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Thermo-Stress Analysis of Coated and Non-Coated Engine Piston To Find Effective Heat Barrier.

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Abstract: *To avoid generation of heat by friction oil control ring is provided. It lubricates engine piston and avoid extensive friction and wear. But at the T.D.C. power stroke will generate the extensive heat and power which directly impinge on the piston top. During long term running of engine this heat on the engine top and thrust generated cause the piston material wear and damage. To avoid such damage, we can provide coating on the piston surface which will be thermal insulating material and tough enough to withstand on high impact loading.*

In this project thermal analysis of coated and non-coated piston will be carried out with the help of ANSYS 2020 R1 software, which is FEM tool. For that purpose, CAD model of Piston will be created in CATIA V5R21 Software. The temperature, thermal stresses and heat transfer rate will be compared with each other to find effectiveness of the thermal barrier coating. For coating of piston ceramic will be used which is thermal insulator and good adhesive.

Keywords: T.D.C. power stroke

I. INTRODUCTION

Although the piston seems to be a simple part, it is actually quite complex from a design standpoint.

The efficiency and economy of the engine depending on the working of the piston. It must operate in the cylinder with minimum friction and it should be able to withstand the high explosive force generated in the cylinder and also the very high temperature ranging from 2,000°C to over 2,800°C during operation.

The piston should be as strong as possible, however, its weight should be minimized as far as possible in order to reduce the inertia due to its reciprocating mass.

II. METHODS

Methods for Thermo-Stress Analysis

- Modeling : FEA software is used to create a 3D model of the piston, including the coating (if applicable), and simulate the thermal and structural loads.
- Material Properties : Accurate material properties (thermal conductivity, thermal expansion coefficient, etc.) are input into the model.
- Boundary Conditions : Realistic boundary conditions, such as heat flux from the combustion chamber and cooling conditions applied
- Simulation : The FEA software solves the heat transfer equations to determine the temperature distribution throughout the piston.

III. CONCLUSION

Thermo-stress analysis consistently demonstrates that TBCs are an effective way to improve the thermal performance of engine pistons. By reducing heat transfer and lowering temperatures, TBCs contribute to increased engine efficiency, durability, and reduced emissions.

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the maximum temperature on the top surface of the GZO/YSZ DCL-coated piston increased by 60.25 °C compared to the uncoated piston. This suggests that the GZO/YSZ DCL coating effectively reduced the temperature of the piston substrate, thereby protecting the piston against high thermal load.

REFERENCES

[1]. The Thermal Stress Distribution for coated and uncoated piston models show that the thermal stress is maximum at the centre for uncoated model and at edges for the coated model. This method can eliminate the severe restrictions on the development of the natural gas engine and also can be referenced by other internal combustion engine components. Experiments and simulation analyses were conducted to determine the effects of the Nano PYSZ TBCs on temperature and thermal load distributions.

[2]. Results showed that the substrate temperature of Nano PYSZ TBCs piston was considerably lower (about 16% or 55 °C lower) than that of the conventional (uncoated) piston, which indicates that TBCs can effectively provide thermal fatigue protection for pistons and reduce thermal damage to pistons.Simultaneously, the top surface temperature of the piston increased about 52% or 179 °C after applying the coatings, which increased the combustion chamber temperature, resulting in an improved the engine thermal efficiency.