Design and Analysis of Cylinder Fins

R. Suresh[1], K. Lalith narayan [2], Ch. Lakshmi Poornima[3]

[1]*SIR .C.R.Reddy College Of Engineering , Eluru.*

[2]*Professor in ME Department,SIR .C.R. Reddy College Of Engineering , Eluru, A.P*

[3] *Assistant Professor, in ME Department,SIR . C.R. Reddy College Of Engineering , Eluru, A.P.*

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 any airA parametric model of piston bore fins has been developed to predict the transient thermal behavior. The parametric model is created in 3D modeling software Pro/Engineer. 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. Transient thermal analysis is for above two materials to validate the better material for fin body. The die is prepared by first modeling the part, extracting core & cavity and generating CNC program. Die is designed in this thesis according to HASCO Standards.

Keywords*— Designing; Analysis; Machining; Casting.*

1. Introduction

1.1: Cooling System For I.C. Engines

Internal combustion engines at best can transform about 25 to 35 percentage of the chemical energy in the fuel in to mechanical energy. About 35 percentage of the heat generated is lost in to the surroundings of combustion space, remainder being dissipated through exhaust' and radiation from the engine. The temperature of the burning gases in the engine cylinder is about 2000 to 2500° C. The engine components like cylinder head, cylinder wall piston and the valve absorb this heat. Such high temperatures are objectionable for various reasons state below.

Necessity for Engine Cooling

1) Engine valves warp (twist) due to over heating.

2) Damage to the materials of cylinder body and piston.

3)Lubricating oil decomposes to form gummy and carbon particles.

4)Thermal stresses are set up in the engine parts and causes distortion (twist or change shape) and cracking of components.

5)Pre – ignition occurs (i.e. ignition occurs before it is required to igniter due to the overheating of spark plug.

6) Reduces the strength of the materials used for piston and piston rings.

7)Overheating also reduces the efficiency of the engine.

To avoid the above difficulties, some form of cooling is provided to keep the temperature of engine at the desired level. It should be noted that if the engine becomes every cool the efficiency reduces, because starting the engine from cold requires more fuel.

1.2 Investigation plan :

I. Present used material for cylinder fin body is Cast Iron. In this thesis it is replaced with Aluminum Alloy 6082.

II. Thermal analysis is done on the fin body by varying the materials to determine the thermal behavior. The present thickness of fin body is 3mm. In this thesis, thickness is reduced to 2.5mm. Thermal analysis is used to determine the better material for cylinder fin body.

Presently Material used for manufacturing fin body is Cast Iron. In this thesis, it is replaced by aluminum alloy. Transient thermal analysis is for above two materials to validate the better material for fin body. Die is designed in this thesis according to HASCO Standards. Total die components and its complete detailed drawings, material selection for each component, manufacturing processes for each component are also included.

2. Dissimilar Materials

Cast iron is the material used for the current investigation. The major constituents of this alloying material are C-2.60-4.0%,Cr-0.05-2.50%,Cu-0.050-7.50%,Fe-92.0-95.0%,Mn-0.10-1.10%,Mo-0.05-0.60%, Ni-0.05-17.50%P-0.05-0.20%,Si-1.0-3.0%and S-0.025-0.150%. Material Aluminum alloy 6082 is also used for the current investigation. The major constituents of this alloying material are Al-95.2-98.3%,Cr-0.25%,Cu-0.10%,Fe-0.50%,Mg-0.60-1.2%,Mn-0.40-1.0%,Si-0.7-1.3%,Ti-0.10% and Zn-0.20% This is one of the most widely used wrought aluminium alloy. AA6082 has the ultimate tensile strength of 130 MPa, yield strength of 60MPa, Shear strength of 85 Mpa , Vickers hardness of 35 and percentage elongation of 27%. This alloy is used for heavy-duty forgings, air craft fittings and truck frames..

3. Design of cylinder fin body:

In this a cylinder fin body for Passion Plus 100cc motorcycle is modeled using parametric software Pro/Engineer. The thickness of the original model is 3mm, in this thesis it is reduced to 2.5mm.

2.1 Original fin body design:

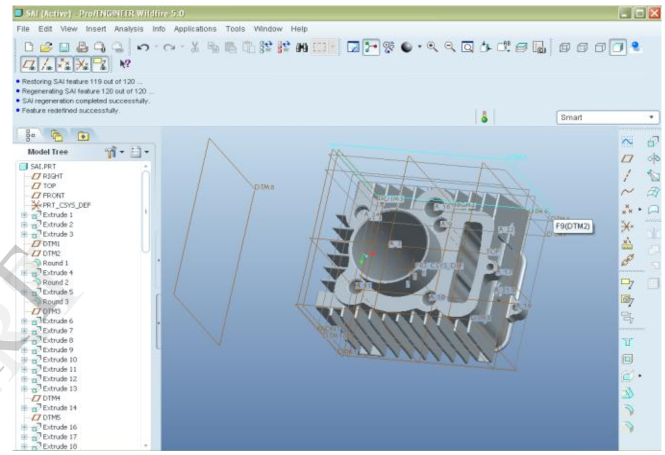

Fig 1: 3mm thickness fin body

2.2 Modification of fin body:

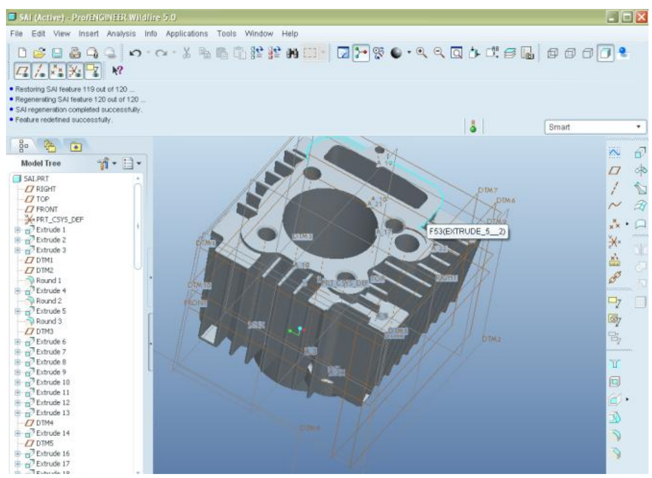

Fig 1: 2.5mm thickness fin body

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4. Experimental Procedure

A. Analiyisis

Transient thermal analysis determines temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as with cooling.

Build Geometry

Construct a two or three dimensional representation of the object to be modeled and tested using the work plane coordinate system within ANSYS.

Define Material Properties

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

Generate Mesh

At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

Apply Loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

Obtain Solution

This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

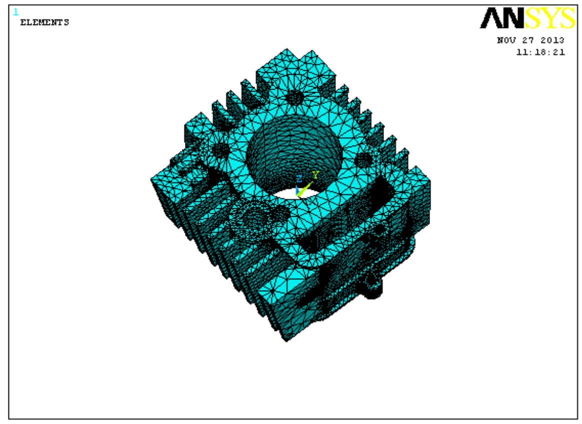

Fig. 3 Meshed model for 3mm thickness body

B. Cast iron analysis

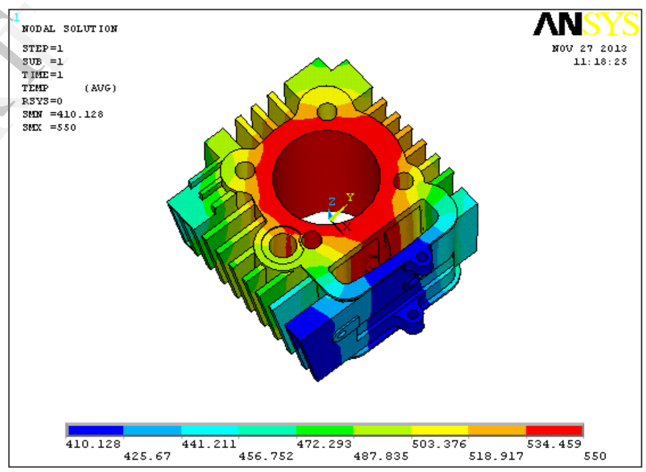

Fig. 4 Nodal Temperature

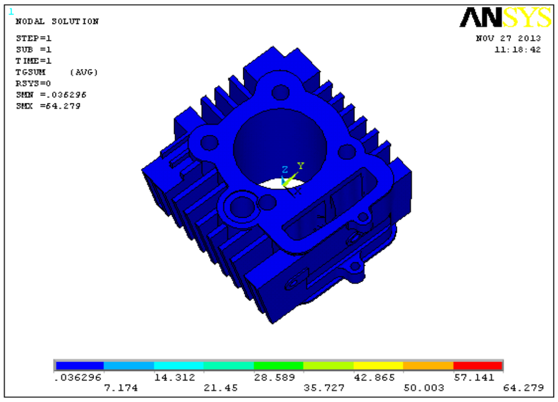

Fig 5. Thermal Gradient Sum

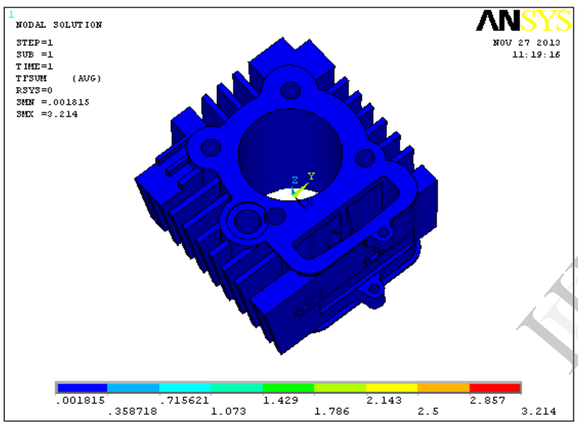

Fig. 6. Thermal Flux

C. Aluminium analysis

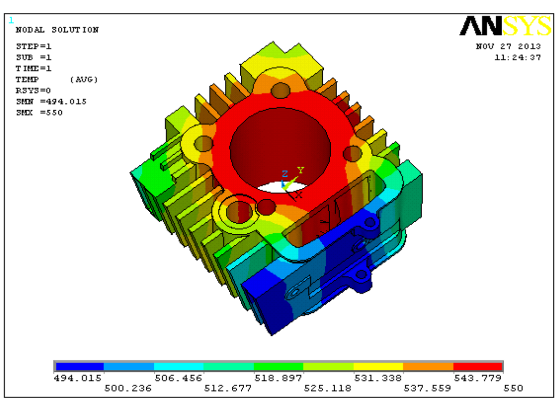

Fig 7. Nodal Temperature

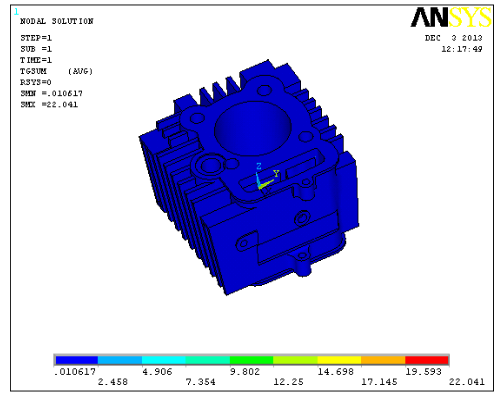

Fig 8. Thermal Gradient Sum

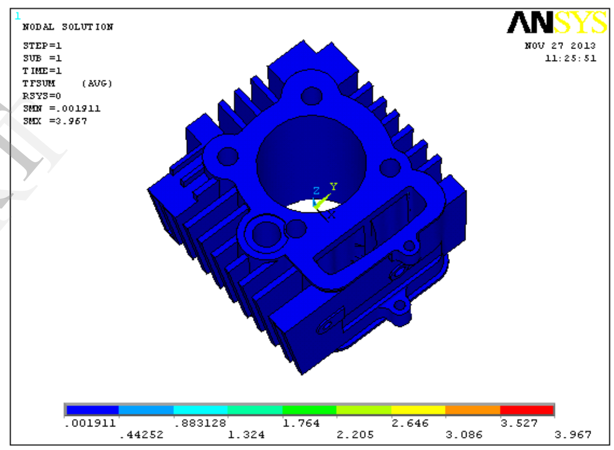

Fig 9. Thermal Flux

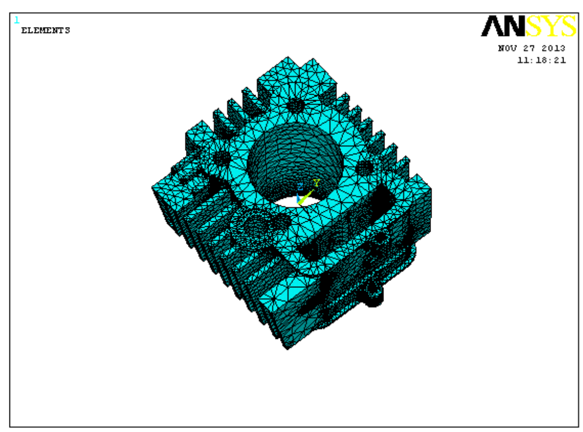

Fig 10. Meshed for 2.5mm thickness fin body

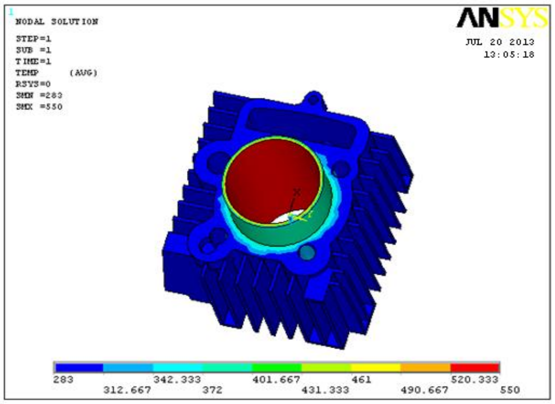

Fig 11.Nodal Temperature for cast iron

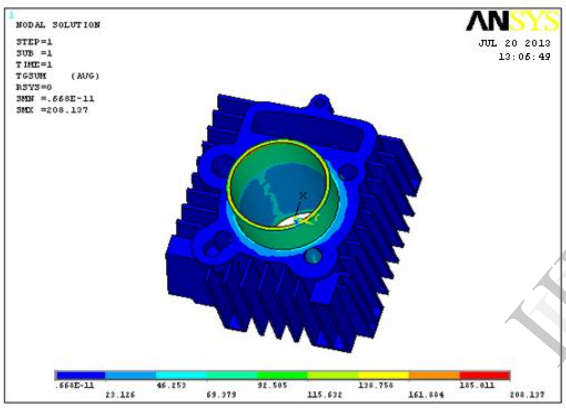

Fig 12. Thermal Gradient Sum For Cast Iron

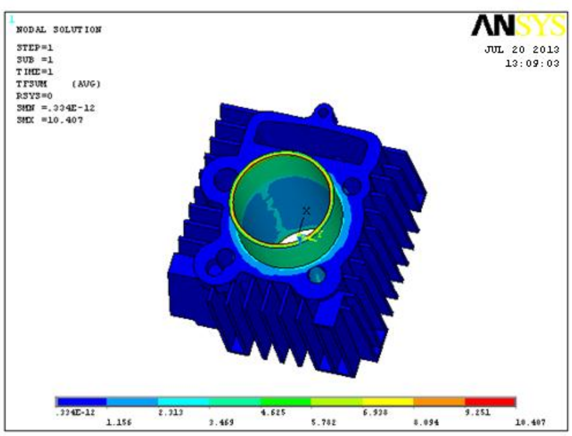

Fig 13. Thermal Flux For Cast Iron

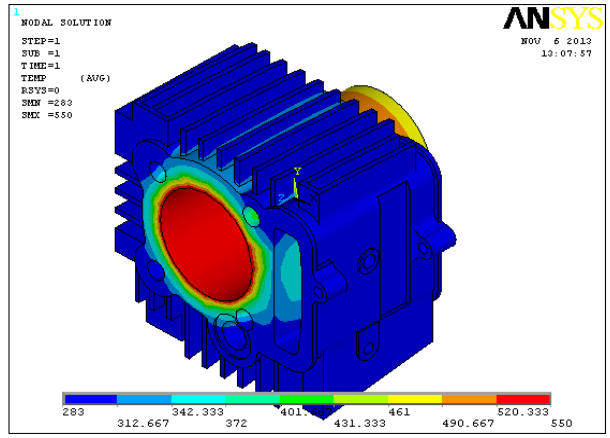

Fig 14. Nodal Temperature for AA6082

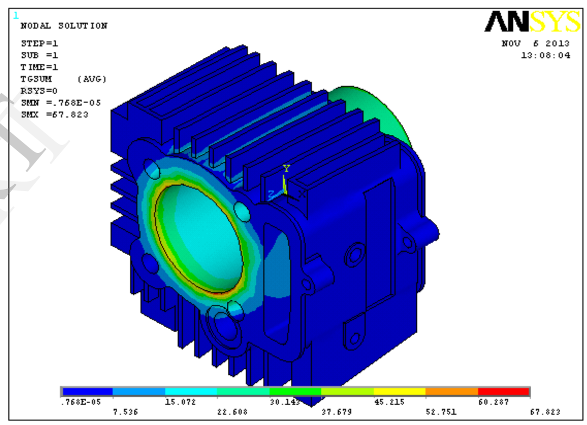

Fig 15. Thermal Gradient Sum For AA6082

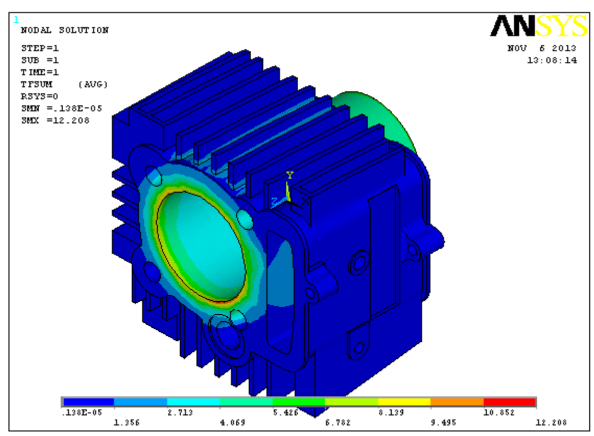

FIG 17. Thermal Flux For AA6082

5. Results And Discussions

FEA has become a solution to the task of predicting failure due to unknown stresses by showing problem areas in a material and allowing designers to see all of the theoretical stresses within. This method of product design and testing is far superior to the manufacturing costs which would accrue if each sample was actually builtandtested.
In practice, a finite element analysis usually consists of three principal steps:

a) Preprocessing: The user constructs a model of the part to be analyzed in which the geometry is divided into a number of discrete sub regions, or elements," connected at discrete points called nodes." Certain of these nodes will have fixed displacements, and others will have prescribed loads. These models can be extremely time consuming to prepare, and commercial codes vie with one another to have the most user-friendly graphical "preprocessor" to assist in this rather tedious chore. Some of these preprocessors can overlay a mesh on a preexisting CAD file, so that finite element analysis can be done conveniently as part of the computerized drafting-and-design process.

b) Analysis: The dataset prepared by the preprocessor is used as input to the finite elementcode itself, which constructs and solves a system of linear or nonlinear algebraic equations

Kijuj = fi

where u and f are the displacements and externally applied forces at the nodal points. The formation of the K matrix is dependent on the type of problem being attacked, and this module will outline the approach for truss and linear elastic stress analyses. Commercial codes may have very large element libraries, with elements appropriate to a wide range of problem types.

c) Postprocessing: In the earlier days of finite element analysis, the user would pore through reams of numbers generated by the code, listing displacements and stresses at discrete positions within the model. It is easy to miss important trends and hot spots this way, and modern codes use graphical displays to assist in visualizing the results. A typical postprocessor display overlays colored contours representing stress levels on the model, showing a full field picture similar to that of photo elastic or moiré experimental results.

After the solution has been obtained, there are many ways to present ANSYS' results, choose from many options such as tables, graphs, and contour plots.

Material properties	**Cast iron**	**Aluminium alloy 6082**
Thermal conductivity (w/mm)	**0.05**	**180**
Specific heat (J/kg °C)	**500**	**0.963**
Density (g/cc)	**7.1**	**2.7**
Loads		
Temperature (K)	**550**	**550**
Film coefficient (w/m2K)	**39.9**	**39.9**
Bulk temperature (K)	**283**	**283**

Table 1. Material properties and loads

For 3mm &2.5mm thickness Fin body

	Cast iron, 3mm	**Aluminium alloy 6082,2.mm**
Weight (Kg)	**2.53**	**0.8936**
Nodal temperature K)	**550**	**550**
Thermal gradient (K/mm)	**208.137**	**67.823**
Thermal flux(W/mm^2)	**10.407**	**12.208**

Table 2 .Experimental results.

7. Conclusions

The following conclusions can be drawn from the present work:-

i. In this thesis, a cylinder fin body for Passion Plus 100cc motorcycle is modelled using parametric software Pro/Engineer. The thickness of the original model is 3mm, in this thesis it is reduced to 2.5mm.

ii. Present used material for fin body is Cast Iron. In this thesis, thermal analysis is done for all the two materials Cast Iron 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.

iii. 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. And also by reducing the thickness of the fin, the heat transfer rate is increased.

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Biography

R.Suresh was born in Pamaru in India, on july 15, 1989. He was graduated from D.M.S S.V.H College of Engineering, Guntur in 2010 and student of M.E MACHINE DESIGN at SIR C.R Reddy Engg College, eluru India. His areas of interest are Design, Casting, related topics.

Dr.K.Lalithnarayana is M.Tech from JUTU HYDERABAD. He completed his P.hd from JNTU KAKINADA. He is presently working as professor at SIR C.R Reddy Engg College, Eluru, His areas of interest are Design, Manufacturing and related topics.

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