International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

Modelling and Thermal Analysis On Cylinder Fins

G. Ashok kumar[1], K. Yathish [2], B. Prasanna kumar reddy[3], P. Dheeraj kumar[4], A. Harinath[5]

[1,2,3,4] *U.G.Scholar , Sri Venkateswara Institute Of Technology,*
[5] *Assistant professor ,Sri Venkateswara Institute Of Technology, Department Of Mechanical*

Abstract - *The engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim is to analyze the thermal properties by varying geometry and material of fins*

Presently material used for manufacturing cylinder fin body is Aluminium Alloy 204 which has thermal conductivity of 110-150W/mk. In our project, the geometry of the fin i.e. straight fins are replaced with aero-dynamic fins and also replaced with Aluminium Alloy 7075 and Magnesium alloy.
The cylinder block with fins is designed by using UNI-GRAPHICS (NX) software . Thermal analysis is carried by using ANSYS V15.0 software.

The main objective of this project is to present the Thermal analysis which is subjected to high temperature variations on Fins by varying the geometry and materials. Comparison of the temperature distribution and heat flux in both aero dynamic fins and straight fins. Finally obtained optimum temperature distribution, heat flux. We can increases the durability of the engine by increasing the rate of heat transfer.

Key Words: Fin, convection, Thermal conductivity, Aero-Dynamic fins, Heat flux, Uni-Graphics, Ansys

1.Introduction

The Cylinder is the one of the major components in Engine, which is subjected to high temperature variations and thermal stresses. To cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer rate. Fins are Basically Mechanical structures which are used to cool various structures via the process of convection and conduction. Extended fins are well known for enhancing the heat transfer in IC engines. The construction of air cooling system is very simpler. Therefore it is important for an air-cooled engine to utilize the fins effectively to obtain uniform temperature in the Engine cylinder.

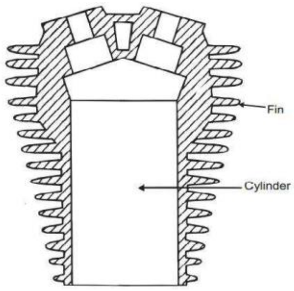


Fig:1

An internal combustion engine is an engine in which the combustion of a fuel takes place in a combustion chamber. Here, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to component of the engine, such as piston, turbine blades, or a nozzle. This force transfers the component over a distance, generating useful mechanical energy. Air cooled engines are replaced by water cooled engines which are more efficient, but all two wheelers uses Air cooled engines, because Air-cooled engines are lighter weight and lesser space requirement.

And after converting the heat to power Excess heat must be removed cycle. The heat is moved to the atmosphere by means of fluids water and air. In engines, heat is moved to the atmosphere by fluids low temperature. Due to combustion process Engine temperature is not consistent throughout the power. If excess heat is not removed, engine components fail due to excessive temperature.

The internal combustion engine is an engine in which the combustion of a fuel (normally a fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine, the expansion of the high temperature and -pressure gases produced by combustion applies direct force to some component of the engine, such as pistons, turbine blades, or a nozzle. This force moves the component over a distance, generating useful mechanical energy.

Heat moves from areas of high temperature to areas of low temperature as shown in below area. In Engine When fuel is oxidized (burned) heat is produced. Additional heat is also generated by friction between the moving parts. Only approximately 30% of the energy released is converted into useful work. The remaining (70%) must be removed from the engine to prevent the parts from melting.

All the heat produced by the combustion of fuel in the engine cylinders is not converted into useful power at the crankshaft. A typical distribution for the fuel energy is given below:

Useful work at the crank shaft	=	25 per cent
Loss to the cylinders walls	=	30 per cent
Loss in exhaust gases	=	35 per cent
Loss in friction	=	10 per cent

It is seen that the quantity of heat given to the cylinder walls is considerable and if this heat is not removed from the cylinders it would result in the pre-ignition of the charge. In addition, the lubricant would also burn away, thereby causing the seizing of the piston. Excess heating will also damage the cylinder material.

Advantages Of Air Cooled Engines

- Its design of air-cooled engine is simple.
- It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
- It is cheaper to manufacture.
- It needs less care and maintenance.

This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where there is scarcity of water as in deserts. No risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.

History Of Fins

Fins are used as heat transfer fins to regulate temperature in heat sinks or radiators. In the study of heat transfer, fins are surfaces that extend the rate of heat transfer to or from the environment by increasing convection. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient or increasing the surface area of the object increases the heat transfer. Adding a fin to an object increases the surface area and can be economical solution to heat transfer problems.

Fins are most commonly used in heat exchanging devices such as radiators for in cars, heat exchangers in power plants etc.,. They are also used in newer technology such as hydrogen fuel cells. Nature has also taken advantage of the phenomena of fins. As the ears of rabbit and fennec foxes act as fins to release the heat from the blood that flows through them.

Usually the purpose and importance of fins as a heat exchangers is to transfer heat from any component which is subjected to temperature which causes damage to it unless it is dissipated. This phenomena was an essential criteria for the origin of Fins as a heat exchanger in Engines, specifically Internal Combustion engines.

Fig: 2

We know that in the generation of power there are high ranged temperatures which can cause the engine to cease and some improper conditions which cause the disaster to the engine. Fins can be of various types and they are used accordingly to their properties and place of usage. Fins of IC engines must have optimistic behavior regarding to the design and manufacturing of an engine. Hence there will be many barriers in selecting the correct fins for the correct component.

"S. Chandra Sekhar, P. Satish Reddy, CH. Chandra Rao" has published a International Journal of sub-title "Structural and Thermal Simulation Of Fins Of An Air Cooled Engine Cylinder Under Varying Speed Conditions" as studied on Engine cylinder is the main component of the automobile which is subjected to high temperature variations and thermal stresses. Fins are basically mechanical structures which are used to cool various structures via the process of convection. The heat transfer rate depends upon the velocity of the vehicle, fin geometry and the ambient temperature. Thermal results are imported in to structural analysis, thermal stresses and deformation results have found using transient couple field analysis.

"A. Satish Kumar, MD. Kathir Kaman, S. Ponsankar, C. Balasuthagar" has published a International Journal of sub-title "Design and Thermal Analysis On Engine Cylinder Fins by Modifying its Material and Geometry" as studied on the thermal properties by varying geometry, material and angle of cylinder fins and the models are created by changing the geometry like rectangular, circular, angular and curved shaped fins. The circular fins increase the efficiency of the engine by reducing the weight of the engine. Also, observed that the engine with curved fins is shown better efficiency due to its less weight.

"D. Merwin Rajesh and K. Suresh Kumar" has published a International Journal of sub-title "Effect Of Heat

Transfer In A Cylindrical Fin Body By Varying Its Geometry And Material", Thermal analysis is done on the fins to determine variation temperature distribution overtime. The material for the original model is changed by taking the consideration of their densities and thermal conductivity. By observing the thermal analysis results, thermal flux is more for Beryllium than other materials and also by reducing the thickness of the fin 2.5mm, the heat transfer rate is increased.

S. Ananth, S. Chaitanya has published a International Journal of sub-title" Mechanical and Thermal Analysis On Engine Cylinder Fin by Changing Material and Geometry" In this present study, the parametric model of cylinder with Trapezoidal fin, Elliptical fin and Triangular fin bodies are created in 3D modeling software Pro/Engineer. Steady state thermal analysis is done on the fins to determine Temperature Distribution, Total Heat flux and Directional Heat flux that are caused by thermal loads that do not vary over time. Analysis is conducted by varying material. By observing the thermal analysis results, Total Heat flux is more for Triangular A356 than other Trapezoidal fin and Elliptical fin by using both the material.

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper.

3Modeling

The modeling is the process of developing a mathematical representation of any surface of an object in three dimensions. The model is creating by using the UNI-GRAPHICS version 10 software.

The solid model is designed based on the following specifications:

The diameter of the cylinder	= 50 mm
The length of the cylinder	= 70 mm
Total No. of fins	= 25 mm
The distance between the fins(PITCH)	= 10 mm
The thickness of the fin	= 3 mm
The length of fin	= 70 mm
The width of the fin	= 20 mm

The creation of parametric solid model of cylinder block with fin s is described in the following steps.

Firstly open the Uni-graphics software v10. Start > NX V10 > New > file name t> click on OK

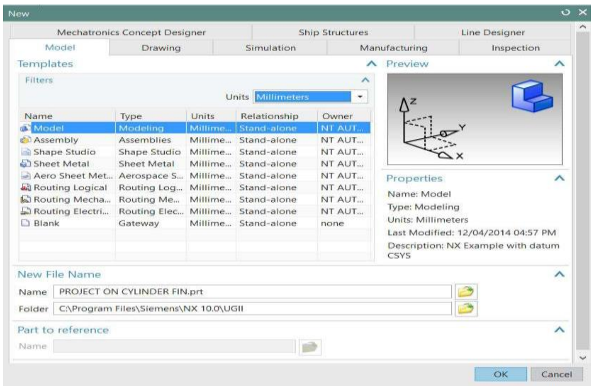


Fig: 3

SKETCHING:

In NX 10 you can create sketch using two ways.

The first method creates the Sketch in the current environment and application Choose Menu →Insert →Sketch

In the other method you can create Sketch using Choose Sketch in Home toolbar

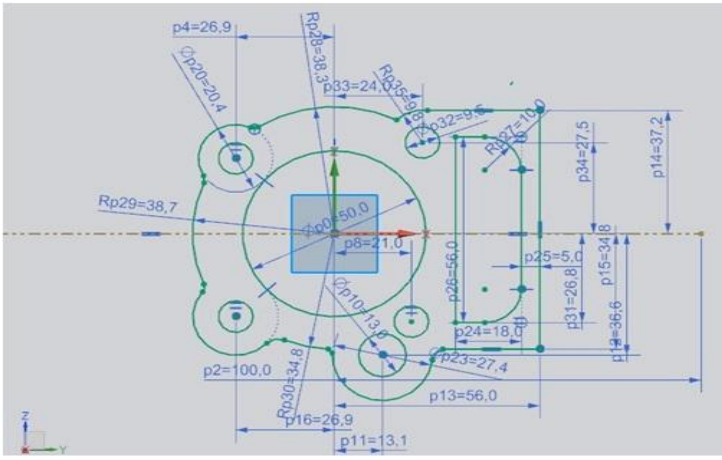


Fig: 4

In any method, a dialog box pop-ups asking you to define the Sketch Plane. The screen will display the sketch options. You can choose the Sketch Plane, direction of sketching and type of plane for sketching. When you create a sketch using the Create Sketch dialog box, you can choose the plane on which the sketch can be created by clicking on the coordinate frame as shown. This will highlight the plane you have selected. The default plane selected is XC-YC. However, you can choose to sketch on another plane. If there are any solid features created in the model beforehand, any of the flat surfaces can also be used as a sketching plane.

UNION: The cylinder and individual fins are being converting into one single object by using the UNION command

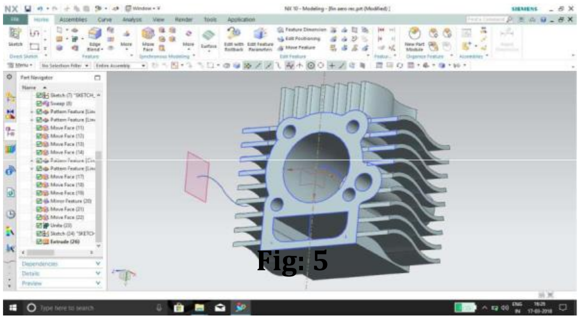


Fig: 5

CONVERT ING THE FILE INTO IGS FORMAT: The UNI-GRAPH ICS model is converted into IGS format in order to import the model into the analysis software like Ansys, Nastran, Computer Fluid Dynamics etc.,

4. ANALYSYS

The boundary conditions are assigned to inner and outer surface of the cylinder block. The boundary conditions consists of

(i) Temperature generated inside the cylinder block
(ii) The heat transfer co-efficient (convection process)

(i) Temperature Generated Inside The Cylinder Block:

The Temperature generated inside the cylinder block is depending up on the capacity of the engine i.e . Cubic capacity of the engine. Generally the temperature inside the cylinder block is continuously varies and the maximum temperature is observed in the cylinder block during combustion process.

By selecting the inner surface of the cylinder assign the value of the maximum temperature which is generated inside the cylinder i.e. 673 ^{o}K.

Ansys software > Project > Model > Transient Thermal > Temperature > ok.
The temperature 673 ^{o}K is applied at the inside the cylinder.

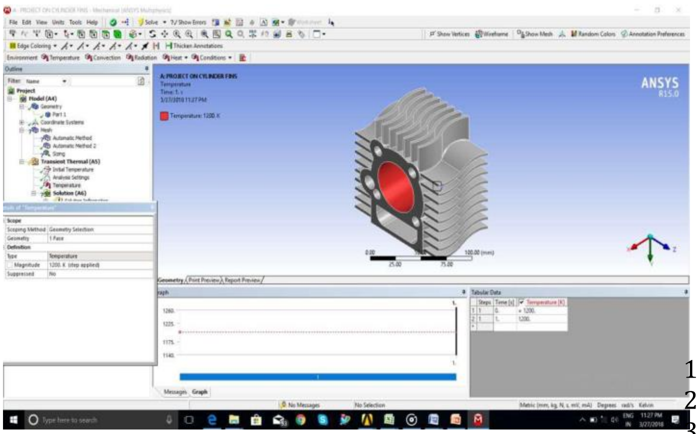


Fig: 6

(ii) The Heat Transfer Co-Efficient (Convection Process)
The convection process is the exchange of heat between the solid body i.e. cylinder fins to invisible working fluid i.e. atmospheric air.

The rate of heat transfer from the fin is governed y the N EWTON'S law. According to the Newton's law the rate of heat transfer is directly proportional to the product of cross-sectional area of the fin body and temperature difference and is given by

$$Q \propto A.dT$$

$$Q = hAdT$$

The "h" indicates the heat transfer co-efficient value which is dep ending up on the geometry of the fin surface and environment conditions. The value o f h is calculated theoretically i.e. h = 29.54 W/m^{2}K

The convective heat transfer co-efficient is applied to the surface of the fins.

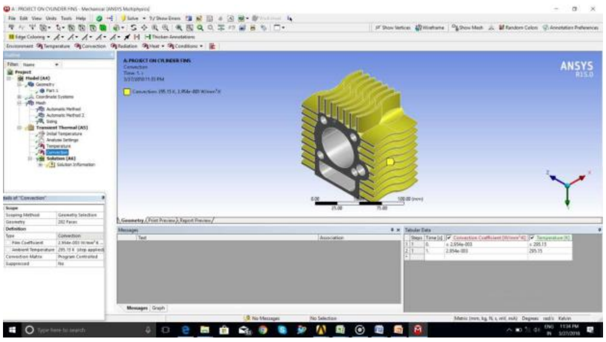


Fig:7

5. Results

The temperature and heat flux values are obtained from the Ansys by applying the boundary conditions to the cylinder block with fins. The results are obtained from the Ansys is as follows:

Ansys software > Model > Transient Thermal analysis > solution > Temperature and Heat flux > ok.

Transient Thermal Analysis Of Aero-Dynamic Fins:

The transient thermal analysis carried for 500 seconds. If the temperature is generated inside the cylinder 673^{o}K then, the distribution of the temperature among the fins is calculated by using Ansys V15.0 .

1. Aluminium alloy 204
2. Magnesium alloy
3. Aluminium alloy 7075

After doing analysis on this three materials, according to the results Aluminium Alloy 7075 best for all the properties.

(i) The Temperature Distribution Of Aluminium Alloy 7075

If the temperature 673°K is applied inside the cylinder block, then the distribution of temperature for Aluminium alloy 7075 is shown in the below figure.

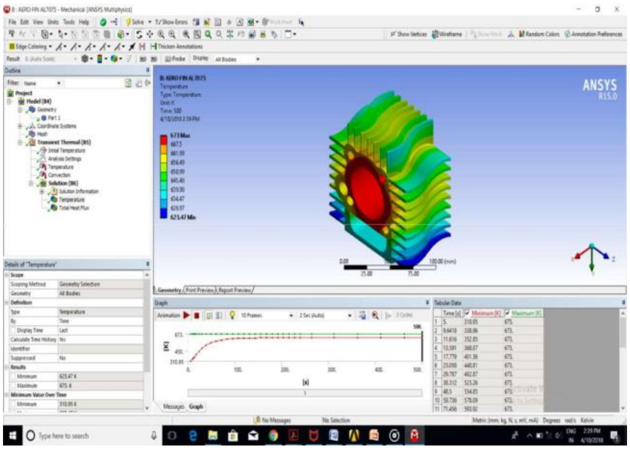


Fig: 8

By performing the analysis on both, the total temperature distribution and the heat flux is appeared with the maximum and minimum values on the engine cylinder fins.

Temperature:

The maximum temperature is given by 673 °K
The minimum temperature is given by 623.47 °K

(ii) The Heat Flux Of Aluminium Alloy 7075:

The temperature inside the cylinder block is 673 °K. Due to this the temperature is transfer from the cylinder to the environment through the fins. The rat e of heat transfer per unit area is called as heat flux. The heat flux in Aero-dynamic fin and these fins are made up Aluminium all oy 7075 is shown in below figure.

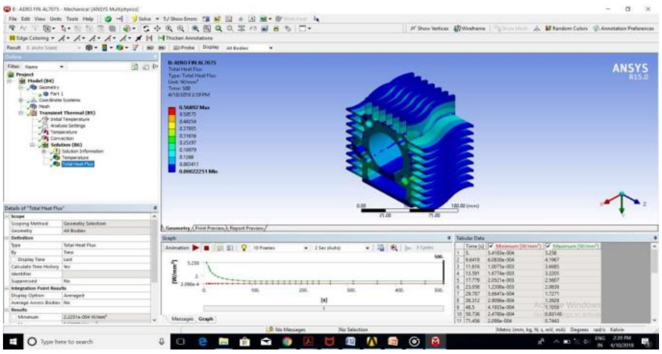


Fig:9

Heat Flux:

From the above figure it is observed that, if we apply 673 °K the maximum and minimum value of heat flux is given by

Heat flux at maximum is given by 0.56892
Heat flux at mini mum is given by 0.00022251 w/mm^2

Temperature Distribution In Aero-Dynamic Fins

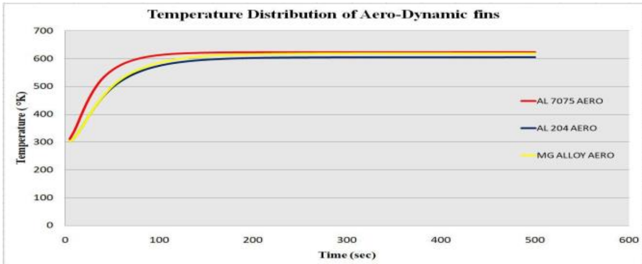


Fig: 10

In the above graph, abscissa represents the time and ordinate represents the temperature. The above represents the relationships between the time and temperature of the cylinder block.

From the above graph it is observed that, if we apply the 673°K inside the cylinder block we get the minimum temperature at the initial stage of engine and it is increased with respected to time. The temperature is increased up to 200 seconds only after that the temperature is constant over the time.

If we apply the 673°K temperature inside the cylinder block, comparing with all the three materials with straight fins are attached to the cylinder block the Aluminium Alloy 7075 will gives the maximum temperature i.e.623.47°K.

The Heat Flux In Aero-Dynamic Fins

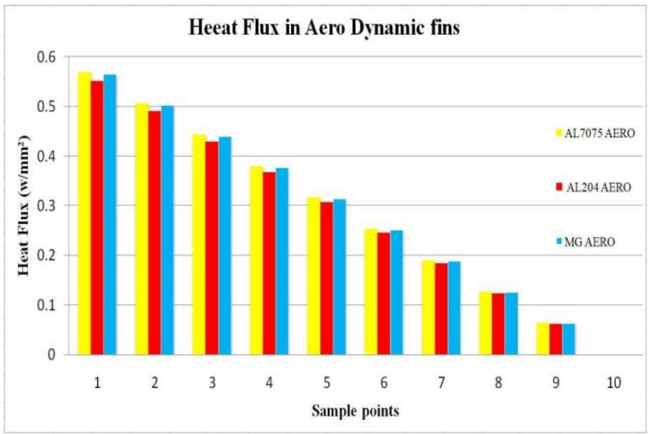


Fig: 11

In the above graph, abscissa represents the sample points and ordinate represents the heat flux. The above graph represents the relationships between the sample points and heat flux of the cylinder block.

From the above graph it is observed that, if we apply the 673°K inside the cylinder block the heat flux in straight fins with three different values are plotted in the above graph. By comparing the heat flux of the different materials, the maximum heat flux is obtained from the Aluminium Alloy 7075 i.e. 0.56892 w/mm^2.

Table: 1

Type of Fins	Material	Temperature (°K)		Heat Flux (w/mm^2)	
		Maximum	Minimum	Maximum	Minimum
AERO – DYNAMIC FINS	ALUMINIUM ALLOY 204	673	604.73	0.55108	0.0002068
	ALUMINIUM ALLOY 7075	673	623.47	0.56892	0.00022251
	MAGNESIUM ALLOY	673	619.59	0.56527	0.0002193
STRAIGHT FINS	ALUMINIUM ALLOY 204	673	609.53	0.41088	0.00089907
	ALUMINIUM ALLOY 7075	673	627.05	0.4274	0.00094703
	MAGNESIUM ALLOY	673	623.43	0.42404	0.00094703

6. CONCLUSION

In present work, the parametric model of the cylinder fin body is modeled with the help of Uni-graphics software V10 and transient thermal analysis is done on the fins to determine variation of temperature distribution and heat flux by using ANSYS V15.0. These fins are used for air cooling system for two wheelers.

In the present study, primarily the thermal analysis is carried out on engine cylinder with straight fins and aero-dynamic fins by using ANSYS workbench v15.0. From the results obtained from thermal analysis it is observed that the maximum temperature can be obtained with aero dynamic fins of material Aluminum Alloy 7075 is maximum as compared with the straight fins.

Secondary the heat flux (Heat carried out by the fin) carried out on engine cylinder fins by varying the shape of the fin from straight to aero dynamic shape of varying the materials like Aluminium Alloy204, Magnesium Alloy and Aluminium Alloy7075. From the results it is clear that the heat flux is maximum when engine cylinder with Aero-Dynamic fins are made up of Aluminium Alloy 7075.

Finally from this thesis the engine cylinder with aero dynamic fin is recommended. While changing the material of the engine cylinder fins with Aluminum Alloy 204 to Aluminium Alloy 7075 is better for maximum heat removal rate from the engine cylinder through the fin. In two and four stroke engines, the designing of the fins is replaced with Aero-Dynamic fins instead of straight fins in order to improve the rate of heat transfer from the cylinder and it increases the life of the engine.

REFERENCES

[1] "S. Chandra Sekhar, P. Satish Reddy, CH. Chandra Rao" has published a International Journal of sub-title "Structural and Thermal Simulation Of Fins Of An Air Cooled Engine Cylinder Under Varying Speed Conditions"

[2] "A. Satish Kumar, MD. Kathir Kaman, S. Ponsankar, C. Balasuthagar" has published a International Journal of sub-title "Design and Thermal Analysis On Engine Cylinder Fins by Modifying its Material and Geometry".

[3] "D. Merwin Rajesh and K. Suresh Kumar" has published a International Journal of sub-title "Effect Of Heat Transfer In A Cylindrical Fin Body By Varying Its Geometry And Material".

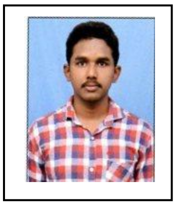
[4] S. Ananth, S. Chaitanya has published a International Journal of sub-title" Mechanical and Thermal Analysis On Engine Cylinder Fin by Changing Material and Geometry"

[5] "B.N. Niroop Kumar Gowd, Rama tulasi" has published a International Journal of sub-title "Calculating Heat Transfer Rate of Cylinder Fin Body by Varying Geometry and Material"

[6] "Rahul Gupta and Rajneesh Kumar and Prateek Kumar Verma" has published a International Journal of sub-title "Heat Transfer Analysis of Engine Cylinder Fins Having Triangular Shape".

BIOGRAPHY:

G. Ashok Kumar,
U.G. Scholar,
Department of mechanical engineering,
Sri Venkateswara institute of Technology



K. Yathish,
U.G. Scholar,
Department of mechanical engineering,
Sri Venkateswara institute of Technology

B. Prasanna Kumar Reddy,
U.G. Scholar,
Department of mechanical engineering,
Sri Venkateswara institute of Technology

P. Dheeraj Kumar,
U.G. Scholar,
Department of mechanical engineering,
Sri Venkateswara institute of Technology

A. Harinath,M.tech,
Assistant professor,
Department of mechanical engineering,
Sri Venkateswara institute of Technology