Heat Engines:

It is a device which converts thermal energy into mechanical work. Typically the chemical energy of fuel is transformed into thermal energy and it used to produce mechanical work.

External Combustion Engines: Here the product of combustion is not the working fluid inside the engine. The combustion of fuel in presence of air occurs outside the engine, only the heat produced is transported inside the engine, having its own working fluid. Example – Steam engines, Stirling engines.

Internal Combustion Engines: Here either the combustion of fuel takes place inside the engine and the products of combustion acts as the working fluid. Example – Petrol Engine, Diesel engine, Gas Turbine.

Internal combustion engines can be of Positive Displacement type or Rota-Dynamic type.

Positive Displacement Machines : Working fluid is handled in batches, eg. Petrol or Diesel engines.

Rota-dynamic Machines : Working fluid is handled continuously, eg. Gas Turbine, Jet Engines.

BASIC TERMINOLOGY

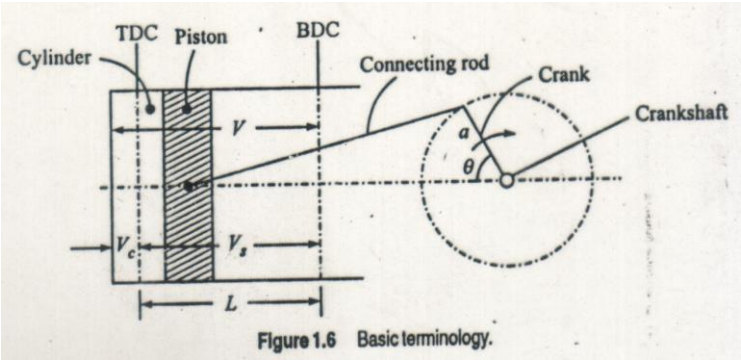


Figure 1.6 Basic terminology.

BORE × STROKE : Typical ratios of stroke/bore (l/d) = 0.9 – 1.4
Now a days generally bore > stroke

TDC / BDC : Typically 180 degree apart

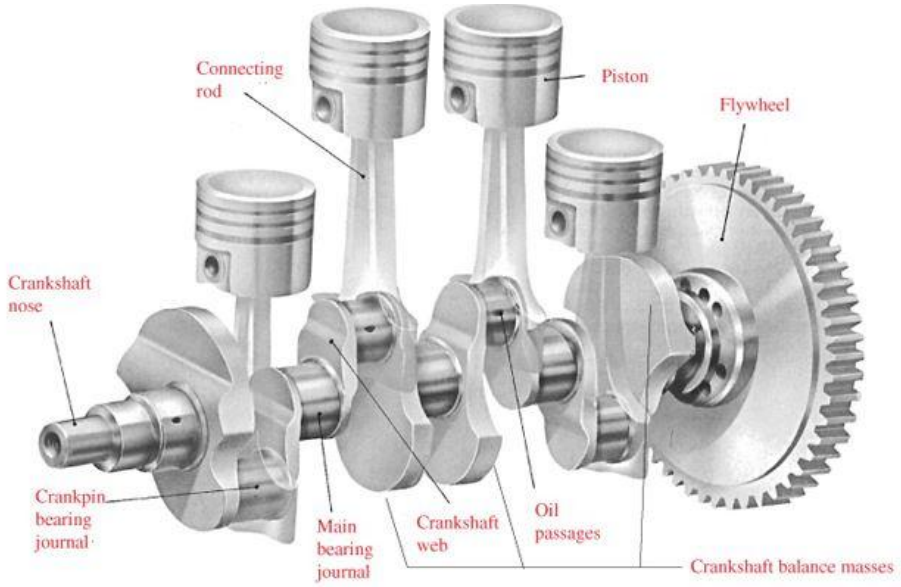
CLEARENCE VOLUME : Comparatively smaller in diesel engines, V_c

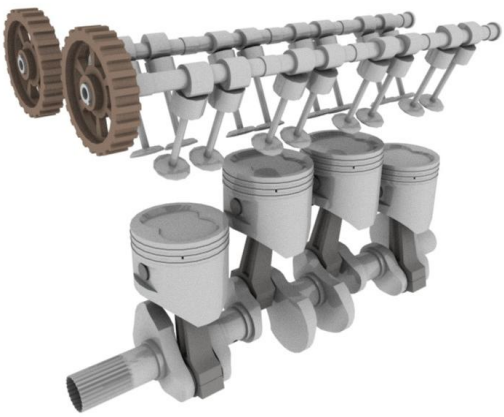
SWEPT / DISPLACEMENT VOLUME : $V_d = \pi/4(B^2)S \times N$

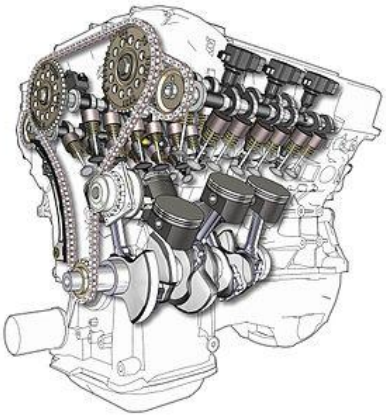
COMPRESSION RATIO : (Max. Volm/Min. Volm), $(V_c+V_d)/V_c$
8-11 for SI engines, 16-24 for CI engines

CRANK-PISTON LINK : Connecting Rod/Crank Radius (r/a) ratio ranging 3 (small)-10(large)

VOLUMETRIC EFFICIENCY : Ratio of actual mass flow rate of air to the calculated mass flow rate, sucked by the engine (70-90%).







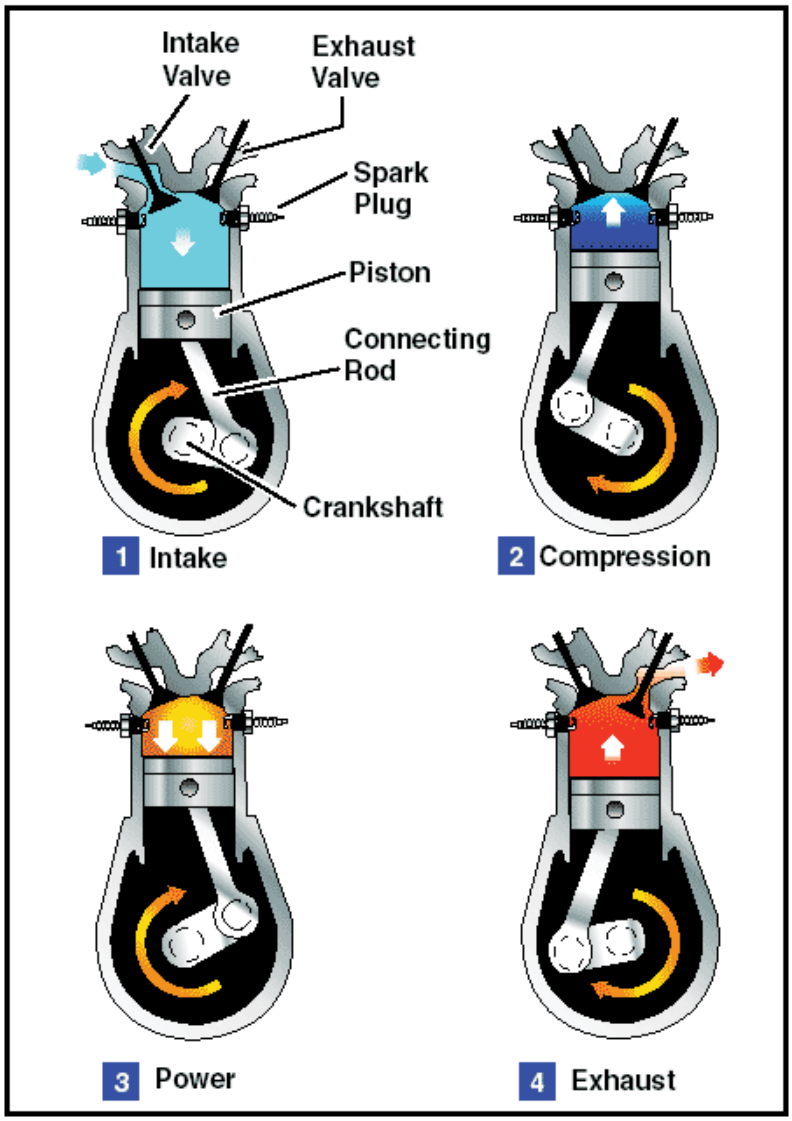
The Four Stroke Cycle

The four strokes refer to intake, compression, combustion (power), and exhaust strokes that occur during two crankshaft rotations per working cycle of the Gasoline engine and Diesel engine.

The cycle begins at top dead center (TDC), when the piston is farthest away from the axis of the crankshaft. On the intake or induction stroke of the piston, the piston descends from the top of the cylinder, reducing the pressure inside the cylinder. Air only (for diesel engine) or a mixture of fuel and air (for a CI engine) is forced (by atmospheric or greater

pressure) into the cylinder through the intake (inlet) port. The intake (inlet) valve (or valves) then close(s), and the compression stroke compresses the fuel–air mixture.

The air–fuel mixture is then ignited near the end of the compression stroke, usually by a spark plug (for a gasoline or Otto cycle engine) or by the heat and pressure of compression (for a Diesel cycle or compression ignition engine). The resulting pressure of burning gases pushes the piston through the power stroke. In the exhaust stroke, the piston pushes the products of combustion from the cylinder through an exhaust valve or valves.

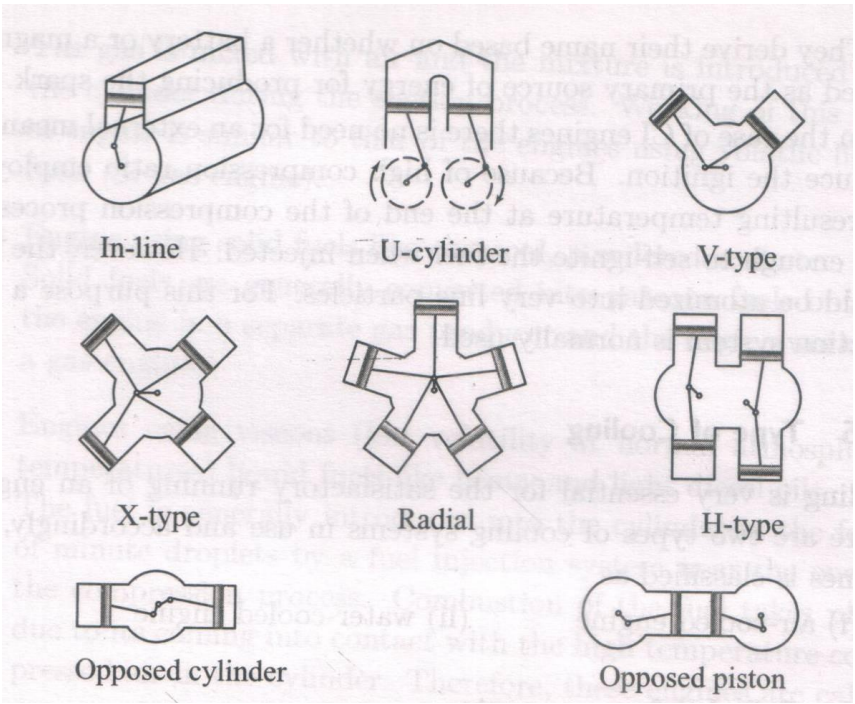


CLASSIFICATIONJ OF ENGINES

Engines can be classified according to :

No. of cylinders : Single Cylinder / Multi Cylinder

Arrangement of Cylinders : Inline, V (60° - 90°), Radial, Opposed, W, H, X .



No. of Strokes per cycle : Two-stroke, Four-stroke

Arrangement of Cams : In-block Cam, Overhead Cam (OHC), Double overhead cam (DOHC)

Type of Cooling :	Water cooled / Air cooled
Number of Valves :	12 Valve (2 Inlet + 1 Exhaust × 4 Cyls) 16 Valve (2 Inlet + 2 Exhaust × 4 Cyls)
Method of Ignition :	Spark Ignition (SI) – Petrol/ Gas engines Compression Ignition (CI) – Diesel engs.
Type of Fuel Used :	Petrol/Gasoline, Diesel, Gas, Alcohol
Type of Designed Motion :	Reciprocating (Diesel/Petrol), Rotary (Wankle / Gas Turbine)
Type of Air Induction :	Naturally Aspirated (NA), Turbo-charged (TC), Super-charged (SC)

Applications of Internal Combustion Engines :

Automobiles

Transportation – Road, Rail, Marine, Small Air crafts

Power Generation - Standby, Small and Medium Scale

Irrigation & Agricultural Machinery

ENGINE SPECIFICATION

Power : Kilowatt (kW), Horse Power (hp), Metric Horse power (PS)

Speed : Revolutions/min (r.p.m), Fixed or Variable speed

Torque : N-m, ft-Ib

Displacement Volume : Total of all the cylinders - 1300 cc, 2.4 litres

Compression Ratio : 8 - 11 for SI, 16 – 24 CI

Brake Specific Fuel Consumption Rate : g/kW-h, g/hp-h

Engine Efficiency : Power/ Heat Input Typically 25-35%

IC Engines in Power Generation

Automobiles

Heavy Equipment

Railway : Diesel-Electric

Irrigation

Mechanized Agriculture

Marine Vessels

Various non-conventional use of small single cylinder diesel engines in Bangladesh. Apart from conventional use in irrigation, small scale power generation or in mechanized country boats, these engines are now widely being used in – building construction, food processing and rural transportation.

Advantages of 4-Stroke IC Engines

Quick Starting and Loading - Fast Response

Efficient use of Fuel

More Environmental Friendly Emissions

Compact, Lighter and Cheaper than other Alternatives

Highly Advantageous for Portable and Remote Applications

Main Competitors: Gas Turbines, Steam Turbines, Electric Motors

Maximum engine power is limited due to Speed, Size and Weight Constrains.

SI Engines	CI Engines
Typically intake charge consists of – air and fuel	Typically intake charge consists of – air only
Combustion is started using a spark	Combustion is started using a auto ignition
Lower Compression ratio (8-12)	Higher Compression ratio (16-24)
Lower peak pressure, Lighter Construction	Higher peak pressure, Heavier Construction (2-3 times)
Relatively higher operating speed	Relatively lower operating speed
Power control – mainly using the throttle valve	Power control – mainly using the quantity of fuel injection
Easier to start	Relatively Difficult to start
Less noise and vibration	More noise and vibration
Relatively lower fuel efficiency, specially at part load	Better fuel efficiency, specially at part load
Less expensive	More expensive
Used for light and medium applications	Used for heavier applications