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Design and Thermal Analysis of Fins for Air Cooled Engine by Varying its Geometry

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Abstract

An air-cooled motorcycle engine releases heat to the atmosphere through the mode of convection to facilitate this, fins are provided on the outer surface of the cylinder. The cooling fins allow the wind to move the heat away from the engine. The heat transfer rate depends upon the velocity of the vehicle, fin geometry and the ambient temperature. Low rate of heat transfer through fins is the main problem of air cooling system. Insufficient removal of heat from engine will lead to high thermal stresses. Engine life and effectiveness of fins can be improved with effective cooling. The main aim of the project is to study the existing design of 150CC motorcycle fins and analyse the heat transfer using different geometry of fins and analyse effects on rate of heat dissipation from fins surfaces. Parametric models of fin block will develop to predict the transient thermal behaviour. The models will create by varying the geometry. Creo parametric is use for modelling. ANSYS Workbench is use for analysis. At last these software based results will compare with analytical results for validation.

Keyword: *Fin, Heat transfer, Internal Combustion Engine.*

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INTRODUCTION

Introduction of Engine Fin

Fin is a solid extended surface protruding from a surface or body and they are meant for increasing the heat transfer rate between the surface and the surrounding fluid by increasing heat transfer area. Heat is transferred by conduction within the solid and by convection from the fin surface in a perpendicular direction to that of conduction. Finally, heat is lost to the surroundings.

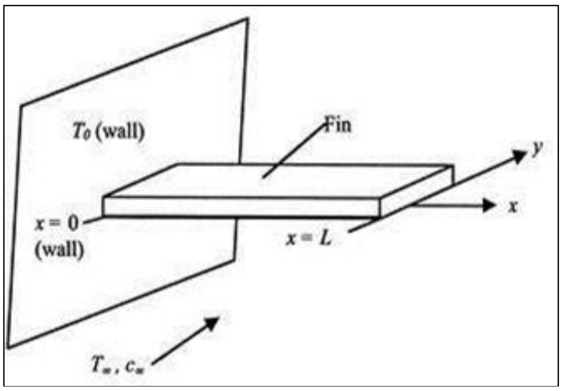


Figure 1: Geometry of Heat Transfer Fin

Purpose of a Fin

Fins increase the rate of heat transfer by increasing the surface area without increase of primary surface area. This increased surface area reduces the convective resistance and increases the rate of heat transfer economically. The fins should have large surface area per unit volume with air passages with natural laminar flow for increased rate of heat transfer. It increases the heat exchange finned cylinder block (figure 1).

To increase heat transfer by increasing the surface area without increase of primary surface area. FIN involves both (conductive + convective) heat transfer. Finally it loses heat to the atmosphere (figure 2 and figure 3).

Different Types of Fin:

Fins can be broadly classified as:

- Longitudinal fin
- Radial fin
- Pin fin

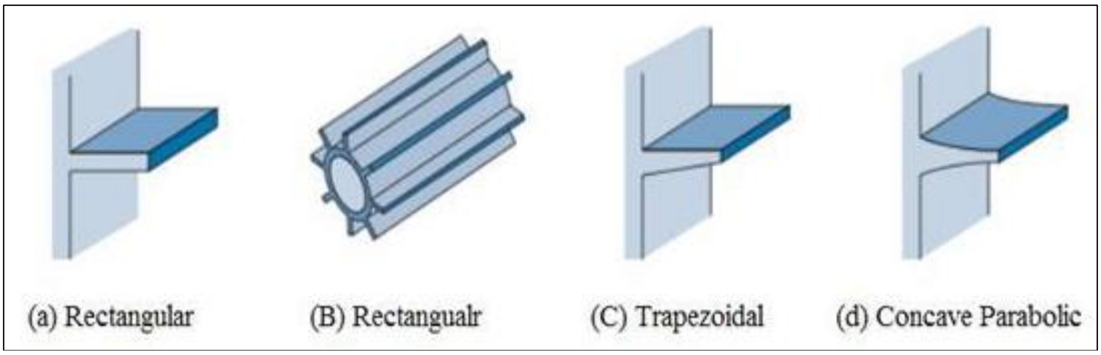


Figure 2: Longitudinal Fin with Various Profile

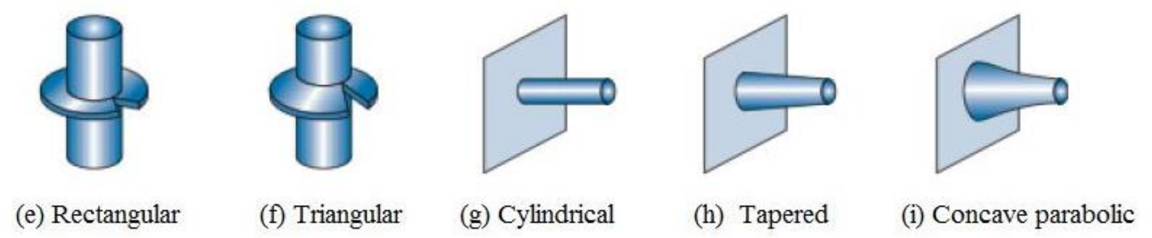


Figure 3: Radial & Pin Fin with Various Profile

Mode of Heat Transfer:

Three modes of heat transfer are there:

(1) Conduction
(2) Convection
(3) Radiation

Conduction:

Conduction is a mechanism of heat transfer takes place due to a temperature difference in body or between bodies in thermal contact, without mixing of mass. The rate of heat transfer through conduction is governed by the Fourier's law of heat conduction.

Q = -kA(dT/dx), where k = Thermal Conductivity
A = Cross Section Area
dT/dx = Temperature Gradient

Convection:

Convection is a process of energy transport affected by the circulation or mixing of a fluid medium. The rate of convective heat transfer is governed by the Newton's law of cooling.

Q = hA(Ts-T∞), where h = Co-efficient of convective heat transfer
A = Surface Area
Ts & T∞ = Surface and ambient temperature

Radiation:

Radiation is the transmission of heat in the form of radiant energy or wave motion from one body to another across intervening space. The rate of heat radiation that can be emitted by a surface at a thermodynamic temperature is based on Stefan-Boltzmann law.

Q = σAT^4, where σ = Stefan-Boltzmann constant T = Temperature
A = Area

Application of Fin:

1) Air cooled cylinders of aircraft engines, I.C. engines and air compressor
2) Refrigeration condenser tubes
3) Reciprocating air compressors
4) Semiconductor devices
5) Automobile radiator
6) Economizers for steam power plants
7) Electrical transformers and motors
8) Cooling coils and condenser coils in refrigerators and air conditioners (table 1)

Comparison of air and liquid cooling system:

Table 1: Air Cooling V_S Water Cooling System

Air Cooling system	**Water cooling system**
Due to direct transfer of heat from engine to air, no water jacket, radiator and water pump are required. Therefore weight is reduced.	Need for pump and radiator increases weight and air resistance of vehicle.
Engine is smaller in size and its design much simpler.	Engine has larger dimensions and its design is more complex.

Warm-up performance of air-cooled engine is better. This results in low wear to cylinders.	Warm-up performance is poor and results in greater cylinder wear.
Air cooling cannot be employed for low specific output engines due to complex nature of fins required.	Since heat transfer coefficient of water is about 350 times that of air, water cooling can be used for high specific output engines.
Air cooled engine is less sensitive to climatic conditions. Anti-freeze solution is not needed.	Engine performance is more sensitive to climatic conditions. Cold weather starting requires use of anti-freeze solutions.

Literature review

Ertan Buyruk et al. [3] conducted study on Enhancement of Heat Transfer for Plate Fin Heat Exchangers. In this paper, heat transfer and pressure drop for a rectangular fins with different fin types of inner zigzag-flat-outer zigzag (B-type) and outer zigzag-flat-outer zigzag (C-type) and with various fin angles of 30° and 90° for 2mm height and 10mm length offset from the horizontal direction. For value of Reynolds no. is 400, the pressure drop is analysed, that shows value of high pressure drop is obtained for 30° fin angle than 90° angle. Nusselt number is increases with the Reynolds number. That paper have the goal to increase the efficiency of plate fin heat exchangers by optimizing fin types, fin angles, fin intervals and fin heights, offsetting fins along the horizontal direction for a channel having 30° angle.

M. Anish et al. [2] conducted study on Experimental Investigation and Heat Transfer Process. In paper, they were studied about the different notch configuration. The arrangement of Fin finds wide applications in heat transfer studies. The key factor is the fin geometry which is much significant in the fin arrays. Here three type of fin case were studied, 1. Fin with triangular notch 2.fin with circular notch & 3. Fin without notch. By the experiment, it has been understood that the rate of heat transfer is increased by having a circular notch at the Centre of fin when compared with triangular and without notch.

Marcelo Moreira Ganzarolli et al. [3] conducted study on Optimum Fins Spacing and Thickness of a Finned Heat Exchanger Plate. In paper, thermal design of a heat exchanger using air as the working fluid was performed with aims; minimum inlet temperature difference and minimum number of entropy generation units. According to calculation, it observed that desired minimum, either dT or Ns was attained very smoothly with the fin thickness and more sharply with the fin spacing. It was concluded, the design based on minimum *Ns* indicated optimum values for thicker fins and larger spacing, due to larger fin spacing, reducing materials & manufacturing costs.

Vladimir Glazar et al. [4] conducted study on Numerical Study of Heat Transfer. In this paper an analysis of laminar heat transfer and fluid flow in a wavy fin-and-tube heat exchanger has been carried out. It calculated velocity vectors, temperature fields, and heat transfer coefficients in the boundary layer, as well as pressure drops. The effect of inlet air velocity, as well as fin pitch on heat transfer characteristics has been studied numerically. In cases when resulting optimal fin pitches tend to small values, related pressure drops become economically for practical applications due to increased energy demands. It can be concluded that presented work could provide guidelines for thermal performance and design optimization of a wavy fin-and-tube heat exchanger. It also conclude wavy angle α is 15 to16 for optimal heat transfer.

Deepak Gupta et al. [5] conducted study on Design and Analysis of Cooling Fins. In this paper they have studied on 100cc Hero Honda Motorcycle and modelled in parametric 3D modelling software Pro/Engineer. Present used material for fin body is aluminium alloy and internal core with grey cast iron. They were replacing in material with Aluminium alloy 6063 and Grey cast iron separately for entire body. They used circular shape fin in place of rectangle fin. It also is reducing the thickness from 3 mm to 2.5 mm. By varying materials, geometry and thickness, it observed that Aluminium alloy 6063 and thickness of 2.5mm is better, since heat transfer rate is more. It concluded efficiency and effectiveness is also more.

Md. Farhad Ismail et al. [6] conducted study on Numerical Investigation of Turbulent

Heat Convection from Solid and Longitudinally Perforated Rectangular Fins. In paper, they conclude that to improve the cooling performance of heat sink, perforations such as small channels of square and circular cross sections are arranged along with stream wise fin's length. A numerical investigation is conducted for study of three-dimensional fluid flow and convective heat transfer from an array of solid and perforated fins, mounted on a flat plate. Numerical simulation is validated with the published experimental results good agreement is observed. To obtain higher performance from a heat sink, more surface area, less weight, and lower cost are necessary. Generally optimization of fins is focused on to maximize heat dissipation rate and to minimize pressure drop for a given mass or volume of the heat sink .Contact surface of perforated fin is high with comparison of solid fins. Thus the perforated fins have higher efficient than the solid fins.

Long Huang et al. [7] conducted study on Air flow distribution and design optimization of variable geometry. This paper presented optimization studies on variable geometry micro-channel heat exchanger designs to investigate their performance potential. The ever-evolving simulation and manufacturing capabilities have given engineers new opportunities in pursuing complex and cost-efficient novel heat exchanger designs. The aim of this new concept is heat transfer enhancement, material savings and fulfilling special design and application requirements. The optimization study shows a 35 per cent reduction in material and 43 per cent savings in envelope volume for a variable geometry for the same performance.

C. Zamfirescu et al. [8] conducted study on Cascaded Fins for Heat Transfer Enhancement. In paper, new design concept of fin was studied in detail. Here fin made in two materials are copper & aluminium. It is sufficient to consider the most basic case of one-dimensional heat conduction through rectangular-triangular, rectangular-rectangular and rectangular-parabolic cascaded fin. Here, three basic configurations of cascaded fins made from two materials. The base portion of fin is made with the highest thermal conductivity material, it is called first material. At the fin's tip are considered three profiles (rectangular, triangular and parabolic) made in a different material which thermal conductivity is lower. Therefore it was conclude that cascaded fins with rectangular-triangular structure are the most interesting practical solution among the three cases analysed.

S. W. Chang [9] conducted study on Detailed Heat Transfer Measurements of Curved Fin Channels. In paper, they studied on Nusselt number (Nu) distributions over six fin surfaces are presented for two sets of curved fin channels with twin- and single-flow exits. This study investigates the impacts of L/D ratio on local and spatially averaged heat transfers in a selected curved fin channel with its cross-sectional shape specified by AVC International Ltd. Heat transfer tests are performed for three curved fin channels of L/D ratios of 9.8, 16.2, and 22.5 with twin and single exist. The Nu values over curve fin surface decreases with the increase of L/D ratio but increases with the increase of Re. Better cooling performance in the curved fin channel with twin exits in the short fin channel (L/D = 9.8) as a result of high heat transfer over the entire curved fin channel.

R. Chakraborty et al. [10] conducted study on Thermal Analysis of Semi-circular Fins. In present paper, the non-linear differential equation of semi-circular fin model has been solved using finite-difference method using MATLAB software. It observed various conditions such as increase size of fin or increases the number of fin. By calculations & experimentally it concluded, the results grossly indicate that a larger fin number is desirable for higher efficiency of semi-circular fin.

Pardeep Singh et al. [11] conducted study on Design and Analysis for Heat Transfer through Fin with Extensions. In this research, the heat transfer performance of fin is analysed by design of fin with various extensions. Fin with various

extensions design with the help of software AutoCAD. Analysis of fin performance done through the software Autodesk simulation multi physics. Types of extension provided on fin such as
(a) Rectangular extensions, (b) Trapezium extensions, (c) Triangular extension, and (d) Circular Segmental extension. It was observed that heat transfer through fin with rectangular extensions higher than that of fin with other types of extensions. Near about ranging 5% to 13% more heat transfer can be achieved with these various extensions on fin.

Ching-yu Yang et al. [12] conducted study on Design of a Longitudinal Cooling Fin with Minimum Volume by a Modified Newton–Raphson Method. In this paper, the minimal volume of nonlinear longitudinal cooling fin design problem by using a modified Newton–Raphson method is presented. The profile of the fin is built by B-spline curve in which the control points of the B-spline curve are regarded as optimization variables. In this section, four cases with the various boundary conditions and thermal properties of the longitudinal fin are adopted to illustrate the proposed method. The optimal results are compared to the Schmidt and Azarkish results. It is concluded that the B-spline with the second degree and three control points could be used enough to find the minimum volume of the longitudinal fin for the linear and nonlinear fin design problems. The modified Newton–Raphson method is an efficient and accurate method in finding the minimum volume of the nonlinear longitudinal cooling fin design problem.

M.G. Sobamowo[13] conducted study on Analysis of Convective Longitudinal Fin with Temperature-Dependent Thermal Conductivity. In this study, finite difference method is used for analysis of heat transfer in a longitudinal rectangular fin with temperature dependent thermal conductivity and internal heat generation. It obtains solution of the problem using MATLAB software. The numerical solution was validated with the exact solution for the linear problem. It shows that fin temperature distribution, total heat transfer, and fin efficiency are significantly affected by the thermo-geometric parameters of the fin. Also, for the stable solution, the fin thermo-geometric parameter must not exceed a specific value. The result was validated with other previous results from other research paper.

M. Yaghoubi et al. [14] conducted study on An Investigation of Natural Convection Heat Transfer from a Horizontal Cooled Finned Tube. In paper, Radiation and Natural convection heat transfer from a cold horizontal compact finned tube is studied experimentally and numerically. For experiments, temperature of surrounding air is varied results show that cold air starts from the upper point and moves downward and that convective heat transfer is higher than radiation. For a low spacing in between fin, flow of wind in between fins is very limited, and it makes a fin have an almost uniform temperature. For cold finned tubes, Nusselt number is slightly greater than that of a hot finned tube.

Raseelo j moitsheki et al. [15] conducted study on Transient heat transfer in longitudinal fins of various profiles. The transient heat transfer in a longitudinal fin of various profiles was studied. The effects of realistic fin parameters such as the thermo geometric fin parameter and the exponent of the heat transfer coefficient on the temperature distribution are studied. The thermo geometric fin parameter also increases when the Biot number is increased. This may be practical in a confined region where the length of the fin cannot be increased. They can thus deduce that the influence of the thermo geometric parameter and the exponent n is very likely related to thermal instability; in our case this was observed for the triangular and concave profiles.

Somayyeh Sadri et al. [16] conducted study on Efficiency analysis of straight fin with variable heat transfer coefficient and thermal conductivity. In this study, differential transformation method (DTM) is used to obtain the efficiency and behaviour of a straight fin with variable thermal conductivity and heat transfer coefficient. DTM is used for solving non-linear equation. Results were finding for various cases such as: condensation or laminar film boiling, forced convection, laminar and turbulent natural convection, nucleate boiling, and radiation. The evaluate results from DTM are compared with the numerical solution to verify the accuracy of this proposed method. They observed the effect of the modes of heat transfer on fin efficiency. It concludes that for radiation heat transfer, thermal efficiency reaches its maximum value.

N. Senthil kumar et al. [17] conducted study on Modification and Analysis of Compressor Intercooler Fin. The main objective of this work is to increase the amount of heat transfer from the hot air when it passed through the intercooler. The best design for maximum heat transfer is chosen by three parameters such as fin material, shape of fin and thickness of pipe using Taguchi's Design of Experiments (DOE). ANSYS software was used for the finite element analysis. A validation analysis is performed with the optimum control parameters. Design of experiment is a statistical technique, used to study many factor simultaneously and most economically, in which best combination factor can be determined.

Seiyed E. Ghasemi et al. [18] conducted study on Thermal Analysis of Convective Fin with Temperature-Dependent Thermal Conductivity. In this paper, Differential transformation is used for solving the non-linear distribution equation in a longitudinal fin. Two main cases are consider to solve problem, first case is heat generation is variable and second case is heat generation and also thermal conductivity are variable .DTM is very effective and convenient compared to numerical method. In paper they found that the local fin temperature increases as the parameters G, εg, and εc increase. The increase in parameter εg implies that the heat generation is increased and hence it causes to produce a higher temperature in the fin. An increase in εc means the thermal conductivity of the fin is increased and it makes more heat conducting through the fin and local temperature will increase.

Federico Brusiani et al. [19] conducted study on Definition of A CFD Methodology. On the basis of the operating cooling fluid, internal combustion engine cooling systems can be classified in two areas: air cooling system and liquid-cooling system. To assure the necessary heat waste in air-cooled engines, the key point is the optimization of the air flow over the cylinder external surface. Air flow separation from cylinder external surface can result in high temperature gradients inside the cylinder volume causing destructive heat problem for the engine. It can be avoided only by a fine optimization of the cylinder fin design placed externally to the cylinder surface. In this paper 3D CFD simulation methodology applied on two machine, brush-cutter machine and edge trimmer machine. This work was aimed to defined CFD simulation methodology to evaluate overall thermal behaviour of air-cooled engine. The methodology is reliable as well as it was possible to appreciate the more capability.

Tytus Tolwin[20] conducted study on A Coupled Numerical Heat Transfer in the Transient Multi Cycle CFD Aircraft Engine. The paper discusses the research results on a high power air-cooled aircraft radial engine. The temperature distribution in a reciprocating combustion engine has an impact on its wear and thermal efficiency. The numerical steady state heat transfer model was used to calculate the external surfaces heat transfer coefficient and to develop two transient coupled models - one for the temperature distribution and one for engines transient in-cylinder processes. A temperature distribution was investigated in different model regions. Weak engine cooling may cause adverse effects in terms of cylinder surface tribology and mechanical strength. High temperature hot spots can appear that cause knock combustion. The change of temperature over time is inversely proportional to the change of heat capacity. The Biot number for an engine head and cylinder does not exceed the value of 0.1. The use of a complex coupled engine model requires more model preparation time and computational time.

Deep N. Patel et al. [21] conducted study on Fin Analysis for Heat Transfer Rate Augmentation of Air Cooled IC Engine. Heat dissipation is one of the most important considerations in engine design. Engine life and effectiveness can be improved with effective cooling. The cooling fins allow the wind or air to move the heat away from the engine. Low rate of heat transfer through cooling fins is the main problem in this type of cooling. To perform the study, virtual simulation by CFD approach is proposed. Here's the obtained surface heat transfer coefficient at the different wind velocity is validated with the experimental data derived by Yoshida et al and Thornhill et al. By comparing simulation result with experimental data for surface heat transfer co-efficient, it is clearly observed that the results are found to be in close agreement with their finding (Figure 4 and figure 5)

Air cooled Engine Block:

Figure 4: 150 CC Engine Block

Material of Fin:

- Aluminum alloy A356 main feature for its popularity is its less weight, low density, this reduce the weight of the engine as well as in the engine (table 2).
- The material have good machinability and also, able to absorb the vibration energy. Chemical composition:

Existing Engine Fin Data:

Table 2 Data Collection.

Engine Capacity	**150 CC**
Thermal Conductivity of Al alloy	200 W/mk
Convective heat transfer coefficient	230 W/m k
Width of Fin	155 mm
Thickness of Fin	3 mm
Fin Pitch	9 mm
Numbers of Fin	6

Modelling of Existing Air Cooled Block:

Existing air cooled block is modelled in cero parametric 3.0 (figure 6, 7 and figure 8).

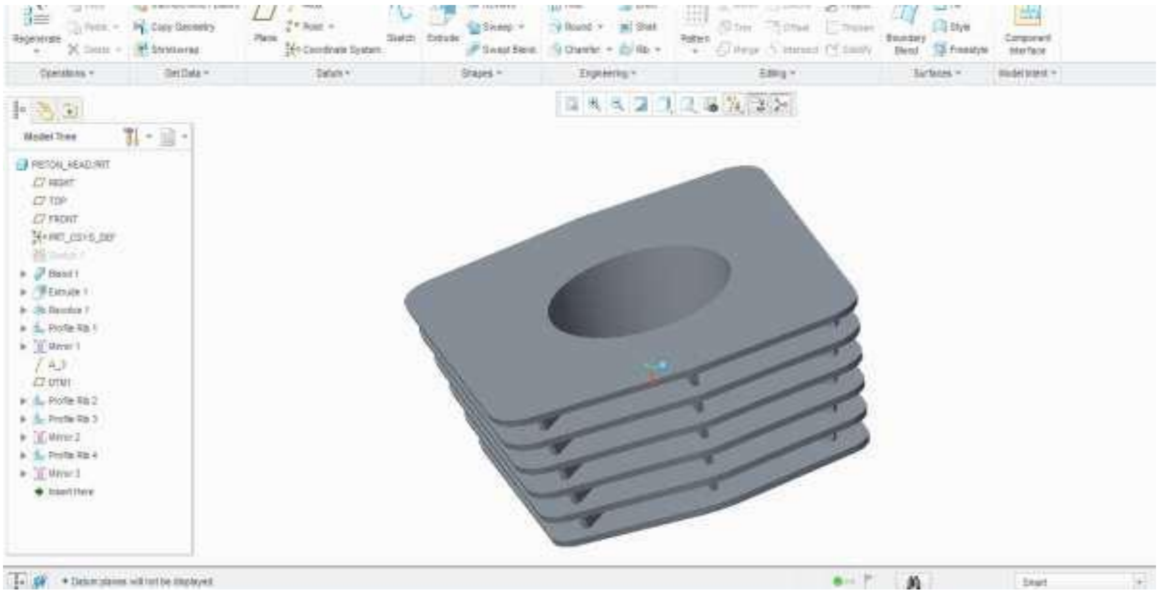
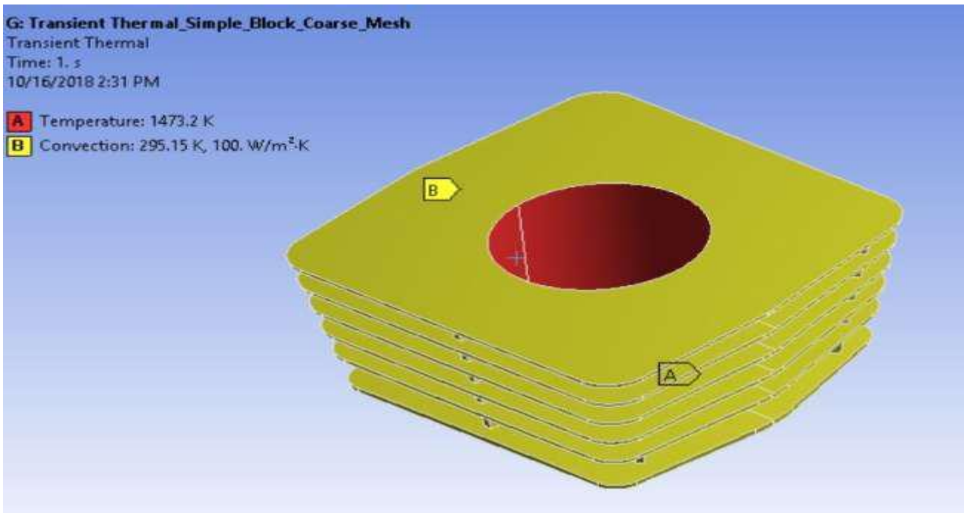


Figure 5: Modelling of Air Cooled Block

Transient Thermal Analysis Results:

a) Transient Thermal

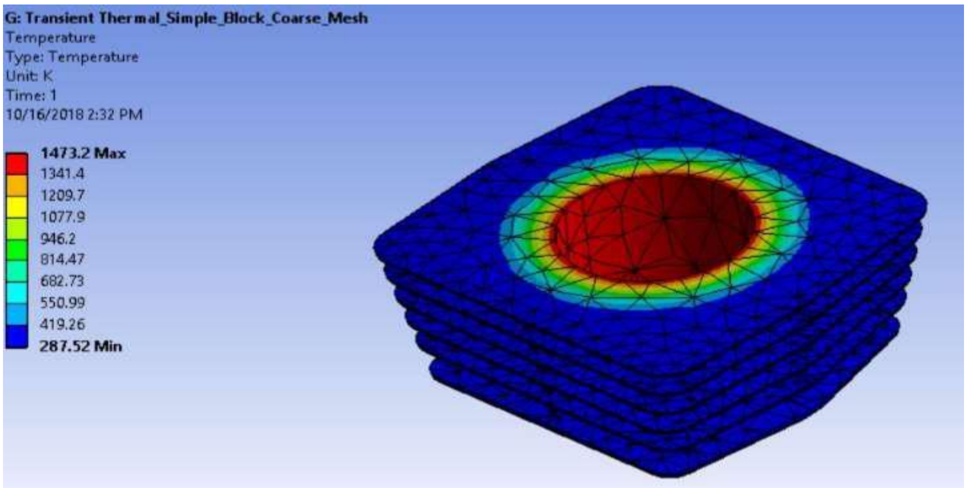


G: Transient Thermal_Simple_Block_Coarse_Mesh
Transient Thermal
Time: 1. s
10/16/2018 2:31 PM

A Temperature: 1473.2 K
B Convection: 295.15 K, 100. W/m²·K

Figure 6: Transient Thermal

b) Temperature Distribution



G: Transient Thermal_Simple_Block_Coarse_Mesh
Temperature
Type: Temperature
Unit: K
Time: 1
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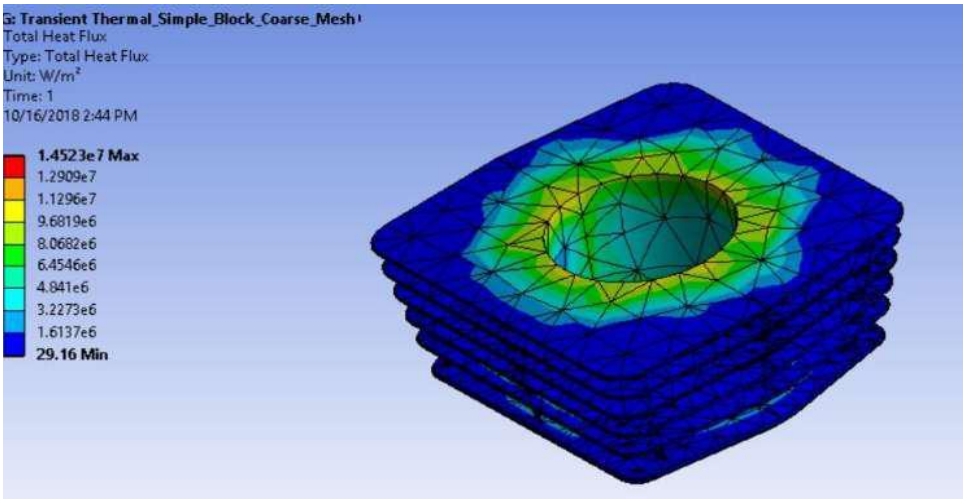
Figure 7: Temperature Distribution

c) Total Heat Flux



G: Transient Thermal_Simple_Block_Coarse_Mesh
Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
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Figure 8: Total Heat Flux

The Obtained result shows the value of total heat flux 1.45 x 10^7 W/m^2 as in fig.

d) Directional Heat Flux

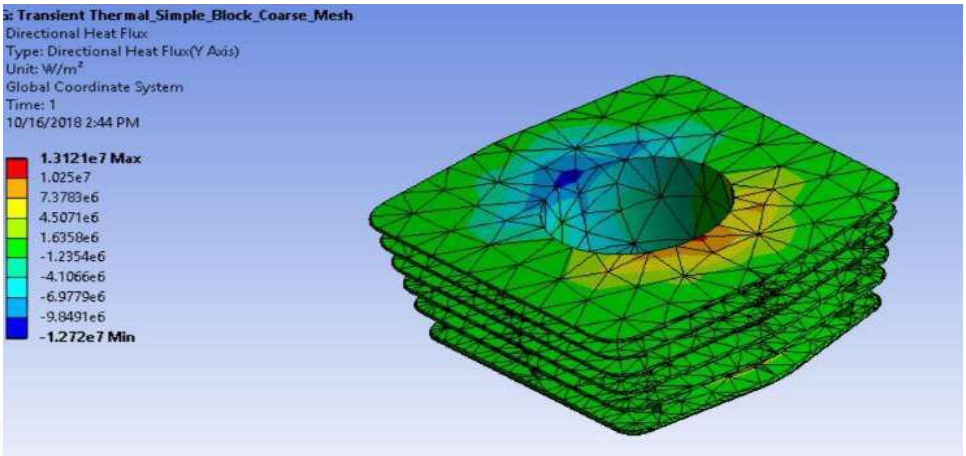


Figure 9: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.31 x 10^7 W/m^2 as in fig 9.

Transient Thermal Analysis Results with Fine Mesh:

a) Temperature Distribution

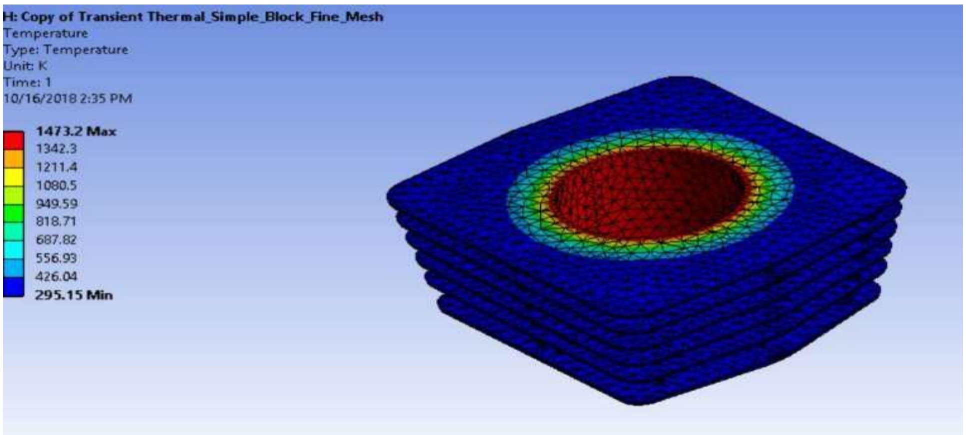


Figure 10: Temperature Distribution

b) Total Heat Flux

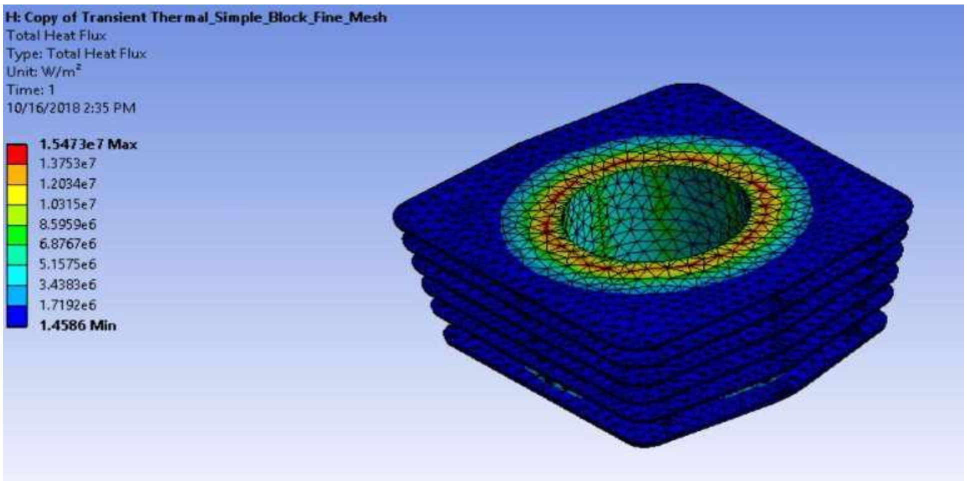
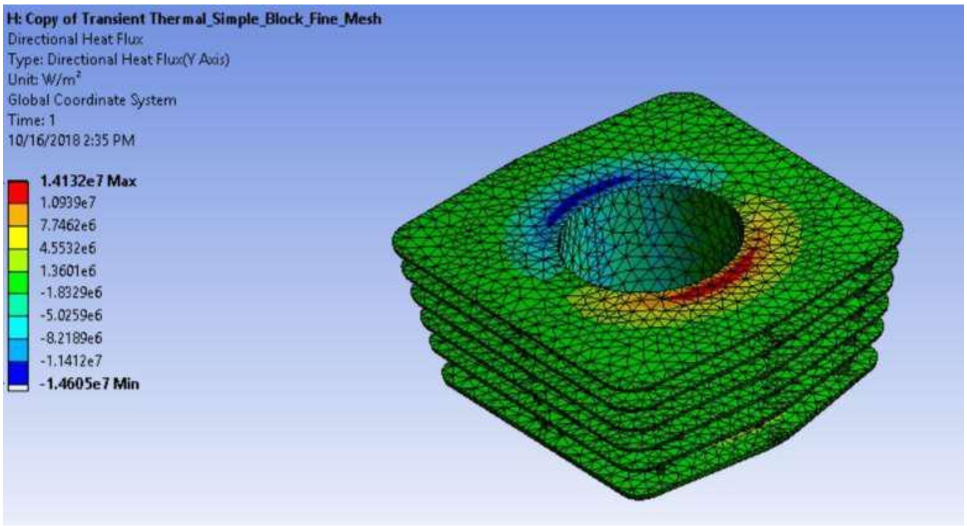


Figure 11: Total Heat Flux

The Obtained result shows the value of total heat flux 1.55 x 10^7 W/m^2 as in fig.11.

c) Directional Heat Flux



H: Copy of Transient Thermal_Simple_Block_Fine_Mesh
Directional Heat Flux
Type: Directional Heat Flux(Y Axis)
Unit: W/m²
Global Coordinate System
Time: 1
10/16/2018 2:35 PM

Figure 12: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.41 x 10^7 W/m^2 as in fig 12.

Modelling of S–Shape Air Cooled Block:

Figure 13: Modelling of S-Shape Air Cooled Block

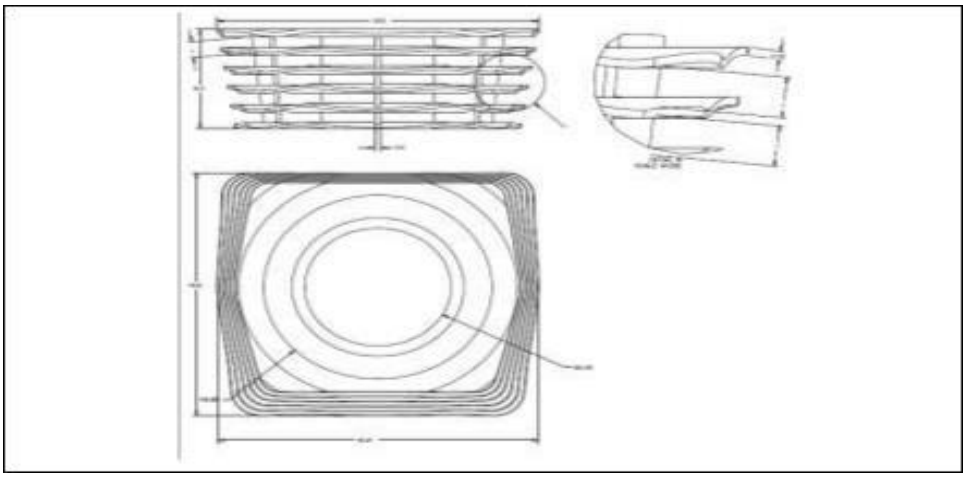
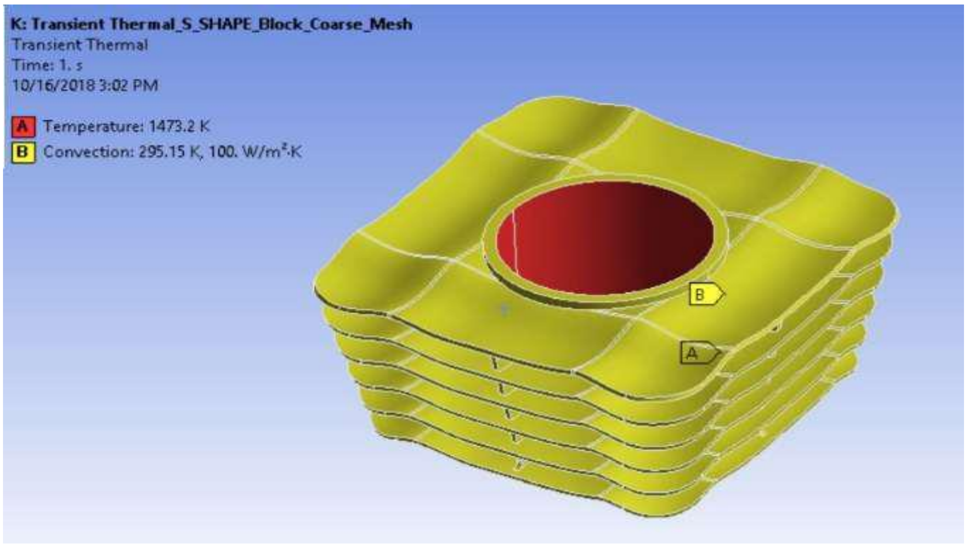


Figure 14: 2D Drawing of S-Shape Fin

Results For S-Shape Fin:

Transient Thermal Analysis Results:

a) Transient Thermal

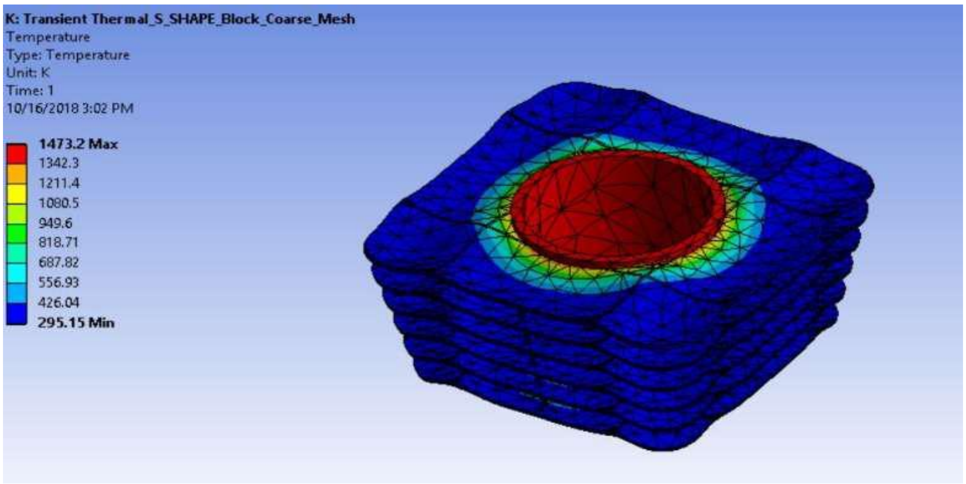


K: Transient Thermal_S_SHAPE_Block_Coarse_Mesh
Transient Thermal
Time: 1. s
10/16/2018 3:02 PM

A Temperature: 1473.2 K
B Convection: 295.15 K, 100. W/m²·K

Figure 15: Transient Thermal.

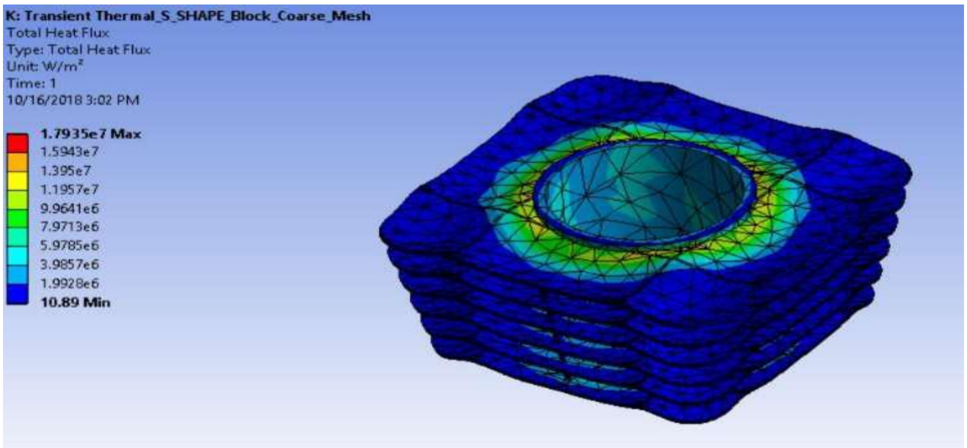
b) Temperature Distribution



K: Transient Thermal_S_SHAPE_Block_Coarse_Mesh
Temperature
Type: Temperature
Unit: K
Time: 1
10/16/2018 3:02 PM

Figure 16: Temperature Distribution.

c) Total Heat Flux



K: Transient Thermal_S_SHAPE_Block_Coarse_Mesh
Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
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Figure 17: Total Heat Flux

The Obtained result shows the value of total heat flux 1.79 x 10^7 W/m^2 as in fig 17.

d) Directional Heat Flux

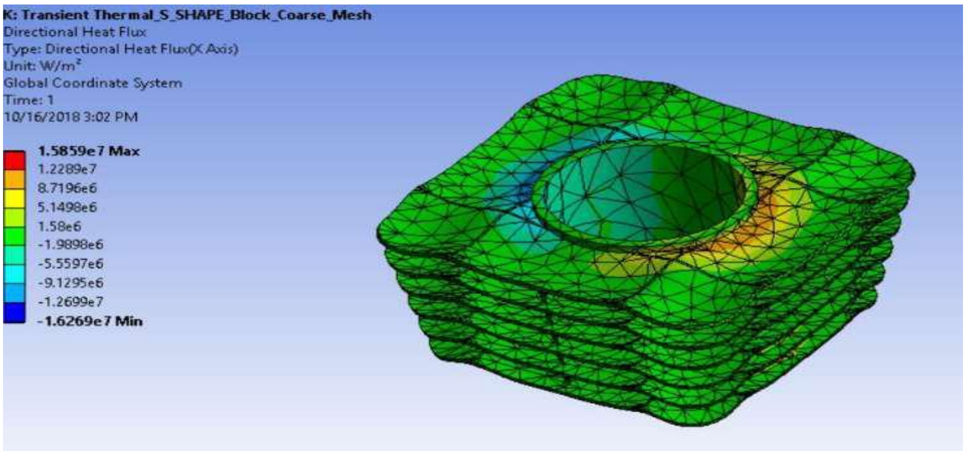


Figure 18: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.58 x 10^7 W/m^2 as in fig 18.

Transient Thermal Analysis Results with Fine Mesh:

a) Temperature Distribution

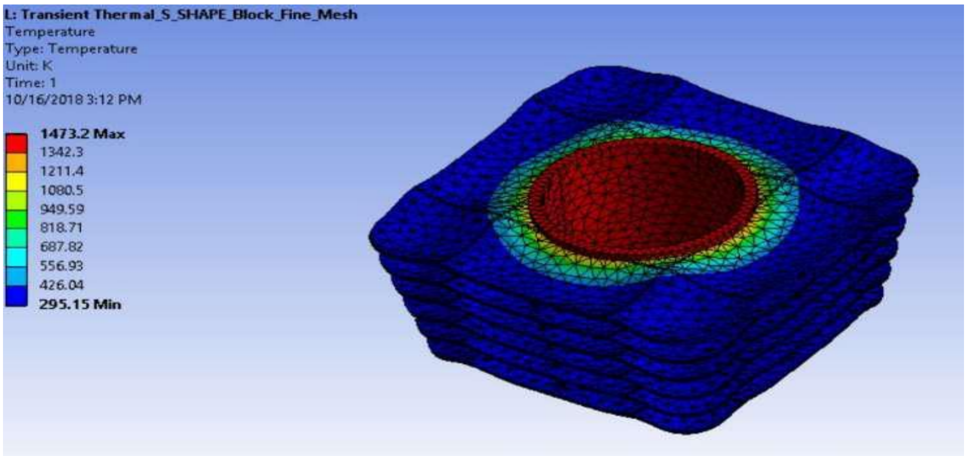


Figure 19:Temperature Distribution

b) Total Heat Flux

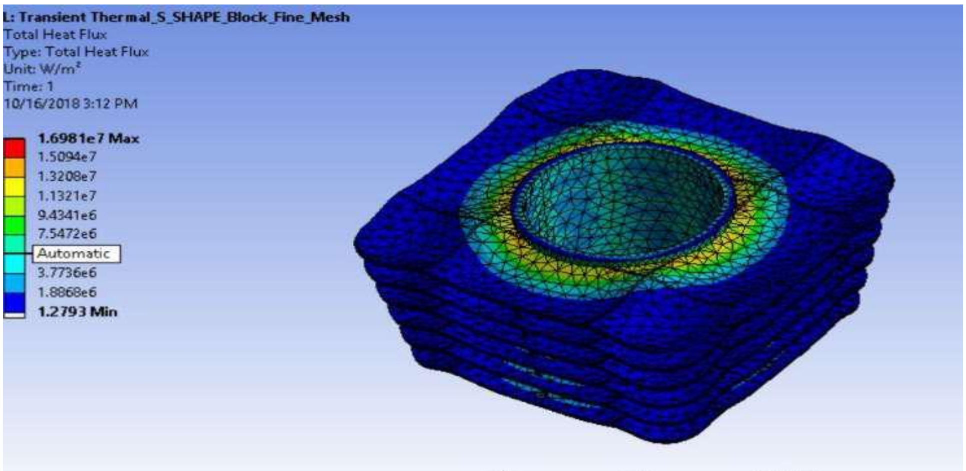
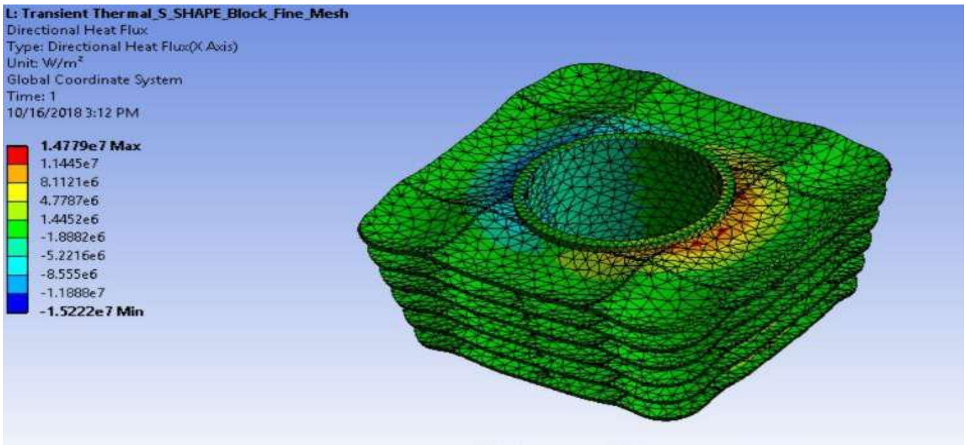


Figure 20: Total Heat Flux

The Obtained result shows the value of total heat flux 1.69 x 10^7 W/m^2 as in fig 20.

c) Directional Heat Flux



L: Transient Thermal_S_SHAPE_Block_Fine_Mesh
Directional Heat Flux
Type: Directional Heat Flux(X Axis)
Unit: W/m²
Global Coordinate System
Time: 1
10/16/2018 3:12 PM

Figure 21: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.47 x 10^7 W/m^2 as in fig 21.

Modelling of Tapper Tip Shape Air Cooled Block:

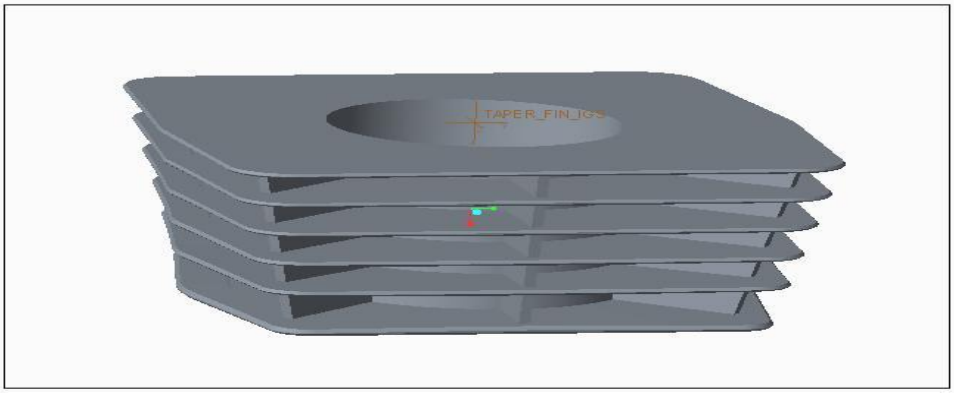
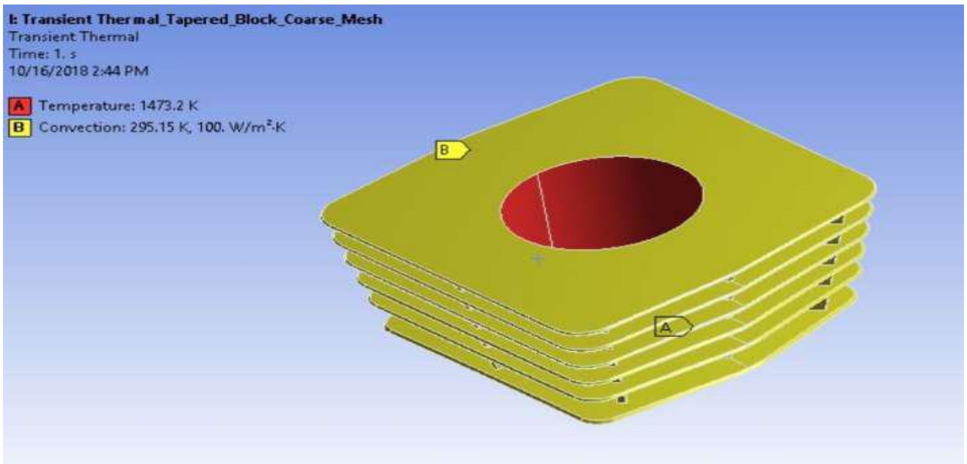


Figure 22: Modelling of Tapper Tip Shape Air Cooled Block

Results For Taper Tip Fin:

Transient Thermal Analysis Results:

a) Transient Thermal



I: Transient Thermal_Tapered_Block_Coarse_Mesh
Transient Thermal
Time: 1. s
10/16/2018 2:44 PM

A Temperature: 1473.2 K
B Convection: 295.15 K, 100. W/m²·K

Figure 23: Transient Thermal

b) Temperature Distribution

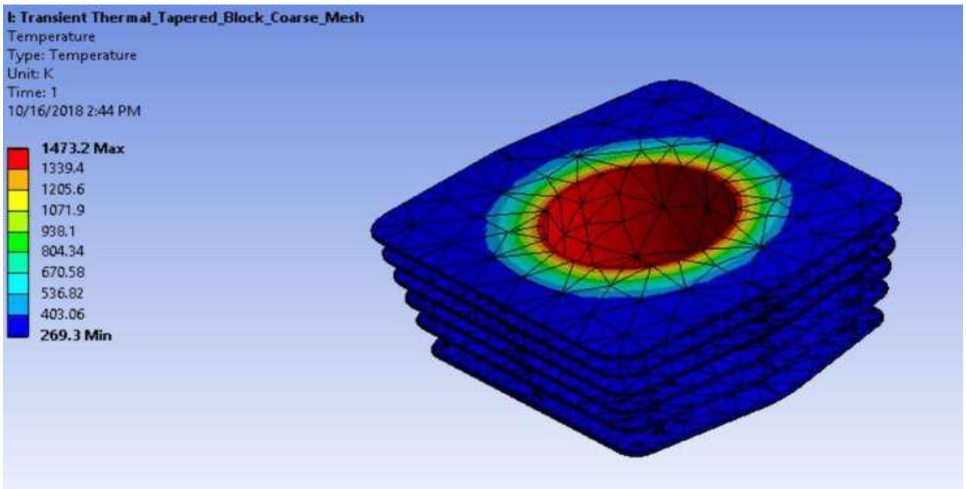


Figure 24: Temperature Distribution

c) Total Heat Flux

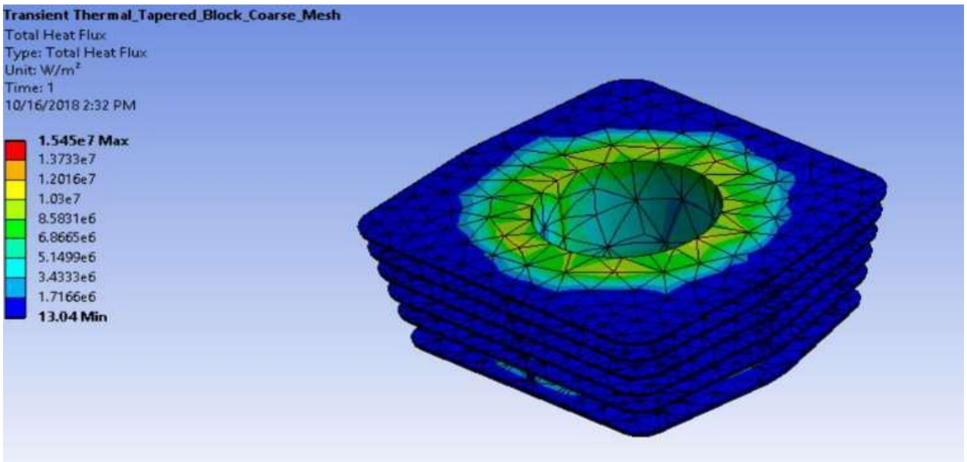


Figure 25: Total Heat Flux

The Obtained result shows the value of total heat flux 1.54 x 10^7 W/m^2 as in fig 25.

d) Directional Heat Flux

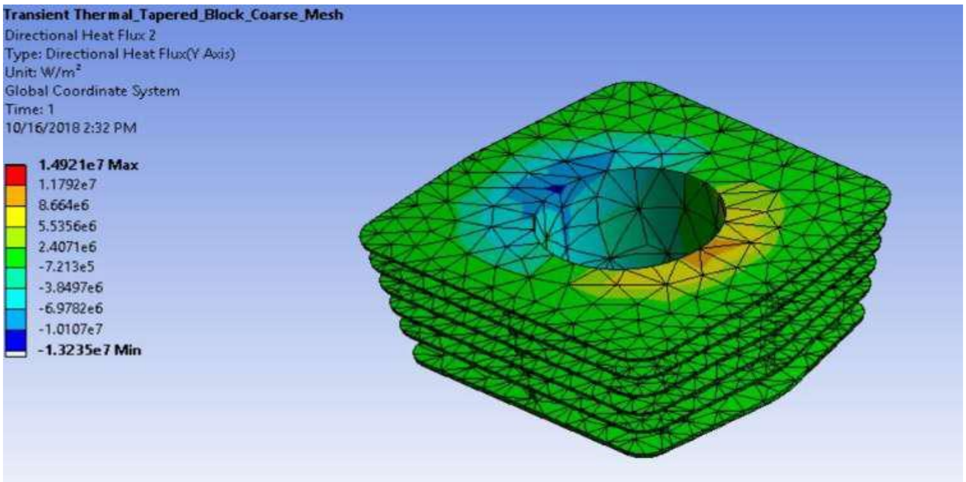


Figure 26: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.49 x 10^7 W/m^2 as in fig 26.

Transient Thermal Analysis Results with Fine Mesh:

a) Temperature Distribution

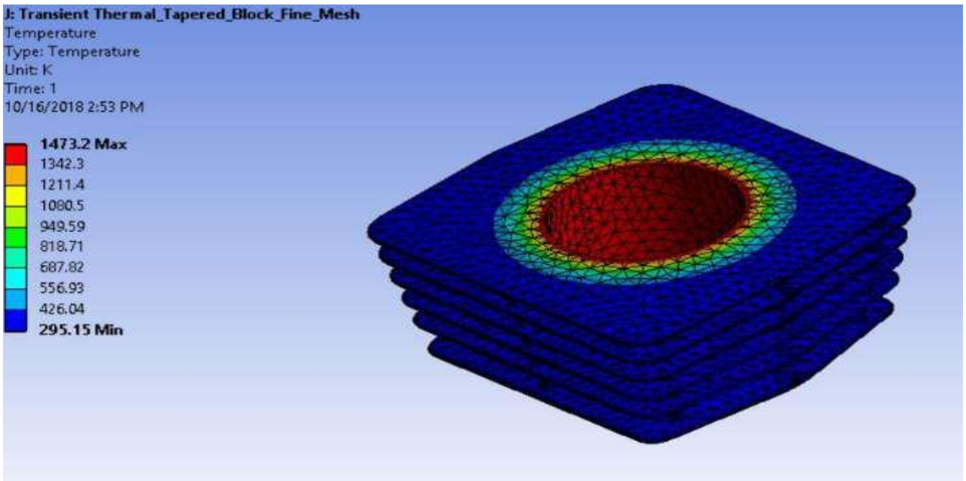


Figure 27: Temperature Distribution

b) Total Heat Flux

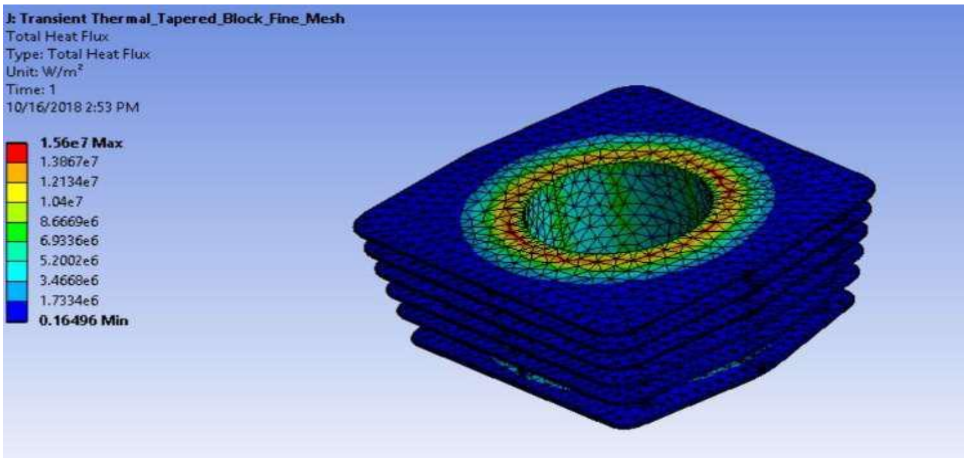


Figure 28: Total Heat Flux

The Obtained result shows the value of total heat flux 1.56 x 10^7 W/m^2 as in fig 28.

c) Directional Heat Flux

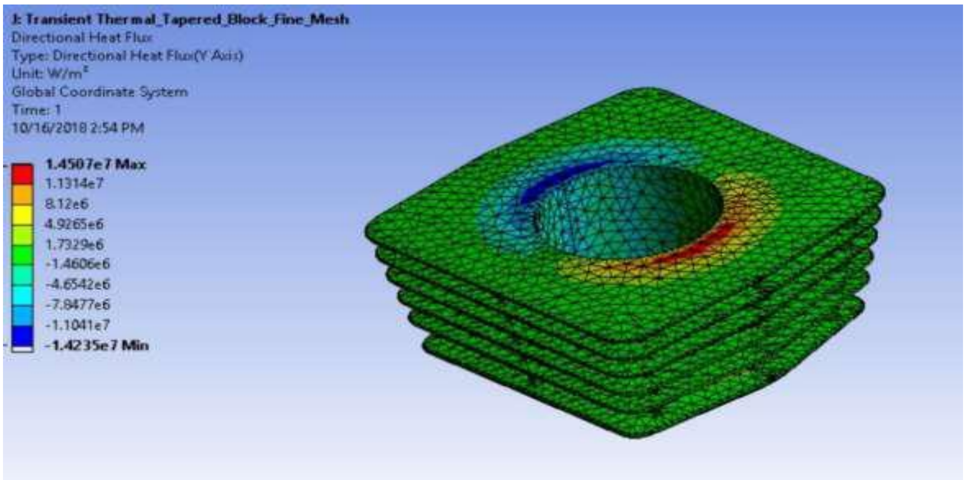


Figure 29: Directional Heat Flux

The Obtained result shows the value of directional heat flux 1.45 x 10^7 W/m^2 as in fig 29

Results and Discussion:

Table 2 Results and Discussion

	Existing Fin	**S-Shape Fin**	**Taper Tip Fin**
Total Heat Flux	1.45 x 10^7 W/m^2	1.79 x 10^7 W/m^2	1.54 x 10^7 W/m^2
Directional Heat Flux	1.31 x 10^7 W/m^2	1.58 x 10^7 W/m^2	1.49 x 10^7 W/m^2
Total Heat Flux with Fine Mesh	1.55 x 10^7 W/m^2	1.69 x 10^7 W/m^2	1.56 x 10^7 W/m^2
Directional Heat Flux with Fine Mesh	1.41 x 10^7 W/m^2	1.47 x 10^7 W/m^2	1.45 x 10^7 W/m^2
Effectiveness	1.88	2.35	2.16
Drag Co-efficient	1.28	1.28	1.14
Drag	High	High	Compare to low
Manufacture of Engine block	Easy	Difficult	Easy

CONCLUSION

In present work, an air cooled block of 150 CC motor cycle engine is modelled and transient thermal analysis is done by using ANSYS. A significant conclusions derived from this work are highlighted below.

- Models for three different shapes of fins i.e. rectangular, taper tip and S-shape were developed and effects of heat transfer and effectiveness of fins are investigated. An Analysis is carried out in ANSYS to find the effect of change in geometry of fins in terms of temperature distribution and heat flux.
- Results obtained by analysis and analytical calculation show that heat flux and effectiveness are increases after changing fin geometry and it is observed that heat flux and effectiveness are more in case of taper tip fins compared to rectangle fins and also more in “S‟ shape fins compared to taper tip fins model.
- The effectiveness of fin increases considerably to the extent of 14.89% in case of taper tip fin and 25% in case of s-shape fin compared to the existing rectangular fin.
- Overall, this study has provide useful information and some insight in respect of increasing fin effectiveness for air cooled engine block by changing it’s geometry.

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