ME 24-221
Thermodynamics I

Solution to Assignment No: 7
Due Date: 27 October 2000
Fall 2000
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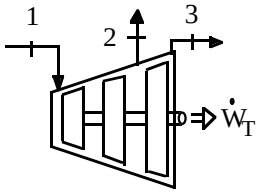
Pb# 6.41

Supply state 1: 20 kg/s at 10 MPa, 500C
Process steam 2: 5 kg/s, 0.5 MPa, 155 C,
Exit state 3: 20 kPa, x = 0.9
Table B.1: $h_1 = 3373.7$, $h_2 = 2755.9$,
$h_3 = 251.4 + 0.9 \times 2358.3 = 2373.9$



Energy Eq.: $\dot{Q}_{CV} + \dot{m}_1 h_1 = \dot{m}_2 h_2 + \dot{m}_3 h_3 + \dot{W}_{CV}$;

$\dot{W}_{CV} = 20 \times 3373.7 - 5 \times 2755.9 - 15 \times 2373.9 =$ **18.084 MW**

Pb# 6.46

$h_1 = 763.5 = 604.74 + x \times 2133.8 \Rightarrow \quad x = 0.07439 = \dot{m}_2/\dot{m}_1$

Table B.1.2: $h_2 = 2738.6$; $h_3 = 191.83 + 0.9 \times 2392.8 = 2345.4$

$\dot{W} = \dot{m}_2(h_2 - h_3) \qquad \dot{m}_2 = \dfrac{1000}{2738.6 - 2345.4} = 2.543$

$\Rightarrow \dot{m}_1 = 34.19$ kg/s = **123075 kg/h**

Pb# 6.47

a) CV: Compressor

$\dot{Q}_{COMP} = \dot{m}(h_1 - h_e) + \dot{W}_{COMP}$

$= 0.05(260.023 - 191.009) - 4.0 =$ **-0.549 kW**

b) CV: Condenser

$\dot{Q}_{COND} = \dot{m}(h_3 - h_2) = 0.05(79.647 - 252.720) =$ **-8.654 kW**

c) CV: Evaporator $h_4 = h_3 = 79.647$ (from valve)

$\dot{Q}_{EVAP} = \dot{m}(h_5 - h_4) = 0.05(187.583 - 79.647) =$ **5.397 kW**

Pb# 6.48

1 : 1 MPa, 200°C, $m_1 = P_1V_1/RT_1 = 1000 \times 0.1/(0.287 \times 473.1) = 0.736$ kg

2 : 100 kPa, 50°C, $m_2 = P_2V_2/RT_2 = 100 \times 0.1/(0.287 \times 323.1) = 0.1078$ kg

$m_{ex} = m_1 - m_2 = 0.628$ kg, $\quad m_2u_2 - m_1u_1 = - m_{ex}\, h_{ex} + {}_1Q_2$

Table A.7: $u_1 = 340.0$ kJ/kg, $u_2 = 231.0$ kJ/kg,

$h_{e\ ave} = (h_1 + h_2)/2 = (475.8 + 323.75)/2 = 399.8$ kJ/kg

${}_1Q_2 = 0.1078 \times 231.0 - 0.736 \times 340.0 + 0.628 \times 399.8 =$ **+25.7 kJ**

Pb# 6.52

C.V. turbine & tank $\Rightarrow$ USUF

Conservation of mass: $m_i = m_2 \Rightarrow m$

Energy Eq: $m_ih_i = m_2u_2 + W_{CV}$; $W_{CV} = m(h_i - u_2)$

Table B.6 : i : $P_i = 0.5$ MPa, $T_i = 300$K, Nitrogen; $h_i = 310.276$ kJ/kg

2: $P_2 = 0.5$ MPa, $T_2 = 250$ K, $u_2 = h_2 - P_2v_2$

$u_2 = 257.799 - 500(0.14782) = 180.89$ kJ/kg

$m_2 = V/v_2 = 50/0.14782 = 338.25$ kg

$W_{CV} = 338.25(310.276 - 180.89) = 43764.8$ kJ = **43.765 MJ**

Pb# 6.58

1st law: $m_ih_i = (m_2u_2 - m_1u_1)_{AIR} + m_{ST}(u_2 - u_1)_{ST}$

$$m_{1\ AIR} = \frac{P_1V}{RT_1} = \frac{500 \text{ x } 1}{0.287 \text{ x } 293.2} = 5.94 \text{ kg}$$

$$m_{2\ AIR} = \frac{P_2V}{RT_2} = \frac{1500 \text{ x } 1}{0.287 \text{ x } T_2}$$

$m_i = (m_2 - m_1)_{AIR} = (5226.5/T_2) - 5.94$

$$[(5226.5/T_2) - 5.94] \text{ x } 1.004 \text{ x } 293.15 = \frac{5226.5}{T_2} \text{ x } 0.717 \text{ x } T_2$$

$$- 5.94 \text{ x } 0.717 \text{ x } 293.15 + 40 \text{ x } 0.48\ (T_2 - 293.15)$$

Solving, $T_2 = 321.3$ K = **48.1°C**