"THERMAL ANALYSIS OF DIFFERENT TYPE OF FINS"

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Abstract - The project "Thermal Analysis of different type of fins" is about designing the arrangement according to the forces acting on it from the gases, which are released during the combustion. The importance of heat transfer in design of IC engine is important to make sure the engine will perform to expectation during actual working conditions. For this a prediction is done on the various heat distribution that might occur during a normal and combustion of the engine. The finite element model was evolved with many boundary conditions that are predicted from theoretical studies. This is to see the general heat transfer of the Piston and cylinder arrangement and what are the changes taking place due to fins. Assumptions are made by approximating temperature to the actual operating condition of the engine. Heat transfer was modeled with conduction as the main source of heat transfer and neglecting convection and radiation. This is because convection is based on gas heat transfer, which is normally very small the same goes for radiation. The study is a transient study with assumption that the heat is flowing for 300 seconds and results been generated.

In the analysis a model is generated using CATIA. the finite element model of the arrangement is generated using Ansys. It is applied with loads and boundary conditions, then by changing sizes of fins results have been justified.

1 INTRODUCTION

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements.The multifaceted nature of ANSYS also provides a means to ensure that users are able to see the effect of a design on the whole behavior of the product, be it electromagnetic, thermal, mechanical etc.

A thermal analysis calculates the temperature distribution and related thermal quantities in a system or component.

Typical thermal quantities of interest are:

- The temperature distributions
- The amount of heat lost or gained
- Thermal gradients
- Thermal fluxes.

Only the ANSYS Multiphysics, ANSYS Mechanical, Ansys Professional, and ANSYS FLOTRAN programs support thermal analyses.

The basis for thermal analysis in ANSYS is a heat balance equation obtained from the principle of conservation of energy. The finite element solution you perform via ANSYS calculates nodal temperatures, then uses the nodal temperature to obtain other thermal quantities.

The ANSYS programs handles all three primary modes of heat transfer: conduction, convection, and radiation.

2 METHODOLOGY

It involves various steps

- Modeling the part in CATIA:
- Importing the assembly into ANSYS.
- Preprocessing in ANSYS
- Solving in ANSYS
- Post Processing

Modeling includes creating a model assembly of piston, piston rings and cylinder. It is done using CATIA software.

Basic dimension of engine block Inside diameter of engine block bore	50mm
Height of the engine bore	78mm

Number of nodes	29080
Number of elements	14990

Here in engine block we made two type of engine block one is with rectangular profile fin and another is of taper profile fin.

Two models have been created

- Assembly without Rec. Fin
- Assembly with taper fins

When you want to import a geometry file into ANSYS, you have a number of options. One is to transfer the file to a generic file format such as IGES. Many external CAD packages will export a file in this or a similar format.

3 WORKING

In general, a finite element solution may be broken into the following three stages. This is a general guideline that can be used for setting up any finite element analysis.

1. Preprocessing: defining the problem; the major steps in preprocessing are given below:

- Define keypoints/lines/areas/volumes
- Define element type and material/geometric properties
- Mesh lines/areas/volumes as required.

2. Solution: assigning loads, constraints and solving; here we specify the loads (point or pressure), contraints (translational and rotational) and finally solve the resulting set of equations.

3. Postprocessing: further processing and viewing of the results; in this stage one may wish to see:

- Lists of nodal displacements
- Element forces and moments
- oDeflection plots
- Stress contour diagram

Here we are going to discuss the step by step procedure of our analysis

1. Open Ansys Work Bench
2. SelecttheTransient Thermal module
3. Now from engineering data select the required materials which can be used in project
4. Create the geometry
5. Mesh Attributes
6. Mesh detail

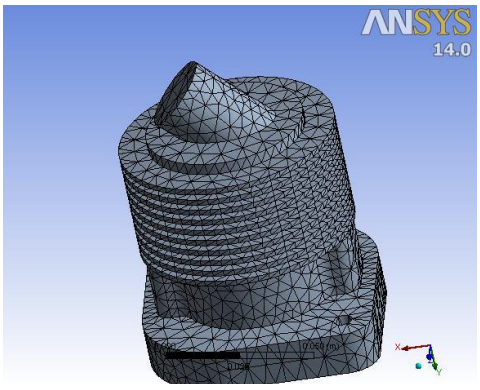
The arrangement of block with rectangular fin

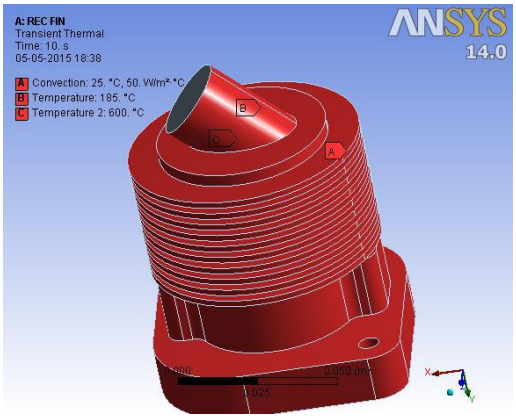
The arrangement of block with taper fin
Number of nodes 52317
Number of elements 26702

7. Apply Constraints
8. Evaluate the required results such as
   - Temperature distribution.
   - Total heat flux.
   - And finally comparing the results.

3.1 Properties of Block Materials

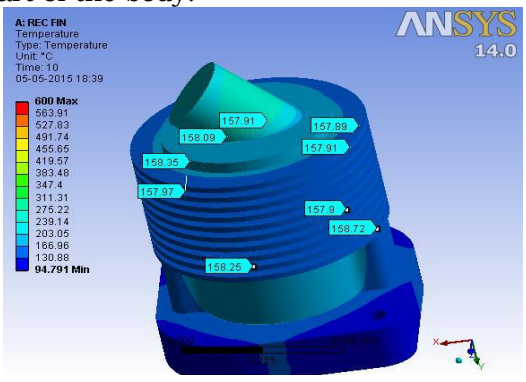
Aluminum alloy Density	2770 kg/m3
Young's modulus	7.1*1010 pa
Poisson ratio	.33
Specific heat	875 J/Kg o c



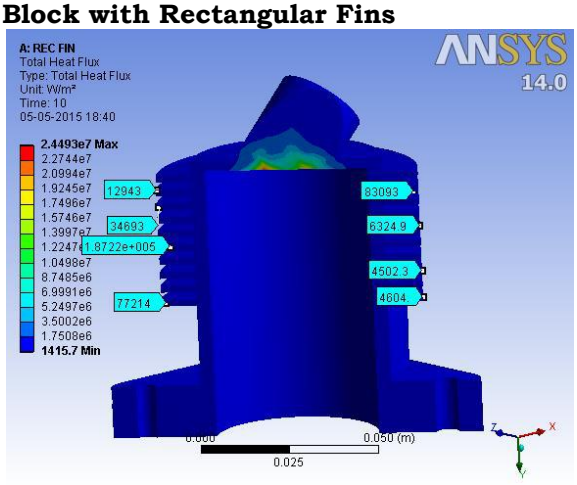


4 RESULTS

Due to the thermal loading given in temperatures the following contours are obtained Here we are displaying some image of our results which guide to conclude the result .The most important result which should be look after in the temperature distribution along the whole body and total heat flux in the different part of the body.



4.1 Temperature Distribution of the Block with Rectangular Fins



4.2 Heat Flux Distribution of Rectangular Profile

Here above we have displayed the image of temperature distribution and total heat flux distribution of the whole model for both the piston and cylinder arrangement and from these images it is clearly seen that the temperature on the fin tip is lower than the temperature on the surface of piston cylinder arrangement without fin.

On the basis of Results obtained by ANSYS following conclusions can be drawn

- Our Motto of heat dissipation is better in case of TAPER fin model.
- Average temperature at the tip of the fin of rectangular fin is more than the taper fin.

As a technical remark the engine seem to dissipate the heat generated quite efficiently as we are placing fin structure in the analysis. Also by increasing length of the fins more better results can be obtained.

5 FUTURE SCOPE

As here in this project we have tried for a simple model of block assembly and did not modelled the arrangement of inlet and outlet valve in the block and applying assumed boundary conditions, which are actually different in real case. Also it was not dynamic analysis. So in future, work can be extend by picking up the exact dimension of the piston cylinder of any standard vehicle with actual boundary conditions considering structural as well as thermal analysis, so as to obtain dynamic conditions of engine.

REFERENCES

1. //http//www.universityofalberta
2. Matweb, Material property data.
3. Detailed Analysis of Heat Flow Pattern in a Piston, T. Morel, R. Keribar Ricardo-ITI, Inc.
4. Ansys_theramalelementdescription.pdf
5. Rosli Abu Bakar, *Heat Transfer Analysis in Air-Cooled Two-Stroke Engine Prototype*, EnTech, 2003.
6. Fem ansys pdf
7. Biermann, Arnold E.; and Ellerbrock, Herman H., Jr.: The Design of Fins for Air-Cooled Cylinders. NACA Rep. 726, 1941.
8. Ansys Advanced analysis technique guide Release 11.0 Documentation
9. SHAM TICKOO, CATIA V5R17 for Engineers & Designers.
10. Incropera, Frank; DeWitt, David P., Bergman, Theodore L., Lavine, Adrienne S. (2007). *Fundamentals of Heat and Mass Transfer* (Sixth Edition ed.). New York.
11. Handbook of Internal Combustion Engines, SAE International
12. Incropera, F. P., and DeWitt, D. P., \Fundamentals of Heat and Mass Transfer", 4th Ed.(fin figures)
13. Giuseppe Pelosi (2007). "The finite-element method, Part I: R. L. Courant: Historical Corner".
14. Introduction to Finite Element Analysis M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp
15. Tai Hun Kwon Introduction to Finite Element Method
16. Finite Element Analysis *Theory and Application with ANSYS* Saeed Moaveni *Minnesota State University, Mankato*
17. C. Fayette Taylor and Edward S. Taylor, The Internal Combustion Engine, International Textbook Company, 1961.
18. Effect of Fin Passage length on Optimization of Cylinder Head Cooling Fins Robert Siege1 and Robert W. Graham.