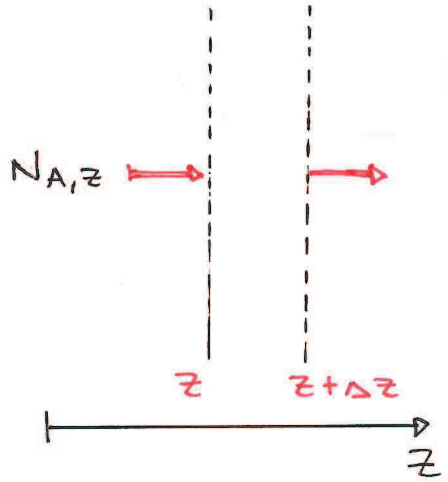
Tors. LV 6

Instationär Masstransport

Instationärt ; 1D ; plan ; diffusion, $\begin{cases} \text{prod} = 0 \\ D_{AB} = \text{konst.} \end{cases}$

Balans: differentiell



Ack = In − Ut + ~~Prod~~ → 0

$$\Delta C_A \Delta z A = \left(N_{A,z}\Big|_z - N_{A,z}\Big|_{z+\Delta z} \right) A \Delta t$$

Dela med $A \Delta z \Delta t \to 0$

$$\to \frac{\partial C_A}{\partial t} = - \frac{\partial N_{A,z}}{\partial z}$$

$$\left\{ N_{A,z} = - D_{AB} \frac{\partial C_A}{\partial z} \right\}$$ Ficks lag

$$\frac{\partial C_A}{\partial t} = D_{AB} \frac{\partial^2 C_A}{\partial z^2}$$

Randvillkor

$$\left.\begin{aligned} C_A(z,0) &= C_{A_0} \\ C_A(0,t) &= C_{A_s} \\ C_A(\infty,t) &= C_{A_0} \end{aligned}\right\} \quad \frac{C_A(z,t) - C_{A_0}}{C_{A,s} - C_{A,0}} = \operatorname{erfc}\left(\frac{z}{2\sqrt{D_{AB}t}}\right)$$

Generell Masstransport ekv.

Ack = In - Ut + Prod

$$\Delta x \Delta y \Delta z \frac{\partial \rho}{\partial t} = \left(n_{A,x}\big|_x - n_{A,x}\big|_{x+\Delta x}\right)\Delta y \Delta z + \left(n_{A,y}\big|_y - n_{A,y}\big|_{y+\Delta y}\right)\Delta x \Delta z + \left(n_{A,z}\big|_z - n_{A,z}\big|_{z+\Delta z}\right)\Delta x \Delta y + r_A \Delta x \Delta y \Delta z$$

Dela med $\Delta x \Delta y \Delta z \rightarrow 0$

$$\frac{\partial \rho_A}{\partial t} = -\underbrace{\left(\frac{\partial n_{A,x}}{\partial x} + \frac{\partial n_{A,y}}{\partial y} + \frac{\partial n_{A,z}}{\partial z}\right)}_{\nabla \vec{n}_A} + r_A$$

Balans av B? $\frac{\partial \rho_B}{\partial t} = -\nabla \vec{n}_B + r_b$

Addition av balanserna för A och B:

$$\underbrace{\frac{\partial}{\partial t}(\rho_A+\rho_B)}_{\rho} = -\nabla(\underbrace{\vec{n}_A+\vec{n}_B}_{\underbrace{\rho_A\vec{V}_A+\rho_B\vec{V}_B}_{\rho\vec{V}}}) + \underbrace{r_A+r_B}_{=0}$$

$$\boxed{\frac{\partial\rho}{\partial t} = -\nabla\rho V}$$

$\left[\frac{kg[A]}{kg[total]}\right]$

$$\vec{n}_A = -\rho D_{AB}\nabla\omega_A + \rho_A\vec{V}$$ (tabell 24.2)

total flux A — diffusion — strömning

$$\frac{\partial\rho_A}{\partial t} = \nabla\cdot(\rho D_{AB}\nabla\omega_A) - \nabla\cdot(\rho_A\vec{V}) + r_A$$

ackumulation — diffusion — strömning — reaktion

strömning: $\rho_A\nabla\vec{V} + \vec{V}\cdot\nabla\rho_A$

Specialfall

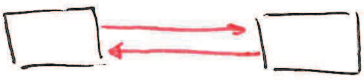
$\rho, D_{AB} = \text{konst.}$

$\nabla\vec{V} = 0$

dela med M_A; $c_A = \frac{\rho_A}{M_A}$; $R_A = \frac{r_A}{M_A}$

$$\Rightarrow \frac{\partial c_A}{\partial t} = D_{AB}\nabla^2 c_A - \vec{V}\nabla c_A + R_A$$

{ envägs koppling
påtvingad konvektion



{ tvåvägskoppling
frikonvektion

Våta temperaturen

$$q = hA(T_G - T_S) = N_A A \Delta H_{vap}$$

$hA(T_G - T_S)$: konvektivt tillförd energi

$N_A = k_c(c_{A,s} - c_{A,G})$

$N_A A \Delta H_{vap}$: energi för avdunstning