ChE 3063 Exam I 9/20/17

Solution

I. $C_5H_{12} + 8O_2 \longrightarrow 5CO_2(g) + 6H_2O(g)$

$$\Delta H^\circ_{c,298} = \sum \nu_i \Delta H^\circ_{f,i,298}$$

$$= 5(-393509)\ \text{J/mole} + 6(-241818)\ \text{J/mole} - (-146760)\ \text{J/mole} - 8(0)$$

$$\boxed{\Delta H^\circ_{c,298} = -3271693\ \text{J/mole}}$$

II. for n-pentane $T_c = 469.7\ K$ $P_c = 33.7\ \text{bar}$ $\omega = 0.252$

$$\frac{C_p^{ig}}{R} = 2.464 + 4.54\times10^{-2}T - 1.41\times10^{-5}T^2 \qquad (D=0)$$

Since it is in its ideal gas state at point 1, $S_1^R = 0$

for S_2^R:

$$T_r = 600/469.7 = 1.28$$

$$P_r = 20/33.7 = 0.593$$

$$\frac{dB^0}{dT_r} = \frac{0.675}{(1.28)^{2.6}} = 0.357 \qquad \frac{dB^1}{dT_r} = \frac{0.722}{(1.28)^{5.2}} = 0.202$$

$$S_2^R/R = -0.593\left(0.357 + 0.252(0.202)\right) = -0.242$$

$$S_2^R = (8.314\ \text{J/mole·K})(-0.242) = -2.014\ \text{J/mole·K}$$

~~Ideal Gas~~

$$R\int_{400K}^{600K} \frac{C_p^{ig}}{R}\frac{dT}{T} = \left[2.464\ln\frac{600}{400} + 4.54\times10^{-2}(600-400) - \left(\frac{1}{2}\right)1.41\times10^{-5}\left(\frac{1}{600^2} - \frac{1}{400^2}\right)\right]8.314\ \text{J/mole·K} = 71.98\ \frac{\text{J}}{\text{mole K}}$$

$$\Delta S = 71.98\ \frac{\text{J}}{\text{mole K}} - R\ln\left(\frac{20\ \text{bar}}{1\ \text{bar}}\right) - 2.014\ \text{J/mole·K} - (0)$$

$$\boxed{\Delta S = 45.06\ \text{J/mole·K}}$$

III. n-pentane = component 1
n-hexane = component 2

$x_1 = 0.2500$, $x_2 = 0.75$

Antoine eqn:

	A	B	C
①	13.7667	2451.88	232.014
②	13.8193	2696.04	224.317

$$P_i^s = \exp\left(A - \frac{B}{t + C}\right) \quad t \equiv {}^\circ C$$

A) Raoult's Law gives

$P = 400\,kPa = x_1 P_1^s + x_2 P_2^s = 0.25 P_1^s + 0.75 P_2^s$

guess T, compute P, iterate

T (guess) (°C)	P (kPa)
100	332.44
110	420.18
105	374.39
107	392.23
107.85	400.00

$$\boxed{\begin{aligned} T &= 107.85\ {}^\circ C \\ P_1^s &= 700.92\ kPa \\ P_2^s &= 299.69\ kPa \end{aligned}}$$

B)

$$\boxed{\begin{aligned} y_1 &= \frac{x_1 P_1^s}{P} = \frac{(0.25)(700.92)}{400} = 0.438 \\ y_2 &= \frac{(0.75)(299.69)}{400} = 0.562 \end{aligned}}$$

C)

$$\boxed{\begin{aligned} f_2^V &= 0.562\,(400\,kPa) = 224.77\ kPa \\ f_2^L &= (0.75)(299.69\,kPa) = 224.77\,kPa \end{aligned}}$$

same!