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DESIGN OF AN INTERNAL COMBUSTION ENGINE WITH SMALL VOLUME

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Abstract: *In recent years RC Model Engines are being used extensively in radio-controlled aerial and ground vehicles in variety of applications and are the subject of increased interest. Fully functional RC engines vary from two-stroke to four-stroke and from single cylinder to multiple cylinders in variety of cylinder arrangements. Electrical motors as well as engines running on a variety of blends of methanol, nitromethane and lubricant are being used in powering this type of vehicles. Contemporary engines' emissions are regulated and need to fall in certain ecological norms, while delivering the best fuel consumption with the greatest distance travelled. The aim of this paper is the design of such an engine in accordance with these requirements.*

Keywords: *RC Model Engine, RC ICE, miniature engines.*

INTRODOCTION

Designing and modeling of engines in CAD environment gives design efficiency, more precision and control. 3D modeling reduces the time and money needed and gives the user the advantage of creating precise virtual models and the confidence that parts will fit and work with minimal issues. It also gives the ability to create better visualizations and make forecasts based on simulations which can greatly reduce the amount of materials used (Simeon Iliev 2014, Simeon Iliev 2014).

Exposition

The aim of this paper is to present some of the main calculations done during the computational phase of designing the engine. The process needed to develop an engine design is relying predominantly on the initial performance goals. During the process attention has been paid to minimising the overall dimensions of the engine and costs associated with the manufacturing. The design of the spark ignition (SI) engine starts with choosing some basic parameters such as: number of cylinders and their arrangement, working cycle, crankshaft rotational speed, compression ratio, the maximum rated power and the type of fuel. Based on the basic parameters and the thermo chemistry of the air-fuel mixture, a V-shaped 6 cylinders SI engine was designed with operating parameters shown in Table 1.

Table 1. Engine Parameters

Piston diameter	17 mm
Stroke	16.15 mm
Displacement volume	22 cm^3
Engine power	760 W
Torque	12.1 Nm

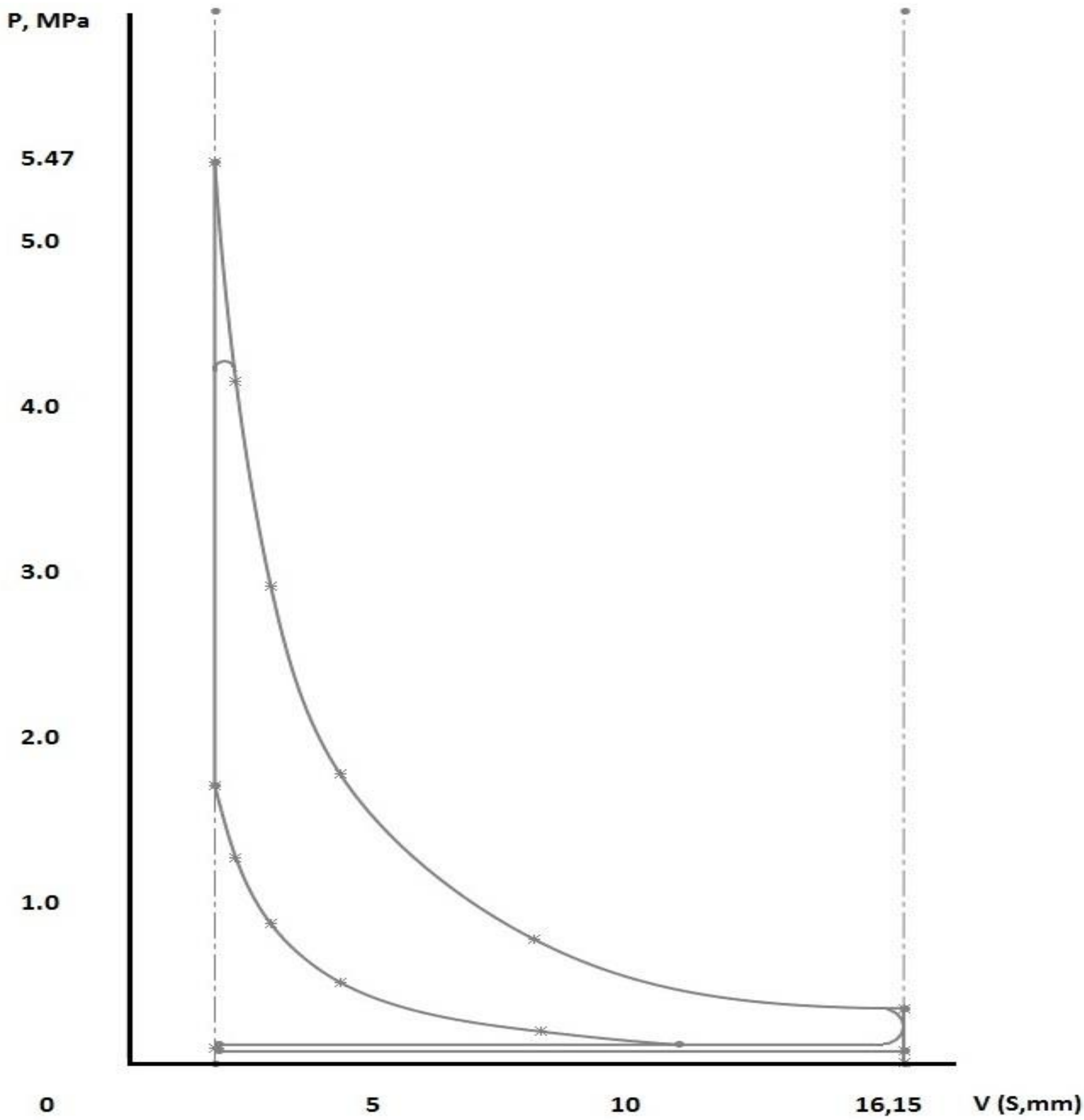

Figure 1. Pressure-Volume diagram.

The pressure-volume (P-V) diagram illustrates the thermodynamic processes occurring in a closed system. It models the relationship between pressure and volume of the air-fuel mixture in the engine's cylinders. The P-V diagram of an engine shows how the pressure in the cylinder changes as a function of the cylinder's volume. In addition to that P-V diagrams are used to calculate work done by the system. Since work is done when there is volume change, the area enclosed by the graph is proportional to the work produced by the engine. It is created by measuring the pressure inside the cylinder and plotting its value against the angle of the crankshaft, for one engine cycle which consists of two complete crankshaft rotations (720 degrees) (Heywood, J.,1988). The P-V diagram for the engine is shown in Figure 1. On the x-axes in millimeters is shown the piston stroke and on the y-axes the pressure in MPa. The maximum pressure achieved during the expansion of the air-fuel mixture as shown in the diagram is 5.47 MPa.

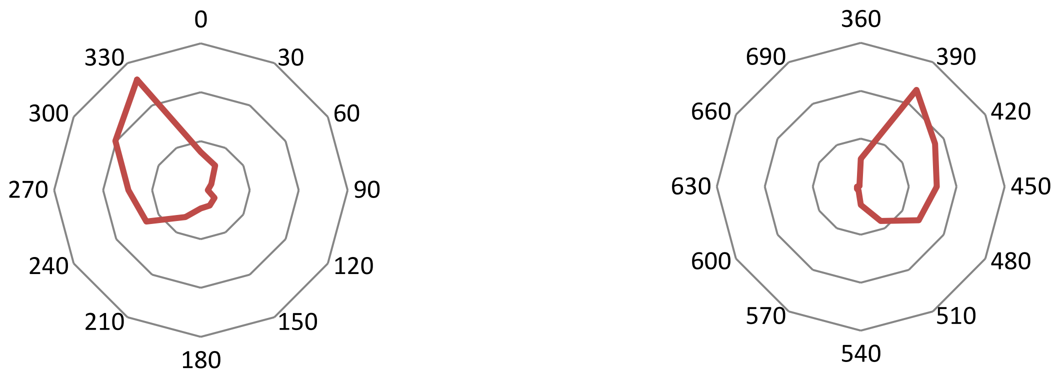

Figure 2. Polar load diagram for connecting rod big-end bearing.

The crankshaft converts the reciprocating linear motion of the piston into rotational motion. Among the most loaded parts of an engine are the crankshaft bearings. Forces with very high magnitudes are acting on the bearings, forces which during the operating cycle change very intensively. The life of the bearing shortens due to the high load and therefore lowers the reliability of the engine. The most common type of bearings used for this application is the journal bearing, also called hydrodynamic journal bearing. The main journal bearing consist of two parts, upper and lower, and the upper part has an oil groove in it as well as a lubricating hole through which pressurized oil maintains the hydrodanimc regime of operation (Basshuysen, R., Schafer, F., 2004).

On Figure 2 is shown the polar load diagram of the connecting rod big-end bearing load distribution for two complete crankshaft rotations (from 0 to 720°). The polar load diagram for the main bearing journal for one rotation of the crankshaft is shown in Figure 3. The lubrication holes feeding the journal bearing are drilled in that zone of the journal where the load is the smallest. Figure 4 shows the upper part of the main bearing (Lilov, C., Iliev, L., Ivanov, C., Marinov, E. , 1976).

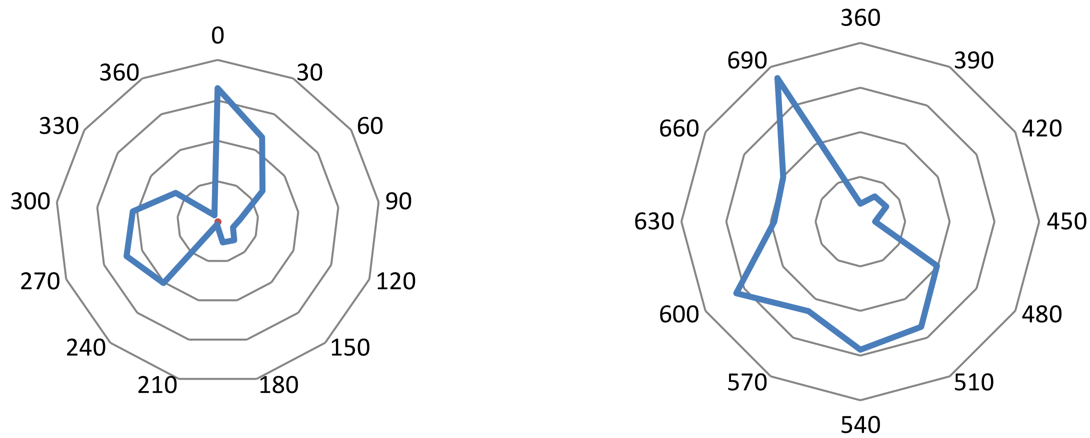

Figure 3. Polar load diagram for main bearing.

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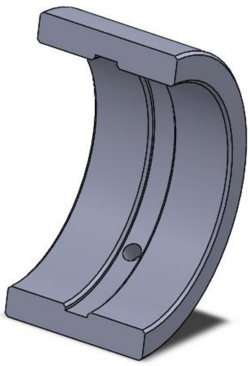

Figure 4. Upper part of a main journal bearing

Engine maps are primarily used to document certain operating parameters. They can be compared and evaluated on specific engine parameters. The engine map contains a lot of compacted information from which a well trained eye can derive an assessment for the particular engine (Orlina, A., Kruglova, M., 1984).

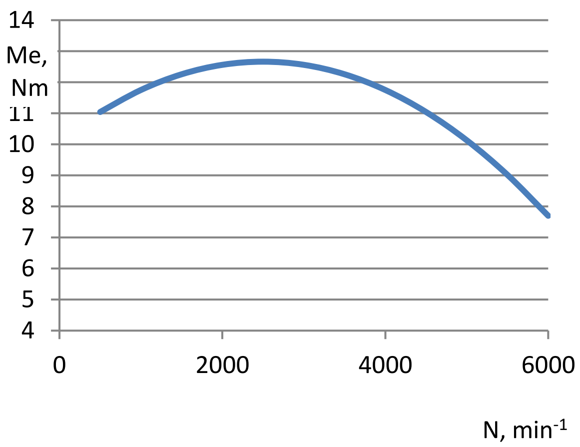

Fig. 5-1. Torque

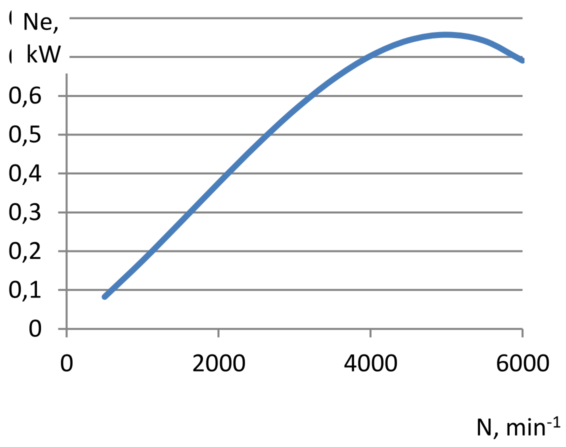

Fig. 5-2. Power

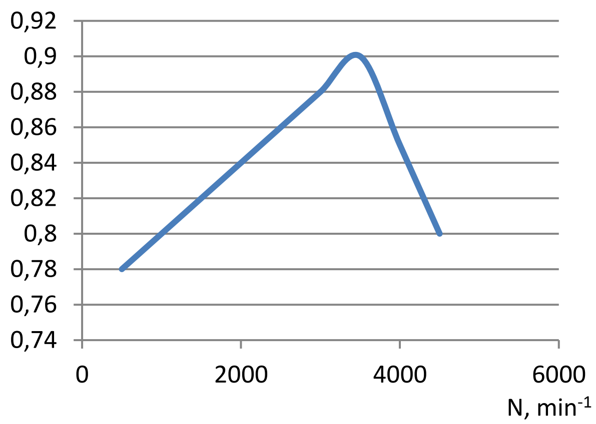

Fig. 5-3. Air ratio

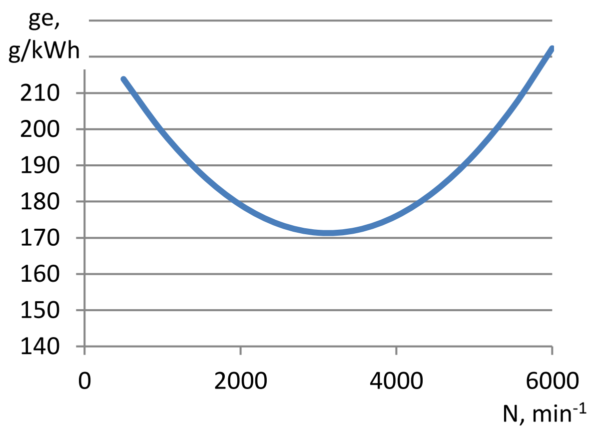

Fig. 5-4. Brake Specific fuel consumption

Figure 5. Engine maps characteristics as functions of crankshaft speed

Based on the initial parameters and the results obtained a 3D model for the internal combustion engine was generated in SolidWorks environment. The final design of the engine at the time of the writing of this paper is shown in Figure 5.

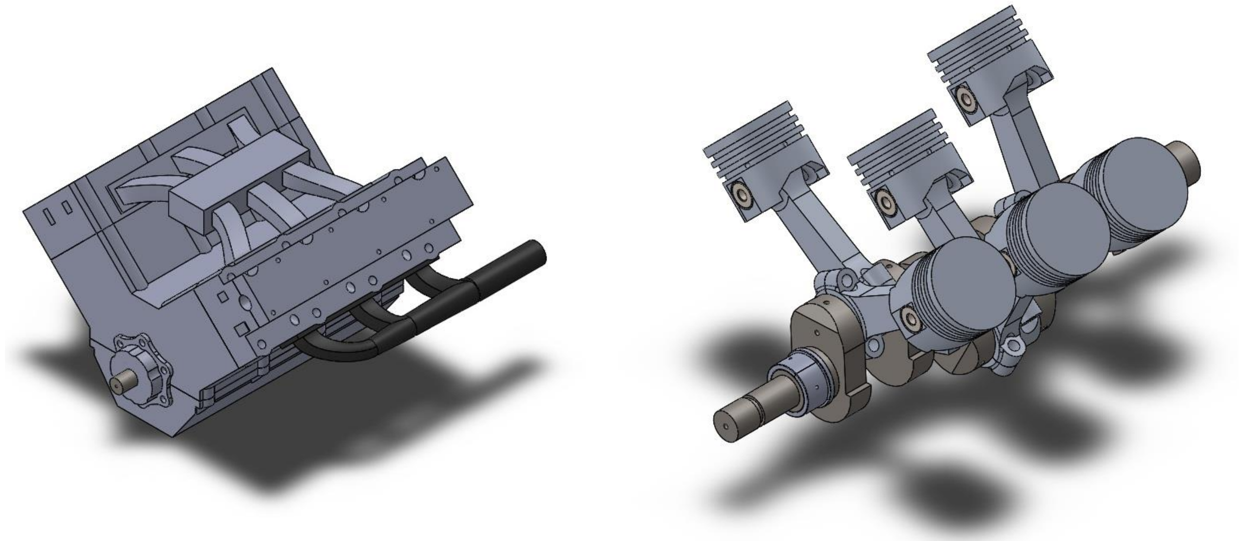

Figure 5. Isometric view of the engine taken from SolidWorks

CONCLUSIONS

The development of such methodology enables the user to compute, design and test the durability, via simulations, of components of internal combustion engines.

The existing 3D model will be subjected to additional computations and simulations of its parts alone and in an assembly. For this purpose softwares like AVL, Ansys and SolidWorks FlowSimulation will be used. The goal is optimization of the different parts and the work output of the engine as a whole system.

With the help of this methodology, a working prototype of this engine will be produced.

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