TEQB – Reslução Exame

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Conteúdo

Questão 1

1 mol gas perfeito num processo reversivel

1. $2.1\,\text{bar}$, $19\,^\circ\text{C}$ 2. $1.2\,\text{bar}$ 3. $0.86\,\text{bar}$ 4. .

- $\Delta H_{1\to 2} = 844$ - $W_{3\to 4} = -1671$
- $2\to 3$: Adiabático $PV^\gamma = Cte$ - $3\to 4$: T constante

Q1 a.

T em 2

$$T_2 = T_1 + \frac{\Delta H_{1 \to 2}}{n\, C_P} = T_1 + \frac{\Delta H_{1 \to 2}}{n\,(C_V + R)} = (19 + 273.15) + \frac{844}{1 * 3.5 * 8.31} \cong 321.15$$

Q1 b.

T em 3

$$P_3 V_3^{\gamma} = P_3 \left(\frac{n R T_3}{P_3} \right)^{1.4} = \frac{n^{1.4} R^{1.4} T_3^{1.4}}{P_3^{0.4}} = P_2 V_2^{\gamma} = \frac{n^{1.4} R^{1.4} T_2^{1.4}}{P_2^{0.4}} \implies$$

$$\implies T_3 = \left(\frac{n^{1.4} R^{1.4} T_2^{1.4} P_3^{0.4}}{P_2^{0.4} n^{1.4} R^{1.4}} \right)^{1/1.4} = T_2 \left(\frac{P_3}{P_2} \right)^{0.4/1.4} \cong 321.15 \left(\frac{0.86}{1.2} \right)^{0.4/1.4} \cong 291.99$$

Q1 c.

P em 4

$$-\int n\,R\,T\,\mathrm{d}V/V = -n\,R\,T_3\,\ln(V_4/V_3) = -n\,R\,T_3\,\ln\left(\frac{n\,R\,T_4}{P_4} - \frac{n\,R\,T_3}{P_3}\right) = W_{3\to4} \implies$$

$$\implies P_4 = \left(\left(\exp\left(-\frac{W_{3\to4}}{n\,R\,T_3}\right) + \frac{n\,R\,T_3}{P_3}\right)\frac{1}{n\,R\,T_4}\right)^{-1} =$$

$$= \left(\exp\left(-\frac{-1671}{1*8.31*291.99}\right) + \frac{1*8.31*291.99}{0.86*10^5}\right)^{-1} 1*8.31*291.99 \cong 1202.74$$

Questão 2

Sistema n-octano+entanol

Q2 a.

Calcule $\gamma_{etanol,I}$ quando $x_{n-octano} = 0.65$ a $75\,^{\circ}\mathrm{C}$

$\gamma_{etanol,I}$

Questão 3

um pouco acima do ponto triplo $(175.5\,\mathrm{K}, 1.86 * 10^{-6}\,\mathrm{bar})$

$$P_{fus} = -1077.3 + 6.1309\,T$$
$$\gtrsim (175.5\,\mathrm{K}, 1.86 * 10^{-6}\,\mathrm{bar}) \wedge P < 500\,\mathrm{bar}$$

- $V_{m,L} = 35.43\,\mathrm{cm^3\,mol^{-1}}$
- $V_{m,S} = 32.47\,\mathrm{cm^3\,mol^{-1}}$
- $P_{vap,L,215\,K} = 3.44 * 10^{-4}\,\mathrm{bar}$
- $C_{P,s} = 52.0\,\mathrm{J\,K^{-1}\,mol^{-1}}$
- $C_{P,l} = 70.8\,\mathrm{J\,K^{-1}\,mol^{-1}}$
- $C_{P,g} = 39.0\,\mathrm{J\,K^{-1}\,mol^{-1}}$

Q3 a.

Calcule P de sub a 173 K

$$P_{sub} = (-1077.3 + 6.1309 * T_t) \exp\left(\frac{-\Delta H_{sub}}{R}(T_1^{-1} - T_0^{-1})\right) =$$

$$= (-1077.3 + 6.1309 * T_t) \exp\left(-\frac{T_1^{-1} - T_t^{-1}}{R}(\Delta H_{fus} + \Delta H_{vap})\right)$$

$$\Delta H_{fus} = T_t \, \Delta V_{fus} \left(\frac{\partial P}{\partial T}\right)_{fus} = T_t \, (V_1 - V_0) \left(\frac{\partial P}{\partial T}\right)_{fus} =$$

$$= T_t \, (V_1 - V_0) \frac{\partial}{\partial T} (-1077.3 + 6.1309 \, T_t) * 10^6 =$$

$$= T_t \, (V_1 - V_0) * 6.1309 * 10^6 =$$

$$= 175.5 * (35.43 - 32.47) * 10^{-6} * 6.1309 * 10^6 \cong 3184.88$$

$$\ln P_{vap,L} = a + b/T \implies \ln 3.44 * 10 - b/215 = \ln 1.86 * 10^{-1} - b/175.5 \implies$$

$$\implies b = \frac{\ln(34.4/0.186)}{175.5^{-1} - 215^{-1}} \cong 4986.48 \implies$$

$$\implies a \cong 3.44 * 10 - 4986.48/215 \cong 11.21 \implies$$

$$\implies \ln P_{vap} \cong 11.21 + 4986.48/T$$

$$\Delta H_{vap} = R T^2 \frac{d \ln P}{dT} \cong R T^2 (4986.48/T_2) \cong 41\,459.93$$

$$P_{sub} \cong$$

$$\cong (-1077.3 + 6.1309 * 175.5)*$$

$$* \exp\left(-\frac{173^{-1} - 175.5^{-1}}{8.31}(3184.88 + 41\,459.93)\right) \cong$$

$$\cong 1383.83$$

Nota : Sobre a equação do P vap encontrada, esta não está correta, ao fazer a aproximação usando uma curva log em 1/T gerou valores em P muito superiores que o esperando, talves seja melhor parametrizar em alguma outra curva como uma reta.

Q3 b.

$\Delta S(180\,\mathrm{K}, 200\,\mathrm{bar}) \to (300\,\mathrm{K}, 0.05\,\mathrm{bar})$

$$\begin{cases} P_{fus,180\,\mathrm{K}} = (-1077.3 + 6.1309 * 180) * 10^6 \cong 262.62 * 10^5 > 200 * 10^5 \\ P_{vap,180\,\mathrm{K}} = (-11.21 + 4986.48/180) * 10^5 \cong 16.50 * 10^5 > 0.05 * 10^5 \\ T_{fus,200\,\mathrm{bar}} = 200 + 1077.3/6.1309 \cong 375.72 > 300 \\ T_{vap,200\,\mathrm{bar}} = \dfrac{4986.48}{\ln(200 * 10^5) - 11.21} \cong 890.25 \end{cases}$$

$\Delta S =$

$$= \begin{pmatrix} \Delta S(l, 180\,\mathrm{K}, (200 \to 16.50)\,\mathrm{bar}) & + \\ + \Delta S((l \to g), 180\,\mathrm{K}, 16.50\,\mathrm{bar}) & + \\ + \Delta S(g, (180 \to 300)\,\mathrm{K}, (16.50 \to 0.05)\,\mathrm{bar}) & \end{pmatrix} =$$

$$= \begin{pmatrix} 0 & + \\ + - n\ \Delta H_{vap}/180 & + \\ + \displaystyle\int n\,C_{P,g}\ \mathrm{d}T/T - n\,R\,\ln(P_1/P_0) & \end{pmatrix} =$$

$$= \begin{pmatrix} -41\,459.93/180 & + \\ +39 * \ln 300/175.5 - 8.31 * \ln(0.05/16.5) & \end{pmatrix} \cong$$

$$\cong -209.45$$

Q3 c.

$\Delta G(300\,\text{K}, 10\,\text{bar}) \rightarrow (300\,\text{K}, 0\,05\,\text{bar})$

$\{P_{fus,300\,\text{K}} = (1077.3 + 5.1309 * 300) * 10^6 \cong 2616.57 * 10^6 > 10 * 10^5 \quad\}$

$\Delta G =$
$$= \begin{pmatrix} \Delta G(s, (10 \rightarrow P_f us)\,\text{bar}) & + \\ + \Delta G((s \rightarrow l), P_{fus}\,\text{bar}) & + \\ + \Delta G(l, (P_{fus} \rightarrow P_{vap})\,\text{bar}) & \end{pmatrix} =$$

$$= \begin{pmatrix} \displaystyle\int_{P_1}^{P_2} V \; \mathrm{d}P & + \\ +0 & + \\ + \displaystyle\int_{P_0}^{P_1} V \; \mathrm{d}P & \end{pmatrix} =$$

$$= \begin{pmatrix} V \displaystyle\int_{P_1}^{P_2} \mathrm{d}p \quad (\text{vol liq constante em } \Delta P) & + \\ + \displaystyle\int_{P_0}^{P_1} \frac{n\,R\,T}{P} \; \mathrm{d}P & \end{pmatrix} =$$

$$= \begin{pmatrix} V_l\,(P_2 - P_1) & + \\ + \dfrac{n\,R\,T}{\ln}(P_3/P_2) & \end{pmatrix}$$

Nota: Continuo a sofrer com a ma parametrização da curva de P de vaporização

Questão 4

- $P_{vap,sol,30\,°C} = 0.1026\,\text{bar}$
- $M_{naf} = 128.17\,\text{g}\,\text{mol}^{-1}$
- $\ln P_{vap,eta} = 14.502 - 5084.7/T$
- $M_{eta} = 46.07\,\text{g}\,\text{mol}^{-1}$
- $\rho_{sol} \approx \rho_{eta} = 0.789\,\text{g}\,\text{cm}^{-1}$

(i)

Pressão osmótica da sol a 20 C

$$\Pi = \frac{[i]\, P_{eta}}{n_{eta}}$$

(ii)

> **T de vap sol a 0.951** bar
>
> $$t_{vap,sol} = \left(t_{vap,eta}^{-1} - \ln x_{eta}\, \frac{R}{\Delta H_{vap,eta}} \right)^{-1} =$$
>
> $$= \left(\left(\frac{5084.7}{14.502 - \ln P} \right)^{-1} - \ln(x_{eta})\, \frac{R}{\Delta H_{vap,eta}} \right)^{-1} =$$
>
> $$= \left(\frac{14.502 - \ln P}{5084.7} - \frac{\ln(x_{eta})\, R}{\Delta H_{vap,eta}} \right)^{-1};$$
>
> $$\left. \frac{\mathrm{d}P}{\mathrm{d}T} \right|_{vap} = \frac{\Delta H_{vap}}{T\, \Delta V_{vap}} = \frac{\Delta H_{vap}}{T\, (V_{vap,g} - V_{vap\,l})} \cong \frac{\Delta H_{vap}}{T\, V_{vap,g}} \cong \frac{\Delta H_{vap}}{T\, (R\,T/P)} = \frac{P\, \Delta H_{vap}}{R\,T^2} \implies$$
>
> $$\implies \frac{\mathrm{d}P/P}{\mathrm{d}T} = \frac{\mathrm{d}\ln P}{\mathrm{d}T} = \frac{\mathrm{d}}{\mathrm{d}T}\left(14.502 - 5084.7\,T^{-1} \right) = 5084.7\,T^{-2} = \frac{\Delta H_{vap}}{R\,T^2} \implies$$
>
> $$\implies \Delta H_{vap} = 5084.7\, R t_{vap,sol} = \left(\frac{14.502 - \ln P}{5084.7} - \frac{\ln(x_{eta})\, R}{5084.7\, R} \right)^{-1} =$$
>
> $$= \frac{5084.7}{14.502 - \ln(0.951 * x_{eta})} \cong$$

Questão 5

- $T = 30\,^{\circ}\mathrm{C}$
- $n_{oct,tot} = 3\,\mathrm{mol}$
- $n_{agua,tot} = 2\,\mathrm{mol}$
- $x_{oct,1} = 0.744$
- $x_{oct,2} = 0.002$

Q5 a.

Razão entre as quantidades (mol) da fase mais rica em n-octano e da fase mais rica em agua

(i)

Fase mais rica em n-Octano