INTERNAL COMBUSTION ENGINES

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Abstract: *In this work we make a study of the internal combustion engines. We make a comparison of two principal types spark-ignition engine and the compression-ignition engine. Compression-ignition engines are normally use because they are more advantageous economically.*

Keywords: engines, combustion, pressure, piston, analysis.

1.INTRODUCTION

The paper make a study of the internal combustion engines.

Although most gas turbines are also internal combustion engines, the name is usually applied to reciprocating internal combustion engines of the type commonly used in automobiles, trucks, and buses. These engines differ from the power plants because the processes occur within reciprocating piston–cylinder arrangements and not in interconnected series of different components. Two principal types of reciprocating internal combustion engines are the spark-ignition engine and the compression-ignition engine.

In a spark-ignition engine, a mixture of fuel and air is ignited by a spark plug.

In a compression-ignition engine, air is compressed to a high enough pressure and temperature that combustion occurs spontaneously when fuel is injected.

Spark-ignition engines have advantages for applications requiring power up to about 225 kW. Because they are relatively light and lower in cost, spark-ignition engines are particularly suited for use in automobiles.

Compression-ignition engines are normally preferred for applications when fuel economy and relatively large amounts of power are required (heavy trucks and buses, locomotives and ships, auxiliary power units).

In the middle range, sparkignition and compression-ignition engines are used.

2. INTERNAL COMBUSTION ENGINE

Figure 1 is a sketch of a reciprocating internal combustion engine consisting of a piston that moves within a cylinder fitted with two valves. The sketch is labeled with some special terms. The bore of the cylinder is its diameter. The stroke is the distance the piston moves in one direction.

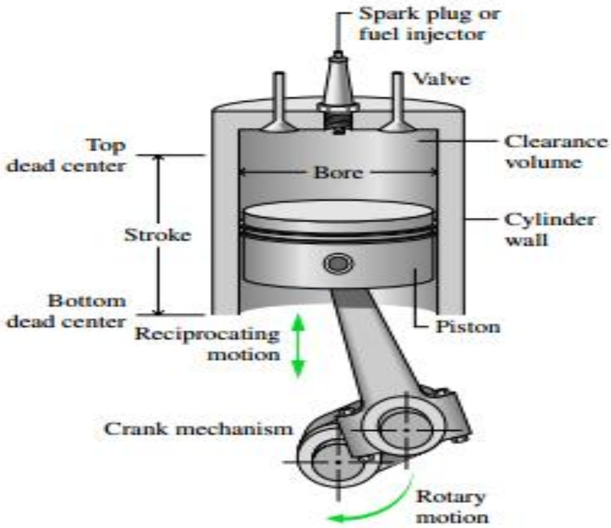

Fig. 1. *Reciprocating internal combustion engine*

The piston is said to be at top dead center when it has moved to a position where the cylinder volume is a minimum. This minimum volume is known as the clearance volume. When the piston has moved to the position of maximum cylinder volume, the piston is at bottom dead center. The volume swept out by the piston as it moves from the top dead center to the bottom dead center position is called the displacement volume. The compression ratio r is defined as the volume at bottom dead center divided by the volume at top dead center. The reciprocating motion of the piston is converted to rotary motion by a crank mechanism. In a four-stroke internal combustion engine, the piston executes four distinct strokes within the cylinder for every two revolutions of the crankshaft.

Figure 2 gives a pressure–volume diagram such as might be displayed electronically.

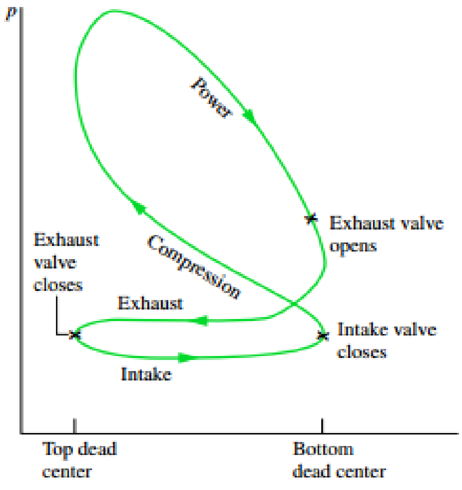

Fig. 2. *Pressure–volume diagram*
for a reciprocating internal combustion engine

1. With the intake valve open, the piston makes an intake stroke to draw a fresh charge into the cylinder. For spark-ignition engines, the charge is a combustible mixture of fuel and air. Air alone is the charge in compression-ignition engines.

2. With both valves closed, the piston undergoes a compression stroke, raising the temperature and pressure of the charge. This requires work input from the piston to the cylinder contents. A combustion process is then initiated, resulting in a high-pressure, high-temperature gas mixture. Combustion is induced near the end of the compression stroke in spark-ignition engines by the spark plug. In compression-ignition engines, combustion is initiated by injecting fuel into the hot compressed air, beginning near the end of the compression stroke and continuing through the first part of the expansion.

3. A power stroke follows the compression stroke, during which the gas mixture expands and work is done on the piston as it returns to bottom dead center.

4. The piston then executes an exhaust stroke in which the burned gases are purged from the cylinder through the open exhaust valve. Smaller engines operate on two-stroke cycles. In two-stroke engines, the intake, compression, expansion, and exhaust operations are accomplished in one revolution of the crankshaft. Although internal combustion engines undergo mechanical cycles, the cylinder contents do not execute a thermodynamic cycle, for matter is introduced with one composition and is later discharged at a different composition. A parameter used to describe the performance of reciprocating piston engines is the mean effective pressure, or mep. The mean effective pressure is the theoretical constant pressure that, if it acted on the piston during the power stroke, would produce the same net work as actually developed in one cycle. That is:

$$\text{mep} = \frac{\text{net work for one cycle}}{\text{displacement volume}}$$

For two engines of equal displacement volume, the one with a higher mean effective pressure would produce the greater net work and, if the engines run at the same speed, greater power.

CONCLUSION

A detailed study of the performance of a reciprocating internal combustion engine would take into account many features. These would include the combustion process occurring within the cylinder and the effects of irreversibilities associated with friction and with pressure and temperature gradients. Heat transfer between the gases in the cylinder and the cylinder walls and the work required to charge the cylinder and exhaust the products of combustion also would be considered. Owing to these complexities, accurate modeling of reciprocating internal combustion engines normally involves computer simulation.

To conduct elementary thermodynamic analyses of internal combustion engines, considerable simplification is required. One procedure is to employ an air-standard analysis having the following elements: A fixed amount of air modeled as an ideal gas is the working fluid. The combustion process is replaced by a heat transfer from an external source. There are no exhaust and intake processes as in an actual engine. The cycle is completed by a constant-volume heat transfer process taking place while the piston is at the bottom dead center position. All processes are internally reversible.

In addition, in a cold air-standard analysis, the specific heats are assumed constant at their ambient temperature values. With an air-standard analysis, we avoid dealing with the complexities of the combustion process and the change of composition during combustion. A comprehensive analysis requires that such complexities be considered, however.

Although an air-standard analysis simplifies the study of internal combustion engines considerably, values for the mean effective pressure and operating temperatures and pressures calculated on this basis may depart significantly from those of actual engines. Accordingly, air-standard analysis allows internal combustion engines to be examined only qualitatively. Still, insights concerning actual performance can result with such an approach. In the remainder of this part of the chapter, we consider three cycles that adhere to airstandard cycle idealizations: the Otto, Diesel, and dual cycles. These cycles differ from each other only in the way the heat addition process that replaces combustion in the actual cycle is modeled.

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