Design and Analysis of Cooling Fins of Engine

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***Abstract*- Fins is an integral part of any heating or cooling system. It is primarily responsible for improving heat transfer. The different characteristics of fins such as fin tip, base temperature, fin array, fin efficiency, fin effectiveness amongst others were studied in order to understand how they affect fin effectiveness and fin efficiency and propose a working algorithm which will be capable of flexible analysis and design which can be used in refrigerators and transformers. The result of numerical computation showed that the fin effectiveness and heat transfer through fins increases as the length and width increases. Though, efficiency increases with thickness and fin effectiveness decreases. The heat transfer surface area is a function of fin dimensions and fin shape, as the surface area increases the amount of heat transferred increases. Also, copper material had highest fin effectiveness and heat transfer. The fin efficiency can be improved by using a material with higher conductivity.**

Keywords: - Fin, Cylinder, Engine Heat Exchanger

I. INTRODUCTION

fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first two options. Thus, adding a fin to an object, increases the surface area and can sometimes be an economical solution to heat transfer problems

II. LITERATURE REVIEW

A. Fin Pitch, Design and Method

G. Babu and M. Lavakumar[1] 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.

S.S Chandrakant [2] 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.

Praful Date et. al. [3] proposed the novel approached toward the heat transfer enhancement of plate and fin heat exchanger using improved fin design facilitating the vortex generation.

B. Fin Thickness, Height and Method

J. Ajay Paul et. al. had done numerical simulations were carried out to determine the heat transfer characteristics of different fin parameters namely, number of fins, fin thickness at varying air velocities. The single cylinder air cooled engines were assumed to be a set of annular fins mounted on a cylinder.

C. Wind Velocity, Material and Methods

A.Mohammadi, M.Rashidi et.al. had done the computational fluid dynamics (CFD) code KIVA-3V is applied to simulate in cylinder flow in a four-stroke single cylinder engine with pent roof combustion chamber geometry, having two inlet valves and two exhaust valves.

Shinde Sandip Chandrakant et. al. It has conducted the feasibility study on engine test rig to suggest the optimum fin profile for heat transfer enhancement. Experiments were conducted for rectangular and triangular fin profiles for several air velocities ranging from 0 to 11 m/s.

Mr. N. Phani Raja Rao et. al. did the transient thermal analysis to analyze the thermal properties by varying geometry, material and thickness of cylinder fins. Here in the analysis three material were used i.e. Aluminum Alloy A204, Aluminum alloy 6061 and Magnesium alloy.

III. AIR COOLING SYSTEM

Cars and trucks using direct air cooling (without an intermediate liquid) were built over a long period from the very beginning and ending with a small and generally unrecognized technical change. Before World War II, water-cooled cars and trucks routinely overheated while climbing mountain roads, creating geysers of boiling cooling water. This was considered normal, and at the time, most noted mountain roads had auto repair shops to minister to overheating engines.

IV. ADVANTAGES AND DISADVANTAGES OF AIR-COOLED SYSTEM

A. Advantages of Air-Cooled System

- Its design of air-cooled engine is simple.
- It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
- It is cheaper to manufacture.
- It needs less care and maintenance

B. Disadvantages of Air-Cooled System

Because of the absence of cooling water, Air-cooled engines are noisier. As the coefficient of heat transfer for water is more than that of air, there is less efficient cooling in this case.

V. FIN COOLING SYSTEM DEPENDS

A. FIN LENGTH
B. FIN SURFACE AREA
C. FIN METAL

A. Fin Length

heat transfer from a fin increases with mL almost linearly at first, but the curve reaches a plateau later and reaches a value for the infinitely long fin at about mL=5. Therefore, a fin whose length is L=m/5 can be considered to be an infinitely long fin.
The correction length can be determined by using the formula: Lc=L+(Ac/P), where Ac is the cross-sectional area and P is the perimeter of the fin at the tip.

B. Fin Surface Area

The Fin surface area formula is defined as the area on the surface required for the fin for effective heat transfer is calculated using surface_area = (pi/2)*Number of fins*((Fin diameter^2)-(Outer diameter^2)). To calculate Fin surface area, you need Number of fins (NF), Fin diameter (FD) and Outer diameter (Do).

C. Fin Metal

- Desired heat transfer levels
- Compatibility with air, gasses or particulates passing over fins
- Compatibility with other materials used in the coils
- Installation and service requirements
- The budget for the project

Copper fins offer the best heat transfer, while aluminum fins offer good value. Steel fins reduce heat transfer compared to aluminum fins. Compared to both aluminum and steel, stainless steel fins significantly reduce heat transfer.

VI. THE PURPOSE OF COOLING SYSTEM

The cooling system serves three important functions. First, it removes excess heat from the engine; second, it maintains the engine operating temperature where it works most efficiently; and finally, it brings the engine up to the right operating temperature as quickly as possible

Consequence of Engine Running Too Hot, If your engine is overheating, it may start to detonate. The engine may rattle and ping and lose power. If detonation continues, it may damage the rings, pistons and/or rod bearings. Overheating can also cause piston scuffing.

VII. METHODOLOGY

Step 1: Collecting information and data related to cooling fins of IC engines.
Step 2: A fully parametric model of the Engine block with fin is created in Pro-e software.
Step 3: Manual calculations are done.

VIII. THEORETICAL CALCULATION

Rate of heat conduction into the element x = Rate of heat conduction from the element x + Δx+Rate of heat convection into the element where,

Qconvection=

$$h(p\Delta x)(T - Ta)$$

$$d2\theta$$

$$dx2 = m2\theta, whwre, m2 = hp / KAc$$

$$\theta(x) = C1emx + C2e - mx$$

$$Qfin = \sqrt{} hpKAc(TS - Ta)(\tanh(ml) + h / km) \div 1 + h \tanh(ml)km$$

$$\theta(x) \div \theta(p) = T - Ta \div Ts - Ta = \cosh\{m(1 - x)\} + h / km[\sinh\{m(1 - x)\}] \div \cosh(ml) + h / km[\sinh(ml)]$$

D. Efficiency of fin

$$(\eta fin) = q_f / hA_a\theta_b$$

IX. RESULT

ANSYS Structural software addresses the unique concerns of pure structural simulations without the need for extra tools. The product offers all the power of nonlinear structural capabilities - as well as all linear capabilities - in order to deliver the highest-quality, most reliable structural simulation results available.

ANSYS Structural easily simulates even the largest and most\ intricate structures. ANSYS Design Space software is an easy-to-use simulation software package that provides tools to conceptualize design and validate ideas on the desktop. A subset of the ANSYS Professional product, ANSYS design space allows users to easily perform real-world, static structural and thermal, dynamic, weight optimization, vibration mode, and safety factor simulations on all designs without the need for advanced analysis knowledge. Dynamics software provides incredibly short solution\ times for even the most complex multi-part assemblies undergoing dramatic translations and rotations. It is an ANSYS Workbench add-on module that works directly with ANSYS Structural, ANSYS Mechanical, and ANSYS Metaphysics**.**

X. CONCLUSION

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

- We have analysis the effects of temperature and heat transfer coefficient values of fin.
- The cooling rate of fin changes by changing the parameter of fin.
- The parametric model is created in 3D modeling software AUTOCAD. Thermal analysis is done on the fins to determine variation temperature distribution over time. The analysis is done using ANSYS. Analysis is conducted by varying material. Presently Material used for manufacturing fin body is Cast Iron. In this thesis, it is replaced by aluminum alloy. By observing the analysis results, total heat flux is more for aluminum alloy than remaining two materials for both condenser and evaporator. So using aluminum alloy is better. The 220cc engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the cylinder to increase the rate of heat transfer.

XI. REFERENCE

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