

$$= h_{f1} + x_1 h_{fg1} - h_{f2} = h_1 - h_{f2}$$

$$= \text{heat rejected during } cd = x_2 h_{f2}$$

Work Done = Heat absorbed - Heat rejected.

$$= (h_1 - h_{f2}) - x_2 h_{f2} = h_1 - (h_{f2} + x_2 h_{f2}) = h_1 - h_2$$

This shows that work done during the cycle is equal to the difference b/w Total heats at point b & c.

$$\text{Efficiency} = \frac{\text{work Done}}{\text{heat supplied}} = \frac{h_1 - h_2}{h_1 - h_{f2}}$$

Q.10 Define the term Equivalent Evaporation. It is the quantity which when multiplied by the Amount of steam generated at a given pressure from water at a given temp. gives the equivalent evaporation from and at 100°C.

if  $F$  = factor of Evaporation.

Then equivalent evaporation from and at 100°C

$$F = \text{Actual evaporation} \times \left( \frac{h - h_{f1}}{2258} \right)$$

$$F = \frac{h - h_{f1}}{2258}$$

Q.11 Explain the principle of Regenerative Rankine cycle.

Ans - modified Rankine cycle: The Area of the P-v diag. of the Rankine cycle represents the work done. The work done obtained near the toe end of P-v diagram is very small. It is not even sufficient to overcome the work lost in friction due to reciprocating parts.

The adiabatic expansion is

terminated at e the pressure is  $P_2$  then allowed to drop suddenly to  $P_3$  at const-volume. The line ef represents this operation.

The work done during the modified Rankine cycle can be calculated as follows

Let  $P_1, v_1, v_1$  and  $h_1$  apply to initial condition of steam at b

$P_2, v_2, v_2$  and  $h_2$  apply to condition of steam at e

$P_3$  and  $h_{f3}$  apply to condition of water at d

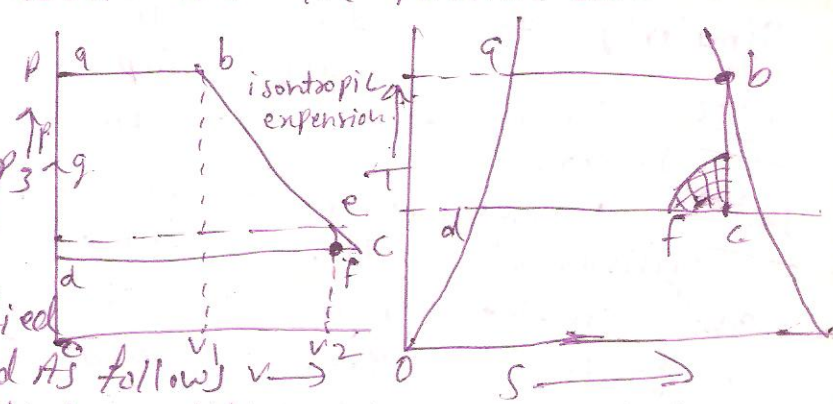
Work Done during the cycle / kg of steam.

$$= \text{Area } abef = \text{area } gabe + \text{area } gefd$$

$$= (h_1 - h_2) + (P_2 - P_3) \times v_2$$

$$\text{heat supplied} = h_1 - h_{f3}$$

$$\text{The modified Rankine } \eta = \frac{(h_1 - h_2) + (P_2 - P_3) \times v_2}{h_1 - h_{f3}}$$



work done during the cycle of steam  
 $= \text{area } abefd = \text{area } oabn + \text{area } nbem - \text{Area } odfn$   
 $= P_1 V_1 + (U_1 - U_2) - P_3 V_2$

heat supplied  $= h_1 - h_3$

The modified Rankine  $\eta = \frac{P_1 V_1 + (U_1 - U_2) - P_3 V_2}{h_1 - h_3}$

Q.12 write a short note on

M1 1. Boiler Accessories: see @

2. Gibbs and Helmholtz Functions: This law concerning changes in energy and entropy. The thermodynamic potentials are

1- Enthalpy  $H = U + PV$  2- Gibbs fun  $G = H - TS$

3- Helmholtz free energy  $F = U - TS$

As per Clausius inequality,

$$ds \geq \frac{dQ}{T} \geq \frac{dU + PdV}{T}$$

$$\Rightarrow ds - \frac{dU + PdV}{T} \geq 0 \Rightarrow Tds - dU - dW \geq 0$$

$$\Rightarrow -dF - dW \geq 0 \Rightarrow -(F_P - F_R) - W \geq 0$$

for a process without work.

$$F_R \geq F_P$$

This shows that As per the second law a workless isothermal reaction is not feasible unless the Helmholtz fun. of the greater than or equal to the Helmholtz fun. of products.

Similarly for a flow reaction Gibbs fun.

$$G_R \geq G_P$$

Q.13 Give the constructions details of the Locomotive boiler-2

M1) Locomotive boiler is a fire tube boiler. It is made of cylindrical shell. It is fitted with fire box at one end and smoke box at the other end. coal is burnt on grate in fire box and fire gases pass through number of small fire tubes surrounded by water in the shell.

