

CHE 3173

EXAM II Solution

Nov. 12, 1985

$$1. \ln \phi = \ln(\phi^o \phi')^{\omega}$$

$T_c^{\circ}K$	305.4	369.8	425.2
$P_c \text{ atm}$	48.2	41.9	37.5
ω	0.091	0.145	0.193
T_r	1.47	1.22	1.06
P_r	6.22	7.16	8.00
ϕ^o	0.65	0.43	0.28
ϕ'	1.43	1.22	0.84
ϕ_i	0.67	0.44	0.27
$y_i \phi_i$	0.3	0.5	0.2
$y_i \phi_i$	0.20	0.22	0.05
f_i	60.3	66.0	16.24
	C_2H_6	C_3H_8	C_4H_{10}

use
 gen.
 comp.
 factors

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 SEVN



$$2. PV = RT \left[1 + \frac{PT_c}{17P_cT} \left(1 - \frac{15T_c^2}{2T^2} \right) \right]$$

$$RT \ln \phi = \int_0^P \left(\bar{V}_i - \frac{RT}{P} \right) dP$$

for pure comp. $\bar{V}_i = V$

$$RT \ln \phi = \int_0^P \left[\left(\frac{RT}{P} - \frac{RT}{P} \right) + \frac{T_c RT}{17P_cT} \left(1 - \frac{15T_c^2}{2T^2} \right) \right] dP$$

$$\ln \phi = \frac{\frac{RT_c}{17P_c} \left(1 - \frac{15T_c^2}{2T^2} \right) P}{RT}$$

$$\ln \phi = \frac{P_r R}{17.2 T_r} \left(1 - \frac{15 T_c}{2 T^2} \right)$$

for ethane at 20 atm

$$P_r = \frac{20}{48.2} = 0.415$$

$$T_r = \frac{400}{305.4} = 1.31$$

$$\ln \phi = \frac{(0.415) \left(\frac{0.08205 \text{ L-atm}}{\text{mole-K}} \right)}{17(1.31)} \left(1 - \frac{15}{2(1.31)^2} \right)$$

$$\ln \phi = \frac{.415}{17(1.31)} \left(1 - \frac{15}{2(1.31)^2} \right)$$

$$\phi = 0.939$$

$$f = .939 \times 20 = 18.78 \text{ atm}$$

III. for azeotrope $y_1 = x_1$

$$y_2 = x_2$$

$$y_1 \phi_1 P = x_1 \gamma_1 P^s$$

$$y_2 \phi_2 P = x_2 \gamma_2 P^s$$

$$P = \gamma_A P_A^s = \gamma_B P_B^s$$

$$\left[e(0.3)(x_B)^2 \right] (338) = \left[e(0.3)(x_A)^2 \right] (300)$$

$$x_B^2 = 0.888 x_A^2$$

$$x_B = .942 x_A$$

$$x_B = .942 - .942 x_B$$

$$x_B = .485$$

$$x_A = .515$$

$$e^{(.3X_B^2) - (.3X_A^2)} = 300/338$$

$$.3X_B^2 - .3X_A^2 = \ln(300/338) = -0.119$$

$$X_B^2 - X_A^2 = -.398$$

$$X_B^2 - (1 - X_B)^2 = -.398$$

$$2X_B - 1 = -.398$$

$$X_B = .301$$

$$X_A = .699$$

← azeotrope, yes

$$P = X_A P_A^S = e^{(.3X_B)^2} (300)$$

$$P = 308 \text{ mm Hg}$$