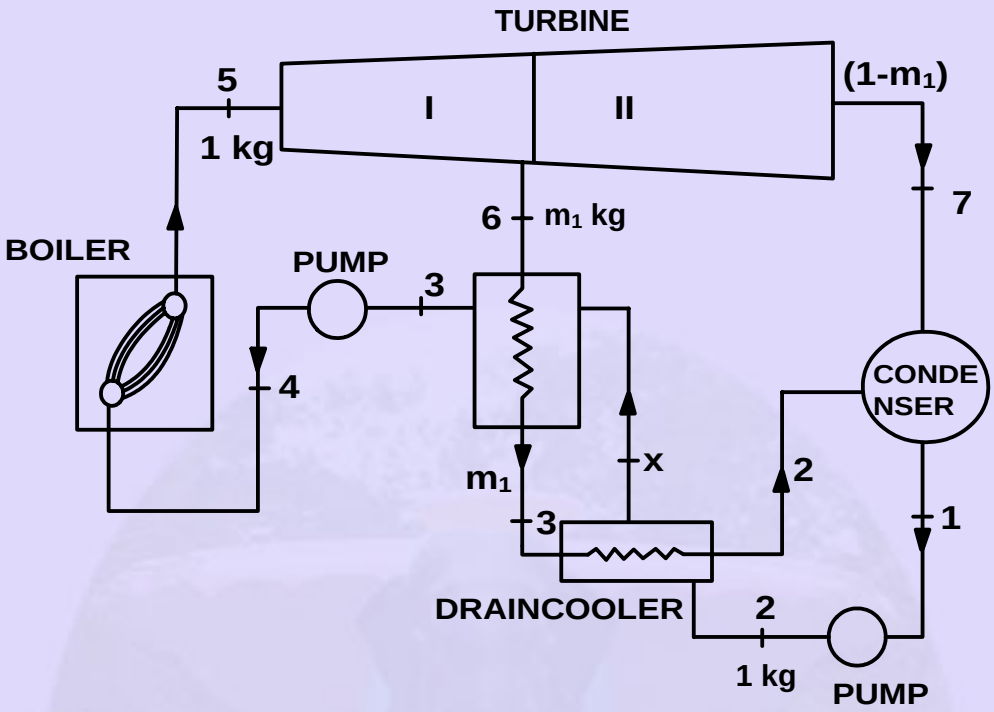
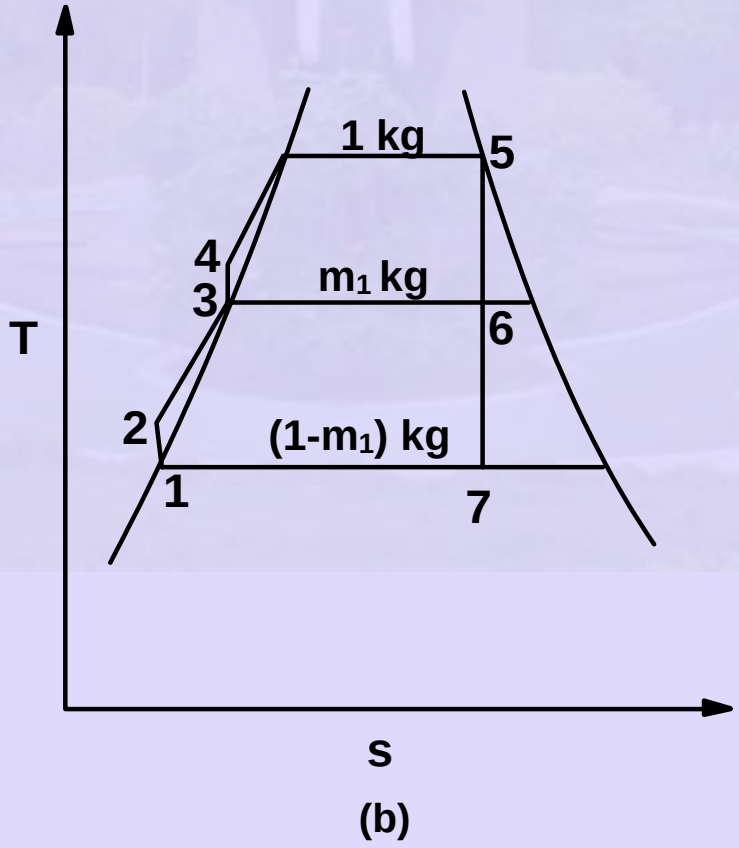
## 5.8 Closed Feed Water Heater:




(a)




(b)

**Fig.5.8. Closed feed water heater**

Regeneration here is single stage, while turbine is of two stages. The extracted steam of mass $m_1$ kg is completely condensed in the heater and this liquid is first passed through a drain cooler and then enters the condenser where it mixes with the main condensate of mass (1-$m_1$) kg. This liquid from the condenser is first heated from state 2 to state x in the drain cooler and then from state x to state 3 in heater. If we assume perfect heat exchange in water heater, then the feed water as well as the condensate of the extracted steam will leave the feed water heater at state 3. Similarly in the drain cooler, the liquid coming from heater will get cooled to the temperature $t_2$ of the condensate from the pump.

Let, $m_1$ = mass of extracted steam per kg steam supplied to the turbine.

Heat balance for drain cooler gives,

$$m_1(h_3 - h_2) = 1(h_x - h_2)$$

$$h_x = h_2 + m_1(h_3 - h_2)$$

Heat balance for feed heater gives,

$$m_1(h_6 - h_3) = (h_3 - h_x) = h_3 - h_2 - m_1(h_3 - h_2)$$

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

$$m_1 = \frac{h_3 - h_2}{h_6 - h_2}$$

Since, $h_2 \approx h_1$

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

$$\eta_{th} = \frac{(h_5 - h_7) - m_1(h_6 - h_7)}{(h_5 - h_3)}$$ (neglecting pump work)