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OPTIMIZATION OF ENGINE CYLINDER FINS OF VARYING GEOMETRY AND MATERIAL A REVIEW

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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 cylinder to increase the rate of heat transfer. By increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main purpose of using these cooling fins is to cool the engine cylinder by air. The main aim of this work is to analyze the thermal properties by varying geometry, material, distance between the fins and thickness of cylinder fins. The 3D modeling software used is Pro/Engineer. Thermal analysis is done on the cylinder fins to determine variation temperature distribution over time. The analysis is done using ANSYS. Presently Material used for manufacturing cylinder fin body is Cast Iron. In this work, using materials Copper and Aluminum alloy 6082 are also analyzed. Thermal analysis is done using all the three materials by changing geometries, distance between the fins and thickness of the fins for the actual model of the cylinder fin body.

Key words: By using catia v5 and ansys.

INTRODUCTION

Created by Dr. Samuel P. Geisberg in the mid-1980s, Pro/ENGINEER was the industry's first successful parametric, 3D CAD modeling system. The parametric modeling approach uses parameters, dimensions, features, and relationships to capture intended product behavior and create a recipe which enables design automation and the optimization of design and product development processes. Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

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.

An engine or motor is a machine designed to convert one form of energy into mechanical energy.[1][2] Heat engines, including internal combustion engines and external combustion engines (such as steam engines), burn a fuel to create heat, which then creates a force. Electric motors convert electrical energy into mechanical motion; pneumatic motors use compressed air and others—such as clockwork motors in wind-up toys—use elastic energy. In biological systems, molecular motors, like myosins in muscles, use chemical energy to create forces and eventually motion

Necessity of cooling system in ic engines:

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
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:
1. Thermal efficiency is decreased due to more loss of heat to the cylinder walls.
2. The vaporization of fuel is less; this results in fall of combustion efficiency.
3. 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.

Aim of the Project

main aim of the project is to design cylinder with fins for Passion Plus 100cc engine, by changing the geometry, distance between the fins and thickness of the fins and to analyze the thermal properties of the fins. Analyzation is also done by varying the materials of fins. Present used material for cylinder fin body is Cast Iron.

Our aim is to change the material for fin body by analyzing the fin body with other materials and also by changing the geometry distance between the fins and thickness of the fins.

Geometry of fins – Original model and Modified Model, For Original Model - Thickness of fins – 2mm and Distance between the fins – 7.5mm

For modified model - Thickness of fins – 1.5mm and Distance between the fins for combustion side 9.65mm and for opp side 4.23 mm

Materials used in this work was carried out by using Cast Iron, Copper and Aluminum alloy 6082

Basic Principles

There are many demands on a cooling system. One key requirement is that an engine fails if just one part overheats. Therefore, it is vital that the cooling system keep *all* parts at suitably low temperatures. Liquid-cooled engines are able to vary the size of their passageways through the engine block so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots, which are more difficult to avoid with air cooling. Air cooled engines may also vary their cooling capacity by using more closely-spaced cooling fins in that area, but this can make their manufacture difficult and expensive.
Conductive heat transfer is proportional to the temperature difference between materials. If engine metal is at 250 °C and the air is at 20°C, then there is a 230°C temperature difference for cooling. An air-cooled engine uses all of this difference. In contrast, a liquid-cooled engine might dump heat from the engine to a liquid, heating the liquid to 135°C (Water's standard boiling point of 100°C can be exceeded as the cooling system is both pressurized, and uses a mixture with antifreeze) which is then cooled with 20°C air.

STATIC ANALYSIS:

A static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time varying loads. A static analysis can, however, include steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind and seismic loads commonly defined in many building codes).

Static analysis determines the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time. The types of loading that can be applied in a static analysis include:

_ Externally applied forces and pressures

_ Steady-state inertial forces (such as gravity or rotational velocity)

_ Imposed (nonzero) displacements

_ Temperatures (for thermal strain)

_ flounces (for nuclear swelling)

A static analysis can be either linear or nonlinear. All types of nonlinearities are allowed - large deformations, plasticity, creep, stress stiffening, contact (gap) elements, hyper elastic elements, and so on. This analysis gives a clear idea whether the structure or component will withstand for the applied maximum forces. If the stress values obtained in this analysis crosses the allowable value, it will result in the failure of the structure in the static condition itself. To avoid such a failure, this analysis is necessary.

Modeling of solid element:

Modeling solid element named SOLID 45 is taken. It is the element which is having a higher order 3-D, 8-node element. The element is defined by 8 nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions. The element has plasticity, creep, swelling, stress stiffening, large deflection, and large strain capabilities. It also has mixed formulation capability for simulating deformations of nearly incompressible elastoplastic

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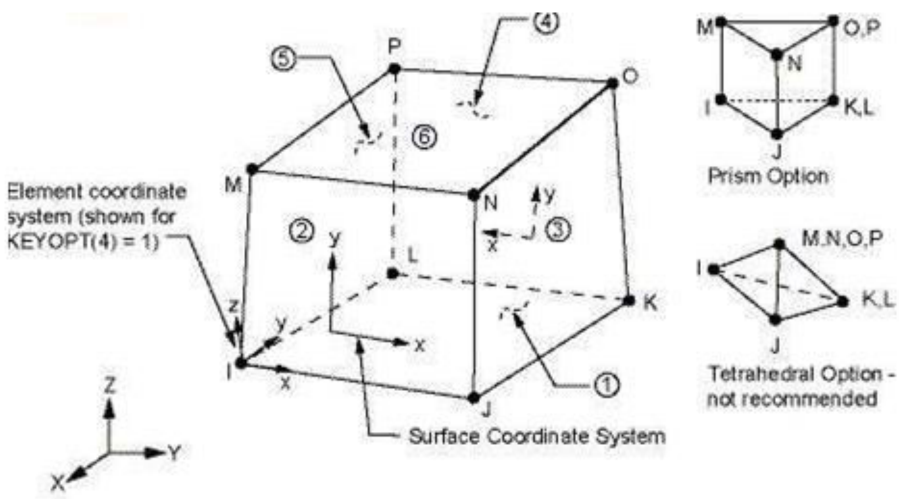
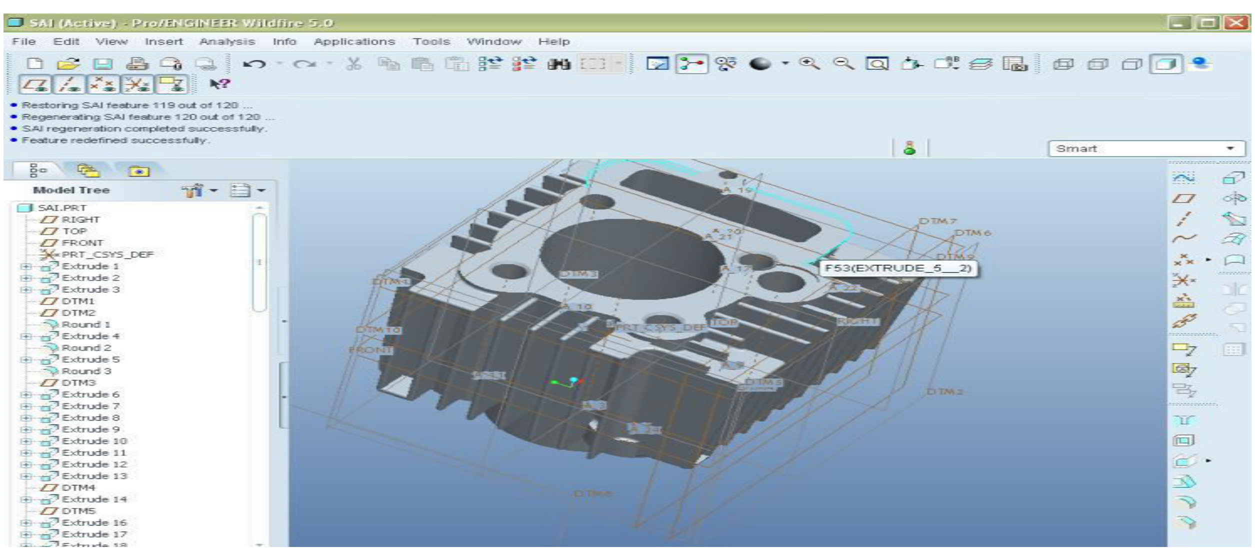
materials, and fully incompressible hyper elastic materials. The geometry, node locations, and the coordinate system for this element are shown in the figure. In addition to the nodes, the element input data includes the orthotropic or anisotropic material properties. Orthotropic and anisotropic material directions correspond to the element coordinate directions.



Steps involved in the project

1. Modeling
2. Thermal Analysis



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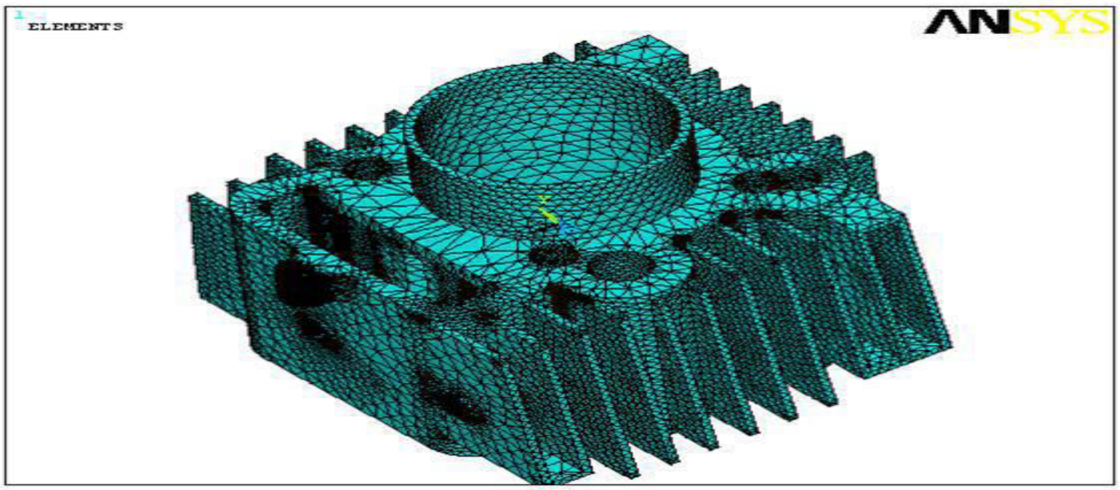
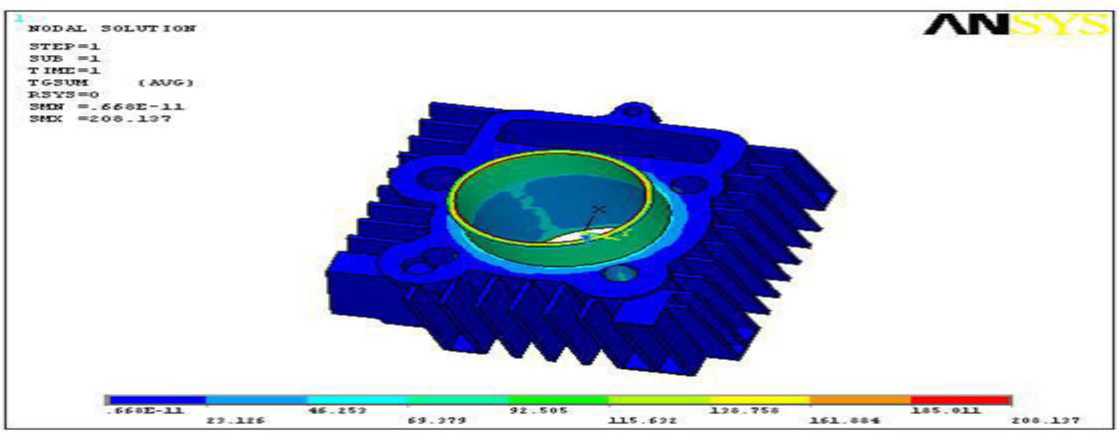
part model of the Fin

RESULTS:



meshing of the model using tetrahedral shape



Thermal Gradient Sum

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Table: 2 Results with Modified Model

	cast iron	copper	aluminum alloy 6082
weight (kg)	2.12	2.24	0.80
nodal temperature (k)	550	550	550
thermal gradient (k/mm)	213.63	188.74	104.63
thermal flux (w/mm^2)	10.68	11.89	18.83

CONCLUSION

In this thesis, a cylinder fin body for Passion Plus 100cc motorcycle is modeled using parametric software Pro/Engineer. The original model is changed by changing the geometry of the fin body, distance between the fins and thickness of the fins.

Present used material for fin body is Cast Iron. In this thesis, thermal analysis is done for all the three materials Cast Iron, Copper and Aluminum alloy 6082. The material for the original model is changed by taking the consideration of their densities and thermal conductivity. Density is less for Aluminum alloy 6082 compared with other two materials so weight of fin body is less using Aluminum alloy 6082. Thermal conductivity is more for copper than other two materials.By observing the thermal analysis results, thermal flux is more for Aluminum alloy than other two materials and also by using Aluminum alloy its weight is less, so using Aluminum alloy 6082 is better.

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