FTII TM IV

1. $K_{G_{SO_2}} = 0.768 \frac{kmol}{h\,m^2 atm}$ $\qquad \frac{1}{k_G} = \frac{H}{k_L}$

$K_{G_{NH_3}} = 2.217 \frac{kmol}{h\,m^2 atm}$

$k_G = A\,\mathcal{D}^{\alpha}$ $\qquad \mathcal{D}_{SO_2} = 0.041\ m/h$

$\mathcal{D}_{NH_3} = 0.083\ m/h$

$\frac{H_{SO_2}}{H_{NH_3}} = \frac{1}{0.018}$ $\qquad \mathcal{D}_{SO_2-H_2O} \simeq \mathcal{D}_{NH_3-H_2O}$

$\Downarrow$

$k_{L_{SO_2}} = k_{L_{NH_3}}$

(SO_2)

$\frac{1}{0.768} = \frac{1}{k_{G_{SO_2}}} + \frac{H_{SO_2}}{k_L}$ $\longrightarrow$ $1.302 = 0.651 + 0.651$

(NH_3) $\frac{1}{2.217} = \frac{1}{k_{G_{NH_3}}} + \frac{H_{NH_3}}{k_L}$

$\frac{H_{SO_2}}{k_L} = 0.651$

$H_{NH_3} = 0.018\ H_{SO_2}$

$\frac{1}{2.217} = \frac{1}{k_{G_{NH_3}}} + \frac{0.018\ H_{SO_2}}{H_{SO_2}/0.651}$

$$k_{G_{NH_3}} = 2.276 \frac{kmol}{h\,m^2 atm}$$

$\frac{1}{k_{G_{SO_2}}} = 0.651$ $\qquad$ $k_{G_{SO_2}} = 1.536 \frac{kmol}{h\,m^2 atm}$

$\frac{1.536}{2.276} = \left(\frac{0.041}{0.083}\right)^{\alpha}$ $\qquad$ $\alpha = 0.56$

$Sh = 0.023\,Re^{0.8}\,Sc^{0.44}$ $\qquad k_G \propto \mathcal{D}^{1-0.44} \propto \mathcal{D}^{0.56}$

2. $K_G(p_{A_G} - p_A^*) = \underbrace{K_G RT}_{k_{G_C}} (C_{A_G} - C_{A_G}^*)$

$k_L (C_{Ai} - C_{A_L}) = k_L C_L (x_{Ai} - x_A)$

$p_{Ai} = H x_{Ai} = 10^5 H x_{Ai}$

$k_L \propto \sqrt{\mathcal{D}_L}$ $\quad k_{L_{O_2}} = 0.2 \times 10^{-3}$ m/s

$$k_L = \frac{k_{L_{O_2}}}{\sqrt{\mathcal{D}_{L_{O_2}}}} \cdot \sqrt{\mathcal{D}_L}$$

$$k_L = \frac{0.2\times10^{-3}}{\sqrt{2.1\times10^{-9}}}\sqrt{\mathcal{D}_L} = 4.364\sqrt{\mathcal{D}_L}$$

$$b = \frac{10^5}{C_L RT} = 7.39 \times 10^{-4}$$

$$\rho_{ar} = \frac{P\,M_{ar}}{RT}$$

$$\rho_{ar} = \frac{5\times10^5 * 29\times10^{-3}}{8.314 * 293.15}$$

$\rho_{ar} = 5.94$ kg/m^3

$Sh = 0.023\, Re^{0.8}\, Sc^{0.44}$

$$\frac{k_G d}{\mathcal{D}?} = 0.023 \left(\frac{ud}{\nu}\right)^{0.8} Sc^{0.44}$$

$$\nu = \frac{\mu}{\rho}$$

$$Sc = \frac{\nu}{\mathcal{D}}$$

$$\mathcal{D}_G = \frac{\nu}{Sc}$$

$$Re = \frac{5.94 * 0.4 \times 3\times10^{-2}}{1.84\times10^{-5}}$$

$Re = 3880$

$$k_G = \frac{17.1}{0.03} Sc^{0.44} \mathcal{D}_G$$

$$k_G = 56.97\, Sc^{0.44} \mathcal{D}_G$$

ver ficheiro Excel

3.

G (kmol/s)	K_G ($kmol/m^2 s Pa$)
0.04	8.4×10^{-5}
0.10	10×10^{-5}

$$\frac{1}{K_G} = \frac{1}{k_G} + \frac{H}{k_L}$$

$$\frac{1}{K_G} = \frac{1}{a G^{0.8}} + b \qquad y = \frac{1}{a} G^{-0.8} + b$$

$$1.19 \times 10^{4} = \frac{1}{a} * 13.13 + b \qquad b = 1.19 \times 10^{4} - \frac{13.13}{a}$$

$$1 \times 10^{4} = \frac{1}{a} 6.31 + b$$

$$1 \times 10^{4} = \frac{6.31}{a} + 1.19 \times 10^{4} - \frac{13.13}{a}$$

$$\frac{13.13 - 6.31}{a} = 0.19 \times 10^{4} \qquad a = \frac{13.13 - 6.31}{0.19 \times 10^{4}} = 3.58 \times 10^{-3}$$

$$b = 1.19 \times 10^{4} - \frac{13.13}{3.58 \times 10^{-3}} = 8.24 \times 10^{3}$$

$G = 0.5$ kmol/s

$$k_G = a G^{0.8} = 2.06 \times 10^{-3} \frac{kmol}{m^2 s Pa}$$

$$\frac{H}{k_L} = b \qquad k_L = \frac{H}{b} = \frac{20}{8.24 \times 10^{3}} = 2.43 \times 10^{-3} \, m/s$$

$$K_G = 11.5 \times 10^{-5} \frac{kmol}{m^2 s Pa}$$