

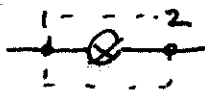
Thermo Quiz T3

16. Unified Sp 09 25

A:

a)  $T_1 = 400^\circ\text{C}$   $\rightarrow h_1 = 3040 \text{ kJ/kg}$  (superheated steam)  
 $p_1 = 12.5 \text{ MPa}$   $s_1 = 6.0417 \text{ kJ/kg-K}$

1st law:  $h_2 = h_1$  (no work, no heat transfer)

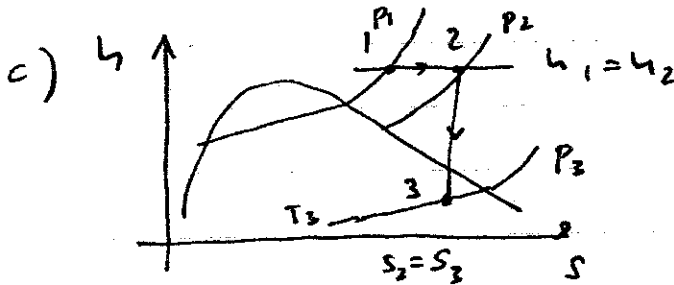


so  $h_2 = 3040 \text{ kJ/kg}$

Note:  $T_2 \neq T_1$  since not an ideal gas with  $c_p = \text{const}$

b)  $p_2 = 1.4 \text{ MPa}$   $\rightarrow T_2 = 300^\circ\text{C}$   
 $h_2 = 3040 \text{ kJ/kg}$   $s_2 = 6.9534 \text{ kJ/kg-K}$

2nd law:  $\Delta S_{\text{tot}} = \Delta S_{12} = \Delta S_{\text{gen}} = s_2 - s_1 \rightarrow \Delta S_{\text{gen}} = 0.9117 \text{ kJ/kg-K}$



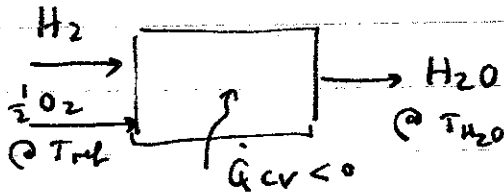
d)  $s_2 = s_3 = s_g(T_3)x_3 + (1-x_3)s_f(T_3)$

$s_g(T_3) = 7.1296 \text{ kJ/kg-K}$

$s_f(T_3) = 1.5276 \text{ kJ/kg-K}$

$\rightarrow x_3 = \frac{s_2 - s_f}{s_g - s_f} \quad x_3 = 0.968$

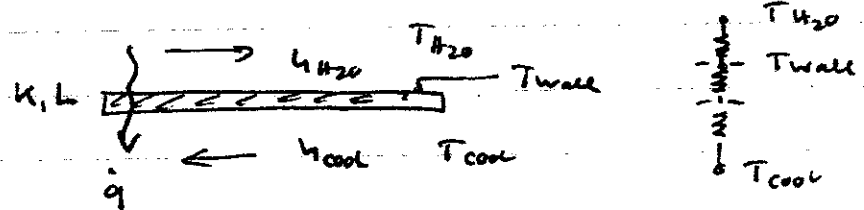
B:



$\sum_R \dot{n}_i (h_i^0 + \Delta h_i)_i + \dot{Q}_{cv} = \sum_P \dot{n}_e (h_e^0 + \Delta h_e)_e$

a)  $\dot{Q}_{cv} = 1 \cdot h_{f, \text{H}_2\text{O}}^0 + 1 \cdot \bar{c}_{p, \text{H}_2\text{O}} (T_{\text{H}_2\text{O}} - T_{\text{mf}}) \rightarrow T_{\text{H}_2\text{O}} = T_{\text{mf}} + \frac{\dot{Q}_{cv} - h_{f, \text{H}_2\text{O}}^0}{\bar{c}_{p, \text{H}_2\text{O}}}$

$T_{\text{H}_2\text{O}} = 2799 \text{ K}$



b) 1st law:  $\dot{q} = \text{const}$   
 $\dot{q} = h_{\text{H}_2\text{O}} (T_{\text{H}_2\text{O}} - T_{\text{wall}})$   
 $\dot{q} = 89.962 \text{ W/m}^2$

c)  $\dot{q} = \frac{T_{\text{wall}} - T_{\text{cool}}}{R_{\text{wall}} + R_{\text{cool}}} = \frac{T_{\text{wall}} - T_{\text{cool}}}{L/k + 1/h_{\text{cool}}}$

$T_{\text{cool}} = 377.8 \text{ K}$

$T_{\text{cool}} = T_{\text{wall}} - \dot{q} (L/k + 1/h_{\text{cool}})$