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Fins in Thermal Engineering from ANSYS

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ABSTRACT

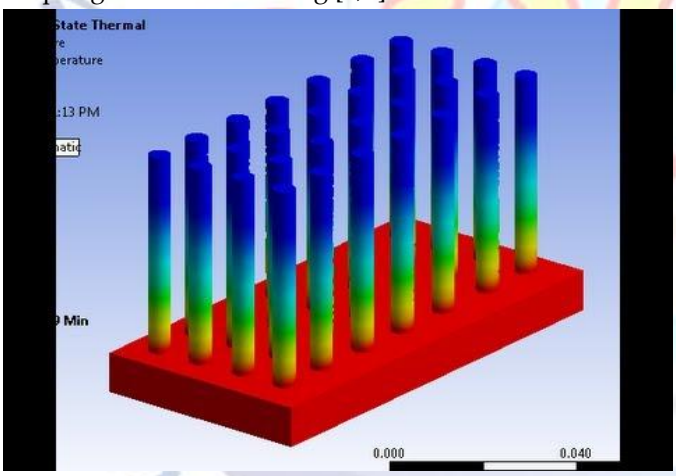
The Engine chamber is one of the essential engine components, that is subjected to over the top temperature differences and thermal stresses. Fins are set on the surface of the cylinder to improve the quantity of heat exchange by convection. When fuel is burned in an engine, heat is produced. Additional heat is also generated by friction between the moving parts. In air-cooled I.C engine, extended surfaces called fins are provided at the periphery of engine cylinder to increase heat transfer rate. That is why the analysis of fin is important to increase the heat transfer rate. The main of aim of this work is to study various researches done in past to improve heat transfer rate of cooling fins by changing cylinder fin geometry and material. In the present work, Experiments have been performed to discover the temperature variations inside the fins made in four kind geometries (plate Fins, Circular Pin fins, plate fins with holes, and draft Pin fins) and consistent state heat exchange examination has been studied utilizing a finite element software ANSYS to test and approve results. The temperature variations at various areas of fins models are evaluated by FEM and compared models of fins performance by heat flux and temperature variations obtained by experimentally in Analysis. The principle implemented in this project is to expand the heat dissipation rate by utilizing the wind flow. The main aim of the study is to enhance the thermal properties by shifting geometry, material, and design of fins

KEYWORDS: fins, ansys, thermal, engineering, wind , flow, heat, transfer, temperature, variations

1.INTRODUCTION

We know that in case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result in seizing or welding of same that is chances of piston seizure, chances of piston ring, compression ring, oil ring etc. can be affected. Excess temperature can also damage the cylinder material. So this temperature must be reduced to about 150- 200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency.[1,2] So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. To avoid overheating, and the consequent ill effects, the heat transferred to an engine component (after a certain level) must be removed as quickly as possible and be conveyed to the atmosphere. It will be proper to say the cooling system as a temperature regulation system. It should be remembered that abstraction of heat from the working medium by way of cooling the engine components is a direct thermodynamic loss. The rate of heat transfer depends upon the wind velocity, geometry

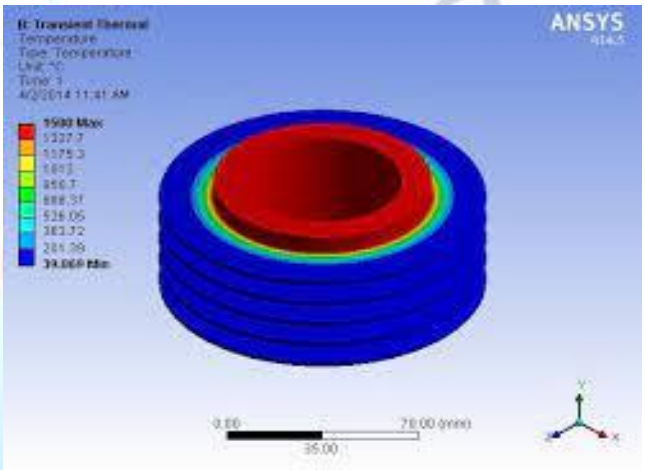
of engine surface, external surface area and the ambient temperature. In this work analysis is done on engine block fins considering temperature inside by means of conduction and convection, air velocity is not consider in this work. Motorbikes engines are normally designed for operating at a particular atmosphere temperature, however cooling beyond optimum limit is also not considered because it can reduce overall efficiency. Thus it may be observed that only sufficient cooling is desirable. Air-cooled engines generally use individual cases for the cylinders to facilitate cooling. Inline motorcycle engines are an exception, having two-, three-, four-, or even six-cylinder air-cooled units in a common block. Water-cooled engines with only a few cylinders may also use individual cylinder cases, though this makes the cooling system more complex. The Ducati motorcycle company, which for years used air-cooled motors with individual cylinder cases, retained the basic design of their V-twin engine while adapting it to water-cooling.[3,4]



Thermal analysis of FINS (circular)

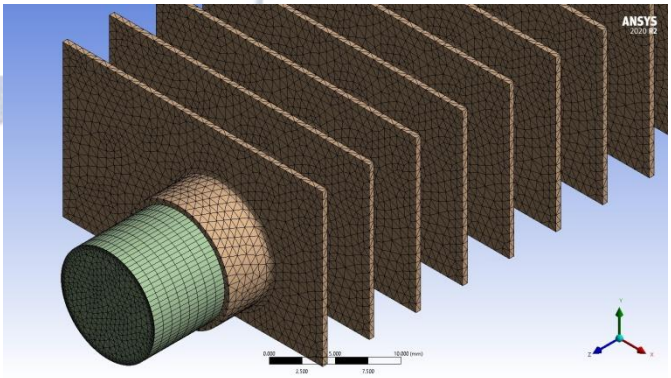
OBSERVATIONS

ANSYS stands for Analysis System. ANSYS Mechanical is a finite element analysis tool for structural analysis, including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behaviour, and supports material models and equation solvers for a wide range of mechanical design problems Ansys provide a cost effective way to explore the performance of products or processes in a virtual environment. This type of product development is termed virtual prototyping. With virtual prototyping techniques, users can iterate various scenarios to optimize the product long before the manufacturing is started. This enables reduction in the level of risk, and in the cost of ineffective designs.[5,6] The Heat transfer and flow characteristics of a fins can be visualized of the contour diagrams of Heat flux and Temperature distribution and values of Temperature, and the graphs of Heat Flux and Time which have been plotted ANSYS Transient Thermal 14.0 . The present work is successfully carried out by comparing various shapes of fins with holes and without holes. The four types of shapes are chosen for the comparison i.e. circular, rectangular, helical and trapezoidal. Analysis has been carried out in ANSYS 14.0 Transient Thermal by changing shape of fins with holes and without holes. [7,8]



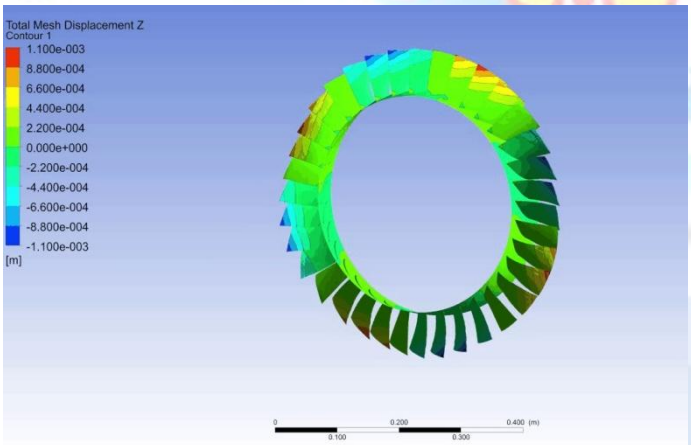
Engine cylinder thermal analysis

- The fins without holes are compared for different chosen shapes. Comparing this, it is found that helical fin gives better result because it has maximum surface area which provides maximum heat transfer.
- The same process is carried out for with holes condition. In this process also, helical fin provides better results among other fins.
- It is found that geometry of Helical Fins with hole have a better Heat transfer rate as compared to the fins without holes[9,10]



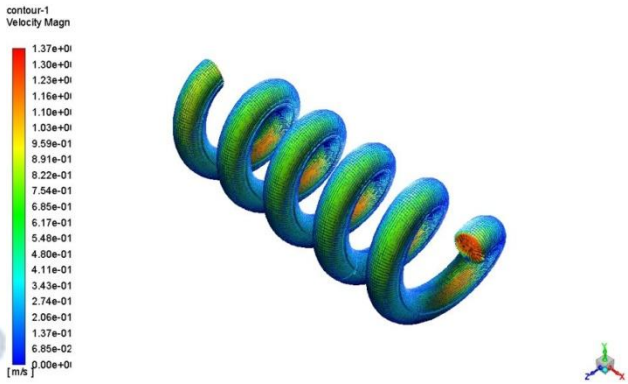
Fin pipe radiator heat transfer

Methods of finite components are a valuable tool for finding a numerical solution for various technical studies. The method is common enough for all materials at different borders and load conditions for any complex form or geometry. The method came as a means of analyzing the strain in a complex airframe structure in the aerospace industries. It grew up and became the technology used in aircraft design for matrix evaluation. Both researchers and practitioners have received wide popularity in the technique. The beauty of finite element technology is that a body or a form could be separated into small finite-dimensional pieces known as finite factors. The particular structure is taken into account when assembled into a final set of joints known as nodes. Static measurement of displacement, stresses, stresses and forces in structures or materials is used because hundreds do not result in significant inertia or damping. In response conditions, stable loading is assumed. Loading types that can be used for a static test include external forces and loads, regular domestic inertial forces, imposed (non-0) movement speed, temperatures (for thermal stress). A linear or nonlinear static analysis may be available. We don't neglect linear static analysis in our current work. [11]



ANSYS engineering simulation software

These key steps are the protocol for static analysis: Construction the model.¬ Achieving the solution.¬ Evaluation the results.¬ A structural examination is carried out using the ANSYS Workbench V.14.0 to carry out the finite element examination of the Fins models during the engine temperature transfer to the air with the aid of fins. At this stage research by the Fins involves a continuous thermal analysis and minor modifications in order to obtain designs. The fins model was built and saved in*.Igs in this file in Solidwork 2016 and imported to the workbench in ANSYS [12,13]

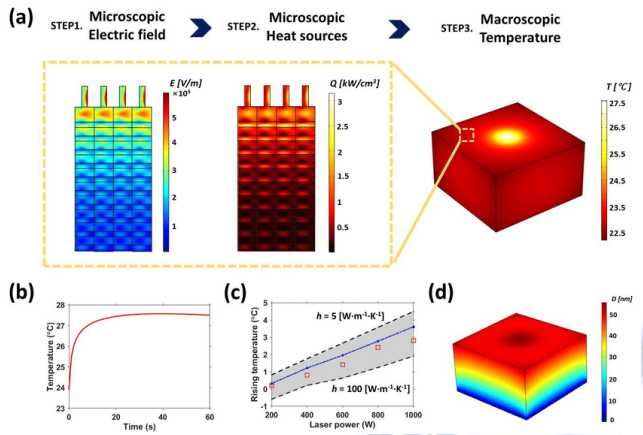


Remote points in ANSYS workbench

DISCUSSION

Transient thermal analysis was carried out. Transient thermal analyses determine 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 of electronic packages or a quenching analysis for heat treatment.

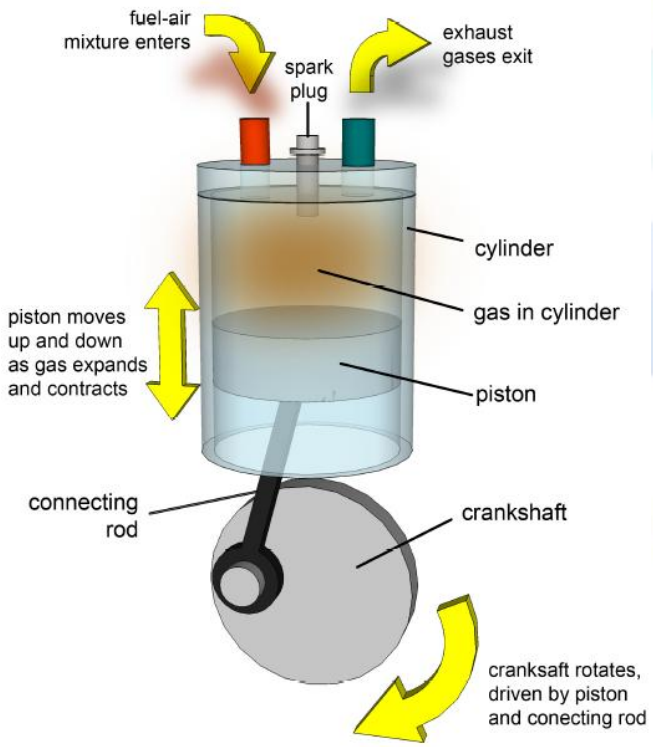
Also of interest are the temperature distribution results in thermal stresses that can cause failure. In such cases the temperatures from a transient thermal analysis are used as inputs to a static structural analysis for thermal stress evaluations. In the present study as the fins undergo temperature variation along time so transient thermal analysis was carried out. Boundary conditions were given in terms of temperature as follows, Maximum temperature = 15000 C Minimum temperature = 1400 C Materials that are used for present analysis are aluminium alloy A2404 and aluminium alloy 6061. Aluminium alloy 6061 is compared with Aluminium Alloy A204. The various parameters (i.e., geometry and thickness of the fin) are considered in the study, By reducing the thickness and also by changing the shape of the fin to circular shape from the conventional geometry i.e rectangular , the weight of the fin body reduces thereby increasing the heat transfer rate and efficiency of the fin. The results shows, by using circular fin with material Aluminium Alloy 6061 is better since heat transfer rate of the fin is more. By using circular fins the weight of the fin body reduces compared to existing rectangular engine cylinder fin[14]



Thermal analysis

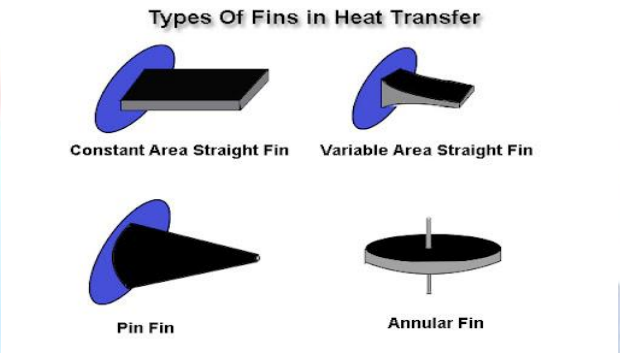
RESULTS

In normal cause, larger parts of an engine remain exposed to the atmospheric air. When the vehicles run, the air at certain relative velocity impinges upon the engine, and sweeps away its heat. The heat carried-away by the air is due to natural convection, therefore this method is known as natural air-cooling. Engines mounted on 2-wheelers are mostly cooled by natural air. As the heat dissipation is a function of frontal cross-sectional area of the engine, therefore there exists a need to enlarge this area. An engine with enlarge area will becomes bulky and in turn will also reduce the power by weight ratio. [13]



Heat / thermal engine

Hence, as an alternative arrangement, fins are constructed to enhance the frontal cross-sectional area of the engine. Fins (or ribs) are sharp projections provided on the surfaces of cylinder block and cylinder head. To avoid overheating, and the consequent ill effects, the heat transferred to an engine component (after a certain level) must be removed as quickly as possible and be conveyed to the atmosphere. The heat exchange from surfaces may, in general, be enhanced by expanding the heat exchange coefficient between a surface and its environment, by expanding the heat exchange zone of the surface, or by both. In most cases, the region of Heat exchange is expanded by using extended surfaces as balances the fins joined to walls and surfaces. Expanded surfaces (fins) are much of the time utilized in heat exchanging devices to increase the heat exchange between an essential surface and the surrounding liquid. Different types of fins, going from moderately simple geometries to complex geometries have been utilized. [14]

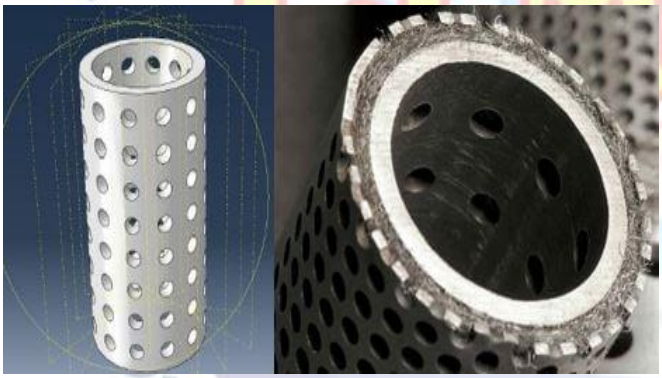


A shape of the regular fins geometries is rectangular, triangular, cylindrical, trapezoidal etc. For the guideline of conduction, convection, radiation of a fin arrangement optimized the quantity of heat it exchanges Increasing the temperature contrast between the fin setup and based upon surroundings, marginally expanding the convection heat transfer coefficient, or somewhat expanding the surface region of the fin design of the object enhance the heat exchange. This can be achieved by faster heat dissipation. By using the extended surfaces (Fins) we can improve the heat transfer rate from engine cylinder. For this analysis of the heat transfer rate of the fins is imperative. Every combination of shape, size and material have their own efficiency thereby selecting the best possible combination which give maximum efficiency to get required heat transfer rate for maximum engine efficiency. Extended area on the cylinder surfaces is use to increase the surface area in contact with the fluid flowing around it.[13,14]

Directional heat flux which is the third parameter shows better result for helical fins. The problem which could arise in case of helical fins is the helical angle which should give the best results. We find that lower the helical angle more will be the surface area and better results will be obtained and greater helical angle could not give better results. According to certain fixed boundary conditions and considering all the conditions we found that the helical fins can be used to get optimum results

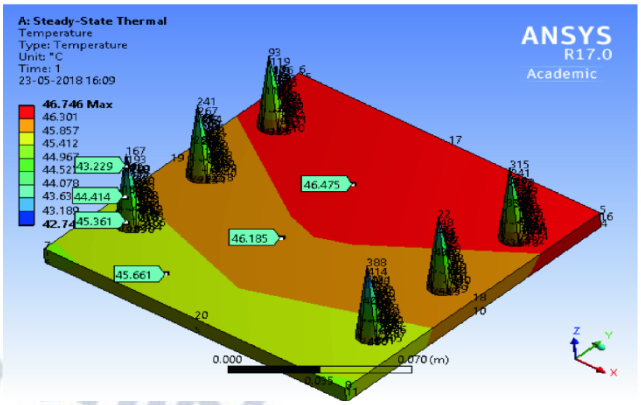
CONCLUSION

In circular perforation when we consider both temperature and 'h' it is better to select aluminum with three circular perforations in it when compared with copper. In Square perforation when we consider both temperature and 'h' it is better to select aluminum with three square perforations in it when compared with copper. In Hexagon perforation when we consider both temperature and 'h' it is better to select aluminum with three hexagon perforations in it when compared with copper.



Perforation pipe in ansys

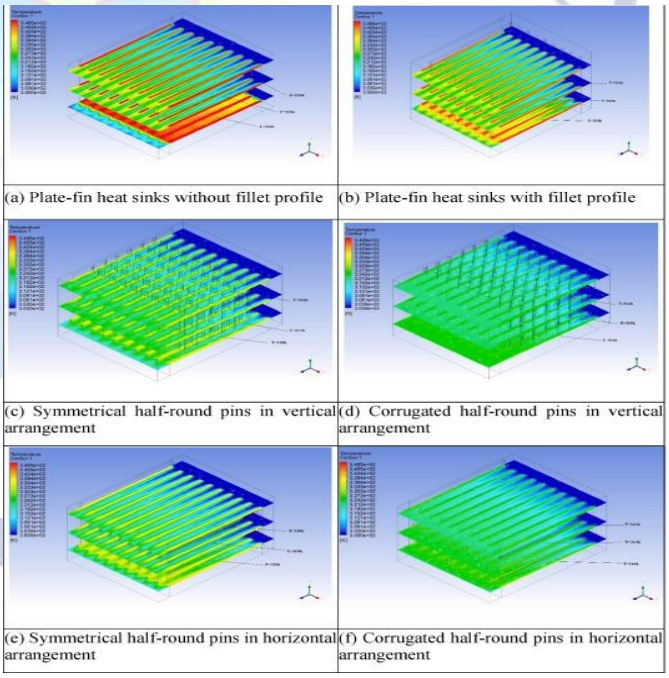
In Triangular, perforation when we consider both temperature and 'h' it is better to select aluminum with three triangular perforations in it when compared with copper. From the above research, it is evident that tip temperature is minimum for aluminum triangularly perforated with three perforations in it and h increase is maximum for triangularly perforated with three perforations of aluminum material. From the above research, we can say that convective heat transfer coefficient increases for perforated fin when compared with non- perforated fin. From the above research, we can say that Nusselt's numbers increases for perforated fin when compared with non- perforated fin. Therefore, a three triangle laterally perforated aluminum is most suitable for the fin applications[15]



Conical draft fin pins

From the comparative analysis of plate Fins, Circular Pin fins, plate fins with holes, and draft Pin fins study conclusion is that the Total heat flux found maximum 0.016W/mm2 in Circular Pin fins. [14]

Maximum temperature found in Conical draft Pin Fins is 81.68 0C and Minimum Temperature found in Plate Fins is 55.32 0C. Maximum Temperature drop found on Conical draft pin fin 5.6 °C and minimum temperature drop found on plate fin is 1.72°C. So, it is concluded that Pin Fins with Conical draft Pin Fins is shows better Heat transfer properties in this analysis. Thus, better heat transfer for fins or an experimental result shows that Conical draft Pin Fins having better than plate Fins. The overall analysis is performed on ANSYS FEM analysis Tool. [15]



Thus, further research can be carried with the advance materials and different designing, analysis tools. From the above study work the following conclusions are made: The thermal analysis of fins by modifying its

certain parameters such as geometry and Plate fins and Pin fins has been completed. By observing the analysis results, we can easily say; using Conical draft Pin Fins with material Aluminum alloy 1060 is better since the temperature drop and the heat transfer rate in a Conical draft Pin Fins much more compared to Plate fins.[15]

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