Basic knowledge

Internal combustion engines

Internal combustion engines are thermal fluid energy machines: they generate mechanical energy by burning a mixture of fuel and air. All work processes take place inside a working area: the cylinder. Since the force / energy within the cylinder is transferred by means of a variable volume, internal combustion engines are part of the group of positive displacement machines.

Motors or engines are often used to power motor vehicles, ships or locomotives. They are also used for drives that must be reliable and independent of the electrical power supply, such as emergency backup generators, construction machines or agricultural machinery.

Small single-cylinder engines are perfect for demonstrating the fundamentals of engine technology. GUNT offers various internal combustion engines with capacities of up to 75 kW, including real car engines with a volumetric displacement of up to two litres. Among these engines are four-stroke diesel engines, four-stroke petrol engines and two-stroke petrol engines.

Comparison of engines: 2-stroke petrol engine, 4-stroke petrol engine, 4-stroke diesel engine

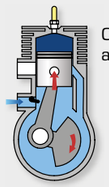
	2-stroke petrol engine	4-stroke petrol engine	4-stroke diesel engine
Load	air / fuel mixture	air / fuel mixture	pure air
Fuel supply	carburettor	carburettor	injector nozzle
Ignition	ignition spark	ignition spark	compression
Compression ratio	5...8	5...12	14...21
Fuel-air ratio	0,8...1,2	0,8...1,2	1,5...10
Fuel	petrol	petrol	diesel

2-stroke engine: one work cycle = one crank revolution

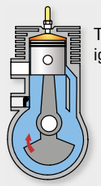
1st stroke: compression / intake

The piston moves upward: from bottom dead centre to top dead centre

Processes above the piston:
The precompressed mixture is further compressed above the piston. The compressed mixture is ignited shortly before the top dead centre is reached.



Compression and intake



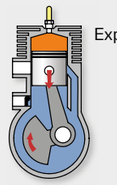
Top dead centre: ignition

Processes below the piston:
The transfer port is closed as the piston travels upwards. Due to the resulting negative pressure the inlet valve opens: The fuel and air mixture is drawn in.

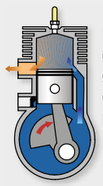
2nd stroke: power / precompression

Downward motion of the piston: from top dead centre to bottom dead centre

Processes above the piston: The resulting pressure forces the piston downward and opens first the outlet channel and then the transfer port. The precompressed mixture under the piston pushes the accumulated exhaust fumes out and fills the cylinder.



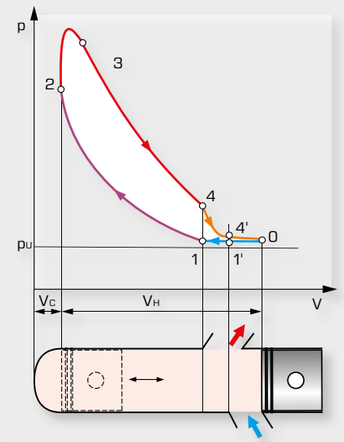
Expansion



Bottom dead centre gas exchange: exhaust and purging

Processes below the piston:
The mixture that was sucked in is precompressed by the upward motion of the piston and pressed into the transfer port. The positive pressure closes the inlet valve.

Indicator diagram of a 2-stroke engine

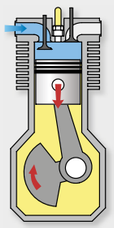


1st stroke (0 - 1): the cylinder is charged with the fuel / air mixture,
(1 - 2): compression of the mixture,
(2 - 3): ignition and combustion of the mixture,
2nd stroke (3 - 4): expansion of the combustion gases,
4 : exhaust opens, expansion is finished
4': transfer port opens, purging starts
1': purging is finished
1 : exhaust closes and compression starts

intake, compression, power, exhaust;
p_U ambient pressure, **V** volume,
V_H displaced volume, **V_C** compression volume

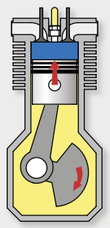
4-stroke engine: one work cycle = two crank revolutions

1st stroke: intake



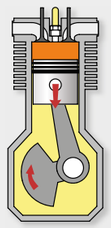
The piston moves from the top to the bottom dead centre. As it does, the fuel and air mixture is sucked in.

2nd stroke: compression



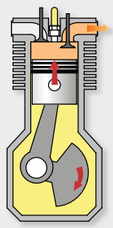
The piston moves from the bottom to the top dead centre. As it does, the fuel and air mixture is compressed.

3rd stroke: power – ignition and expansion



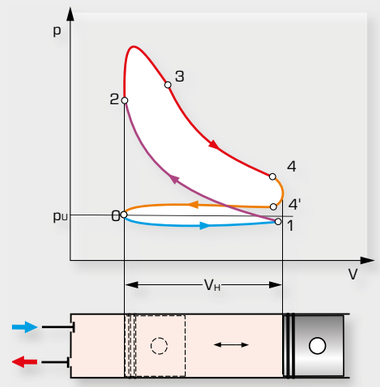
The compressed fuel and air mixture is ignited shortly before the top dead centre is reached. The resulting pressure presses the piston downwards.

4th stroke: exhaust



The piston moves from the bottom to the top dead centre. As it does, the exhaust gases are discharged.

Indicator diagram of a 4-stroke engine



1st stroke (0 - 1): intake
- of the fuel and air mixture in a petrol engine,
- of pure air in a diesel engine

2nd stroke (1 - 2): compression
- of the fuel and air mixture in a petrol engine,
- of air to a least 700°C in a diesel engine

3rd stroke (2 - 3): ignition and combustion
- of the fuel and air mixture in a petrol engine (spark plugs),
- injection of diesel oil, ignition caused by high air temperature

(3 - 4): expansion of the combustion gases
4th stroke (4 - 4'): exhaust of the combustion gases
(4' - 0): expulsion of the remaining combustion gases