LIST OF FORMULAS (1ST CHAPTER BASIC THERMAL ENGINEERING)

Summary

① Heat equation $Q = dU + W$, J or KJ

② Enthalpy $H = U + PV$ Change in Enthalpy

③ Entropy $dS = \frac{\delta Q}{T}$, KJ/KgK $dH = mC_p(T_2 - T_1)$, J or KJ

④ General gas equation $\frac{PV}{T} = C$ ie $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} = C$

⑤ Characteristic gas equation $PV = mRT$

⑥ Universal gas constant $R_U = MR$

⑦ Work done $W = P(V_2 - V_1)$

ie $W = mR(T_2 - T_1)$ $(\because PV = mRT)$

⑧ specific heat at constant volume

$Q = mC_v(T_2 - T_1)$ Here $Q = dU + W$

$dU = mC_v(T_2 - T_1)$ $Q = dU + 0$

$W = 0$ i.e $\boxed{Q = dU}$

⑨ specific heat at constant Pressure

$Q = mC_p(T_2 - T_1)$ ✓

$dU = mC_v(T_2 - T_1)$ ✓

$W = P(V_2 - V_1)$

i.e $W = mR(T_2 - T_1)$ ✓

Here $Q = dU + W$

ie $mC_p(T_2 - T_1) = mC_v(T_2 - T_1) + mR(T_2 - T_1)$

⑩ Relation between C_p and C_v

$C_p - C_v = R$

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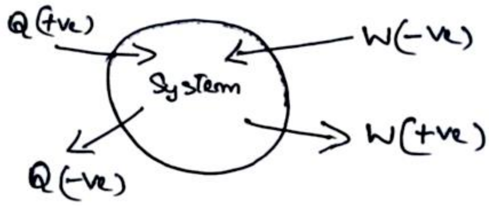
(11) $\frac{C_P}{C_V} = \gamma$ Here γ is adiabatic index

(12) $R = C_V(\gamma - 1)$

(13) SFEE

$$\boxed{u_1 + P_1 V_{s_1} + \frac{v_1^2}{2} + g z_1 + Q = u_2 + P_2 V_{s_2} + \frac{v_2^2}{2} + g z_2 + W}$$

(14)



Heat supplied into the system is +ve
Heat Rejected from the system is −ve
Work done on the system is −ve
Work done by the system is +ve

(15) Pressure :- in N/m^2

$Pa = N/m^2$

$bar = 10^5 \, N/m^2$

(16) Force :- in N

$$\boxed{Kg \, m/s^2 = N}$$

(17) Work, Heat and internal energy all are measured in J or KJ

$$\boxed{Nm = J}$$

(18) Temperature in K

$K = {}^\circ C + 273$

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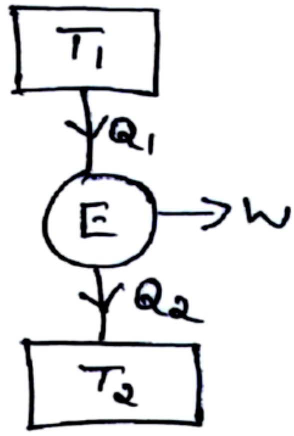
(19) $$\text{Efficiency} = \frac{\text{output}}{\text{input}} \times 100$$

ie $$\eta = \frac{\text{output}}{\text{input}} \times 100$$

(20) <u>Heat Engine</u>:-



$$\boxed{W = Q_1 - Q_2}$$

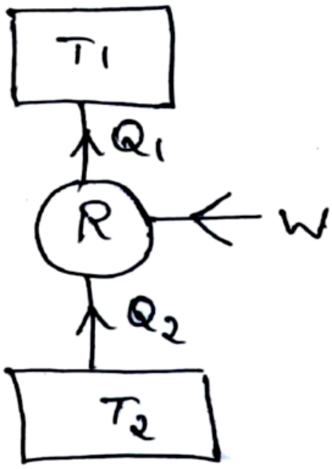
$$\eta = \frac{W}{Q_1}$$

$$\boxed{\eta = \frac{Q_1 - Q_2}{Q_1}} \quad \text{or} \quad \boxed{\eta = \frac{T_1 - T_2}{T_1}}$$

$$\eta = \frac{\cancel{Q_1}}{\cancel{Q_1}} - \frac{Q_2}{Q_1}$$

$$\boxed{\eta = 1 - \frac{Q_2}{Q_1}} \quad \text{or} \quad \boxed{\eta = 1 - \frac{T_2}{T_1}}$$

(21) <u>Refrigerator</u>:-



$$-W = Q_2 - Q_1$$

$$W = -(Q_2 - Q_1)$$

$$W = -Q_2 + Q_1$$

$$\boxed{W = Q_1 - Q_2}$$

$$COP = \frac{Q_2}{W}$$

$$\boxed{COP = \frac{Q_2}{Q_1 - Q_2}} \quad \text{or} \quad \boxed{COP = \frac{T_2}{T_1 - T_2}}$$

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U_1 = initial internal energy,

U_2 = final internal energy

then, change in internal energy is given by

$$dU = U_2 - U_1$$

26] Gas Constant,	R=287 J/kgk	or	R=0.287 kJ/kgK
27] Specific Heat at Constant Volume,	C_v=713 J/kgk	or	C_v = 0.713 kJ/kgk
28] Specific Heat at Constant Pressure,	C_p=1000 J/kgk	or	C_p=1 kJ/kgk
29] Universal Gas Constant,	R_u=8314 J/kg mol K	or	8.314kJ/kg mol K