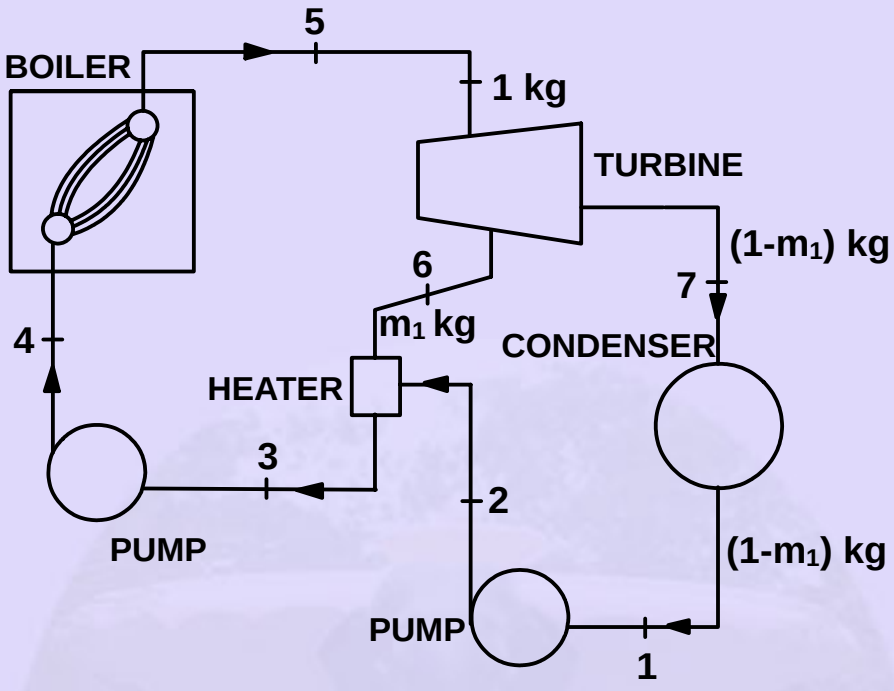
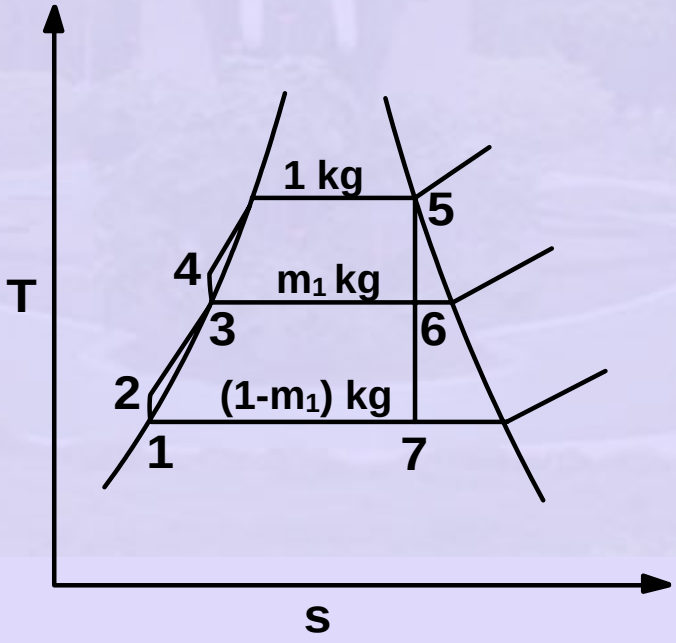
5.7 Open Feed Water Heater:



(a)



(b)

Fig.5.7. Open feed water heater cycle

A regenerative cycle having a single stage of feed water heating is shown above. Steam enters the turbine at state 5. After expansion to state 6, part of this steam is extracted and supplied to the feed water heater while the remainder continues to expand to state 7. Other processes are as shown above. The above T-s diagram is not the exact one, (because the mass flow rate is changing at all the state points) but, it simply shows various states of the working fluid.

Let m_1 = mass of steam extracted at state 6 then, heat balance for heater gives,

$$m_1 h_6 + (1 - m_1) h_2 = h_3$$
$$m_1 h_6 + h_2 - m_1 h_2 = h_3$$
$$m_1 (h_6 - h_2) = (h_3 - h_2)$$
$$m_1 = \frac{(h_3 - h_2)}{(h_6 - h_2)}$$

if, $h_2 \approx h_1$

$$m_1 = \frac{(h_3 - h_1)}{(h_6 - h_1)}$$

The amount is so adjusted that the liquid leaving the feed water heater at state 3 is saturated.

Thermal Efficiency:

$$\text{Turbine work} = (h_5 - h_6) + (1 - m_1)(h_6 - h_7)$$

$$\text{Heat supplied} = (h_5 - h_4) \approx (h_5 - h_3)$$

$$\text{Therefore, } \eta_{th} = \frac{(h_5 - h_6) + (1 - m_1)(h_6 - h_7)}{(h_5 - h_3)}$$

$$= \frac{(h_5 - h_7) - m_1 (h_6 - h_7)}{(h_5 - h_3)}$$