③

$$\frac{1}{DC_A}\cdot\frac{1}{2}X_{ox}^2 + \left(1+\frac{k_s}{h}\right)\frac{1}{k_sC_A}X_{ox} = \frac{1}{N_1}(t+\tau)$$

$\uparrow$ integration ~~time~~ const.

$$\Rightarrow X_{ox}^2 + \underbrace{2D\left(\frac{1}{k_s}+\frac{1}{h}\right)}_{A}X_{ox} = \underbrace{\frac{2DC_A}{N_1}}_{B}(t+\tau)$$

$$\Rightarrow X_{ox}^2 + A X_{ox} = B(t+\tau)$$

Initial condition $t=0$, $X_{ox}=X_i$

$$\tau = \frac{X_i^2 + AX_i}{B}$$

$$X_{ox} = -\frac{A}{2} + \sqrt{\left(\frac{A}{2}\right)^2 + B(t+\tau)}$$

$$= \frac{A}{2}\left[\sqrt{1+\frac{t+\tau}{\left(\frac{A}{2}\right)^2\cdot\frac{1}{B}}} - 1\right]$$

(1) Large $t \Rightarrow X_{ox} \to \sqrt{Bt}$

(2) Small $t \Rightarrow \sqrt{1+\epsilon} = (1+\epsilon)^{1/2} = 1+\frac{\epsilon}{2}$

$\tau=0$

$$X_{ox} \approx \frac{A}{2}\left[1+\frac{1}{2}\frac{t+\tau}{\left(\frac{A^2}{4B}\right)} - 1\right]$$

$$X_{ox} = \frac{B}{A}t$$

$$F_1 = h\,(C_A - C_o) \qquad h = \frac{h_g}{HkT}$$

$$F_2 = D\,\frac{C_o - C_i}{X_{ox}}$$

h_g : mass transfer coef

H : Henry's const.

$$F_3 = k_s \cdot C_i$$

$$F_2 = F_3 \Rightarrow k_s C_i = \frac{D}{X_{ox}} \cdot (C_o - C_i)$$

$$\Rightarrow C_o = C_i + \frac{k_s X_{os}}{D} \cdot C_i$$

$$F_1 = F_3 \Rightarrow h\left[C_A - \left(C_i + \frac{k_s X_{os}}{D} C_i\right)\right] = k_s C_i$$

$$\Rightarrow \cancel{C_i =}$$

$$C_A = C_i + \frac{k_s X_{ox}}{D} \cdot C_i + \frac{k_s}{h} \cdot C_i$$

$$\Rightarrow C_i = \frac{C_A}{1 + \frac{k_s}{h} + \frac{k_s X_{ox}}{D}}$$

$$\frac{dX_{ox}}{dt} = \frac{F}{N_1}$$ ← oxidant moleculer densiey

$$\frac{dX_{ox}}{dF} = \frac{dt}{N_1} \Rightarrow \frac{dX_{ox}}{k_s C_i} = \frac{dt}{N_1}$$

$$\Rightarrow \int dX_{ox} \cdot \frac{1}{k_s C_A}\left(1 + \frac{k_s}{h} + \frac{k_s X_{ox}}{D}\right) = \int \frac{dt}{N_1}$$