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Design and analysis on piston used in IC engine- A Review

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ABSTRACT

This paper describes the equivalent stress distribution and thermal stresses behaviour of two different types of materials such as Structural Steel and graphite as piston materials. The parameters used for the simulation are temperature properties and engineering properties of piston material. This paper illustrates the procedure for analytical design of structural steel piston and graphite piston a component of I.C. engine. The results predict the maximum stress and critical region on the different piston materials using FEA. It is important to locate the critical area of concentrated stress for appropriate modifications. Static and thermal stress analysis is performed by using ANSYS. The best piston material is selected based on stress analysis results. The analysis results are used to optimize piston geometry of best piston material.

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INTRODUCTION

Internal Combustion engine is a Mechanical device which work on the basis of the chemical energy of fuel is released inside the engine and used directly for mechanical work. In the suction process the mixture of air and fuel is first enter into the crank case and by the movement of upward stroke of the piston the vacuum created and similarly during the downward stroke the poppet valve is forced closed due to increased pressured in crank case. Then the mixture of fuel and air is being compressed in the crank case during the remaining section of the stroke.

The piston is a disc which reciprocates within a cylinder. It is either moved by the fluid or it causes the fluid to move which enters the cylinder. The piston of an internal combustion engine is mainly designed to functioning as the part which receives the impulse from the expanding gas and to transmit the energy to the

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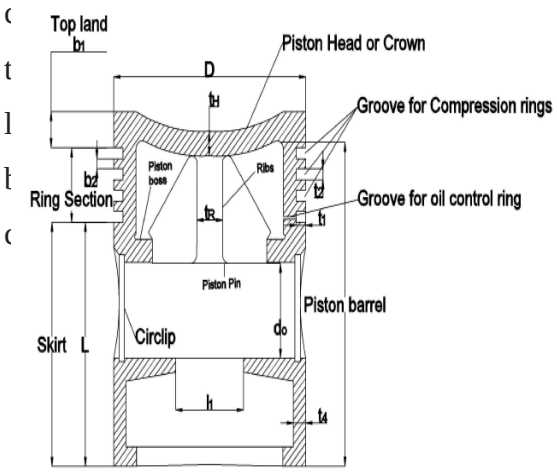

Figure: 1 The Piston

LITERATURE REVIEW

Yaohui Lu[2016] stated that the improvement of the diesel engine power and performance, the piston in the combustion chamber is subjected to higher thermal load and the thermal stress decreases its working life. Therefore, it is necessary to analyse the subsequent thermal stress on the piston during design process to reach the optimum one. They tried to present a new calculation method for the theoretical design of the piston. In his study, the 3D solid model of piston in 16V280 diesel engine was developed and the simulation calculation of the steady-state and the transient-state temperature field is carried out. The results show that the maximum temperature is 354 °C , which appears at the edge of the combustion chamber. The steady-state temperature field of finite element simulation shows a good agreement with the experimental results. The thermal stress obtained from thermal mechanical decoupling method was within the allowable range, since the maximum value is 270 MPa. Danger zone appears at the combustion chamber throat, the contact area of piston head and skirt.

V G Cioată[2016] discussed here about the piston is one of the most important components of the internal combustion engine. Piston fails mainly due to mechanical stresses and thermal stresses. In this paper is determined by using the finite element method, stress and displacement distribution due the flue gas pressure and temperature, separately and combined. The FEA is performed by CAD and CAE software. The results are compared with those obtained by the analytical method and conclusions have been drawn.

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conclusions are drawn. Autodesk Inventor Professional is used to obtain the 3D model of the piston and ANSYS Workbench V.15 is used for the finite element analysis.

C. Kirnera[2016] described the piston assembly is the most complex system within the internal combustion engine. In order to fully exploit its optimization potential a high level of system understanding is required. Therefore, in this paper experimental studies of two single cylinder engines are combined with CFD-simulation of the piston ring pack. The introduced measurement and simulation techniques enable a holistic approach to the investigation of the tribological conditions of the piston assembly. The results – like the comparison of crank-angle resolved oil film thickness to the piston assembly friction measurement – illustrate the implications of design parameters of the piston assembly on the functional parameters friction, oil consumption, blow-by, wear and acoustics and thereby permit purposive system optimization.

Nunna Durga Prasanth [2015] worked on some composite materials those are framed by the mixing of two or more materials to accomplish properties that are better than those of its constituents. Aluminium metal matrix composites are increasing across the board acknowledgement for vehicles, modern, aviation applications in view of their low thickness, high quality and great structural unbending nature. In the present work a specimen is made to Al-Sic-graphite contained in particulate metal matrix composites by stir casting method. The expansion level of graphite being Varied from 3-5wt% in venture of 1wt% and the rate of SiC is consistent (i.e. 5%). Brinnel hardness, tensile properties and impact strength of the composites were tested according to the norms.

Kethavath Vishal [2015] described on this project which mainly deals with the design, analysis of piston. A piston is a component of reciprocating engines, reciprocating compressors and pneumatic cylinders among other similar mechanisms. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod/and or connecting rod. Here the piston is designed, analysed and the manufacturing processes have been studied. Piston temperature has considerable influence on efficiency, emission, performance of the SI engine. Purpose of the investigation is the

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measurement of piston transient temperature at several points on the piston, from cold start to steady condition and comparison with the results of finite element analysis. In this project the piston is modelled and assembled with the help of CATIA software and component is meshed and analysis is done in ANSYS software and the thermal and static behaviour is studied and the results are tabulated. The various stresses acting on the piston under various loading conditions has been studied. In the present thesis work has been taken up on the following aspects to cover the research gaps and to present the results based on the systematic studies.

G.Anusha[2015] presented this research paper that now-a-days technology the diesel engines plays an important role in the transportation sector, agricultural pumping sets etc., where large amount of diesel is consumed. But according to the ministry of petroleum, this petroleum fuels will last in few years. So, one must concentrate much on the diesel engine modifications so that the amount of fuel consumption and the environmental pollutions can be reduced. In a normally diesel engine the amount of useful energy available is less and remaining is lost to the cooling water, exhaust gases and as frictional losses. The most effective way of burning various fuels in the engine and reducing the energy losses is by using thermal barrier coatings on the various elements of the combustion chamber like cylinder head, cylinder liner, piston and valves. In IC engines, approximately one-third of the total fuel input energy was converted in to useful work and Two-third has been lost through exhaust gas and cooling system. Among all the components in the engine, piston will play a very important role for the production of power. The amount of useful work can be increased with the modification of piston. With the various piston materials the amount of temperature available in the engine can be increased which further increases the efficiency. The paper presents results of modeling in piston and analyzing the temperature distribution. The temperature distribution in the piston is a crucial parameter which influences the thermal stresses and deformations in the piston materials. This stress and deformation varies with different materials of the piston.

Aims and Objectives of the present work

The aims and objectives of the present investigation are as follows:

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- Selection of IC engine piston material and numerical computation to validate the results obtained analytically.
- Determination of Von-mises stresses acting on piston head and to analyze the stress generated due to gas pressure.
- Determination of thermal stresses acting on piston head due to temperature differences between the centre and edge of the piston.
- Solving the problem using different piston materials to obtain the best possible outcome and using graphite as a new material for piston.

MATERIAL FOR PISTONS

Cast iron, cast aluminium, forged aluminium, cast steel and forged steel. Are the most commonly used materials for piston of I.C. engines. With piston speeds below 6 m/s the cast iron pistons are used and for highly rated engines running at higher piston speeds aluminium alloys pistons are used.

Piston in an IC engine must possess the following characteristics:

- Strength to resist gas pressure.
- Minimum weight.
- Reciprocate with minimum noise.
- Sufficient bearing area to prevent wear.
- Must seal the gas from top and oil from the bottom.
- Resistance to distortion under heavy forces and heavy temperature.

CONCLUSION

Using software in our study such as CATIA & ANSYS the required output can be obtained. The CATIA software can provide different deformation and stress zones for better understand and analysing the result. CATIA has taken fewer efforts in solving the complex calculation and performed better results. By using Graphite and structural steel as the piston material the performance of the piston can be improved. The meshing element having triangular and quadrilateral nodes with least mesh size can perform better and gives desired output.

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