DESIGN AND ANALYSIS OF CERAMIC COATED DIESEL ENGINE PISTON USING FEA

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ABSTRACT

The main objective of this project is to improve performance of the IC engine piston using coated a ceramic material. In this work, bonding layer is NiCrAl and ceramic based magnesium partially stabilized zirconium were plasma sprayed onto piston crowns and in order to minimize thermal stresses. Several samples were deposited with NiCrAl bonding layers prior to coating of mgzro3 for comparison purpose with the uncoated piston. The performance of the coating against high temperature was tested using a burner rig. The temperatures on the top of piston crown and piston underside were measured. Finally, the heat fluxes of all conditions of piston crown were calculated. In short, the mgzro3/NiCrAl coated piston crown experienced the least heat fluxes than the uncoated piston crowns and the coated piston crown, giving extra protection during combustion operation.
Keywords—TBC (Thermal Barrier Coating), FEA, Ansys, Piston, Diesel Engine.

INTRODUCTION

Over past few decades numerous changes were brought in internal combustion (I.C) engines.This numerous researches laid foundation to improve the performance characteristics of I.C engine.Increasing the efficiency and reducing the exhaust gases have been the dominant role in the field of research.Thermal barrier coating will be a solution for this problem.It is important to calculate the piston temperature distribution

In order to control the thermal stresses and deformations within acceptable levels. The temperature distribution enables the designer to optimize the thermal aspects of the piston design at lower cost, before the first prototype is constructed.

As much as 60% of the total engine mechanical power lost is generated by piston ring assembly. Most of the internal combustion (IC) Engine pistons are made of aluminum alloy which has a thermal expansion coefficient 80% higher than the cylinder bore material made of cast iron.

This leads to some differences between running and the design clearances. Therefore, analysis of the piston thermal behavior is extremely crucial in designing more efficient engines. The thermal analysis of piston is important from different point of views. First, the highest temperature of any point on piston should not exceed 66% of the melting point temperature of the alloy.

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This limiting temperature for the current engine piston alloy is about 370 °C.This temperature level can be increased in ceramic coating diesel engines although the various table text styles are provided.

METHODOLOGY

Here heat transfer reduction process is calculated by using FEA method in analysis software(Ansys).Part modeling is created by using solidworks(modeling software).

EXPERIMENTAL SETUP

structure

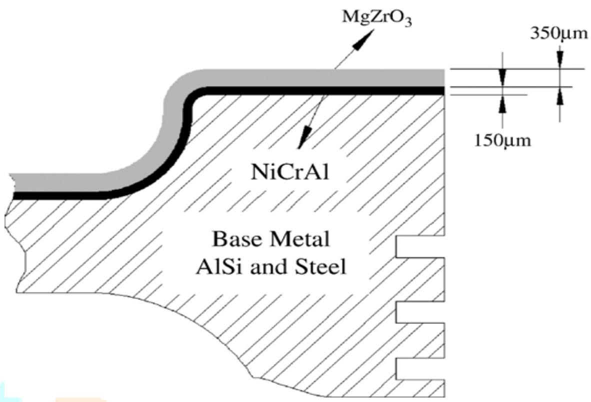
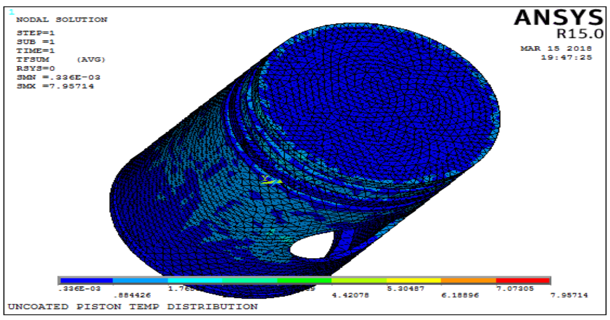


Fig 1 Thermal barrier coating thickness

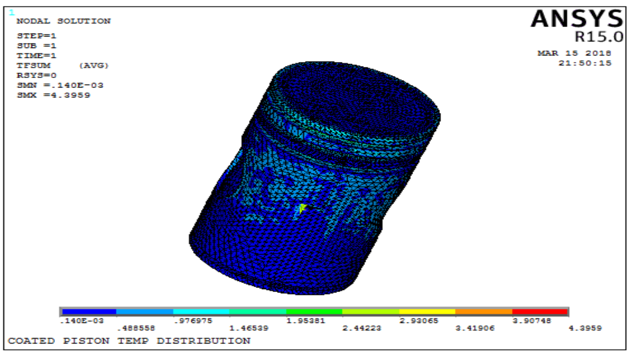
Magnesium alloys are promisingly applied in a number of domains including automotive, aerospace and computer and communication industries owing to their prominent characteristics, such as low density, high specific strength and stiffness. However, the applications of magnesium alloy are seriously restricted by their poor corrosion resistance and heat resistance.

It is necessary for magnesium alloy products to adopt proper surface protective treatment. Micro-arc oxidation (MAO) has been generally recognized as one of the most prospective methods of surface treatment for magnesium alloys.

RESULTS AND DISCUSSION



TEMPERATURE DISTRIBUTION FOR AlSi ALLOYS (UNCOATED PISTON)



TEMPERATURE DISTRIBUTION FOR NiCrAl ALLOYS (COATED PISTON)

RESULT AND DISCUSSION

Sl.NO	MATERIAL	DEFORMATION (maximum)	TEMPERATURE DISTRIBUTION (max temp:350 C)
1	AL-SI	4.271*e^-5	343.2 C
2	$Mgzro_3$	4.1808e^-5	318.7 C

Above result table discussion about temperature distribution of uncoated and ceramic coated piston in FEA method. Comparison of these two result concluded at the temperature distribution of coated piston is less then the uncoated piston.

CONCLUSION

Thermal analyses are investigated on a conventional (uncoated) diesel piston, made of aluminium silicon alloy and steel. Secondly, thermal analyses are performed on pistons, coated with MgZrO3 with bonding of NiCrAl material by means of using a commercial code, namely ANSYS. Finally, the results of four different pistons are compared with each other. The effects of coatings on the thermal behaviours of the pistons are investigated. It has been shown that the maximum surface temperature of the coated piston with material which has low thermal conductivity is improved approximately 48% for the AlSi alloy and 35% for the steel. In this projects we have simulate the coated piston used by ANSYS 14.0 then compare the conventional (uncoated) diesel piston and coated with MgZrO3 with bonding of NiCrAl material.

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