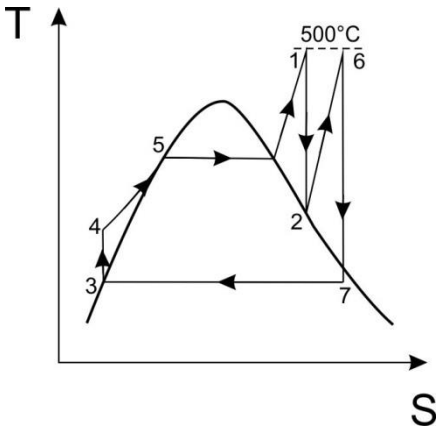
Example 3

Calculate the new cycle efficiency and specific steam consumption if reheat is included. The steam condition at the inlet to the turbine are 42 bar and 500°C, and the condenser pressure is 0.035bar. Assume that the steam is just dry saturated on leaving the first turbine, and is reheated to its initial temperature. Neglect the feed pump term.



$h_{1@500°C@42bar,\ superheated\ vapor} = 3442.7\,kJ/kg$

Considering;

$s_{1@500°C@42bar,\ superheated\ vapor} = s_2 = 7.069\,kJ/kg.K$

$h_{2,g@2.40bar@125.92°C} = 2714.29\,kJ/kg$

$h_{6@2.40bar@500°C,\ superheated\ vapor} = 3486.8\,kJ/kg$

$s_{6@2.40bar@500°C,\ superheated\ vapor} = 8.453\,kJ/kg.K$

Considering;

$s_6 = s_7 = 8.453\,kJ/kg.K$

$s_{7@0.035bar} = s_f + xs_g \Rightarrow 8.453 = 0.39067 + x8.52233 \Rightarrow x = 0.9460$

$h_{7@0.035bar} = h_f + xh_g \Rightarrow h_7 = 111.8 + (0.946 \times 2550.21) = 2524.30\,kJ/kg$

From example1

$h_3 = 111.8\,kJ/kg$

$$\text{Turbine work} = (h_1 - h_2) + (h_6 - h_7) = (3442.7 - 2714.29) + (3486.8 - 2524.47) = 1690.74\,\text{kJ/kg}$$
$$\text{Heat supply} = (h_1 - h_3) + (h_6 - h_2) = (3442.7 - 111.8) + (3486.8 - 2714.29) = 4103.41\,\text{kJ/kg}$$

$$\text{Cycle efficiency} = \frac{1690.74}{4103.41} = 0.412 \text{ or } 41.2\%$$

$$\text{SSC} = \frac{3600}{1690.74} = 2.1292\,\text{kg/kWhr}$$

Comparing these answers with the results of example 2 (2.71kg/kWhr, it can be seen that the SSC has been improved considerably by reheating. The effect of efficiency is very small (previously 39.9%). If reheating takes place at low pressure, then the thermal efficiency will be reduced by reheating, since the average temperature during heating will then be low.