Volume 3, Issue 2, February-2016, pp. 76-80 ISSN (O): 2349-7084

International Journal of Computer Engineering In Research Trends

Available online at: www.ijcert.org

Design and Analysis of Engine Cylinder Fins of Varying Geometry and Materials.

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Abstract:- The 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. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. The principle implemented in this project is to increase the heat dissipation rate by using the invisible working fluid, nothing but air. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. Presently Material used for manufacturing cylinder fin body is Cast Iron. In this thesis, using materials Copper and Aluminium alloy 6082 are also analyzed. Thermal analysis is done using all the three materials by changing geometries, distance between the fins and thickness of the fins for the actual model of the cylinder fin body.

Keywords – Engine cylinder fins, CATIA, FEM

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1. INTRODUCTION

In Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result it seizing or welding of same. So, this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. Heat engines generate mechanical power by extracting energy from heat flows, much as a water_wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste_heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling.

A typical distribution for the fuel energy is given below:

Useful work at the crank shaft	= 25 per cent
Loss to the cylinders walls	= 30 per cent
Loss in exhaust gases	= 35 per cent
Loss in friction	= 10 per cent

2. LITERATURE OVERVIEW

Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling. Engines with higher efficiency have more energy leave as mechanical motion and less as waste heat. Some waste heat is essential: it guides heat through the engine, much as a water wheel works only if there is some exit velocity (energy) in the waste water to carry it away and make room for more water. Thus, all heat engines need cooling to operate.

Cooling is also needed because high temperatures damage engine materials and lubricants. Internal-combustion engines burn fuel hotter than the melting temperature of engine materials, and hot enough to set fire to lubricants. Engine cooling removes energy fast enough to keep temperatures low so the engine can survive.

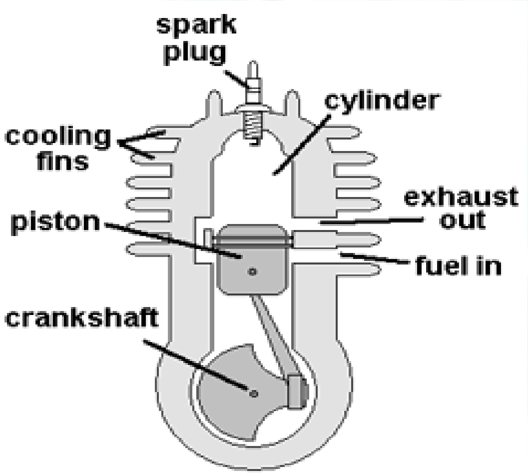

Fig.1 Engine cylinder fin

Most internal combustion engines are fluid cooled using either air (a gaseous fluid) or a liquid coolant run through a heat exchanger (radiator) cooled by air. Marine engines and some stationary engines have ready access to a large volume of water at a suitable temperature. The water may be used directly to cool the engine, but often has sediment, which can clog coolant passages, or chemicals, such as salt, that can chemically damage the engine. Thus, engine coolant may be run through a heat exchanger that is cooled by the body of water.

COOLING SYSTEMS

Liquid cooling system

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.

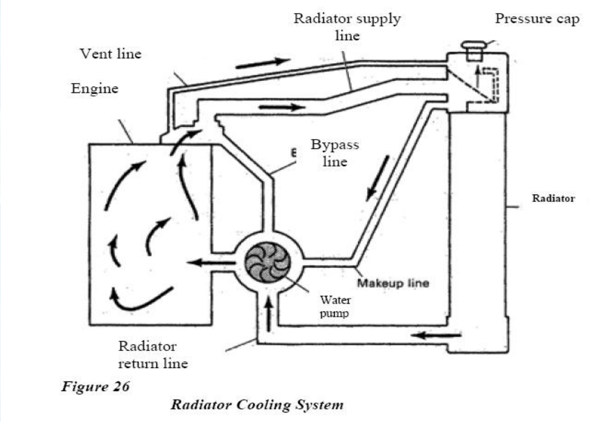

Fig.2. Water cooling system

Liquid-cooled engines usually have a circulation pump. The first engines relied on thermo-siphon cooling alone, where hot coolant left the top of the engine block and passed to the radiator, where it was cooled before returning to the bottom of the engine. Circulation was powered by convection alone. Other demands include cost, weight, reliability, and durability of the cooling system itself.

Conductive heat transfer is proportional to the temperature difference between materials.

Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

The amount of heat dissipated to air depends upon:

(a) Amount of air flowing through the fins.

(b) Fin surface area.

(c) Thermal conductivity of metal used for fins.

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.

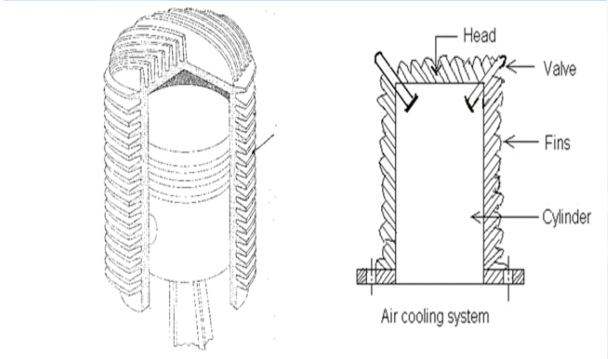

Fig.3. Air cooling system

3. MODELING OF FIN THROUGH CATIA

Model are prepared by using CATIA V5

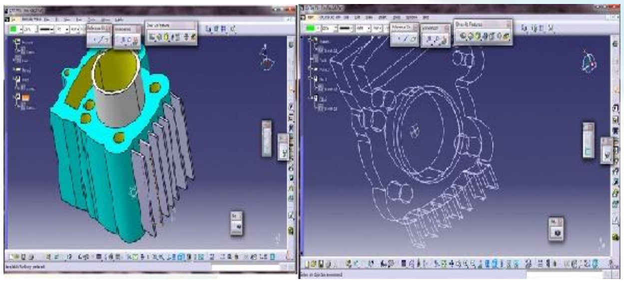

Fig.3 Solid and Wire frame model

4. ANALYSIS BY ANSYS

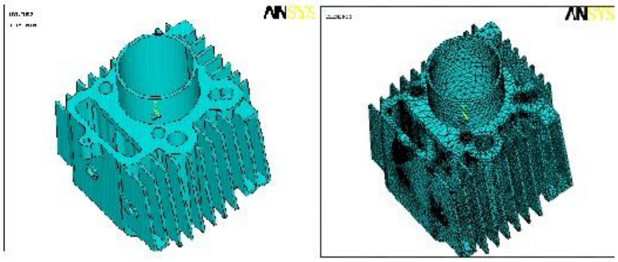

Fig.4 Imported original and its meshed model

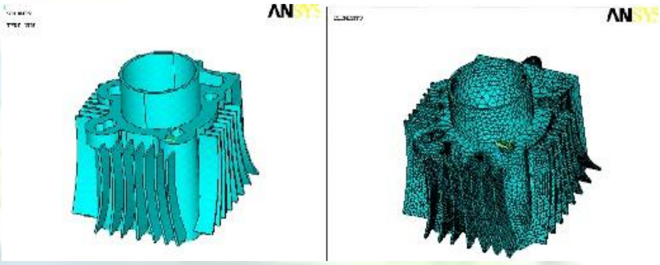

Fig.5.Imported modified and its meshed model

5. THERMAL ANALYSIS OF FIN BODY

I. ORIGINAL MODEL

a) Cast iron

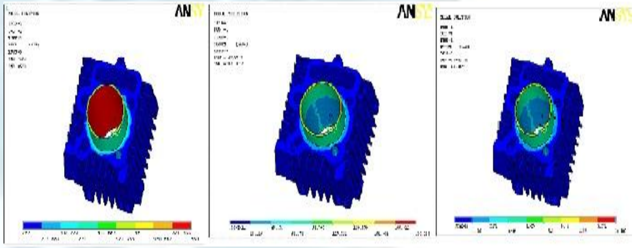

Fig.6 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

b) Aluminum alloy 6082

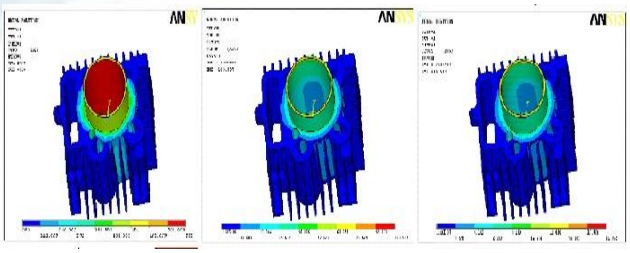

Fig.7 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

c) Copper

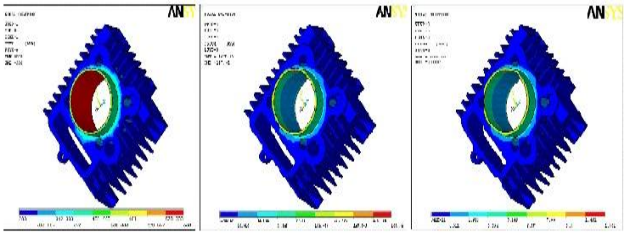

Fig.8 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

II. MODIFIED MODEL

a) Cast Iron

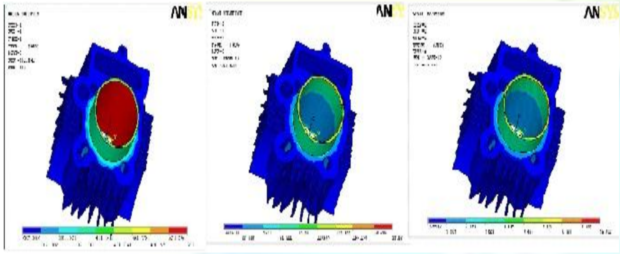

Fig.9 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

b) Aluminum alloy 6082

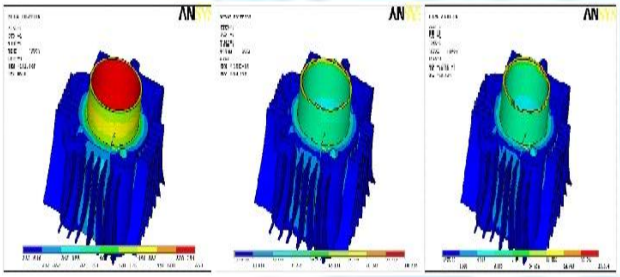

Fig.10 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

c) Copper

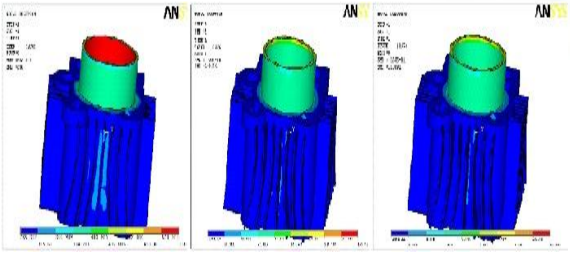

Fig.11 Heat distribution of fin at nodal temperature, thermal gradient sum and thermal flux sum

6. RESULT AND DISCUSTION

A. ORIGINAL MODEL

	CAST IRON	COPPER	ALUMINUM ALLOY 6082
WEIGHT (Kg)	2.35	2.48	0.8936
NODAL TEMPERATURE (K)	550	550	550
THERMAL GRADIENT (K/mm)	208.137	187.34	103.537
THERMAL FLUX (W/mm^2)	10.407	11.802	18.637

B. MODIFIED MODEL

	CAST IRON	COPPER	ALUMINUM ALLOY 6082
WEIGHT (Kg)	2.126	2.24	0.808
NODAL TEMPERATURE (K)	550	550	550
THERMAL GRADIENT (K/mm)	213.632	188.74	104.635
THERMAL FLUX (W/mm^2)	10.682	11.891	18.834

7. CONCLUSION

In this thesis, a cylinder fin body for motorcycle is modeled using parametric software CATIA. The original model is changed by changing the geometry of the fin body, distance between the fins and thickness of the fins. Present used material for fin body is Cast Iron. In this thesis, thermal analysis is done for all the three materials Cast Iron, Copper and Aluminum alloy 6082. The material for the original model is changed by taking the consideration of their densities and thermal conductivity. Density is less for Aluminum alloy 6082 compared with other two materials so weight of fin body is less using Aluminum alloy 6082. Thermal conductivity is more for copper than other two materials. By observing the thermal analysis results, thermal flux is more for Aluminum alloy than other two materials and also by using Aluminum alloy its weight is less, so using Aluminum alloy 6082 is better.

Future scope

The shape of the cylinder fin body is modified and proven analytically that it can be used. But more experiments have to be done on that modified model to check the feasibility of the arrangement in the two wheeler. Since the shape of the fins of modified model is curved, the cost for manufacturing is also to be considered. Since to manufacture this model, if the cost is very high, it is not preferable since it may increase the cost of two wheeler

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