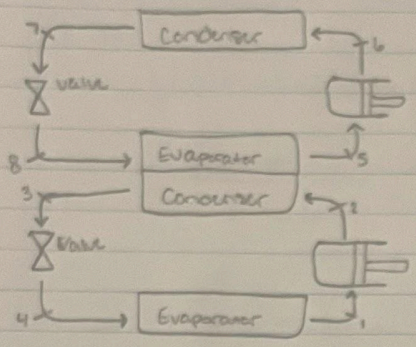
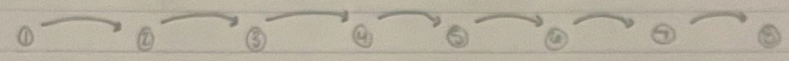
Homework 3.2 MET 850





$h_1 = 240.14$ kJ/kg $P_1 = 500$ kpa $h_2 = 273.32$ kJ/kg $= h_4$ $P_2 = 1400$ kpa $m = 127.25$ $h_8 = h_7$

$P_1 = 1400$ kpa $s_2 = s_1$ $h_4 = h_5$ $h_5 = 255.61$ kJ/kg $s_6 = s_5$ $P_7 = 1400$ kpa

$h_8 = 270.41$ kJ/kg $s_5 = .9271$ kJ/kg $h_6 = 281.56$ kJ/kg

$h_{f8} = 264.55$ kJ/kg $m_B = 285.04$

A) $m_A(h_5 - h_8) = m_B(h_2 - h_3)$

$m_A(255.61 - 127.25) = (.11)(270.41 - 73.32) = .1689$ kg/s $= m_A$

B) $Q_L = m_B(h_1 - h_4)$ = plug and chug

$Q_L = 18.46$ kW

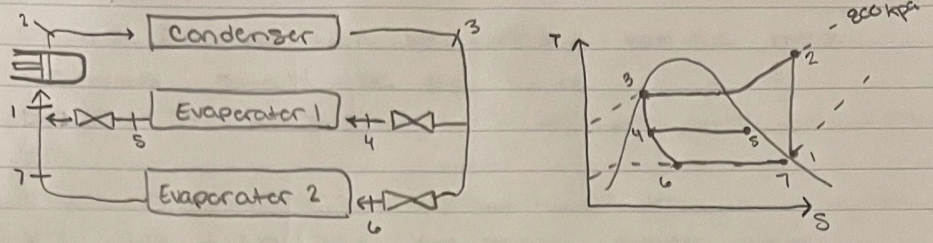
C) $W_m = m_B(h_6 - h_5) + m_B(h_2 - h_1)$

$W_m = 8.698$ kW

But $COP = Q_L / W_m$

$COP = \frac{18.46}{8.698} = 2.12$ = COP

11-60



①	②	③	④	⑤	⑥	⑦
$P_1 = 100$ kPa	$P_2 = 800$ kPa	$P_3 = 800$ kPa	$h_4 = h_6 = h_3$	$T_5 = 0$	$h_4 = 95.81$	$T_7 = -26.4°C$
$h_1 = 241.26$	$s_2 = s_1$	$h_3 = 95.81$ kJ/kg	$h_4 = 95.81$	$h_5 = 250.50$		$h_7 = 234.44$
$s_1 = .9941$	$h_2 = 286.26$					

Mass flow Rate

$$Q_L = m_2(h_7 - h_6) \rightarrow m_2 = \frac{Q_L}{h_7 - h_6}$$

$$Q_L = .05757 \text{ kg/s}$$

$$m_1 = m - m_2 = .1 - .05757 = .04243 \text{ kg/s}$$

$$m_1 h_5 + m_2 h_7 = m h_1 \quad = h_1 = \frac{m_1 h_5 + m_2 h_7}{m}$$

$$h_1 = 241.26 \text{ kJ/kg}$$

Cooling Rate $Q_L = m_1(h_5 - h_4) = \boxed{6.57 \text{ kW}}$

Power $W_{in} = m(h_2 - h_1) = \boxed{4.506 \text{ kW}}$

COP $COP = Q_L / W_{in} = 8 + 6.57 / 4.506 = \boxed{8.24}$

13-1 → 13-13

1) the mole fractions will be different but the mass fractions should be the same

2) yes

3) yes, CO_2 + N_2O have the same molar mass which is equal to 44 kg/mol

4) No, they have to be the same mol fraction

5) No, if the average molar mass equal to the mixture

6) $m_{fA} = \frac{m_A}{m_m} = \frac{N_A M_A}{N_m m_m}$ therefore $y_A \frac{M_A}{m_m}$, $m_{fA} = m_{fB}$

$M_m = \frac{m_m}{N_m} = y_A M_A + y_B M_B$

$y_B = \frac{m_B}{m_{AL}(1/m_{fA} - 1) + m_B}$ $y_B = 1 - y_A$

8) Molar Mass $m = \sum y_M = .78(28) + .20(32) + .02(18) = 28.6$ kg/mol

$N_2 \rightarrow 28$

$O_2 \rightarrow 32$

$H_2O \rightarrow 18$

Equation = $m_f = y\frac{M}{M}$ $.78\ \frac{28}{28.6} = .764$ or $76.4 = N_2$

$.20\ \frac{32}{28.6} = .224$ or $22.4\% = O_2$

$.02\ \frac{18}{28.6} = .013$ or $1.3\% = H_2O$

9) Molar mass

$N_2 = 28$ $N_2 = 60(28) = 1680$ $m_m = m_{N_2} + m_{O_2} = 3440$ kg

$CO_2 = 44$ $CO_2 = 44(40) = 1760$

$m_{fN_2} = \frac{1680}{3440} = 48.8\%$

$m_{fO_2} = \frac{1760}{3440} = 51.2\%$

$M_m = \frac{3440}{100} = 34.40$ kg/mol

$R_m = \frac{R_u}{M_m} = \frac{8.314}{34.4} = .242$ kJ/kgK

10) Molar Mass

$O_2 = 32$ $N_{O_2} = 60(32) = 1920$ kg

$CO_2 = 44$ $N_{CO_2} = 40(44) = 1760$ kg $\rightarrow$ Add = 3680 kg

$m_{fO_2} = 1920/3680 = 52.2\%$ $\quad Mm = 3680/100 = 36.80$ g/mol

$m_{fCO_2} = 1760/3680 = 47.8\%$ $\quad R_m = 8.314/36.8 = .226$ kJ/kgK

11) Molar Mass total mass given = 14 kg mole fraction

$O_2 = 32$ $\quad m_{fO_2} = 2/14 = .1429$ $\quad O_2 = 2/32 = .0625$ kmol

$N_2 = 28$ $\quad m_{fN_2} = 5/14 = .3571$ $\quad N_2 = 5/28 = .1781$ kmol

$CO_2 = 44$ $\quad m_{fCO_2} = 7/14 = .5$ $\quad CO_2 = 7/44 = .1591$ kmol

N_m total = .4002 kmol $\quad y_{O_2} = .0625/.4002 = .1562$ $\quad Mm = 14/.4002 = 34.99$ kg/mol

$y_{N_2} = .1781/.4002 = .4492$ $\quad R_m = 8.314/34.99 = .2376$ kJ/kgK

$y_{CO_2} = .1591/.4002 = .3976$

12) Molar Mass

$CH_4 = 16.0$ $\quad C_{H_4} = 75\text{kg}/16 = 4.66$ kmol $\quad$ total = 5.256 kmol

$CO_2 = 44.0$ $\quad C_{O_2} = 25/44 = .568$ kmol

Mole fraction $\quad C_{H_4} = 4.68/5.256 = .892 = 89.2\%$ $\quad Mm = 100/5.256 = 19.03$

$C_{O_2} = .568/5.256 = .102 = 10.2\%$ $\quad R_m = 8.314/19.03 = .437$ kJ/kgK

13) Molar Mass

$H_2 = 2$ $\quad H_2 = 6(2) = 12$ kg

$N_2 = 28$ $\quad N_2 = 2(28) = 56$ kg

total mass and moles

$Mm = 12 + 56 = 68$ kg

$Nm = 6 + 2 = 8$ mols

$Mm = 68/8 = 8.5$ kg/k mol

$R_m = 8.314/8.5 = .978$ kJ/kgK