FT II – Teste 2024.1 Resolução

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Conteúdo

Questão 1

- **Altura:** $h = 30\,\mathrm{cm}$
- **Diametro:** $d = 1\,\mathrm{cm}$
- **Altura liquido A:** $h_0 = 10\,\mathrm{cm}$
- $y_{A,h} = 0$

Dados a $25\,°\mathrm{C}$

- $D_{A,ar} = 2\,\mathrm{E}^{-5}\,\mathrm{m}^2/\mathrm{s}$
- $R = 8.314\,462\,618\,\mathrm{J\,mol^{-1}\,K^{-1}}$
- $P_A^* = 80\,\mathrm{mmHg}$
- $P = 1\,\mathrm{atm} = 80\,\mathrm{mmHg} = 10\,\mathrm{E}^5\,\mathrm{Pa}$
- $M_A = 30\,\mathrm{g/mol}$
- $\rho_A = 0.9\,\mathrm{E}^3\,\mathrm{kg/m}^3$

Q1 a.

Expressão para evaporação completa em função do tempo

Resposta

Evaporação em geometria linear:

$$N_{A,z} = Q_A =$$
$$= -C_{A,ar}\frac{\mathrm{d}V}{\mathrm{d}t} = -C_{A,ar}\frac{\mathrm{d}\pi\,(d/2)^2\,z}{\mathrm{d}t} = -C_{A,ar}\,\pi\,(d/2)^2\,\frac{\mathrm{d}z}{\mathrm{d}t} \implies$$

$$\implies \int_0^t N_{A,z}\,\mathrm{d}t = N_{A,z}\int_0^t \mathrm{d}t = N_{A,z}\,t =$$
$$= \int_{h/3}^0 -C_{A,ar}\,\pi\,d^2\,\mathrm{d}z/4 = -\frac{C_{A,ar}\,\pi\,d^2}{4}\,(-h/3) \implies$$

$$\implies N_{A,z} = \frac{C_{A,ar}\,\pi\,d^2}{12}\,h/t$$

Condições de fronteira para fluxo:

$$\begin{cases} z = h_0 & y_A = y_A^* \\ z = h & y_A = 0 \end{cases};$$

Fluxo molar:

$$N_A = y_{A,z}\,N_A - C\,\mathscr{D}_{A,ar}\,\frac{\mathrm{d}y_{A,z}}{\mathrm{d}z} \implies$$

$$\implies \int N_A\,\mathrm{d}z = N_A\,(h - h_0) =$$
$$= \int_{y_A^*}^0 -C\,\mathscr{D}_{A,ar}\,\frac{\mathrm{d}y_{A,z}}{1 - y_{A,z}} =$$
$$= C\,\mathscr{D}_{A,ar}\int_{y_A^*}^0 \frac{\mathrm{d}(1 - y_{A,z})}{1 - y_{A,z}} =$$
$$= C\,\mathscr{D}_{A,ar}\,\ln(1 - y_{A,z}^*) \implies$$
$$\implies N_A = \frac{C\,\mathscr{D}_{A,ar}}{h - h_0}\,\ln(1 - y_{A,z}^*)$$

Q1 b.

Calcule esse tempo

Q1 c.

Novo tempo para metade da altura e dobro do diametro, comente

Questão 2

- $d = 1\,\mathrm{cm}$
- $T = 1500\,\mathrm{K}$
- $P = 1\,\mathrm{atm}$
- Velocidade limit pela dif do O_2
- $M = 1280\,\mathrm{kg/m^3}$
- $\mathscr{D}_{O_2,ar} = 1\,\mathrm{E}^{-4}\,\mathrm{m^2/s}$

$$3\,C + 2\,O_2 \longrightarrow 2\,CO + CO_2$$

Q2 a.

Expr: vel de consumo de O_2 e cond fronteira

Resposta

$$N_{O2,r} =$$
$$= y_{O2,r}(N_C + N_O2 + N_{CO} + N_{CO2}) - C\,\mathscr{D}_{O2,ar}\,\frac{\mathrm{d}y_{O2,r}}{\mathrm{d}r} =$$
$$= y_{O2,r}(N_{O2}/3 + N_{O2}/2 - N_{O2}/2 - N_{O2}) - C\,\mathscr{D}_{O2,ar}\,\frac{\mathrm{d}y_{O2,r}}{\mathrm{d}r} =$$
$$= y_{O2,r}\,N_{O2}\,(-2/3) - C\,\mathscr{D}_{O2,ar}\,\frac{\mathrm{d}y_{O2,r}}{\mathrm{d}r} \implies$$

Condições de fronteira

$$\begin{cases} r = R & y_{O2} = 0 \\ r = \infty & y_{O2} = y^*_{O2} \end{cases}$$

$$\implies \int_R^\infty N_{O2}\,\mathrm{d}r = \int_R^\infty \frac{Q_{O2}}{4\,\pi\,r^2}\,\mathrm{d}r = \frac{Q_{O2}}{4\,\pi}\,\int_R^\infty \frac{\mathrm{d}r}{r^2} =$$
$$= \frac{Q_{O2}}{4\,\pi}\,(R^{-1} - 0) = \frac{Q_{O2}}{4\,\pi\,R} =$$

$$= -C\,\mathscr{D}_{O2,ar}\,\frac{\mathrm{d}y_{O2,r}}{1 + y_{O2,r}2/3} = -\frac{C\,\mathscr{D}_{O2,ar}}{2/3}\,\frac{\mathrm{d}(1 + y_{O2,r}2/3)}{1 + y_{O2,r}2/3} =$$
$$= -\frac{C\,\mathscr{D}_{O2,ar}}{2/3}\,\ln(1 + y^*_{O2,r}2/3) \implies$$

$$\implies Q_{O2} = -\frac{4\,\pi\,R\,C\,\mathscr{D}_{O2,ar}}{2/3}\,\ln(1 + y^*_{O2,r}2/3) =$$
$$= -\frac{4\,\pi\,R\,P\,\mathscr{D}_{O2,ar}}{R\,T\,2/3}\,\ln(1 + y^*_{O2,r}2/3)$$

Q2 b.

Vel de consumo de C