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Deformation Analyses of Modified Piston Head with Different Thermal Barrier Coatings for IC Engine

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ABSTRACT- In this article, the structural performance of the piston was analyzed by different piston head design with different alloys. The Piston model was created using CATIA and analysis was performed on ANSYS. The boundary conditions used are load, support, coefficient and temperature flow. Different piston head such as Deep cylindrical piston, Shallow Re-entrant piston, Hemispherical piston and various alloys such as Alcoa alloy, Nimonic alloy, Stainless Steel Grade 201L have been used in current research. Various tests were performed on the model designed for flexibility. Lastly, when it compare the size of wearables such as Alumina, Magnesia, Titanium are better to use on a piston head. Pistons are usually made of high-alloy steel. The Piston ring area incorporates circular brass-like jewelry between the piston partitions and ensures a comfortable piston suit inside the cylinder. They help to provide a lid to prevent leakage of compressed gases throughout the piston and save the lubricating oil from entering the combustion chamber.

KEY WORD- Internal combustion engines; Coating; Deformation analyses; Catia; Ansys.

1 INTRODUCTION

In piston engines, the crankshaft allows for rapid rotation of the shaft with a rod mounted on the transmission plug. With a propeller installed when a hole is set, the engine must power the engine. Installed inside the cylinder, it can strengthen the engine or car. The IC engine refuses about two-thirds of its gasoline power to the environment through its walls or by using energy output valves while about one-third of them are used as power output. The concept of an LHR engine eliminates this heat dissipation to a cool environment and improves energy efficiency and carbon dioxide emissions. The use of ceramic TBCs in engines improves gas emissions, high piston temperatures, fuel efficiency and protects against heat exhaustion. It also protects the piston from thermal stress, corrosion attacks, high heat dissipation and reduced heat flow in the piston [1] [3].

2 LITERATURE REVIEW

Conducts research on Isothermal circulation in the piston body and the temperatures flowing in the cooling water and air under the piston in four different load loads is shown both with and without protective coating [1-4]. The results show a 6% reduction in thermal damage by using a piston with the use of a protective cover on the cylinder wall. Engine performance can be improved by reducing the weight of the car and increasing the thermal capacity of the thermos of Engine parts, especially the piston [5 - 7]. The strategic approach incorporates the assurance of different piston sizes using the analysis method under very large power conditions [8]. the test function is to investigate and analyze the piston pressure distribution in the actual engine condition. The parameters used to investigate the performance of gas pressure, temperature and physical properties of the piston. In I.C. The engine piston is very confusing and is an important part of the proper operation of the car piston should be in good working condition [9 - 10].

3 TYPES OF PISTONS

3.1 TRUNK PISTONS

Pistons are longer compared to their width. It acts as a piston and above a fork head. Since the connecting rod has an angle and tons of rotation, there may be a pressure of the responding side next to the side of the piston in the cylinder wall. A long piston helps to do this. The pistons have been a common internal piston since the early days of an internal motor. It was used for gasoline and diesel engines, although high -speed engines use a clean piston slipper. The trunk pistons are very wide in diameter and display twice. Their ‘handle’ turned into a thin shell formed in the center of the piston.

3.2 CROSSHEAD PISTONS

Large diesel engines need the help of an electrical system in the piston. Those engines usually use piston heads. Prevent the flow of exhaust gas from the piston and avoid exhaust fumes entering the combustion chamber. The main piston is charged when the fuel is closed and there are piston stones. The small piston is an engineering manual. It runs in a small tire as a body guide and also has a tar badge. Your whole controversy between the piston and the savage head is probably the strong storm that is inside the piston. Due to the added weight of these pistons, they are no longer used for high -speed engines.

3.3 SLIPPER PISTONS

The piston slipper is a gasoline engine piston that reduces size and weight as much as possible. In the worst cases, they put down into the piston ring, supporting the piston ring, and only enough of the piston sleeve is left to leave two states to prevent the piston from going into the piston ring. The second space can reduce interference with the wall, since the part of the body, which encloses the skin up and down, is reduced in half. However, most of the friction is caused by the piston rings, which are actually parts that are very similar to the screw and mounting support points, and therefore reduce the availability.

3.4 DEFLECTOR PISTONS

Deflector pistons used in high -pressure motors, where oil flows and flows into the cylinder, must be carefully adjusted so that one can deliver properly. Most engines today use Schnuerle porting. It provides a few holes in the sides of the tire and circulates the gas around the straight side, rather than the horizontal.

4 METHODOLOGIES

Piston is tested using CATIA with a wide range of geometries obtained from the specification model. Then import it into the ANSYS Workbench. In order for the sample to be analyzed by FEM, a triangular type of mesh is used with 148405 elements generated using the model. The boundary conditions are defined as load and support in the case of thermal analysis, and convection coefficient and temperature in the case of thermal analysis. After researching and analyzing the problem in reality, there are two conditions for basic research and two for basic research. For standardized tests, the first level of the boundary is 5 MPa pressure, which acts on piston head and the second level of support in the geometry.Different sizes of Thermal Barrier Coating are mentioned. The methodology of this study has 3 main components listed below

1. Calculation of various data of the modified piston.
2. Modelling of modified piston & coating
3. Pre-processing of the model.

5 RESULT AND DISCUSSIONS

Identify piston defects and the level of detected defects. Von Mises stress is commonly used in piston design because it allows any sudden 3D stress to be measured at a fixed cost. The equilibrium weight is the component of the maximum probability study equal to the probability used to determine the yield in any of the four objects. Here, compare the cycle stresses and mean values of the same for all entries. Finally, deformations are found in different materials.

6 ANSYS AND TAGUCHI ANALYSIS

DEFORMATION

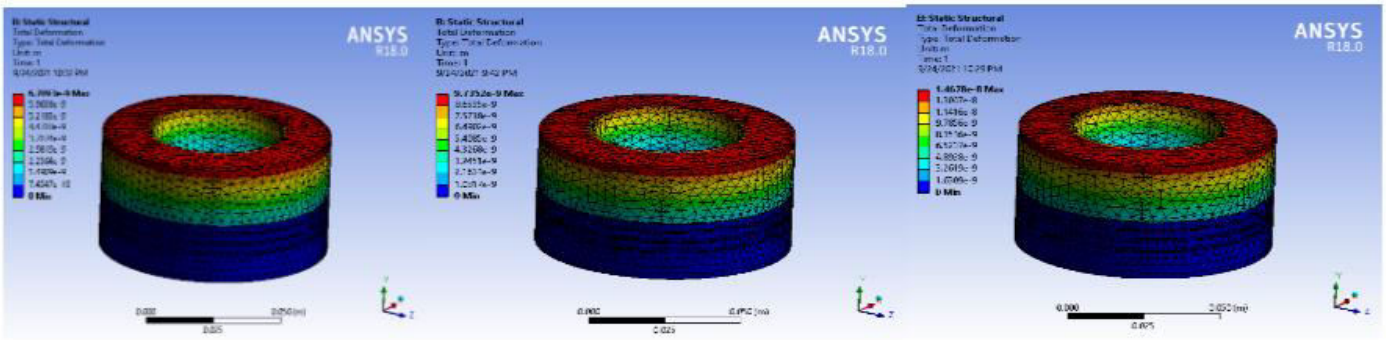

Figure 1(a) D1M1C1 Figure 1(b) D1M2C2 Figure 1(c) D1M3C3

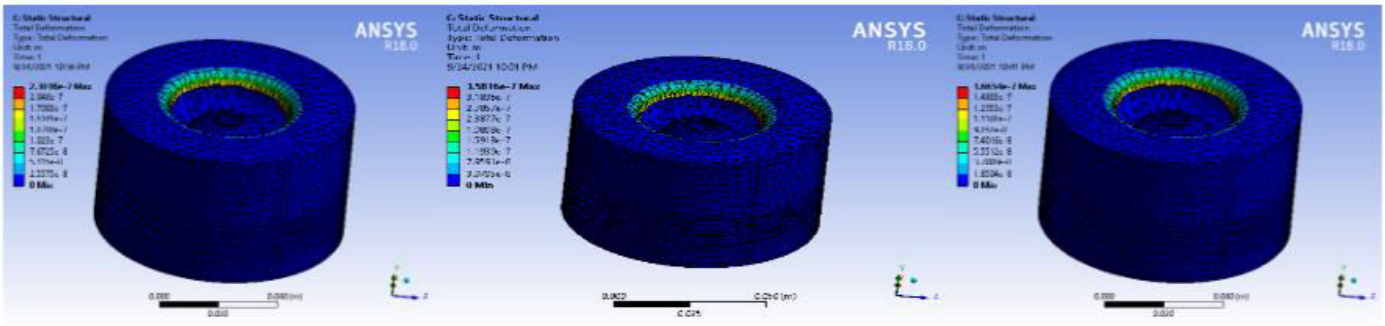

Figure 1(d) D2M1C1 Figure 1(e) D2M2C2 Figure 1(f) D2M3C3

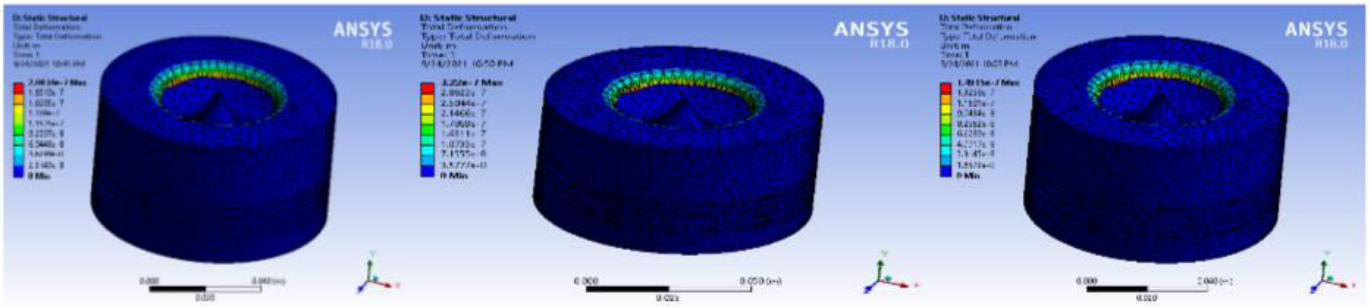

Figure 1(g) D3M1C1 Figure 1(h) D3M2C2 Figure 1(i) D3M3C3

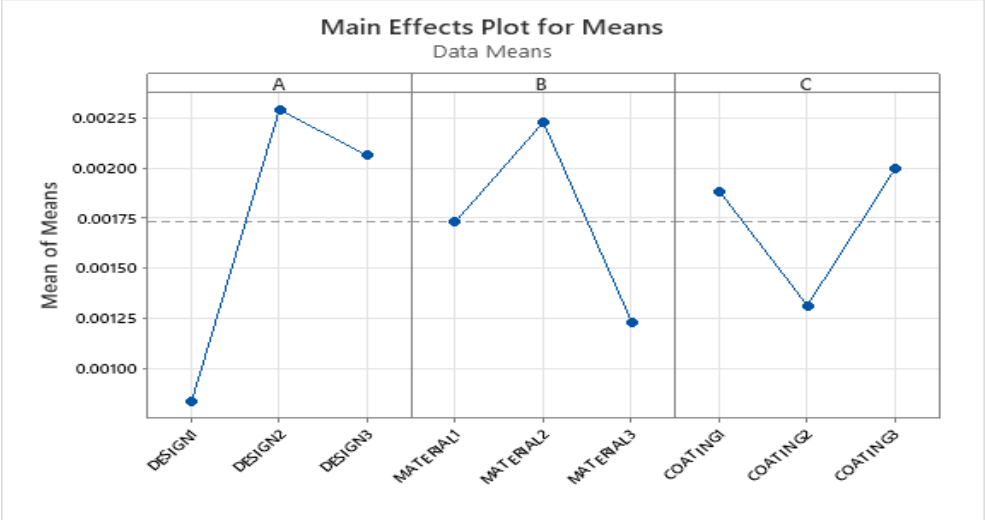

Figure 2 Main effect plot for means

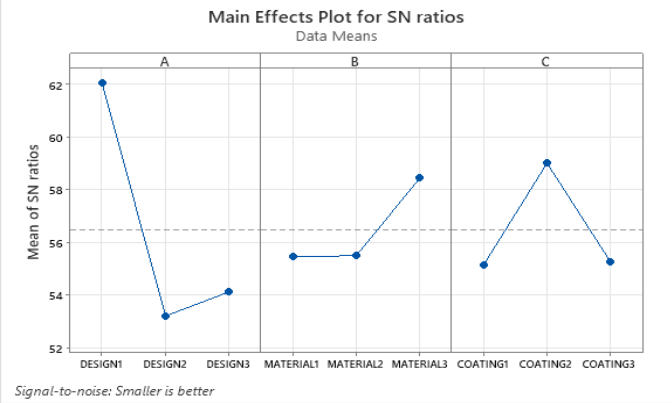

Figure 3 Main effect plot for SN ratio

Table 1 Deformation values

PISTON DESIGN	MATERIAL	COATING	DEFORMATION (M)
DEEP CYLINDRICAL	ALCOA ALLOY	ALUMINA	0.001201
DEEP CYLINDRICAL	NIMONIC ALLOY	MAGNESIA	0.000492
DEEP CYLINDRICAL	STEEL GRADE 201	TITANIUM	0.000827
SHALLOW RE ENTRANT	ALCOA ALLOY	ALUMINA	0.002098
SHALLOW RE ENTRANT	NIMONIC ALLOY	MAGNESIA	0.003265
SHALLOW RE ENTRANT	STEEL GRADE 201	TITANIUM	0.001518
HEMISPHERICAL EXISTING	ALCOA ALLOY	ALUMINA	0.001899
HEMISPHERICAL EXISTING	NIMONIC ALLOY	MAGNESIA	0.002936
HEMISPHERICAL EXISTING	STEEL GRADE 201	TITANIUM	0.001360

6 CONCLUSIONS

In structural analysis, deformations are proportional to changes in gas pressure. Different alloys are used, such as Alcoa alloy, Nimonic alloy, 201L Grade Stainless Steel in the present study. Several tests were performed on the designed model with respect to deformation. Finally, when comparing the thickness of lining material such as Alumina, Magnesia, Titanium is better to use in the piston head. It is concluded that the smallest deformation was found as 0.000492 Meter, which is shown in Table 1, using Design 1 (Deep cylinder piston), Material 2 (Nickel-Chrome) and coating 2 (Magnesia).

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