APPLICATION OF THERMODYNAMICS

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CREATED BY VISHAL

Internal Combustion Engine vs External Combustion Engine

Internal Combustion Engine ⟶ Heat is Supplied by

↓

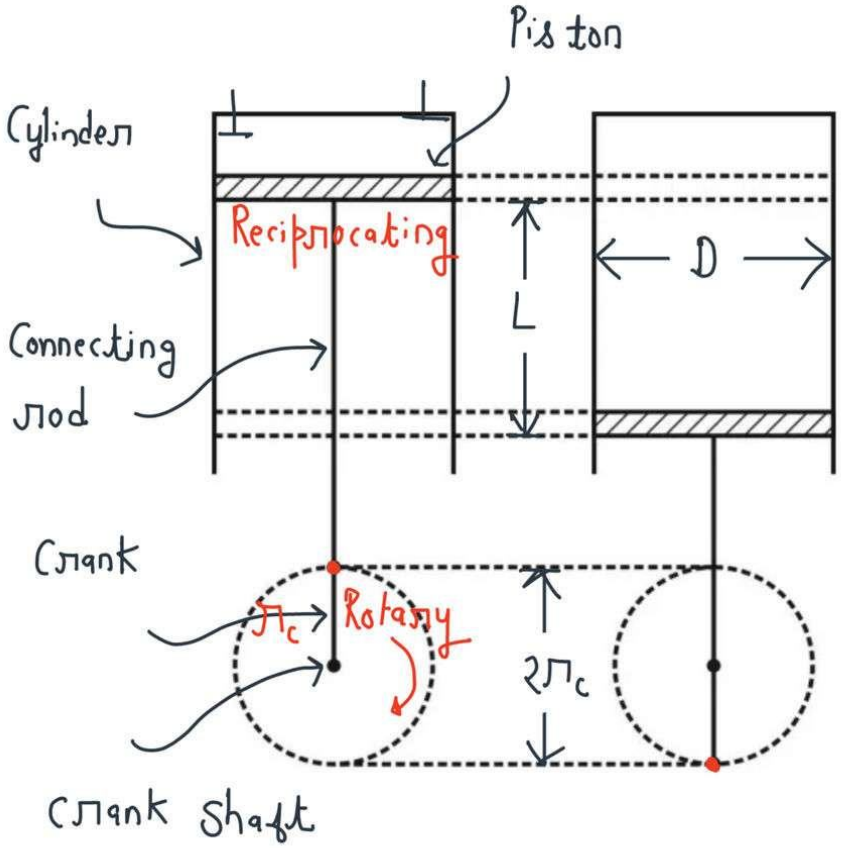
Burning the Fuel

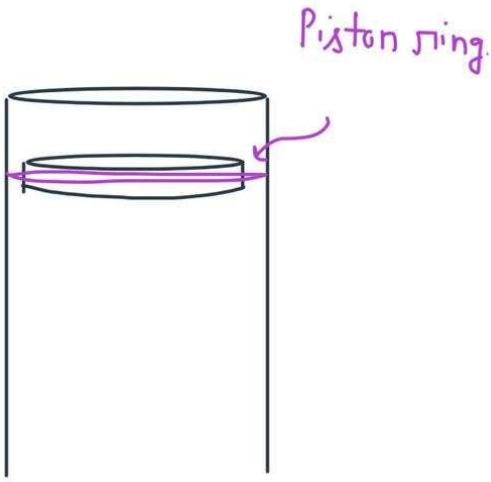
↓

within System Boundary

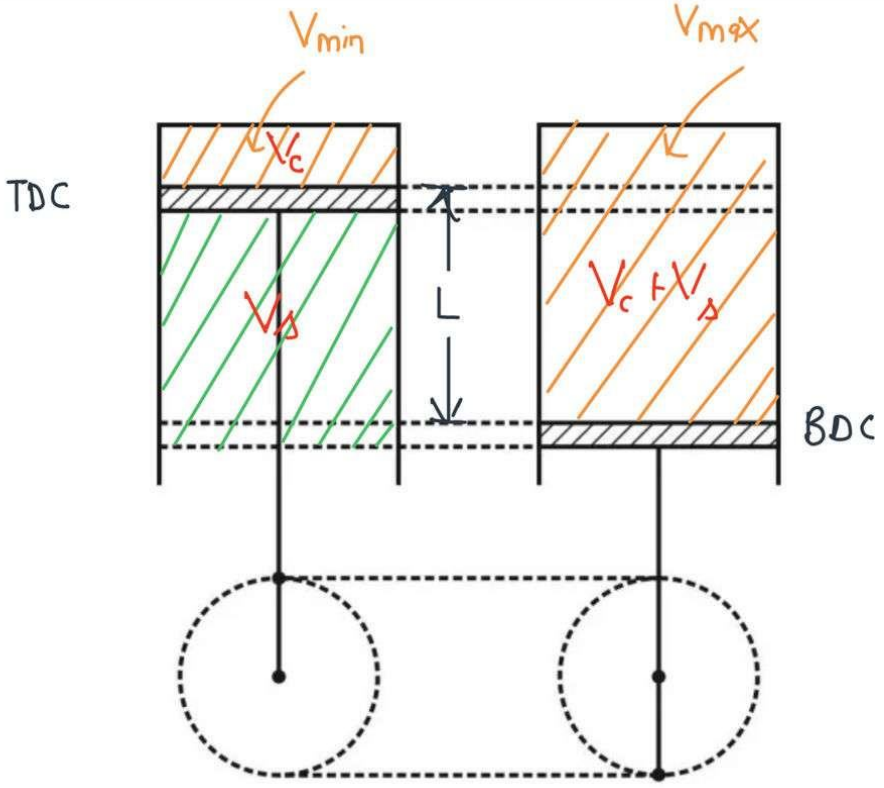
- In Internal Combustion engine, heat is supplied by burning the fuel within the system boundary.
  Ex:- Sparks ignition engine (Petrol engine), Compression ignition engine (Diesel engine), Conventional gas turbine power plant

- In External Combustion engine heat is supplied to working fluid from external source such as furnace and nuclear reactor.
  Ex:- Vapour power plants





* $L = 2r_c$



Top dead center ⇒ TDC

Minimum Volume ⇒ V_{min}

Clearance Volume ⇒ V_c

Bottom dead center ⇒ BDC

Maximum Volume ⇒ V_{max}

Stroke Length ⇒ L

Swept Volume ⇒ V_s

Bore ⇒ D

* $V_s = \frac{\pi}{4} D^2 L$

Displacement Volume $\geq V_s$

$V_d = n V_s$

*

$$V_d = n \frac{\pi}{4} D^2 L$$

↑ Number of Cylinders

(Engine Size)

Basic Terminologies

Top dead center (TDC)

A piston is said to be at TDC when cylinder volume is minimum. The minimum cylinder volume is known as clearance volume (V_c).

Bottom Dead center (BDC)

A piston is said to be at BDC when cylinder volume is maximum.

Stroke Length (L)

Stroke length is the distance travelled by piston when it moves from TDC to BDC (or) vice-versa.

Bore (D)

Internal diameter of the cylinder is known as bore.

Swept volume (V_s)

The volume swept by piston as it moves from TDC to BDC (or) vice-versa is known as swept volume.

Displacement volume of an engine is the swept volume multiplied by no of cylinders(n).Displacement volume is the main characteristic of engine size.

Clearance Ratio (c)

$$\text{Clearance Ratio (c)} = \frac{\text{Clearance Volume } (V_c)}{\text{Swept Volume } (V_s)}$$

* $$c = \frac{V_c}{V_s} \qquad (c < 1)$$

Compression Ratio (Π)

$$\text{Compression Ratio } (\Pi) = \frac{\text{Maximum Volume } (V_{max})}{\text{Minimum Volume } (V_{min})}$$

$$\Pi = \frac{V_{max}}{V_{min}}$$

*

$$\Pi = \frac{V_c + V_s}{V_c}$$

$$\Pi = 1 + \frac{V_s}{V_c}$$

$(\Pi > 1)$

Relation b/w Π & c

$$\Pi = \frac{V_c + V_s}{V_c}$$

$$\Pi = 1 + \frac{V_s}{V_c}$$

$$c = \frac{V_c}{V_s}$$

$$\frac{1}{c} = \frac{V_s}{V_c}$$

*

$$\Pi = 1 + \frac{1}{c}$$

Question

If $c = 0.1$

$\Pi = ?$

$$\Pi = 1 + \frac{1}{0.1}$$

$$\Pi = 1 + 10$$

$$\Pi = 11$$

Clearance ratio (c)

It is defined as the ratio of clearance volume to the swept volume of the cylinder.

$$C = \frac{V_c}{V_s}$$

Compression ratio (r)

It is defined as the ratio of maximum volume to the minimum volume of the cylinder.

$$r = \frac{V_c + V_s}{V_c} = 1 + \frac{1}{C}$$

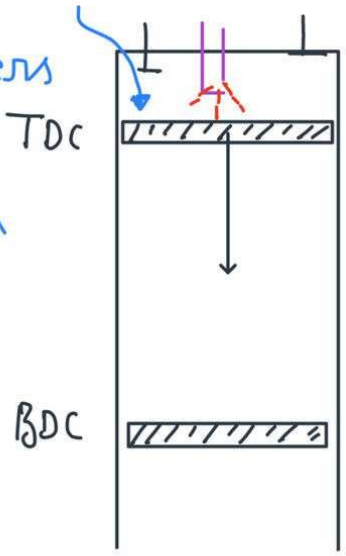
4 - Stroke SI Engine

Suction ⟶ A+F Mixture enters

Compression ⟶ Pressure ↑
Temperature ↑

Power ⟶ Expansion of Exhaust Gas

Exhaust ⟶ Exhaust Gas leaves

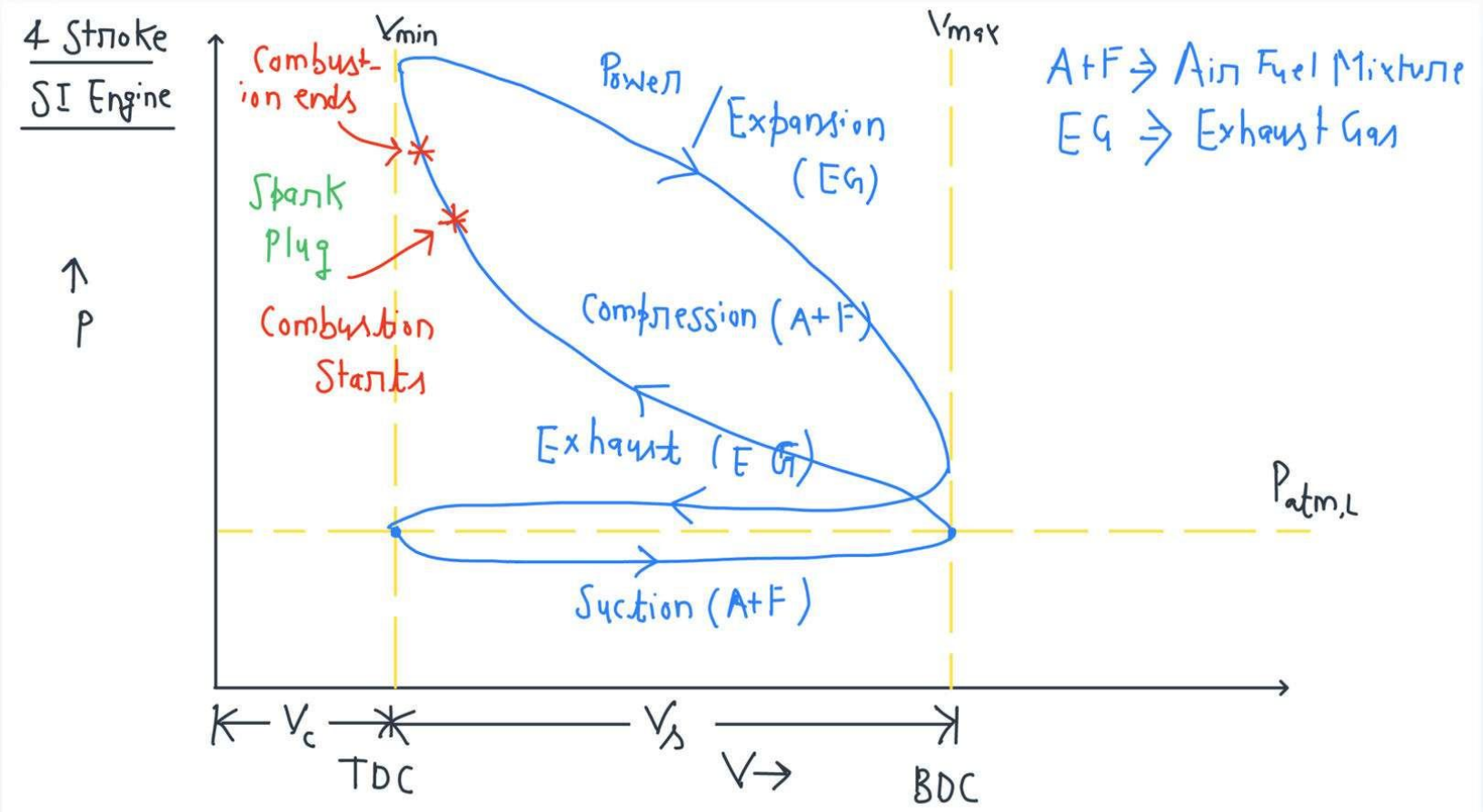


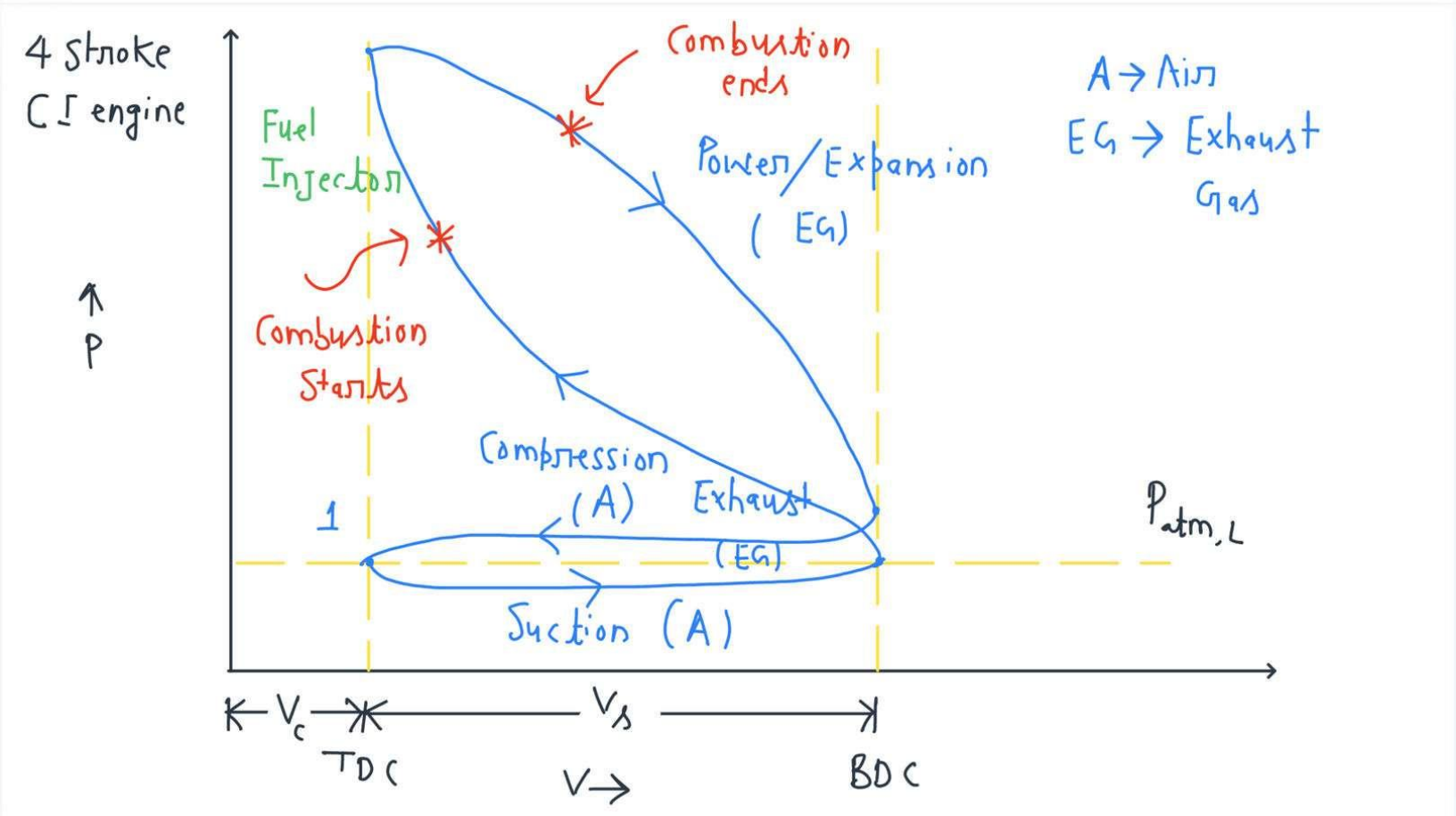
CI Engine

Spark Plug ⟶

Fuel Injector

Suction ⟶ Air


4 Stroke
SI Engine
Vmin
Vmax
Combust-ion ends
Power / Expansion (EG)
A+F ⇒ Air Fuel Mixture
EG ⇒ Exhaust Gas
Spark Plug
Combustion Starts
Compression (A+F)
Exhaust (EG)
P
Patm,L
Suction (A+F)
Vc
Vs
V→
TDC
BDC


4 Stroke
CI engine
Combustion ends
A → Air
EG → Exhaust Gas
Fuel Injection
Power / Expansion (EG)
Combustion Starts
Compression (A)
Exhaust (EG)
1
P
Patm,L
Suction (A)
Vc
Vs
V→
TDC
BDC