cheg325 homework7 SIS 11.4-1

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a

for two liquid phases we know that for each component the fugacity in each phase is equal

$$\bar{f}_i^I(T,P,\underline{x}) = \bar{f}_i^{II}(T,P,\underline{x}) \qquad (\text{for } i \in \{1,2,3\})$$

but since they're liquids and have the same vapor pressure at this temperature

$$x_i^I \gamma_i^I = x_i^{II} \gamma_i^{II} \qquad (\text{for each component } i)$$

and just to make sure i get all my delicious points i'll write out all 3 equations

$$x_1^I \gamma_1^I = x_1^{II} \gamma_1^{II}$$

$$x_2^I \gamma_2^I = x_2^{II} \gamma_2^{II}$$

$$x_3^I \gamma_3^I = x_3^{II} \gamma_3^{II}$$

now i think this is what is wanted, but some of my friends pointed out that there are 3 mass balances that also need satisfied

$$N_i = N_i^I + N_i^{II} \qquad (\text{for } i \in \{1,2,3\})$$

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b

this time we only have an equation to solve for species 1 since species 2 and 3 are completely immiscible. let phase I be rich in species 2 and phase II be rich in species 3

$$\bar{f}_1^I(T,P,\bar{x}) = \bar{f}_1^{II}(T,P,\bar{x})$$

which could actually be used in a problem as

$$x_1^I \gamma_1^I = x_1^{II} \gamma_1^{II}$$

then to get the other compositions,

$$x_2^I = 1 - x_1^I$$

$$x_3^{II} = 1 - x_1^{II}$$

and that gets you the compositions. again you could argue theres a mole balance here (even though the question asks for COMPOSITION), so

$$N_1 = N_1^I + N_1^{II} \qquad N_2 = N_2^I \qquad N_3 = N_3^{II}$$

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c

for three phases it might be easy to think like oh okay (phase 1 in equalibrium with phase 2), (phase 2 in equalibrium with phase 3), (phase 1 in equalibrium with phase 3). but only two of these are independent! if phase 1 is in equlibrium with phase 2 and phase 3, then phase 2 MUST be in equlibrium with phase 3. this is the same logic as the 0th law of thermodynamics (hopefully i'm referencing that correctly)

$$\bar{f}_i^I(T,P,\bar{x}) = \bar{f}_i^{II}(T,P,\bar{x}) \qquad (\text{for } i \in \{1,2,3\})$$

$$\bar{f}_i^I(T,P,\bar{x}) = \bar{f}_i^{III}(T,P,\bar{x}) \qquad (\text{for } i \in \{1,2,3\})$$

and the obligatory mass balances that need fufilled but like in my soul i feel like what's above is all you're looking for

$$N_i = N_i^I + N_i^{II} + N_i^{III} \qquad (\text{for } i \in \{1,2,3\})$$

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#filler
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