Air Standard Cycles
(or) (Ideal I.C. engine cycles)
(or) (Const. Volume Cycle)

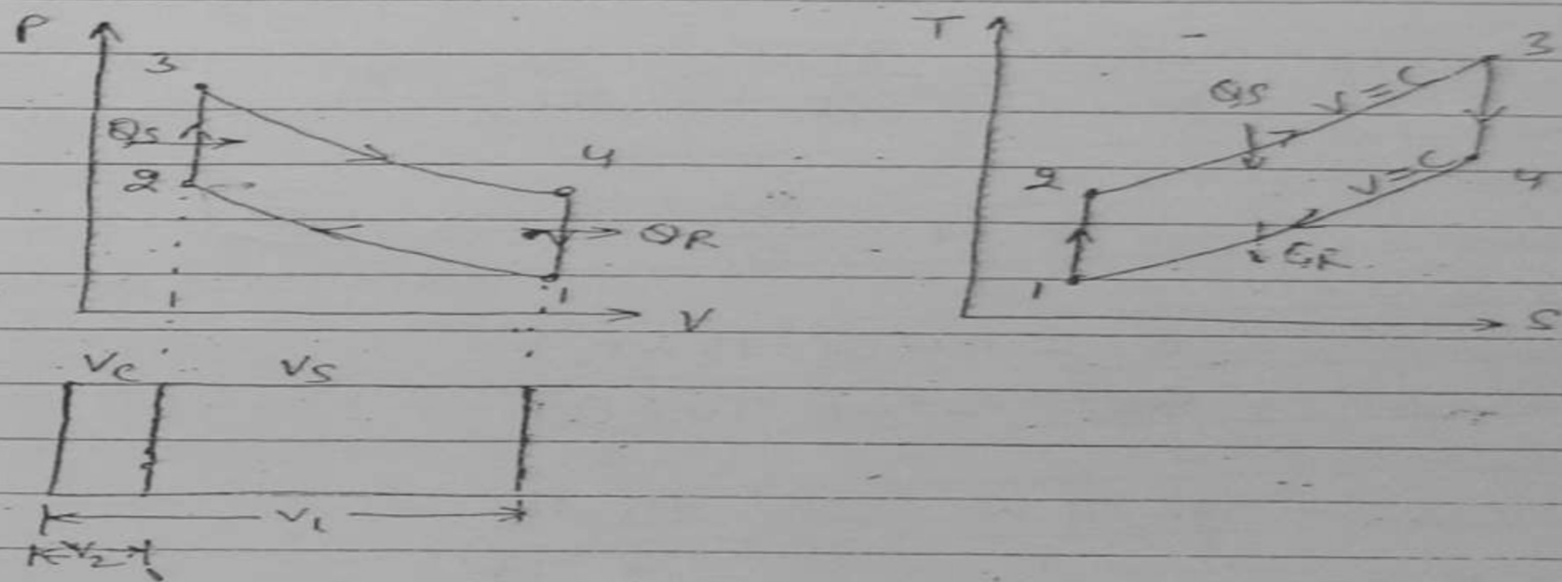
(6)

Assumptions made in Air Standard Cycles:-

1. The working substance is air and it behaves as an ideal gas.
2. The working substance is of fixed mass. (Closed System analysis)
3. The specific heats of working fluid remains Constant. (γ remains constant)
4. The working fluid does not undergo any ~~chang~~ chemical change.
5. All the processes are reversible processes.

Otto Cycle

(or) (Const. volume cycle)



1 – 2 Adiabatic Compression

2 – 3 Const. vol. heat addition (Qs)

3 – 4 Adiabatic Expansion

4 – 1 Const. vol. heat rejection (QR)

Air standard efficiency (or) Ideal effⁿ of otto cycle:-

$$\eta = \frac{\text{output}}{\text{input}} = \frac{W}{Q_S} = \frac{Q_S - Q_R}{Q_S}$$

$$\eta = 1 - \frac{Q_R}{Q_S} \quad (8)$$

$$Q_S = mC_v(T_3 - T_2)$$

$$Q_R = mC_v(T_4 - T_1)$$

$$\eta = 1 - \frac{mC_v(T_4 - T_1)}{mC_v(T_3 - T_2)}$$

$$\eta = 1 - \frac{T_4 - T_1}{T_3 - T_2}$$

$$\eta = 1 - \frac{T_1\left(\frac{T_4}{T_1} - 1\right)}{T_2\left(\frac{T_3}{T_2} - 1\right)}$$

1-2 (Adiabatic)

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = (r)^{\gamma-1} \quad \text{--- (1)}$$

3-4 (adiabatic)

$$T_3 V_3^{\gamma-1} = T_4 V_4^{\gamma-1}$$

$$\frac{T_3}{T_4} = \left(\frac{V_4}{V_3}\right)^{\gamma-1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = (r)^{\gamma-1} \quad \text{--- (2)}$$

$\therefore$ from ① and ② we have

$$\frac{T_2}{T_1} = \frac{T_3}{T_4}$$

** $$\boxed{T_1 T_3 = T_2 T_4}$$ ⑨

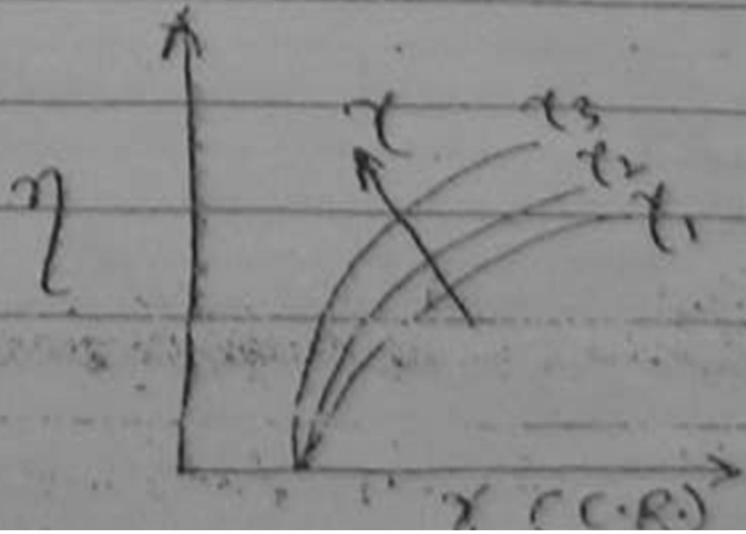
$$\therefore \frac{T_4}{T_1} = \frac{T_3}{T_2}$$

$$\therefore \eta = 1 - \frac{T_1}{T_2}$$

$$\eta = 1 - \frac{1}{(T_2/T_1)}$$

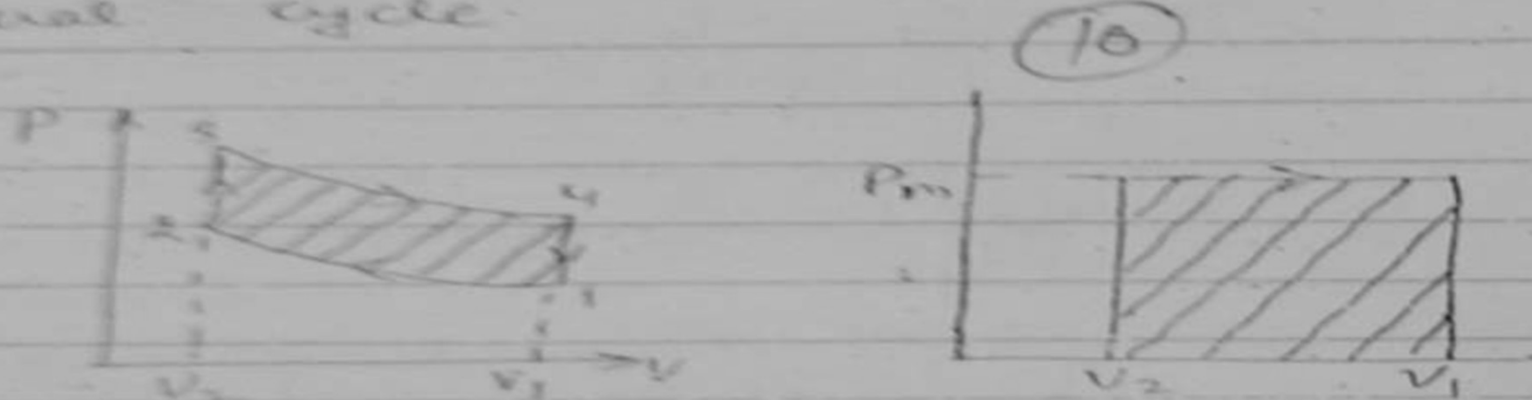
** $$\boxed{\eta = 1 - \frac{1}{(r)^{\gamma-1}}}$$

efficiency vs compression ratio (η vs r



Mean effective pressure (mep)

It is the constant pressure (the Hypothetical pressure) during expansion producing same work as the actual cycle.



$$P_m (V_1 - V_2) = W_{net}$$

$$P_m = \frac{W_{net}}{V_1 - V_2}$$

$$\boxed{P_m = \frac{W_{net}}{V_S}}$$