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Static & Thermal Analysis of Piston for Single Cylinder Diesel Engine by Ansys : A Review

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Abstract- The main objective of this present research work is to investigate and analyze the stresses which are acting on the piston. The parameter which is used for analysis is temperature, operating pressure and properties of materials. Piston in internal combustion engine play most important role because it transfers the force which is produced during the combustion of fuel to crankshaft due to which it converts the pressure energy into mechanical energy. Piston fails due to thermal and mechanical stresses which are produced under the running condition of engine. The boundary conditions are applied for static and thermal analysis which includes pressure on piston head during working period and uneven temperature distributions occurs from head of piston to skirt of piston. The 3D-model will be created using SOLIDWORKS2018.the 3D model will be imported in the Ansys software for geometry and meshing purposes then the FEM Analysis will be done on ANSYS software. Analysis will help to change the existing design for reduce the weight. Finite Element Analysis is the best method for analyzing the stresses in piston.

keywords- *FEA,Ansys,piston,I.C engine*

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I. INTRODUCTION

Piston is one of the components of internal combustion engine which transfer the force from piston head to crank shaft due to which it converts the pressure energy into mechanical energy. It is also used in reciprocating engine, compressors, pumps & pneumatic cylinder etc.

II. OBJECTIVE OF RESEARCH

The objectives of present research are given below.

1. To select material based on quality, weight and economy consideration.
2. To create structural model of piston.
3. To perform static analysis of piston.
4. To perform thermal analysis of piston.
5. To minimize the weight and stresses are acting on the piston under the operating conditions.

III. MAJOR FORCES ACTING ON PISTON

The major forces are acting on the piston given below.

1. Force acts due to explosion of charge.
2. Force acts due to compression of charge.
3. Force acts due to piston cylinder wall friction.
4. Force acts due to thermal load.
5. Inertia force acts due to reciprocating of piston inside cylinder under high speed.
6. Friction forces acts on crank pin and piston pin.

IV. CHARACTRISTICS OF PISTON MATERIALS

1. It should have enough strength to withstand against a very high pressure.
2. It should have minimum weight to resist the inertia forces.
3. It should have enough thermal conductivity so it can easily transfers the heat from piston wall to cylinder wall.

4. It should have high melting point to withstand against the high operating temperature.
5. It should have enough support for piston pin.
6. The construction of piston should be rigid to withstand against thermal and mechanical distortions.

V. LITRATURE REVIEW

[1] Deovrat Vibhandik, Ameya Pradhan, Sampada Mhaskar, Nikita Sukthankar, Atul Dhale, (2014) , Design Analysis and Optimization of Piston and Determination of its Thermal Stresses Using CAE Tools, 3(5), pp.273-277.performed of thermal analysis on conventional diesel piston and secondly on optimized piston which is made of aluminum alloy and titanium alloy material. Structural steel use for making Conventional diesel piston. To reduce the stress concentration on the upper end of the piston for increase life of piston is the main objective of this Analysis. After the analysis he conclude that thermal property of titanium is much better.

[2] Manjunatha.T. R, Dr. Byre Gowda. H. V, Prabhunandan. G. S, (2013), Design and Static Structural Analysis of Cylinder and Piston of Two Stage Reciprocating Compressors Using ANSYS, International Journal of Innovative Research in Science, Engineering and Technology , 2 (12), pp. 7590-7596.study about specification for both high pressure and low pressure stages and analysis is identify area which are likely to fail due to maximum stress concentration during suction and compression. For the cylinder cast-iron used as a Material and for piston aluminum alloy used as a Material for both case low and high pressure.

[3] Swati S. Chougule, Vinayak H. Khatawate, (2013), Piston Strength Analysis Using FEM,International Journal of Engineering Research and Applications, 3, pp.124-126.focused on the main objective of this paper is to investigate and Analysis the stress distribution of piston during combustion process at actual engine conditions. Pressure of operating gas and properties of piston material these both type of parameters are used for simulation.

[4] M. Cerit, "Thermo mechanical analysis of a partially ceramic coated piston used in an SI engine," Elsevier, p. 3499-3505, 2010.temperature and the stress distributions in a partial ceramic coated spark ignition engine’s piston. Effects of coating thickness and width on temperature and stress distributions were investigated including comparisons with results from an uncoated piston. It is observed that the coating surface temperature increase with increasing the thickness in a decreasing rate.

[5] Balahari Krishnan S, AezhisaiVallavi MS, Arunkumar M and Haripraveen A, 2017, “Design and Analysis of an IC Engine Piston using Composite Material", European Journal of Advances in Engineering and Technology, 4, pp. 209-215.The piston crown was made of Inconel, which has high temperature strength and relatively low thermal conductivity. The crown was attached by four bolts with disk springs to maintain a sufficient clamping load despite dimensional changes due to thermal expansion. The effective thickness of the air gap was about 4 mm. The diameter of the air gap was made as large as possible to minimize the heat flow area.

[6] Ankit Kumar Pandey, Sandeep Jain, LokeshBajpai, 2016, "Design, Analysis and Optimization of Four Stroke S.I. Engine Piston using Finite Element Analysis in ANSYS software", International Journal of Advance Engineering and Research Development, 9, pp. 16-27.The area of the combustion chamber above the piston rings. Their research was focused on insulated steel piston for the development of limited cooled engine. They made significant efforts to study the pollution impact on diesel engines and fuel consumption at part load operating conditions.

[7] Dilip kumar sonar, Madhura Chattopadhyay, Theoretical analysis of stress and design of piston head using catia and ansys, international journal of engineering science invention, PP 52-61, Damage mechanisms have different origins and are mainly wear,temperature, and fatigue related. Among the fatigue damages, thermal fatigue and mechanical fatigue, either at room or at high temperature, play a prominent role. In this present work a piston is designed using CATIA V5R20 software. Complete design is imported to ANSYS 14.5 software then analysis is performed. Aluminium alloy have been selected for structural and thermal analysis of piston.

[8] Aditya Kumar Gupta, Vinay Kumar Tripathi, Design analysis and optimization of international combustion engine piston using CAE and ANSYS, Journal of engineering and application, PP 04-10.Here are two steps of analysis of the piston they are designing and Analysis. Firstly design the model of the piston in giving design specification on the modelling software like INVENTOR. Then giving it the constraints which are act on the working condition of the piston after import the model of the piston into the analysis software ANSYS in IGES format. Then the analysis become completed on the different parameters (temperature, stress, deformation) and easily analysis the result. In this work the piston become optimized after the reducing the material of the piston. The mass and volume of the piston become reduced.

[9] Vaishali R. Nimbarte, Prof. S.D. khamankar, Stress analysis of piston using pressure load and thermal load,

international journal of mechanical engineering. Analysis of piston is done with boundary conditions, which includes pressure on piston head during working condition and uneven temperature distribution from piston head to skirt. The analysis predicts that due to temperature whether the top surface of the piston may be damaged or broken during the operating conditions, because damaged or broken parts are so expensive to replace and generally are not easily available. The CAD model is created using PRO-E software. CAD model is then imported into ANSYS software for geometry and meshing purpose. The FEA performed by using ANSYS12

VI. PROBLEM STATEMENTS

Problem statements come from literature survey. Crack are appears on upper end of the piston head due to higher working temperature on the piston head which causes the deformation on the piston head. The greatest stress concentration is developed on the piston head under the operating condition which becomes serious when piston material has less stiffness due to which it continuously deforms against the load. In order to reduce the stress concentration and maintain uniform distribution of temperature the piston material should have high stiffness as well as high thermal conductivity to transfer the easy to cylinder wall.

VII. METHODOLOGY

Present research methodology is given below.

1. To study literature review related to given subject or matter.
2. To calculate dimensions of piston according to specification and procedure given in the machine design data book.
3. The cad model of piston is design by using SOLIDWORKS2018
4. Fea analysis is carried out in ansys

VIII. FUTURE SCOPE.

The future scope of present research is given below.

1. Experimental research can be possible to validate the results of simulations.
2. Coating technique can be used to optimize the weight of piston.
3. Further research is possible to find out the composite material which gives better performance without increasing the cost of piston.

IX. REFERENCE

[1]. Deovrat Vibhandik, Ameya Pradhan, Sampada Mhaskar, Nikita Sukthankar, Atul Dhale, (2014) , Design Analysis and Optimization of Piston and Determination of its Thermal Stresses Using CAE Tools, 3(5), pp.273-277.

[2]. Manjunatha.T. R, Dr. Byre Gowda. H. V, Prabhunandan. G. S, (2013),Design and Static Structural Analysis of Cylinder and Piston of Two Stage Reciprocating Compressors Using ANSYS, International Journal of Innovative Research in Science, Engineering and Technology , 2 (12), pp. 7590-7596.

[3]. Swati S. Chougule, Vinayak H. Khatawate, (2013), Piston Strength Analysis Using FEM,International Journal of Engineering Research and Applications, 3, pp.124-126

[4]. M. Cerit, "Thermo mechanical analysis of a partially ceramic coated piston used in an SI engine," Elsevier, p. 3499-3505, 2010.

[5]. Balahari Krishnan S, AezhisaiVallavi MS, Arunkumar M and Haripraveen A, 2017, “Design and Analysis of an IC Engine Piston using Composite Material", European Journal of Advances in Engineering and Technology, 4, pp. 209-215.

[6]. Ankit Kumar Pandey, Sandeep Jain, LokeshBajpai, 2016, "Design, Analysis and Optimization of Four Stroke S.I. Engine Piston using Finite Element Analysis in ANSYS software", International Journal of Advance Engineering and Research Development, 9, pp. 16-27.

[7]. Dilip kumar sonar, Madhura Chattopadhyay, Theoretical analysis of stress and design of piston head using catia and ansys, international journal of engineering science invention, PP 52-61.

[8]. Aditya Kumar Gupta, Vinay Kumar Tripathi, Design analysis and optimization of international combustion engine piston using CAE and ANSYS, Journal of engineering and application, PP 04-10.

[9]. Vaishali R. Nimbarte, Prof. S.D. khamankar, Stress analysis of piston using pressure load and thermal load, international journal of mechanical engineering.