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Research Paper

STATIC AND THERMAL ANALYSIS OF V SHAPECYLINDER HEAD

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Abstract A cylinder head is made of box type of section of considerable depth to accommodate ports of air and gas passages, inlet valve, exhaust valve and spark plug. The studs or bolts are screwed up tightly along with a metal gasket or asbestos packing to provide a leak proof joint between the cylinder and cylinder head. The cylinder head is subjected to temperatures due to combustion in cylinder and pressure on surface. The aim of the project is to design2 cylinder heads (straight fins and V-shape fins)and analysis is done by using different materials. Cylinder heads are modeled by using SOLID WORKS software. SOLID WORKS is a 3d modeling software widely used in the design process. SOLID WORKS is used by the automotive and aerospace industries for automobile and aircraft product and tooling design. Analysis is done on the models by using different materials. Comparison between materials is done by observing the results of displacement and stress with respect to tables and graphs. Thermal analysis is also done. Analysis is done by using software ANSYS. Here existing material is steel and new materials are (al-6061, cast iron,) by comparing all static thermal results we conclude which material is more optimum in both static and thermal loading conditions.

1. INTRODUCTION

In Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result it seizing or welding of same. So, this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling. Heat engines generate mechanical power by extracting energy from heat flows, much as a water wheel extracts mechanical power from a flow of mass falling through a distance. Engines are inefficient, so more heat energy enters the engine than comes out as mechanical power; the difference is waste heat which must be removed. Internal combustion engines remove waste heat through cool intake air, hot exhaust gases, and explicit engine cooling.

CYLINDER HEAD AND CRANKCASE INTEGRATED

Casting technology at the dawn of the internal combustion engine could reliably cast either large castings, or castings with complex internal cores to allow for water jackets, but not both simultaneously. Most early engines, particularly those with more than four cylinders, had their cylinders cast as pairs or triplets of cylinders, then bolted to a single crankcase. As casting techniques improved, an entire cylinderblock of 4, 6, or 8 cylinders could be cast as one. This was a simpler construction, thus less expensive (unitwise) to make. For straight engines, this meant that one engine block could now comprise all the cylinders plus the

crankcase. Monobloc straight fours, uncommon when the Ford Model T was introduced with one in 1908, became common during the next decade, and Monobloc straight sixes followed soon after.

Combined Head and Crankcase

Light-duty consumer-grade Honda GC-family small engines use a Monobloc design where the cylinder head, block, and half the crankcase share the same casting, termed 'unblock' by Honda. One reason for this, apart from cost, is to produce an overall lower engine height. Being an air-cooled OHC design, this is possible thanks to current aluminum casting techniques and lack of complex hollow spaces for liquid cooling.

2. LITERATURE REVIEWS

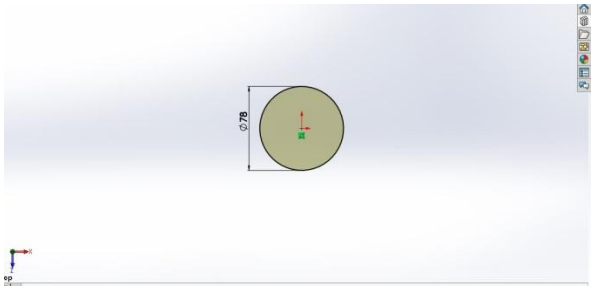
Arnold E. Biermann and Benjamin Pinkel, Obtained heat transfer coefficient over a range of air speeds from 30 to 150 miles per hour from tests in a wind tunnel of a series of electrically heated finned steel cylinder, which covered a range of fin pitches from 0.10 to 0.60 inch, average fin thickness from 0.04 to 0.27 inch, and fin width from 0.37 to 1.47 inch. They concluded that the value of surface heat transfer coefficient varies mainly with air velocity and the space between fins. The effect of the other fin dimensions is small.

J.C. Sanders et.al. To carried out the cooling tests on two cylinders, one with original steel fins and one with 1-inch spiral copper fins brazed on the barrel. The copper fins improved the overall heat transfer coefficient from the barrel to the air 115 percent. They also concluded that in the range of practical fins dimensions, copper fins having the same weight as the original steel fins will give at least 1.8 times the overall heat transfer of the original steel fins.

Developing Models by Using Solid Works

Select Solid works →open

New →enter name→ok



The above sketch should follow 3 conditions those are the sketcher should be closed and there should be no open end there should be no over lapping. By following these conditions we have to create our model. After completion of sketch click ok and we will get below model.

Then extrude it→78mm→ok

After completion of that just click on ok then we will get below model

To create holes here we using extrude cut option and the sketch dimensions Is shown in below

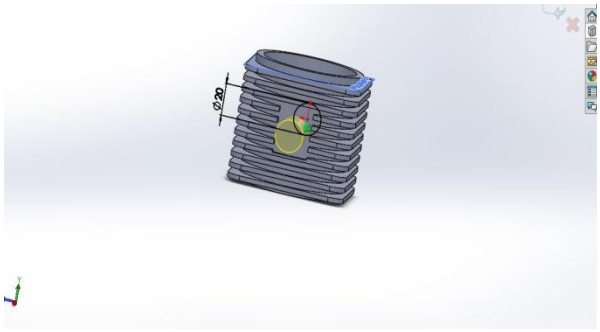
By using shell option, select two sides with 5mm thickness

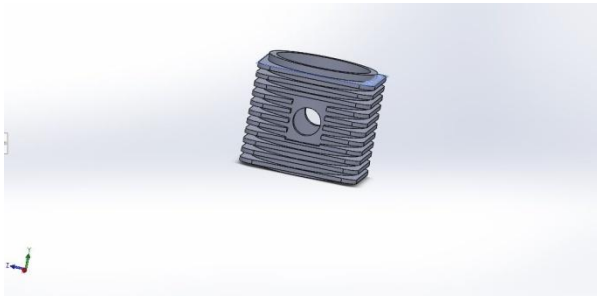
Select or reference plane →select top plane→5mm

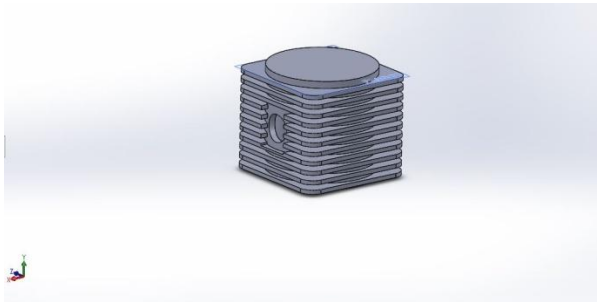
Select sketcher→create fins dimensions above mentioned→ok

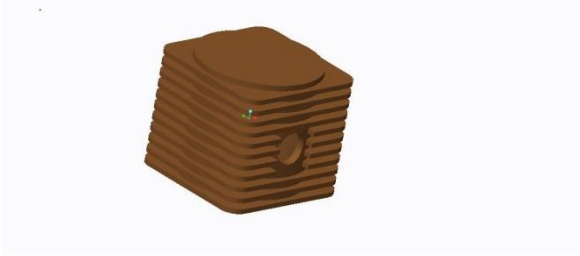
Exit sketcher→ fin thickness→3mm

Use pattern option to create multiple fins, and here we using direction pattern to create fins.





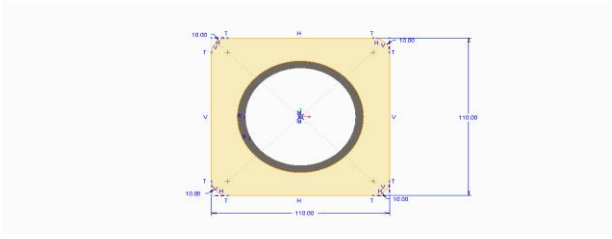


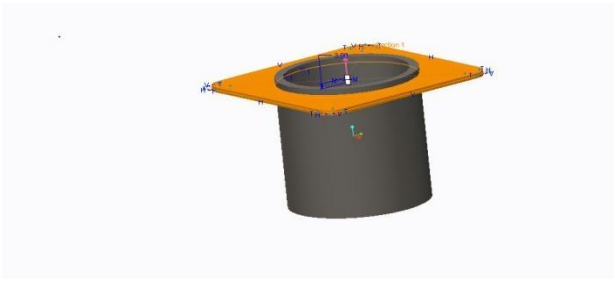


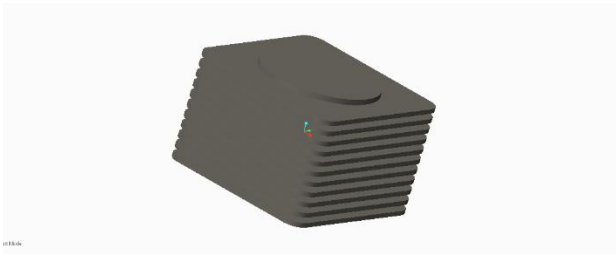
Final model straight fins cylinder

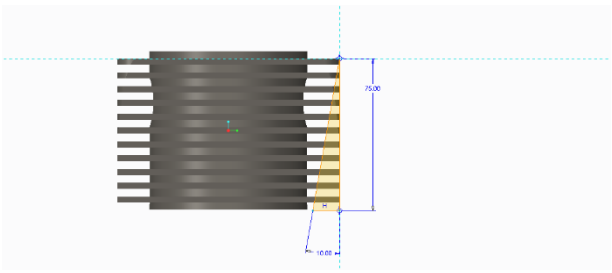
V-shape cylinder

To create V-shape cylinder here we follows same steps which we were used to create straight fins cylinder.











V-shape cylinder final model

3. MATERIALS USED

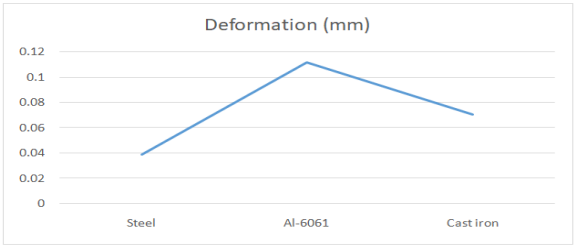
Al-alloy 6061

6061 is a precipitation-hardened aluminum alloy, containing magnesium and silicon as its major alloying elements. Originally called "Alloy 61S", it was developed in 1935. It has good mechanical properties, exhibits good weldability, and is very commonly extruded (second in popularity only to 6063). It is one of the most common alloys of aluminum for general-purpose use.

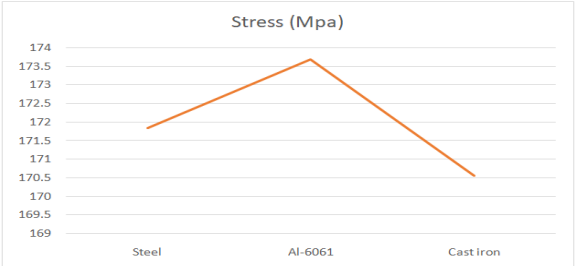
Cast iron

The tensile strengths are dictated by the class of the material. Grey irons are brittle, and have little plastic deformation and thus the yield strength and tensile strengths are almost identical. Further to this, grey irons exhibit little if any strain under tensile loadings and do not follow Hooke's law very well. This is because microslip is experienced due to the presence of the graphite in the structure. As these materials do not obey Hooke's law, the stress-strain curve is not linear, making it difficult to calculate the modulus of elasticity.

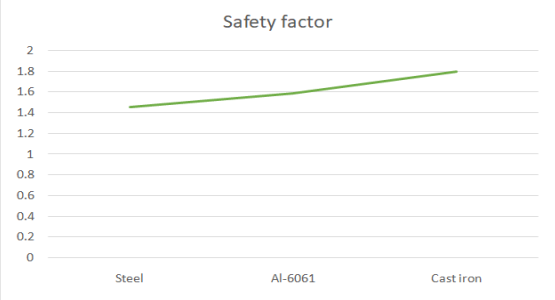
4. ANALYSIS RESULTS



Comparison of deformation

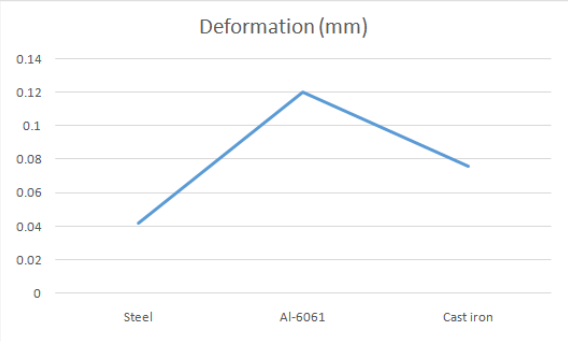


Comparison of stress

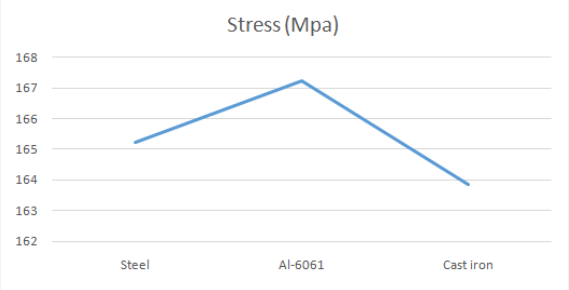


Comparison of safety factor

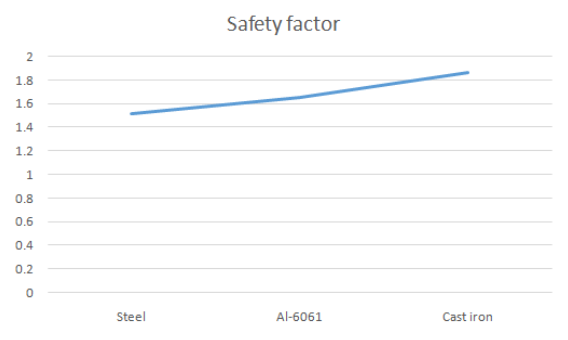
V-shape cylinder results



Comparison of deformation

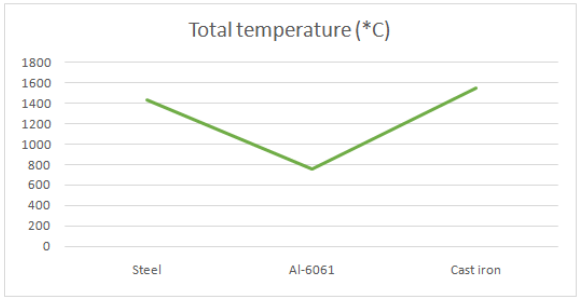


Comparison of stress

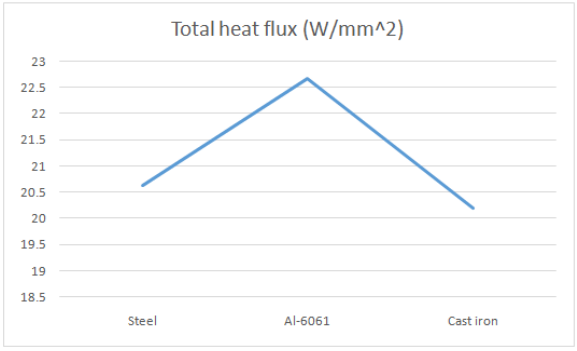


Comparison of safety factor

Thermal analysis

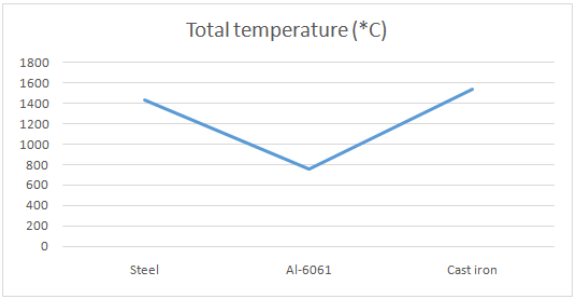


Comparison of total temperature

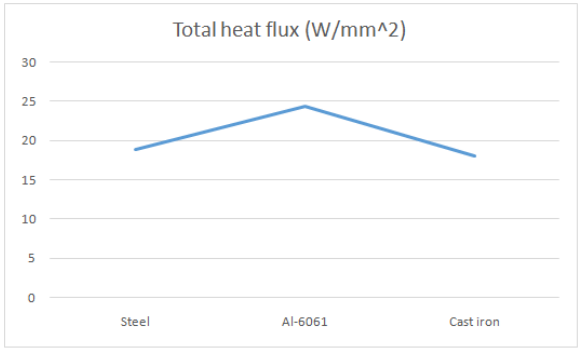


Comparison of total heat flux

V-shape cylinder results



Comparison of total temperature



Comparison of total heat flux

5. CONCLUSIONS

In this project we designed two cylinder heads (straight and V-shape fins) by using cad tool solid works analyzed with cae tool Ansys

workbench, here we took steel as an existing material for both models and to get more results here also we modified materials and we took 2 new materials (al-6061, cast iron,) While analyzing our models with static load conditions here we came to know that straight fins cylinder can with stand 9Mpa inside pressure only but other 3 materials are having good safety factor values than existing material, in this process V-shape cylinder (165.24Mpa) has less stress values than straight fins (171.84Mpa) model, by changing the shape of cylinder we can decreases over all stress values up to 5%, and we can increase the strength.

From the thermal results of straight fins cylinder here al-6061 has lowest temperature values but the difference between existing material and al-6061 is very high and we cannot replace this material with steel material even though it has good heat flux values. Other two materials are producing high temperature values and low heat flux values compare to existing material steel, so we cannot replace these materials even though these materials have good static analysis results. But we can reduce the temperature by changing design here we got less temperature values for V-shape cylinder compare to straight fins model. Finally, we can conclude V-shape cylinder head is satisfying both static and thermal load conditions with steel material.

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