Colby Watts & Gabriel Torres

330 HW 3.3

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CH 13 - 30

$$\frac{P_i}{P_m} = y_i \qquad mf_i = y_i \frac{M_i}{M_m}$$

TOTAL kPa = 100 kPa

$$C_p - C_v = R$$

CO_2 = 20 kPa $\boxed{y_{CO_2} = \frac{20}{100} \text{ kPa} = 0.2}$

$$C_{p_m} = \sum_{i=1}^{k} mf_i C_{p_i}$$

O_2 = 30 kPa $\boxed{y_{O_2} = \frac{30}{100} = .3}$

$$C_{p_m} = mf_{CO_2} C_{p_{CO_2}} + mf_{O_2} C_{p_{O_2}} + mf_{N_2} C_{p_{N_2}}$$

N_2 = 50 kPa $\boxed{y_{N_2} = \frac{50}{100} = .5}$

MOLAR MASS

CO_2 = 44.01 g/mol

O_2 = 32 g/mol

N_2 = 28.02 g/mol

$$M_m = [(.2)(44.01)] + [(.3)(32)] + [(.5)(28.02)]$$

$$\boxed{M_m = 32.41 \text{ g/mol}}$$

$$R_m = \frac{R_u}{M_m} = \frac{8.31447}{32.41}$$

$$\boxed{R_m = 0.2565 \text{ kJ/kmol K}}$$

$$\boxed{mf_{CO_2} = (0.2)\frac{44.01}{32.41} = 0.272}$$

$$\boxed{mf_{O_2} = (.3)\frac{32}{32.41} = 0.296}$$

$$\boxed{mf_{N_2} = (.5)\frac{28.02}{32.41} = 0.432}$$

$$C_{p_m} = (.272)(0.846) + (.296)(.918) + (.432)(1.039)$$

$$C_{p_m} = 0.9507$$

$$C_v = -R_m + C_{p_m} = 0.2565 + 0.9507$$

$$\boxed{C_v = 0.6942 \text{ kJ/kg K}}$$

$$\boxed{k = \frac{C_p}{C_v} = \frac{0.9507}{0.6942} = 1.369}$$

CH 13 - 39

Methane (CH_4) ~~mf~~ $y_{CH_4} = 15\%$ OR .15

$V = 5L$ OR $0.005 m^3$ $\qquad y_{AIR} = 85\%$ OR .85

$P = 80 kPa$

$T = 20°C$ OR $293.15 K$ $\qquad n = 3000$

$M_{CH_4} = 16.043 \frac{kg}{kmol}$ AND $M_{AIR} = 28.97 \frac{kg}{kmol}$

$$M_m = y_{CH_4} M_{CH_4} + y_{AIR} M_{AIR}$$

$$M_m = (0.15)(16.043) + (28.97)(.85)$$

$$M_m = 27.03$$

$$\dot{V} = \frac{nV}{2} = \frac{(3000)(0.005)}{2} \Rightarrow \dot{V} = 7.5 \frac{m^3}{m}$$

specific volume

$$v = \frac{R_u T}{M_m P} = \frac{(8.31447)(293.15)}{(27.03)(80)} \qquad v = 1.127 \frac{m^3}{kg}$$

$$\dot{m} = \frac{\dot{V}}{v} = \frac{7.5}{1.127}$$

$$\boxed{\dot{m} = 6.65 \text{ kg/min}}$$

HW 3.3

Colby Watts

13-54

Ne	Ar
100 kPa	200 kPa
20°C	50°C

15 kJ

$$N_{Ne} = \left(\frac{P_1 V_1}{R_u T_1}\right)_{Ne} = \frac{(100\ \text{kPa})(0.45\ \text{m}^3)}{(8.314\ \text{kPa}\cdot\text{m}^3/\text{kmol}\cdot\text{K})(293\ \text{K})}$$

$$N_{Ne} = 0.0185\ \text{kmol}$$

$$N_{Ar} = \left(\frac{P_1 V_1}{R_u T_1}\right)_{Ar} = \frac{(200\ \text{kPa})(0.45\ \text{m}^3)}{(8.314\ \text{kPa}\cdot\text{m}^3/\text{kmol}\cdot\text{K})(323\ \text{K})}$$

$$N_{Ar} = 0.0335\ \text{kmol}$$

$$N_m = N_{Ne} + N_{Ar} = 0.0185 + 0.0335$$

$$N_m = 0.0520\ \text{kmol}$$

$$E_{in} - E_{out} = \Delta E_{system}$$

$$-Q_{out} = \Delta U = \Delta U_{Ne} + \Delta U_{Ar} \rightarrow -Q_{out} = [mc_v(T_m - T_1)] + [mc_v(T_m - T_1)]_{Ar}$$

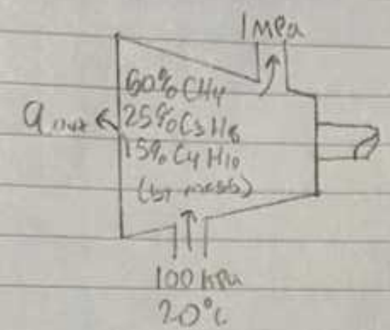
$$-15\ \text{kJ} = (0.0185 \cdot 20.18\ \text{kg})(0.6179\ \text{kJ/kg}\cdot{}^\circ\text{C})(T_m - 20^\circ\text{C})$$
$$+ (0.0335 \cdot 39.95\ \text{kg})(0.3122\ \text{kJ/kg}\cdot{}^\circ\text{C})(T_m - 50^\circ\text{C})$$

$T_m = \underline{16.2^\circ\text{C}}$ or $289.2\ \text{K}$

$$P_m = \frac{N_m R_u T_m}{V_m} = \frac{(0.052\ \text{kmol})(8.314\ \text{kPa}\cdot\text{m}^3/\text{kmol}\cdot\text{K})(289.2\ \text{K})}{0.9\ \text{m}^3}$$

$P_m = \underline{138.9\ \text{kPa}}$

13-59



$$N_{CH_4} = \frac{m_{CH_4}}{M_{CH_4}} = \frac{60\,kg}{16\,kg/mol} = 3.75\ kmol$$

$$N_{C_3H_8} = \frac{m_{C_3H_8}}{M_{C_3H_8}} = \frac{25\,kg}{44\,kg/mol} = 0.5682\ kmol$$

$$N_{C_4H_{10}} = \frac{m_{C_4H_{10}}}{M_{C_4H_{10}}} = \frac{15\,kg}{58\,kg/mol} = 0.2586\ kmol$$

$$N_m = N_{CH_4} + N_{C_3H_8} + N_{C_4H_{10}}$$
$$= 3.75 + 0.5682 + 0.2586 = 4.5768\ kmol$$

$$M_m = \frac{m_m}{N_m} = \frac{100\,kg}{4.5768\,kmol} = 21.85\ kg/mol$$

$$R = \frac{R_u}{M_m} = \frac{8.314\ kJ/kmol\cdot K}{21.85\ kg/kmol} = 0.3805\ kJ/kg\cdot K$$

$$w_{in} = RT\ln\left(\frac{P_2}{P_1}\right) = (0.3805\ kJ/kg\cdot K)(293\,K)\ln\left(\frac{1000\,kPa}{100\,kPa}\right)$$
$$= 257\ kJ/kg$$

$$w_{in} - q_{out} = c_p(T_2 - T_1) = 0 \qquad T_2 = T_1$$

$$q_{out} = w_{in} = \underline{257\ kJ/kg}$$