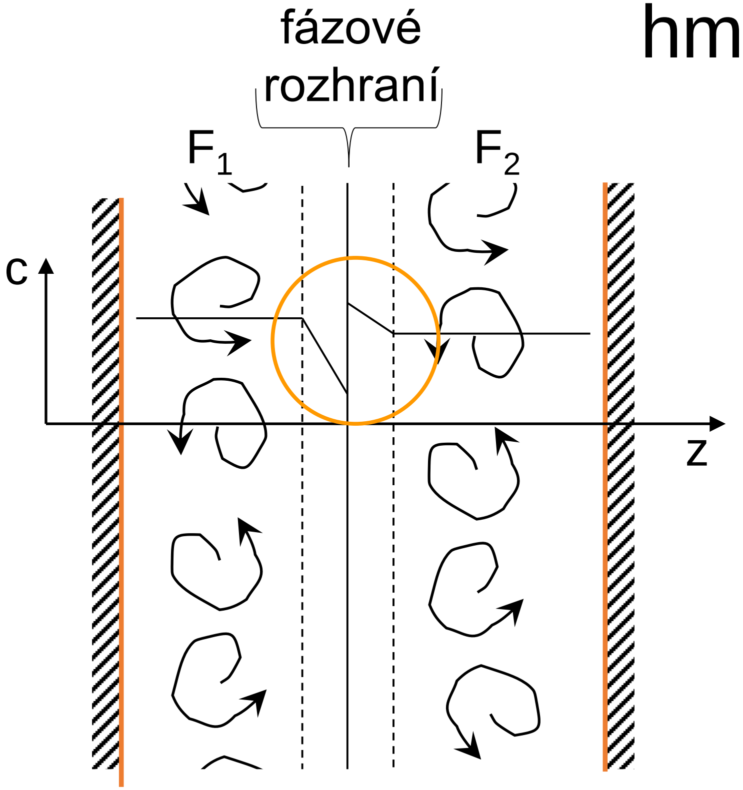
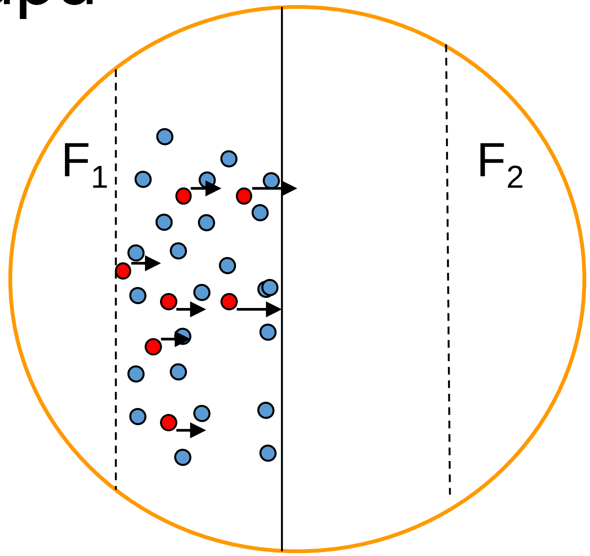
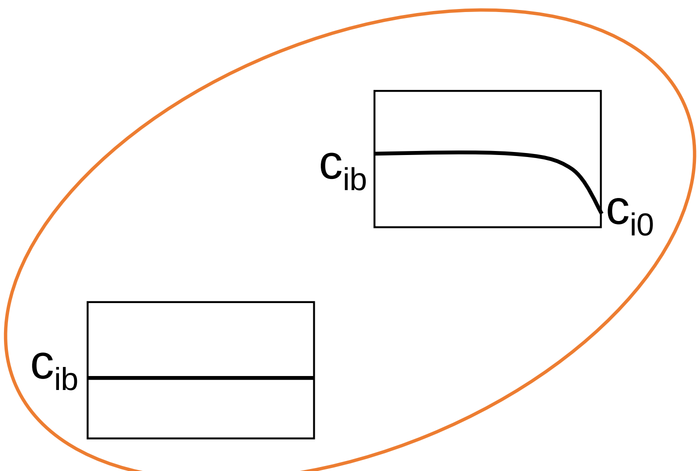
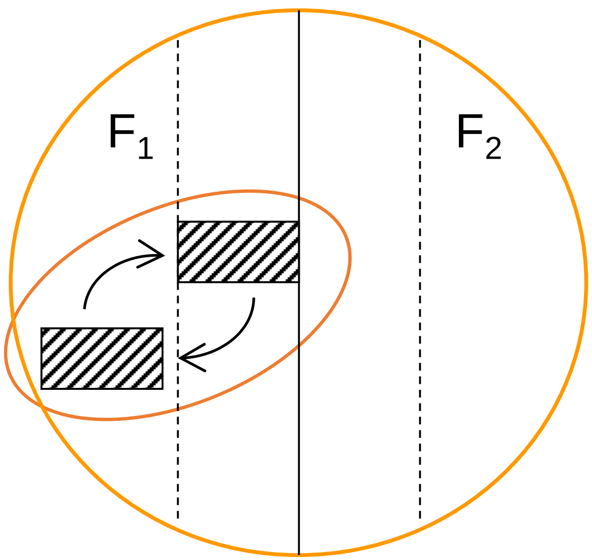
Shrnutí teorií přestupu hmoty





stagnantní film, ustálený stav

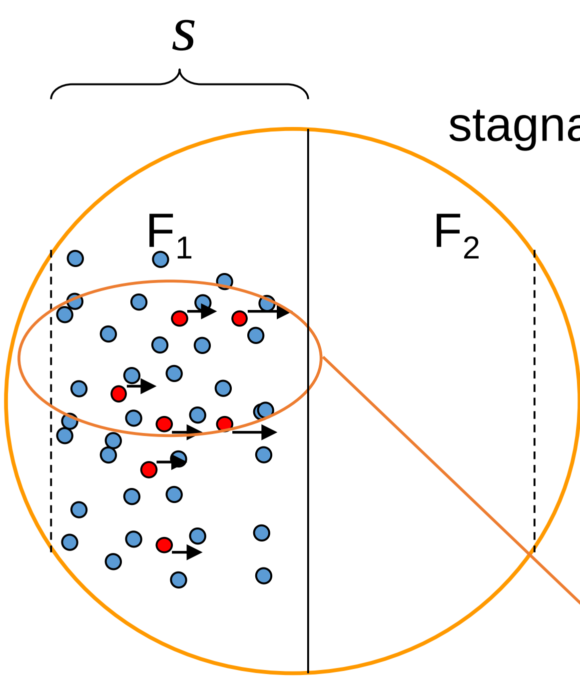




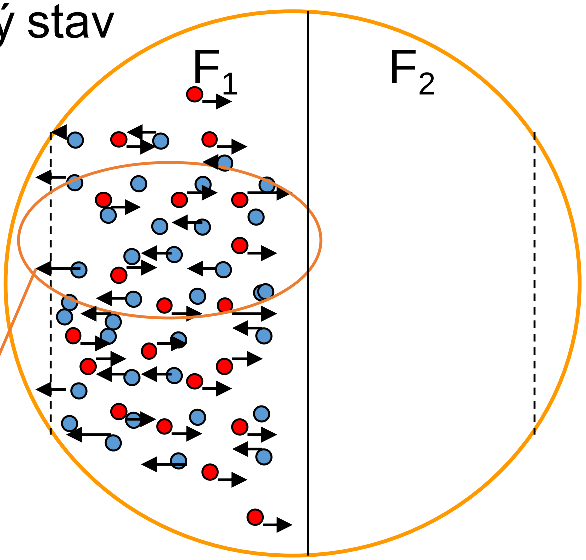
periodické obměňování elementů u fázového rozhraní

Shrnutí teorií přestupu hmoty

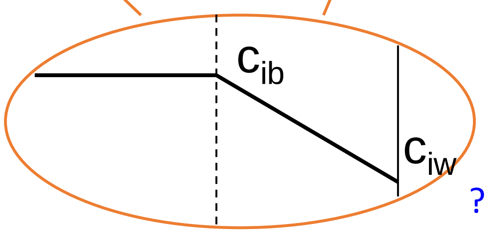
stagnantní film, ustálený stav



$x_i << 1 \wedge j_{kz} \doteq 0 \quad \Rightarrow \upsilon_z \to 0$



$\underline{j_{iz} \doteq -j_{kz}} \quad \Rightarrow \quad \upsilon_z \to 0$



kontrolní otázka k předešlým přednáškám ☻

? jak lze korigovat rovninci při nesplnění podmínky ?

(tj. $j_{iz} \neq -j_{kz}$)

$$\boxed{j_{iz} = -D_{ik} \frac{dc_i}{dz}}$$

1. Fickův zákon

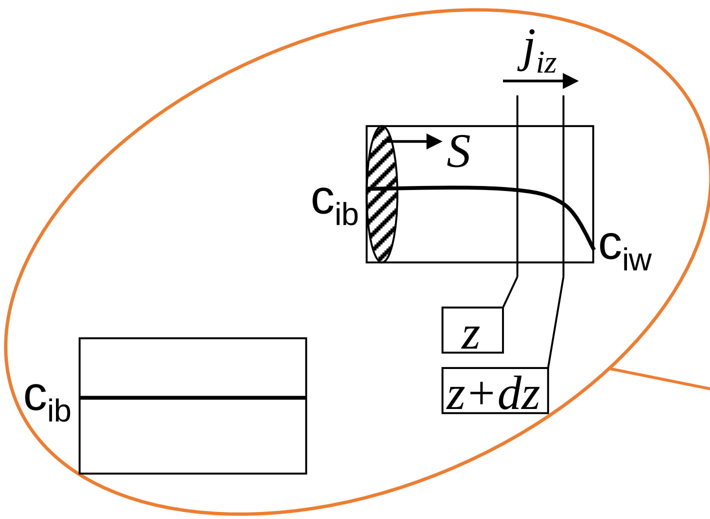
$$j_{iz} = \frac{D_{ik}}{s}(c_{ib} - c_{iw})$$

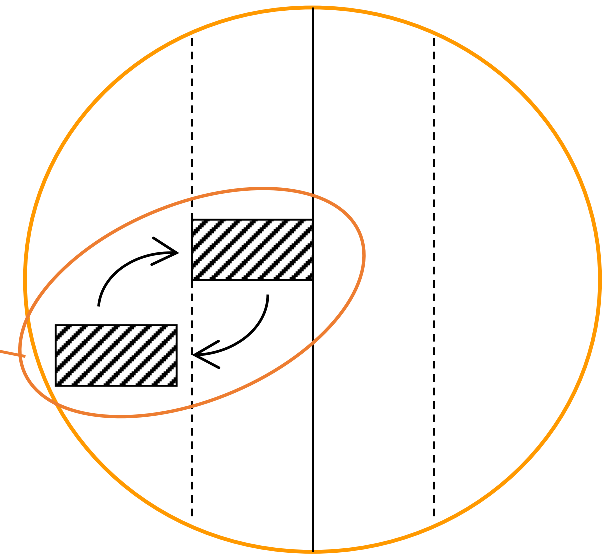
Filmová teorie

k_{F_1} koeficient přestupu hmoty

Shrnutí teorií přestupu hmoty

periodické obměňování elementů u fázového rozhraní





$x_i << 1$ nebo $j_{iz} = -j_{kz}$

$$-\frac{\partial c_i}{\partial \tau} = \cancel{\frac{\partial (c_i \upsilon_z)}{\partial z}} - D_{ik}\frac{\partial^2 c_i}{\partial z^2}$$

$$\boxed{\frac{\partial c_i}{\partial \tau} = D_{ik}\frac{\partial^2 c_i}{\partial z^2}}$$

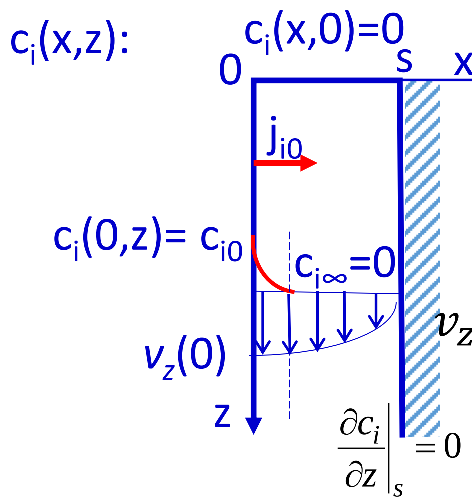
2. Fickův zákon

Penetrační teorie (Higbie)

$$j_{iz} = 2\cdot\sqrt{\frac{D_{ik}}{\pi\tau}}\,(c_{ib} - c_{iw})$$

k_{F_1}

Absorpce do stékajícího filmu (aplikace řešení r. neustálené difúze)



popis ustáleného stavu - R.K. složky bez členu akumulace

$$D_{ik}\left(\frac{\partial^2 c_i}{\partial x^2} \gg \frac{\partial^2 c_i}{\partial z^2}\right) = \overset{=0}{v_x}\frac{\partial c_i}{\partial x} + v_z\frac{\partial c_i}{\partial z} + c_i\underbrace{\left(\frac{\partial v_x}{\partial x} + \frac{\partial v_z}{\partial z}\right)}_{\text{R.K. nestlač. L}}$$

$$x = 0: \quad c_i = c_{i0}$$

$$\cancel{x = s \quad \frac{\partial c_i}{\partial x} = 0}$$

$$x \longrightarrow \infty: \quad c_i = 0$$

$$x > 0 \ \wedge \ z = 0: \quad c_i = 0$$

$$v_z(x) = v_z(0)[1 - \cancel{\left(\frac{x}{s}\right)^2}]$$

malá hloubka penetrace

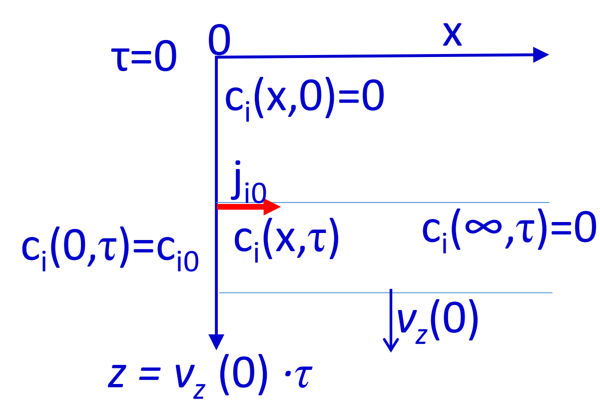
?

$$D_{ik}\left(\frac{\partial^2 c_i}{\partial x^2}\right) = v_z(0)\frac{\partial c_i}{\partial z}$$

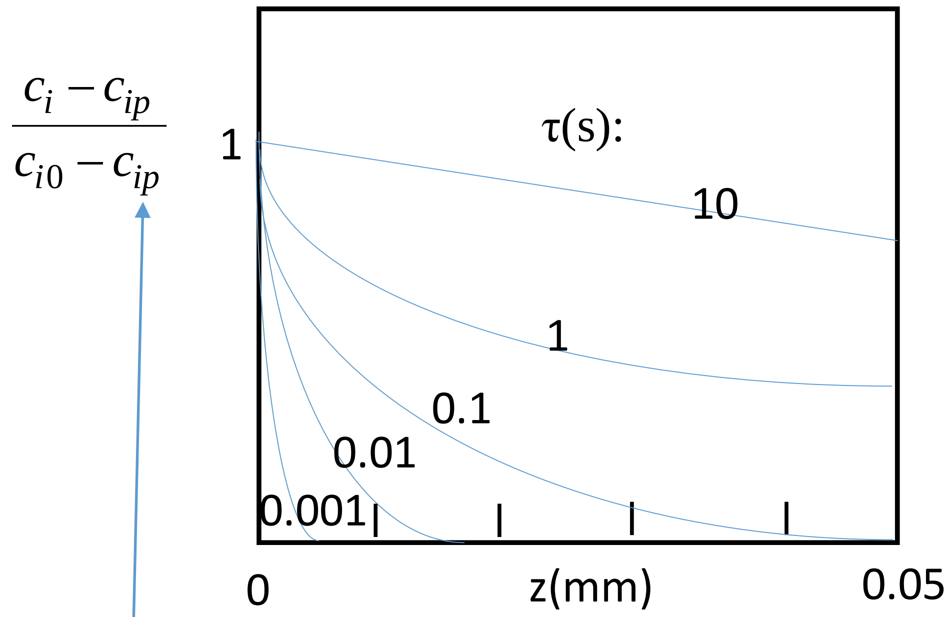
$$\tau = \frac{z}{v_z(0)}$$

neustálená difúze v elementu stékajícího filmu za dobu přetoku

$$D_{ik}\left(\frac{\partial^2 c_i}{\partial x^2}\right) = \frac{\partial c_i}{\partial \tau}$$



Neustálená difúze do polonekonečné nehybné vrstvy



L: $D_i = 10^{-9}$ m²/s

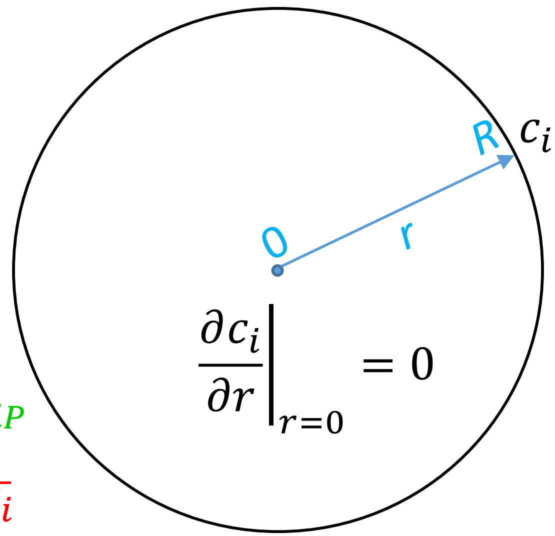
G: $D_i = 10^{-5}$ m²/s

$z = z \cdot 10^{2}$

$\tau = \tau \cdot 10^{-4}$

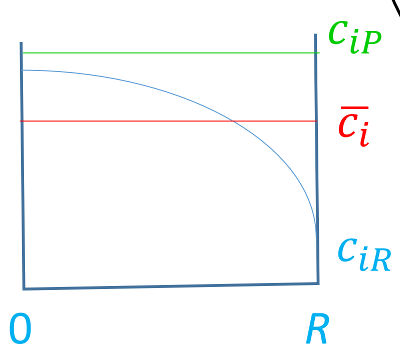
stejné řešení i pro nenulovou počáteční koncentraci absorbované složky

Neustálená difúze do koule



$$c_i(R,\tau) = c_{iR}$$

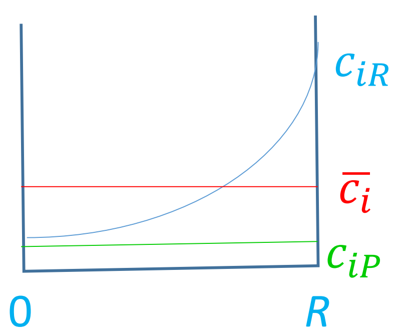
$$\left.\frac{\partial c_i}{\partial r}\right|_{r=0} = 0$$



$$\frac{\partial c_i}{\partial \tau} = D_i\left(\frac{\partial^2 c_i}{\partial r^2} + \frac{2}{r}\frac{\partial c_i}{\partial r}\right)$$

$$c_i(r,0) = c_{ip}$$

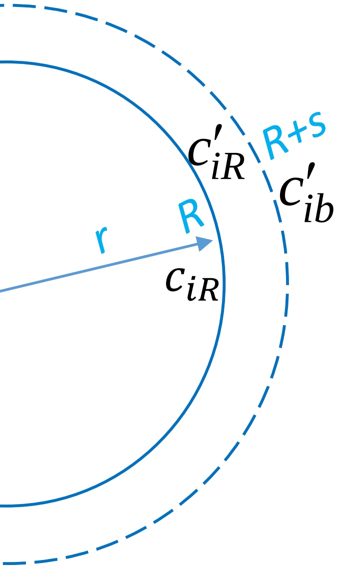
$$\frac{c_i - c_{iP}}{c_{iR} - c_{iP}} = f\left(\frac{r}{R}, \underbrace{\frac{D_i \tau}{R^2}}_{Fo}\right)$$



$$\frac{\overline{c_i} - c_{iP}}{c_{iR} - c_{iP}} = f(Fo)$$

$$= 1 - 6\sum_{n=1}^{\infty} \frac{1}{(n\pi)^2} \exp\{-n^2\pi^2 Fo\}$$

Prostup hmoty z vnějšího prostředí

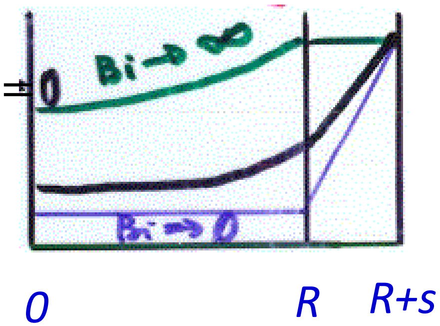


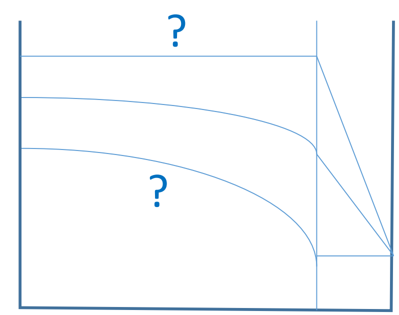
$$D_i \frac{\partial c_i}{\partial r}\bigg|_R = k'_c\ (c'_{ib} - c'_{iR})$$

$$c'_{ib} = \frac{c_i^*}{K_i} \qquad c'_{iR} = \frac{c_{iR}}{K_i} \qquad \left| Z = \frac{r}{R} \right|$$

$$\frac{\partial c_i}{\partial Z}\bigg|_1 = \underbrace{\frac{k'_c\ R}{K_i D_i}}_{Bi}(c_i^* - c_{iR})$$

$$\frac{\partial c_i}{\partial r}\bigg|_{r=0} = 0$$





R.D.S.
(rate determining step)

Bi→∞ odpor vnitřní difúzí

Bi→*0* odpor vnější difúzí

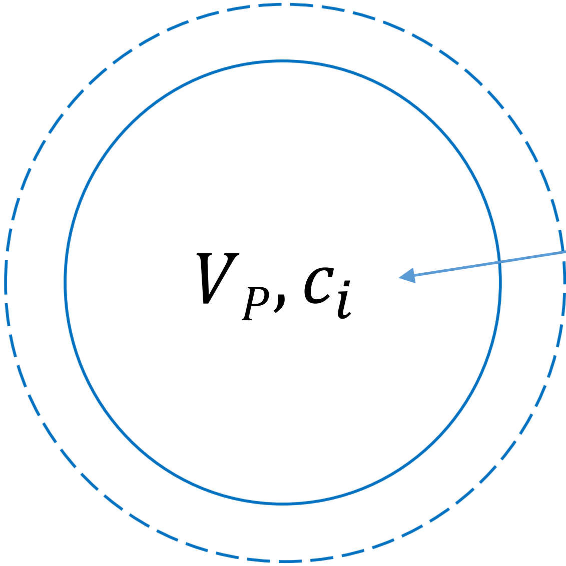
s~ 0.1 mm (G)

s~ 0.01 mm (L)

Prostup hmoty z vnějšího prostředí

bez odporu vnitřní difúze

Bi $\rightarrow 0$ $c_i(r,\tau) \rightarrow c_i(\tau)$ *konst. v celém* V_P



koncentrace složky i v okolním prostředí

$$j_i = k_c'(c_{ib}' - c_{iR}') = \frac{k_c'}{K_i}(c_i^* - c_{iR})$$

konst

$$V_P \frac{dc_i}{d\tau} = \frac{k_c'}{K_i}(c_i^* - c_i)A$$

$$\frac{4}{3}\pi R^3 \qquad 4\pi R^2$$

$$-\ln\frac{c_i^* - c_i}{c_i^* - c_{ip}} = \frac{3k_c'\tau}{R \cdot K_i} \cdot \frac{R}{R} \cdot \frac{D_i}{D_i} = 3BiFo$$