"Design and thermal analysis of IC engine piston design using CATIA and ANSYS software"

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Abstract

Cylinder is one among the most basic parts in a reciprocating engine, reciprocating siphons, gas blowers and pneumatic barrels, among other comparable mechanisms in which it changes over the substance imperativeness acquired by the consuming of fuel into supportive (work) mechanical control. The present proposition manages the properties of cylinder material identified with heat. Primary issue anticipated that would be found in the framework of the broad cylinder is the distortion, because of weight and temperature. The glow starting from the exhaust gases will be the essential reason of deformation. The most critical part is that least time is required to outline the cylinder and only a couple of essential detail of the engine. Cylinders made of different materials like Aluminium Alloy, Structure steel (S-460), Cast Iron Alloy and Titanium Alloy were outlined and investigated effectively. In static-helper investigation, the cylinders were examined to discover the relative (von-misses) stress, comparable flexible strain and deformation. It tends to be seen that greatest stress force is on the base surface of the cylinder crown in everyone of the materials. Here we discovered Aluminium amalgam this material has more estimations of warmth motion with different materials.

Keywords: CATIA, ANSYS, Modeling, Analysis, Structure, FEM

I. INTRODUCTION

Piston is considered to be one of the most important parts in a reciprocating engine, reciprocating pumps, among other similar mechanisms in which it helps to convert the chemical energy obtained by the combustion of fuel into useful (work) mechanical power.

II. MATERIALS

We have selected three materials:

- Aluminium Alloy
- Structural Steel (S-460)
- ALSI Alloy
- Cast iron
III. MODELING & SIMULATION

SPECIFICATIONS (Splendor-Pro)

<table>
<thead>
<tr>
<th>Engine Type</th>
<th>Air-cooled, 4-stroke single cylinder, OHC</th>
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<tbody>
<tr>
<td>Displacement</td>
<td>97.2 cc</td>
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<tr>
<td>Max. Power</td>
<td>5.66 KW, @ 5000 rpm</td>
</tr>
<tr>
<td>Max. Torque</td>
<td>7.130 N-m @ 2500 rpm</td>
</tr>
<tr>
<td>Compression Ratio</td>
<td>9.9 : 1</td>
</tr>
<tr>
<td>Starting</td>
<td>Kick Start / Self Start</td>
</tr>
<tr>
<td>Ignition</td>
<td>DC - Digital CDI</td>
</tr>
<tr>
<td>Bore</td>
<td>50 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>49 mm</td>
</tr>
</tbody>
</table>

![Fig.3.1 2D Drafting](image1)

![Fig.3.2 CATIA Model](image2)

![Fig.3.3 Import Geometry ANSYS](image3)

![Fig.3.4 Meshing](image4)

![Fig.3.5 Fixed support Aluminium Alloy Materials](image5)
Fig. 3.6 Pressure applied Aluminium6061 Alloy Materials

Fig. 3.7 Total Deformation Aluminium Alloy Materials

Fig. 3.8 Equivalent Stress Aluminium Alloy Materials

Fig. 3.9 Transient Thermal Boundary conditions

Fig. 3.10 Temperature Aluminium Alloy

Fig. 3.11 Total Heat Flux Aluminium Alloy
Fig. 3.12 Pressure and fixed support boundary conditions S-460 Materials

Fig. 3.13 Thermal Stresses S-460 Materials

Fig. 3.14 Total Deformation S-460 Materials

Fig. 3.15 Transient Thermal heat flow S-460 Materials

Fig. 3.16 Temperature S-460 Materials

Fig. 3.17 Total Heat Flux S-460 Materials
Fig. 3.18 Pressure and fixed support boundary condition ALSI Alloy Materials

Fig. 3.19 Equivalent Stress ALSI Alloy Materials

Fig. 3.20 Total Deformation ALSI Alloy Materials

Fig. 3.21 Transient Thermal ALSI Alloy

Fig. 3.22 Temperature Titanium Alloy

Fig. 3.23 Total Heat Flux Titanium Alloy
Fig. 3.24 Pressure and fixed support boundary condition ALSI Alloy Materials

Fig. 3.25 Equivalent Stress ALSI Alloy Materials

Fig. 3.26 Total Deformation ALSI Alloy Materials

Fig. 3.27 Transient Thermal ALSI Alloy

Fig. 3.28 Temperature Titanium Alloy

Fig. 3.29 Total Heat Flux Titanium Alloy
V. RESULT & DISCUSSION

We take four different materials 3D models of piston are created based on the dimensions obtained. CATIA V5 R20 is used for creating the 3D model. These models are then imported into ANSYS WORKBENCH 19.2 for analysis. Static structural analysis of pistons is carried out. Meshing is done with an automatic which gives a fine mesh. For static transient structural analysis, gas pressure is applied on the top of the piston and frictionless support is applied across the surface of piston and also on the piston pin holes. Then results are obtained for von-misses stress and maximum elastic strain. A comparison is made between the results and the best suited aluminum alloy is selected based on the parameters.

- The static structural analysis of S-460, Cast Iron, Aluminium Alloy 6061 and AL SI 120Cu Mg Ni are done and results are obtained for Thermal stress, Temperature, deformation and heat flux.

- We can observe that in case of equivalent (von-mises) stress, piston made of S-460 is found to have maximum stress of 84.469 Mpa is observed. When piston made of Cast Iron then stress value maximum 85.71 Mpa. Maximum stress on Aluminium 6061 Alloy is found to be 84.49 Mpa and AL SI 120Cu Mg Ni that of was found to be 84.91 Mpa.

- We can observe that in case of deformations (mm), piston made of S-460 is found to have maximum deformation of 0.0069 mm is observed. When piston made of Cast Iron then deformation maximum value 0.012 mm. When piston made Aluminium 6061 Alloy then deformation is found to be 0.023 mm and deformation for AL SI 120Cu Mg Ni that of is found to be 0.017 mm.

- We can observe that in case of Temperature (°C), piston made of S-460 is found to have maximum temperature of 269.13 °C is observed. When piston made of Cast Iron then maximum temperature269.13°C, maximum temperature for Aluminum 6061 Alloy is found to be 191.32 °C and maximum temperature for AL SI 120Cu Mg Ni that of is found to be 190.82 °C.

- We can observe that in case of heat flux (w/mm²), piston made of S-460 is found to have maximum heat flux of 3.32 (w/mm²), is observed. When piston made of Cast Iron then heat flux value maximum 2.921 (w/mm²), maximum heat flux for Aluminium 6061 alloy is found to be 9.17 (w/mm²) and maximum heat flux for AL SI 120Cu Mg Ni that of is found to be 7.446 (w/mm²).

We can observe that in all cases take here four materials Structure steel (S-460), Cast iron, Aluminium 6061 Alloy and AL SI 120Cu Mg Ni then we have found that Aluminium 6061 Alloy is the best material compare to the other materials because it has more heat flux value.

![Fig.4.1 Comparison Graph for Stress with different materials](image1)

![Fig.4.2 Comparison Graph for Deformation with different materials](image2)

![Fig.4.3 Temperature Comparison charts](image3)
The basic ideas and outlines techniques worried about single-barrel petroleuem engine have been considered in this paper. Outcomes found by the utilization of this systematic strategy are almost equivalent to the genuine measurements utilized now a days. Henceforth it gives a quick strategy to outline a piston which can be additionally enhanced by the utilization of different programming and strategies. The most critical part is that less time is required to outline the piston and just a couple of essential details of the engine. Pistons made of various materials like Aluminium 6061 Alloy, S-460, Cast Iron and AL Si 120Cu Mg Ni were outlined and investigated effectively.

In static auxiliary investigation, the pistons were re-examined to discover the proportional (von-mises) stress, comparable flexible strain and deformation.

It tends to be seen that the greatest stress force is on the base surface of the piston crown in everyone of the materials.

Hereweselected Aluminium 6061 Alloy this material has more heat flux value with different materials. So we will recommend this material for future work.

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