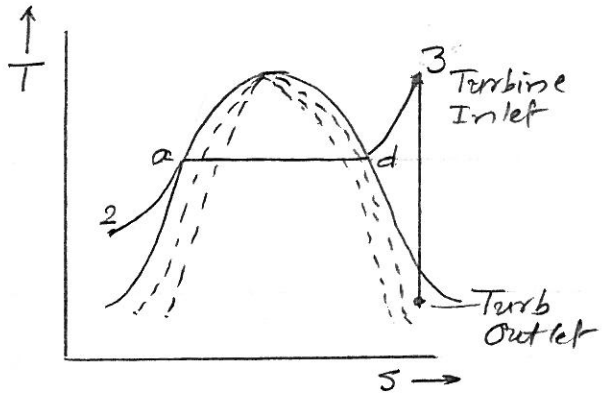
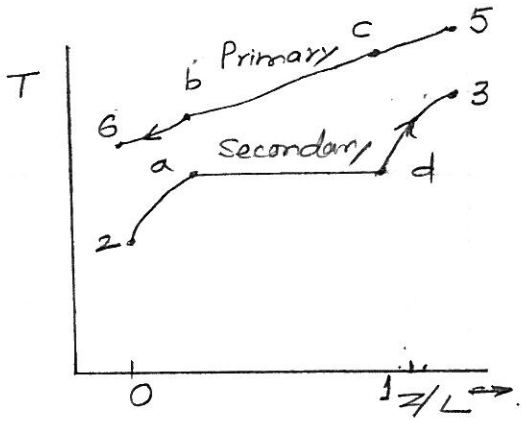
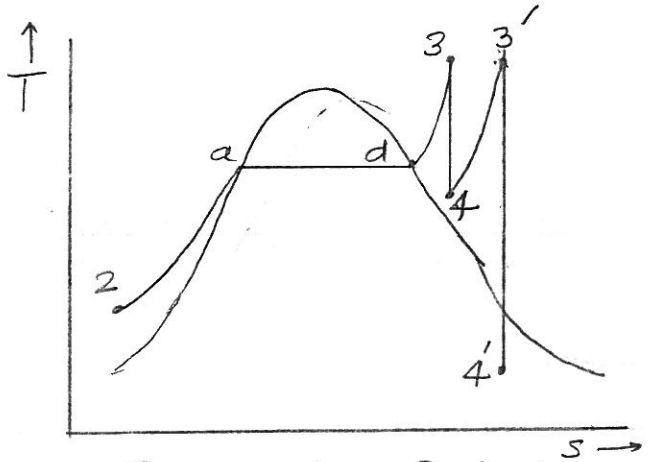
Rankine Cycle: Superheat, Reheat, regeneration and Moisture separation



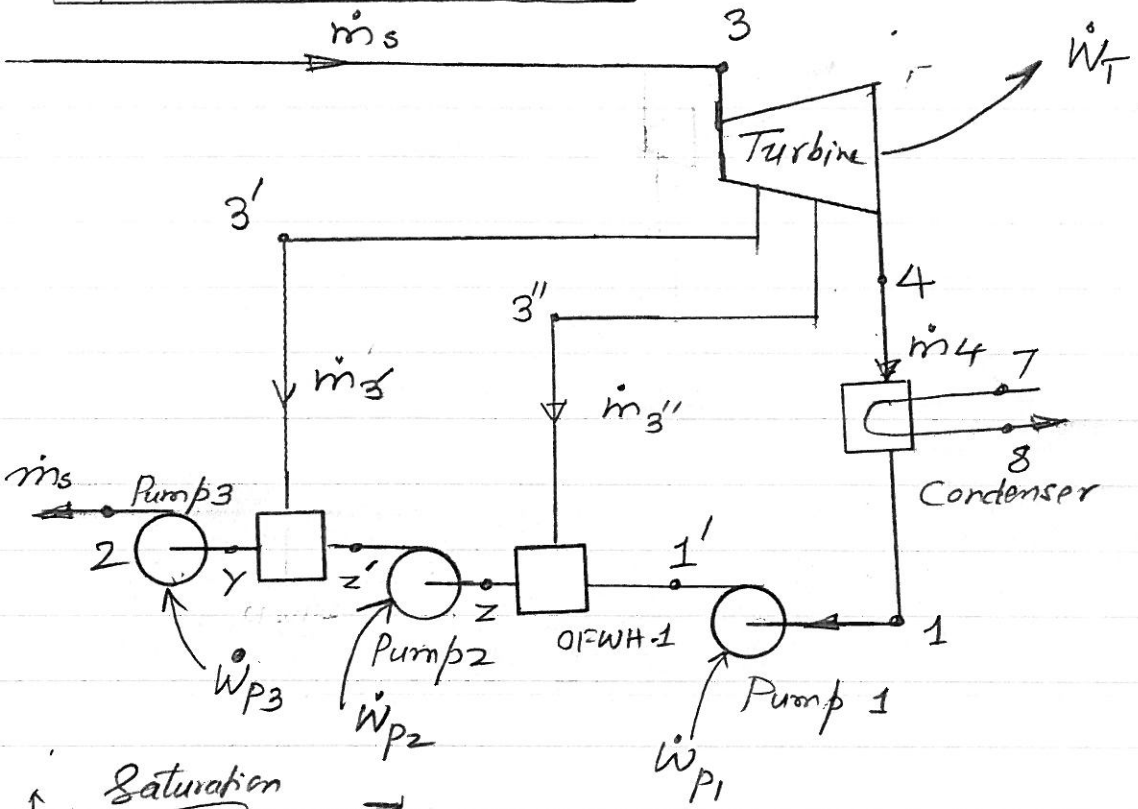


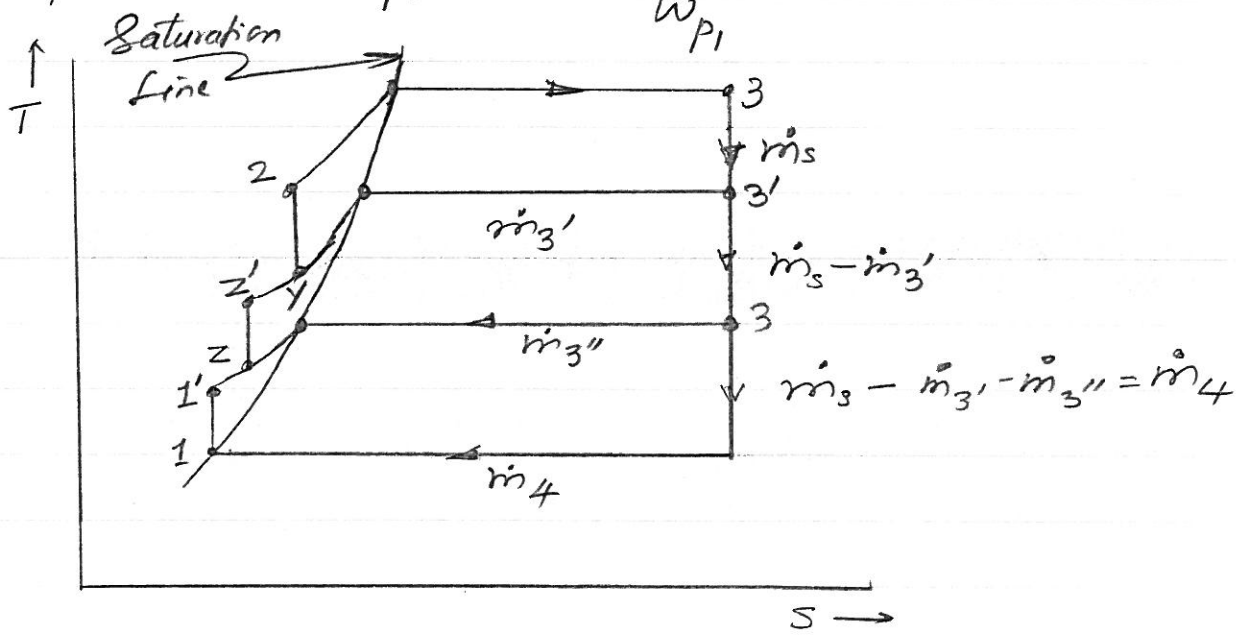
Superheated Process



Superheat & Reheat process.

Open Feed Water heaters





Turbine work

$$\dot{W}_T = \dot{m}_5(h_3 - h_3') + (\dot{m}_5 - \dot{m}_3')(h_3' - h_3'') + \dot{m}_4(h_3'' - h_4)$$

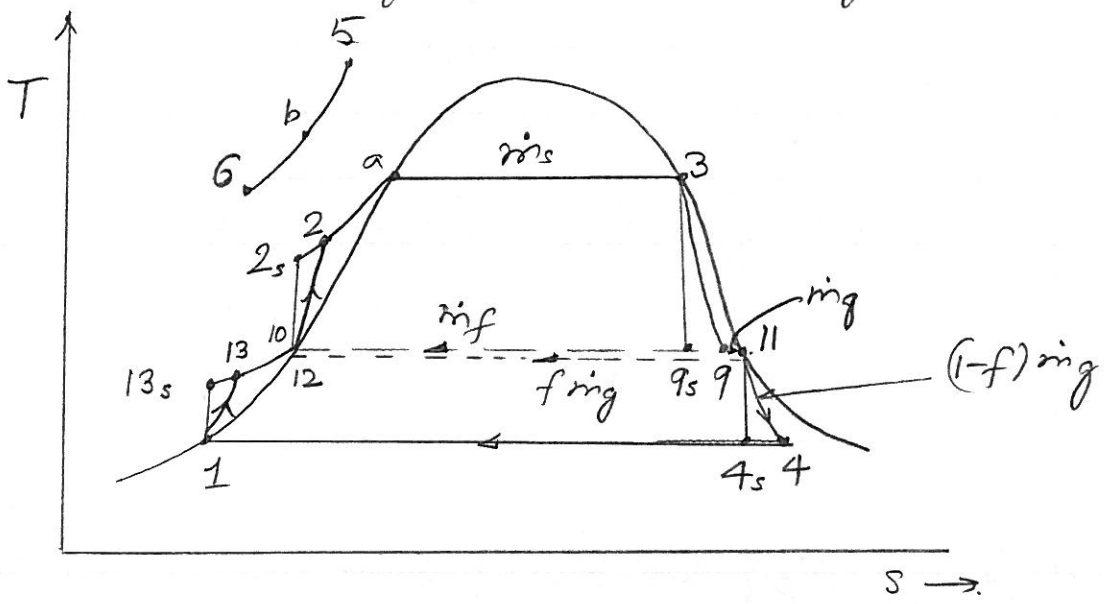
Exit enthalpy for OFHW #1

$$h_2 = \frac{\dot{m}_3'' h_3'' + \dot{m}_4 h_1'}{\dot{m}_3'' + \dot{m}_4} = \frac{\dot{m}_3'' h_3'' + \dot{m}_4 h_1'}{\dot{m}_5 - \dot{m}_3'}$$

For OFWH #2.

$$h_y = \frac{\dot{m}_3' h_3' + (\dot{m}_s - \dot{m}_3') h_{z'}}{\dot{m}_s}$$

Example: PWR Cycle with moisture separation and one stage feedwater heating.



$$\frac{\dot{m}_p}{\dot{m}_s} = \frac{h_3 - h_a}{\bar{c}_p [T_5 - (T_a + \Delta T_p)]}$$

$$\eta_{th} = \frac{\dot{m}_s (h_3 - h_9) + (1-f)\dot{m}_g (h_{11} - h_{4s})}{\dot{m}_s (h_3 - h_2)}$$

(neglecting pump work)

$$h_9 = h_3 - \eta_T (h_3 - h_{9s})$$

$$h_{9s} = h_f + x_{9s} h_{fg} = h_f + \left(\frac{s_{9s} - s_f}{s_{fg}}\right) h_{fg}$$

$$\dot{m}_g = x_9 \dot{m}_s = \frac{h_9 - h_f}{h_{fg}} \cdot \dot{m}_s \; ; \; \dot{m}_f = \left(1 - \frac{\dot{m}_g}{\dot{m}_s}\right) \dot{m}_s$$

$$h_4 = h_{11} - \eta_T (h_{11} - h_{4s})$$

$$h_{4s} = h_f + x_{4s} h_{fg} = h_f + \left(\frac{s_{4s} - s_f}{s_{fg}}\right) h_{fg}$$

$$h_{13} = h_1 + \frac{v_1 (P_{13} - P_1)}{\eta_P}$$

Energy balance:

$$f \rightarrow \quad \dot{m} f h_{12} + f \dot{m} h_{11} + (1-f) \dot{m} h_{13} = \dot{m} h_{10}$$

$$h_2 = h_{10} + \frac{v_{10} (P_2 - P_{10})}{\eta_P}$$