

Engine Design

Chapter 02: IC Engine Fundamentals

by

Mohd Razali Hanipah
Faculty of Mechanical Engineering
mohdrazali@ump.edu.my



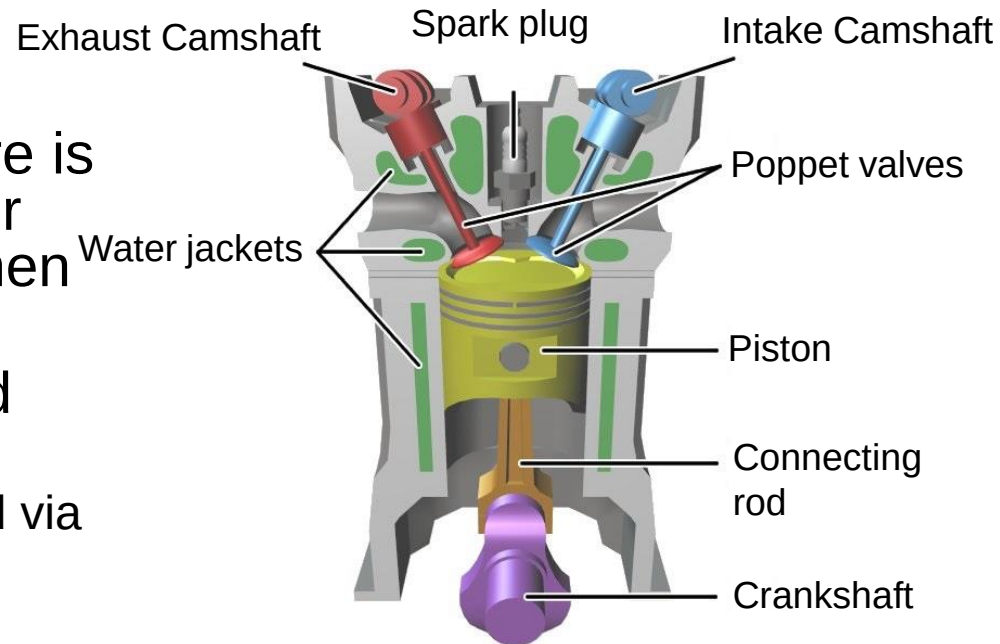
Chapter Description

- Aims
 - To explain fundamentals of internal combustion engines.
 - To analyse the four-stroke and two-stroke cycle engines operation.
- Expected Outcomes
 - To understand the fundamentals of internal combustion engines and able to differentiate its thermodynamic cycles.
- References
 - Heywood, J. B. (1988). Internal Combustion Engine Fundamentals, McGraw-Hill International.
 - David A. Crolla, 2009, Automotive Engineering: Powertrain, Chassis System and Vehicle Body, Butterworth-Heinemann (Elsevier).



Fundamentals of Internal Combustion Engine (ICE)

- The internal combustion engine is a form of heat engine
- Works as follows:
- A supply of air-and-fuel mixture is fed to the inside of the cylinder where it is compressed and then burnt.
- The way this mixture is ignited defined the type of IC engine:
 - Spark Ignition (SI) will be ignited via spark plug.
 - Compression Ignition (CI) will be ignited when the high compression in-cylinder pressure raised the mixture temperature beyond the ignition limit of the fuel.



[Fig.2.1 Typical 4-Stroke Internal combustion engine design and components](#)

Fundamentals of Internal Combustion Engine (ICE)

- The heat energy is converted into useful mechanical work when the high gas pressure generated forces the piston to move along its stroke in the cylinder.
- To enable the piston movement to be harnessed, the driving thrust on the piston is transmitted by means of a connecting-rod to a crankshaft whose function is to convert the linear piston motion in the cylinder to a rotary crankshaft movement.
- The piston can thus be made to repeat its movement via the rotational motion of the crankshaft and the guiding cylinder.
- The backward-and-forward displacement of the piston is generally referred to as the reciprocating motion of the piston, so these power units are also known as reciprocating engines.

IC Engines parameters

- The typical IC engine parameters are shown in Fig. 2.2.
- Top-dead-centre (TDC) is the highest stop position of the piston in an engine cycle.
- Bottom-dead-centre (BDC) is the lowest stop position of the piston in the cycle.
- The stroke is defined as the distance between TDC and BDC.

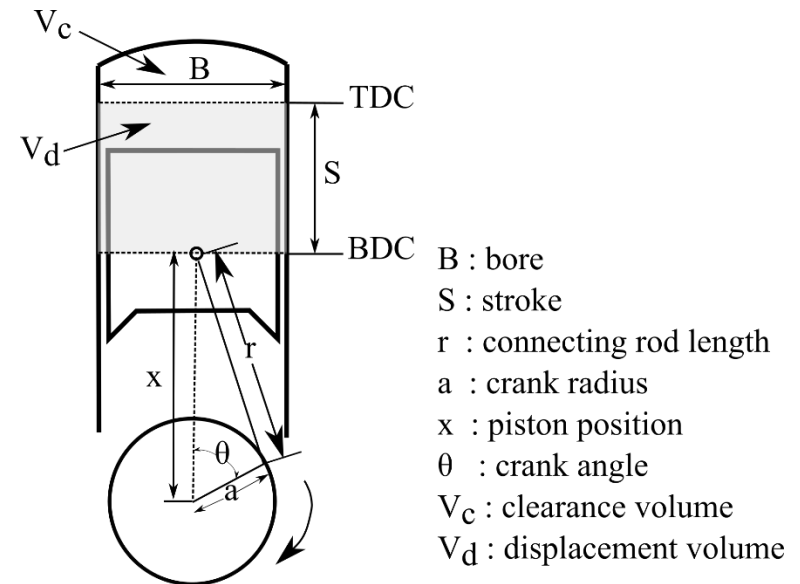


Fig. 2.2: Crank-slider mechanism and single cylinder internal combustion engine components.

Thermodynamics

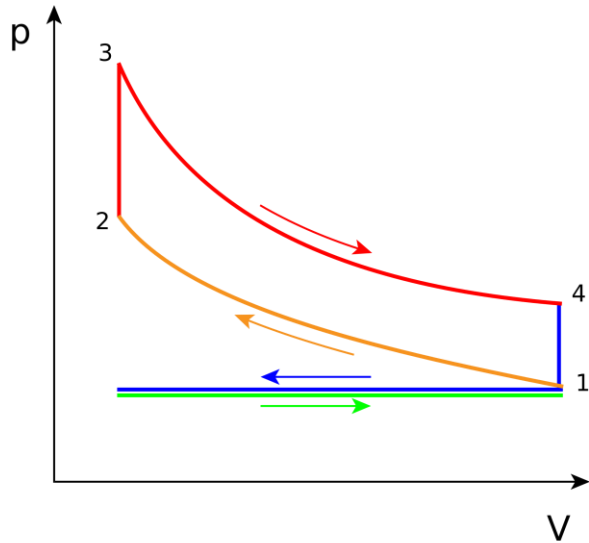
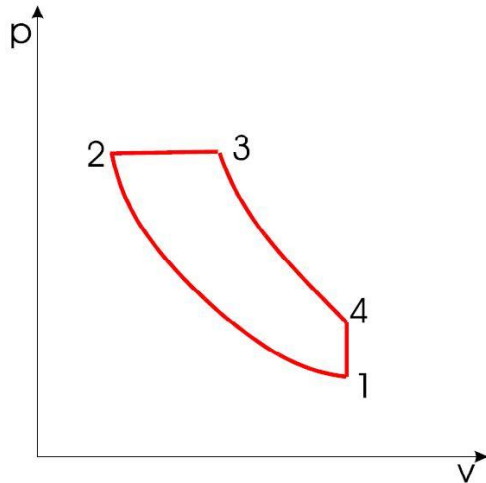


Fig.2.3 Spark Ignition cycle

- Also known as Otto cycle.
- Fuel ignited by spark plug.

1-2: Isentropic compression
2-3: Constant volume heat input
3-4: Isentropic expansion
4-1: Constant volume heat rejection

Thermodynamics



[Fig.2.3 Compression Ignition cycle](#)

- Also known as diesel cycle.
- Fuel ignited due to high in-cylinder temperature.

1-2: Isentropic compression
2-3: Constant **pressure** heat input
3-4: Isentropic expansion
4-1: Constant volume heat rejection

© Mohd Razali Hanipah (2017)

BSc Mechanical (Automotive), UTM, Malaysia

MSc Mechanical, UTP, Malaysia

PhD in Energy Technologies, Newcastle University, UK

mohdrazali@ump.edu.my