I.C.

CHAPTER-1

- Clearance ratio $= C = \frac{V_c}{V_s}$
- Compression ratio $= r = \frac{V_c + V_s}{V_c}$

$\Rightarrow C = \frac{1}{r-1}$

- Efficiency of otto cycle

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma-1}$$

- Efficiency of Diesel cycle

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma-1} \cdot \frac{(e^{\gamma}-1)}{\gamma(e-1)}$$

∴ e = cutt off point

$e = \frac{V_3}{V_2}$

- Efficiency of Dual cycle

$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma-1} \cdot \frac{(\alpha e^{\gamma}-1)}{[\gamma(e-1)\alpha + (\alpha-1)]}$$

∴ α = Explosion ratio

$\alpha = \frac{P_{2'}}{P_2}$

- $P_m = \frac{\eta_{otto}}{(\gamma-1)(r-1)} \Delta P$ ∴ $\Delta P = P_3 - P_2$

- when workdone of a diesel cycle is increased, its efficiency will decrease.

- The process of leftover exhaust gas being pushed out by fresh AFM due to crowning is called scavenging.

- mechanical efficiency $= \eta_m = \frac{BWD}{IWD} = \frac{BMEP \times V_s}{IMEP \times V_s}$

- Specific fuel consumption $= \frac{m_f/hr}{\text{Power (kw)}}$ $\frac{kg}{kw\,hr}$

- Average Piston speed $= \frac{2LN}{60}$ m/s when L is in 'm'.

- Specific output $= \frac{\text{Power}}{\text{Size of Engine}}$ [otto engine > Diesel engine

CHAPTER - 2

morse Key test

- 4B = Brake Power when all the engines are firing
- $3B = \dfrac{3B_1 + 3B_2 + 3B_3 + 3B_4}{4}$

  = Arithomatic mean of engines firing when one of engine is stoped one by one.

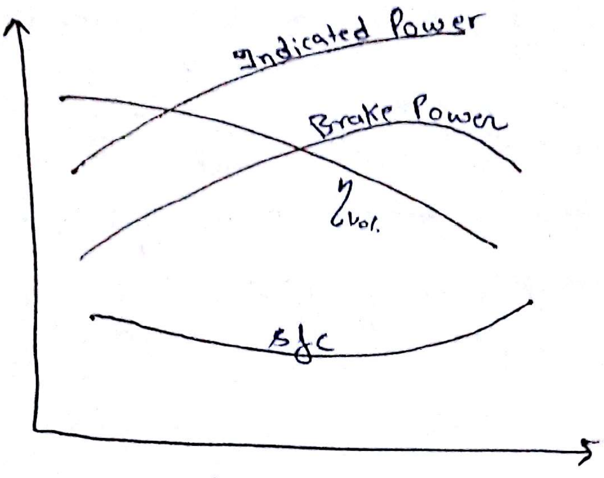
- $I = 4B - 3B$
- $4I = 4[4B - 3B]$ = Indicated power of engine.
- $\eta_m = \dfrac{4B}{4I}$

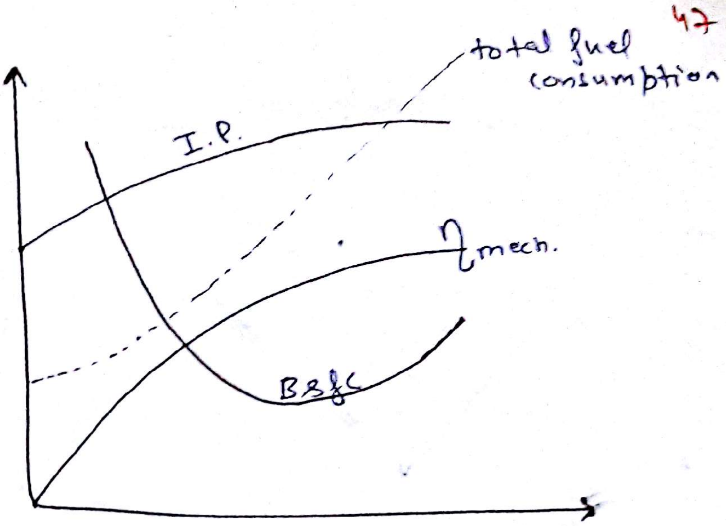
motoring test

- used to find friction Power of engine.
- rpm of running engine are noted
- motor is attached to engine shaft and made to run at same rpm. The power input to motor is friction power [take motor efficiency in account, motor output is friction power]

Supercharging

- These are the rotary compressors attached at inlet port of engine
- increase air circulation in engine
- higher Power output & higher thermal efficiency.
- reduction in specific fuel consumption
- increase volmetric efficiency.
- Scavenging is much better
- higher thermal stresses ⇒ moving parts damage.
- more loss of work due to leakage of Air from piston sides.
- Increase Knocking in Petrol engine.





- radiation Heat loss is more in 2-stroke engine due to large surface area.
- mileage of 2-stroke engine is less than 4 stroke
- overall efficiency of 2-stroke engine is less than 4 stroke
- Power output of 2-stroke is more than 4 stroke.
- $\eta_{Otto} > \eta_{Diesel}$ for same compression ratio
- compression ratio $r = 6-10$ → Petrol engine
  $r = 12-16$ → Diesel engine
  $r = 16-20$ → Dual cycle engine
- Cruising speed ⇒ AFR = 16 → Petrol
  AFR = 25 to 30 → Diesel

CHAPTER-3

- Stoichiometric AFR ⇒ no fuel in excess, no Air in excess → This ratio of AFM is Stoichiometric AFR
- Equivalence ratio (ϕ) $= \frac{(FAR)_{actual}}{(FAR)_{stoich.}} = \frac{(m_f)_{actual}}{(m_f)_{ideal}}$

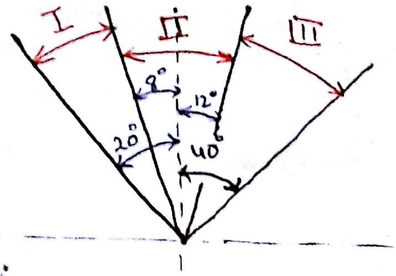
$\phi < 1.0$ ⇒ Less tempr, less power, less knocking (in Petrol)

$1.1 \le \phi \le 1.4$ ⇒ high tempr, high power, high knocking (in Petrol)

$\phi > 1.4$ ⇒ same effect as $\phi < 1$

I Stage ⇒ Sparking ⇒ depends on rpm
II Stage ⇒ Independent of rpm

Stages of combustion in SI engine



I stage ⇒ only sparking
II stage ⇒ ~~only~~ Sparking + ignition
III stage ⇒ only ignition

I stage ⇒ Chemical lag or ignition lag or preparatory phase

- Chemical lag is more when tempr of fuel particle is equal to self ignition after chemical action as compared to particle having tempr higher then self ignition tempr.

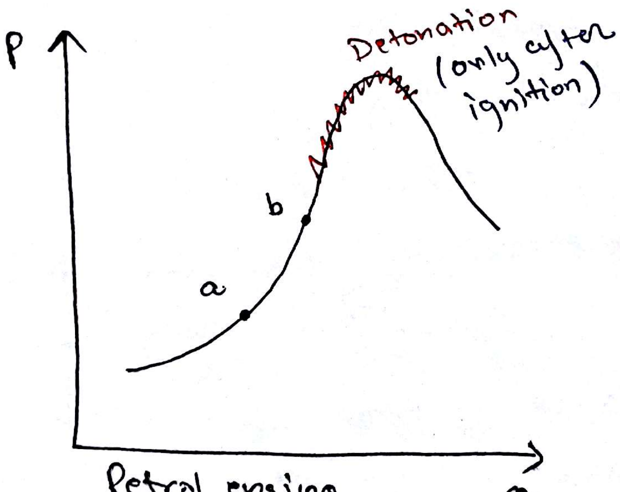
Stages of combustion in CI engine

I stage ⇒ Delay period = physical delay + chemical delay.

II stage ⇒ uncontrolled combustion

III Stage ⇒ controlled combustion

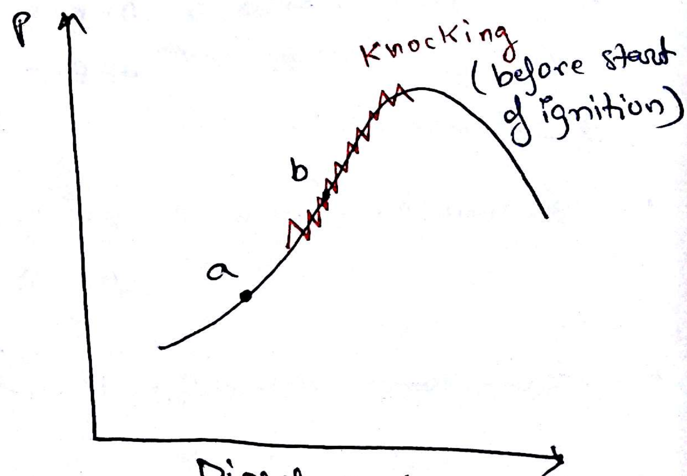
IV Stage ⇒ After burning.



Petrol engine

a = sparking begins (20° before TDC)

b = ignition begins (8° before TDC)



Diesel engine

a = injection of fuel (20° before TDC)

b = Ignition (8° before TDC)

Factors effecting Knocking/Detonation

Factors		Petrol	Diesel
Compression ratio	↑	↑	↓
load	↑	↑	↓
Advancing in spark	↑	↑	-
Distance of flame travel	↑	↑	-
location of spark plug		↓ when nearest to center & away from inlet	-
Engine speed	↑	↓	↑
AFR		$1 < \phi < 1.4$ ↑	-
Octane no.	↑	↓	-
Cetane no.	↑	-	↓
End charge S.	↓	↓	-
Power output	↑	↑	↓
inlet value temp^r	↑	↑	↓
Turblance	↑	↓	↓

CHAPTER-4

- CO → Poisioness, causes gidiness when taken in small Quantity
  → can cause fatal
- HC → Cause photo chemical smoge when exposed to atmosphere
  → will effect lungs & cause skin cancer
  → Also effect plant & animals.

- NO_x → same as HC
  → formed due to
    - high temp^r
    - excess Air
    - incomplete combustion

methods to prevent pollution

- slightly lesser compression ratio
- leaner AFM
- Use of thermal converter

  $CO \rightarrow CO_2$
  $HC \rightarrow H_2O + CO_2$
  → So called two way converter

- Use of catalytic converter

  Catalyst ⇒ Alumina (Al_2O_3)
  ⇒ Steel casing

  - Platinum → for HC
  - Palladium → for CO
  - Rhodium → for NO_x [placed at start]

Quality of fuel
- → Petrol ⇒ Iso-octane (0% Knock)
  Normal heptane (100% Knock)
- → Diesel ⇒ normal cetane (0% Knock)
  ⇒ α-methyl Napthalene (100% Knock)

- Octane no. = 70 to 80
  cetane no. = 40 to 50
  } in india

Stoichiometric AFR in petrol engine

cold starting	2 - 3
idling	5 - 9
max. acceleration	12 - 13
cruising	16
lean mixture	17 - 21

- AFR $\propto \sqrt{\rho_a}$

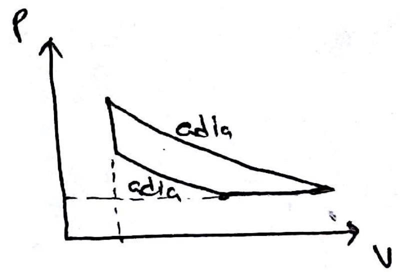
materials of engine → still made of cast iron in some of the engines.

- Cylinder & Piston → Aluminium Alloy
- Piston Pin
- connecting rod
- crank rod

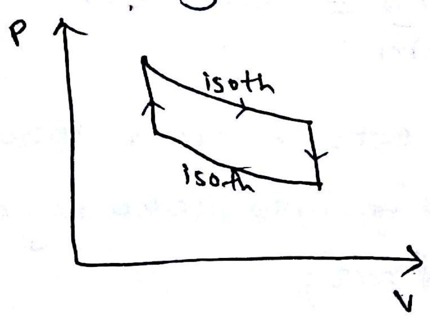
(Piston Pin, connecting rod, crank rod) → forged steel

- Engine shaft → HSS
- Piston ring → Silicon cast iron

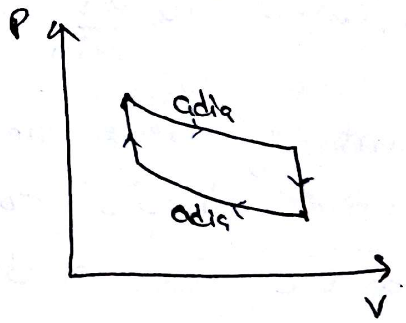
- Atkison cycle ⇒ 2 adiabatic
  1 const. Pr
  1 const vol.



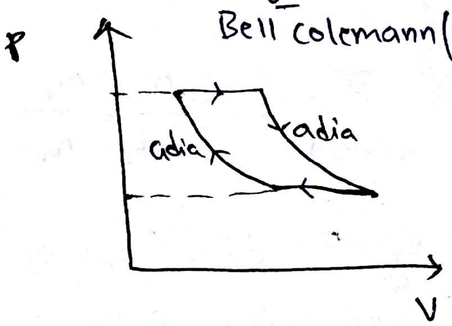
- Stirling cycle



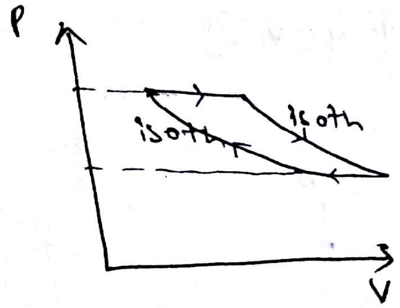
- otto cycle



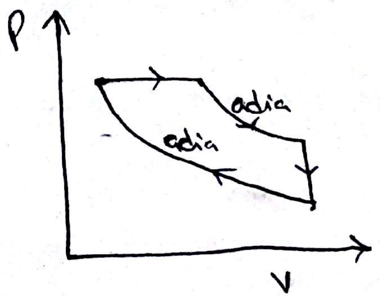
- Joule / Braton or Bell colemann (Reverse Brayton)



- Ericson cycle



- Diesel Kycle



- Dual cycle