aspects this study is useful to know the better geometry and material for the fins for better engine cooling.**

***Keywords:* Engine cylinder, Heat transfer, Transient heat transfer, heat conduction, convection, Perforated fins, Ansys19 R1, CATIA V5, CFD.**

I. Introduction

In IC engine the combustion takes place inside the cylinder where the chemical energy of the fuel converts into mechanical energy. Only 25 to 35% of the total generated thermal energy converts into useful work and rest of it rejected into the surrounding. The generated energy causes the engine temperature up to 550ºC which may result into burning of oil film between moving parts and may result into seizing or welding. Hence this temp must be maintained up to safe temperature limits. The present study aims to investigate heat dissipative effect of fins made up of different materials and different geometries. It's necessary to analyze the heat transfer rate of fins. Study will lead to the different cylinder experiments which have been made to increase fin efficiency by changing fin material properties, climatic condition around fins, using perforations and notches in fins and fin geometry. The main thermal analysis tool is CFD analysis with the help of computer modeling software. The main study is focused on a two wheeler engine.

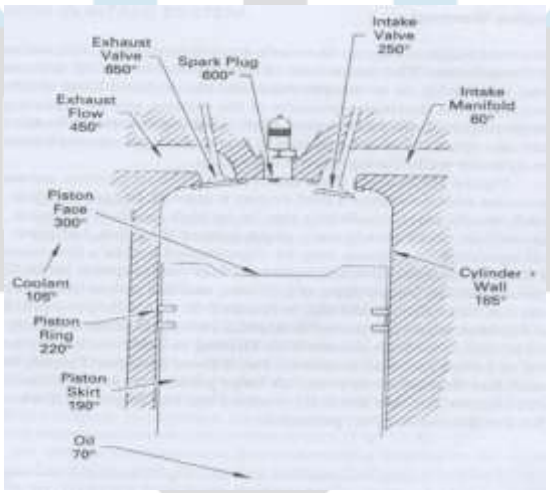

Fig1: Temperature distribution.

The conduction heat transfer from inner wall to fin surface is given as:-

$$Q = k\,(T_w - T_{fin})$$

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

$$Q = h_f\,(T_{fin} - T_{air})$$

II. Literature review

In past few year different research and studies have been done on thermal distribution on engine cylinder and also change there geometry and materials to increasing the heat convection through engine cylinder fins. Distinctive literature overviews of how the heat exchange across extended surfaces and the heat exchange coefficient determined by the nature of the cross-area is helpful in understanding better geometry and material for the fins for better cooling of the motor.

[1]Masao Yoshida, Soichi Ishihara, Kohei Nakashima, Air-Cooling Effects of Fins on a Motorcycle Engine" The author had developed the experimental cylinder for an air-cooled engine and the effects of the number of fins, fin pitch and wind velocities on cylinder cooling were investigated. The major results obtained are to increase the cylinder cooling; the cylinder should have a greater number of fins. But not more at a lower speed the airflow separated on the fin surface at the leeward side and the temperature on the fin surface increased. The higher temperature on the local fin surface makes cylinder bore a greater deformation, as a result, scuffing and increased lubricating oil consumption may occur. The average fin surface heat transfer coefficient can be obtained using the following equation at the speed from 0 to 60 km/h.

$$\alpha_{avg} = (2.47-2.55/p^{0.4})u^{0.9}\times 0.087\ 2p+4.31$$

[2]L. Natrayan et. al. Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Wavy fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be compare with all the four model of the engine fins geometry by CFD Analysis and its flow characteristics are studied for all the geometries it is found that the curved fins provide better result when compared with all the other geometries.

[3] 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 analysis 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.

[4]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.

[5]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.

[6]Divyank Dubey, "Thermal Analysis of Engine Cylinder having thick tip fin with varying slot sizes and material" Science Direct, pp 2214–7853, Published by Elsevier Ltd, 2017. Google ScholarCrossref.

[7]Magarajan U. , Thundil karrupa Raj R. , Elango T. " Numerical study on heat transfer I C Engine cooling by extended fins using CFD" [4]In this study, heat release of an IC engine cylinder cooling fins with six numbers of fins having pitch of 10 mm and 20 mm are calculated numerically using commercially available CFD tool Ansys Fluent. The IC engine is initially at 150 and the heat release from the cylinder is analyzed at a wind velocity of 0 km/h.

[8] 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.

[9]Sachin Kumar Gupta et al. Had thermal analysis at the fin body by means of various materials, geometry and slot sizes. And they concluded now a day's cloth used for fin frame of IC engine is Aluminium alloys. They have replaced older fabric with Aluminium alloy 6061, Aluminium Alloy C443 and Aluminium Alloy 2014. The form of the fin stays the equal with variable slots sizes. The default thickness of fin is 2.35mm. By slotting the load of the fin body reduces thereby growing the warmth transfer rate however extra growth in slot sizes leads to decrease in warmth transfer. By watching the evaluation consequences they compared fin floor temperature of diverse sized slotted fins for unique substances and based that the value of engine decreases due to discount in the material requirement of cylinder. 75mm slotted fins have maximum warmness switch within distinctive fabric slotted fin. The minimum surface provided for 75mm for fin surface temperature 75mm slotted fin engine of Aluminium 2014 fabric have maximum heat switch as the slots length increase above 75mm warmness switch decreases.

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.

Mahendra Kumar Ahirwar et. al. (2018) The primary aim of the project is to explore and compare the heat characteristics with 100 cc Hero Honda Motorcycle fins by different design , material, and density. Parametric cylinder designs with fins were developed to forecast the temporary conduct of heat. The aluminum alloy 6063 used in the construction of the prototypes currently has a thermal conductivity of 200W / mk. Study of designs intended to achieve heat temperature of 1000 oC. The power flows from the combustion chamber of an internal combustion engine are dissipated in 3 distinct ways. Transient thermal analyzes were performed for the real and proposed engine cylinder configuration to optimize geometric parameters and boost heat transfer from the IC engine. The result shows that the suggested IC engine configuration has a higher efficiency and heat transfer rate from the cooling area in the IC engine, which is why the result of this job is more based on it and also suggested replacing the current model with the use of ANSYS 17.0 software.

III. Conclusion

From special look at of the papers it can be concluded that the geometry and segment vicinity of the fin is the maximum essential standards that decides the performance of the cooling fin. For increasing the phase vicinity making holes at the surfaces of fins additionally will increase the warmth rejection from fins quicker than the plan square fin. By evaluating experimental & CFD simulation on a solid & perforated fin array its miles observed that during each cases heat switch rate increases as the scale of perforations is going on increasing, as more free convection due to perforation. By doing CFD analysis on permeable fins, heat transfer efficiency of is located to be elevated with the aid of a few percentage over geometrically changed fins.

IV. Scope of work

From the examine it is clear that there's large scope of designing cooling fins for air cooled engines. This can improve heat dissipation from engine which may be finished through converting fin geometry, fin material. Thermal analysis of cooling fin can without problems be performed by means of CFD on ANSYS whilst the model can be prepared on any modeling software program like CATIA V5. In which the thermal analysis of the extremely good meshed model take place very correctly. This look at additionally tells that CFD evaluation is higher than the theoretical analysis of the model. It also says that in gift time Aluminum alloys like AL6061, 6063,AL6064 are used on the large scale for the producing of cooling fins of IC engines and that they shows higher thermal conductivity than the traditional metal alloys.

References

[1] 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.

[2] 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.

[3] Pulkit Sagar, Puneet Teotiu, Akash Deep Sahlot, "Heat transfer analysis and optimization of engine fins of varying geometry", Materials Today: Proceedings, 2017, 8558–8564.

[4] Sandeep Kumar, Nitin Dubey, "Investigation and Thermal Analysis of Heat Dissipation Rate of Single Cylinder SI Engine", IJEDR, Volume 5, Issue 2, 2017.

[5] 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.

[6] Ramesh Kumar, Nandha Kumar.S, "Heat Transfer Analysis of Engine Cylinder Fin by Varying Extension Geometry", April 2016.

[7] 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.

[8] 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.

[9] 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.

[10] Srinivas, Thalla. santosh kumar, V suresh, Eshwaraiah, "thermal Analysis and optimization of engine cylinder fins by varying geometry and material", 1st International Conference on manufacturing, material science & engineering 2019.

[11] 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.

[12] 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.

[13] 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.

[14] 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.

[15] 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.

[16] 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.

[17] J P Hollman (2010).Heat transfer,(The McGraw-Hill international editions)

[18] Magarajan U. , Thundilkarrupa Raj R. , Elango T. " Numerical study on heat transfer I C Engine cooling by extended fins using CFD" Research journal of Recent sciences, ISSN 2277-2502,Vol. 1(6), June(2012), pp.32-37