TRANSIENT ANALYSIS OF A PISTON WITH DIFFERENT THERMAL MATERIAL USING ANSYS SOFTWARE

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ABSTRACT

Piston is one amongst the most essential parts in a reciprocating Engine, reciprocating pumps, gas blowers and pneumatic barrels, among other comparable mechanisms in which it changes over the substance vitality acquired by the burning of fuel into helpful (work) mechanical power. The present thesis deals with the properties of piston material related to heat. Primary issue anticipated that would be found in the outline of the expansive piston is the deformation, because of weight and temperature. The warmth originating from the fumes gases will be the primary reason of deformation.The most critical part is that less time is required to outline the piston and just a couple of essential detail of the engine. Pistons made of various materials like AL –Si 398, AL-6061 and ALG-HS 1300 Aluminum Alloy were outlined and investigated effectively. In static-auxiliary investigation, the pistons were examined to discover the proportional (von-mises) stress, comparable flexible strain and deformation. It tends to be seen that greatest stress force is on the base surface of the piston crown in everyone of the materials. Here we discovered ALG-HS 1300 Aluminim alloy this material has more values of heat flux with different materials.

Keyword: - *ANSYS, Modeling, Analysis, Structure, FEM, AL –Si 398, AL-6061, ALG-HS 1300.*

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1. INTRODUCTION

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.

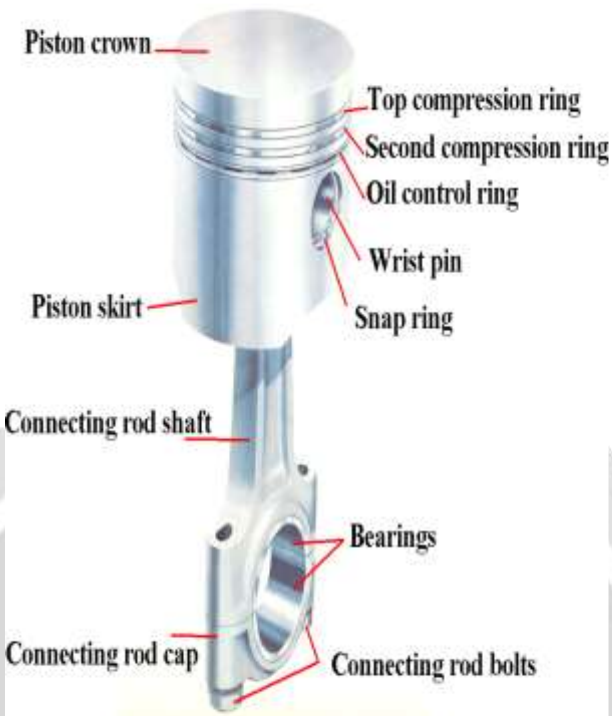

Fig.1 Piston with connecting Rod

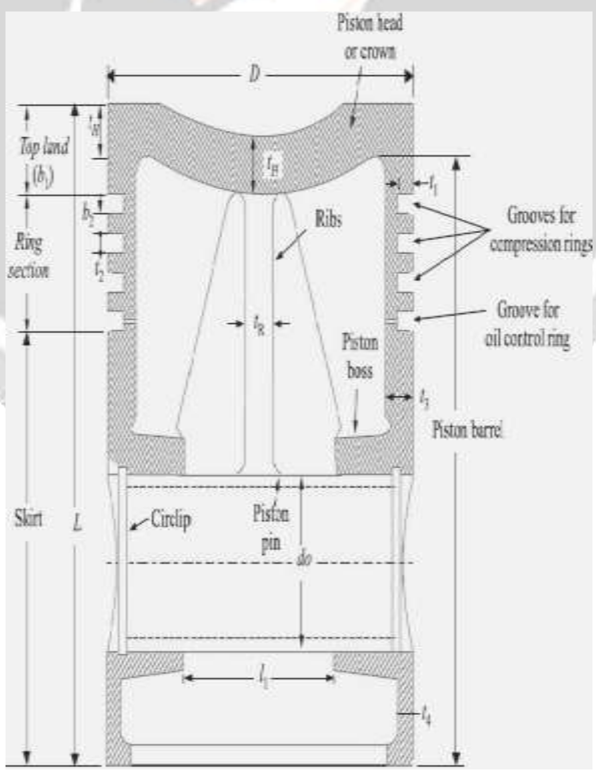

Fig.2 Piston elements

2. MATERIAL

We have selected three materials

- AL –Si 398
- AL-6061 Alloy
- ALG-HS 1300 Alloy

3. MODELING & SIMULATION

Table:3.1 Diesel engine specifications

Sl. No	Description	Specification
1	Engine make	Kirloskar diesel engine
2	Bore	80 mm
3	Stroke	110mm
4	Engine speed taken for study	1500 rpm
5	Compression ratio	16.5:1
6	Test condition/Type	Water cooled direct injection diesel single cylinder engine
7	Max pressure at study rpm	54 bars or 5.4 MPa

Fig.3.1 3D Drafting

Fig.3.2 CATIA Model

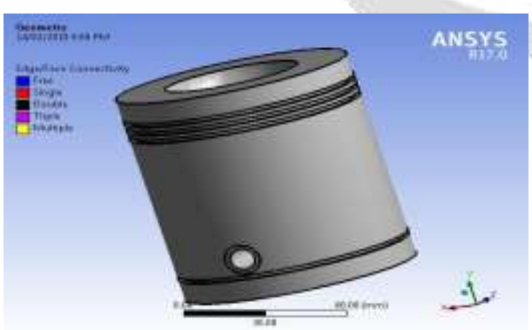

Fig.3.3Import Geometry ANSYS

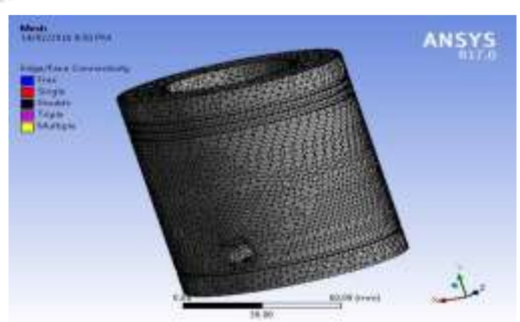

Fig.3.4 Meshing

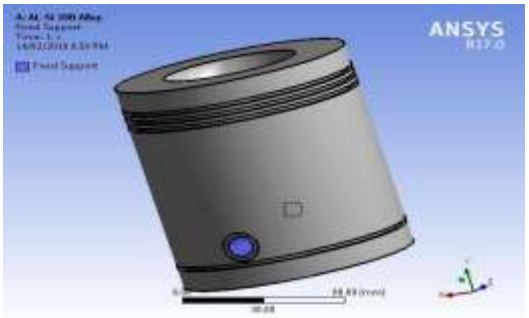

Fig.3.5AL-Si 398 fixed support boundary condition

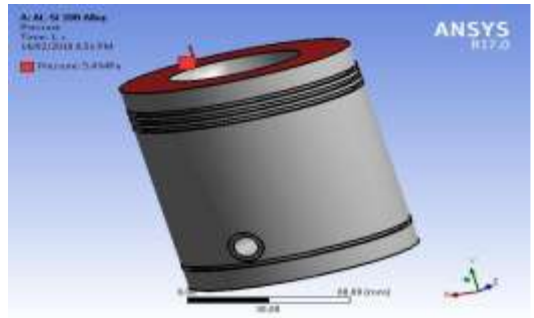

Fig. 3.6 AL-Si 398 pressure applied boundary condition

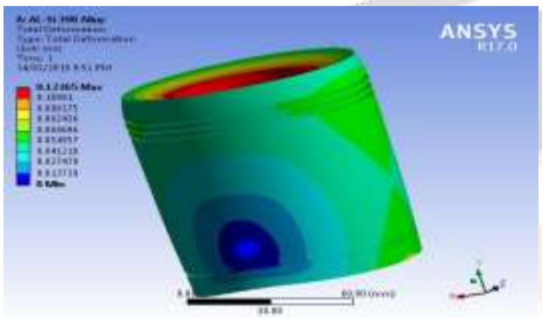

Fig. 3.7 AL-Si 398 Total deformation

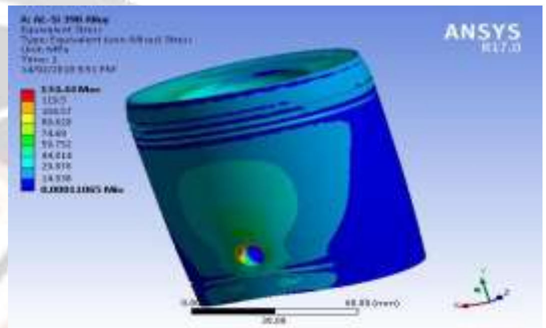

Fig.3.8 AL-Si 398 thermal stresses

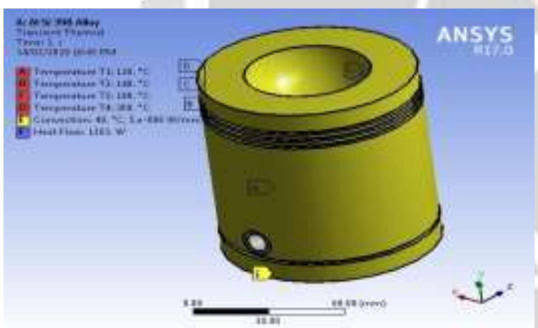

Fig.3.9TransientThermal Boundary conditions

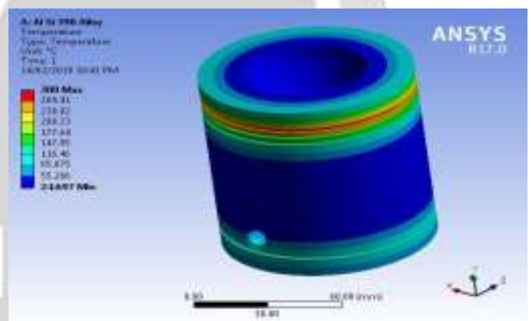

Fig.3.10AL-Si 398 temperature result

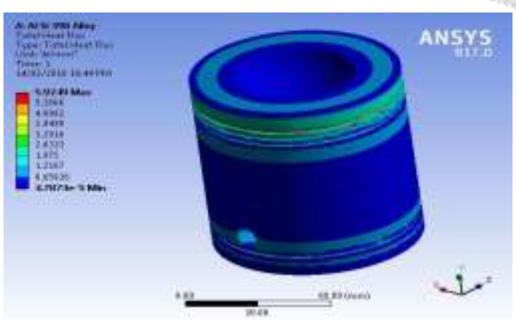

Fig.3.11AL-Si 398 heat flux result

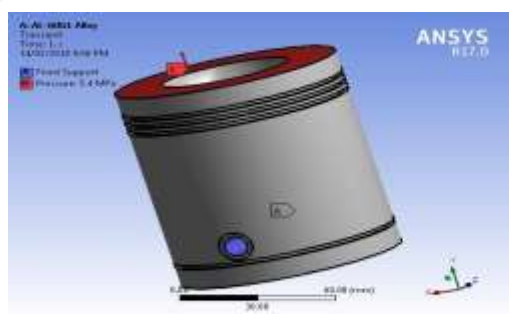

Fig.3.12 Pressure and fixed support boundary conditions

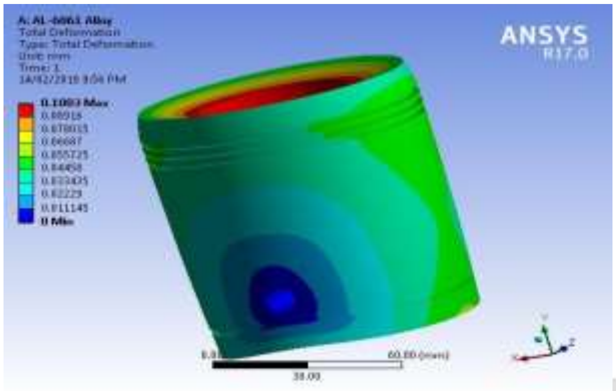

Fig.3.13 AL- 6061 total deformation result

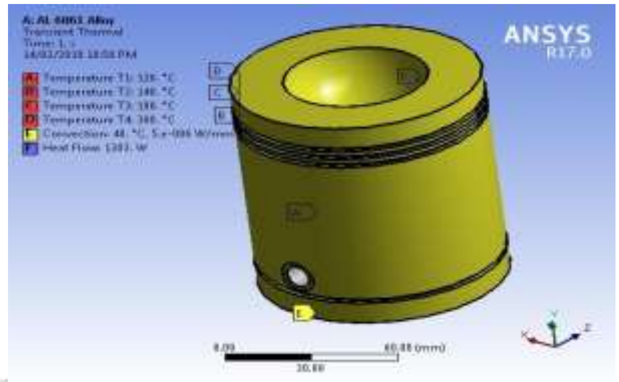

Fig.3.14 AL- 6061 thermal boundary condition

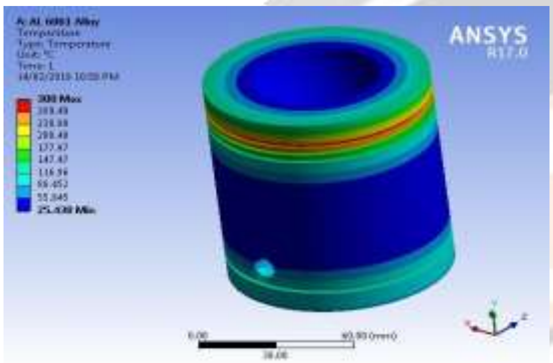

Fig.3.15 AL- 6061 temperature result

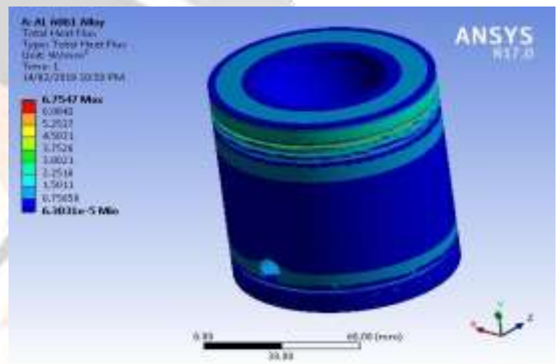

Fig.3.16 AL- 6061 heat flux result

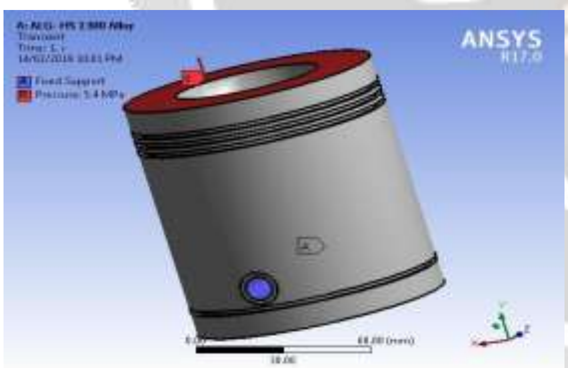

Fig.3.17ALG-HS -1300 applied boundary condition

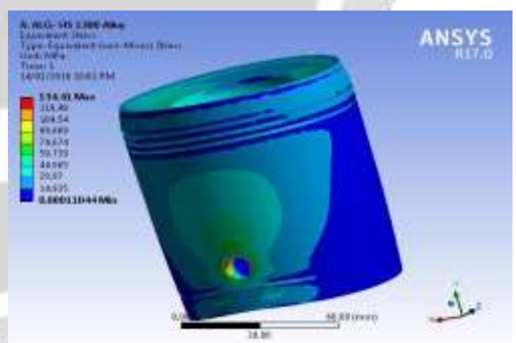

Fig.3.18 ALG-HS -1300 thermal stresses results

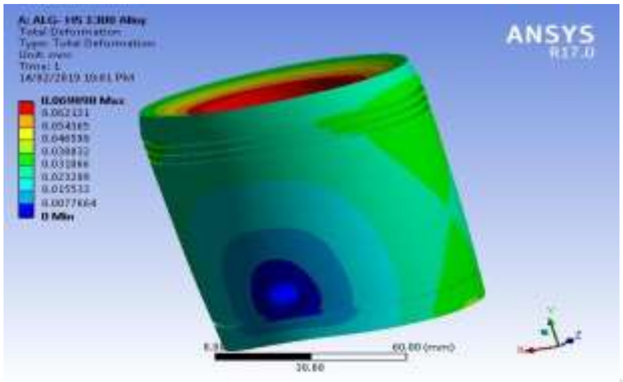

Fig.3.19ALG-HS -1300 total deformation results

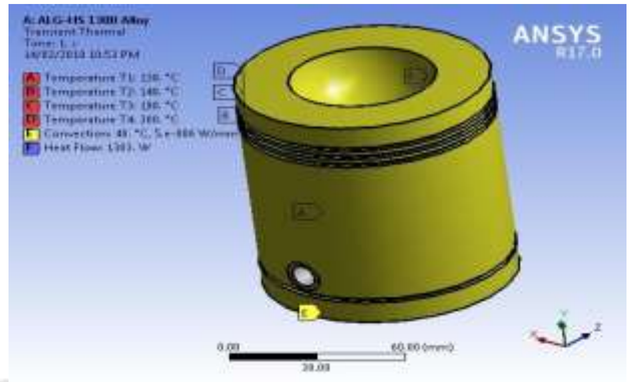

Fig.3.20 ALG-HS -1300 thermal boundary conditions

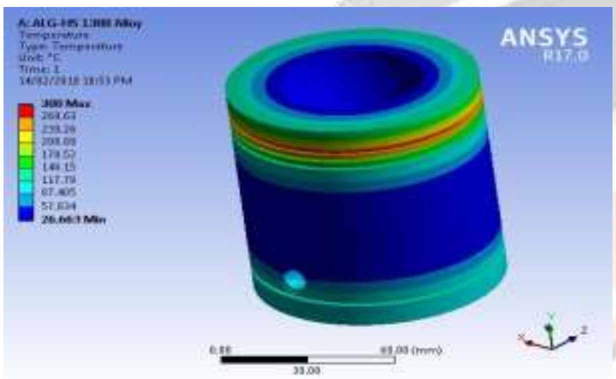

Fig3.21 ALG-HS -1300 temperature results

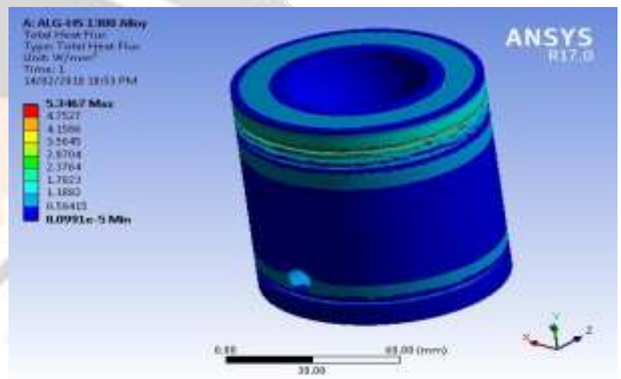

Fig. 3.22 ALG-HS -1300 heat flux results

4. RESULT & DISCUSSION

Design of Jaw Plates

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 17.0 for analysis. Static structural analysis of pistons is carried out. Meshing is done with an automatic which gives a fine mesh. For static structural analysis, gas pressure is applied on the top of the piston and frictionless support is applied across the surface of piston and also on the piston pin holes. Then results are obtained for von-misses stress and maximum elastic strain.

A comparison is made between these results and the best suited aluminium alloy is selected based on the parameters which shown in Fig 4.1.The static structural analysis of AL6061 Aluminium, ALG- HS 1300 Alloy, AL-Si 398 are done and results are obtained for Equivalent (Von-Mises) stress, Temperature, deformation and heat flux .

We can observe that in case of Thermal stress, piston made of AL 6061is found to have maximum thermal stress of 134.48 Mpa is observed. When piston made of ALG-HS 1300 then thermal stress value maximum 134.41 MPa. when piston made of AL-Si 398 alloy then maximum thermal stress on is found to be134.44Mpa .

We can observe that in case of deformations shown in Fig 4.2 , piston made of AL-Si 398 is found to have maximum deformation of 0.123 mm is observed. When piston made of ALG-HS 1300then deformations value maximum 0.0698 mm. when piston made of AL 6061 alloy then maximum deformation on is found to be 0.1003mm.

We can observe that in case of Temperature shown in Fig 4.3 , piston made of ALG-HS 1300 is found to have maximum temprature of 269.63 °C is observed. When piston made of AL 6061 then temperature value maximum 269.49 °C. when piston made of AL-Si 398 alloy then Maximum temperature on is found to be 269.41 °C

We can observe that in case of heat flux (w/mm²) shown in Fig 4.4, piston made of AL 6061 is found to have maximum heat flux of 6.75 (w/mm²), is observed. When piston made of ALG-HS 1300 then heat flux value maximum 5.34 (w/mm²), maximum heat flux for AL Si 398 be5.92 (w/mm²), and maximum heat flux for AL 6061 that of is found to be 6.75 (w/mm²).

We can observe that in all case we take here four materials ALG-HS 1300 aluminium alloy is good thermal conductive compared with other than materials its light weight and it has more value heat flux.

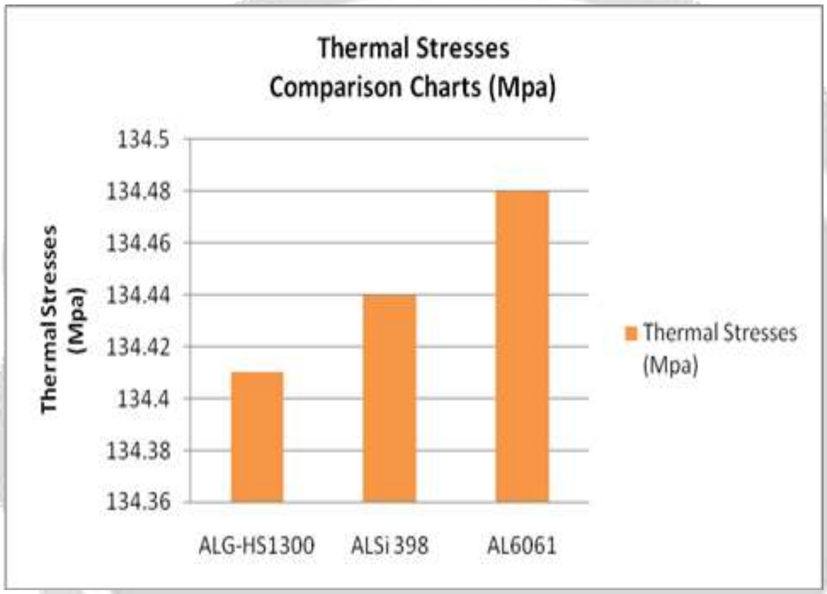

Fig.4.1 Comparison Graph for thermal Stress with different materials

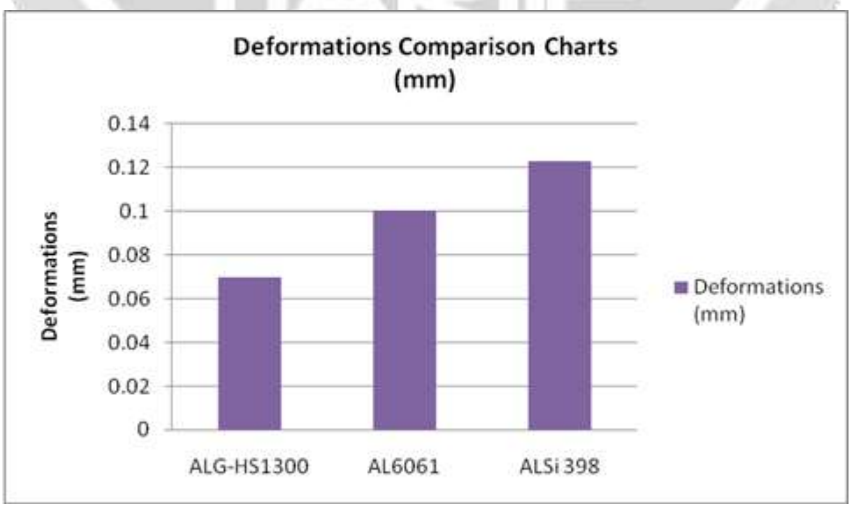

Fig.4.2 Heat Flux Comparison Charts

5. CONCLUSION

The fundamental concepts and design methods concerned with single cylinders petrol engine have been studied in this project the thermal results found by the use of this Thermal transient and Thermal transient method are nearly equal to the actual dimensions used now a days. Hence it provides a fast procedure to design a piston which can be further improved by the use of various ANSYS thermal software and methods. The most important part is that very less time is required to design the piston and only a few basic specification of the engines. The most critical part is that less time is required to outline the piston and just a couple of essential detail of the engine.

- Pistons made of various aluminum alloy like AL Si 398 , AL-GHS 1300, Al 6061were outlined and investigated effectively.
- We find Piston move even at minimum pressure carried out with help of thermal transient software.
- In static-auxiliary investigation, the pistons were examined to discover the proportional.Thermal stress, comparable flexible strain, deformation and thermal heat flux.
- It tends to be seen that greatest stress force is on the base surface of the piston crown in everyone of the materials.

Here we discovered ALG-HS 1300 is good because its has less deformations compared with different materials of aluminum alloy . So we will be recommended this ALG-HS 1300 basic of thermal streses ,thermal heat flux, velocity and turbulence for future work because all thermal parameter are in considerable range.

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