Average piston speed = $2SN = \bar{V}_p$

Instantaneous piston speed = V_p

$$\frac{V_p}{\bar{V}_p} = \frac{\pi}{2}\sin\theta\left(1 + \frac{\cos\theta}{\sqrt{R^2 - \sin^2\theta}}\right)$$

$R = l/a$

piston position $(L) = a\cos\theta + \sqrt{l^2 - a^2\sin^2\theta}$

Instantaneous volume =

$$\frac{V}{V_c} = 1 + \frac{(r_c - 1)}{2}\left[R + 1 - \cos\theta - \sqrt{R^2 - \sin^2\theta}\right]$$

$$\eta_m = \frac{bp}{IP}, \quad \eta_{th} = \frac{BP}{\text{Fuel power}} = \frac{BP \times 3600}{(\text{Fuel consm})CV}$$

Specific fuel consumption (SFC) = $\frac{\text{mass of fuel}}{BP}$

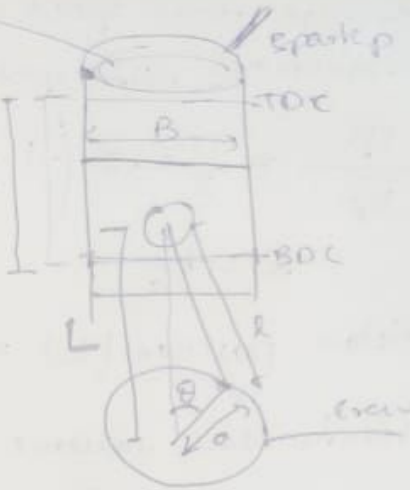
$$\eta_{BT} = \frac{BP}{\text{energy supplied}} = \frac{BP}{m_F \times CV \times \eta_c}$$

$$\eta_{IT} = \frac{IP}{m_F \times CV \times \eta_c}$$

V_d, V_c → clearance

$r_c = \frac{V_d + V_c}{V_c}$

$V_d = \frac{\pi}{4} B^2 S$



$\frac{B}{S} = 1$ → square engine.

$\frac{B}{S} > 1$ → Over square

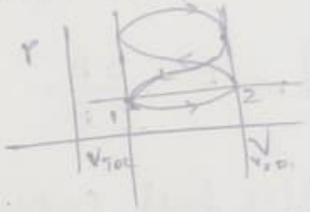
$\frac{B}{S} < 1$ → Under square

W_b → Work available at crank shaft

W_i → Indicated work

W_f → friction work

$W_b = W_i - W_f$



MEP ⟵ $W = \int p dV$

$MEP = \frac{W}{V_d}$, $bMEP = \frac{W_b}{\Delta V}$, $imEP = \frac{W_i}{\Delta V}$

Comparison of engines

$bmep = imep - fmep$

$2\pi T = W_b$ → brake work of one revolution

$2\pi T = \frac{bmep\ V_d}{N}$ → 4 stroke ($N = 2$)

$\eta_v = \frac{\text{Volume of air taken into cylinder}}{\text{Maximum possible volume that can be taken}}$

power $= 2\pi NT = \frac{\omega n}{N}$ → engine speed

→ No

Hydrocarbon + $b(1+a)(O_2 + 3.76\,N_2) \rightarrow x\,CO_2 + y\,H_2O + a\,bO_2 + z\,N_2$

300 %. Theoretical air maje $\boxed{1+a=3}$

$AF = \frac{m_{air}}{m_{fuel}}$ ⟷ $m_{air} = N_{air} \times M_{air}$

Valve timing

TDC

TDC