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# Design and Analysis of Engine Fins by using ANSYS Workbench

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**ABSTRACT:** The heat transfer processes in an internal combustion engine can be modeled with a variety of methods. These methods range from simple thermal networks to multidimensional differential equation modeling. Fins are placed on the surface of the cylinder to enhance the amount of heat transfer by convection. For thermal analysis of the engine cylinder fins, it is more beneficial to know the heat dissipation inside the cylinder. Literature survey shows that heat transfer is enhanced through extended surfaces and the heat transfer coefficient is affected by changing cross section of the fins. This study is useful to recognize the better geometry and material for the fins for higher heat dissipation rate and engine cooling. In this project we are taking general material like gray cast iron for engine block. The components are designed by using SOLIDWORKS and analysis is done by ANSYS.

**KEYWORDS:** Heat transfer, Conduction, Convection, Thermal Analysis.

## I. INTRODUCTION

Fins are basically mechanical structures which are used to cool various structures via the process of convection. Most part of their design is basically limited by the design of the system. But still certain parameters and geometry could be modified to better heat transfer. In most of the cases simple fin geometry is preferred such as rectangular fins and circular fins. Many experimental works has been done to improve the heat release of the internal combustion engine cylinder and fin efficiency. A transient numerical analysis is carried out with wall cylinder temperature of 423 K initially and the heat release from the cylinder is analyzed for zero wind velocity. The heat release from the cylinder which is calculated numerically is validated with the experimental results. In the present paper an effort is made to study the effect of fin parameters on fin array performance which includes variation in pitch and fin material. In addition, the current paper considers the effect of air flow velocity on different fin pitch. With the help of the available numerical results, the design of the internal combustion engine cooling fins can be altered for better efficiency. In this study, the effective thermal conductivity of aluminium filled high-density polyethylene composites is investigated numerically as a function of filler concentration. The obtained values are compared with experimental results and the existing theoretical and empirical models. The thermal conductivity is measured by a modified hot-wire technique. For numerical study, the effective thermal conductivity of particle-filled composite was calculated numerically using the micro structural images of them.

## II. RELATED WORK

Heat is the transfer of thermal energy. Heat is always transferred from an object of higher heat to one with lower heat. Exchange of heat occurs till body and the surroundings reach at the same temperature. The high-temperature body passes energy to the low-temperature one, eventually achieving thermal equilibrium. The tendency to thermal equilibrium, or even distribution of kinetic energy, is an expression of the second law of thermodynamics, the driving force of heat transfer. According to the second law of thermodynamics, 'Where there is a temperature difference between objects in proximity, heat transfer between them can never be stopped'; it can only be slowed



down. Heat is the energy in transit between systems which occurs by virtue of their temperature difference when they communicate.

Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, and exchange of thermal energy (heat) between physical systems. Heat transfer is classified into various mechanisms, such as thermal conduction, thermal convection, thermal radiation, and transfer of energy by phase changes. Engineers also consider the transfer of mass of differing chemical species, either cold or hot, to achieve heat transfer. While these mechanisms have distinct characteristics, they often occur simultaneously in the same system. Heat conduction, also called diffusion, is the direct microscopic exchange of kinetic energy of particles through the boundary between two systems. When an object is at a different temperature from another body or its surroundings, heat flows so that the body and the surroundings reach the same temperature, at which point they are in thermal equilibrium. Such spontaneous heat transfer always occurs from a region of high temperature to another region of lower temperature, as described in the second law of thermodynamics.

### III. METHODOLOGY

Most engines have cylinder liners made of cast iron. Some cylinder liners or cylinders are also coated with high resistance to wear materials such as nickel, silicon carbide, boron nitride, etc depending on the application. Generally the temperature inside an IC engine cylinder ranges from 600 to 2000°C. Grey cast iron is the first and most material used for manufacturing of engine blocks. Though the aluminum alloy also contains many similarities with low weight, it is still used in the manufacturing of diesel engine blocks because their internal stresses are higher. Aluminium Alloy 6061.

Al	Mg	Si	Fe	Cu	Cr	Zn	Ti	Mn	Remainder
95.85%	0.8%	0.40%	0.0	0.15%	0.04%	0.0	0.0	0.0	0.05%
-98.56%	-	-	-	-	-	-	-	-	-
	1.2%	0.8%	0.7%	0.40%	0.35%	0.25%	0.25%	0.15%	0.15% (each total)

### IV. EXPERIMENTAL RESULTS

#### MODELING

Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance (the inverse of the heat transfer coefficient) through the nearly stagnant film that forms when a fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that comes in contact with the fluid. Fin geometries and densities that create turbulent flow and improve performance also increase pressure drop, which is a critical requirement in most high performance applications. The optimum fin geometry and fin density combination is then a compromise of performance, pressure drop, weight, and size. A figure-of-merit comparison based on performance, pressure drop, weight, and size among common fin types is described in "Air Cooled Compact Heat Exchanger Design for Electronics Cooling." Aside from fin geometry, parameters such as thickness, length, height, can also be altered to improve performance. Typically, fin thicknesses vary 3mm, heights vary from 3mm, length 80mm and densities vary from 2.7 g/cc (Fins per mm).

#### ANALYSIS

Analysis is the process of breaking a complex topic or substance into smaller parts in order to gain a better understanding of it. The technique has been applied in the study of mathematics and logic since before Aristotle (384–322 B.C.), though analysis as a formal concept is a relatively recent development. Atomic force microscopy uses a fine stylus to map the topography and mechanical properties of surfaces to high spatial resolution. By controlling the temperature of the heated tip and/or the sample a form of spatially resolved thermal analysis can be carried out. Thermal analysis is also often used as a term for the study of heat transfer through structures. Many of the basic engineering data for modelling such systems comes from measurements



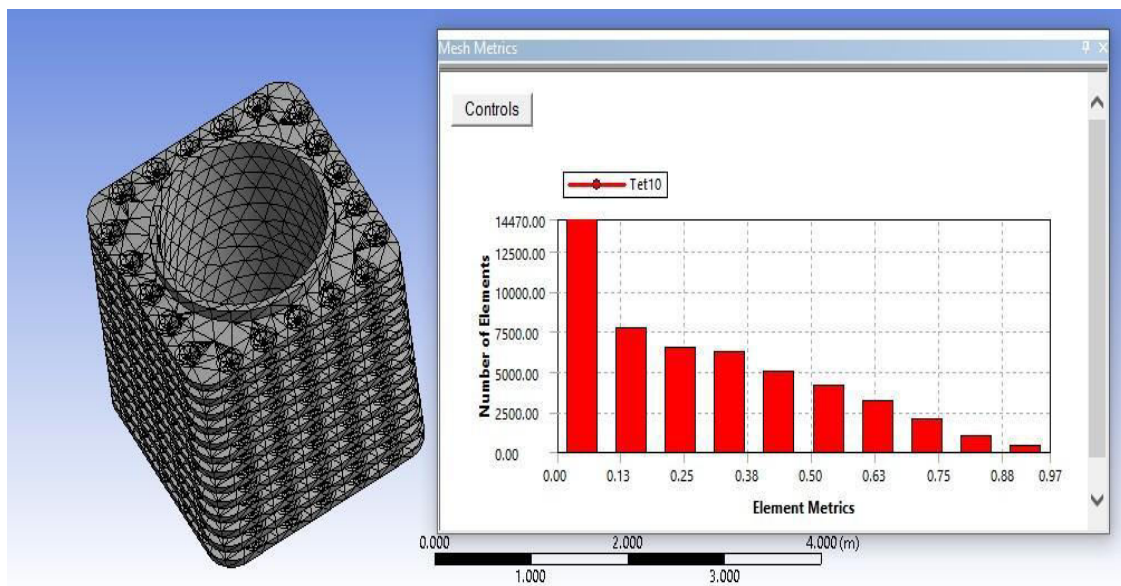


of heat capacity and thermal conductivity. The word comes from the Ancient Greek ἀνάλυσις (analysis, "a breaking-up" or "an untying;" from ana- "up, throughout" and lysis "a loosening"). From it also comes the word's plural, analyses.

**MESHING**

The Engine Fins models are analyzed using ANSYS Workbench Version 14.5 as outlined in Section 2.0. The models are meshed using the ANSYS default settings for path conforming volume with a relevance of 0.5 on a scale of -100 to 100. The resulting mesh is shown in Figure 6. Similar setting the mesh relevance to a maximum of 100 refines the mesh to 185237 nodes and 95422 elements, an almost three-fold increase in number of mesh nodes. The refined mesh is shown in Figure

Introducing the Half circle, Triangular, Square, and Trapezoidal. While the default mesh parameters are acceptable, the maximum mesh refinement Table no elements of the different shapes of component. Parameters are used when possible in order to produce more accurate results. In the convection cooling analyses involving assembly fins, complex model geometries and computing resources available require the models to be reduced to a quarter section of the original geometry. This is acceptable due to the ax symmetric nature of the IC engine Fins - assemblies. The model is conservatively sectioned so that the quarter geometry contains the least cooling surface area of the four quarters possible. Figure 8 shows the plan view of the meshed quarter section model. In all ANSYS cases, the model is first meshed, boundary conditions are applied and then the analysis is performed.



Meshing in circle cut of fins

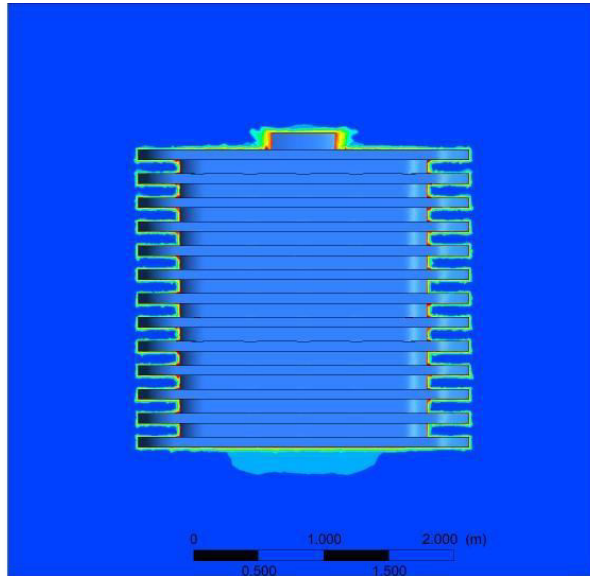
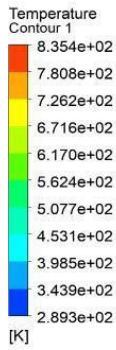
**1. FEA MODEL INPUTS:**

The FEA model boundary conditions, are calculated in based upon empirical. The intent is to mimic those boundary conditions experienced by the Engine Fins during normal plant operation. It is important to note that heat transfer coefficients are calculated for the regions shown in Figure. The Engine Fins heat transfer coefficient is calculated by treating the Engine Fins as a flat plate; therefore two Engine Fins surfaces have the varying heat transfer coefficient.

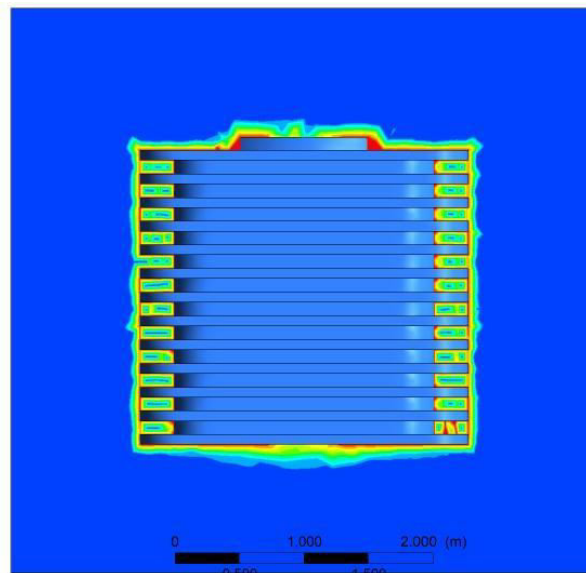
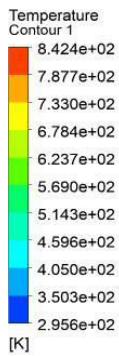


1. CONTOUR FLOW ANALYSIS:

TEMPERATURE

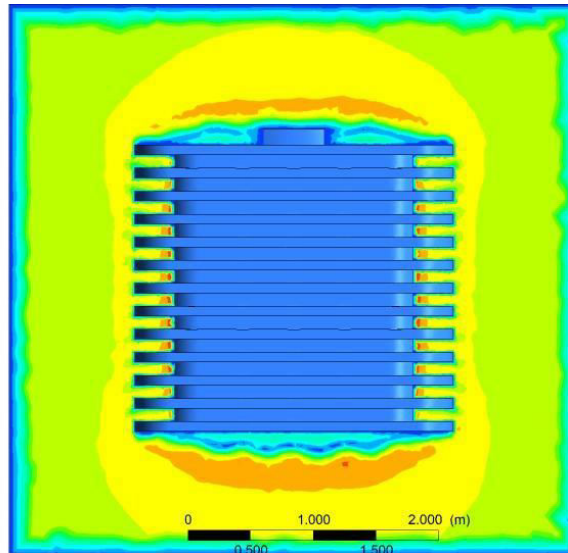
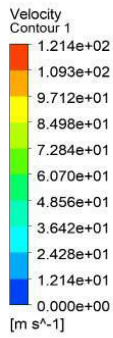


Contour temperature of flow analysis in circle cut fins

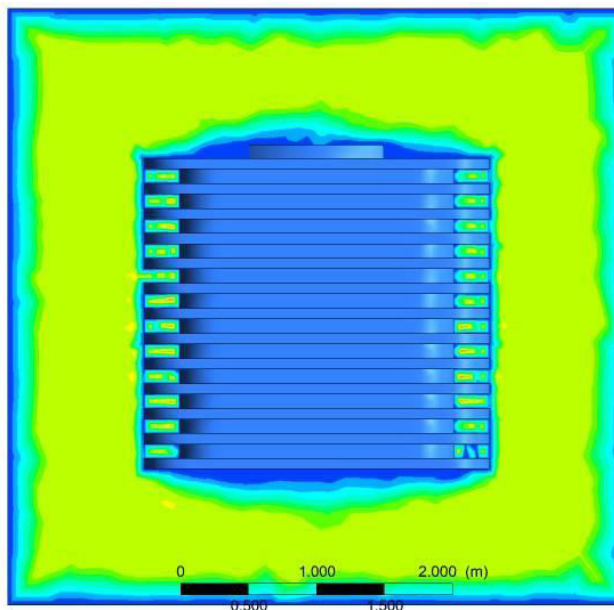
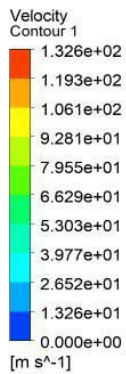


Contour temperature of flow analysis in no circle fin

**VELOCITY**



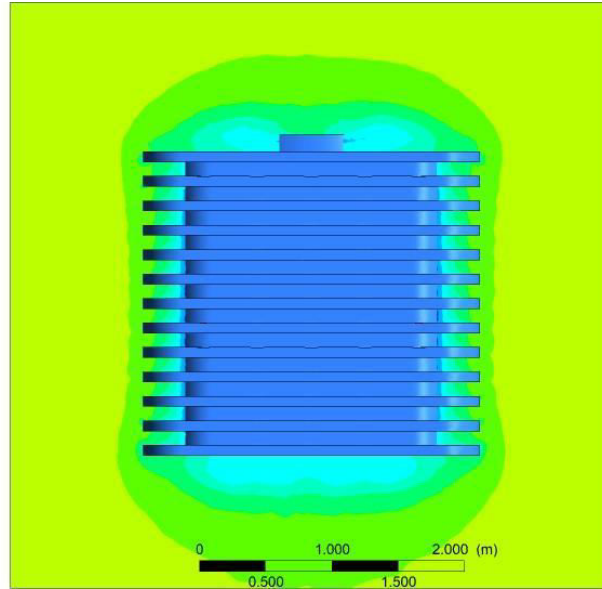
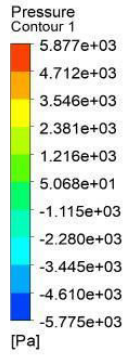
Contour velocity of flow analysis in circle cut fins



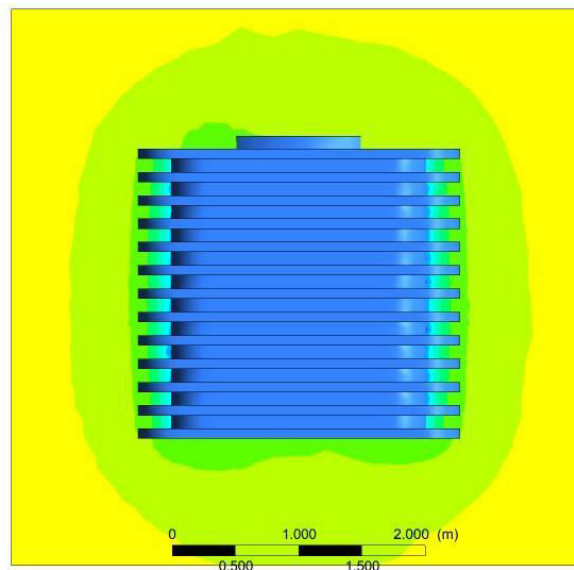
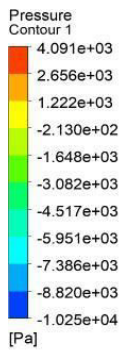
Contour velocity of flow analysis in no circle fins



**PRESSURE**



Contour pressure of flow analysis in circle cut fins

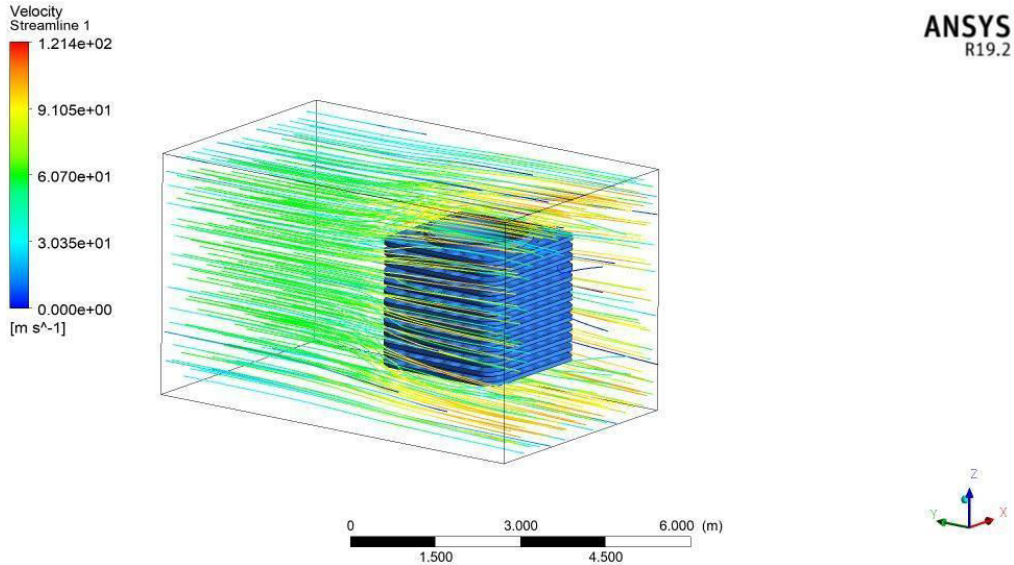


Contour pressure of flow analysis in no circle fins

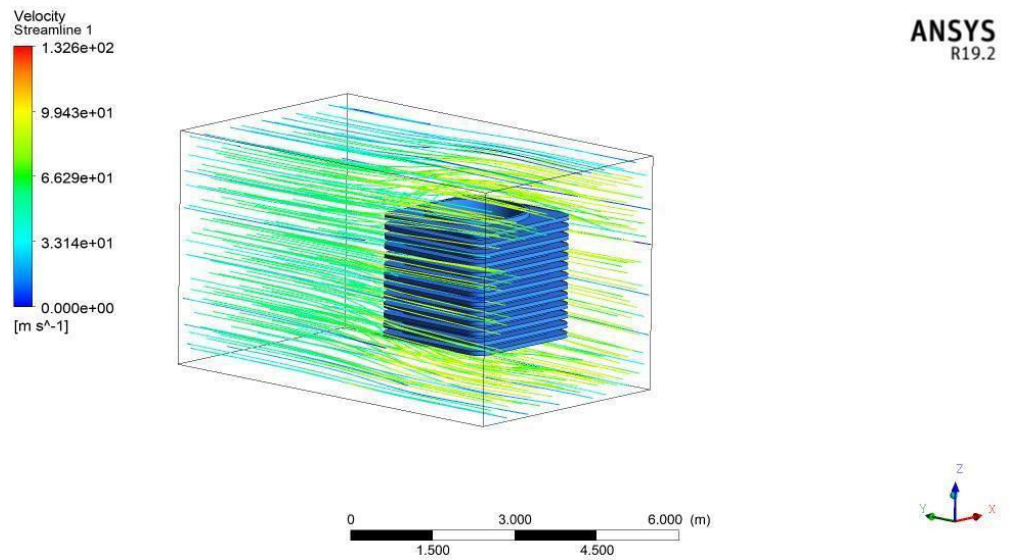


**2. STREAMLINE FLOW ANALYSIS:**

**VELOCITY**



Streamline velocity flow analysis in circle cut fins



Streamline velocity flow analysis in no circle fins

**RESULT**

After simulation was done, we found deviation in theoretically calculated value and simulated result.

**CIRCLE CUT FINS**

ANSYS value of heat flux = 31177 w/m<sup>2</sup> Obtained  
 value of heat flux = 28350 w/m<sup>2</sup> So,

$$\text{Percentage Error} = \frac{\text{Actual value} - \text{Obtained value}}{\text{Actual value}}$$

$$= \frac{31177 - 28350}{31177}$$





Percentage Error = 9.06%

#### NO CIRCLE FINS

ANSYS value of heat flux = 26704 w/m<sup>2</sup> Obtained  
value of heat flux = 22087 w/m<sup>2</sup> So,

$$\begin{aligned} \text{Percentage Error} &= \frac{\text{Actual value} - \text{Obtained value}}{\text{Actual value}} \\ &= \frac{26704 - 22087}{26704} \end{aligned}$$

Percentage Error = 17.28%

#### V. CONCLUSION

Analysis of heat transfer through fins of engine was done. There was 9.06% error while calculating results which might have occurred due to various factors. Temperature distribution of cylinder and fins, heat flux through walls was observed with the help of ANSYS R19.2. Generally Heat transfer rate in conduction is directly proportional to thermal conductivity. Grey cast iron has low thermal conductivity hence the heat transfer rate is comparatively very low, considering other metals cast iron can withstand high temperatures & the cost is less compared. So it is mainly used in I. C Engine cylinder.

#### REFERENCES

1. K. Sathishkumar, K. Vignesh, N. Ugesh, P. B. Sanjeevaprathap, S. Balamurugan, "Computational Analysis of Heat Transfer through Fins with Different Types of Notches", International Journal of Advanced Engineering Research and Science, ISSN: 2349-6495(P) | 2456-1908(O), Vol-4, Issue-2, Feb- 2017.
2. Ajay Sonkar, Ishwar Singh Rajput, Jageshwar Dhruv, Kishore Kumar Sahu, "Comparative Thermal Analysis of Fin of I.C. Engine with Extensions", International Journal of Engineering Research & Technology, ISSN: 2278-0181, Vol. 6 Issue 04, April-2017.
3. G. Angel, N. Sambasiva Rao, "Design and Analysis of Two Wheeler Cooling Fins", International Journal of Engineering Science and Computing, Volume 6 Issue No. 9, September 2016.
4. Deepak Gupta, Wankhade S.R., "Design and Analysis of Cooling Fins", International Journal on Mechanical Engineering and Robotics, ISSN (Print): 2321- 5747, Volume-3, Issue-2, year-2015.
5. Harish P, Ramakrishna Reddy B, Optimization of Engine Cylinder Fins of Varying Geometry and Material". International Journal of Innovative Research in Advanced Engineering, 1(2), 2014.
6. K.A. Rajput, A review on effect of perforation and carbon nanotubes coating on heat transfer augmentation, Maharashtra, India, February, 2014.



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