MECHANICAL

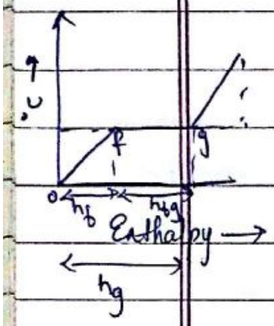
Module 1

* Steam formation

h_f = Enthalpy of ~~th~~ saturated liquid
(Δ added from $0^\circ c$ to f.)
also called sensible heat

h_{fg} = Enthalpy of evaporation
also called latent heat

h_g = Enthalpy of saturated steam
(Δ added from $0^\circ c$ to g.)



* Dryness fraction: (x)

$$x = \frac{m_g}{m_f + m_g}$$

m_f = mass of water
$m_f + m_g$ = total mass of mixture
m_g = mass of steam

* Degree of Superheat : (ΔT)

$\Delta T = T_{sup.} - T_{sat.}$
$T_{sat.}$ = Saturated temp.
$T_{sup.}$ = Superheated temp.

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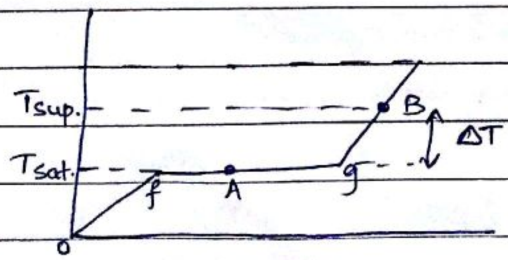

h_A = amount of heat added from 0 to A
$h_A = h_f + x\,h_{fg}$.

h_B = amount of heat(Δ) added from 0 to B.

$$h_B = h_g + C_{sp.}(\Delta T)$$

C_{sp} = specific heat of steam

* Specific volume

v_f = vol. occupied by 1kg of sat. liq.
v_g = " " " Sat. vapour

$$v_A = (1-x)v_f + x v_g$$

$$v_A \cong x v_g$$

$V_B \Rightarrow$

$$p v_g = R T_{sat.}$$
$$p v_B = R T_{sup.}$$

$$\frac{v_B}{v_g} = \frac{T_{sup.}}{T_{sat.}}$$

$$\therefore v_B = \frac{T_{sup.} \cdot v_g}{T_{sat.}}$$

* Internal Energy (u)

$$h = u + pv$$
$$\therefore u = h - pv.$$

$$u_f = h_f - p v_f$$
$$u_g = h_g - p v_g$$

$$u_A = h_A - p v_A$$
$$u_B = h_B - p v_B$$

Module 2

* Swept volume

$$V_s = \left(\frac{\pi d^2}{4}\right) L \quad \text{--- } cm^3$$

d = bore / diameter

L = stroke length

* Compression Ratio (r)

$$r = \frac{(V_s + V_c)}{V_c}$$

V_s = swept volume
V_c = clearance volume
$V_s + V_c$ = total volume of cylinder

for petrol engine $r = 7$ to 10
for diesel engine $r = 15$ to 24

* ~~Mean effective pressure~~

~~$p_m = \frac{s.a}{l}$ & (in expansion stroke) --- N/m^2~~

* Indicated power (IP)

$$IP = \boxed{\frac{n\, p_m L A N K}{60 \times 1000}} \quad \text{--- } kW$$

n = no. of cylinders

$p_m = \frac{s.a}{l}$ = mean effective pressure --- N/m^2

s = spring constant of spring
a = area of indicator diagram
l = length of indicator diagram
L = stroke length
A = area of cross-section of piston
N = no. of power producing cycles per minute --- rpm (Engine speed)

$k \Rightarrow$ for 4 stroke $\rightarrow \frac{N}{2}$
for 2 stroke $\rightarrow N$

* Brake power (BP).

Torque on brake drum = $T = (W - S) \times R$

W = wt. on rope
S = Spring balance reading
R = mean radius of brake drum, m.

$$BP = \frac{2\pi NT}{60 \times 1000}$$

T = torque
N = no. of power producing cycles per min. ... rpm

* Frictional power (FP)

$FP = IP - BP$ .... kW

* Mechanical Efficiency ($\eta_{mech.}$)

$$\eta_{mech.} = \frac{BP}{IP}$$

* Thermal Efficiency: ($\eta_{thermal}$)

$$\eta_{thermal.} = \frac{\text{power o/p}}{\Delta \text{ produced}} \times 100$$

$$\eta_{thermal.\,(IP)} = \frac{\text{indicated power}}{m_f \times C_v}$$

$$\eta_{thermal\,(BP)} = \frac{\text{brake power}}{m_f \times C_v}$$

$m_f \times C_v = \Delta$ produced
(mass of produce × calorific value)
(mass of fuel used × calorific value)

* Specific fuel consumption (SFC)

$$SFC = \frac{m_f}{power} \quad \ldots \text{kg/kW-hr}$$

$$BSFC \text{ (Brake SFC)} = \frac{m_f}{BP}$$

$$ISFC \text{ (indicated SFC)} = \frac{m_f}{IP}$$

Module 4 & 3

No formula . Full theory

Module 5

* Coefficient of performance (COP)

Q = Δ absorbed or removed ... kW
W = work supplied ... kW

$$COP = \frac{Q}{W}$$

* Relative COP

$$RCOP = \frac{\text{Actual COP}}{\text{Theoretical COP}}$$

* SI unit → ton of refrigeration

1 ton of refrig. = 210 kJ/min

= 3.5 kW