HW 3.3

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13-13)

$m_{H2} = 6\,kmol\,(2\,kg/kmol)$

$\boxed{m_{H2} = 12kg}$

$m_{N2} = 2kmol\,(28\,kg/kmol)$

$\boxed{m_{N2} = 56\,kg}$

total Mass : $12kg + 56kg = 68kg$

total moles : $6kmol + 2\,Kmol = 8\,kmol$

Apparent molar mass $= \frac{68kg}{8kmol} = 8.5\,kg/kmol$

Apparent Gas Constant: $\frac{8.314\,kJ/kmol\,k}{8.5\,kg/kmol} = \boxed{0.978\,kJ/kg\cdot k}$

13-30)

$CO_2 = 20/100 = 0.2$
$O_2 = 30/100 = 0.3$
$N_2 = 50/100 = 0.5$

$M_{CO2} = 44.01\ kg/kmol$ $M_{O2} = 32\ kg/kmol$ $M_{N2} = 28.01\ kg/kmol$

$M_{mix} = (0.2)(44.01) + (0.3)(32) + (0.5)(28.01) = \boxed{32.41\ kg/kmol}$

CO_2: $mF_{CO2} = ((0.2)(44.01)) / 32.41 = 0.2716$

O_2: $mF_{O2} = ((0.3)(32)) / 32.41 = 0.2962$

N_2: $mF_{N2} = ((0.5)(28.01)) / 32.41 = 0.4322$

Apparent Gas Constant

$R_{mix} = 8.314 / 32.41$
$= \boxed{0.2566\ kJ/kg \cdot K}$

Specific Heat ratio at 300k

$Cv = (0.271)(0.657) + (0.296)(0.658) + (0.432)(0.743)$
$= 0.6945$

$C_{Pmix} = 0.694 + 0.256$
$= 0.9511\ kJ/kg \cdot K$

Specific heat ratio: $\frac{0.9511}{0.6945} = \boxed{1.369}$

13-39)

$N = 3000\ rpm$

$Disp = 0.005 m^3$

$P = 80\ kPa$

$T = 293.15 K$

$$V = \frac{N}{2}(V_{disp}) = \frac{3000\ rpm}{2}(0.005 m^3)$$

$$V = 7.5\ m^3/min$$

$$\dot{n} = \frac{PV}{R_u T} = \frac{80\ kPa(7.5\ m^3/min)}{8.314\ kPa\ (m^3/kmol)\cdot K\ (293.15 K)}$$

$$\dot{n} = 0.2461\ kmol/min$$

Molar mass: $M_{CH_4} = 16.04\ kg/kmol$ $M_{air} = 28.97\ kg/kmol$

$$M_m = (0.15)(16.04) + (0.85)(28.97)$$

$$M_m = 2.406 + 24.624$$

$$M_m = 27.031\ kg/kmol$$

$$\dot{m} = (0.2461\ kmol/min)(27.031\ kg/mol)$$

$$\boxed{\dot{m} = 6.654\ kg/min}$$

13-54]

Neon = 0.4119 kJ/kg·K
T_1 = 293.15 K

$$m_{Ne} = \frac{P_1 V_1}{R_{Ne} T_1} = \frac{(100\ kPa)(0.45\ m^3)}{(0.4119\ kJ/kg\cdot K)(293.15\ K)} = 0.373\ kg$$

Argon = 0.2081 kJ/kg·K
T_2 = 323.15 K

$$m_{Ar} = \frac{P_2 V_2}{R_{Ar} T_2} = \frac{(200\ kPa)(0.45\ m^3)}{(0.2081\ kJ/kg\cdot K)(323.15\ K)} = 1.338\ kg$$

$T_F(^\circ C) = 289.35 - 273.15$
$= 16.2^\circ C$

$$P_F = \frac{(0.3727)(0.4119) + (1.3383)(0.2081)(289.35)}{0.9}$$

$P_F = 138.9\ kPa$

13-59)

$M_{CH_4} = 16.04$ kg/kmol
$M_{C_3H_8} = 44.10$ kg/kmol
$M_{C_4H_{10}} = 58.12$ kg/kmol

$$\frac{1}{M_{mix}} = \sum \frac{mf_i}{M_i} = \frac{0.60}{16.04} + \frac{0.25}{44.10} + \frac{0.15}{58.12}$$

$$= 21.91 \text{ kg/kmol}$$

$$R_{mix} = \frac{8.314 \text{ kJ/mol}}{21.91 \text{ kg/kmol}} = 0.3796 \text{ kJ/kgK}$$

$$w = \int_{P_1}^{P_2} v\,dP$$

$T = 208^\circ C = 481.15$ K
$P_1 = 100$ kPa
$P_2 = 1000$ kPa

$$w = (0.3796)(481.15)\ln\left(\frac{1000}{100}\right) = \boxed{420.5 \text{ kJ/kg}}$$