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"Design and thermal analysis of ic engine piston design using catia and Ansys software."

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Abstract

The cylinder is one among the most basic parts in a reciprocating Engine, reciprocating siphons, gas blowers and pneumatic barrels, among other comparablemechanisms in which it changes over the substance imperativeness acquired by the consuming of fuel into supportive (work) mechanical control. The present proposition manages the properties of cylinder material identified with heat.Primary issue anticipated that would be found in the framework of the broad cylinder is the distortion, because of weight and temperature. The glow starting from the exhaust gases will be the essential reason for deformation.The most critical part is that lesstime is required to outlinethe cylinder and only a couple of essentialdetail of theengine. Cylinders made of different materials like Aluminum Alloy, Structure steel (S-460), Cast Iron Alloy and Titanium Alloy wereoutlined and investigated effectively.In static-helper investigation, the cylinders were examined to discoverthe relative (von-mises) stress, comparable flexible strain and deformation. It tends to beseen that greateststressforce is on thebasesurface of the cylinder crown in everyone of thematerials. Here we discovered Aluminium amalgam this material has more estimations of warmth motion with different materials.

Keyword: *CATIA, ANSYS, Modeling, Analysis, Structure, FEM*

I. INTRODUCTION

The piston is considered to be one of the most important parts in a Reciprocating Engine, reciprocating Pumps, among other similar mechanisms in which it helps to convert the chemical energy obtained by the combustion of fuel into useful (work) mechanical power.

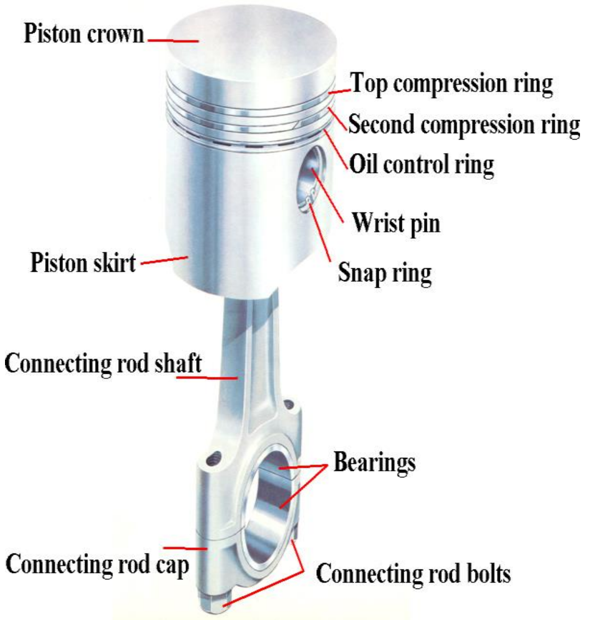

Fig.1

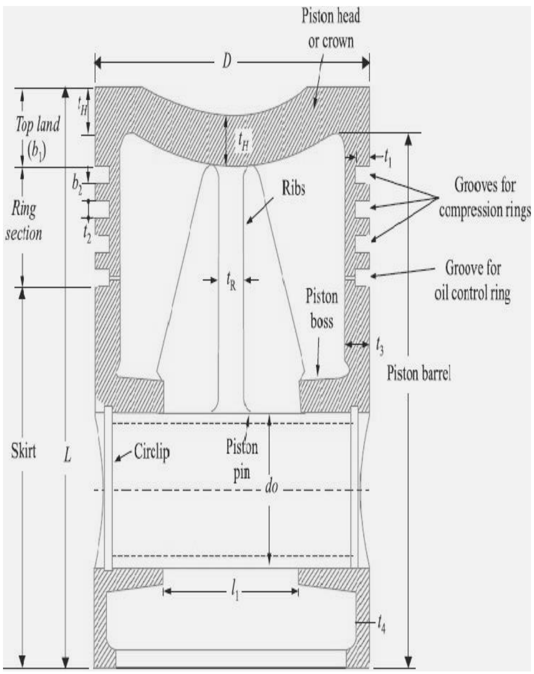

Fig.2

II. MATERIALS

We have selected three materials

- Aluminium Alloy
- Structural Steel (S-460)
- ALSI Alloy
- Cast iron

III. MODELING & SIMULATION

SPECIFICATIONS (Splendor-Pro)

EngineType	Air-cooled, 4-stroke single cylinder OHC
Displacement	97.2 cc
Max. Power	5.66 KW,@ 5000 rpm
Max. Torque	7.130 N-m @ 2500 rpm
Compression Ratio	9.9: 1
Starting	Kick Start / Self Start
Ignition	DC - Digital CDI
Bore	50 mm
Stroke	49 mm

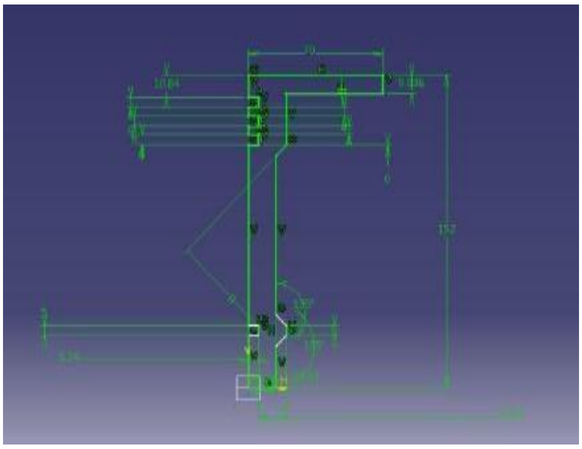

Fig.3.1 2D Drafting

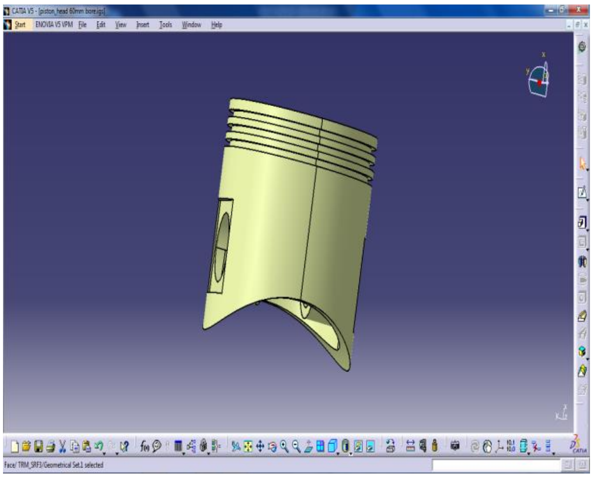

Fig.3.2 CATIA Model

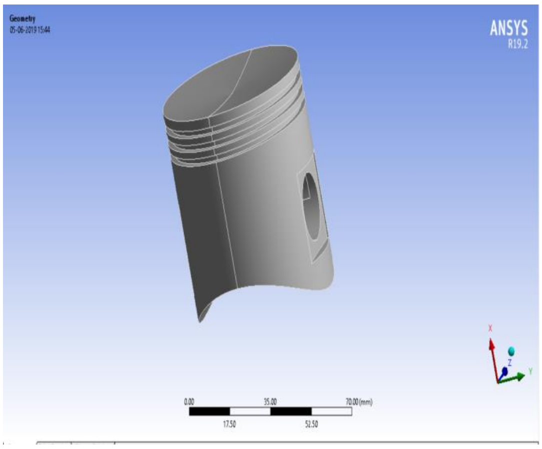

Fig.3.3Import Geometry ANSYS

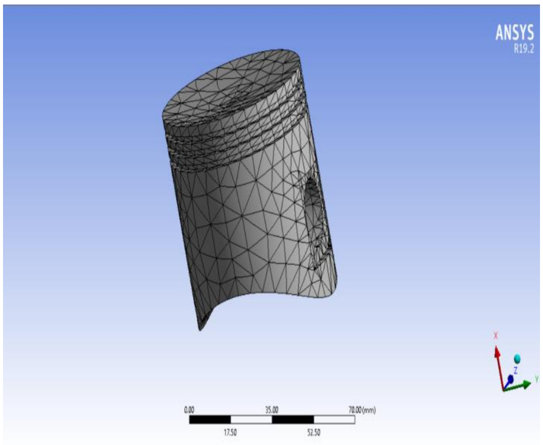

Fig.3.4 Meshing

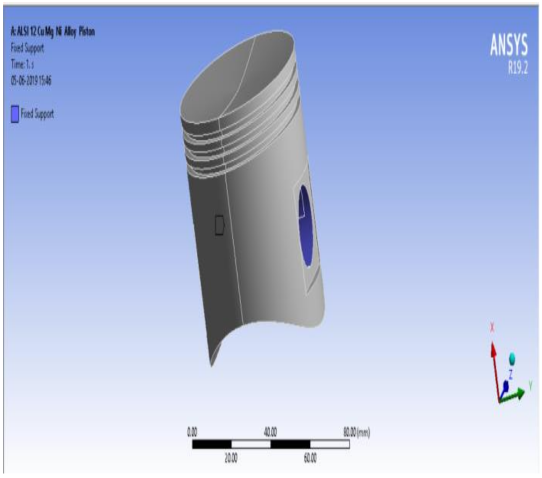

Fig.3.5 Fixed support Aluminium Alloy Materials

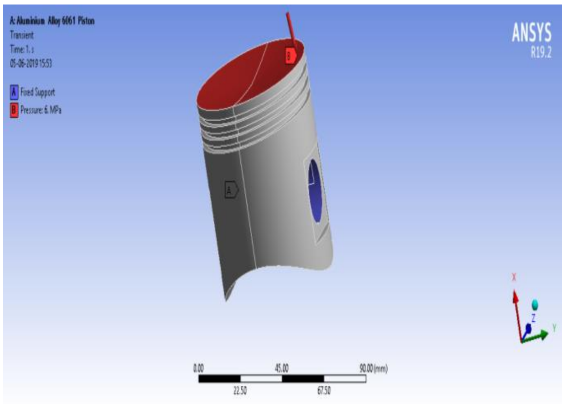

Fig. 3.6 Pressure applied Aluminium6061 Alloy Materials

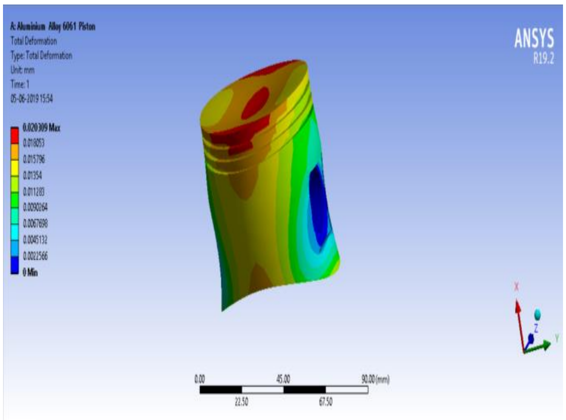

Fig. 3.7 Total Deformation Aluminium Alloy Materials

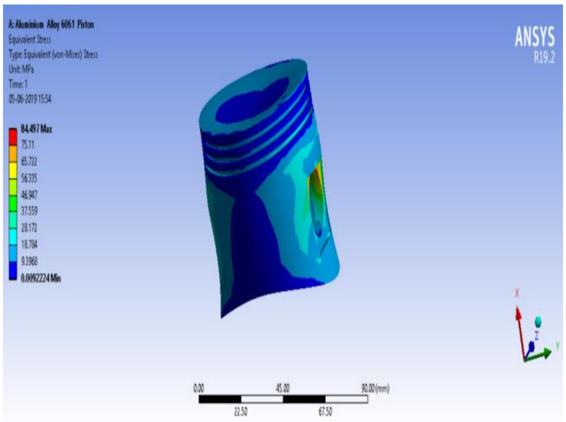

Fig.3.8 Equivalent Stress Aluminum Alloy Materials

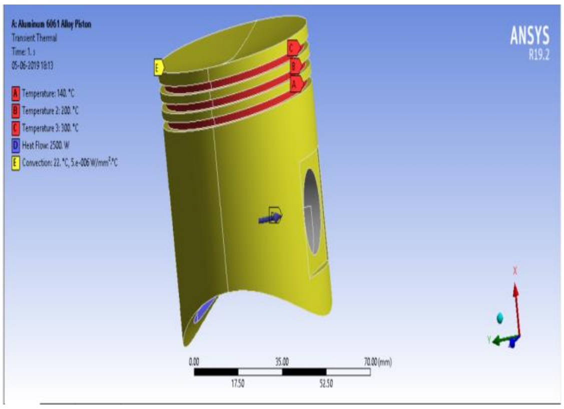

Fig.3.9TransientThermal Boundary conditions

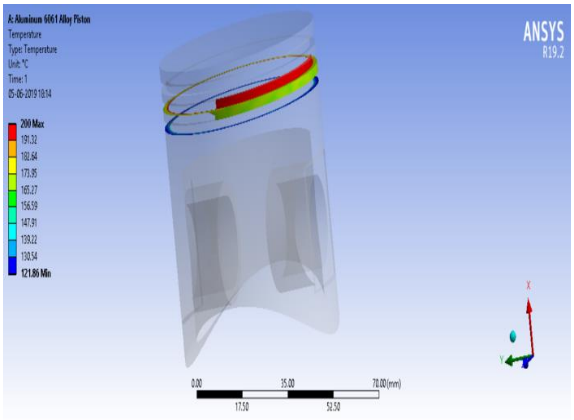

Fig.3.10TemperatureAluminium Alloy

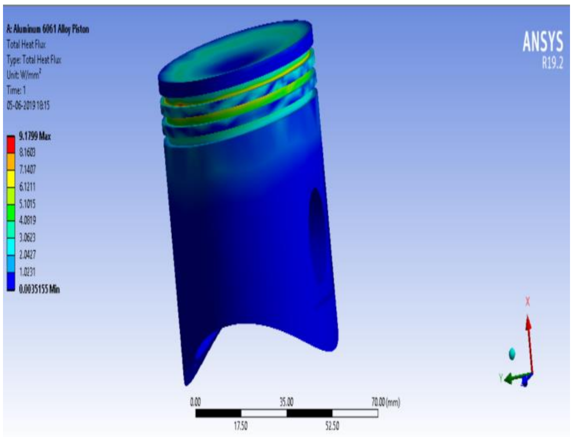

Fig.3.11 Total Heat Flux Aluminium Alloy

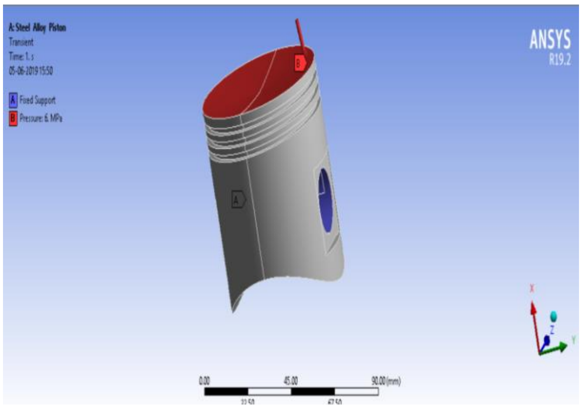

Fig.3.12 Pressure and fixed support boundary conditions-460 Materials

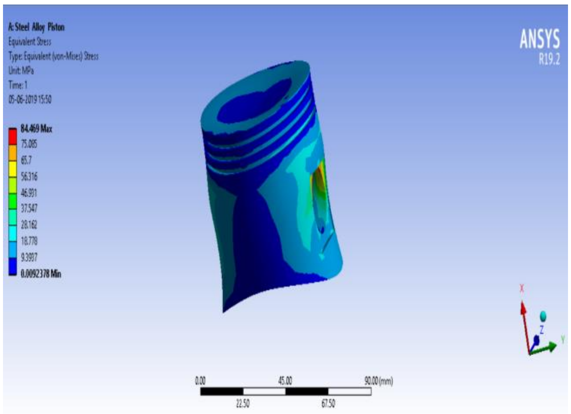

Fig.3.13 Thermal Stresses S-460 Materials

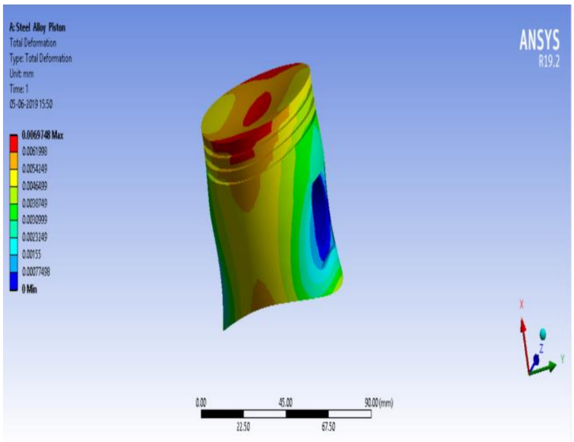

Fig.3.14 Total Deformation S-460 Materials

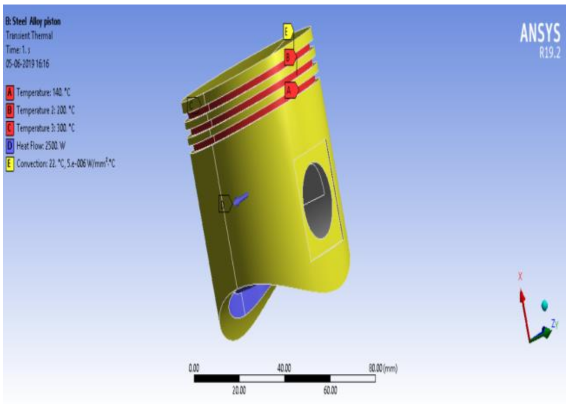

Fig.3.15TransientThermalheat flowS-460 Materials

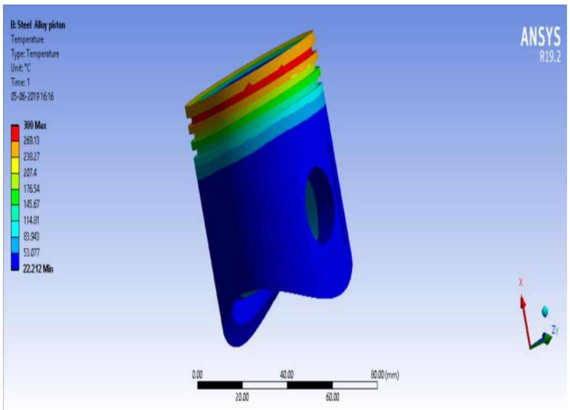

Fig.3.16TemperatureS-460 Materials

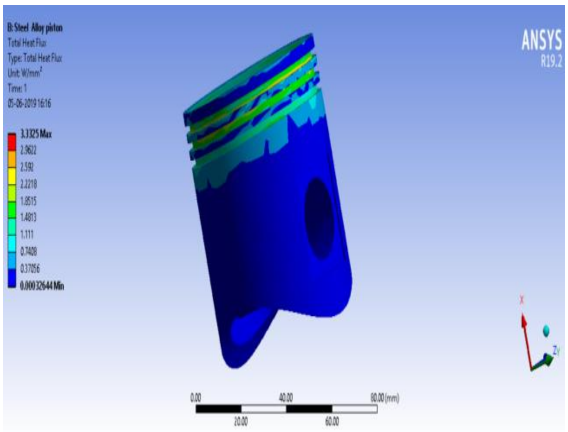

Fig.3.17 Total Heat FluxS-460 Materials

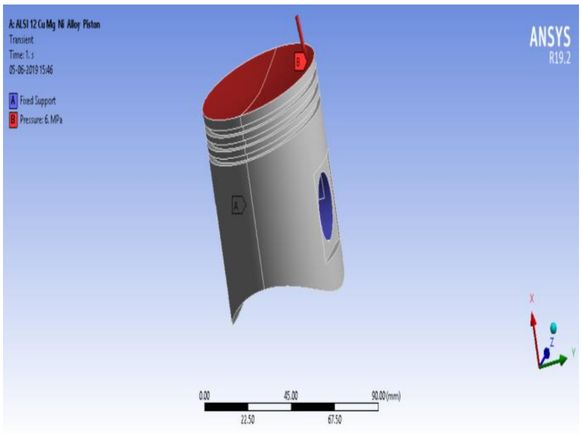

Fig.3.18 Pressure and fixed support boundary conditions Alloy Materials

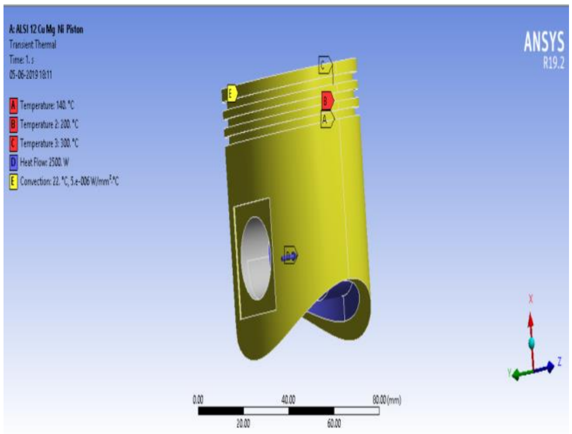

Fig.3.21TransientThermalALSI Alloy

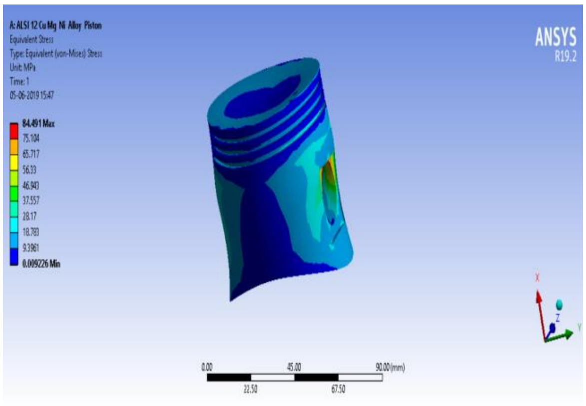

Fig.3.19 Equivalent Stress ALSIAlloy Materials

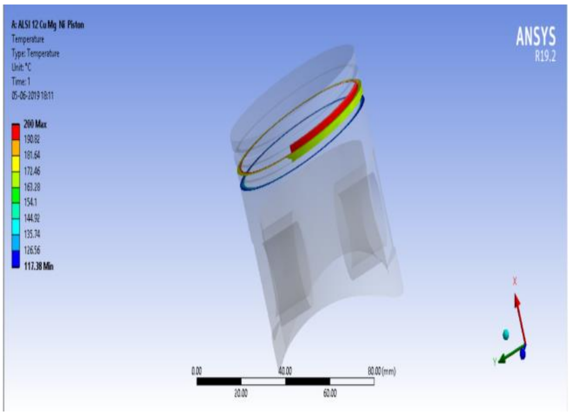

Fig3.22Temperature Titanium Alloy

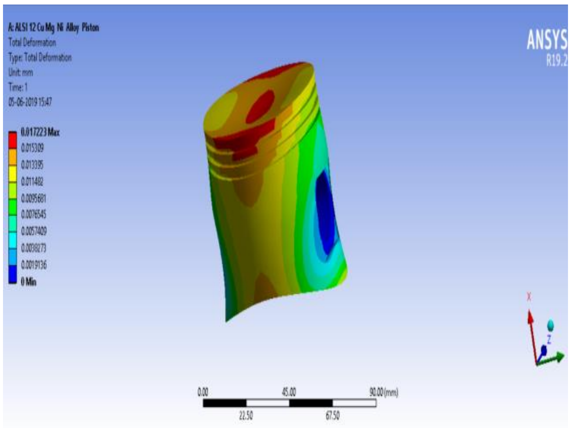

Fig.3.20 Total Deformation ALSI Alloy Materials

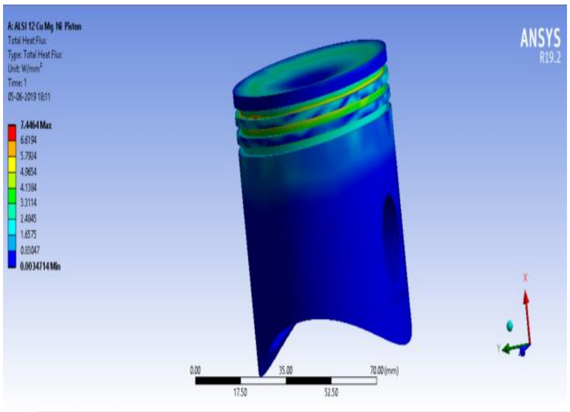

Fig. 3.23 Total Heat Flux Titanium Alloy

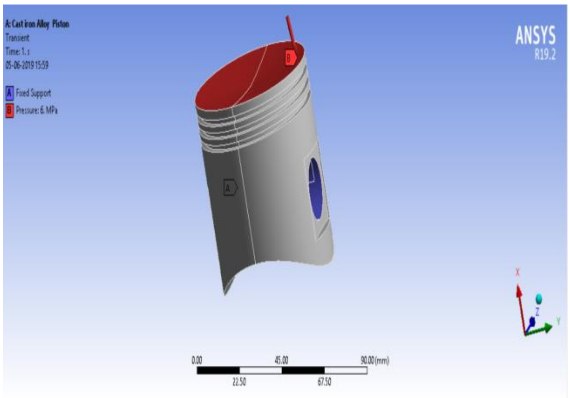

Fig.3.24 Pressure and fixed support boundary condition ALSI Alloy Materials

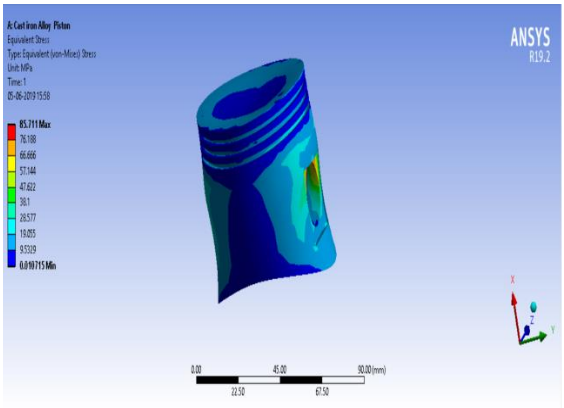

Fig.3.25 Equivalent Stress ALSIAlloy Materials

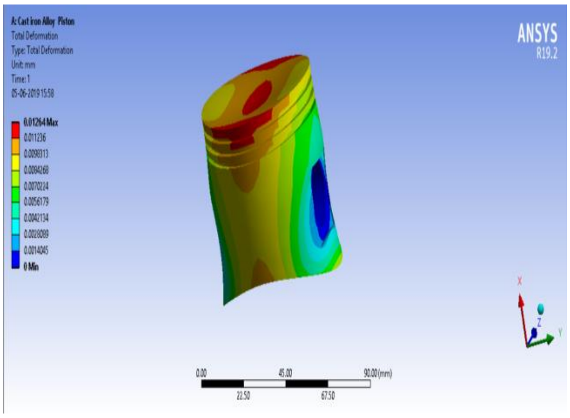

Fig.3.26 Total Deformation ALSI Alloy Materials

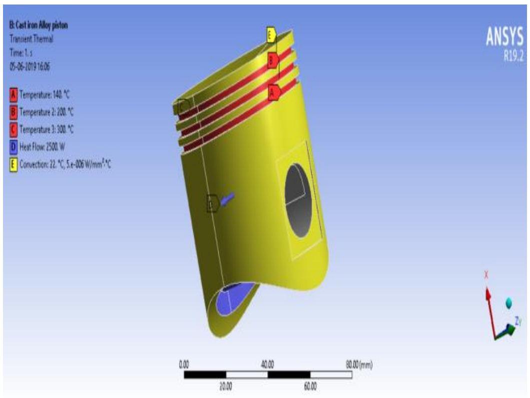

Fig.3.27TransientThermal ALSI Alloy

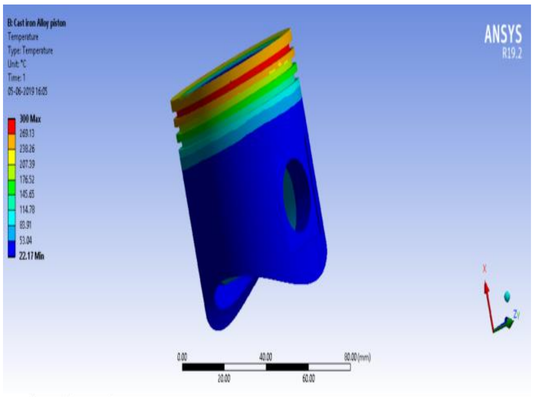

Fig3.28Temperature Titanium Alloy

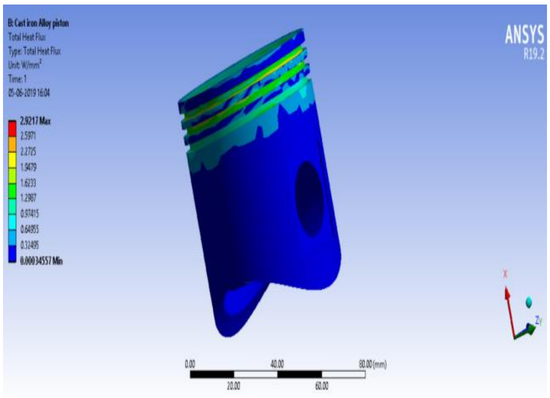

Fig. 3.29 Total Heat Flux Titanium Alloy

V. RESULT & DISCUSSION

We take four different materials 3D models of piston are created based on the dimensions obtained. CATIA V5R20 is used for creating the 3D model. These models are then imported into ANSYS WORKBENCH 19.2 for analysis. Static structural analysis of pistons is carried out.Meshing is done with an automatic which gives a finemesh. For static, transient structural analysis, gas pressure is applied on the top of the piston, and frictionless support is applied across the surface of the piston and also on the piston pin holes. Then results are obtained for von-missesstress and maximum elastic strain. A comparison is made between these results, and the best suited aluminium alloy is selected based on the parameters.

- The static structural analysis of **S-460, Cast Iron, Aluminium Alloy 6061 and AL SI 120Cu Mg Ni** are done and results are obtained for Thermal stress, Temperature, deformation and heat flux.
- Wecan observe that in case of equivalent (von-mises) stress, piston made of **S-460** is found to have maximum stress of 84.469 Mpa is observed. When pistonmade of **Cast Iron** then stress value maximum 85.71 MPa. Maximum stress on **Aluminum 6061 Alloy** is found to be 84.49 Mpa and **AL SI 120Cu Mg Ni** that of was found to be 84.91 Mpa.

- We can observe that in case of deformations (mm), piston made of **S-460** is found to have maximum deformation of 0.0069 mm is observed. When piston made of **Cast Iron** then deformation maximum value**0.012 mm**, when piston made**Aluminum 6061 Alloy** then deformation is found to be**0.023 mm** and deformation for **AL SI 120Cu Mg Ni** that of is found to be**0.017 mm**.
- We can observe that in case of **Temperature (ºC)**, piston made of **S-460** is found to have maximum temperature of 269.13 **ºC** is observed. When piston made of **Cast Iron**then maximum temperature 269.13**ºC**, maximum temperature for **Aluminum 6061 Alloy** is found to be **191.32 ºC**and maximum temperature for **AL SI 120Cu Mg Ni** that of is found to be**190.82 ºC**.
- We can observe that in case of **heat flux (w/mm²)**, piston made of **S-460** is found to have maximum heat flux of **3.32 (w/mm²)**, is observed. When pistonmade of **Cast Iron** then heat flux value maximum **2.921 (w/mm²)**, maximum heat flux for **Aluminum 6061** alloy is found to be**9.17 (w/mm²)**, and maximum heat flux for **AL SI 120Cu Mg Ni** that of is found to be**7.446 (w/mm²)**.

We can observe that in all case we take here four materials Structuresteel (S-460), Cast iron, Aluminium 6061Alloy and **AL SI 120Cu Mg Ni**then we have found that **Aluminium 6061Alloy** is best material compare to the other materials because it has more heat flux value.

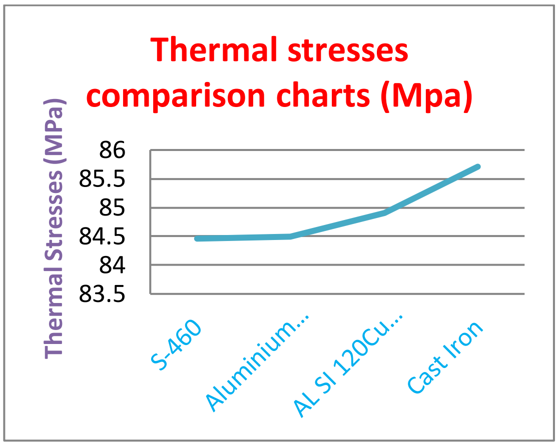

Fig.4.1 Comparison Graph for Stress with different materials

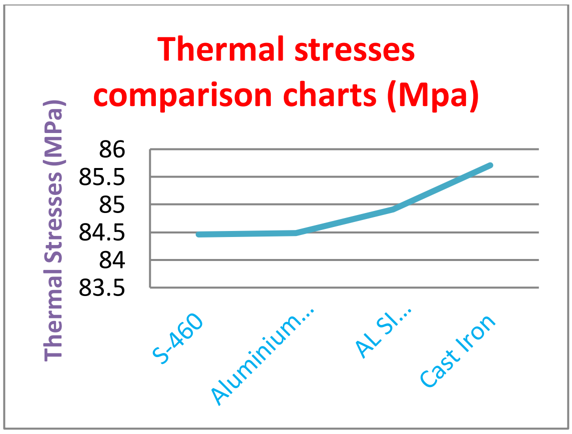

Fig.4.2Comparison Graph for Deformation with different materials

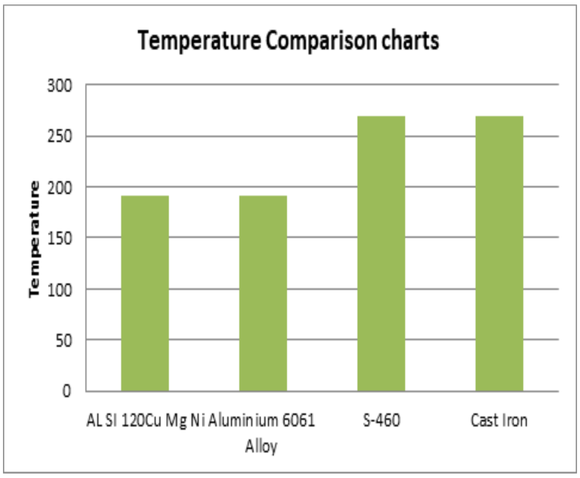

Fig.4.3 Temperature Comparison charts

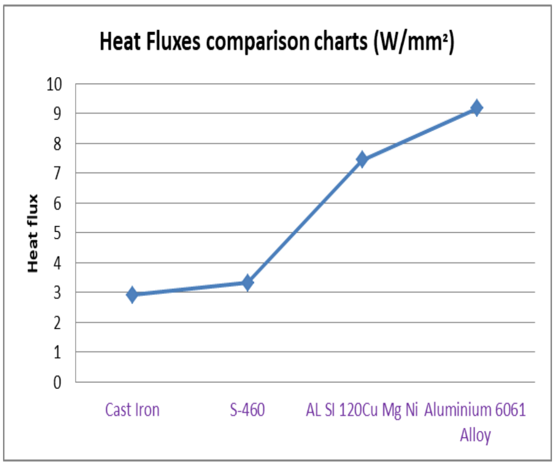

Fig.4.4 Heat Flux Comparison Charts

V. CONCLUSION

The basic ideas and outline techniques worried about single barrels petroleum engine have been considered in this paper the outcomes found by the utilization of this systematicstrategy are almost equivalent to the genuinemea sure mentsutilized now a days. Henceforth it gives a quick strategy to outline a piston which can be additionally enhanced by the utilization of different programming and strategies.The most critical part is that less time is required to outline the piston and just a couple of essential detail of theengine. Pistons made of various materilas like Aluminium 6061 Alloy, S-460, Cast Iron and **AL SI 120Cu Mg Ni** were outlined and investigated effectively.

- In static-auxiliary investigation, the pistons wereexamined to discoverthe proportional (von-mises) stress, comparable flexible strain and deformation.
- It tends to beseen that greatest stress force is on the base surface of the piston crown in everyone of thematerials.
- Here we selected Aluminium 6061Alloy this material has more heat flux value with different materials. So we will be recommended this material for future work.

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