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Designing and Analysis of Piston under Forces

[1]Mohsen Rezaei, [1]Masoud Mohammadi, [1]Esmaeil Fotouhi, [1]Mohammad Reza Asadi, [1]Mohammad Ranjbar Kohan

[1]Department of Mechanical Engineering, Buinzahra Branch, Islamic Azad University, Buinzahra, Qazvin, Iran.

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ABSTRACT

Piston inside the cylinder makes strokes of motor by traverse movement and so tolerates compression and expression forces that expansion are created because of ignition and all of motor force is made by pistons. This research was done for analyzing stress and strain of piston. As diagrams show the most degree of stress is at its center that is equal to 56 mega Pascal of course resistance of aluminum alloys is about 200 MPa. So we can say that piston can tolerate the stress. Paying attention to alternative forces that come to it while working it is suggested that exhaustion analyze be done for a piston.

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INTRODUCTION

Piston inside the cylinder makes strokes of motor by traverse movement and so tolerates compression and expression forces that expansion are created because of ignition and all of motor force is made by pistons. Because aluminum is a light metal so piston is made of aluminum. In most motor cars full slider pistons are used. The low part of piston is cut for lowering its weight and so it has a space for balance weights of crankshaft. Diameter of pistons is between 76 to 122 milimeter and their weight is 500 grams. Pistons are made through two methods: blacksmithing and molding. Blacksmithed pistons are made from pieces of aluminum alloy and after machining they become warm and cold through a special method and after this stage they are covered by a thin layer of tin so that piston doesn't abrade while working and moving up and down [1 to 4].

Aluminum piston is expanded more than other kinds because of heat increase and it may remove piston clearance. If piston is heated more than cylinder partition it will expand more and more but if the bottom of piston gets too hot it may cause selfignition and it may damage motor. One of the methods of controlling piston expansion is increasing speed of repelling heat from piston bottom. Whatever piston bottom is thicker it will send out more heat and piston will work in cold conditions but increasing thickness will increase its weight [5, 6, 7].

So if bottom of piston is too cold then full-air mixture will not burn and it will be send out through exhaust pipe and as a result efficiency of motor will decrease for controlling expansion of pistons they are cut in such way that they can have a kind of elliptical chamber. When pistons are heated in such a chamber their shapes are changed. Another way for controlling piston expansion is using a metal brace. When the piston gets heat this brace limit expansion of piston bottom and piston- pin in many motors, bottom flat piston is used but the shape of bottom of piston may Change with shape of cylinder head and form of ignition chamber. In some pistons there is a place for valve. When the valves are opened they can move. In some pistons, piston head is round or it has other shapes [8, 9]. Figure 1 shows set of piston connecting rod and different parts.

Corresponding Author: Mohammad Ranjbar Kohan, Department of Mechanical Engineering, Buinzahra Branch, Islamic Azad University, Buinzahra, Qazvin, Iran.
E-mail: ranjbarkohan61@yahoo.com

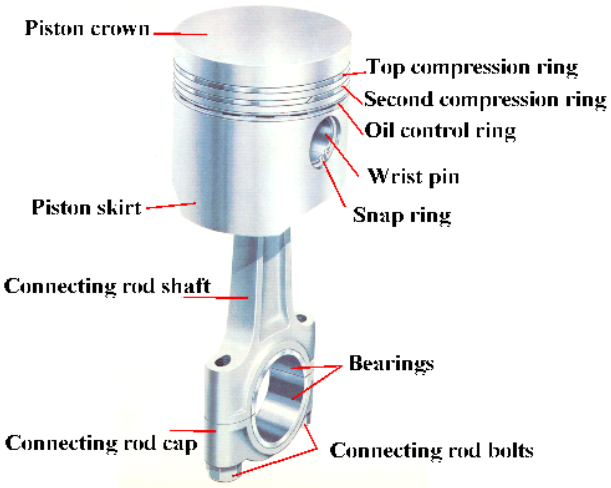

Fig. 1: piston parts and connecting rod and its different

Research method:

In order to design piston, Solidworks software was used. This software has high capacity of modeling and analyzing stress of mechanical pieces. The piston selected for designing and analyzing stress was the piston of petrol motor. Figures 2 and 3 show modeled piston.

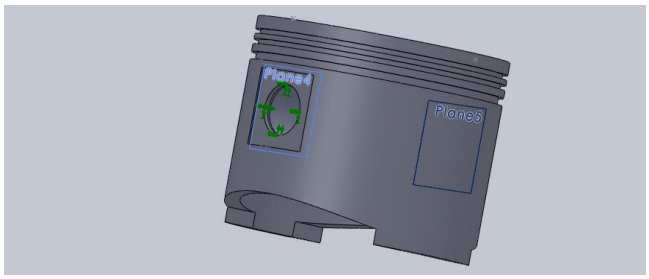

Fig. 2: the piston modeled in Solidworks software

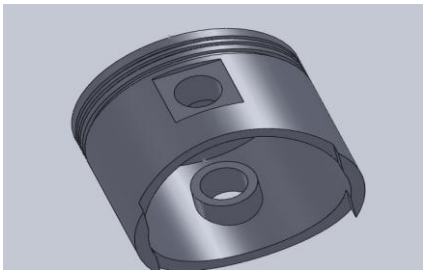

Fig. 3: the piston modeled in Solidworks software

After modeling analyzing stress was ended. Stress is degree of resistance of materials against forces and these forces are external ones. The main part of piston that is forced is called piston crown. About 15000 Newton forces are applied to modeled piston and paying attention to piston diameter this force is about 2 MPa. Of course piston sides and space of rings are so affected but we concentrate on the piston crown.

Results:

In order to analyses piston stress the following stages were done: in the first stage piston supports identified. The above half part of piston pin was selected as a support. Place of piston pin is shown in figure 4.

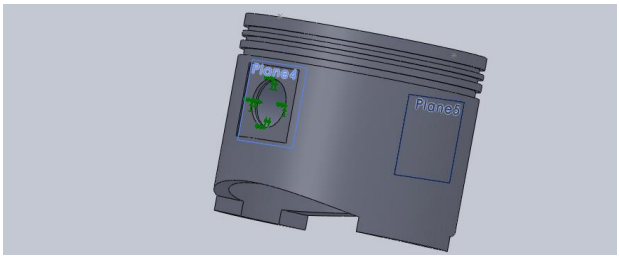

Fig. 4: the place of piston pin

After specifying the place of backrests the pressure that was said in the previous stage was applied to the piston. 2 Mega Pascal pressure was applied on the above part of piston. Figure 5 shows the place of applying pressure and method of applying it.

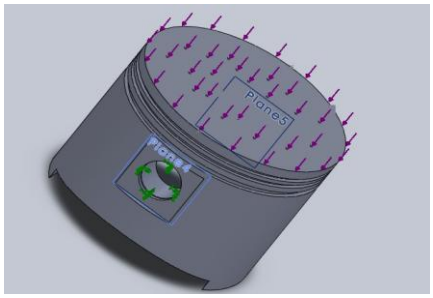

Fig. 5: the place of applying pressure and method of applying it

In the next stage type of piston was chosen. Aluminum was chosen for making piston. Then the piston was meshing. Solid 72 element was used for this case [10, 11]. It is shown in figure 6. Also figure 7 shows a piston that has been meshed using this element.

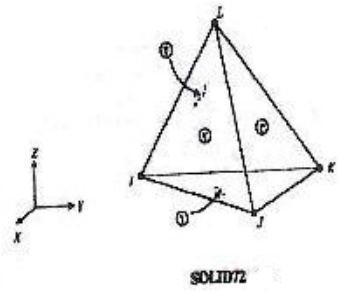

Fig. 6: solid 72 three dimensional element

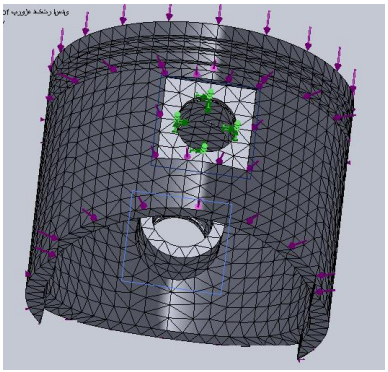

Fig. 7: Meshing piston

In the next stage stress analysis and strain was done. Figure 8 and 9 show degree of stress and strain for the piston.

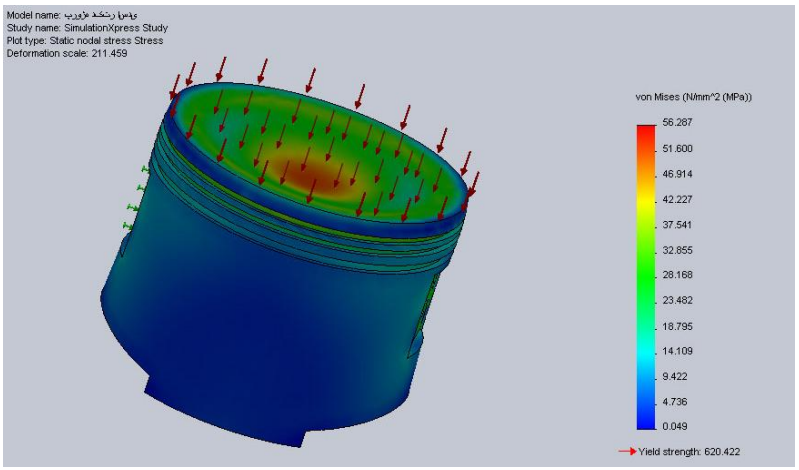

Fig. 8: diagram of piston stress analysis

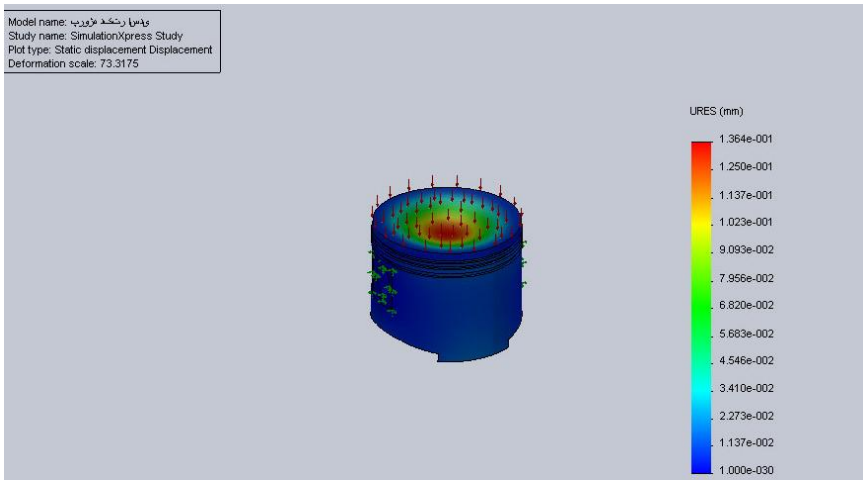

Fig. 9: diagram of piston strain analysis

Conclusion and Suggestions:

This research was done for analyzing stress and strain of piston. As diagrams show the most degree of stress is at its center that is equal to 56 mega Pascal of course resistance of aluminum alloys is about 200 MPa. So we can say that piston can tolerate the stress.

As we know forces that come to piston are alternative ones. Pressure force of ignition at the top dead center is the highest and at the bottom dead center is the lowest. Paying attention to alternative forces that come to it while working it is suggested that exhaustion analyze be done for a piston.

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