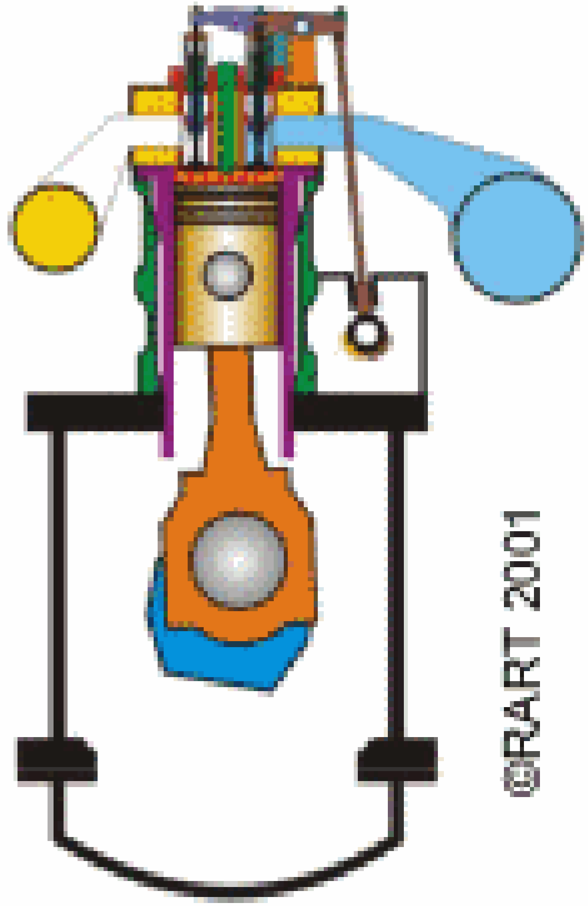
Diesel Engine Process



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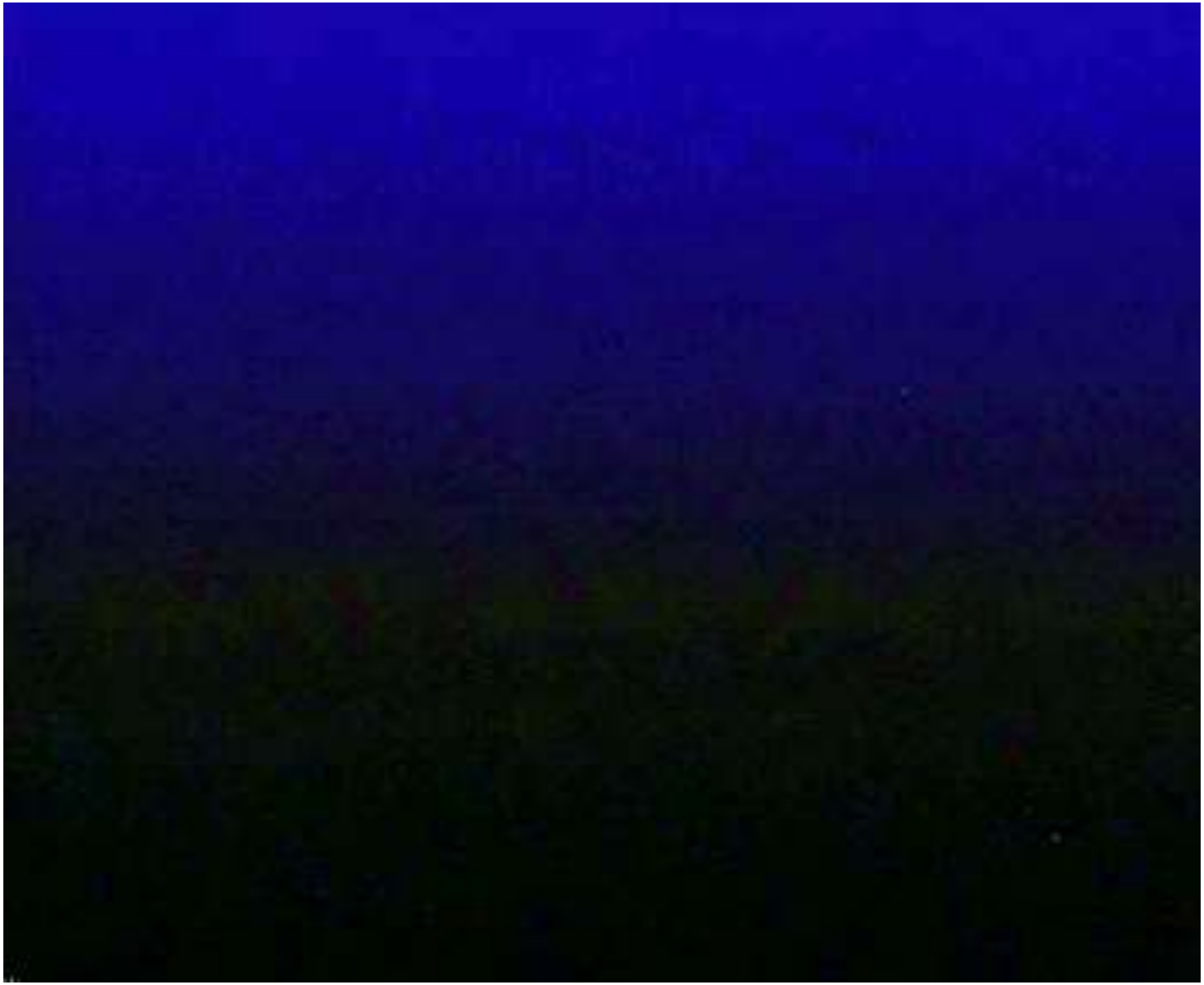
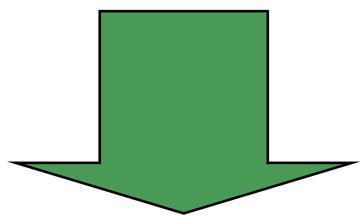
Combustion Process



Oxygene

Compression



POWER

Diesel Engine

Chemically bound energy into mechanical energy

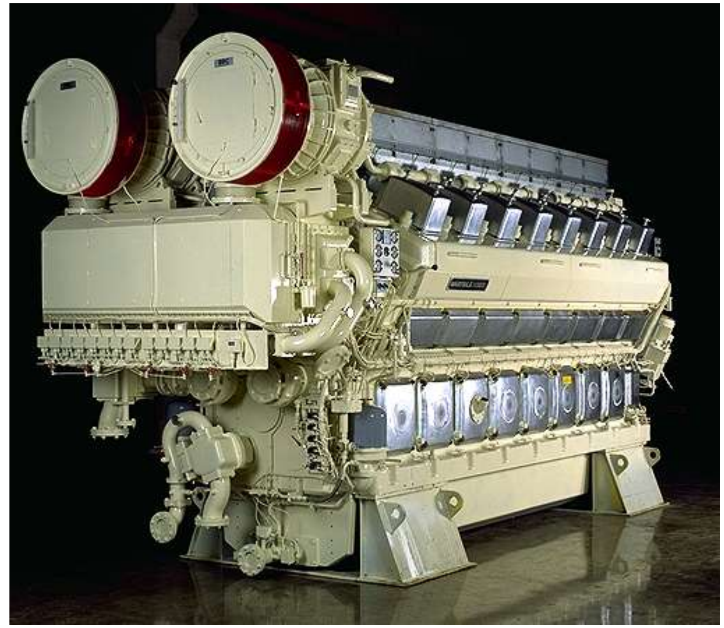
Combustion in the cylinder

Fuel ignites from heat of air compression

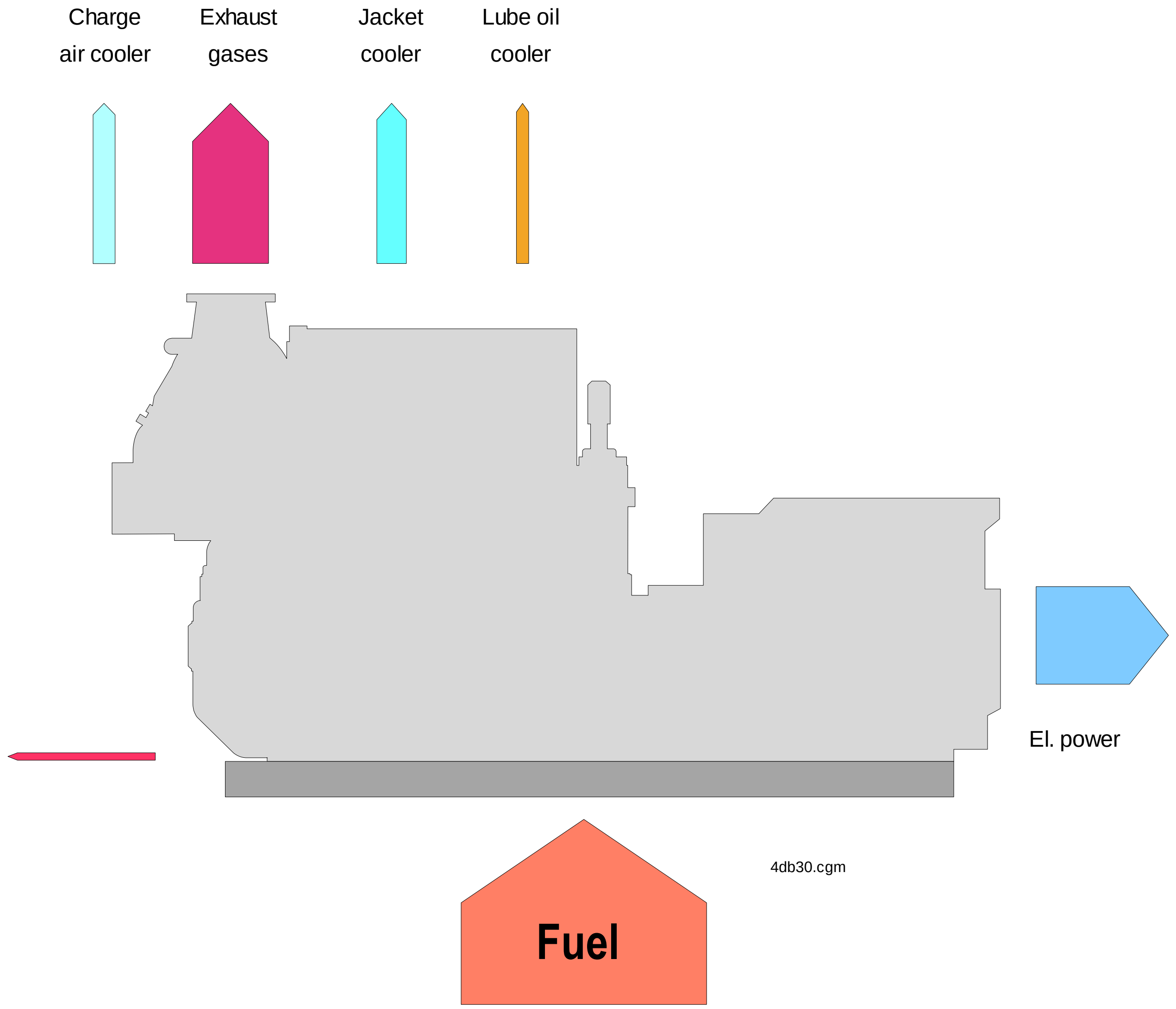
Force from the piston applied at the crank radius

Work is a force applied for a distance

Power is work performed per unit of time



Energy Losses



Energy Comparison

Heavy fuel

Nominal viscosity		380 cSt/50^{o}C
Density (15^{o}C)		0,98 kg/dm^3
Density at 135^{o}C		0,91 kg/dm^3
Heat value		40400 kJ/kg

Marine Diesel Fuel

Density (15^{o}C)		0,84 kg/dm^3
Density at 45^{o}C		0,82 kg/dm^3
Heat value		42500 kJ/kg

Heat Value per Volume

For HF	0,91 x 40400	36764 kJ/dm^3
For MDH	0,82 x 42500	34850 kJ/dm^3
	Difference	1914 kJ/dm^3

or 5,5% more in HF

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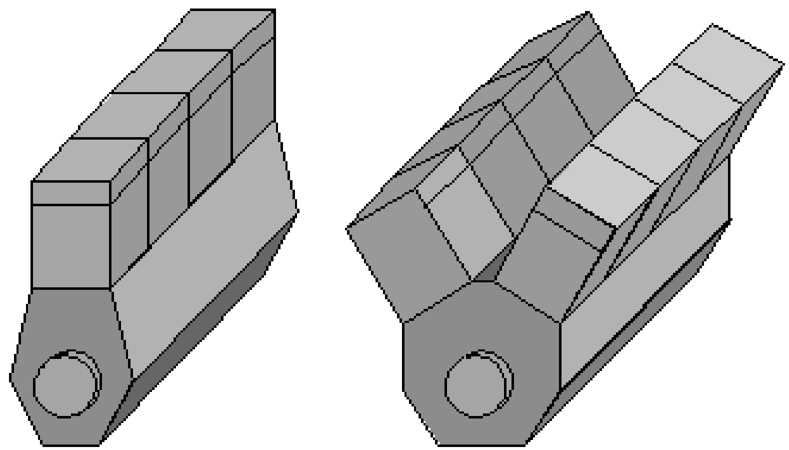
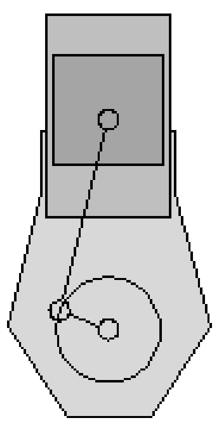
Different Ways of Construction

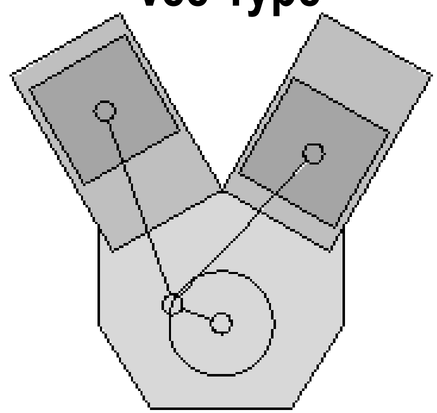
Trunk Piston



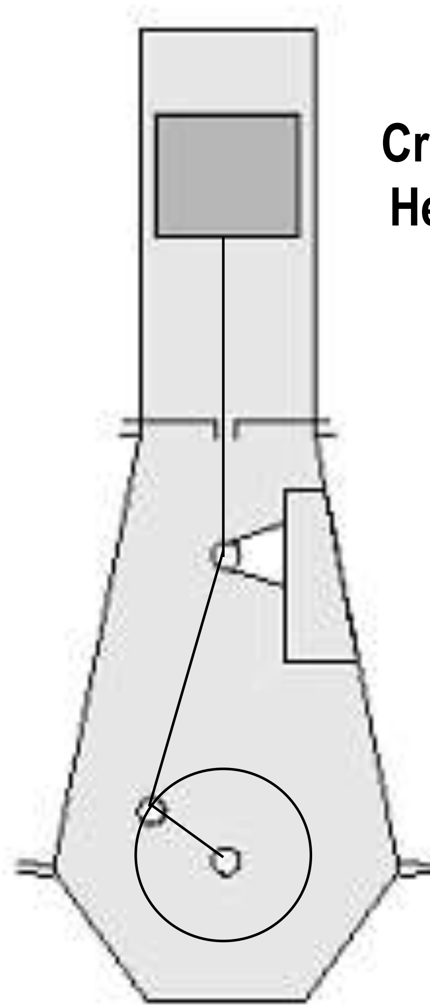
In-Line



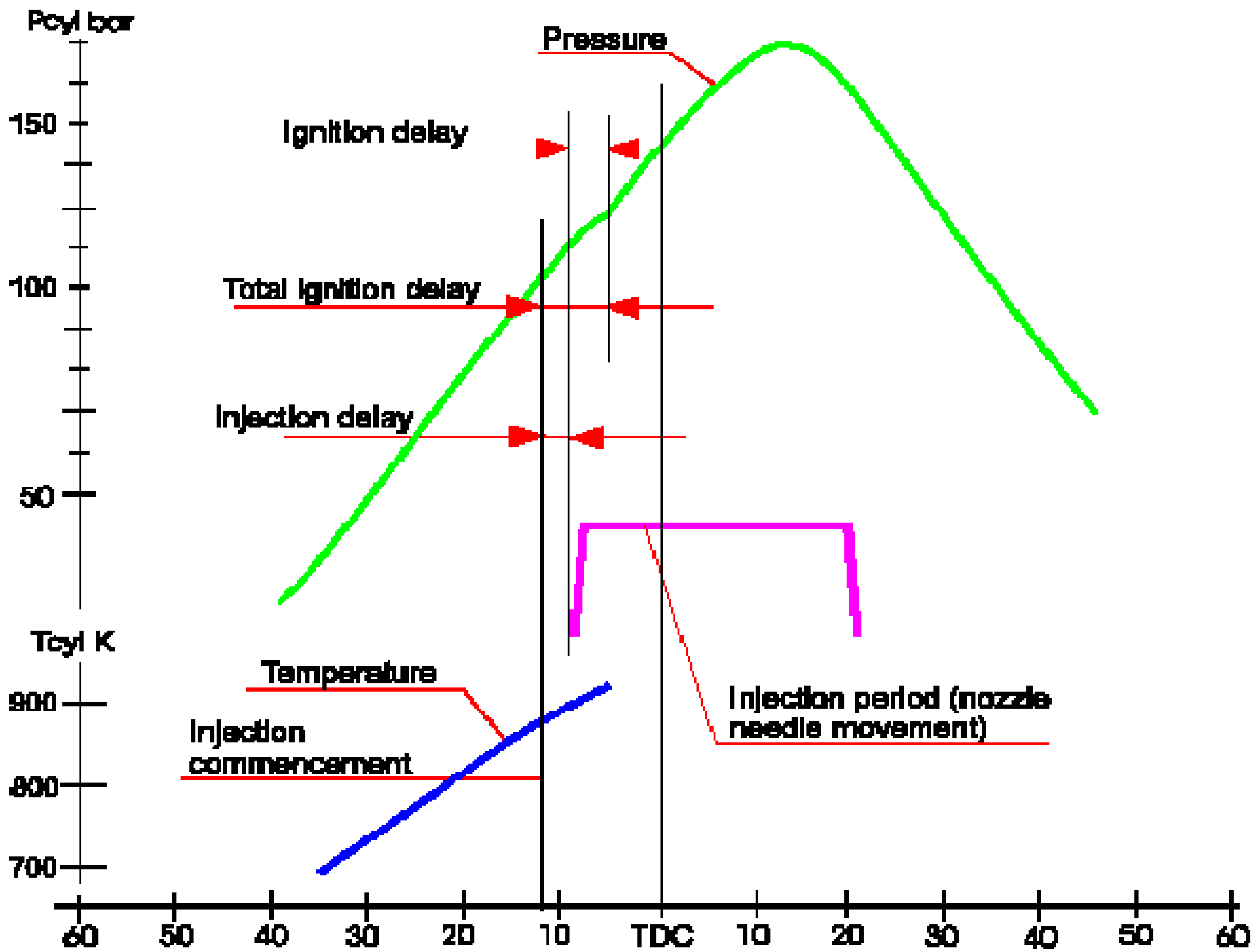
Vee Type



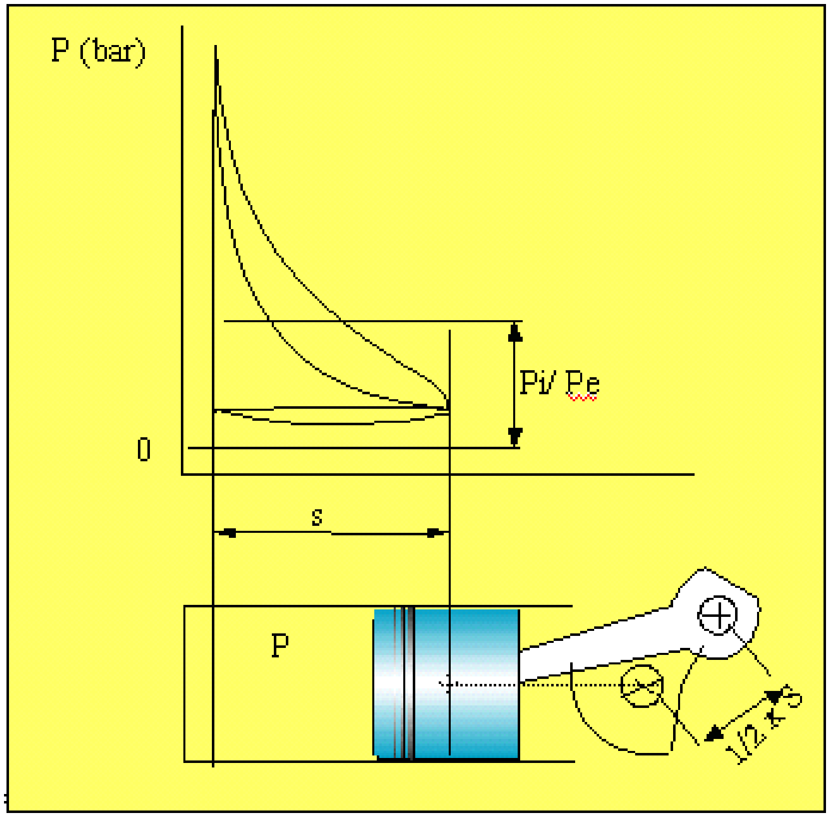
Cross Head



Typical Cylinder Pressure and Temperature Curbs

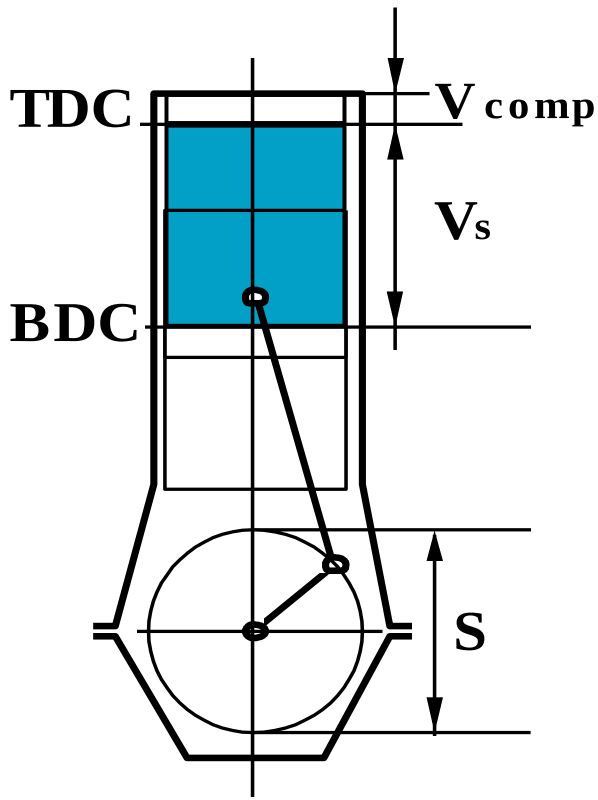


Mean Effective Pressure



MEP is the value referring to the constant pressure which would have to exist in a cylinder during power stroke to produce the same power at the flywheel.

Working Principle of Diesel Engine



$$\varepsilon = \frac{V_s + V_c}{V_c} = \frac{V_1}{V2}$$

$$V_c = \frac{\pi \times D_2}{4} \times S$$

pk $= p_1 \times \varepsilon^n$

n = polytrope exponent 1.35

p_1 = pressure at the beginning of the compression absolute pressure

$$t_k = T_1 \times \varepsilon^{n-1} - 273$$

T_1 = temp at the beginning of the compression in Kelvin degree (rec. temp. +273)

Compression ratio ε

Swept volume : $$V_i = \frac{\pi \cdot D^2}{4} \cdot s$$

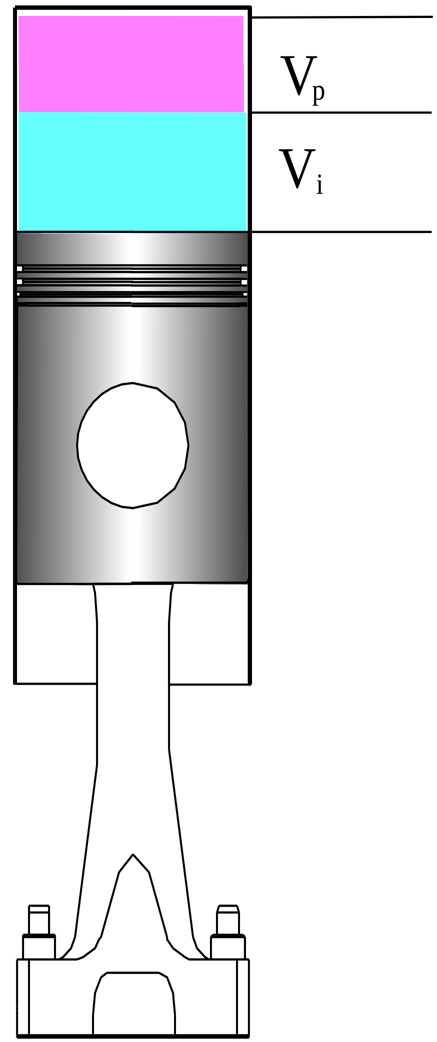
Compression volume : V_p

Cylinder volume : V_s

$V_s = V_i + V_p$

$$\varepsilon = \frac{\text{cylinder volume}}{\text{compression volume}}$$

$$= \frac{V_s}{V_p} = \frac{V_i + V_p}{Vp}$$



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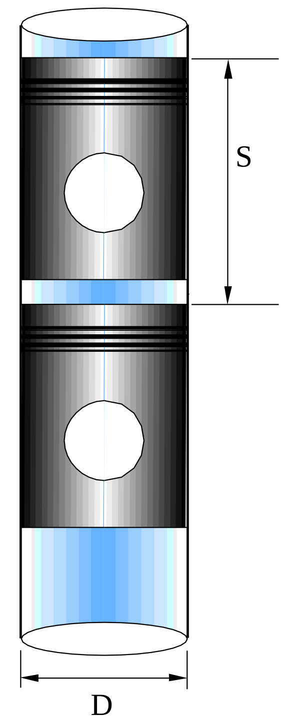
Stroke to bore ratio

$$\frac{S}{D} = \frac{\text{stroke}}{\text{cylinder bore}}$$



- **big influence on the size of the engine structure**
- **s/d big ∴ big structure, high, small output in respect of structure volume**
- **s/d small ∴ piston is big compared to swept volume (heavy)**

Piston Stroke and Cylinder Bore Ratio

PISTON STROKE TO CYLINDER BORE RATIO
Stroke to bore ratio is of importance for the size of the engine.

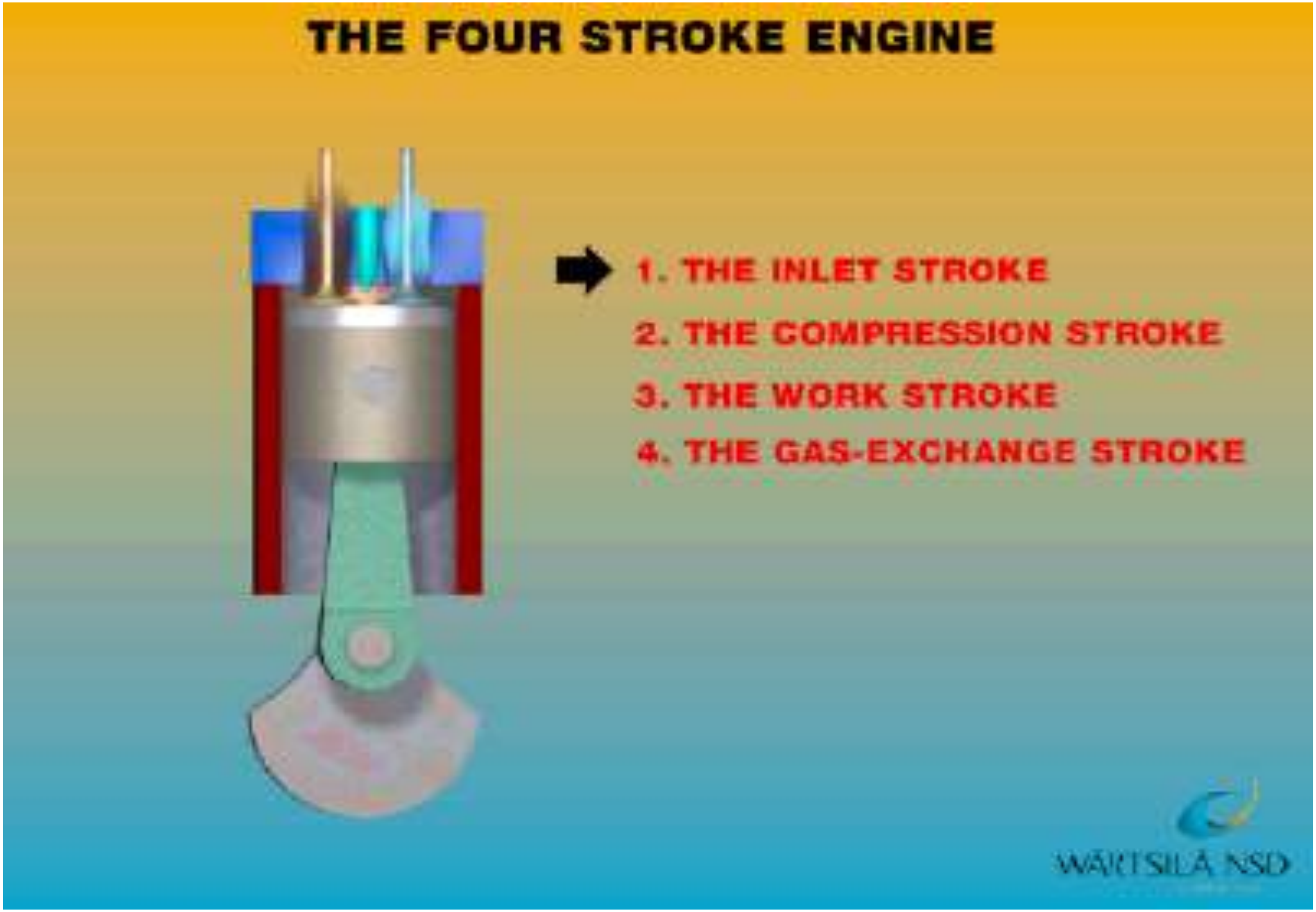
- The bigger the ratio is the bigger (higher) the engine will be.
- The bigger the ratio the better efficiency (be)

Mean Piston Speed

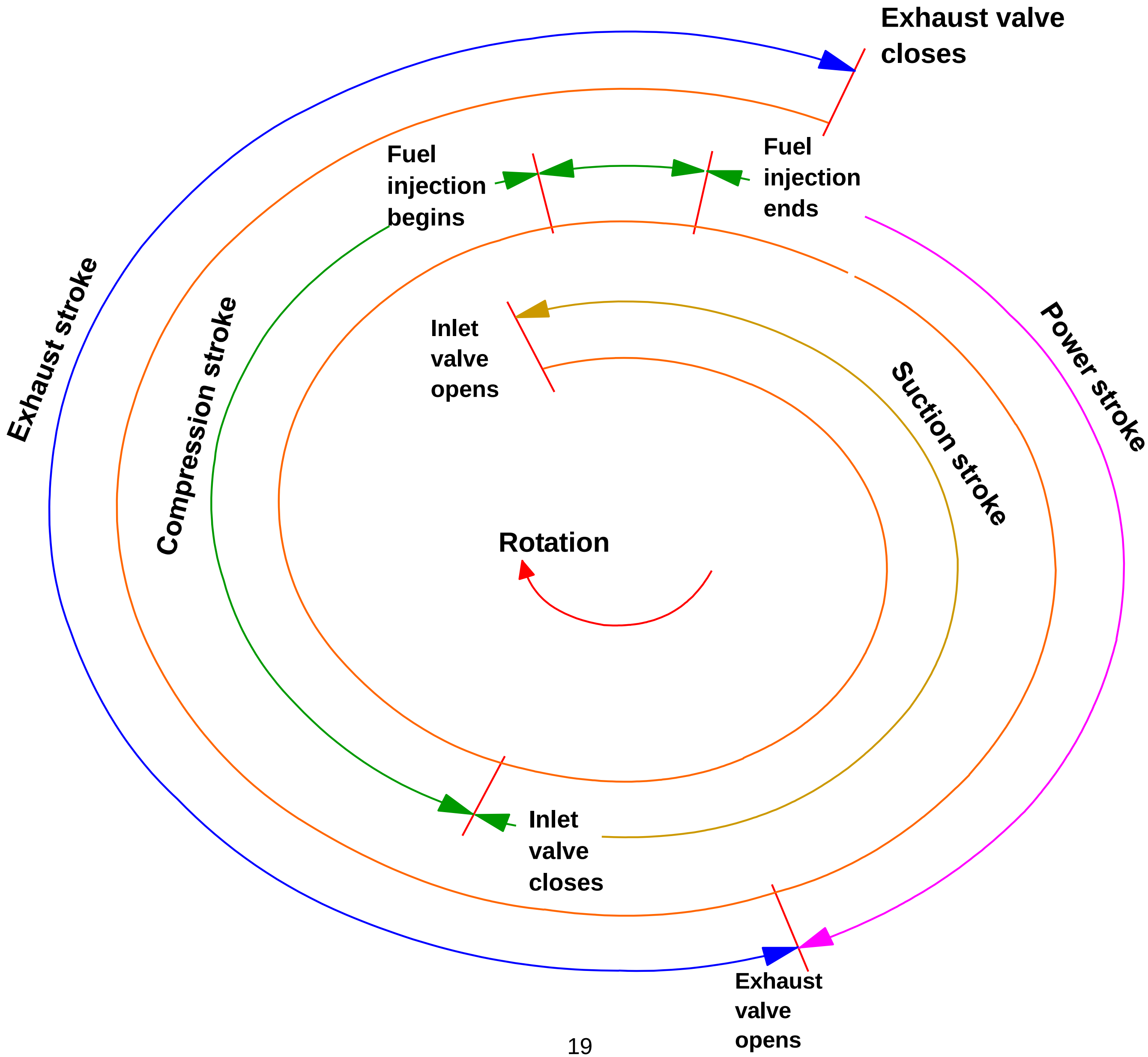
Average speed values of the piston in diesel engines

Engine type	c_m m/s
2-stroke high speed	8,50 ... 13,00
4-stroke high speed	8,00 ... 12,00
Medium speed:	
main-engine	6,50 ... 9,00
auxiliary-engine	7,00 ... 10,00
2-stroke low speed	5,50 ... 7,00
4-stroke low speed	5,70 ... 7,50

The Four Stroke Cycle Engine



Valve Graph 4-Stroke Cycle Engine



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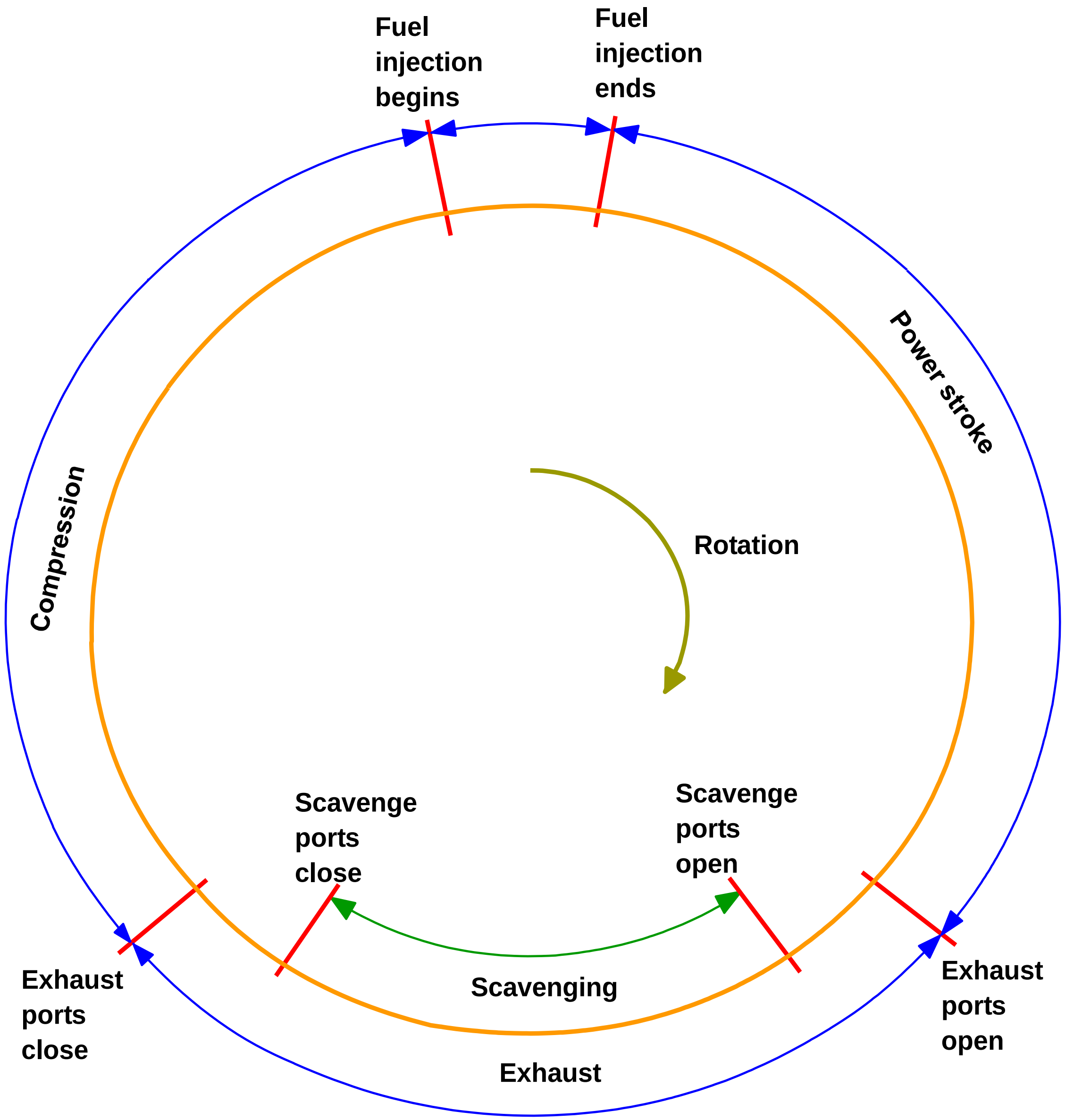
The First Stroke of 2-Stroke Diesel Engine



1st Stroke (Compression)

Piston at BDC

Scavenge Ports and Exhaust Valve Open

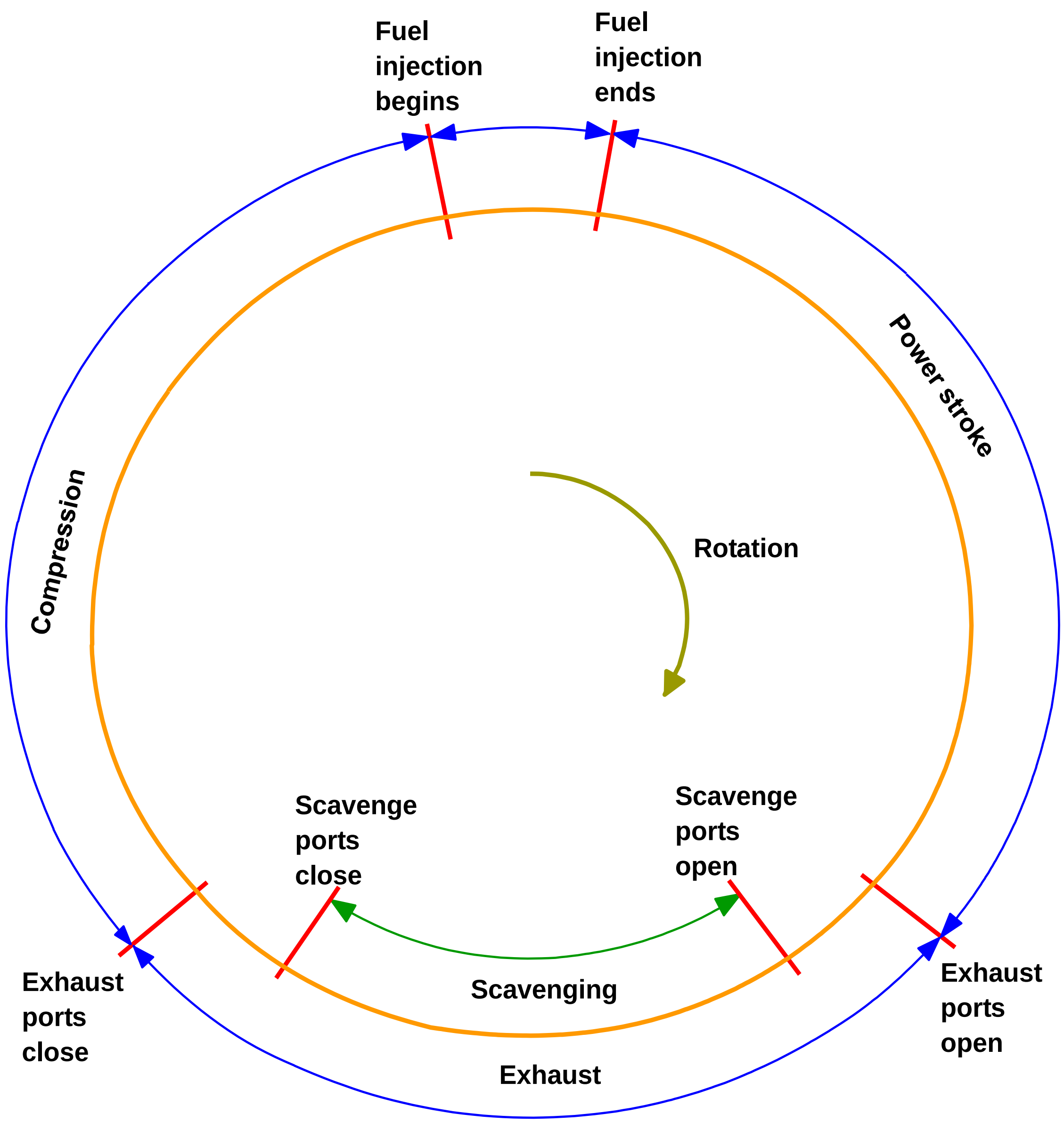
Scavenge air flows into the cylinder and presses the exhaust gases through the exhaust valve to the turbocharger.

Piston Moves Upwards:

Scavenge ports are being closed

Exhaust valve shuts, compression begins

The Second Stroke of 2-Stroke Diesel Engine



2nd Stroke (Ignition – Combustion – Expansion – Exhaustion – Scavenging)

Just Before TDC

Fuel is injected into the cylinder, Fuel Ignites in the compressed and heated air = ignition, with ignition combustion begins

Gases Expands and Press Piston Downwards (working stroke)

The exhaust valve opens, exhaust gases flow out if the cylinder to the turbo.

Scavenge ports are being uncovered by the downward moving piston, scavenge air flows into the cylinder and presses the exhaust gases out through the exhaust valve to the the turbocharger.

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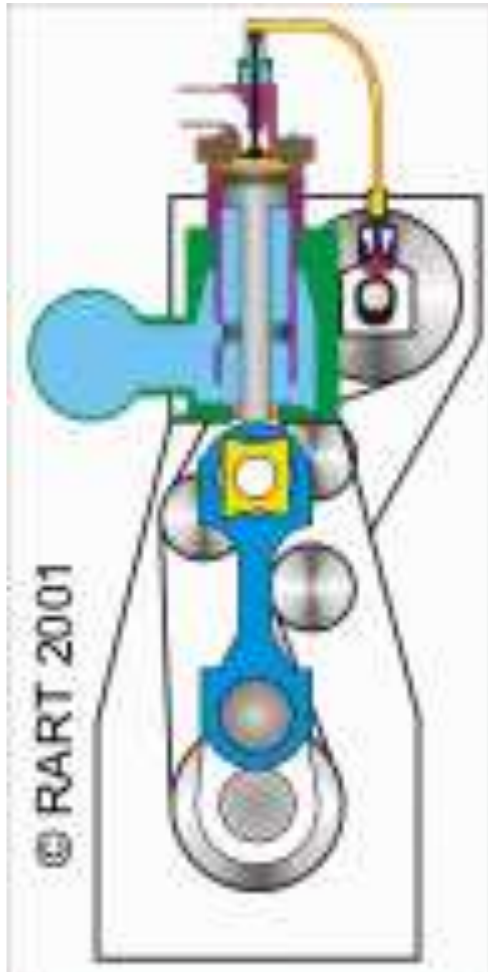
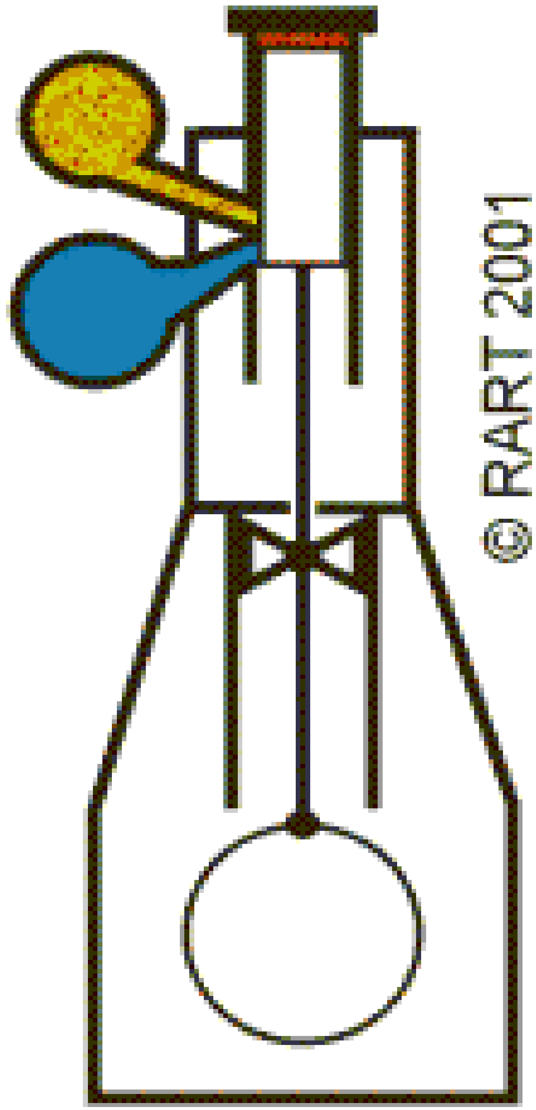
Uniflow Scavenging

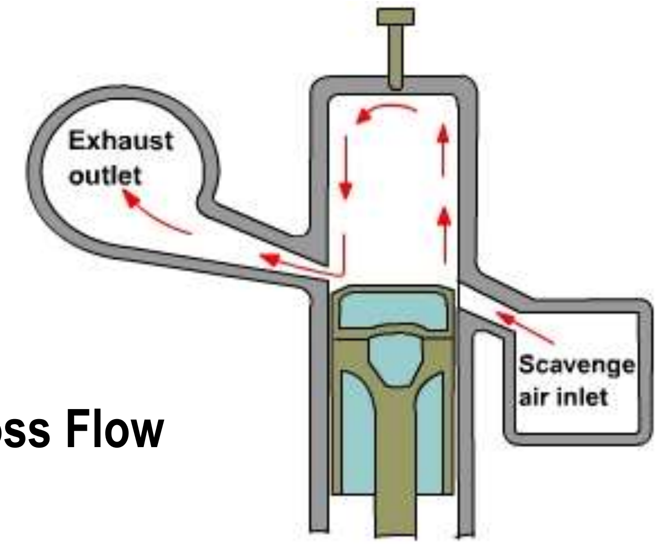


Animation of Loop Flow

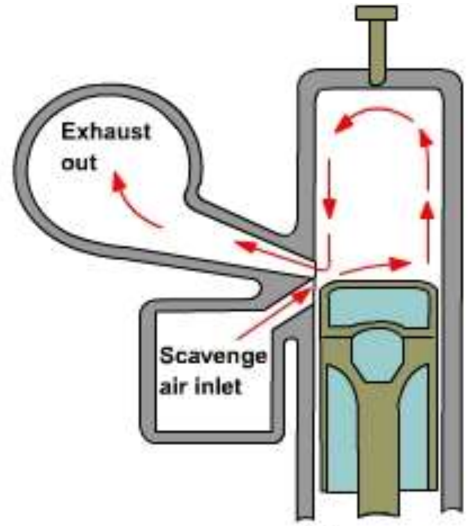


Scavenging

Cross Flow

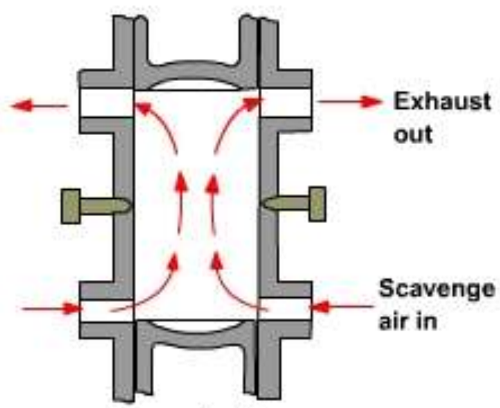


(a)

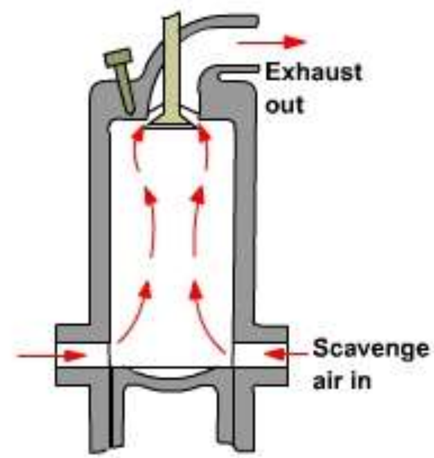


(b)

Loop Flow

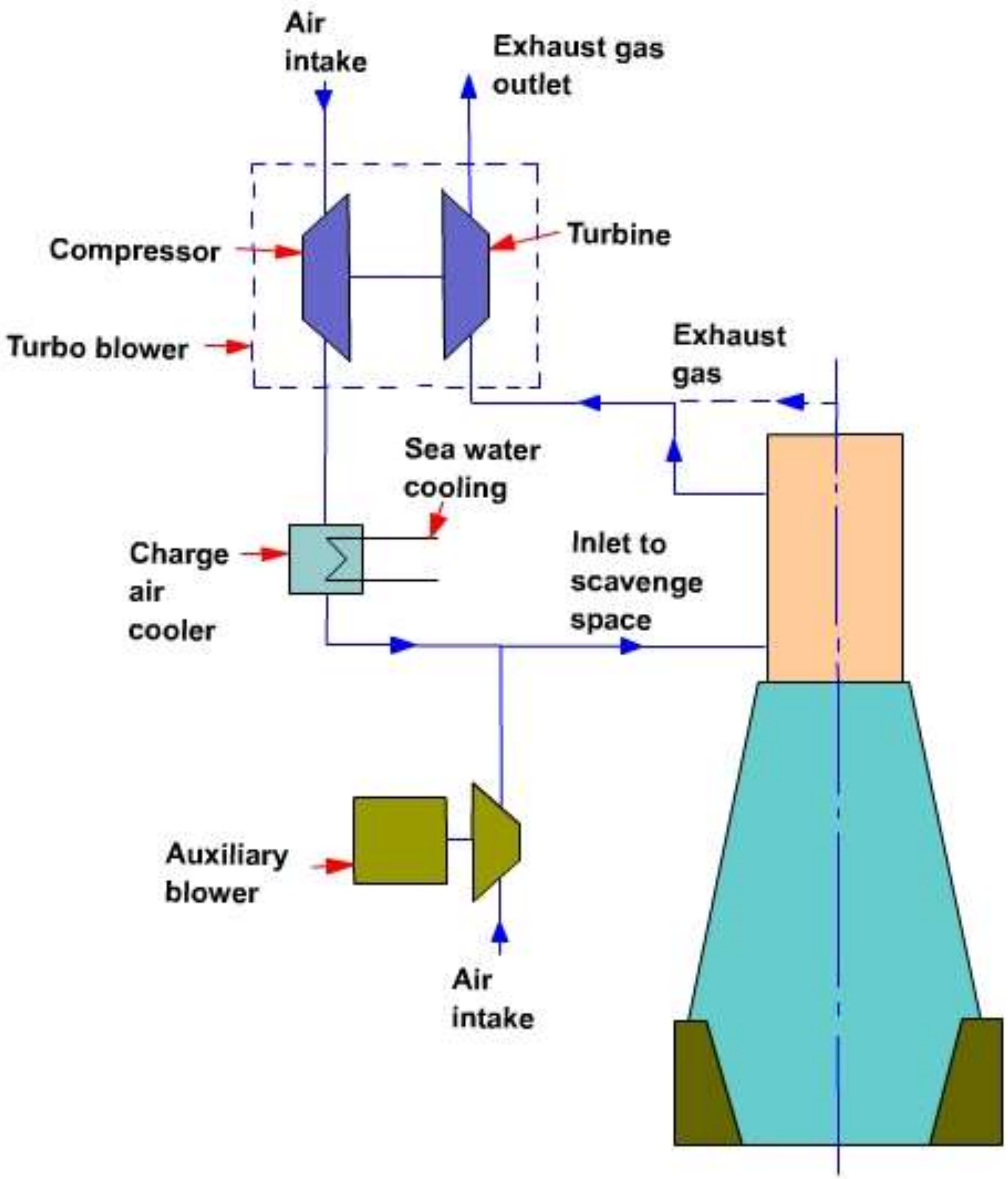


Opposed piston

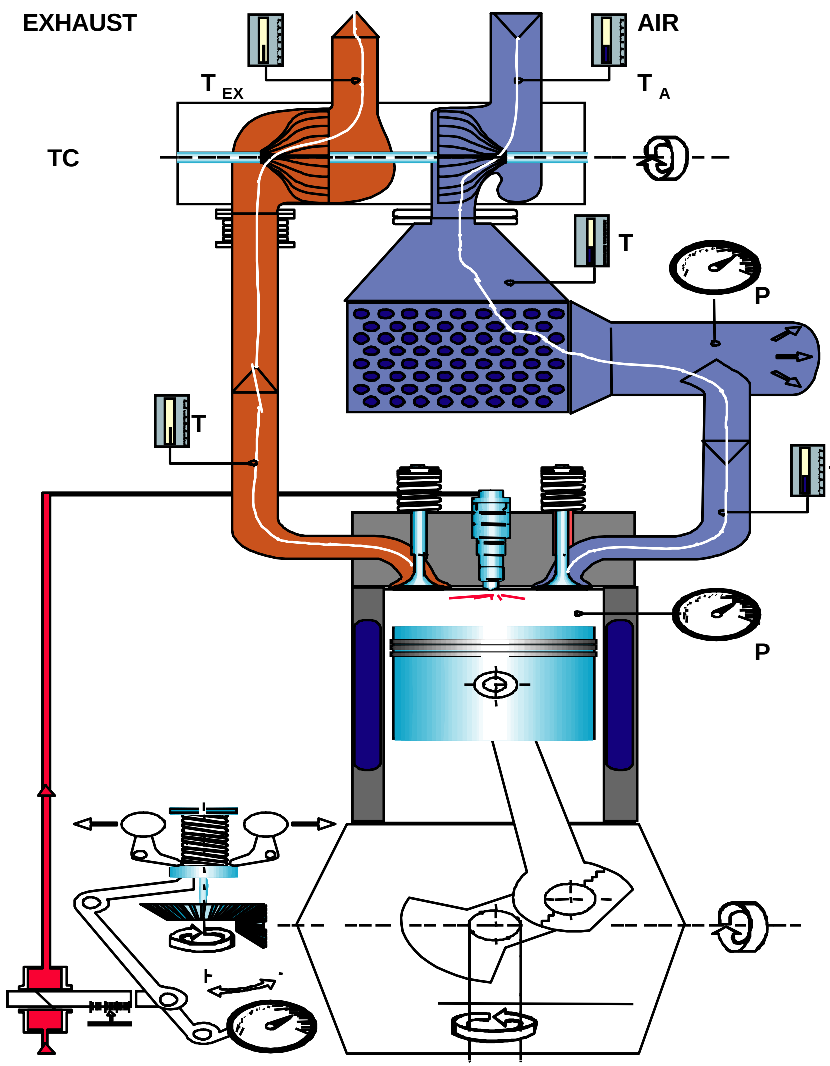


Exhaust valve

Gas Exchange Process



Gas Exchange Process



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EExhaust Gas Temperatures

- 1°C change in ambient temperature will change exhaust gas temperature by 1,5…2°C
- 1°C change in receiver temperature will change exhaust gas temperature by 1,0…1,5°C

Good To Know

Charge air pressure will increase because of

1. High ambient pressure (P_o>1013 mbar or >750 mm Hg)
2. Low ambient temperature (T_o<25°C)
3. High LT-water temperature (T_{LT}>35°C)
4. Retarded injection timing (5°=0,3 bar)

Charge air pressure will decrease because of

1. Low ambient pressure (P_o<1013 mbar or < 750 mm Hg)
2. High ambient temperature (T_o>25°C)
3. Low LT-water temperature (T_{LT}<30°)
4. Advanced injection timing (5°=0,3 bar)
5. Charge air or exhaust gas leakage
6. High exhaust gas back pressure (P_{ATC}>300 mm H_2O)