Heat Transfer Analysis Of Fins With Varied Geometry And Materials

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Abstract: In this work attempt is made to increase the heat dissipation rate with the help of air as invisible working fluid. 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 fins is to reduce the temperature of the engine cylinder by air. To analyze the thermal properties by using ANSYS with varying geometry, material and thickness of cylinder fins. Parametric models of cylinder with fins have been developed to predict the transient thermal behavior. The models are created by varying the geometry, rectangular, circular and curved fins. Present thickness of the fin is 3mm, it is reduced to 2.5mm. The 3D modeling software used is Pro/Engineer. Presently Material used for manufacturing cylinder fin body is Aluminum Alloy 204 which has thermal conductivity of 110-150W/mk. In this thesis, it is replaced with Aluminum Alloy 7075 and Beryllium.

Keywords: Fin, Shape, Geometry, Engine, Cylinder

I. INTRODUCTION

The IC engine is an engine in which converts chemical energy into mechanical energy in aid of combustion chamber, during this process high temperature and pressure gases are produced. The forces of these gases displace the piston by exerting high pressure force where chemical energy converted into mechanical energy during expansion stroke.

The heat produced during combustion of fuel in the cylinder is not converted into useful work completely due to some losses is listed below.

Useful work at the crank shaft = 25 %
Loss to the walls of cylinder = 30%
Loss due to Exhaust = 35%
Frictional losses = 10%

From above, heat loss through the cylinder walls is noticeable, if this heat is not controlled properly will result in pre-ignition, excess heat propagation through cylinder walls leads to severe damage to the cylinder material, lubricant will burn, seizing of piston ultimately the engine will be affected. In order to prevent the engine from severe damage due to excess heat an attempt is made to control the heat dissipation in this work, by changing different fin materials and geometry with variable thickness.

However, excessive cooling is not desirable, will decrease brake thermal efficiency, lowers atomization of air fuel mixture due to increase of fuel viscosity, even though more cooling increases the volumetric efficiency but finally the overall efficiency of engine will be decreased.Because of the above reasons desirable cooling is required and any variation from the optimum cooling limit will leads to decrease in the engine overall efficiency.

Types of cooling systems for IC engines are air cooling and liquid cooling.

Air cooling system:

Some of the automobiles like two wheelers using air cooling system directly with extended surfaces in ordered to reduce the excess heat from engine cylinder. Within the cylinder the heat transfer takes place by conduction where as with fins and the surrounding the heat transfer takes place by convection, working fluid as air.

Liquid cooling system:

Fluid cooling is likewise utilized in oceanic vehicles. For vessels, the seawater itself is generally utilized for cooling. At times, compound coolants are too utilized (in shut frameworks) or they are blended with seawater cooling.Fins have dependably been utilized as an aloof technique for upgrading the convection heat transfer from barrels. The nearness of the strong fins has an impact on both the streamlined and additionally the warm qualities of the stream. The fins have a tendency to block the wind current close to the chamber surface, in this manner lessening the heat transfer from the barrel to the encompassing liquid. On the other hand, the fins increment the heat transfer zone bringing about an expansion in the heat transfer from the barrel to the encompassing liquid. The net aftereffect of these two restricting impacts relies upon the mix of the number of fins, blade tallness, and Reynolds number. A.R.A. Khaled , displayed and broke down systematically heat transfer through joint fins frameworks that are uncovered to two diverse convective media from its the two finishes what's more, inferred that heat transfer through joint fins is amplified at certain basic length of each bit. Bassam A/K Abu-Hijleh researched numerically the issue of laminar normal and constrained convection from an even chamber with numerous similarly divided high conductivity porous fins on its external surface.

The heat transfer attributes of a cylinder with penetrable versus solids fins were examined for a few mixes of number of fins and blade tallness over the scope of Reynolds number if there should arise an occurrence of constrained convection and Rayleigh number if there should be an occurrence of common convection. Porous fins gave much higher heat transfer rates contrasted with more conventional strong fins for a comparable cylinder setup. In the present work, thermal analysis of a engine cylinder fins has performed numerically by changing its geometry, shape, material and thickness of the extended surfaces i.e., heat transitions for temperature and thermal analysis values. The geometry of the model is changed for analysis and the outcomes so acquired are reliable with desires, as in the temperature and heat transfer parameters like adequacy and proficiency of the balance increment with change in their geometry and thickness of the balance.

Objectives of the project

The objectives of the work are listed below:

i) The main focus is to design extended surfaces of the engine cylinder by changing fin material, thickness and shape such as rectangular, circular and curved.

ii) Focused on unsteady heat analysis of fin models.

iii) Comparison of physical properties thermal gradient, thermal flux of different materials using ANSYS.

2. FINITE ELEMENT METHOD

In modeling parameters, dimensions, features and functions are used to make required model, design and the optimization of design. The numerical approach used in FEM for solving several engineering problems of thermal, fluid flow, structural and electromagnetic potential. The FEM provides solution by applying boundary conditions in partial differential equation. The FEM gives the solution for the problem by formulating with algebraic equations. The problem is solved by descretizing large problem into small elements. By analyzing small elements and formulating the global stiffness matrix the FEM gives optimized solution with minimum errors.

2.1 Rectangular fin:

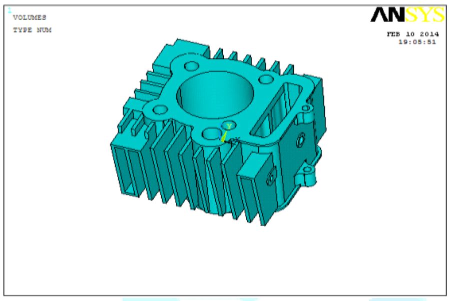

Fig.1. Pro/E model of rectangular fin (3mm thickness)

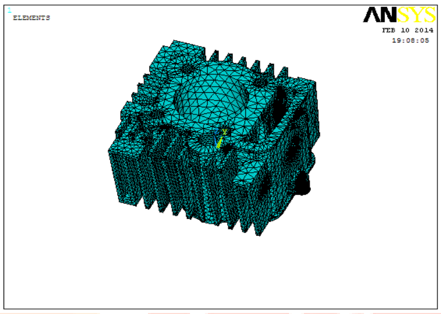

Fig.2. Mesh model of rectangular fin(3 mm thickness)

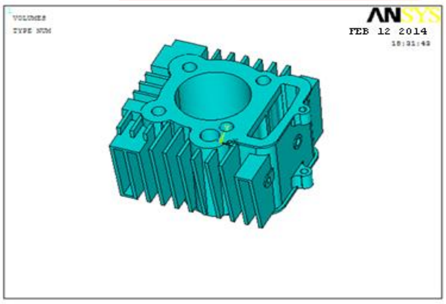

Fig.3. Pro/E model of rectangular fin (2.5mm thickness)

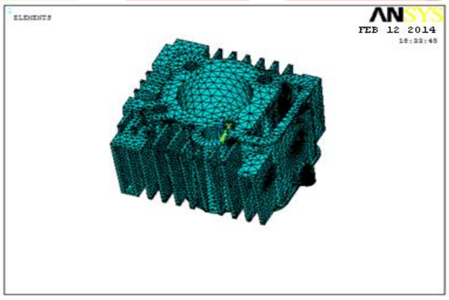

Fig.4.Mesh model of rectangular fin(2.5mm thickness)

2.2.Curved fin:

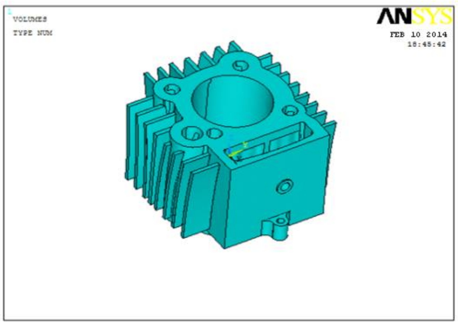

Fig.5. Pro/E model of curved fin (3mm thickness)

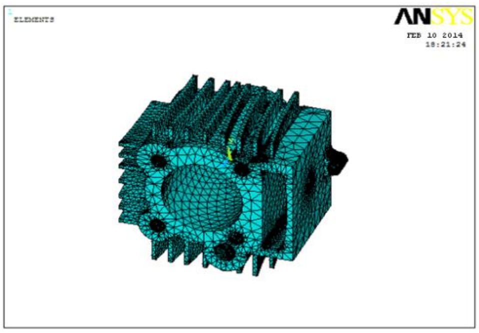

Fig.6.Mesh model of circular fin(3mm thickness**)**

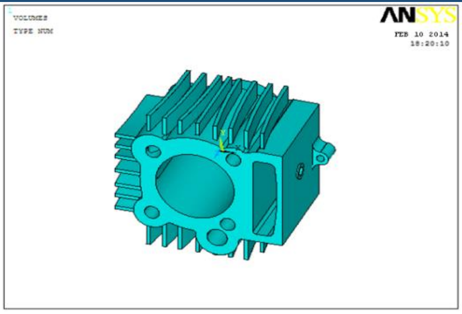

Fig.7. Pro/E model of curved fin (2.5mm thickness)

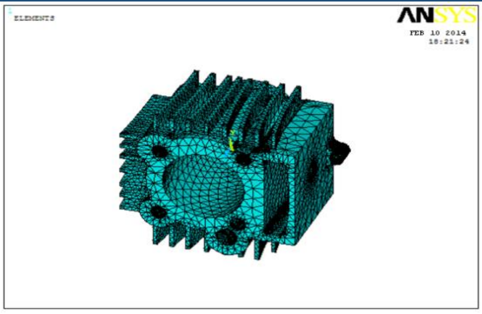

Fig.8.Mesh model of curved fin(2.5mm thickness

3. UNSTEADY THERMAL ANALYSIS

In thermal analysis the materials changes their physical and chemical properties when exposed to heat. Unsteady thermal analysis the physical quantities temperature, heat flux etc variations are measured with respect to programmed time.

Unsteady thermal analysis can be linear or non-linear. Thermal analysis is a branch of materials science where the properties of materials are studied as they change with temperature. Several methods are commonly used - these are distinguished from one another by the property which is measured.

Thermal Analysis is also often used as a term for the study of Heat transfer through structures. Many of the basic engineering data for modeling such systems comes from measurements of heat capacity and Thermal conductivity.

3.1. Temperature Distribution through the fin for the material (Aluminum Alloy 204)

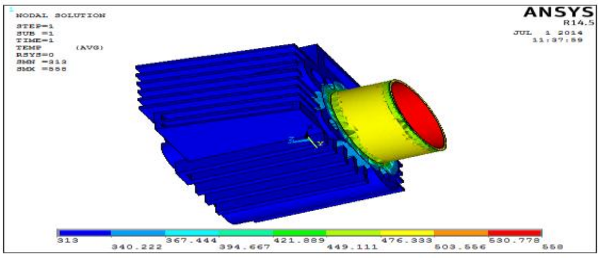

Fig.9. Temperature Distribution through Rectangular fin3mm thickness)

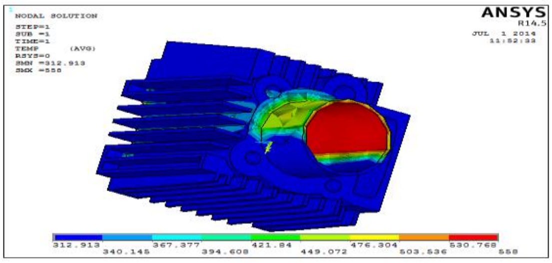

Fig.10. Temperature Distribution through Rectangular fin2.5mm thickness)

3.2. Temperature Distribution through the fin for the material (Aluminum Alloy 7075)

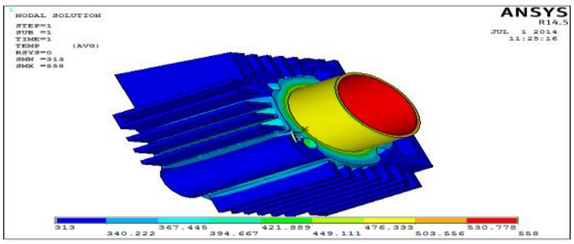

Fig.11. Temperature Distribution through Rectangular fin3mm thickness)

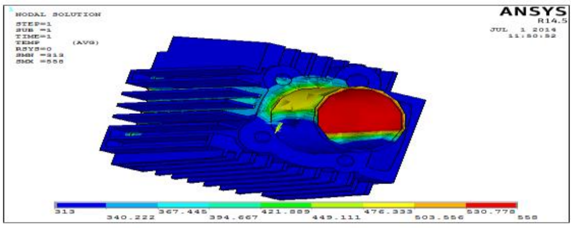

Fig.12. Temperature Distribution through Rectangular fin2.5mm thickness)

3.3. Temperature Distribution through the fin for the material (Beryllium)

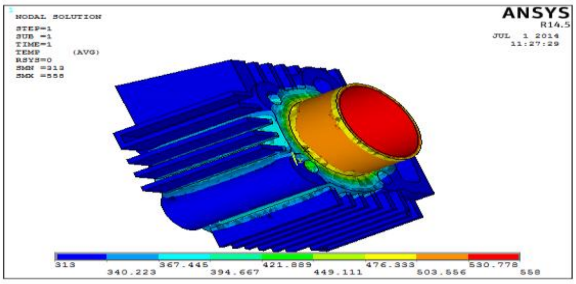

Fig.13. Temperature Distribution through Rectangular fin3mm thickness)

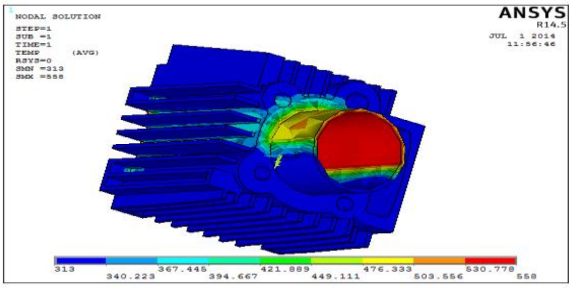

Fig.14. Temperature Distribution through Rectangular fin2.5mm thickness)

3.4. Parametric representation of heat flux and thermal gradient through Rectangular fin:

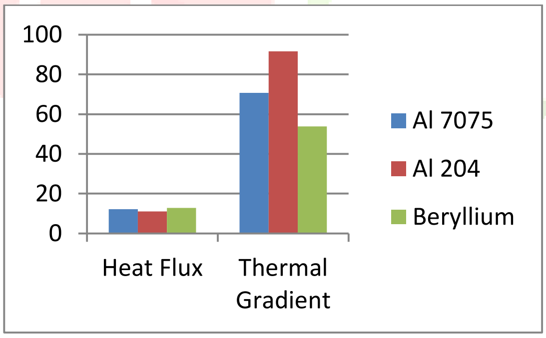

Fig.15

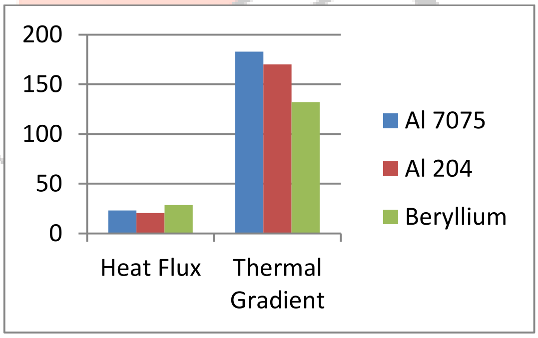

Fig.16

Fig: 15&16. Shows Heat Flux and Thermal Gradients for various materials of 3mm &2.5mm thickness with Rectangular Fins.

3.5 Temperature Distribution through the fin for the material (Aluminum Alloy 204)

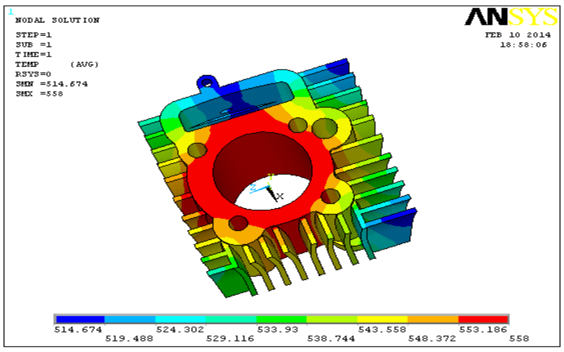

Fig.17.Temperature Distribution through curved fin3mm

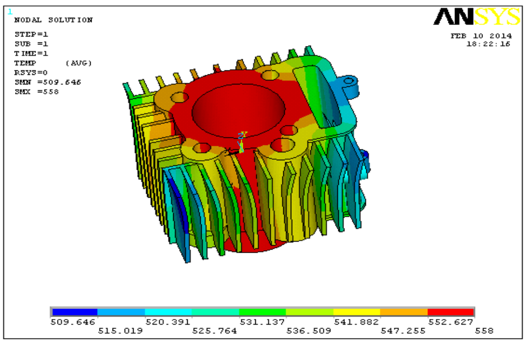

Fig.18. Temperature Distribution through curved fin2.5mm

3.6. Temperature Distribution through the fin for the material (Aluminum Alloy 7075)

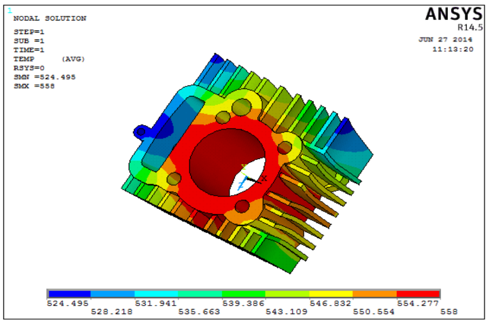

Fig.19.Temperature Distribution through curved fin 3mm

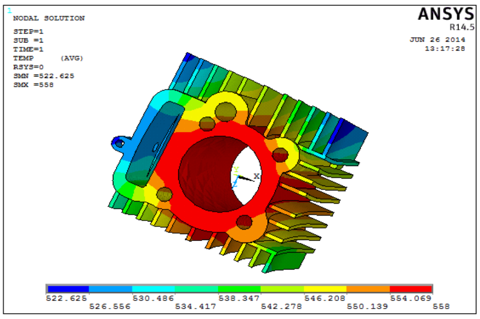

Fig.20.Temperature Distribution through curved fin 2.5mm

3.7. Temperature Distribution through the fin for the material (Beryllium)

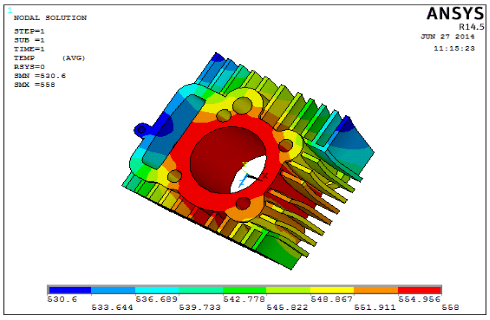

Fig.21.Temperature Distribution through curved fin 3mm

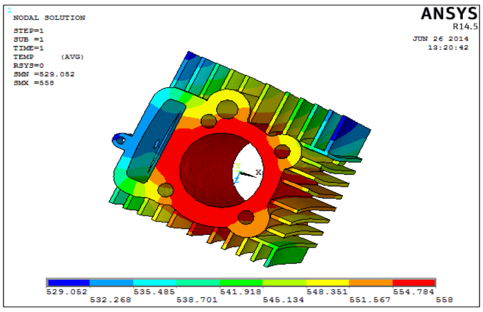

Fig.22. Temperature Distribution through curved fin 2.5mm

4. CONCLUSION

In this work, a cylinder fin body for a 150cc motorcycle is modeled using parametric software Pro/Engineer. The original model is changed by changing the thickness of the fins. The thickness of the original model is 3mm, it has been reduced to 2.5mm. By reducing the thickness of the fins, the overall weight is reduced.

Present used material for fin body is Aluminum Alloy 204. In this work, three other materials are considered which have more thermal conductivities than Aluminum Alloy 204. The materials are Aluminum alloy 7075 and Beryllium. Thermal analysis is done for all the three materials. The material for the original model is changed by taking the consideration of their densities and thermal conductivity.

By observing the thermal analysis results, thermal flux is more for Beryllium than other materials and also by reducing the thickness of the fin 2.5mm, the heat transfer rate is increased.

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