A Review on Internal Combustion Engine Fins

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Abstract

When fuel is burned in an engine, heat is produced. Additional heat is also generated by friction between the moving parts. Only approximately 30% of the energy released is converted into useful work while remaining 70% must be removed from the engine to prevent the parts from melting. In air-cooled I.C engine, extended surfaces called fins are provided at the periphery of engine cylinder to increase heat transfer rate. That is why the analysis of fin is important to increase the heat transfer rate. 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 fin geometry and material.

Keywords-- *IC Engine, Fins, Engine Performance, Efficiency.*

I. INTRODUCTION

The internal combustion engine is an engine in which the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high-temperature and
-pressure gases produced by combustion apply direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy. Most modern internal combustion engines are cooled by a closed circuit carrying liquid coolant through channels in the engine block, where the coolant absorbs heat, to a heat exchanger or radiator where the coolant releases heat into the air. Thus, while they are *ultimately* cooled by air, because of the liquid-coolant circuit they are known as *water-cooled*. In contrast, heat generated by an air-cooled engine is released directly into the air. Typically this is facilitated with metal fins covering the outside of the cylinders which increase the surface area that air can act on. In all combustion engines, a great percentage of the heat generated (around 44%) escapes through the exhaust, not through either a liquid cooling system or through the metal fins of an air-cooled engine (12%). About 8% of the heat energy finds its way into the oil, which although primarily meant for lubrication, also plays a role in heat dissipation via a cooler.

Heat transfer is classified into three types. The first is conduction, which is defined as transfer of heat occurring through intervening matter without bulk motion of the matter. A solid has one surface at a high temperature and one at a lower temperature. This type of heat conduction can occur, for example, through a turbine blade in a jet engine. The outside surface, which is exposed to gases from the combustor, is at a higher temperature than the inside surface, which has cooling air next to it. The second heat transfer process is convection, or heat transfer due to a flowing fluid. The fluid can be a gas or a liquid; both have applications in aerospace technology. In convection heat transfer, the heat is moved through bulk transfer of a non-uniform temperature fluid. The third process is radiation or transmission of energy through space without the necessary presence of matter. Radiation is the only method for heat transfer in space. Radiation can be important even in situations in which there is an intervening medium; a familiar example is the heat transfer from a glowing piece of metal or from a fire. Convective heat transfer is between the surfaces and surrounding fluid can be increased by providing the thin strips of metal called fins. Fins are also referred as extended surfaces. Whenever the available surfaces are inadequate to transfer the required quantity of heat, fins will be used. Fins are manufactured with different sizes and shape depends on the type of application. Air cooling for an IC Engine is well known example for Air cooling system in which air acting as a medium. Heat generated in the cylinder will be dissipated in to the atmosphere by conduction mode through the fins or extended surfaces are used in this system, which are incorporated around cylinder.

II. LITERATURE SURVEY

Pulkit Agarwal etc. [1] simulated the heat transfer in motor cycle engine fan using CFD analysis. It is observed that ambient temperature reduces to the very low value; it results in over cooling and poor efficiency of the engine. They have concluded that over cooling also affects the engine efficiency.

Magarajan U et.al. [16] have studied heat release of engine cylinder cooling fins with six numbers of fins having pitch of 10 mm and 20 mm, and are calculated numerically using commercially available CFD tool Ansys Fluent. The engine was at 150 C and the heat release from the cylinder was analyzed at a wind velocity of 0 km/h. Their CFD results were mostly same as that of the experimental results. So, they concluded that, it is possible to modify the fin geometry and predict those results, changes like tapered fins, providing slits and holes in fins geometry can be made and the optimization of fins can be done.

A.K. Mishra et.al. [17] carried out transient numerical analysis with wall cylinder temperature of 423 K initially and the heat release from the cylinder is analyzed for zero wind velocity. The heat release from the cylinder which is calculated numerically is validated with the experimental results. To increase the cylinder cooling, the cylinder should have a greater number of fins. However, the cylinder cooling may decrease with an increased number of fins and too narrow a fin pitch.

G. Babu and M. Lavakumar [19] analyzed the thermal properties by varying geometry, material and thickness of cylinder fins. The models were created by varying the geometry, rectangular, circular and curved shaped fins and also by varying thickness of the fins. Material used for manufacturing cylinder fin body was Aluminum Alloy 204 which has thermal conductivity of 110-150W/mk and also using Aluminum alloy 6061 and Magnesium alloy which have higher thermal conductivities. They concluded that 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. The weight of the fin body is reduced when Magnesium alloy is used and using circular fin, material Aluminum alloy 6061 and thickness of 2.5mm is better since heat transfer rate is more and using circular fins the heat lost is more, efficiency and effectiveness is also more.

S.S. Chandrakant et.al.[20] conducted experiments for rectangular and triangular fin profiles for air velocities ranging from 0 to 11 m/s. Experimental and CFD simulated result proves that annular fins with rectangular fin profiles are more suitable for heat transfer enhancement as compared to triangular fin profiles. Surface temperature of triangular fin profile is higher than rectangular fin profile at different air velocity. Heat transfer coefficient increase with increases with increases in velocity in both profiles. In comparison of both profile rectangular fin profile have higher heat transfer coefficient than triangular fin profile.

III. BASIC PRINCIPLES

There are many demands on a cooling system. One key requirement is that an engine fails if just one part overheats. Therefore, it is vital that the cooling system keep *all* parts at suitably low temperatures. Liquid-cooled engines are able to vary the size of their passageways through the engine block so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots, which are more difficult to avoid with air cooling.

Air cooled engines may also vary their cooling capacity by using more closely-spaced cooling fins in that area, but this can make their manufacture difficult and expensive. Conductive heat transfer is proportional to the temperature difference between materials. If engine metal is at 250 °C and the air is at 20°C, then there is a 230°C temperature difference for cooling. An air-cooled engine uses all of this difference.

IV. CONCLUSION

A brief summary of the work completed and significant conclusions derived from this investigation are :

- Models for three different shapes of Fins were developed and effects of wind velocity and heat transfer coefficient values were investigated.
- Heat transfer rate increases after changing fin geometry.
- Because of non-uniformness in the geometry of Fins turbulence of flowing air increases which results in more heat transfer rate.

The shape and thickness along with material plays an important role in defining the amount of heat transfer from the fins. The elliptical shape fins are giving the best results than the rectangular and triangular fins. Also, thickness of the fins plays an important role in heat transfer. As we keep reducing the thickness, heat transfer rate is shooting up for a defined shape and material. But while reducing the thickness, we should consider the strength of the fins to understand that till which thickness fins can withstand the working temperatures.

REFRENCES

[1] Pudiri Madhu and N. Sateesh., An experimental investigation into the Modeling and Simulation of Fins for 150cc Engine, SAE paper (2015)R. Caves, Multinational Enterprise and Economic Analysis, Cambridge University Press, Cambridge, 1982.

[2] D. Merwin Rajesh and K Suresh Design and thermal analysis of cylinder fins by varying its geometry and material, IJME International Journal, ISSN NO: 2348- 4845 (2014)

[3] Thornhill D. and May A., An Experimental Investigation into the Cooling of Finned Metal Cylinders in a free Air Stream, SAE Paper 1999-01-3307 (1999)

[4] Gibson H., The Air Cooling of Petrol Engines, Proceedings of the Institute of Automobile Engineers, Vol.XIV, 243-275 (1920)

[5] Biermann E. and Pinkel B., Heat Transfer from Finned Metal Cylinders in an Air Stream, NACA Report No. 488 (1935)

[6] Masao Yoshida, Soichi Ishihara, Yoshio Murakami, Kohei Nakashima and Masago Yamamoto, Air-Cooling Effects of Fins on Motorcycle Engine, JSME International Journal, Series B, 49(3), (2006)

[7] Zakhirhusen, Memon K., Sundararajan T., Lakshminarasimhan V., Babu Y.R. and Harne Vinay, Parametric study of finned heat transfer for Air Cooled Motorcycle Engine, SAE Paper, 2005-26-361, (2005)

[8] Zakirhusen, Memon K. and Sundararajan T., Indian Institute of Technology Madras, V. Lakshminarasimhan,
Y.R. Babu and Vinay Harne, TVS Motor Company Limited, Simulation and Experimental Evaluation of Air Cooling for Motorcycle Engine, 2006-32-0099 / 20066599 (2006)

[9] Pathak Sunil, Turbo charging and oil techniques inlight motor vehicles, Res.J. Recent Sci, 1(1), 60-65 (2012)

[10] Dev Nikhil, Attri Rajesh, Mittal Vijay, Kumar Sandeep, Mohit, Satyapal, Kumar pardeep, Thermodynamic analysis of a combined heat and power system, Res.J. Recent Sci, 1(3), 76-79 (2012)

[11] G.Raju, et al. (2012). "Optimal Design of an I.C. Engine Cylinder Fin Arrays Using a Binary Coded Genetic Algorithms." International Journal of Modern Engineering Research (IJMER) 2(6): 4516-4520.

[12] U. Magarajan, et al. (2012). "Numerical Study on Heat Transfer of Internal Combustion Engine Cooling by Extended Fins Using CFD." International Science Congress Association 1(6): 32-37.

[13] A. Mishra, et al. (2012). "Heat Transfer Augmentation of Air Cooled Internal Combustion Engine Using Fins through Numerical Techniques." Research Journal of Engineering Sciences ISSN 2278:9472.

[14] J.A. Paul, et al. (2012). "Experimental and Parametric Study of Extended Fins in the Optimization of Internal Combustion Engine Cooling Using CFD." International Journal of Applied Research in Mechanical Engineering (IJARME) 2(1).

[15] G. Babu and M. Lavakumar (2013). "Heat Transfer Analysis and Optimization of Engine Cylinder Fins of Varying Geometry and Material." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) 7(4): 24-29.

[16] S.S.Chandrakant, et al. (2013). "Numerical and Experimental Analysis of Heat Transfer through Various Types of Fin Profiles by Forced Convection." International Journal of Engineering Research & Technology (IJERT) 2(7).

[17] A.R. Kumar, et al. (2013). "Heat Transfer Analysis in the Cylinder Head of a Four-Stroke SI Engine." International Journal of Engineering Research & Technology (IJERT) 2(5).

[18] R.P. Patil and P. H. M. Dange (2013). "Experimental and Computational Fluid Dynamics Heat Transfer Analysis on Elliptical Fin by Forced Convection." International Journal of Engineering Research & Technology (IJERT) 2(8).

[19] N.P.R. Rao and T. V. Vardhan (2013). "Thermal Analysis of Engine Cylinder Fins By Varying Its Geometry

and Material." International Journal of Engineering 2(8).

[20] S. Wange and R. Metkar (2013). "Computational Analysis of Inverted Notched Fin Arrays Dissipating Heat by Natural Convection." International Journal of Engineering and Innovative Technology (IJEIT) 2(11).

[21] V. GANESAN, (2008). I C Engines, McGraw-Hill Education (India) PVT Limited.