Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 7, July-2016

COMPARING THE TEMPERATURE RESULT IN STEADY STATE THERMAL FOR CI ENGINE PISTON COATED WITH SINGLE TBC MATERIAL LAYER

Ankit Manral[1], Osama Lari[2]

[1](Mechanical Department, IIMT ENGIEERING College)
[2](Mechanical Department, IIMT ENGIEERING College)

Abstract : *There is a very vital role of Diesel Engine on Today Scenario. On both Agriculture and Transportation for higher fuel economy with compatible price. Here the heat carried out by the coolant from heat engine where 30-40% is used in useful work. The cooling system used in engine absorb heat energy generate due to friction and due to combustion and vanish it to surroundings to ensure engine temperature always remain below the safe level. Due to the emission of useful form energy to the environment it is need to their use of some thermal barrier system which overcome all this type of problem. Now the major deal is to improve performance characteristics and the efficiency of the Internal Combustion engines due to the environmental requirement and some continuous technological demand from industries besides rapid increase in the cost of the fuel. On the other hand, there is increasingly important to improvement in engine material by the introduction of new alternative fuels. In order to overcome the problem there some idea has generated to solve the problem which arises and that can be solve by using TBC material coating on the surface of piston crown by using different material and comparing the result.*

Keywords – *TBC, Piston, CI Engine, Diesel Engine, Temperature.*

I. INTRODUCTION

Generally, the used of TBC material coating on gas turbine blade. Than it is partially added on the SI engine piston crown, the petroleum crisis and the subsequent increase in the cost of fuels, the improvement of fuels and the improvement of fuel economy of the I.C Engines has become a high priority to the researchers. Reducing heat rejection in reciprocating engines is a possible way of reducing fuel consumption. The used of TBC material coating on the surface of piston is help in maintain the temperature inside the cylinder the result of this reduce in temperature of piston skirt which reduces the thermal stresses and complete combustion of hydro carbon which reduce the emission of harmful gases at exhaust. The comparative result analysis for used of different TBC material coating on the top surface is done by tool ANSYS 14.

II. TBC COATING ON PISTON CROWN

There is a very wide used of TBC material to increase the performance of SI engine for maintain the temperature inside the combustion chamber. The uses of TBC coating material inside the CI Engine increase the Performance by reduce the heat loss along the piston length and result of this reduce thermal stresses on the skirt of piston. The Coating is done with the help of Plasma Spray on the surface of piston crown. Here TATA INDICA V2 Diesel Variant Aluminium Alloy piston is used for analysis work on ANSYS and find out the Temperature Distribution along the surface of piston length. Here the TBC material used for analysis up to a working condition of temperature 800^{o}C due to the low thermal conductivity of TBC material it will restrict the flow of heat from piston Crown to piston skirt which reduce the deformation of piston due to increase of thermal stresses and also increase the life of piston.

III. EFFECT OF TBC COATING AND METHOD OF COATING

In our analysis ANSYS 14 is used to get out the results of temperature variation on the surface of piston. There are different methods are use of coating on the surface of piston crown they are as follows.

1. Physical Vapour Decomposition (PVD)
2. Chemical Vapour Decomposition (CVD)
3. Ion Coating

4. Splash Coating
5. Electron Beam Evaporation Coating (EBE)
6. Flame Spray (FS)
7. Plasma Spray (PS)
8. Sol-gel (SG)
9. Detonation Gun (DG)

10. Reactive ion coating (IP)
11. Hot izostatical press coating (HIP)

There are following effects on the performance of CI engine as follows: -

1. Decrease fuel consumption
2. Increase Piston life
3. Decrease emission of unburnt carbon.
4. Compete combustion of hydrocarbons

IV. MATERIALS USED FOR THERMAL BARIER COATING IN ENGINE

There are some properties according to which TBC material or coating is used. They are high melting point, no phase transformation between room temperature and operation temperature, low thermal conductivity, chemical inertness, thermal expansion match with the metallic substrate, good adherence to the metallic substrate and low sintering rate of the porous microstructure. For according to given properties following are the material which satisfied the given conditions.

1. YSZ
2. Zirconia
3. Mullite
4. NiCrAl
5. $MgZrO_3$

V.ANALYSIS ON PISTON SURFACE COATED WITH TBC MATERIAL ON TOP

In our analysis the tool is used for get the result is ANSYS 14. And the piston Dimension is used in our work for TATA INDICA V2 DIESEL VARIANT that should be model on SOLID WORKS, and then it is import on ANSYS. On Aluminium Alloy Piston Coating of 1mm TBC material applied and all are compare with result of uncoated piston. Than find out the result, compare it to each other, then find out the best. The condition is used for STEADY STATE THERMAL are, the top surface temperature is 800°C and the conventional or ambient temperature is 22°C. After apply the condition the given result is shown below in figures 1-6.

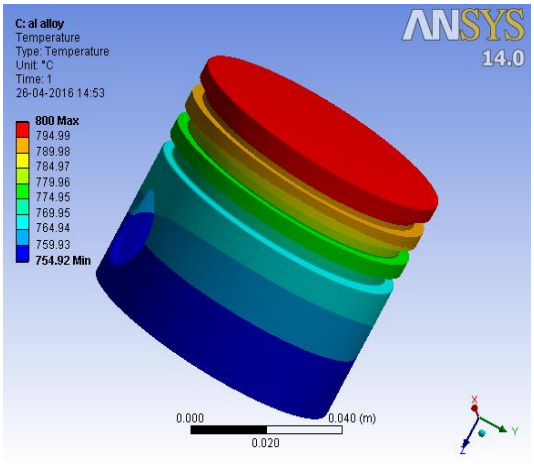

Fig.1 Uncoated piston

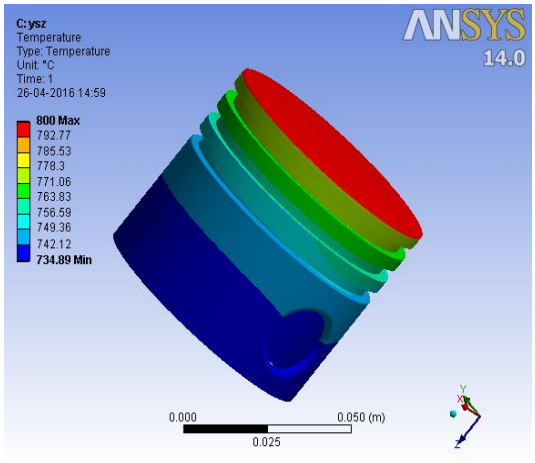

Fig. 2 YSZ Coated

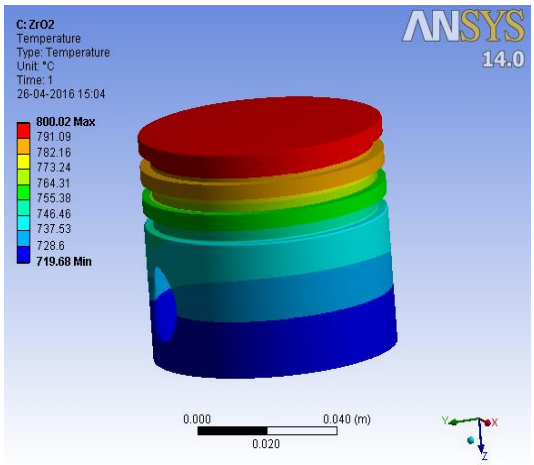

Fig.3 Zirconia coated

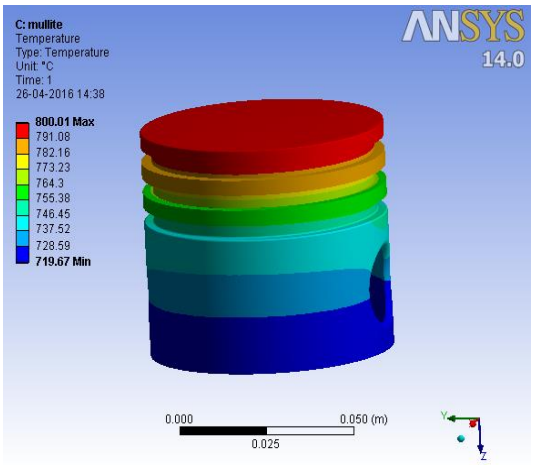

Fig.4 Mullite Coated

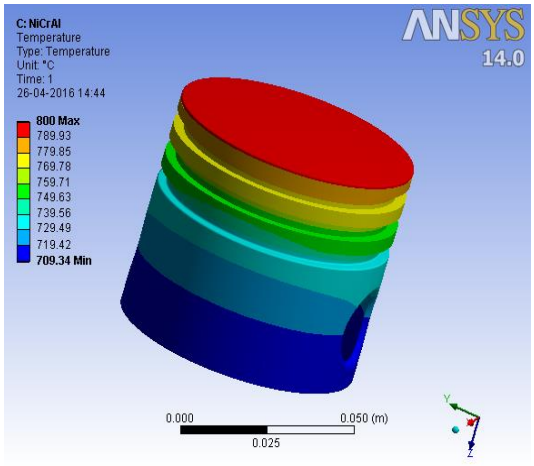

Fig.5 NiCrAl coated

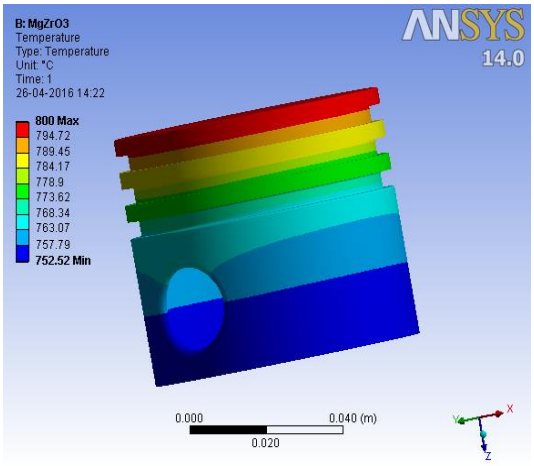

Fig.6 MgZrO3

In Above Figures different colors shows the different variation of temperature nor above result is tabulated in table 1 below.

Table 1- Temperature Variation result of coated and uncoated result

MATERIALS	Temperature at top (^{0}C)	Temperature at bottom (^{0}C)
UNCOATED PISTON	800	754.92
YSZ COATED	800	734.89
ZIRCONIA COATED	800	719.68
MULLITE COATED	800	719.67
NiCrAl COATED	800	709.34
$MgZrO_3$ COATED	800	752.52

In above result all coating result compared with uncoated piston result are showed above on which NiCrAl give the best result for maintain the temperature inside the cylinder or to restrict the temperature towards the piston skirt due to efficient property of the NiCrAl.

VI. CONCLUSION

The applications of thermal barrier coatings to various components of combustion zone of an engine such as valves and cylinder liner has produced significant improvements in mechanical and thermal efficiency and other performance parameters of the engine like reduces exhaust emission and specific fuel consumption and. Thus this paper explores various aspects, effect and application of thermal barrier coating in piston, cylinder liner, SI engine and Diesel engine. So this paper reference guide for the researches who work on coatings for engine applications.

REFERENCES

[1] G. Anusha, et al, "Modeling and Analysis of Piston Design through Pro/E & ANSYS", International Research Journal of Engineering and Technology, vol.02, No-6, (2015)

[2] Silva, F., "Fatigue on engine piston –A compendium of case studies", Engineering Failure Analysis,vol.13, no.3, pp.481-492, (2005)

[3] H. Pandey, et al, "Thermal stress analysis of a speculative IC engine piston using CAE tools", International Journal of Engineering Research and Applications, Vol. 4, Issue 11, pp.60-64, (2014)

[4] Reddy, S.S. et al, "Thermal Analysis and Optimization of I.C. Engine Piston Using Finite Element Method", International Journal of Innovative Research in Science Engineering and Technology, *vol*. 2, no-12, (2013)

[5] Sharma, S.K. et al, "Experimental Thermal Analysis of Diesel Engine Piston and Cylinder Wall"**,** Hindawi Publishing Corporation Journal of Engineering, Article ID 178652, pp.159-169, (2015)

[6] G, Siva Kumar, "Investigation on effect of Yttria Stabilized Zirconia coated piston crown on performance and emission characteristics of a diesel engine", Alexandria Engineering Journal, vol.- 53, no.- 4, pp.787–794, (2014)

[7] Sridhar, K. et al, "Thermal barrier Analysis in Diesel", International Journal of Modern Engineering Research, vol.3, no.3, (2013)

[8] Moskal, G., "Thermal barrier coatings: characteristics of microstructure and properties, generation and directions of development of bond", Journal of Achievements in Materials and Manufacturing Engineering, vol.37, no.2, pp.323-331, (2009)

[9] Helmisyah, A.J. et al, "Effect of Thermal Barrier Coating on Piston Crown for Compressed Natural Gas with Direct Injection Engine", Applied Mechanics and Materials, vol. 52-54, pp. 1830-1835, (2011)

[10] Gnanamoorthi, V. and Devaradjane, G., "The effect of thermal barrier coating material in CI engine using higher fraction ethanol diesel blend", Journal of Chemical and Pharmaceutical Research, vol.7, no.2, pp.416-422, (2015)

[11] Lakshmanan, S. et al, "Investigation of Thermal Barrier Coating on I.C Engine Piston", International Journal for Research in Applied Science and Engineering Technology, Special Issue-1, pp.44-48, (2014)

[12] Kumar, R. et al, "Alternative Thermal Barrier Coatings for CI Engines -A Research Review", International Journal of Research In Advent Technology, Vol.2, No.5, (2014)