Design And Analysis Of Four Stroke Engine Fins And Compared With Modified Design

S.K.Palanisamy[1], R.Baskaran[2], M.Sridhar[3], T.Suganthan[4], M.Vignesh[5]M.Vimal kumar[6].
[1]Assistant Professor,[2]Professor,Department Of Mechanical Engineering, Cheran College Of Engineering, Karur,India,
salarapatty@gmail.com,baskaranauto1970@gamil.com.
[3,4,5,6] UG Student, Department of Mechanical Engineering, Cheran College of Engineering, Karur, Tamilnadu, India.
sridharsha143@gmail.com,suganthanmech125@gmail.com,vickeyvickey3472@gmail.com,vimalkumar18kvi@gmail.com .

ABSTRACT
The engine cylinder, which is exposed to extreme temperature changes and thermal stresses, is the heart of the automotive components. The primary goal of this study is to investigate the thermal characteristics.

Keywords:- Structural steel, Aluminium alloy and Magnesium alloy.

1.INTRODUCTION

It is well knowledge that hot gases are produced during the combustion of air and fuel inside the cylinder of an internal combustion engine. In the range of 2300-2500 degrees Celsius, the gases will be at their hottest. Piston seizure, piston ring seizing, compression ring seizing, oil ring seizing, and the welding together of other moving parts are all possible outcomes of this extraordinarily high temperature. The cylinder's material might be compromised by prolonged exposure to high temperatures. Therefor, the temperature has to be lowered to between 150 and 200 degrees Celsius, where the engine operates most efficiently. [1]-[8]. Too much cooling is not recommended since it reduces thermal efficiency. Therefore, the purpose of the cooling system is to keep the engine at an optimal operating temperature. It's important to keep in mind that a cold engine is far less efficient than one at operating temperature, thus the cooling system is designed to shut off during the engine's warming up phase and restart after the engine has achieved its optimal operating temperature. Heat transfer rates are sensitive to wind speed, engine surface geometry, external surface area, and ambient temperature. This study analyses the function of the engine block's fins. When calculating the indoor temperature by means of conduction and convection [9, 14], the researchers did not account for the speed of the air. Motorcycle engines are designed for a certain operating temperature range, however overcooling is seldom considered since it decreases performance. Therefore, it is evident that minimal cooling requirements exist. Cylinder housings are often built separately in air-cooled engines. Motorcycles with inline engines, which have two, three, four, or even six air-cooled cylinders in a single block, are an outlier. Only a small number of water-cooled engines are much more complex. Ducati converted their V-twin engine from air cooling to water cooling while maintaining the basic architecture that made it so successful. You may alternatively utilise separate casings for each cylinder, although that makes the cooling system more involved [15–17].

2.METERIAL PROPERTIES

Aluminium alloy

Aluminium alloys are used for fin material because of aluminum's thermal conductivity.
Alloys are more expensive. Aluminium is the finest material for manufacturing numerous car components due to its unique features. It possesses high strength and ductility, as well as great corrosion resistance and machinability.

Structural steel

Structural steel is a kind of steel that is used to create a wide range of building materials. Many structural steel forms are in the shape of an extended beam with a specified cross section profile. In most developed nations, structural steel forms, sizes, chemical composition, mechanical attributes such as strengths, storage procedures, and so on are governed by standards.
Most structural steel designs, such as I-beams, have significant second moments of area, which implies they're stiff in relation to their cross-sectional area and can withstand a lot of weight without drooping.

Magnesium alloy

Table.1. Material Properties

Properties	Metric	Imperial
Tensile strength	260 MPa	37700 psi
Yield strength (strain 0.200%)	200 MPa	29000 psi
Compressive yield strength (at 0.2% offset)	97 MPa	14100 psi
Ultimate bearing strength	385 MPa	55800 psi

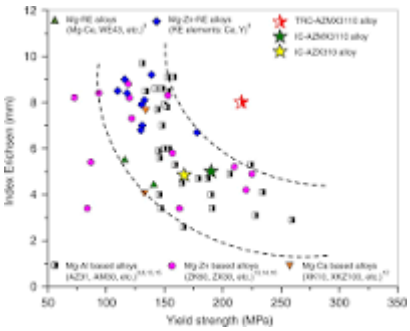


Figure.2. Strength of the Materials

The excellent strength-to-weight ratios, superior machinability, and inexpensive cost of magnesium alloys make them attractive materials. In comparison to other popular alloys such as aluminium or steel alloys, they have a low specific gravity of 1.74 g/cm3 and a low Young's modulus (42 GPa).

3.METHODOLOGY

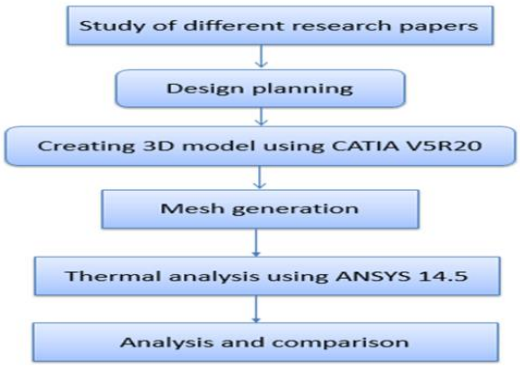


Figure.3. Flowchart of the Analysis

Figure.4. Design Of Normal Engine Fins

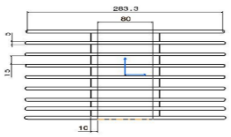
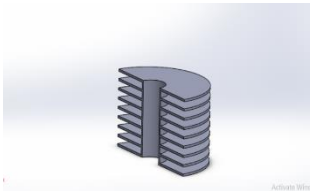


Figure.5. 3D design of normal engine



CAD: Computer Aided Designing (Technology to create, Modify, Analyze or Optimize the design using computer.
CAE: Computer Aided Engineering (Technology to analyze, Simulate or Studybehavior of the cad model generated using computer.
CAM: Computer Aided Manufacturing (Technology to Plan, manage or control the operation in manufacturing using computerANSYS is a general purpose software, used to simulate interactions of all disciplines of physics,structural, vibration, fluid dynamics, heat transfer and electromagnetic for engineers.

Need for CAD, CAE & CAM

Technology like computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) has revolutionised business and sped up innovation in many sectors. In most cases, it has led to a more agile methodology and creative solutions.

Solid modeling:-

In computer-aided design (CAD) software, a solid model is the most precise geometric model that can be created. To specify the model's edges and faces, both the wireframe and the surface geometry are incorporated. A solid model stores not just its geometry but also its topology, which specifies the connections between the geometry. Simply put, what does it mean when we talk about topology? An examination of the interplay between the edges of various surfaces (curves). As a result of this intelligence, adding new features is simpler. Select an edge and enter the desired radius to add a fillet to your model.

4.WORKING

Workbenches provide a variety of tools that you may require throughout the component creation process. The following two methods may be used to swap between any principal workbenches:

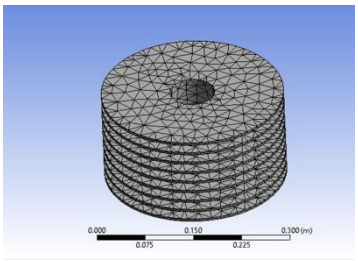


Figure.6. Meshed images of normal engine fin

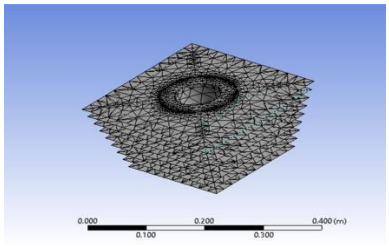


Figure.7. Meshed images of modified engine fin

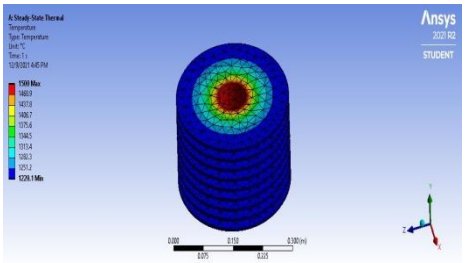


Figure.8. Temperature distribution of Aluminium engine fin

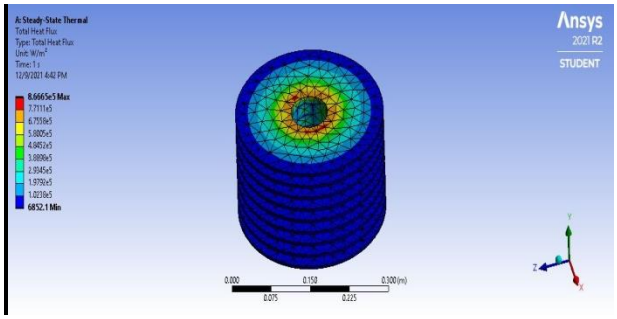


Figure.9. Total heat flux of structural steel

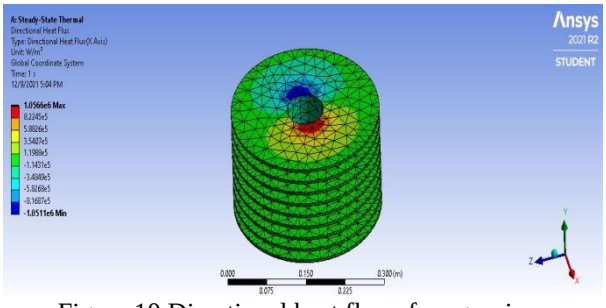


Figure.10.Directional heat flux of magnesium

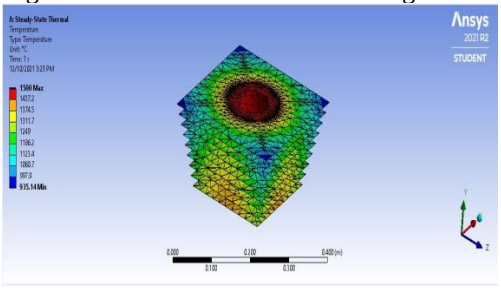


Figure.11.Temperature distribution of Aluminium engine fin

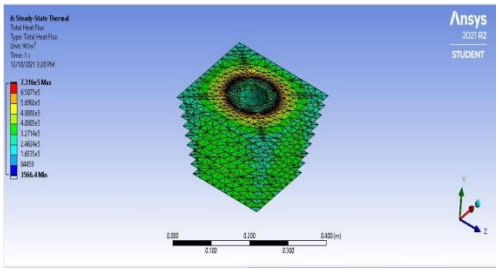


Figure.12. Total heat flux of structural steel engine fin

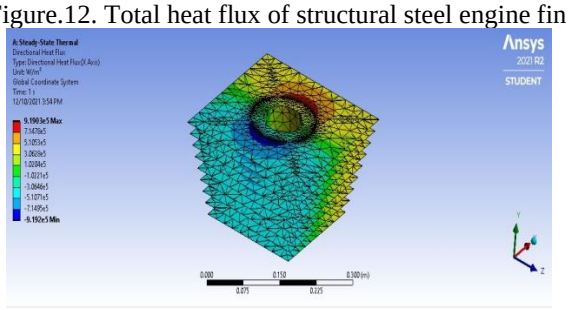


Figure.13.Directional heat flux of Magnesium fin

 : Enter CAD environment by clicking, later into part designing mode to construct model.

-  : Select plane as basic reference.
-  : Enter sketcher mode.

Figure.14. CAD Model

The "preprocessing" features of ANSYS allow it to accept CAD data as input and then produce a geometry. A finite element model, also called a mesh, is constructed as part of the same preprocessing phase. The numerical and graphical representations of the results of defining loadings and performing analysis are available for inspection.

The sophisticated engineering studies that ANSYS can undertake be carried out quickly, safely, and realistically due to the software's wide variety of contact techniques, time-based loading characteristics, and nonlinear material models.

•

It is common practise in engineering to move heat from one location to another, or between different bodies. Heat travels from warmer to cooler areas; temperature gradients power this exchange. • Temperature differences induce mechanical stresses and strains in bodies due to the coefficient of thermal expansion (sometimes abbreviated CTE in engineering literature).

Heat transfer rate is proportional to the temperature difference between the two surfaces and the thermal resistance of the materials used.

•

In engineering, these three mechanisms stand out as the most important:

In other words, 1 - conductance

secondly, convection

Relating to: 3, Radiation

Below is the layout of the elements of the standard CATIA application.

A. Menu Commands
B. Specification Tree
C. Window of Active document
D. Filename and extension of current document
E. Icons to maximize/minimize and close window
F. Icon of the active workbench
G. Toolbars specific to the active workbench
H. Standard toolbar
I. Compass
J. Geometry area

Different types of engineering drawings, construction of solid models, assemblies of solid parts can be done using inventor.

Different types of files used are:

1. Part files: .CATPart
2. Assembly files: .CATProduct.

Table.2. Comparison Results Of Normal Engine Fin

S.No.	Content		Steel	Mg alloy	Al alloy
1	Temperature	Max	1500	1500	1500
		Min	1220.1	1194	918.04
2	Total heat flux	Max	8.6665e5	1.13644e6	1.16e6
		Min	6852.1	9907	110186
3	Directional heat flux	Max	7.956e5	1.0566e6	1.0826e6
		Min	-7.987e5	-1.0511e6	-1.076e6

Table.3. Comparison Results Of Modified Engine Fin

S.No.	Content		Steel	Mg alloy	Al alloy
1	Temperature	Max	1500	1500	1500
		Min	509.33	886.28	935.14
2	Total heat flux	Max	7.316e5	1.0174e6	1.0441e6
		Min	3566.4	7991.4	8622
3	Directional heat flux	Max	6.7347e5	9.1903e5	9.423e5
		Min	-6.736e5	-9.192e5	-9.426e5

5. CONCLUSION

We modified the fins' design to make them as small as possible, which lowered the engine's operating temperature to an acceptable level. Furthermore, we were able to lower the engine's minimum operating temperature by replacing AL 6063 with an aluminium alloy (Al + Silicon carbide), which is superior than structural steel and magnesium alloy in terms of performance and efficiency. Aluminum silicon carbide increases engine temperature distribution, total heat flux, and directional heat flux by up to 20%. Aluminum silicon carbide, according to the results of the thermal analysis, is the material of choice for engine fins since it provides the best cooling results.

6. REFERENCES

1. Shri. N.V. Hargude and Dr. S.M. Sawant, “Experimental Investigation of Four Stroke S.I. Engine using Fuel Energizer for Improved Performance and Reduced Emissions”, International Journal of Mechanical Engineering & Technology (IJMET), Volume 3, Issue 1, 2012, pp. 244 - 257, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.
2. J.Ajay Paul, SagarChavan Vijay, Magarajan&R.ThundilKaruppaRaj, “Experimental and Parametric Study of Extended Fins In The Optimization of Internal Combustion Engine Cooling Using CFD”, International Journal of Applied Research in Mechanical Engineering.
3. J.C.Sanders, et al. Cooling test of an air-cooled engine cylinder with copper fins on the barrel, NACA Report E-103.
4. D.G.Kumbhar, et al. (2009). Finite Element Analysis and Experimental Study of Convective Heat Transfer Augmentation from Horizontal Rectangular Fin by Triangular Perforations. Proc. Of the International Conference on Advances in Mechanical Engineering.
5. N.Nagarani and K. Mayilsamy (2010). "EXPERIMENTAL HEAT TRANSFER ANALYSIS ON ANNULAR CIRCULAR AND ELLIPTICAL FINS." International Journal of Engineering Science and Technology 2(7): 2839-2845.
6. S.S.Chandrakant, et al. (2013). "Numerical and Experimental Analysis of Heat Transfer through Various Types of Fin Profiles by Forced Convection." International Journal of Engineering Research & Technology (IJERT).
7. T. Pise and U. V. Awasarmol (2010). "Investigation of Enhancement of Natural Convection Heat Transfer from Engine Cylinder with Permeable Fins." International Journal of Mechanical Engineering & Technology (IJMET) 1(1): 238-247.
8. G.Raju, Dr.BhramaraPanitapu, S. C. V. RamanaMurty Naidu. “Optimal Design of an I C engine cylinder fin array using a binary coded genetic algorithm”. International journal of Modern Engineering Research. ISSN 2249-6645,Vol. 2 Issue.6, Nov-Dec.(2012),pp.4516-4520.
9. R.P. Patil and P. H. M. Dange (2013). "Experimental and Computational Fluid Dynamics Heat Transfer Analysis on Elliptical Fin by Forced Convection." International Journal of Engineering Research & Technology (IJERT) 2(8).
10. Magarajan U., Thundilkaruppa Raj R. and Elango T., “Numerical Study on Heat Transfer of Internal Combustion Engine Cooling by Extended Fins Using CFD”, Research Journal of Recent Sciences ISSN 2277-2502 Vol. 1(6), pp.32-37, June (2012).
11. P. Agarwal, et al. (2011). Heat Transfer Simulation by CFD from Fins of an Air Cooled Motorcycle Engine under Varying ClimaticConditions. Proceedings of the World Congress on Engineering.
12. Mr. N. Phani Raja Rao, Mr. T. Vishnu Vardhan. “Thermal Analysis Of Engine Cylinder Fins By Varying Its Geometry And Material.” International journal of Engineering Research & Technology.ISSN:2278- 0181,Vol. 2 Issue 8, August(2013).

13. S. Wange and R. Metkar (2013). "Computational Analysis of Inverted Notched Fin Arrays Dissipating Heat by Natural Convection." International Journal of Engineering and Innovative Technology (IJEIT) 2(11).
14. Heat Transfer Augmentation of Air Cooled 4 stroke SI Engine through Fins- A Review Pape. International Journal of Recent Development in Engineering and Technology. ISSN 2347 – 6435, Volume 2, Issue 1, January (2014).
15. N.Nagarani and K. Mayilsamy, Experimental heat transfer analysis on annular circular and elliptical fins." International Journal of Engineering Science and Technology 2(7): 2839-2845 .
16. Islam Md. Didarul, OyakawaKenyu, Yaga Minoru and SenahaIzuru, "Study on heat transfer and fluid flow characteristics with short rectangular plate fin of different pattern" Experimental Thermal and Fluid Science, Volume 31, Issue 4, February 2007 .
17. P. R. Kulkarni, "Natural Convection heat transfer from horizontal rectangular fin arrays with triangular notch at the center." Paper presented at NCSRT-2005. (Nov 18-19, 2005), Pg. No.: 241-244.