DESIGN & THERMAL ANALYSIS OF 220CC OIL COOLED ENGINE CYLINDER HEAD BY DIFFERENT ALUMINUM ALLOYS

SAMBARI GOPINATH[1], Y.UMASHANKAR[2]

[1]M. Tech Student, Department of Mechanical Engineering, Vaagdevi College of Engineering, Khammam - Warangal Hwy, Road, Bollikunta, Telangana 506005

[2]Associate Professor, Department of Mechanical Engineering, Vaagdevi College of Engineering, Khammam - Warangal Hwy, Road, Bollikunta, Telangana 506005

Abstract *The engine block is the linchpin of vehicles that run on internal combustion, providing the powerhouse for the vehicle. It is called a "block" because it is usually a solid cast car part, housing the cylinders and their components inside a cooled and lubricated crankcase.*

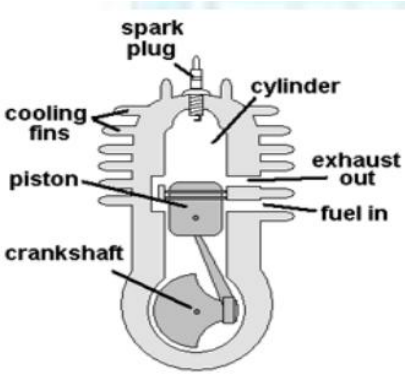
The main aim of the project is to analyze the thermal properties by varying geometry of cylinder block fins using ANSYS work bench. The 3D model of the geometries are created using CATIA and its thermal properties are analyzed using Ansys workbench 14.5. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life.

Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer.

1. INTRODUCTION

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.

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 resignation 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. Keeping the above factors in view, it is observed that suitable means must be provided to dissipate the excess heat from the cylinder walls, so as to maintain the temperature below certain limits. However, cooling beyond optimum limits is not desirable, because it decreases the overall efficiency due to the following reasons: Thermal efficiency is decreased due to more loss of heat to the cylinder walls. The vaporization of fuel is less; this results in fall of combustion efficiency. Low temperatures increase the viscosity of lubrication and hence more piston friction is encountered, thus decreasing the mechanical efficiency. Though more cooling improves the volumetric efficiency, yet the factors mentioned above result in the decrease of overall efficiency. Thus it may be observed that only sufficient cooling is desirable and any deviation from the optimum limits will result in the deterioration of the engine performance.



Engine cylinder fin

Fins

A fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, radiation of an object determines the amount of heat it transfers. Increasing

the temperature difference between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Sometimes it is not economical or it is not feasible to change the first two options. Adding a fin to the object, however, increases the surface area and can sometimes be economical solution to heat transfer problems. Circumferential fins around the cylinder of a motor cycle engine and fins attached to condenser tubes of a refrigerator are a few familiar examples.



Fins

Objectives of the project

The following are the main objectives of the present work:

1. To design cylinder with fins for a 150cc engine by varying the geometry such as rectangular, circular and curve shaped (parabolic) withdifferent materials and temperatures.
2. To determine the heat transfer coefficient with help of CFD analysis
3. To determine thermal properties of the proposed fin models.
4. To identify suitable alloy for the based on results obtained from finite element analysis and analytical method.

2. LITERATURE REVIEWS

KM Sajesh et al. [1] had studied that the heat lost by the body can be increased by increasing the surface area. The increment in surface area is done by creating holes of different sizes on the surface of fins. Increasing the diameter of hole created on the fin brings the overall temperature of the body lower than the lesser diameter model. By creating holes on fins the temperature of fins can be reduced. It also says that the turbulence of air also get increased by creation on holes. This result came by performing a CFD analysis of rectangular fin engine made up with AL 6063 having thermal conductivity of 200W/mK. This CFD is done on steady state and transient state both. This also shows that, the transient temperature of all fins reached to the steady state temperature within 400 seconds of time.

V. Karthikeyan et al. [2] have founded that heat transfer rate of rectangular fin arrays is analyzed by design with perforated and with extension, analysis is carried out using ANSYS Workbench. In that steady state thermal analysis, temperature variations with respect to distance at which heat flow occur through the fin is analyzed. Heat transfer through fin arrays with rectangular extensions higher than that of fin with other type of fins compared to it. Temperature at the end of fin arrays with rectangular extensions is minimum as compare to fin with extensions, without extension and with perforated. Fin arrays with rectangular extensions provide near about 13 % to 21% more enhancement of heat transfer as compare to other type of fins. This result may vary for forced convection heat transfer.

L. Natrayan et al. [3] Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer ofair cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Wavy fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be compare with all the four model of the engine fins geometry by CFD Analysis and its flow characteristics are studied for all the geometries it is found that the curved fins provide better result when compared with all the other geometries.

3. METHODOLOGY USED

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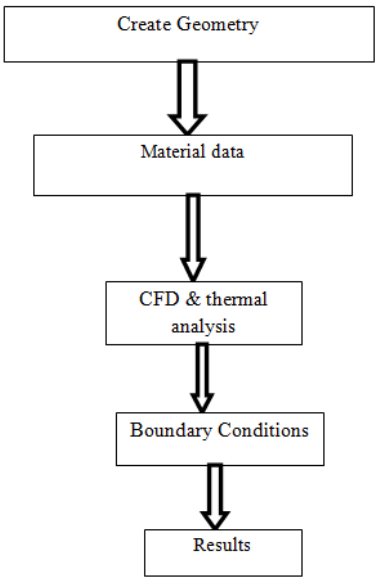


Technical Specifications of Cylinder Block Used to Study

In the survey we have collected the information about the existing model by using sources like garages, service centers, research papers and web sources and we collected the all specifications of the existing design of the cylinder block. And the information collected in this survey is given below

Engine model : Bajaj pulsar
Engine type : Four-stroke, air cooled,
Bore X stroke : 52.0 X 58.6 mm
Fuel system : Carburetor
Number of valves : 2
Displacement volumes : 150 c.c.
Compression ratios : 12.2
Spark advance : 5 °/1500 rpm, 26 °/ 4500 rpm
Cylinder head material : Aluminum alloy
(Thermalconductivity110-150 w/m k)Combustion chamber : Hemisphere shaped
Fin shape : Rectangular with curves at corner
Curve radius : R18
Fin thickness' : 3.048
Tapper angle : 5*
Pitch of fin : Uneven

4. MATERIAL PROPERTIES AND MODELING

Cast iron

Thermal conductivity=52 w/m k
Specific heat=0.46 kj/kg k
Density =7200 kg/m^3

Aluminum alloy 7475

Thermal conductivity=152 w/m k
Specific heat=714 j/kg k
Density =2810 kg/m^3

Alloy 6082

Thermal conductivity=180 w/m k
Specific heat=900 j/kg k
Density =2700 kg/m^3

MODELLING AND ANALYSIS OF CYLINDER FIN

Cylinder along with fin was modelled in CREO. The dimensions of the cylinder along with fin were taken from commercially available bike data sheet. Fins with different geometries (circular, Curved, aerodynamic and rectangular) were modelling using CREO Software

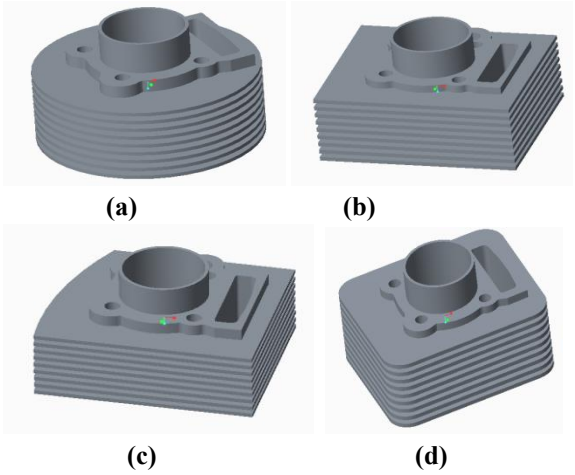
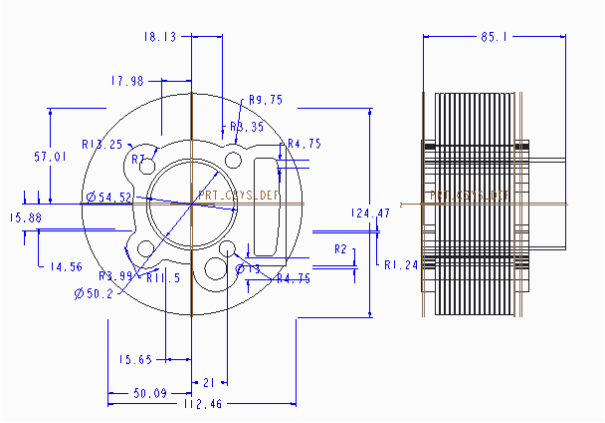


Figure. 3D models of Cylinder Fins, (a) Engine Cylinder 3D model with circular Fins (b) Engine Cylinder 3D model with rectangular Fins (c) Engine Cylinder 3D model with aero dynamicFins (d) Engine Cylinder 3D model with curved Fins

2d drawing



CFD SIMULATION OF ENGINE CYLINDER FINS

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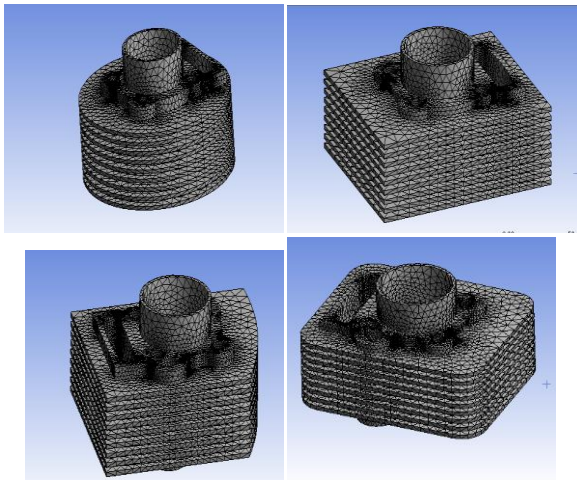
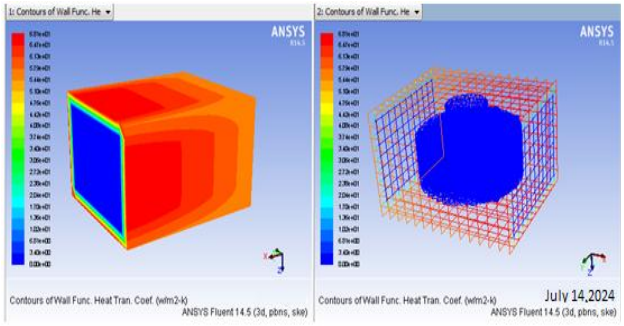
Analysis of the cylinder fin for different geometries was carried out in ANSYS workbench. The basic model was generated using CREO and that model is imported to ANSYS work bench. Meshing is done in Ansys work bench.



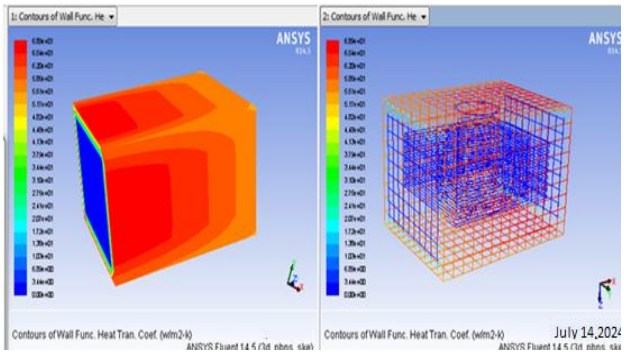
Meshing models engine cylinder fins

Our next step in steady state CFD analysis is to generating mesh. The design using efficient mesh generation techniques, meshes were created with high contact sizing relevance. The total number of elements and nodes are19778 and 36988respectively.

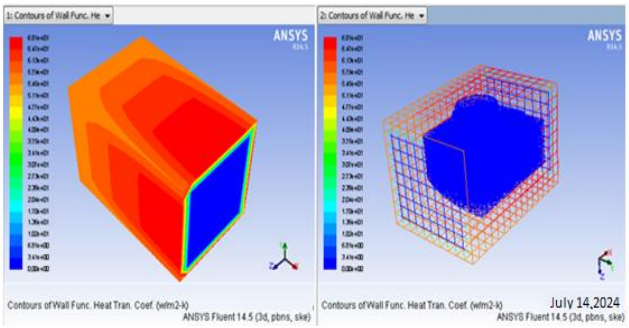
CFD ANALYSIS RESULTS



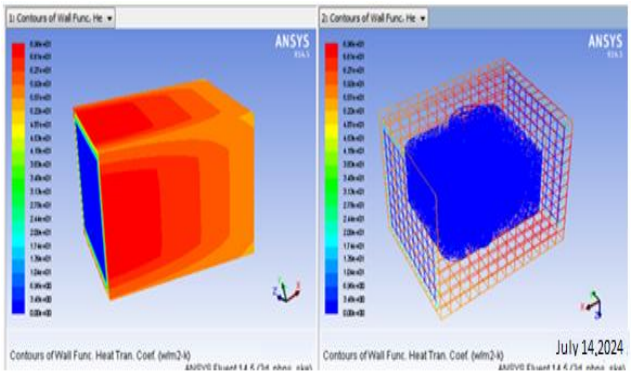
Heat transfer coefficient for cylindrical fins engine



Heat transfer coefficient for rectangular fins engine



Heat transfer coefficient for aerodynamic fins engine



Heat transfer coefficient for curved fins engine

Materials used and properties

1. Cast iron

Thermal conductivity=52 w/m k
Specific heat=0.46 kj/kg k
Density =7200 kg/m^3

2. Aluminum alloy 7475

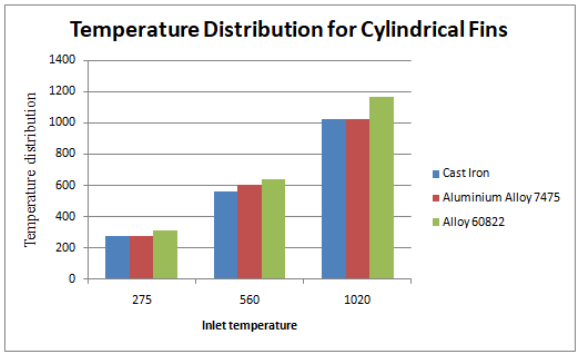
Thermal conductivity=152 w/m k
Specific heat=714 j/kg k
Density =2810 kg/m^3

3. Alloy 6082

Thermal conductivity=180 w/m k
Specific heat=900 j/kg k
Density =2700 kg/m^3

5. RESULTS AND ANALYSIS

CASE: 1 Cylindrical Fins



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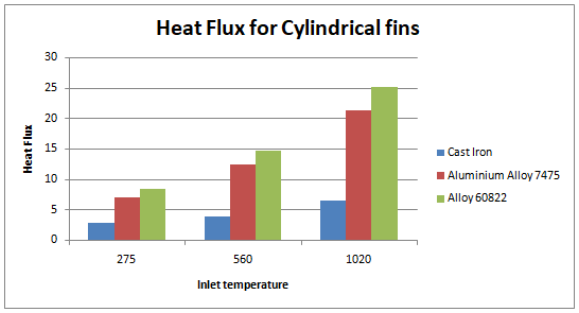
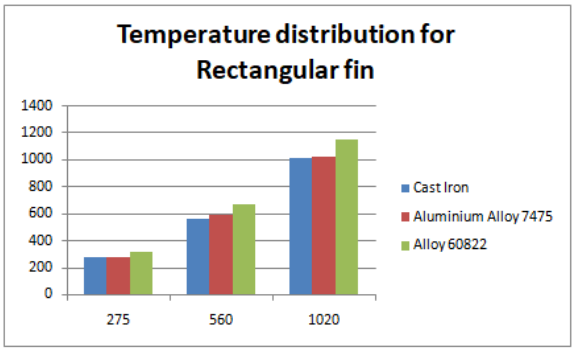
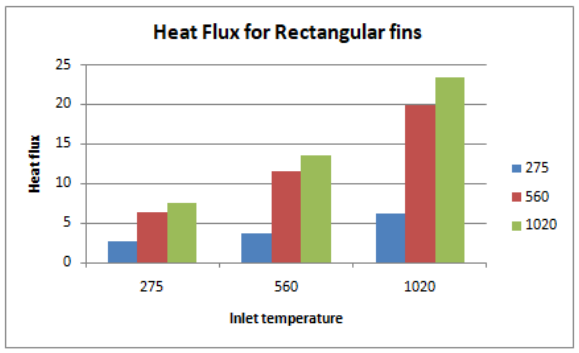
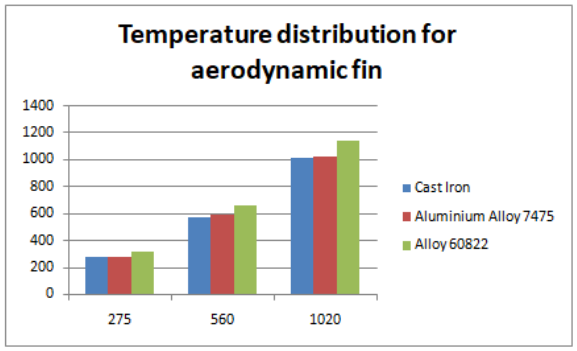


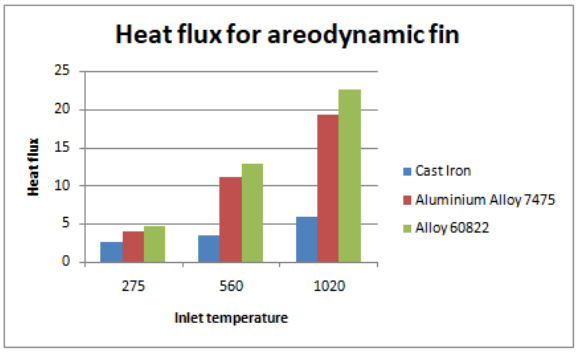
CASE: 2 Rectangular fins



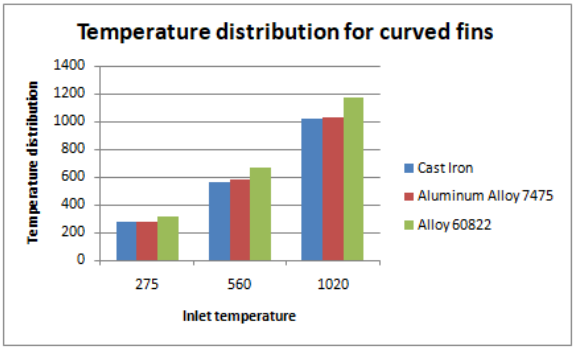


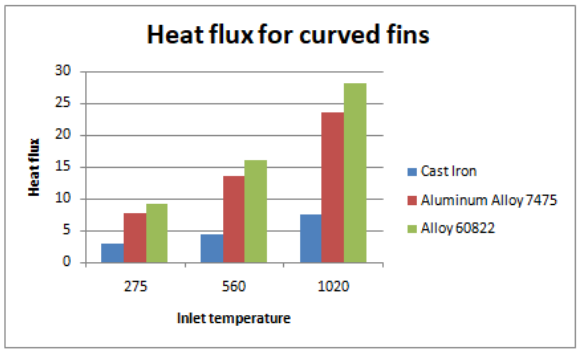
CASE: 3 Aerodynamic fins





CASE: 4 Curved Fins





6. CONCLUSIONS

The main aim of the project is to analyze the thermal properties by varying geometry of cylinder fins using Ansys work bench. The 3D model of the geometries are created using CREO and its thermal properties are analyzed using Ansys workbench 14.5. The variation of temperature distribution over time is of interest in many applications such as in cooling. The accurate thermal simulation could permit critical design parameters to be identified for improved life.

Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of

air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Curved fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be comparing with all the three models of the engine fins geometry by CFD Analysis and its flow

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