DESIGN AND INVESTIGATION OF MOTOR CYCLE ENGINE BLOCK

UPENDRA BALIJA
M.Tech Student, Dept of Mechanical-CAD/CAM, Brilliant grammar school educational institutions group of institutions integrated campus, T.S, India

PRASHANT S. D.
Associate Professor, Dept of Mechanical-CAD/CAM, Brilliant grammar school educational institutions group of institutions integrated campus, T.S, India

ABSTRACT

In this thesis, the design of an internal combustion four-stroke engine is analyzed in the following areas; lubrication system, cooling system, crank train, valve train, induction system and exhaust system. It was concluded that a unique engine configuration could be made i.e. a W-9 engine (a nine cylinder engine with three cylinder rows). This W- 9 engine includes many attractive properties, such as: high efficiency, a compact and stiff engine block as well as a rigid crankshaft.

The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of heat transfer. By doing thermal analysis on the engine cylinder fins, it is helpful to know the heat dissipation inside the cylinder. We know that, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult.

The whole engine was modelled in computer aided design (CAD) software and a finite element analysis (FEA) was made on vital parts. The dynamics of the engine were simulated in multi-body simulation (MBS) software. The engine machining was performed with the latest computer aided manufacturing (CAM) software.

By scientifically combine different areas and use advanced computer aid, it was possible to construct and build an automotive engine from scratch, in a comparable short timeframe. Fittings of parts were excellent. The measured weight of 105 kg together with an estimated power above 500 hp, gives a superior power to weight ratio.

Keywords: *lubrication system, cooling system, crank train, valve train, induction system and exhaust system, CAD, FEA, MBS, CAM.*

1.0 INTRODUCTION

Internal combustion engines are without comparison, the most widespread transformer of chemical to mechanical energy. They were conceived and developed in the late 19th century and have had a significant impact on mankind and society since then. Although the understanding of engine processes has increased and new inventions as well as better materials have improved the design, the basic engine principle is still the same. Internal combustion engines can deliver power from 0.01 kW to 20 MW depending on engine size. The advantages with internal combustion engines are their low weight and small bulk compared to the output.

Engines are an integral component of an automobile that are built in a number of configurations and are considerably more complex than early automotive engines. Technological innovations such as electronic fuel injection, drive-by-wire (i.e., computer-controlled) throttles, and cylinder-deactivation have made engines more efficient and powerful. The use of lighter and stronger engineering materials to manufacture various components of the engine has also had an impact; it has allowed engineers to increase the power-to-weight of the engine, and thus the automobile. Common components found in an engine include pistons, camshafts, timing chains, rocker arms, and other various parts. When fully stripped of all components, the core of the engine can be seen: the cylinder block. The cylinder block (popularly known as the engine block) is the strongest component of an engine that provides much of the housing for the hundreds of parts found in a modern engine. Since it is also a relatively large component, it constitutes 20-25% of the total weight of an engine .Thus there is much interest in reducing the block's weight.

The mechanical properties of the individual alloys will be incorporated, as well as the manufacturing processes used to fabricate the component. We know that in case of 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. To avoid overheating, and the consequent ill effects, the heat transferred to an engine component (after a certain level) must be removed as quickly as possible and be conveyed to the atmosphere. It will be proper to say the cooling system as a temperature regulation.

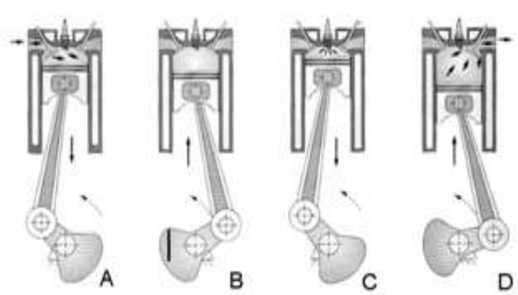

Figure1: strokes of piston

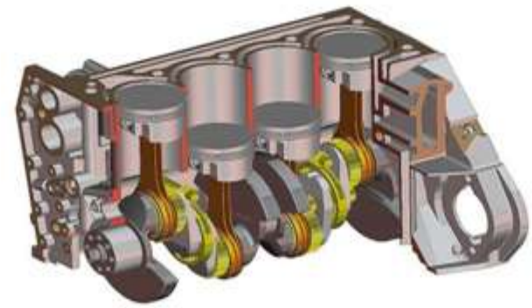

Figure 2: Engine block

Table 1 Nine-cylinder W-engine

Cylinder volume	2977 cc
Bore	90mm
Stroke	52mm
W-angle:	60°-0°-60°
Compression	12.7:1
Fuel	Ethanol, E85
Weight	110 kg
Power	more than 500 hp
Cylinder spacing	104 mm
Head layout	4- valve, spark ignited

2.0 LITERATURE SURVEY

1. Kouremenous et al. (1999) examined the effect of the fuel composition and physical properties on the mechanism of combustion and pollutant formation. A number of fuels having different density, viscosity, chemical composition, (especially aromatics type), are used in their investigation and found that the fuel properties namely density and viscosity are more important than fuel composition (aromatics) in respect of engine Performance and emissions.

2. Hajdukovic et al. (2000) reported that the toxicity of diesel fuel is generally attributed to soluble aromatic compounds. Alkyl derivatives of benzene and polycyclic aromatic hydrocarbons are considered as most harmful. The routine use of fuel additive in diesel began in 1960's in Europe as cold flow improvers. The additives added in parts per millions (ppm) levels achieve a specific objective of either improving the physical or chemical characteristics of the fuel or improving the combustion characteristics.

3. **Kidoguchi et al. (2000)** in their investigations reported that in fuels with higher aromatics content, the pyrolysis of fuel will not be satisfactory and therefore there are local high temperature regions on account of higher adiabatic flame temperature capability of ring structure hydrocarbons. The aromatic compounds are very compact with very less surface to volume ratio compared to long chain normal polymers. They have higher C/H ratio and also cm ratio per unit volume. They are also more reactive because of lower C-C bond strength compared to C-H bonds.

4. **Jensen et al (1983)** observed that the concentrations of alkyl homologues of PAH and oxy-PAH in the particulates were found to decrease with increasing cylinder exhaust temperatures. The degree of alkylation for the most abundant homologue of these compounds increased by one to two carbons as the cylinder exhaust temperature decreased. The inverse relationship between engine temperature and production of extractable organics suggests one possible emission control strategy.

5. **Jensen et al (1983)** observed that the concentrations of alkyl homologues of PAH and oxy-PAH in the particulates were found to decrease with increasing cylinder exhaust temperatures. The degree of alkylation for the most abundant homologue of these compounds increased by one to two carbons as the cylinder exhaust temperature decreased.

3.0 MODELLING OF ENGINE BLOCK

Cylinder along with fin was modelled in CATIA. The dimensions of the cylinder along with fin were taken from commercially available bike data sheet. Fins with different geometries (circular, Curved, Angular and rectangular) were modelling using CATIA Software.

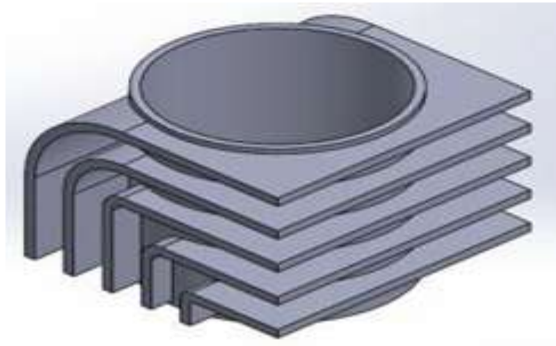

Figure 3.1 Engine Cylinder 3D model

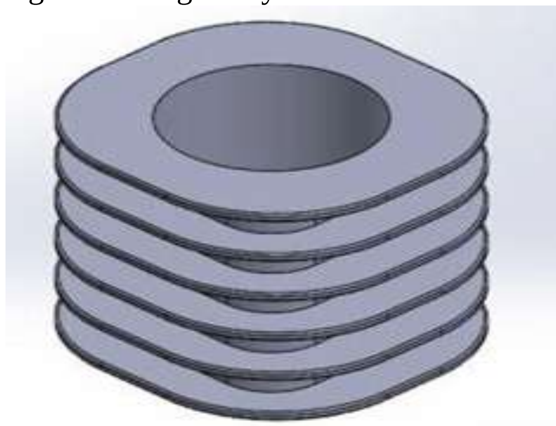

Figure 3.2 final view of block

Material properties

Aluminium alloy 6063

Thermal conductivity K = 200 W/m-K=0.2 W/mm-K

Specific heat Cp = 0.9 J/g0C = 900 J/Kg-K

Density = 2.7 g/cc = 2700 kg/m^3= 0.0000027kg/mm^

Grey Cast Iron

Thermal conductivity K=53.3 W/m-K= 0.0533W/mm-K

Specific heat Cp= 490 J/Kg-K

Density=7.1 g/cc = 7100 kg/m^3=0.0000071 kg/mm^3

Boundary conditions:

Thermal Temperature taken in analysis =1100 deg =1373K

4.0 ANALYZED RESULTS OF VARIOUS STRUCTURES ENGINE BLOCK

Completion of the analysis such as static, modal, harmonic, transient etc.. It is necessary to evaluate the changes in the design concepts by conducting the parametric study. A parametric study means study of different parameters and analyzes the effect of change of each parameter. For this study, we have to increase or decrease the particular parameter by a certain amount, say 1.0% or 25% and identify the changes such as displacements at some significant nodes. In order to conduct the parametric study, we have to select parameters which place a major role in the design of system. After selecting the parameters, the important nodes are identified that contribute the maximum displacements and maximum stresses to the system. In our parametric analysis, five important nodes are selected, one at steering top (node 169), second at rear left portion (node 1), third at passenger seat (node 562), fourth at front suspension bottom (node 861), and other at rear right suspension bottom (node 799). The parameters that we considered for the study are stiffness, damping coefficients of tyres and suspension system. Thus the above mentioned steps are followed for analysing the different structures of designs which is created and its characteristics are differentiated for different model and its results are as follows.

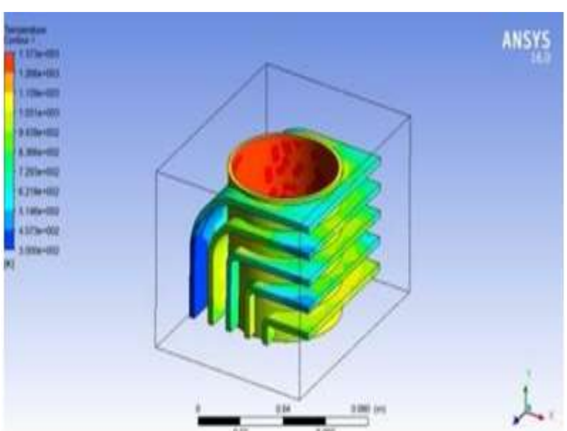

Figure 4.1 static stresses along the block for temperature

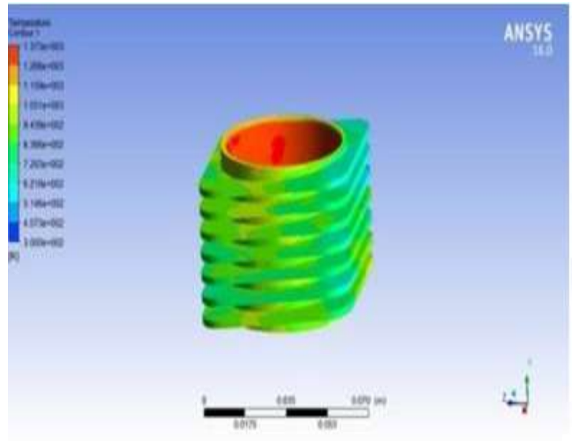

Figure 4.2 von mises stress along the block for temperature

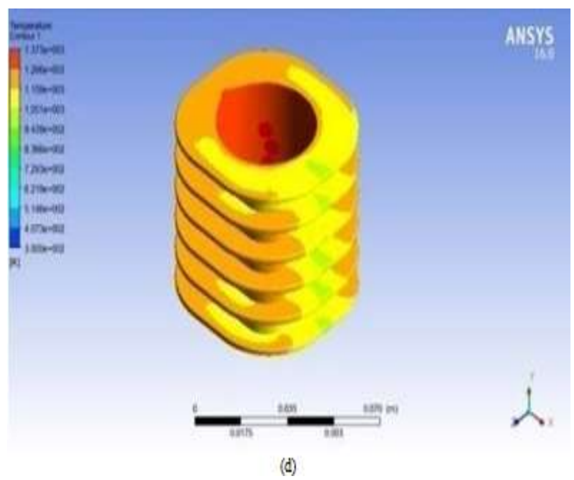

Figure 4.3 total deformation along the block for temperature

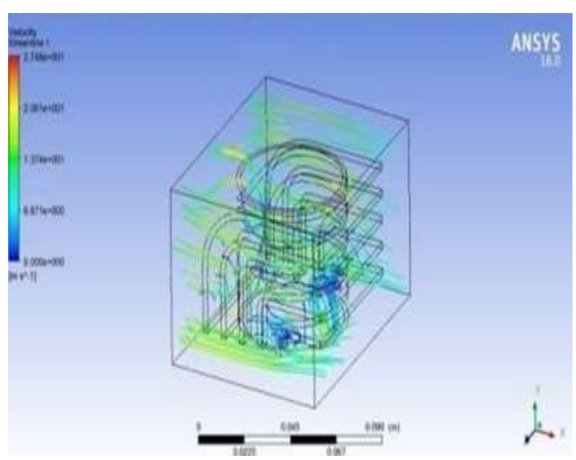

Figure 4.4 steam flow along the block

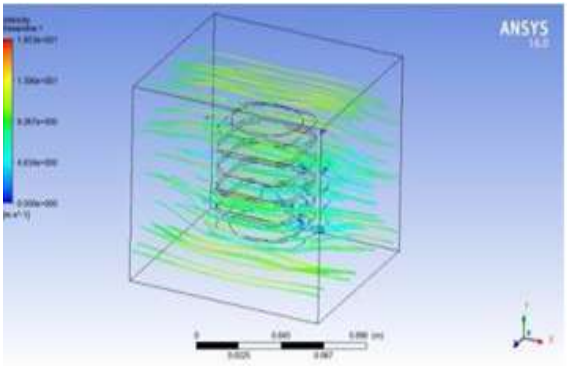

Figure 4.5 steam vector flow along the block

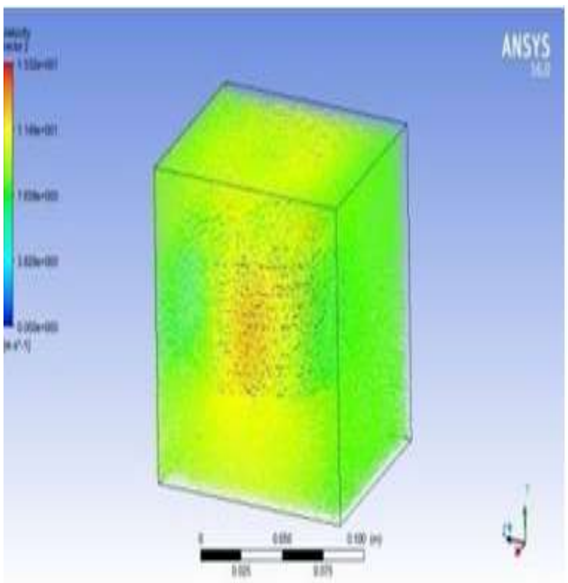

Figure 4.6 velocity vector along the flow

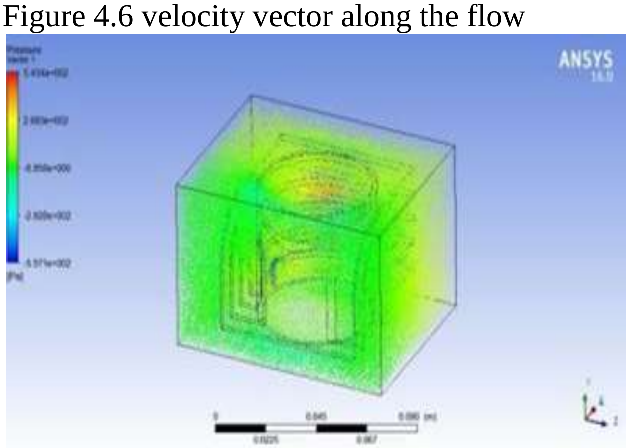

Figure 4.7 pressure flow along the block

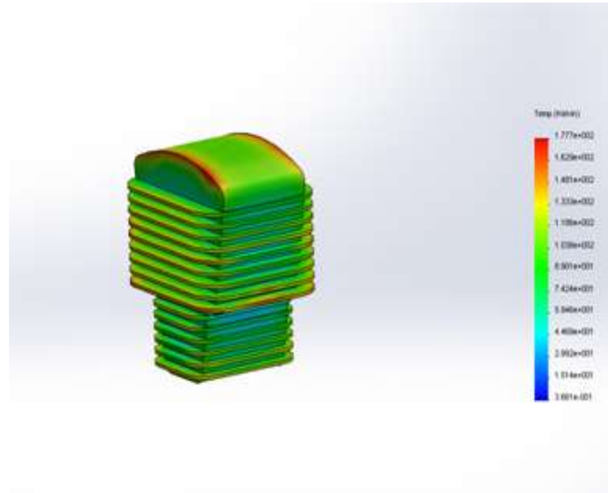

Figure 4.8 complete deformation of block

5.0 CONCLUSION & FUTURE SCOPE

Design of fin plays an important role in heat transfer. There is a scope of improvement in heat transfer of air cooled engine cylinder fin if mounted fin's shape varied from conventional one. Contact time between air flow and fin (time between air inlet and outlet flow through fin) is also important factor in such heat transfer. Wavy fin shaped cylinder block can be used for increasing the heat transfer from the fins by creating turbulence for upcoming air. Improvements in heat transfer can be compare with all the four model of the engine fins geometry by CFD Analysis and its flow characteristics are studied for all the geometries it is found that the curved fins provide better result when compared with all the other geometries

FUTURE SCOPE

Fossil fuels are widely used as a source of energy in various different fields like power plants, internal &external combustion engines, as heat source in manufacturing industries, etc. But its stock is very limited and due to this tremendous use, fossil fuels are depleting at faster rate. So, in this world of energy crisis, it is inevitable to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved. One of the major fields in which fossil fuels are used is Internal Combustion Engine. An alternative of IC Engine is **"AIR POWERED ENGINE"**. It is an engine which will use compressed air to run the engine. It is cheap as it uses air as fuel, which is available abundantly in atmosphere. There are several technical benefits of using this engine, like as no combustion takes place inside the cylinder, working temperature of engine is very close to there is no possibility of knocking. This in turn results in smooth working of engine.

One more technical benefit is that there will not be any need for installing cooling system or complex fuel injection systems. This makes the design simpler. Here air is compressed using compressor which in turn uses electricity, to run, which is cheaper and widely used. This adds value to its economic benefits. Also, as discussed earlier, as no combustion takes place which results in smooth working of the engine with minimum wear and tear, this will require less maintenance. So these are some of its economic benefits. One more interesting thing is that the exhaust temperature of this engine will be slightly less than the atmospheric temperature. So this will help in cooling the environment and if this technology is widely used than it will help in controlling global warming. These are some green bytes associated with this technology. Exhaust Gases leaving the engine will be only air having low temperature. So this will eliminate the problem of harmful emissions, in conventional engines. This gives us environmental benefit of using this engine. Also as there will be no thermal radiations produced, radar can't detect these vehicles. So this will help our army too. Also the components used in this are: conventional SI engine, air vessel to store compressed air, and timing circuit are economical.

These economical and readily available components make the technology easily adaptable.

- The Engine cylinder is one of the major automobile components, which is subjected to high temperature variations and thermal stresses.
- In future this may be possible as, by increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult.

REFERENCES:

1 G.W. Stachowaiak, A.W. Batchelor (1993), Engineering Tribology, Elsivier science publishers B.V.
2 R.I. Taylor (2002), Lubrication,Tribology & Motorsport, SAE paper 2002-01-3355
3 Y. Yasuada et. al. (2003), Reserch on Diamond-Like Carbon Coatings for Low-Friction Valve Lifters, 2003-01-1101
4 John B. Heywood (1988), Internal Combustion Engine Fundamentals, McGraw-Hill Publishing Company
5 L.K. Goldenstein et. al. (2002), The Effect of Nanoparticle Additions on the Heat Capacity of Common Coolants, SAE paper 2002-01-3319
6 Suzuki Motor Corporation (1985), Suzuki GSX-R750 Service Manual
7 C.F Taylor (1985), The Internal Combustion Engine in Theory and Practice, V2, MIT Press
8 H Rahnejat (1998), Multi-Body Dynamics, Vehicles, Machines, and Mechanisms, Proffessional Engineering Publishing