

“A REVIEW OF HEAT DISSIPATION ANALYSIS BY VARYING GEOMETRICAL CONDITION OF CYLINDRICAL FIN”

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Abstract: If the heat in the heat engine is not removed properly, it causes the development of the detonation and eventually reduces the efficiency of the engine, so that the heat dissipation rate of the cylinder an important and interesting task is the option. The cylinder of the engine is one of the most important automotive components, variations of high temperature and thermal loads. To cool the cylinder, the ribs are provided on the surface of the cylinder, to increase the rate of heat transfer. By a thermal analysis of the motor cylinder and the ribs that surround it, it is useful to know the heat transfer rate and the temperature distribution inside the cylinder. We know that we can increase the heat dissipation rate by increasing the surface so it is very difficult to design such a complex motor. The main objective of this project is to analyze thermal properties such as thermal directed flow, total heat flow and temperature distribution.

The cooling mechanism of the air cooled engine depends mainly on the design of the cylinder head and the block ribs. The cooling fins are used to increase the heat transfer rate of the specified surface. The life and efficiency of the engine can be improved by efficient cooling.

The finite element method was used using the ANSYS software as a simulation tool for analysis.

Keywords:- IC Engine, FEM, ANSYS, Engine cylinder, Fin.

I. INTRODUCTION

The internal combustion engine (ICE) has been part of the company since the beginning of the 19th century. Although the fuel was different (oil was produced commercially only in the 1850s), the concept was the same. The first internal combustion engines were used mainly in industrial applications, but then they were introduced in vehicles that can now move. The first modern car was designed and produced in 1885 by Karl Benz, the car was called and 25 of these were sold between 1888 and 1893. In the following years, more and more car manufacturers came to the market and

began to build, design and sell cars The first economic car produced was Ransom Olds Mobile in 1902.

An engine is a device that converts thermal energy into mechanical work. The thermal energy is generated by combustion of the air and fuel mixture inside the cylinder by means of start-up methods provided by the starter cover. Because it uses thermal energy, it is known as a thermal engine. It is a source of energy for some applications.

The cylinder head closes one side of the cylinder. Usually, they have a one piece roll and they are directed to the highest point of the cylinder. Between the cylinder and the head there is a gasket provided with a specific objective to act as a fixing agent (to prevent the escape of gas during the expansion stroke) and, in addition, to reduce anesthesia.

A. Engine Cylinder and Combustion Chamber

We know that in internal combustion engines, the combustion of air and fuel in the engine cylinder occurs and hot gases. The temperature of the gases is approximately 2300-2500 ° C. This is a very high temperature and can lead to burning of the oil film between the moving parts and can lead to the same seizure or welding, what is the probability of a piston attack and the probability of a piston ring, compression ring, oil ring, etc. They could be interested. Over temperature can also damage the cylinder material. Therefore, this temperature should be reduced to approximately 150 to 200 ° C at which the engine runs more efficiently. Excessive cooling is also undesirable because it reduces thermal efficiency. The purpose of the cooling system is, therefore, to keep the engine at the most efficient operating temperature. It is noted that the cold engine is very inefficient and, therefore, the cooling system is designed to prevent cooling when the engine is heating and until it reaches an efficient maximum operating temperature, it begins to cool.

To avoid overheating and the consequent negative effects, the heat that is transmitted to a component of

the engine (according to a certain level) will be eliminated as quickly as possible and transported to the atmosphere. It is correct to refer to the cooling system as a temperature regulation system. It should be remembered that the extraction of heat from the working fluid to cool the engine components is a direct thermodynamic loss.

The heat transfer rate depends on the wind speed, the geometry of the motor surface, the external surface and the ambient temperature. In this work, the analysis of the fins of the engine block is carried out taking into account the internal temperature by conduction and convection, the air velocity is not considered in this work. Motorcycles Motors are normally designed to operate in a given temperature atmosphere, but cooling beyond the optimum limit is not considered, as it may reduce overall efficiency. Therefore, it can be seen that only sufficient cooling is desirable.

Air-cooled engines generally use individual cylinder housings to facilitate cooling. An exception is the inline engines for motorcycles with two, three, four or even six cylinders cooled by air in a common block. Water-cooled motors with some cylinders can also use the individual cylinder boxes, which, however, makes the cooling system more complex. The Ducati motorcycle company, which has used air-cooled engines with individual cylinder housings for years, has maintained the basic design of its V-twin engine and, at the same time, adapted it to water cooling.

B. Natural Air Cooling

Normally, the larger parts of an engine will remain exposed to atmospheric air. When vehicles drive, the air hits the engine at a relative speed and eliminates its heat. The heat transferred from the air is due to natural convection, so this method is called natural air cooling. The motors mounted on two wheels are mostly cooled by natural air. Since heat dissipation is a function of the frontal area of the cross section of the motor, therefore, it is necessary to increase this range. An engine with an increased area becomes cumbersome and reduces its weight / power ratio. Therefore, the ribs are constructed as an alternative arrangement to improve the front cross-sectional area of the motor. The ribs (or ribs) are sharp protrusions on the surfaces of the cylinder block and the head. They increase the external contact area between a cylinder and the air. The fins are generally printed integrally with the cylinder. They can also be connected to the cylinder.

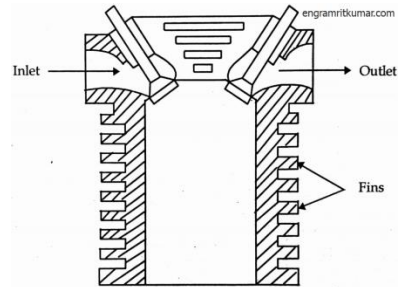


Figure 1: Natural air cooling

C. Fins

A fin is an area that extends from an object to increase the rate of heat transfer to or from the environment as convection increases. The amount of conduction, convection, radiation of an object determines the amount of heat it transfers. By increasing the temperature difference between the object and the environment, increasing the heat transfer coefficient or increasing the surface area of the object increases the heat transfer. Sometimes it's not cheap or you can not change the first two options. However, adding a rib to the object increases the area of the surface and can sometimes be an economical solution to heat transfer problems. Some circumferential ribs around the cylinder of a motorcycle engine and the fins connected to the condenser tubes of a refrigerator are some known examples.



Figure 2: Automobile Fin

The temperature distribution in a gasoline engine is extremely important for the proper functioning of the engine to maximize the thermal efficiency of an engine; It must be used under certain thermal conditions. This condition is controlled by a cooling process of the fins that tends to eliminate heat, which is extremely critical to keep the engine and engine lubricant against thermal failure and thermal effects. In fact, the fins are provided because they provide a channel for cooling the motor each time it is heated.

The fins do not burn the engine. The ribs provided in the cylinder of the engine depend on the capacity of the engine. The greater the capacity of the engine, the greater the fins on the surface of the engine block.

D. Fin terminology and types

- Fin base,
- Fin tip ,
- Straight fin,
- Variable cross-sectional area fin,
- Spine or a pin fin,
- Annular or cylindrical.

E. Thermal Analysis

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:

- Dielectric thermal analysis (DEA): dielectric permittivity and loss factor
- Thermal Analysis (DTA): temperature difference versus temperature or time
- Differential Scanning Calorimetry (DSC): heat flow changes versus temperature or time
- Dilatometry (DIL): volume changes with temperature change
- Dynamic Mechanical Analysis (DMA or DMTA) : measures storage modulus (stiffness) and loss modulus (damping) versus temperature, time and frequency
- Evolved Gas Analysis (EGA) : analysis of gases evolved during heating of a material, usually decomposition products
- Laser flash analysis (LFA): thermal diffusivity and thermal conductivity
- Thermo gravimetric Analysis (TGA): mass change versus temperature or time
- Thermo mechanical analysis (TMA): dimensional changes versus temperature or time
- Thermo-optical analysis (TOA): optical properties
- Derivatography: A complex method in thermal analysis

Thermal analysis calculates the temperature and heat transfer within and between components in your design and its environment. This is an important consideration of design, as many products and material have temperature dependent properties. Product safety is also a consideration—if a product

or component gets too hot, you may have to design a guard over it.

The heat flow through the components can be in a steady state (where the heat flow does not change over time) or transient in nature. The thermal analogy of a linear static analysis is a steady-state thermal analysis, while a dynamic structural analysis is analogous to a transient thermal analysis. Heat transfer problems can be solved using structural and fluid flow analysis methods:

- In a thermal structural analysis, the effect of the moving air or a moving liquid is approximated by a series of boundary conditions or loads.
- In a thermal fluid analysis, the effect of the air or a liquid is calculated, increasing the run time but also increasing to overall solution accuracy.

F. Transient Thermal Analysis

The ANSYS/ Multi physics, ANSYS / Mechanical, ANSYS/Thermal, and analysis determines temperatures and other thermal quantities that vary over time. Engineers commonly use temperatures that a transient thermal analysis calculates as input to structural analyses for thermal stress evaluations. Many heat transfer applications- heat treatment problems, nozzles, engine blocks, piping systems, pressure vessels, etc.-involve transient thermal analyses. A transient thermal analysis follows basically the same procedures as a steady-state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time. To specify time-dependent loads, you first divide the load-versus-time curve into load steps. Each "corner" on the load-time curve can be one load step, as shown in the following sketches.

For each load step, you need to specify both load values and time values, along with other load step options such as stepped or ramped loads, automatic time stepping, etc. You then write each load step to a file and solve all load steps together. To get a better understanding of how load and time stepping work, see the example casting analysis scenario in this chapter.

G. Properties of Materials

The cylinder block should be made from the materials which has the following desirable properties [1, 2].

- It should be relatively cheap,
- It should readily produce castings with good impressions,
- It should be easily machined,

- It should be rigid and strong enough in both bending and torsion,
- It should have good abrasion resistance,
- It should have good corrosion resistance,
- It should have low thermal expansion,
- It should have a high thermal conductivity,
- It should retain its strength at high operating temperatures,
- It should have a relatively low density

For value of heat Transfer Coefficient h

$$Nu=hL/K$$

And for Laminar flow

$$Nu=0.0292 (Re)^{0.8} (Pr)^{0.33}$$

Where Pr =0.6

And Reynolds Number Re given by

$$Re= (\rho vL/\mu)$$

Where ρ =Density of air

V= velocity of air

μ =Dynamic viscosity

Generally, thermal behaviour of any system is determined by the participated modes of heat transfer and characteristics of the system. Considering the conductive and the convective modes of heat transfer, the energy equation given by

$$\rho c_p \left(\frac{\partial T}{\partial t} + \vec{v} \cdot \nabla T \right) = \nabla \cdot (k \nabla T)$$

where, ρ , c_p and k are the thermal properties of the system. With the known value of thermal properties, evaluation of temperature field of the system from Eqn. (1) requires the knowledge of the velocity field. Hence, apart from the energy equation, the governing equations of the considered system (Fig. 1a) also include steady form of continuity and momentum equations, given by

$$\nabla \cdot (\rho \vec{v}) = 0$$

$$\vec{v} \cdot \nabla \vec{v} = -\frac{1}{\rho} \nabla p + \nu \nabla^2 \vec{v}$$

The governing equation has been discretized using finite element method (FEM).

II. LITERATURE REVIEW

QingwenMahendra Kumar Ahirwar et. al. [2018] [1] The cooling mechanism of the air-cooled engine depends mainly on the laminar structure of the cylinder head and cylinder block. The cooling fins are used to increase the heat transfer rate of the specified surface. The life and effectiveness of the engine can be improved with effective cooling. The main objective of the project is to study with motorcycle fins Honda Hero 100 cc and compare and analyze the thermal

properties varying the geometry, material and thickness. Parametric finned cylinder models have been developed to predict transient thermal behavior. Currently, 6063 aluminum alloy is used for the preparation of the model, which has a thermal conductivity of 200 W / mK. We analyze the models designed taking the thermal temperature of 10000C. The energy transfers from the combustion chamber of an internal combustion engine are dissipated in three different ways. Transient thermal analyzes were carried out for the actual and proposed design of the engine cylinder, in order to optimize the geometrical parameters and the improved heat transfer of the internal combustion engine. The result is that the proposed design of the internal combustion engine has a transfer rate performance and a better heat from the heating zone in the combustion engine, so the result of the current work focuses on and even replaces the new design using the most proposed ANSYS software 17.0.

Ravi Gupta et. to the. [2018] [2] When the heat in the heat engine is not properly discharged, it causes a detonation development and finally reduces the efficiency of the engine work, so that the heat dissipation speed of the cylinder is one of the important tasks and interesting and main considerations for the selection of materials for block cylinders and fins. In this article, we try to find the best material in terms of a better heat transfer rate because, for cooling as the most important element, the safe operation of the motor, high strength, light weight and low costs, which are used to the cylinder block The purpose of the present study is to "find the most suitable material among the eight alloys selected for the application of the cylinder block of the engine, which is used for Vespa, depending on several parameters, such as heat dissipation capacity, resistance, costs, etc." is Analysis The finite element method has been used with the Ansys software as a simulation tool.

R. Nirala et al.[2018] [3] discussed that by increasing the surface area the heat dissipation rate increases, This paper presents a review to increase heat transfer rate in a four stroke S I engine by using geometrically modified fins.

Mulukunta Vidya Sagar et. al[2017] [4] The cylinder of the engine is one of the most important automotive components exposed to fluctuations and thermal stress at high temperatures. To cool the cylinder, ribs are provided on the surface of the cylinder to increase the rate of heat transfer. Through thermal analysis of the

engine cylinder and the surrounding cooling fins, it is useful to know the rate of heat release and the temperature distribution in the cylinder. We know that increasing the surface area can increase the rate of heat release. Therefore, it is very difficult to build such a large and complex engine. The main objective of this project is to analyze the thermal properties as a directional heat flow, the total heat flow and temperature distribution by varying the geometry (round, rectangular), the material (aluminum alloy, magnesium alloy), and the thickness of the fin (3 mm, 2 mm) of an approximately square cylinder model, which was created in SolidWorks 2013, and is imported into ANSYS WORKBENCH-2016 for transient thermal analysis at an internal temperature and the medium box of stagnant fluid simplified as cooling air on the external surface, with a film transfer coefficient appropriate as boundary conditions.

Pulkit Sagar et. [2017] [5] The heat transfer depends on the speed of the air, the ambient temperature, the geometry of the nerve and the surface of the nerve. The cooling fins allow the wind to cool on its surface and transfer heat from the surface of the cooling fins to the air. The investigation involved determining the effect of the geometry, the shape and the surface roughness of the ribs in the heat transfer. The main objective of the project is to analyze the rate of heat transfer by changing the shape and roughness of the surface of the ribs. The model is created by varying the shape and the roughness of the fin in Autodesk INVENTOR 2015, and by pretending AUTODESK NASTRAN in 2015. The main objective of this work is the following effect in the transfer of heat through slats in motorcycles and other vehicles of engine to study geometry.

Devendra J. Waghulde et. al. [2017] [6] The main objective of this study is to investigate the influence of geometry and material of the type of material used for two-stroke engines of the distribution of temperature and thermal flux. For this purpose, we have used two types of geometry, rectangular and triangular geometry of different thicknesses such as 2.5 mm, 3 mm and 3.5 mm for both types of geometry, three types of aluminum alloy, that is alloy 2014 and 6061 Alloy alloy 2024 can be used. Depending on the geometry, material and thickness, a total of 18 models have been developed in the ANSYS 16.2 version. Subsequently, the analysis of the finite elements (FEA) of all the models listed with the ANSYS software for parameters such as temperature distribution and heat flow, as well as the results of each model. Finally, to find conclusions, a comparative study was made among the results of a total of 18 models mentioned above.

Pushkar Bhanudas Patil et.al. [2017] [7] This document describes the efforts to discover the effect of the fin height on the cylinder of a two-wheel motor for temperature distribution. For this, we have nerves with rectangular geometry, with variable height of the 7mm 5mm and 3mm terminals used. The thermal analysis performed on geometries made with variable levels of lamellae with the software version ANSYS AIM 18.1 student, examines the results of different geometries according to the temperature distribution, the direction of the heat flow and the total thermal flux and the analysis thermal is carried out in the generated results. Finally, to find conclusions, the comparative study carried out among the previous results.

Sandeep Kumar et.al. [2017] [8] The objective of increasing the present study, the rate of heat transfer from the heating zone in the combustion engine for this transient thermal analysis was carried out in the actual construction of the Bajaj to discover a single cylinder of 125 cc. Transient thermal analyzes were carried out for the actual and proposed design of the engine cylinder, in order to optimize the geometrical parameters and the improved heat transfer of the internal combustion engine. Result to delight that the proposed design of the internal combustion engine 2 has a better performance and heat transfer rate of the engine heating zone, so the result of the current work is more attention and it is even proposed to replace the new drawing.

Divyank Dubey et. [2017] [9] In this work, we try to increase the rate of heat dissipation through these extended surfaces by increasing the thickness of the motor rib to 3 mm, and we also provide slots of 50 mm, 75 mm and 100 mm, 1 The fin height and the fin number were in SolidWorks and the analysis of the stable state of ANSYS. For this research, we use Bajaj Caliber, so we can verify the result with previous research. The result of these different analyzes shows that the engine, the aluminum used in 2014 maintains a groove width of 75 mm, has a high rate of heat dissipation as other width grooves of other materials. Deepak Tekhre et. al. [2017] [10]. This project is based on the development of more efficient cooling fins for a motorcycle engine design of 150cc (Honda Unicorn) and fin materials for improvising. Fin modeling is done with the Creo modeling software and the CFD analysis is done with the ANSYS 15.0 Workbench software.

N. Arul et. al. [2017] [11] The Fins are the extended surfaces that are used to dissipate heat by means of heat conduction and convection. The ribs are the most economical way of heat transfer compared to heat exchangers. For the most part, rectangular fins are

designed and used as heat transfer devices when, for example, less heat transfer and material reduction is required. We can change to other types of fins instead of rectangular ones. In this project, the rectangular, circular and pin-shaped fins are connected separately to the circular bar. So these three models have been subjected to experimental, analytical and computational analysis. In the experimental analysis, three models were heated to 100 ° C, allowing natural convection at room temperature. The temperature distributions were measured and visualized using a thermocouple. In the analytical method, the amount of heat transfer is calculated and represented graphically. In the computerized analysis, these three ANSYS 14.0 models were analyzed. The temperature distribution is compared experimentally and mathematically.

III. CONCLUSION

In this previous steady, thermal analysis of cylinder block using Finite Element Method, ANSYS as a tool were performed with eight different alloys to find out the best suitable material which gives the :

1. Finest heat transfer rate through it for cooling as primary consideration
2. Safe working of Engine
3. Having high strength
4. Light in weight and also
5. Lower Cost

REFERENCES

- [1] Mahendra Kumar Ahirwar, Asst Prof. Ravindra Mohan and Asst Prof. Jagdish Prasad, "I.C. Engine Cylinder Fins Transient Thermal Analysis By Using ANSYS Software" International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 02, Feb-2018.
- [2] Ravi Gupta and Prof K.K. Jain, "Heat Transfer Analysis of Engine Cylinder Block with Different Material Alloys", International Journal of Innovative Research In Technology, IJIRT, Volume 4 Issue 10, 2018.
- [3] R. Nirala, P.K Jain, "Heat Transfer Rate Enhancement of an Air Cooled Four Stroke SI Engine by Geometrically Modified Fins- A Review", Ijoscience, vol 4, Issue 5, 2018. Available at <http://ijoscience.com/ojsscience/index.php/ojsscience/article/view/142/118>.
- [4] Mulukuntla Vidya Sagar and Nalla Suresh, "Thermal Analysis of Engine Cylinder with Fins by using ANSYS Workbench", International Journal of Engineering Research & Technology (IJERT), Vol. 6 Issue 06, June – 2017, ISSN: 2278-0181.
- [5] Pulkit Sagar, Puneet Teotia, Akash Deep Sahlot and H.C Thakur, "Heat transfer analysis and optimization of engine fins of varying geometry", Materials Today: Proceedings 4 (2017) 8558–8564.
- [6] Devendra J. Waghulde, Prof. V H Patil and Prof. T. A. Koli, "Effect of geometry, material and thickness of fin on engine cylinder fins", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 07 | July -2017, e-ISSN: 2395-0056.
- [7] Pushkar Bhanudas Patil and Dr. M. K. Chopra, "Effect of Fins Height on Two Wheeler Engine Cylinder", IJSART- Volume 3 Issue 9 – SEPTEMBER 2017, ISSN [ONLINE]: 2395-1052.
- [8] Sandeep Kumar and Prof. Nitin Dubey, "Investigation and Thermal Analysis of Heat Dissipation Rate of Single Cylinder SI Engine", International Journal of Engineering Development and Research © 2017 IJEDR | Volume 5, Issue 2 | ISSN: 2321-9939.
- [9] Divyank Dubey, Dinesh Singh, Abhishek yadav, Satya jeet pal and Harishchandra Thakur, "Thermal Analysis of Engine Cylinder having thick tip fin with varying slot sizes and material", Materials Today: Proceedings 4 (2017) 7636–7642.
- [10] Deepak Tekhre and Jagdeesh Saini, "Design Modification And Thermal Analysis of IC Engine Fin", International Refereed Journal of Engineering and Science (IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Volume 6, Issue 11 (November 2017), PP. 11-15.
- [11] N. Arul, G. Srinivasan, K. Sriram, M. Vignesh and S. Vijayaraj "Experimental and Computational Analysis of Various Types of Fins", International Journal For Research In Mechanical & Civil Engineering, Volume-3 | Issue-4 | April,2017 | Paper-4, ISSN: 2208-2727.
- [12] Praveen Choudhary, Satyendra Kumar Pankaj, Mukul Tomar and Dr Harish Chandra Thakur, "Unsteady Analysis of Heated Inclined Fin-plate Placed Inside Square Enclosure", 2017 2nd International Conference for Convergence in Technology (I2CT), 978-1-5090-4307-1/17/\$31.00 ©2017 IEEE.
- [13] Obula Reddy Kummitha and B. V. R. Reddy, "Thermal Analysis of cylinder block with fins for different materials using ANSYS", Materials Today: Proceedings 4 (2017) 8142–8148.
- [14] Aju Joseph, Amal Dev C George, Aneesh K, Fabin Shafi, Jijo Joseph and Arunraj A, "Heat Transfer Enhancement Perforations: A Review", International Journal of Innovative Research in Science, Engineering and Technology, (An ISO 3297: 2007 Certified Organization), Vol. 6, Issue 1, January 2017, ISSN(Online) : 2319-8753.
- [15] A Sathishkumar, MD KathirKaman, S Ponsankar and C Balasuthagar, "Design and thermal analysis on engine cylinder fins by modifying its material and geometry", Journal of Chemical and Pharmaceutical Sciences, JCPS Volume 9 Issue 4, October - December 2016, ISSN: 0974-2115.
- [16] Rahul Gupta, Rajneesh Kumar and Prateek Kumar Verma, "Heat Transfer Analysis of Engine Cylinder Fins Having Triangular Shape", International Journal of Scientific & Engineering Research, Volume 7, Issue 5, May-2016, ISSN 2229-5518.
- [17] L. Natrayan, G.Selvaraj, N.Alagirisamy and M.S.Santhosh, "Thermal Analysis of Engine Fins with Different Geometries", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 5, May 2016, ISSN(Online) : 2319-8753.
- [18] Shubham Shrivastava and Shikar Upadhyay, "Thermal Analysis of IC Engine Cylinder Block with Fins Perpendicular to the Axis of Piston Movement", International Journal of Mechanical and Industrial Technology, Vol. 3, Issue 2, pp: (139-149), Month: October 2015 - March 2016, ISSN 2348-7593 (Online).
- [19] Pinja Laaksonen, Timo Hyppänen and Tero Tynjälä, "Effects Of Fin Parameters On Gas-Side Heat Transfer Performance Of H-Type Finned Tube Bundle In A Waste Heat Recovery Boiler", 2015.
- [20] Sachin Kumar Gupta, Harishchandra Thakur and Divyank Dubey "Required of Cooling System in IC Engines", HCTL

Open International Journal of Technology Innovations and Research (IJTIR) <http://ijtir.hcti.org> Volume 14, April 2015
e-ISSN: 2321-1814, ISBN (Print): 978-1-62951-946-3.

- [21] panduga eeshwar prasad, y. dilip kumar and dr. p. h. v. sesha talpa sai “thermal analysis of engine by changing fluid and thickness of fins”, international journal of emerging trends in technology and sciences, volume-06, issue-01, november-2015, (issn: 2348-0246(online)).