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Design and Analysis of Connecting Rod and Piston Crankshaft by Using Ansys

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Abstract - *An internal combustion engine (ICE) is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons, turbine blades, rotor or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy.*

The main objective of the project is how to develop the prototype of engine assembly using CAD tool SOLIDWORKS. This Engine assembly consists major components they are Piston, Connecting Rod Assembly, and Crank Shaft, Cylinder head, Cam Shaft, Valves, crank case, oil tank and spark plug with required dimensions. The components which are developed in SOLIDWORKS are also analyzed in it using simulation tool. The thermal analysis of piston, crank shaft, cam shaft and valve is performed for 800k thermal loading and the results of temperature distribution of the components are shown. Finally the thermal analysis results of the components are compared and the best suited material is selected.

1. INTRODUCTION

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. In some engines, the piston also acts as a valve by covering and uncovering ports in the cylinder wall. A piston ring is a split ring that fits into a groove on the outer diameter of a piston in a reciprocating engine such as an internal combustion engine or steam engine.

The development of modern engines leads to further forcing of its operation process, thus causing more thermal stress of theirs main parts, forming the combustion chamber. The design and, especially, the engine development necessitates conducting of comprehensive and thorough assessments of quality, reliability and performance of all systems and engine parts, comprisingthe piston –cylinder group (further parts of the group operate under significantly high temperatures and in chemically active medium. Secondly, simultaneous impact of thermal and mechanical stresses, which are different

During the cycle due to inconstant gas pressure, has high influence on the cylinders durability. The heat flux, varying significantly during the cycle and reaching the values up to 10^6 W/m^2 and higher, is also irregular through the each surface of the group.

As a result of heat transfer, an intense and unsteady heating of every part of the group occurs. Temperature level of the piston, exhaust valve, cylinder head, valve seats and other parts may attain to the limiting values in terms of mechanical properties of structural materials. In some cases there might be a harmful overheating of details which results in a burnout of piston head, cracking of the walls of the combustion chamber and other effects that lead to the destruction of the engine. Thus, special measures to ensure optimum thermal regime of the main parts of the engine are required for its regular operation.

It is the working medium in the cylinder that results in heating and strain of details, being the main source of heat. Therefore, a careful evaluation of heat transfer conditions, based not on integral, but on a local heat flux as function of the angle of rotation of the crankshaft, is needed.

It is safe to say that an interest of

researchers to that kind of instrumentations is increasingly mounting. Commonly applied approach to the problem presents a combination of experimental measures and theoretical calculations. This is done by use quick-response thermocouples, measuring the average temperature profile in close proximity to the surface. The feedback of these quick-response thermocouples is utilized to resolve the equation of heat transfer, where the boundary conditions are known [1, 3], and calculate temperature gradient and heat flux. Although, the researchers assure of its high accuracy, the error of the measurement does not exceed 2%, the method does not seem to be convincing and applicable beyond the experiment. Also, for the heat flux being a vector quantity, the method is unable to provide complete picture of what is taking place in the cylinder at the moment.

However, there is an emerging approach to measure the heat flux directly. For that purpose, so-called heat flux sensors are employed. The main feature of heat flux sensor is that it generates an electrical signal, which is proportional to the aggregate heat rate applied to the surface of the sensor.

Basic heat transfer models, diverse heat flux sensors and recent experience of theirs application in internal combustion engines will be discussed further in the paper.

Compression Ratio

The compression ratio of an internal-combustion engine or external combustion engine is a value that represents the ratio of the volume of its combustion chamber from its largest capacity to its smallest capacity. In a piston engine it is the ratio between the volume of the cylinder and combustion chamber when the piston is at the bottom of its stroke, and the volume of the combustion chamber when the piston is at the top of its stroke.

Cycles of reciprocating internal combustion engines

As can be seen from its name, an internal combustion engine is a heat engine in which fuel combustion inside the engine transfers heat to the working medium. In these engines during the first and second stroke, the working medium is air or a mixture of air and an easily inflammable liquid or gaseous fuel. During the third stroke, the products of combustion of this liquid or gas fuel (gasoline, kerosene, solar oil, etc.) represent the working medium. In gas engines, the working medium is under comparably low pressures and its temperatures are well above the critical temperature, thus, it allows us to consider the working medium as ideal gas and, thereby, significantly simplifying the thermodynamic analysis of the cycle.

Internal combustion engines have two important advantages, comparing with other types of heat engines. Firstly, the fact that a high-temperature heat source is located inside the engine, there is no need for huge heat transfer surfaces to support heat transfer from a high-temperature source to the working medium. The advantage allows using of compact designs.

The second advantage of internal combustion engines is a possibility to reach higher thermal efficiencies. It is well known that the uppermost cycle temperature of the working medium in the engines, where heat is transferred from external source, is limited by the temperature, which does not entail structural materials failure. Since the heat is released in the volume of the working medium itself and is not transferred through the walls, the uppermost value of the continuously changing temperature of the working medium can considerably exceed this limit. It also worth keeping in mind, that the cylinder walls and the head of the engine are cooled, thus, causing a considerable increase in the temperature range of the cycle, and thereby increasing its thermal efficiency. However, constant cooling is proved to cause a deviation of compression from ideal isoentropicprocess.The core component of any reciprocating engine is the cylinder with a piston connected to an external work consumer by means of a crank shift. A simple engine'scylinder has two openings with valves, through one of which the working medium, air or the fuel-air mixture, is induced into the cylinder, and through the other valve the working medium is exhausted upon completion of the cycle.

2. LITERATURE REVIEW

After thorough study of literature and analyzing brainstorming sessions the following report is made.

Myers et al., [2] had worked on properties which in turn effect on the transfer of heat and also on various efficiencies related to the IC engines and this marks first of its kind effort on adiabatic engines after 25 years of Kirloskar’s research. He clearly mentioned the pros and cons of his research. This is very much useful for researchers for further developments

One of the earliest investigations on the low heat rejection concept was conducted by Griffiths [10]. In his thermodynamic simulation model, he increased the combustion chamber wall temperature and studied its effects on thermal efficiency and heat rejection. In his analysis he found that only 25% of the reduction in heat rejection is recovered as work. About 61% of this reduction appears in the exhaust and 14% is lost in intercooler.

French [64] had conducted an extensive literature review on the subject of adiabatic engine. He has developed a simple model for this survey, based on air cycle, which describes the reduction in coolant heat loss as a function of the ceramic dimensions and engine operating conditions. He even compared the results of his model with experimental results published in the literature. In his analysis he found that increasing the insulating material thickness follows the law of diminishing returns (i.e. a 2 mm layer of zirconia will reduce heat loss by 48% and a 8 mm thick zirconia layer is require to reduce the heat loss by 78%).Wade et al., [74] had concentrated much on the area of the combustion chamber above the piston rings. Their research was focused on insulated steel piston for the development of limited cooled engine. They made significant efforts to study the pollution impact on diesel engines and fuel consumption at part load operating conditions. The major pollutants namely hydrocarbons and particulate matter have been reduced to 7%. They also faced problems like lubricating oil failure at elevated temperatures and drop in volumetric efficiency due to change in densities. They also reported impacts made due to nitrogen oxide emissions

Morel et al., [82] had formulated strategy to work considering the structural parameters related to diesel engines and these embark a new correlation [83] regarding heat transfer and proper mixing of charge inside the engine cylinder as well as combustion gas velocities. They focused on the effects of different insulation approaches and insulating materials placed at several positions within the combustion compartment.

Piston 2d Drawing

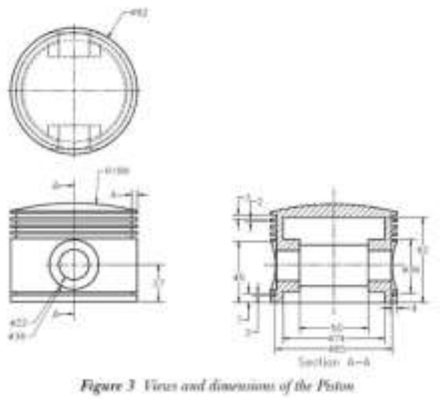

Figure 1: Dimensions of the piston

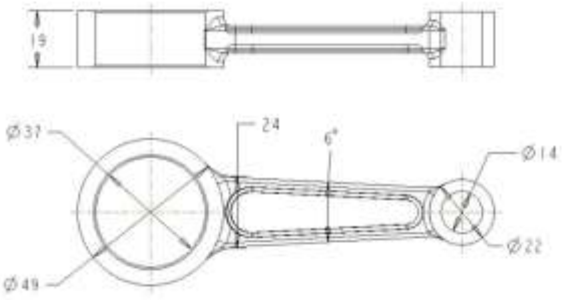

Figure 2:Connecting rod 2D drawing

3. Results for Steel Crankshaft

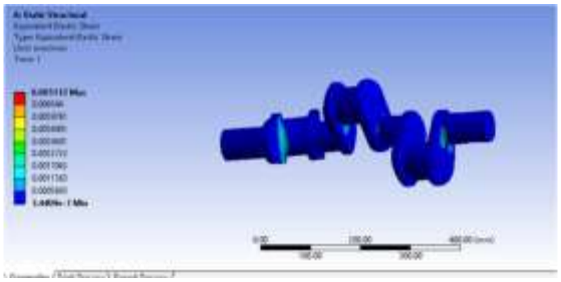

Figure 3: Strain

Results for Aluminium Alloy Crankshaft

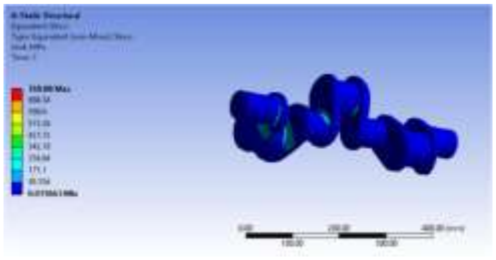

Figure 4:Stress

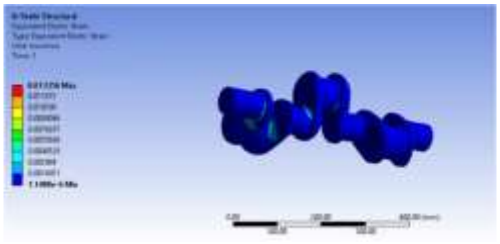

Figure 3:Strain

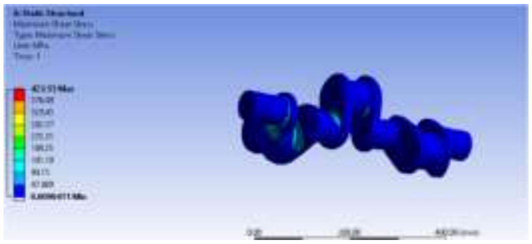

Figure 4:Shear stress

Results for Titanium Alloy Crankshaft

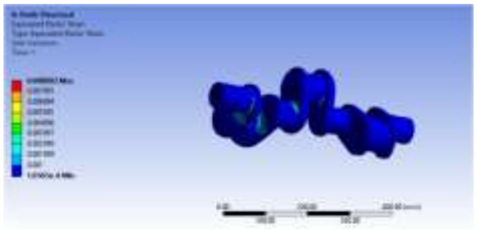

Figure 7: Strain

Piston Results

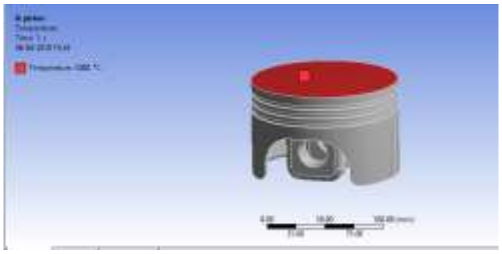

Figure 5:Temp boundary

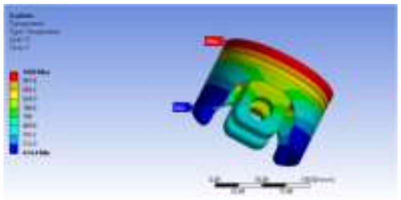

Figure 9:Temperature for steel

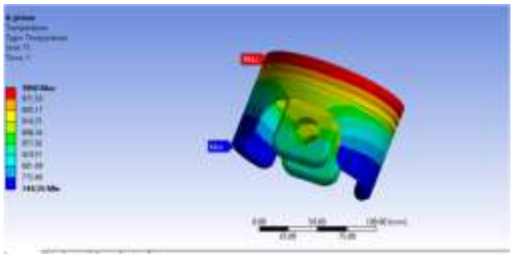

Figure 10:Temp for aluminum alloy

4. OVERVIEW RESULTS

Connecting rod

Material	**Deformation (mm)**	**Elastic strain**	**Shear stress (MPa)**
Aluminum alloy	0.037646	0.00022672	23.983
Structural Steel	0.0133689	0.00063875	24.05

Table 1: Connecting rod results

Piston

Material	**Temperature (oC)**	**Heat flux (W/mm2)**
Aluminum alloy	744.26	1.1828
Structural Steel	474.4	1.6552

Table 2: Piston results

Crankshaft

Material	Deformation (mm)	Von-Mises Stress (MPa)	Shear stress (MPa)
Aluminum alloy	1.1168	769.88	423.55
Structural Steel	0.40182	830	457
Titanium Alloy	0.8137	722.64	384.7

Table 3: Crankshaft results

5. CONCLUSION:

In this Project, the connecting rod, piston and crankshaft model was created by SOLIDWORKS software. Then, the model created by SOLIDWORKS was imported to ANSYS software. The Value of Von-Misses Stresses that comes out from the analysis is far less than material yield stress so our design is safe and we should go for optimization to reduce the material and cost.

In this project we also analyzed on connecting rod with using two different materials Structural steel, aluminum alloy. From the above results Alumium alloy is best material for connecting rosd.

The project also discussed steady state thermal analysis on piston from the above results the aluminum alloy is suitable material for piston.

After Performing Static Analysis I Performed the materials Titanium ally. Because the Titanium alloy's stress value is 722.64 Mpa and the tensile ultimate strength is 1070Mpa. According to above discussion we concluded the Titanium Alloy is prepared one.

- The maximum deformation appears at the center of crankpin neck surface.
- The maximum stress appears at the fillets between the crankshaft journal and crank cheeks and near the central point Journal.
- The edge of main journal is high stress area

6. REFERENCES:

[1] C. D. Rakopolous, G.C. Mavropoulos. 1999. Experimental instantaneous heat fluxes in the cylinder head and exhaust manifold of an air –cooled diesel engine. Energy Conversion and Management.

[2]. Borman G., Nishiwaki K. 1987. Internal –combustion engine heat transfer. Progress in Energy and Combustion Science.

[3]. Yuh –Yih Wu, Bo –Chinuan Chen, Feng –Chi Hsieh. 2006. Heat transfer model for small –scale air –cooled spark –ignition four –stroke engines.

[4]. Rakesh K. Maurya, Avanish K. Agarwal. 2012. Investigations on the effect of measurement errors on estimated combustion and performance parameters in HCCI combustion engine. Measurement.

[5]. V.P. Isachenko, V.A. Osipova, A.S. Sukomel. 1975. Heat transfer. Moscow, p. 45 –73, p. 198 –243.

[6]. J.B. Heywood. 1989. Internal combustion engine fundamentals. McGraw –Hill, New – York, p. 12 –34, 143 –197.

[7]. Kavtaradze R. Z. 2001. Local heat transfer in reciprocating engines.MSTU im.Baumana.

[8]. Woschni G. 1967. A universally applicable equation for the instantaneous heat transfer coefficient in the internal combustion engine.SAE.

[9]. Annand W. J. D. 1963. Heat transfer in the cylinders of reciprocating internal combustion engines. Proc. Instn. Mech. Engrs.

[10]. Nusselt W., 1928. Der WarmeubergangzwischenArbeitmedium und Zylinderwand in Kolbenmaschinen.Forachungsarb.Geb.Ing.

[11]. EichelbergG.. 1939. Some new investigations on old combustion engine problems. Engineering.

[12]. Hohenberg G. F. 1979. Advanced approaches for heat transfer calculations. Society of automotive engineers, paper № 790825, SAE.

[13]. Brilling N. R. 1931. Investigating of working process and heat transfer in diesel engine.Moscow, p. 210 –256.