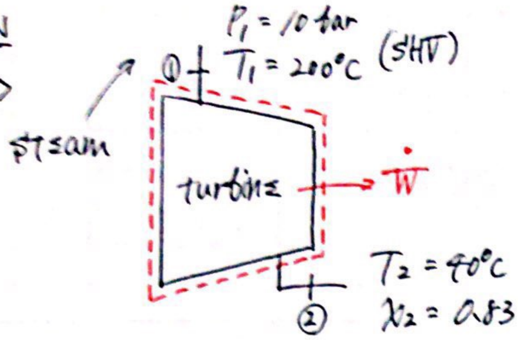
(1)

GIVEN

<EFD>



FIND

(a) The power generated by the turbine, $\dot{w}$, kJ/kg

(b) Δs, kJ/kg-K

ASSUMP

- open sys, $\dot{Q} = 0$, $\Delta KE = \Delta PE = 0$, SSSF, 1DUF

EQN $\cancelto{0}{\frac{dm}{dt}\Big|_{sys}} = \sum_i \dot{m} - \sum_e \dot{m}$, $\cancelto{0}{\frac{dE}{dt}\Big|_{sys}} = \cancelto{0}{\dot{Q}} - \dot{W} + \sum_i \dot{m}(h + \cancelto{0}{pe} + \cancelto{0}{ke}) - \sum_e \dot{m}(h + \cancelto{0}{pe} + \cancelto{0}{ke})$

SOLN

the mass flow rate is constant $\dot{m}_1 = \dot{m}_2 = \dot{m}$

@ state 1 from tables $h_1 = 2828.3$ kJ/kg, $s_1 = 6.696$ kJ/kg-K

@ state 2 $h_f|_{T=40} = 167.53$, $h_g|_{T=40} = 2573.5$ kJ/kg

$s_f|_{T=40} = 0.572400$ kJ/kg-K , $s_g|_{T=40} = 8.2555$ kJ/kg-K

since x_2 is given

$$h_2 = h_f|_{T=40} + (h_g|_{T=40} - h_f|_{T=40})x_2 \simeq 2164.49 \text{ kJ/kg}$$

$$s_2 = s_f|_{T=40} + (s_g|_{T=40} - s_f|_{T=40})x_2 = 6.949373 \text{ kJ/kg-K}$$

(a) $\dot{w} = h_1 - h_2 = 2828.3 \text{ kJ/kg} - 2164.49 \text{ kJ/kg} = 663.81 \text{ kJ/kg}$

$$\boxed{\dot{w} = 664 \text{ kJ/kg}}$$

(b) $\Delta s = s_2 - s_1 = 6.949373 \text{ kJ/kg-K} - 6.696 \text{ kJ/kg-K}$

$= 0.253373$ kJ/kg-K

$$\boxed{\Delta s = 0.25337 \text{ kJ/kg-K}}$$

Scanned with CamScanner

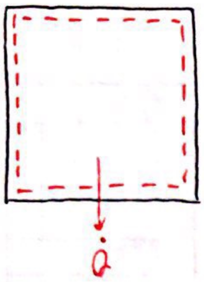
(ii)

GIVEN

rigid tank

water

<EFD>



$p_1 = 100\,kPa = 1\,bar$

$T_1 = 440°C$

$p_2 = 20\,kPa = 0.2\,bar$

FIND

Δs and show T-v, T-s diagrams

ASSUMP

closed sys, rigid tank, iso-vol, $\Delta PE = \Delta KE = 0$, no work

EQN

$$\cancel{\left.\frac{dm}{dt}\right|_{sys}}^{0} = \cancel{\sum_i \dot{m}}^{0} - \cancel{\sum_e \dot{m}}^{0}, \quad \left.\frac{dE}{dt}\right|_{sys} = \dot{Q} - \cancel{\dot{W}}^{0} + \cancel{\sum_i \dot{m}}^{0}(h + \cancel{pe}^{0} + \cancel{ke}^{0}) - \cancel{\sum_e \dot{m}}^{0}(h + \cancel{pe}^{0} + \cancel{ke}^{0})$$

$$\Delta U = Q - \cancel{W}^{0}$$

SOLN

from table for state ①

$$s_1 = 8.665\ kJ/kg\text{-}K, \quad u_1 = 3033.1\ kJ/kg, \quad v_1 = 3.28790\ m^3/kg$$

for state ②

$$v_1 = v_2 \quad (\text{const. vol})$$

$$P_2 = 0.2\ bar$$

comparing

$$v_g|_{p=0.2} = 7.6480\ m^3/kg > v_2$$

$$v_f|_{p=0.2} = 0.0010172\ m^3/kg$$

then

$$x_2 = \frac{v_2 - v_f|_{p=0.2}}{v_g|_{p=0.2} - v_f|_{p=0.2}} = \frac{3.28790 - 0.0010172}{7.6480 - 0.0010172} \cong 0.4298$$

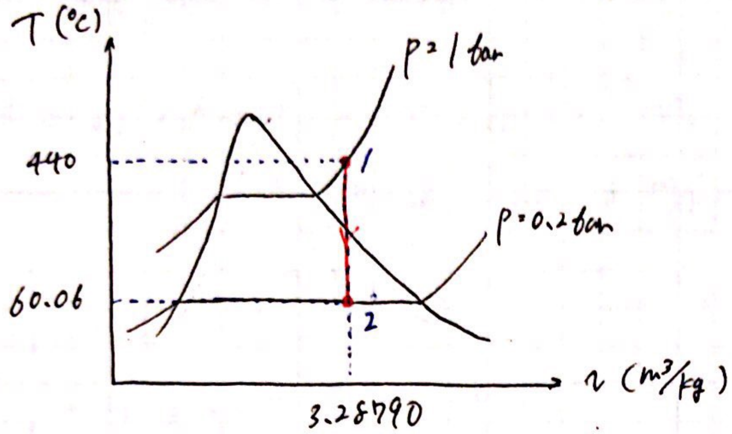
thus

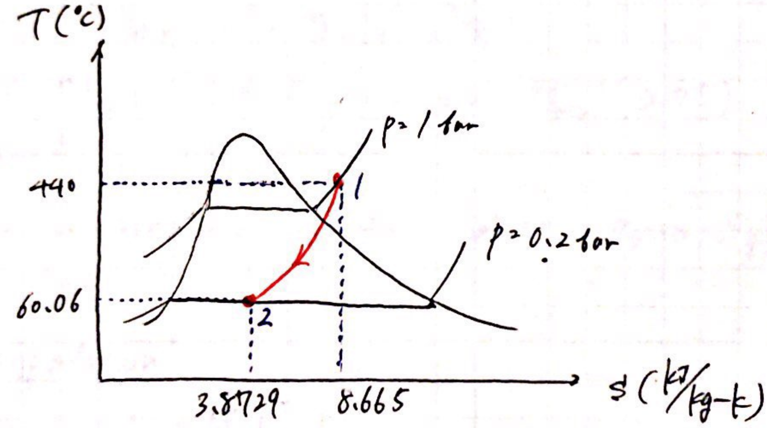
$$s_2 = s_f|_{p=0.2} + (s_g|_{p=0.2} - s_f|_{p=0.2})\,x_2$$

$$= 0.83202\ kJ/kg\text{-}K + (7.9072\ kJ/kg\text{-}K - 0.83202\ kJ/kg\text{-}K)(0.4298)$$

$$\cong 3.872932\ kJ/kg\text{-}K$$

$$\Delta s = s_2 - s_1 \cong \boxed{-4.7921\ kJ/kg\text{-}K}$$


T (°C)
p = 1 bar
440
1
p = 0.2 bar
60.06
2
v (m³/kg)
3.28790


T (°C)
p = 1 bar
440
1
p = 0.2 bar
60.06
2
3.8729
8.665
s (kJ/kg-K)