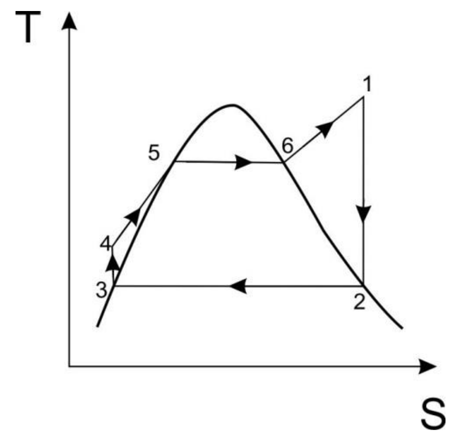
Example 2

Compare the Rankine cycle performance of example 1 with that obtained when steam is superheated to 500°C. Neglect the feed pump work.



$$h_{1@42bar} = 3442.7\,kJ/kg$$
$$s_{1@42bar} = 7.069\,kJ/kg$$

$$s_2 = s_{f2} + x_2 s_{fg2}$$
$$7.069 = 0.391 + x_2 8.13$$
$$x_2 = 0.821$$

$$h_2 = h_{f2} + x_2 h_{fg2}$$
$$= 111.8 + (0.821 \times 2438.53) = 2114.81\,kJ/kg$$

$$h_3 = 111.8\,kJ/kg$$
$$W_{12} = h_1 - h_2 = 3442.7 - 2114.81 = 1327.89\,kJ/kg$$

Neglecting feed pump
$$Q_{in} = h_1 - h_3 = 3330.9\,kJ/kg$$
$$\eta = \frac{h_1 - h_2}{h_1 - h_3} = \frac{3442.7 - 2114.81}{3442.7 - 111.8} = \frac{1327.89}{3330.9} = 0.399 @ 39.9\%$$

The thermal efficiency has increase due to superheating and improvement in SCC

$$SSC = \frac{3600}{W_{12}} = \frac{3600}{1327.89} = 2.71\,kg/kWhr$$

The condenser heat loads for different plants can be compared by calculating the rate of heat removal in the condenser, per unit power output.

Condenser heat load $= ssc \times (h_{2-h_3})$

With dry saturated steam at entry of turbine

Condenser heat load $= 3.64(1808 - 112) = 6175(kJ/h)/kW$

With supeheated steam at entry of turbine

Condenser heat load $= 2.71(2113 - 112) = 5420(kJ/h)/kW$