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THERMAL & STATIC ANALYSIS ON IC ENGINE PISTON USING FEA

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ABSTRACT

In this paper we study, thermal and static structural analyses area unit investigated on a conventional diesel piston, manufactured from aluminum silicon alloy. Secondly, thermal and Static analysis area unit performed on piston, alloy of aluminum with Zirconium material by means that of employing an industrial code, namely ANSYS. The consequences of Zirconium material on the thermal behaviors of the pistons area unit investigated. The finite element analysis is performed by using computer aided design software. The main objective is to research and analyse the thermal stress distribution and static structure analysis of piston at the real engine condition throughout combustion process. This thesis describes the mesh improvement by victimization finite element analysis technique to predict the higher stress and critical region on the element. During this work, the main stress is placed on the study of thermal behavior of functionally graded coatings obtained by means that of of using a commercial code, ANSYS on aluminum and zirconium alloyed aluminum piston surfaces.

The analysis is completed to lessen the stress fixation on the upper end of the piston i.e. (piston head/crown and piston skirt and sleeve). With utilizing computer aided design CATIA software the structural model of a piston will be created. Besides, the limited component investigation is done utilizing Computer Aided Simulation programming ANSYS

I. INTRODUCTION

Engine pistons are one in all the foremost difficult components among all automotive and completely different trade field components. We knew an engine was known as the heart of a motor vehicle as like the piston may be viewed as the most vital part of an engine. There are several exploration works suggesting, for engine pistons, new geometries, materials and producing ways, and this development has veteran with a non-stop amendment within the course of the foremost recent decades and needed complete examination of the tiniest delicate components. Despite all of those studies, there are an infinite of broken pistons. Damage parts have distinctive beginning points and are largely sporting, temperature, and weakness connected. The exhaustion connected piston damages assume overriding preponderating half for the foremost half in lightweight of thermal and mechanical fatigue, either at area or at hot temperature.

Automobiles components are in high-quality interest in recent times because of multiplied usage of automobiles. The improved hobby is due to more desirable execution and reduced fee of these components. Studies and improvement and checking out engineers ought to create critical elements in most confined practicable time to minimize dispatch time for brand spanking new products. This calls for comprehension of latest advances and brief absorption in the development of new products. A piston is part of responding IC-engines.

The IC engine main components are

1. Piston
2. Piston rings
3. Gudgeon pin
4. Connecting rod

1.1 Piston

A piston is part of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. it's far the moving segment which is contained by using a chamber and is made gas-tight by using piston rings. In an engine, its motivation is to trade power from increasing fuel inside the cylinder to the crankshaft by means of a cylinder bar/or connecting rod. In a pump, the role is turned round and electricity is converted from the crankshaft to the piston cylinder for the reason of compacting or ejecting the fluid in the chamber. In a few engines, the cylinder additionally performances as a valve by protecting and revealing ports within the cylinder wall.

Piston cylinders are four sorts there are:

1. Trunk pistons
2. Cross head pistons
3. Slipper pistons
4. Deflector pistons

II. PISTON DESIGN

The cylinder is designed in line with the manner and backbone that are given in machine configuration and statistics hand books. The measurements are ascertained regarding SI units. The pressure implemented on cylinder head, temperatures of various degrees of the cylinder, heat circulation, stresses, traces, duration, diameter of cylinder and hollow, thicknesses, and so forth, parameters are taken into concerns.

2.1 Piston Design Considerations

1. In design planning a piston for an engine, the accompanying points ought to be considered:
2. The cylinder needs to have the strength to oppose the force and state of being inactive forces.
3. Capacity to scatter the warmth of ignition and avoid thermal bending.
4. Closing the fuel and oil

5. Adequate bearing zone to work for huge number of responding cycles
6. Weight required may be minimal
7. Clean silent operation
8. Give enough backing to cylinder pin

2.2 Piston Design Parameters Procedure

The technique for cylinder designs comprises of the accompanying steps:

1. Thickness of cylinder head
2. Warmness guides via the cylinder head
3. Radial thickness of the ring
4. Axial thickness of the ring
5. Width of the top region
6. Size of other ring lands

Consequently, the measurements for the piston are calculated and those are used for exhibiting the piston in CATIA V5 R18. Within the above approach the ribs within the piston aren't completed, in order make the piston model simple in its design. In demonstrating a piston considering all factors will get to monotonous process. On this way, a symmetric version is produced using the above measurements.

2.3 Model of the Piston Before Optimization

The accompanying are the sequence of steps in which the piston is demonstrated.

1. Drawing a half part of piston
2. Exiting the sketcher
3. Developing the model
4. Making a hole

Design Specifications

Sl. No.	Measurements	In metric units
1	Piston length	65.128
2	Piston outer diameter	90
3	Thickness of the piston head	21.629
4	Ring radial thickness(t_1)	3
5	Ring axial thickness (t_2)	2
6	Top land thickness(b_1)	10
7	Other ring lands width(t_1)	2

Material Properties

PROPERTIES	Al	Al-Zr
Young's modulus (E)	70000MPa	2.2E5MPa
Poisson's ratio (μ)	0.31	0.35
Density	2770Kg/M^3	2937 Kg/M^3
Thermal conductivity (K)	234W/M^0C	7W/M^0C
Specific heat	875 J/Kg^0C	894 J/Kg^0C

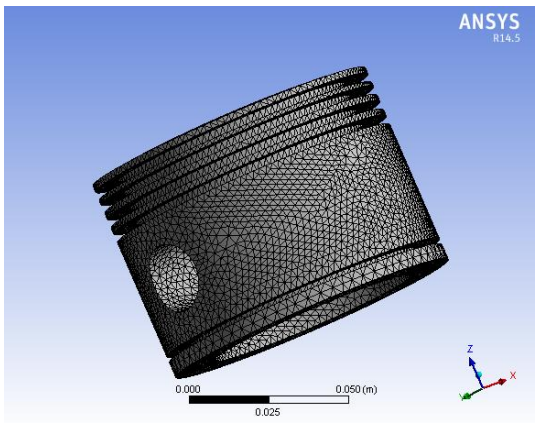
III. FINITE ELEMENT ANALYSIS (FEA)

FEA is the practical utilization of the finite element method (FEM), which is utilized by architects, and scientists to scientifically model and numerically apprehend extremely complex structural, liquid, and multiphase troubles. FEA programming can be used in full-size form of businesses, but is most generally utilized as part of the aeronautical, biomechanical and locomotive industries.

A finite element (FE) version contains an arrangement of factors, known as "hubs", which frame the state of the outline. Joined with these hubs are the finite elements themselves which frame the finite detail mesh and incorporate the material and basic properties of the model, characterizing reaction of it in specific situations. The density of the finite element mesh might also differ all through the material, contingent upon the foreseen change in strain levels of a specific component. Areas that revel in excessive adjustments in stress for the maximum component require a higher mesh density than those who revel in little or no pressure version. Functions of hobby might also comprise crack functions of in advance tried material, fillets, corners, complicated factor of intersect, and high-strain areas.

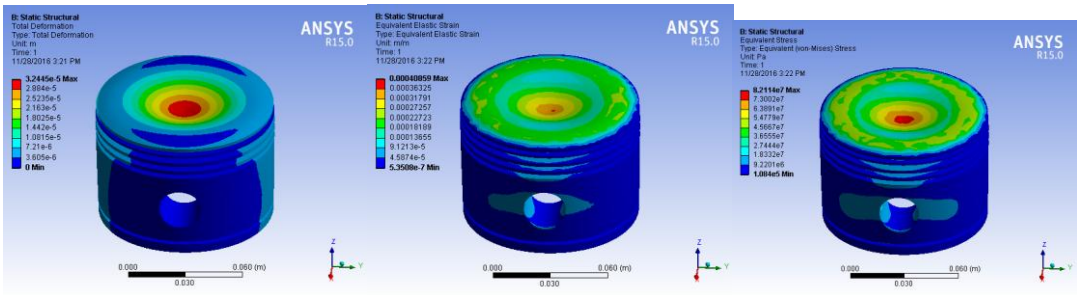
3.1 Static and Thermal Analysis of Piston

Meshed model

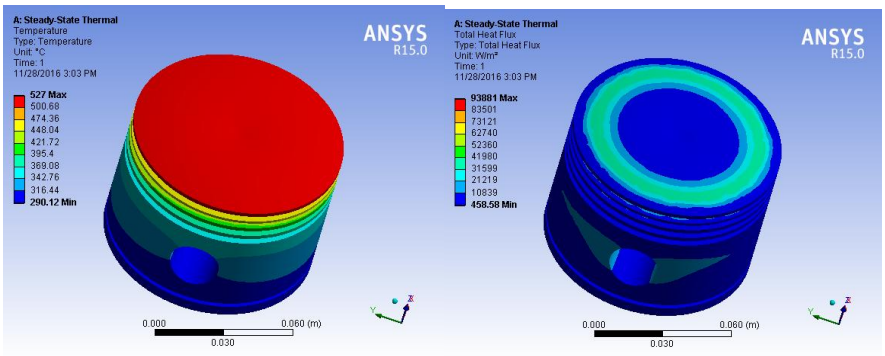


3.2 Aluminium Alloy with Zirconium

Total Deformation Equivalent Elastic Strain Equivalent Stress

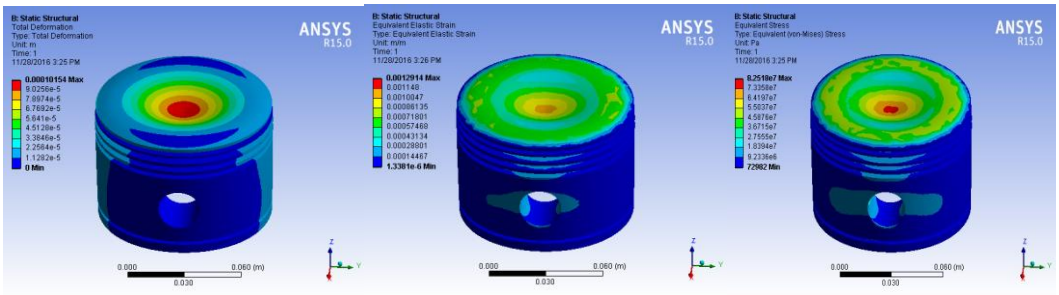


Temperature Total Heat Flux

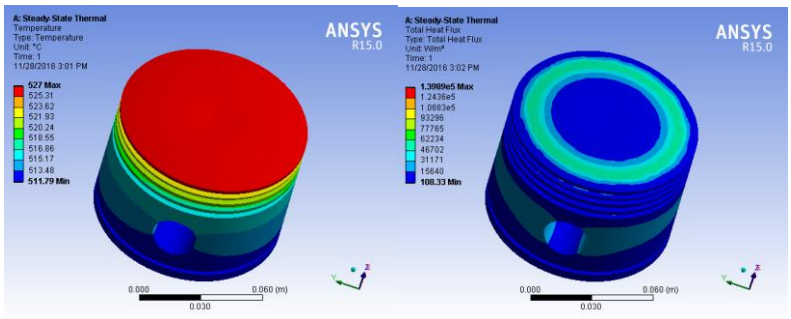


3.3 Aluminium Alloy

Total Deformation Equivalent Elastic Strain Equivalent Stress



Thermal Analysis



Temperature Total Heat Flux

IV. RESULT AND DISCUSSION

From the above analysis of piston head in ANSYS 14.5 the results are collected in tabular form for both materials.We have noticed a change in both temperature basis and static factors

Comparison Table for Static Structure Analysis

	WITH ZIRCONIUM	WITH OUT ZIRCONIUM
Total deformation,(m)	3.2445E-5 m	0.00010154 m
Equivalent elastic strain,(m/m)	0.00040859	0.0012914
Equivalent stress,(pa)	8.2114E7	8.2518E7

Comparison Table for Steady State Thermal Analysis

	WITH ZIRCONIUM	WITH OUT ZIRCONIUM
Conduction temperature,(c)	290.12	511.79
Total heat flux,(w/m^2)	93881	1.3989e5

V. CONCLUSION

Our project is to design and analysis of both static and steady state thermal on piston head. As engine is known as heart of automobile where piston plays a vital role where durability and thermal conduction plays an important role**.** We have designed piston using CAD software namely CATIA V5 and analysis is done using ANSYS 14.5 and the thermal and static analysis is drawn under required boundary conditions.We analysed piston with aluminium alloy material immersed with material namely zirconium and without zirconium in place of silicon for better thermal conditions and deformation factors.

We have observed that alloy material after adding zirconium and without zirconium shows good results when compared to regular alloy material. In static analysis aluminium alloy with zirconium shows lower deformation and less affected to stress and strain factors when compared same alloy without zirconium. The results also effected for thermal analysis where we can see a better results when zirconium and without zirconium are added.By this project we want to conclude that by adding zirconium to aluminium alloy we can extend performance of IC engine. And as a replacement for aluminium with zirconium we can use aluminium without zirconium.

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