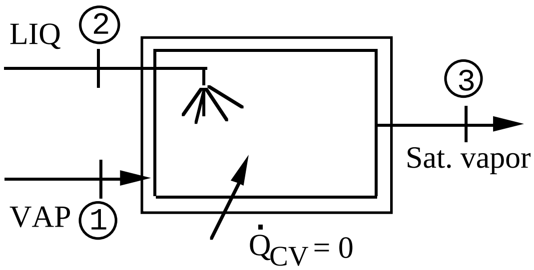
ME 24-221
Thermodynamics I

Solution to Assignment No: 6
Due Date: 20 October 2000
Fall 2000
Instructor: J.Murthy

Pb# 6.8



Cont.: $\dot{m}_1 + \dot{m}_2 = \dot{m}_3$

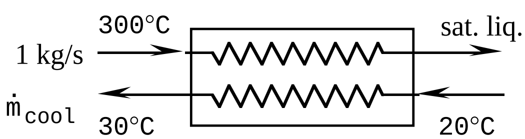
Energy Eq.:

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3$$

$$0.5 \times 3195.7 + \dot{m}_2 \times 171.97 = (0.5 + \dot{m}_2)\, 2797.9$$

$$\Rightarrow \quad \dot{m}_2 = \mathbf{0.0757\ kg/s}$$

Pb#6.14



C.V. Heat exchanger

$$\dot{m}_{cool} h_{20} + \dot{m}_{H_2O} h_{300} = \dot{m}_{cool} h_{30} + \dot{m}_{H_2O} h_{f\ 10kPa}$$

Table B.1.1: $h_{20} = 83.96$ kJ/kg , $h_{30} = 125.79$ kJ/kg

Table B.1.3: $h_{300,\ 10kPa} = 3076.5$ kJ/kg, B.1.2: $h_{f,\ 10\ kPa} = 191.83$ kJ/kg

$$\dot{m}_{cool} = \dot{m}_{H_2O} \frac{h_{300} - h_{f,\ 10kPa}}{h_{30} - h_{20}} = 1 \times \frac{3076.5 - 191.83}{125.79 - 83.96} = \mathbf{69\ kg/s}$$

Pb# 6.20

$$\dot{m}_i = A_i \mathbf{V}_i / v_i = \dot{m}_e = A_e \mathbf{V}_e / v_e, \quad h_i + (1/2)\mathbf{V}_i^2 = h_e + (1/2)\mathbf{V}_e^2$$

$$h_e - h_i = (1/2) \times 200^2/1000 - (1/2) \times 20^2/1000 = 19.8 \text{ kJ/kg}$$

$$T_e = T_i + 19.8/1.35 = \mathbf{319.73\ K}$$

$$v_e = v_i (A_e \mathbf{V}_e / A_i \mathbf{V}_i) = (RT_i/P_i)\,(A_e \mathbf{V}_e / A_i \mathbf{V}_i) = RT_e/P_e$$

$$P_e = P_i (T_e/T_i)\,(A_i \mathbf{V}_i / A_e \mathbf{V}_e)$$

$$= 100(319.73/300)\,(100 \times 200)/(860 \times 20) = \mathbf{123.93\ kPa}$$

Pb# 6.23

C.V. Throttle. SSSF, Process with: $q = w = 0$;

Energy Eq.: $h_i = h_e$, Ideal gas => $T_i = T_e =$ **20°C**

$\dot{m} = \frac{A\mathbf{V}}{RT/P}$ But $\dot{m}$, $\mathbf{V}$, T are constant => $P_iA_i = P_eA_e$

$$\Rightarrow \quad \frac{D_e}{D_i} = \left(\frac{P_i}{P_e}\right)^{1/2} = \left(\frac{1.2}{0.1}\right)^{1/2} = \mathbf{3.464}$$

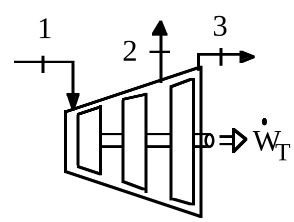
Pb# 6.29

C.V. Turbine SSSF, 1 inlet and 2 exit flows.

Table B.1.3 $h_1 = 3582.3$ kJ/kg, $h_2 = 3137$ kJ/kg

Table B.1.2 : $h_3 = h_f + x_3h_{fg} = 384.3 + 0.95\times2278.6$

$= 2549.1$ kJ/kg



Cont.: $\dot{m}_1 = \dot{m}_2 + \dot{m}_3$; Energy: $\dot{m}_1h_1 = \dot{W}_T + \dot{m}_2h_2 + \dot{m}_3h_3$

$\dot{m}_3 = \dot{m}_1 - \dot{m}_2 = 80$ kg/s , $\dot{W}_T = \dot{m}_1h_1 - \dot{m}_2h_2 - \dot{m}_3h_3 =$ **91.565 MW**

Pb# 6.36

C.V. Compressor, SSSF energy Eq.: $q + h_i + \mathbf{V}_i^2/2 = h_e + \mathbf{V}_e^2/2 + w$

Here $q \cong 0$ and $\mathbf{V}_i \cong 0$ so for const C_{Po}

$$-w = C_{Po}(T_e - T_e) + \mathbf{V}_e^2/2 = 1.004(430 - 20) + \frac{(90)^2}{2 \times 1000} = 415.5 \text{ kJ/kg}$$

$$\dot{m} = \frac{5000}{415.5} = \mathbf{12.0\ kg/s}$$