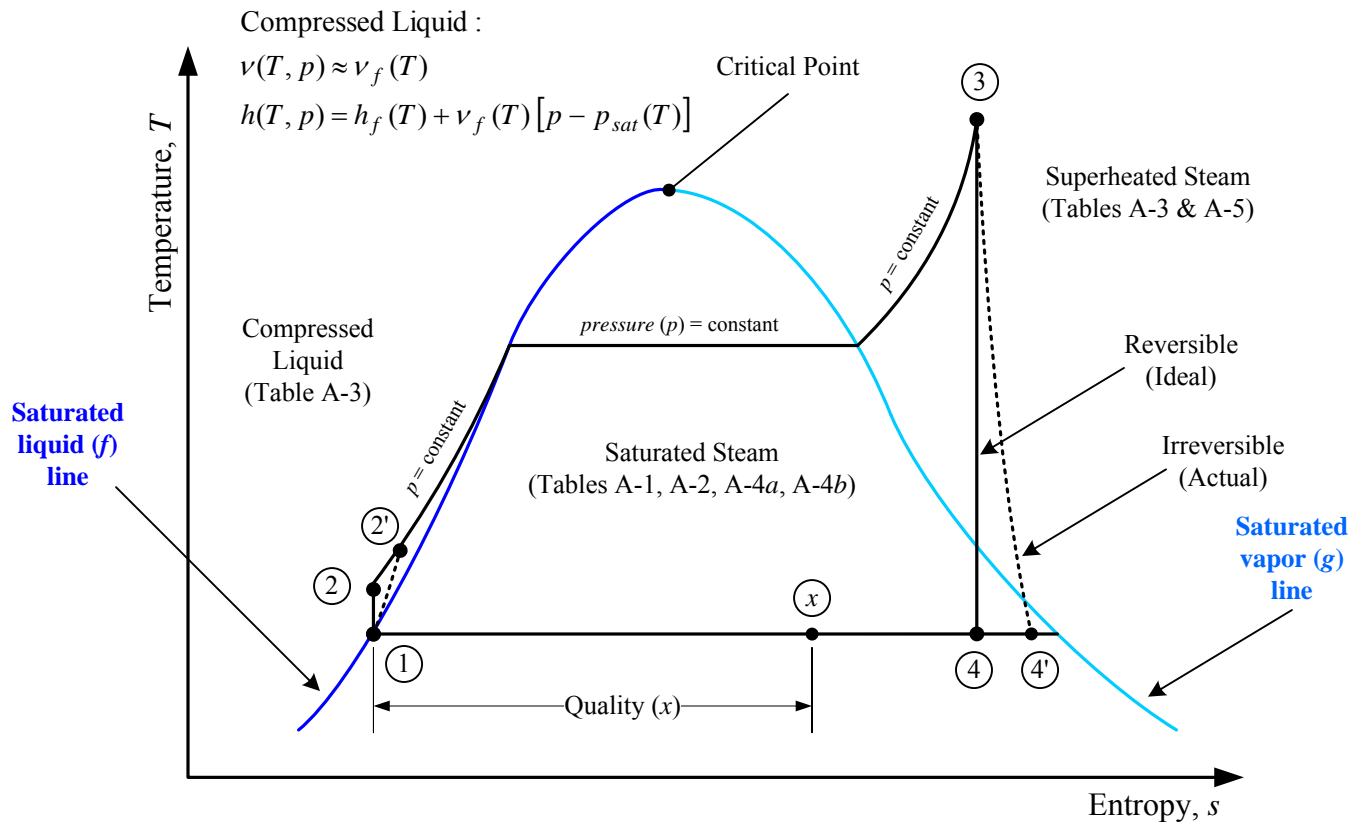


$$P_{net} = P_{gross} - \dot{W}_{pump} = \dot{W}_{turb} - \dot{W}_{pump}$$

mass flow rate :  $\dot{m}$

volume flow rate :  $G = v \dot{m} = \dot{m} / \rho$

$$\eta_{th} = \frac{P_{net}}{\dot{Q}_{add}} = \frac{W_{turb} - W_{pump}}{Q_{add}}$$



①→②; Pump: ( $Q = 0$ ;  $s_2 = s_1$ )

$$\dot{W}_{pump}^{ideal} = \dot{m} (h_2 - h_1) \cong \dot{m} v_1 (p_2 - p_1)$$

$$\dot{W}_{pump}^{actual} = \dot{m} (h_{2'} - h_1) \neq \dot{m} v_1 (p_{2'} - p_1)$$

$$\eta_{pump} = \frac{W_{pump}^{ideal}}{W_{pump}^{actual}} = \frac{\Delta h_{ideal}}{\Delta h_{actual}} = \frac{h_2 - h_1}{h_{2'} - h_1}$$

③→④; Turbine: ( $Q = 0$ ;  $s_4 = s_3$ )

$$\dot{W}_{turb}^{ideal} = \dot{m} (h_3 - h_4)$$

$$\dot{W}_{turb}^{actual} = \dot{m} (h_3 - h_{4'})$$

$$\eta_{turb} = \frac{W_{turb}^{actual}}{W_{turb}^{ideal}} = \frac{\Delta h_{actual}}{\Delta h_{ideal}} = \frac{h_3 - h_{4'}}{h_3 - h_4}$$

②→③; Heating: ( $W = 0$ )

$$\dot{Q}_{add} = \dot{m} (h_3 - h_{2'})$$

④→①; Condenser: ( $W = 0$ )

$$\dot{Q}_{cond} = \dot{m} (h_{4'} - h_1)$$

$$\text{Steam Quality : } x = \frac{\text{mass of vapor}}{\text{mass of liquid \& vapor}} = \frac{h_x - h_f}{h_g - h_f} = \frac{s_x - s_f}{s_g - s_f} = \frac{v_x - v_f}{v_g - v_f}$$