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Modeling and Analysis of Piston Design through Pro/E & ANSYS

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Abstract - ***In the now-a-days technology the diesel engines plays an important role in the transportation sector, agricultural pumping sets etc., where large amount of diesel is consumed. But according to the ministry of petroleum, this petroleum fuels will last in few years. So, one must concentrate much on the diesel engine modifications so that the amount of fuel consumption and the environmental pollutions can be reduced.***

In a normally diesel engine the amount of useful energy available is less and remaining is lost to the cooling water, exhaust gases and as frictional losses. The most effective way of burning various fuels in the engine and reducing the energy losses is by using thermal barrier coatings on the various elements of the combustion chamber like cylinder head, cylinder liner, piston and valves.

In IC engines, approximately one-third of the total fuel input energy was converted in to useful work and Two-third has been lost through exhaust gas and cooling system. Among all the components in the engine, piston will play a very important role for the production of power. The amount of useful work can be increased with the modification of piston. With the various piston materials the amount of temperature available in the engine can be increased which further increases the efficiency. The paper presents results of modeling in piston and analyzing the temperature distribution.

The temperature distribution in the piston is a crucial parameter which influences the thermal stresses and deformations in the piston materials. This stress and deformation varies with different materials of the piston. So in the present work we tried with brass, Aluminum and cast iron pistons. For that we designed the 5B.H.P diesel engine piston. Then the same is modeled in Pro/E and the analysis is carried out in the commercially available analysis software ANSYS. For the general design of the piston, a C program is also added in the appendix.

[1]This analysis is based on fact that coating thickness affects the heat transfer and temperature distribution in the cylinder head and piston a 3d finite element analysis using ansys is performed to evaluate the temperature distribution over the cylinder head, inlet valve, exhaust valve and the piston based on the analysis it can be conclude at that coating of steel layer with a aluminum piston to reduce the temperature distribution of a nodal solution. In general steel coating act as a thermal barrier which improves the efficiency by reducing energy losses

The developed methodology of modeling and simulation may lead to obtain higher thermal resistance, strength and durability of IC engines and their elements with thermal barriers in all fields of applications including aviation.

[2]The results of computations proved high efficiency of the coating as a thermal barrier the working temperature in some Ares inside the piston with a cooling showed a huge decrease and was 40% lower as compared with the temperature for the same piston without a coating at the same time, the heat fluxes inside the piston were reduced all most 10 times.

Key Words: ***Design the piston by using calculations. To develop the geometry of the piston using PRO/E***

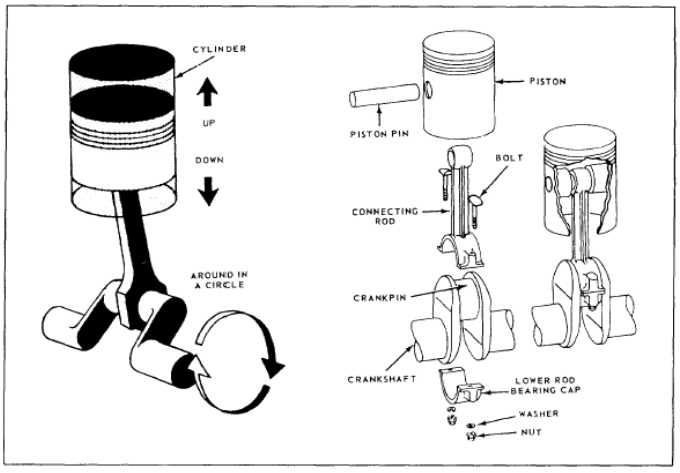
software .And analysys by a ANSYS software.

To investigate the temperature distribueation using thermal analysis

1. INTRODUTION

The increasing trends and demands in the automotive world, there is always tug and tie between the designer and customer. To cope with existing competition in the modern times there is always need for great improvement in compatibility of the engine models. In this chapter the brief introduction about internal combustion engine (IC engine) is presented. The various components, type and recent advancements in IC engine are also presented in this chapter.

An internal combustion engine is most remarkable achievement in the last hundred years. The distinctive feature of IC engine is that combustion and conversion [3]of heat energy into mechanical work occur inside the cylinder. These engines are noted for their efficiency and low operating cost. Such is the versatility of the IC engines that is development has a wide spread effect on the life of every nation. Petrol, gas and diesel engines, wankle engines, and open cycle gas turbines are examples of internal combustion engines. The advantages of internal combustion engines are greater mechanical simplicity, lower weight due to absence of auxiliary equipment like boiler and condenser and thus lower price, higher overall potency, and lesser demand of water for dissipation of energy through cooling system. IC engines square measure in the main used for transport vehicles, locomotives, agricultural pumping sets and aircrafts etc.,



1.1 WORKING PRINCIPLE OF FOUR STROKE CYCLE DIESEL ENGINE:

It is also called as compression ignition motor because the ignition takes place due to heat delivered in the motor cylinder toward the end of pressure stroke. The four strokes of a diesel motor are depicted underneath:

1. Suction or charging stroke:

In this stroke, the inlet valve opens and unadulterated air is sucked into the barrel as the cylinder moves downwards from the top perfectly focused (TDC) to base right on target (BTD).

2. Compression stroke:

In this stroke, both the valves are shut and the air is packed as the cylinder moves onwards from BDC to TDC. As a consequence of pressure, weight and temperature of the air increments impressively (the genuine worth relies on the pressure ratio).This finishes one transformation of the crankshaft.

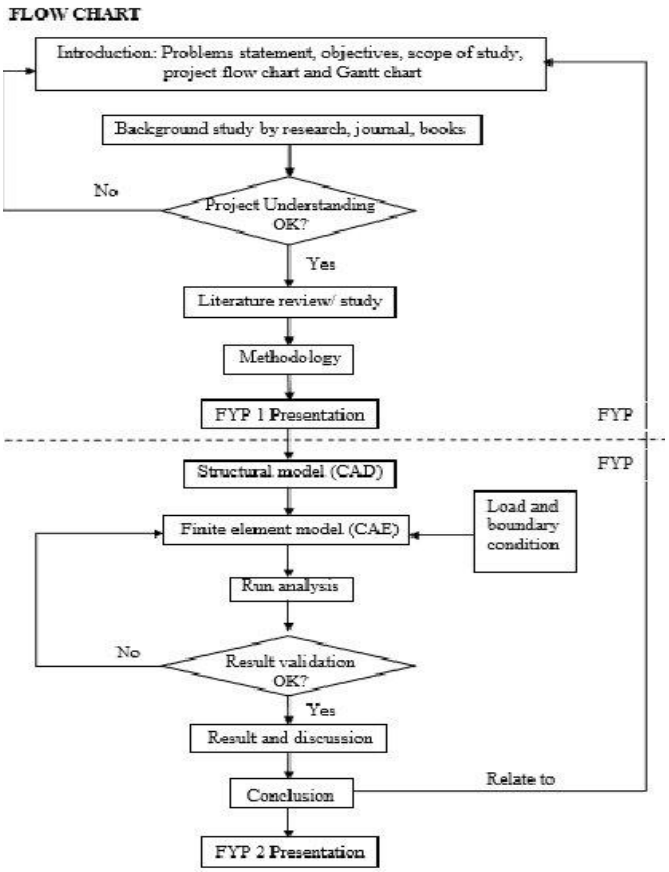
3. Expansion or working stroke:

Prior to the piston achieves the TDC (amid the pressure stroke), fuel is infused as fine splash into the engine cylinder, through the spout, known as fuel infusion valve. Right now, temperature of the compacted air is adequately high to touch off the fuel. It abruptly builds the weight and temperature of the results of burning. The fuel oil is persistently infused for the fraction of revolution.
The fuel oil is thought to be blazed at steady pressure. Because of expanded pressure, the piston is pushed down with an extraordinary power. The blazed gasses extend because of high velocity of the cylinder. Amid this development a percentage of the warmth energy is moved into mechanical work. It might be noticed that amid this working stroke, both the valves are shut and the cylinder moves from TDC to BDC.

4. Exhaust stroke:

[6]The exhaust valve is opened as the piston moves to TDC from BDC. This movement of the piston pushes out the products of combustion from the engine cylinder through the exhaust valve in to the atmosphere.
This completes the cycle and engine is ready to suck the fresh air again. The four stroke cycle diesel engines are generally employed in heavy vehicles such as buses trucks, tractors, pumping sets and in earth moving machinery.
Among all the engine parts, the power produced in the engine mainly depends on the piston. With the modifications of the piston one may reduce the diesel usage and the pollution from it. So in our project we concentrated much on the diesel engine piston, which are having much usage in all types of diesel engine.

1.2 Project flow chart

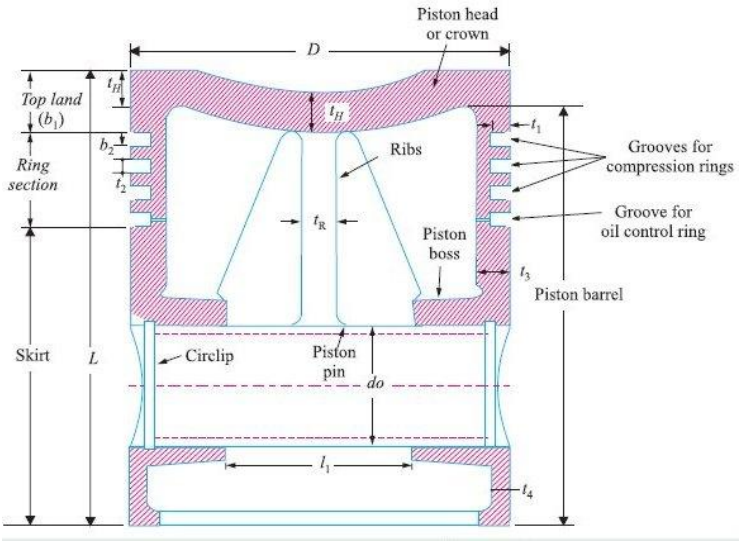


2. METHODOLOGY:

2.1. Design considerations for a piston

In the designing a piston for I.C Engines, through the following points should be taken into considerations:

1. It ought to have huge quality to withstand the high gas weights and inactivity strengths.
2. It ought to have least mass to minimize the inertia forces.
3.It ought to form an effective gas and oil sealing of the cylinder.
4. It ought to give adequate bearing zone to avoid undue wear.
5. It ought to scatter the warmth of combution rapidly to the cylinder walls.
6.It ought to[4] have high speed reciprocation without noise.
7.It should be sufficient rigid construction to withstand thermal and mechanical distortion.
8. It ought to have adequate backing for the piston pin.



2.2. 3-D MODELLING OF PISTON USING PRO/ENGINEER

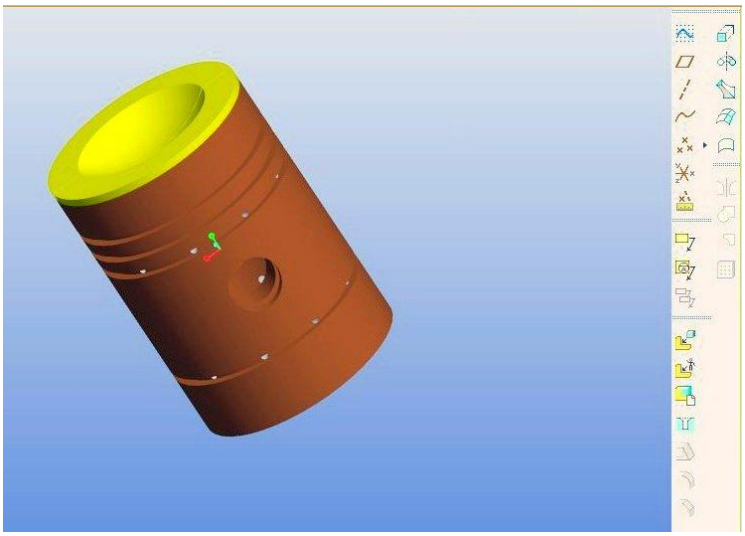
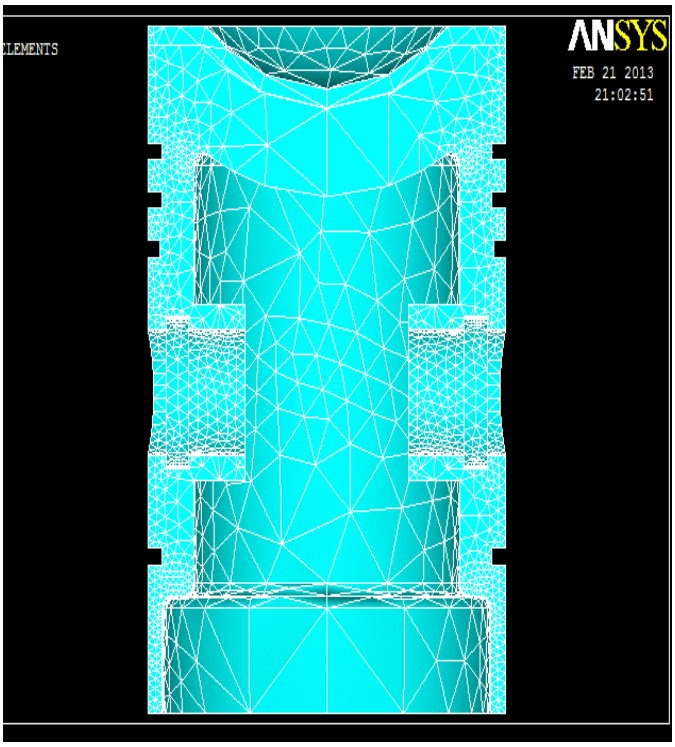


Fig: Over view of the piston

2.3. ANALYSIS OF PISTON USING ANSYS WITH ADDING STEEL LAYER:

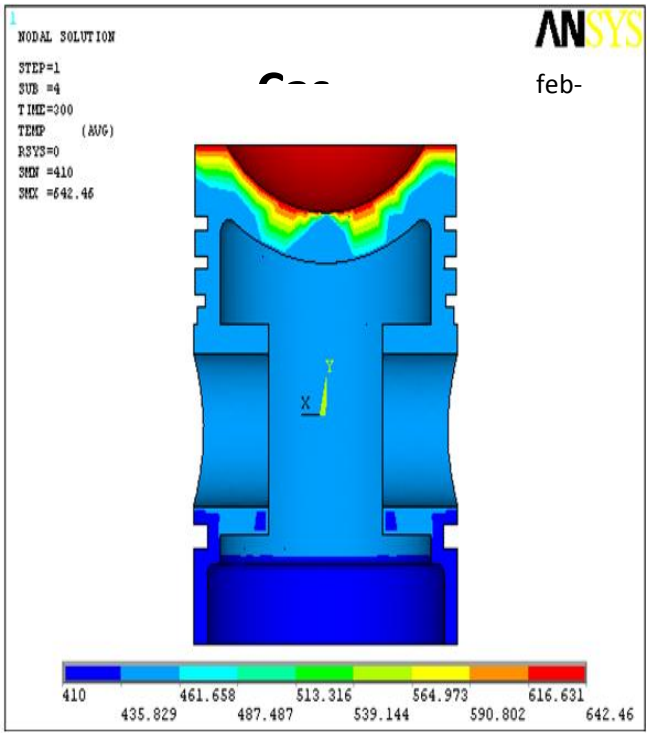
2.3.1. PISTON MODEL AND MESH

The modeling of single cylinder four stroke diesel engine piston using Pro/E is discussed in the third chapter and the same is used for thermal analysis. In this work 10 node solid 87 element is selected for meshing. The finite element mesh of the piston model used in ANSYS is shown in Figure.



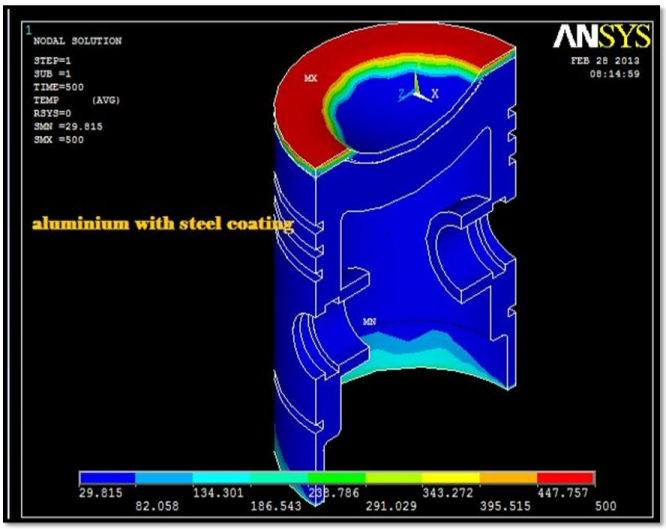
Piston model with mesh

2.3.2. TEMPERATURE DISTRIBUTION IN CAST IRON PISTION:



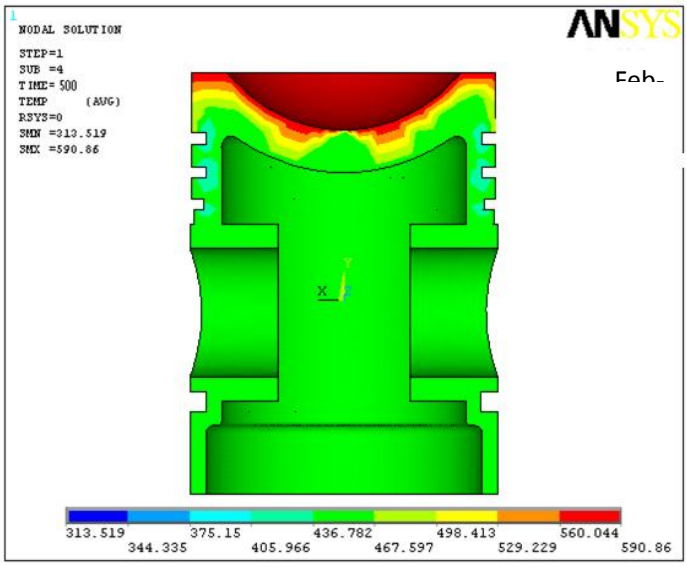
Temperature distribution of Cast iron piston

2.3.3. TEMPERATURE DISTRIBUTION IN ALUMINIUM PISTON:



Temperature distribution of aluminum with steel coating piston

2.3.4. TEMPERATURE DISTRIBUTION IN BRASS PISTON



THERMAL PROPERTIES OF THE MATERIALS:

Material	Thermal Conductivity Btu / (hr-ft-F)	Density (lbs/in)	Specific Heat (Btu/lb/F)	Melting Point (F)	Latent Heat of Fusion (Btu/lb)	Thermal Expansion (in/in/F x 10^{-6})
Iron, Cast	46.33	0.26	0.12	2150	-	6
Brass (Yellow)	69.33	0.306	0.096	1724	-	11.2
Aluminum	136	0.098	0.24	1220	169	13.1
Steel, Carbon, 1.5%C	24.3-65.2	7.753E+3 (kg/m^3)	450-2081			11-16.6

3. CONCLUSIONS

In the diesel engines, the maximum power generation and reduced pollutions mainly depends on the piston modifications only. The power generation further depends on the temperature distributions through that. So in this work a [7]comparative evaluation was made between the temperature distributions of various piston materials.

According to the simulation results conducted in this study, it has been conclude that the cast iron material shows higher surface temperatures and will transfer more heat to the exhaust gases due to its higher specific heat than brass material.

As the self ignition temperature of the diesel is lower and for higher efficiency aluminum piston is more suitable for the diesel engines due to its low density. But for burning low cetane fuels as an alternate for diesel it requires higher heats and the brass piston is more suitable though the density is higher than the remaining two.

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