ISSN:2348-2079

Volume-7 Issue-2

International Journal of Intellectual Advancements and Research in Engineering Computations

Wear and thermal analysis of AL/SI/GR Composite material applied in piston ring using ANSYS

M. Sengottaiyan[1], S. Boopathi Raj [2], M. Harish[2], U. Naveen Kumar[2], S. Jagan[2]

[1]Assistant Professor, [2]UG Students

Department of Mechanical Engineeing, Nandha Engineering College, Erode - 52.

TamilNadu. India.

ABSTRACT

The piston, piston rings and cylinder liners can also work at the higher temperatures and higher pressures and it reduces the frictional losses. In this project the design of piston, piston rings and cylinder liners are modelled in solid works 2015. The alternative material is taken as Aluminium With Silicon Carbide(Sic) And Graphite Composite. Here the analysis is made in the ANSYS 14.5 software where structural and thermal analysis of the piston ring can be determined. Fabricated the al+si+gr Piston ring. Comparing the testing material requirement.

Keyword: Piston ring, Chemical Composion Testing, AL+SI+GR.

INTRODUCTION

Basically, an automobile is a machine that runs on fuel. Fuels such as petrol, gasoline, and diesel that possess stored chemical energy internally, combust inside the engine and result in a highly potent form of kinetic energy. This kinetic energy is used to propel the parts of the engine connected to the axles and the wheels. The motion transmitted to the wheels makes the automobile move.

The work in an automobile is done inside the engine. The engine consists of a combustion chamber. The combustion chamber has an arrangement of a number of cylinders. These cylinders in turn have pistons which are responsible for the working process. The fuel, when injected into the combustion chamber, mixes with compressed air and propels the piston up and down. This piston is connected to a crankshaft which in turn is connected to a drive shaft. This drive shaft provides motion to the axles and these axles move the wheels. Thus, as seen above, the automobile is a piece of art, invented by humans for the betterment of their living and to ease the burden of their daily work. The automobile is a combination of various parts, merged together, in order to provide the required output by the humans. As seen in the diagram, the various parts of the I.C. Engine are shown in detail. Out of these parts, the most critical parts are the Camshaft, the Connecting Rod, the Crankshaft and the Piston. The study project deals with the most important part of the I.C. Engine, i.e., The Pistons and the Piston Rings. To understand the exact cycle of an I.C. engine and the parts of it, the diagram of an Internal Combustion Engine is shown below

Author for correspondence:

Department of Mechanical Engineeing, Nandha Engineering College, Erode - 52. TamilNadu. India.

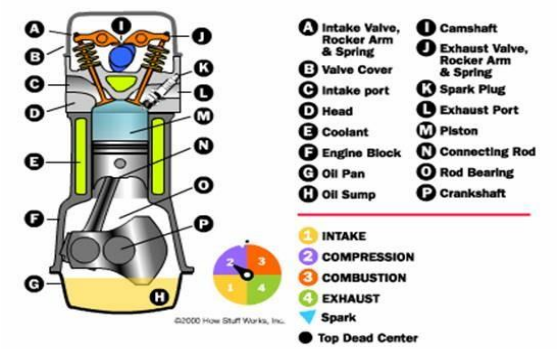


Fig.1 The parts of an Internal Combustion Engine

A disc or short cylinder fitting closely within a tube in which it moves up and down against a liquid or gas, used in an internal-combustion engine to derive motion, or in a pump to impart motion.

Fig.2: The Piston and its main parts

LITERATURE SURVEY

[1]. Ashwani Kumar et al, said that the main objective of this research work is to investigate and analyse the stress distribution of piston at actual engine condition. The parameter used for the simulation is operating gas pressure and material properties of piston. The natural frequency and vibration mode of the piston were obtained and its vibration characteristics are analysed.The free vibration analysis show that the natural frequency of vibration varies from 1.28e-5 hz to 274.44 hz.

[2]. Gudimetal P et al, analysed that damaged or broken parts are generally too expensive to replace, or are no longer available and this is particularly relevant to the automobile industry owing to the ever-increasing accidents. Reverse engineering (re) has been successfully employed to for possible recovery of a damaged or broken part. In this paper, we present a framework which successfully uses re to generate a cad model of a damaged internal combustion (ic) engine piston and then use the state-of-the-art ansys finite element analysis package to perform a linear static and a coupled thermal-structural analysis of the component. Further, a parameteric evaluation of the material properties vis-à-vis operating conditions is carried out to generate a relational database for the piston to arrive at optimal design solutions under different operating conditions.

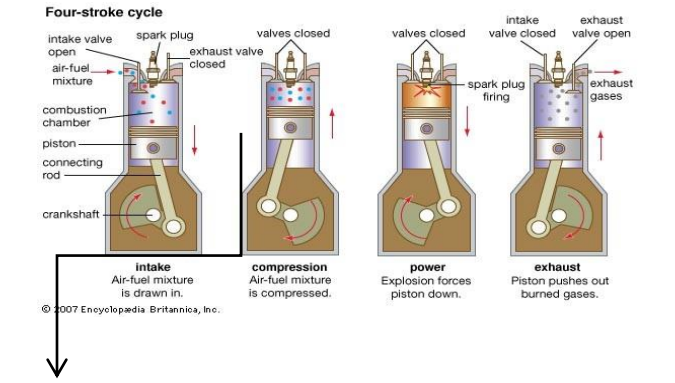
[3]. A.r. Bhagat et al, said that this paper describes the stress distribution of the seizure on piston four stroke engine by using fea. The finite element analysis is performed by using computer aided design (cad) software. The main objective is to investigate and analyze the thermal stress distribution of piston at the

real engine condition during combustion process. The paper describes the mesh optimization with using finite element analysis technique to predict the higher stress and critical region on the component. The optimization is carried out to reduce the stress concentration on the upper end of the piston i.e (piston head/crown and piston skirt and sleeve). With using computer aided design (cad), pro/engineer software the structural model of a piston will be developed. Furthermore, the finite element analysis performed with using software ansys

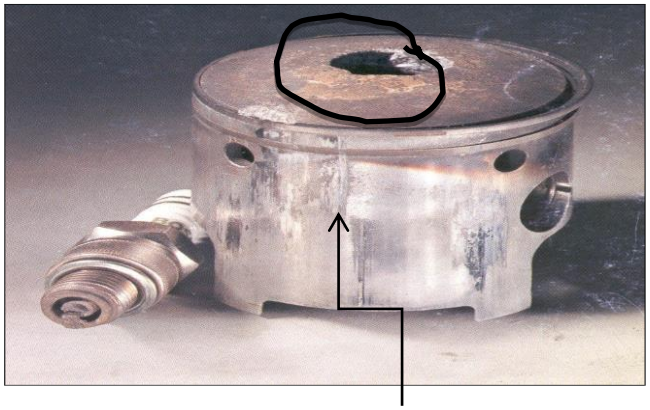
[4]. Isam Jasim Jaber et al, analysed that, In this present work a piston and piston ring are designed for a single cylinder four stroke dieseal engine using CATIA V5R20 software. Complete design is imported to ANSYS 14.5 software then analysis is performed. Three different materials have been selected for structural and thermal analysis of piston. For piston ring two different materials are selected and structural and thermal analysis is performed using ANSYS 14.5 software. Results are shown and a comparison is made to find the most suited design.

[5]. Gunter Knoll et al, A numerical computer simulation program was devel- oped for the interpolation of the three dimensional temperature field of a body on the basis of a few measured temperatures. Inverse techniques are applied, ensuring that the temperature distributions meet measured temperatures and that the interpolation satisfies the governing differential equation and essential physical restrictions. Finite Element methods are used the formulation of both, the forward and the inverse problem. Exemplary, inverse techniques are applied to analyze the temperature field of a combustion engine piston. The number and positions of measured temperatures is varied to find an optimum configuration for practical applications.

FUNCTION OF PISTON RING



PROBLEM IDENTIFICATION



Heat seizure of a Piston

PROCESS FLOW CHART

Present cause friction problem most followed in heavy duty vehicle system. In this concepts while undertaking Model preference Applied Ashock Leyland Industry . This concern A following World Fifth industry automotive industry in Tata Group of consulting 1994. This Product of Engine To consuming Piston Assembly and Focusing Piston in to piston Ring take and Purchased this First our concept [1].

NUMERICAL RESULT & DISCUSSION

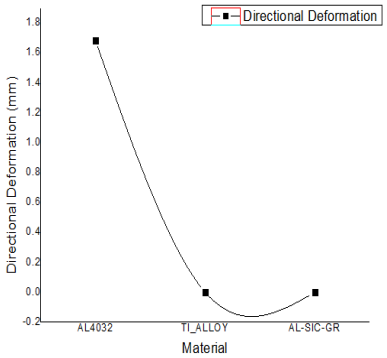


Fig.3 Structural analysis

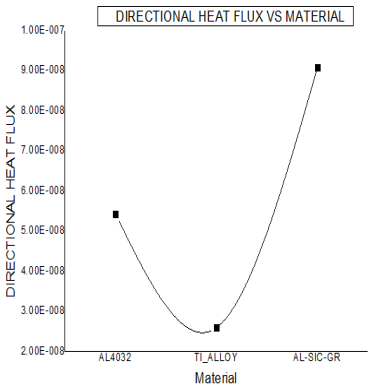


Fig.4 Thermal Analysis

Apply material properties

The materials for the inner, outer ring and balls are linear isotropic structure steel. Young's modulus is $2*10^5$MPa, Poisson's ratio is 0.3 [2-4].

Table. 1 Apply Material Properties

Description	Present material alloy 4032	Aluminium With Silicon Carbide (Sic) And Graphite Composite material	Titanium Ti-6Al -4V
Poisson ratio	0.35	0.28	0.342
Modulus of elasticity(GPa)	79	210	113.8
Thermal conductivity (w/m k)	155	44.5	6.7
Ultimate tensile strength MPa	380	745	950
Yield tensile strength MPa	315	470	880
Density g/cc	2.68	7.8	4.43

It is concluded from the above study that using Solid works 2015 software design and modeling become easier. The few steps are needed to make drawing in three dimensions. Same can be imported to ANSYS 14.5 for analysis. Piston made of three different materials Al Aluminum alloyed , Aluminium With Silicon Carbide(Sic) And Graphite Composite material , material -3 are analyzed. The structural analysis shows that the maximum stress intensity for all the materials on the bottom surface of the piston crown, but stress intensity is close to the Al alloy piston of yield strength. Maximum temperature is found at the piston crown at centre of the top surface. This is equal for all materials. Depending on the thermal conductivity of the materials, heat transfer rate is found minimum in Ti alloy piston and maximum in Al alloy piston. For the given loading conditions, most suitable alloy is found on Al alloy piston. When the loading pattern is changes, other materials may be considered. With the advancement in material science, very light weight materials with good thermal and mechanical properties can be used for fail safe design of the I.C.engine. This will

reduce the consumption of fuel and protect the environment [5].

MANUFACTURING PROCESS

[Piston Ring]

Experimental Approach

We tested the real model of crankshaft to know the composition of material that they used and to gain the exact material properties.

Spark testing

It determiningthe general classification of ferro us materials. It normally entails taking a metal piece, usually scrap, and applying to a grinding wheel in order to observe the sparks emitted. The main disadvantage to spark testing is inability to identify a positively material; if positive identification is to required, chemical analysis must be used. The spark comparison method is also damages the material has being tested, at least slightly. A bench grinder is usually used to the create the sparks, but sometimes this is not convenient, so the portable grinder is used. In either case, the grinding wheel must have adequate surface velocity, at least 23 m/s (4500 surface feet per minute (sfpm)), but should be between 38 and 58 m/s (7500–11,500 sfpm). The wheel should be coarse and hard, therefore aluminum oxide or carborundum often is employed. The test area should be in an area where there is no bright light shining directly into the observer's eyes. Moreover, the wheel grinding and surrounding area should be dark so that the sparks can be observed clearly. The test sample is touched lightly to grinding wheel to the sparks produce. The important spark of characteristics is color, volume, The spark of nature, and length of nature. Note that the length is dependent on the amount of the pressure applied in the grinding wheel,so this is can be poor comparison tool if the pressure is not exactly the same for the samples.Also, the grinding wheel must be dressed frequently to remove the metallic build-up.

Compressed Air Method

Another less common method for the creating sparks is heating up the sample to red heat and then applying sample of compressed air.The compressed air supplies the enough oxygen to ignite the sample and give off sparks.This method is more accurate than using grinder because it will be always give off sparks of the same length for the same sample. At each time the compressed air applies in essence the same "pressure". This makes observations of the spark length a much more reliable characteristic for the comparison.

Automated spark test

Automated spark testing has been developed to remove the reliance upon experience and operator skill, thereby increasing the reliability. The system relies upon the relies spectroscopy, spectrometry, and other methods to be "observe" for the spark pattern. It has found that this system can determine the difference between two materials that give off sparks are indistinguishable to the human eye.

Rockwell hardness test

The Rockwell hardness test method is consists of indenting the test material with a hardened steel ball indenter or diamond cone. The indenter is forced into the tested material under a preliminary minor load F0 usually 10 kgf. When a equilibrium has been reached, an indicating device, which follow the movement of the indenter and responds to changes in the depth of penetration of the indenter is set to datum position. While the preliminary minor load is still applied an additional major load is applied with the resulting increase in penetration. When equilibrium has again been reach, the additional major load is removed but preliminary minor load is still maintained. Removal of additional major load allows a partial recovery, so reducing the depth of penetrations. The permanent increase in the depth of penetration, resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number. The determination of Rockwell hardness of a material involves the applications of a minor load followed by a major load, and then the depth of penetration, hardness value directly from a dial, in which a harder material gives higher number. The chief advantage of Rockwell hardness is its ability to display hardness values directly, thus the obviating tedious calculations involved in the other

hardness measurement techniques. It is typically used in the engineering and metallurgy. Its commercial popularity arises from its speed, reliability, robustness, resolution and small area of indentation. In order to get a reliable reading in the thickness of the test-piece should be at least 10 times the depth of the indentation. Also, readings should be taken from a flat perpendicular surface, because convex of surfaces give lower readings. A correction of factor can be used if the hardness of a convex surface is to be measured.

CONCLUSION

Analysis results from testing piston ring under transient thermal load containing stresses and deflection are tabulated above. Since we found that Aluminium With Silicon Carbide(Sic) And Graphite Composite alumina material is may be accrue less deformation, Stresses and strains than present alumina alloy4032 ,Titanium material and also having better structural and thermal behaviours. So it is better to change the formal piston ring material Alloy 4032 into automotive alumina Aluminium With Silicon Carbide (Sic) And Graphite Composite for better durability it's my goal.

REFERENCES

[1]. Cuddy, M. R. & Wipke, K. B. Analysis of Fuel Economy Benefit of DrivetrainHybridization (National Renewable Energy laboratory) 1997.
[2]. Dr.Najim A.Saad, Dr. Haitham R. Abed Ali, Dr. Hayder Shakir Abudalla, numerical analysis of the thermal –stresses of a petrol engine piston with different materials, The Iraqi Journal for Mechanical and Material Engineering, 8(3), 2008, (249-256).
[3]. Ekrem Buyukkaya, Muhammet Cerit Thermal analysis of a ceramic coating diesel engine piston using 3-D finite element method. Surface and Coatings Technology 202(2), 2007, (398–402).
[4]. F.S. Silva Fatigue on engine pistons – A compendium of case studies. Engineering Failure Analysis, 13, 2006, (480–492).
[5]. Gudimetal P, Gopinath C.V, Finite Element Analysis of Reverse Engineered Internal Combustion Engine Piston, AIJSTPME, 2(4), 2009, (85-92).