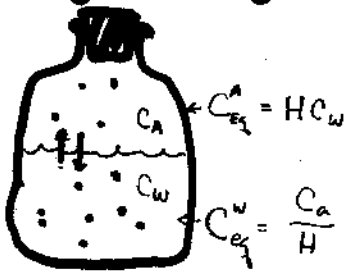


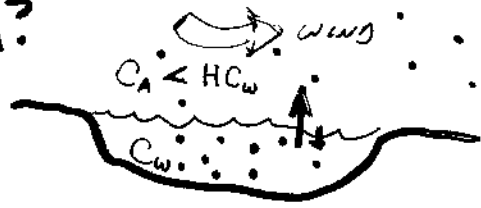
AIR-WATER EXCHANGE

AT FULL EQUILIBRIUM: Henry's Law governs:

$$\frac{C_A}{C_W} = H$$



BUT WHAT IF SYSTEM NOT AT EQUILIBRIUM?



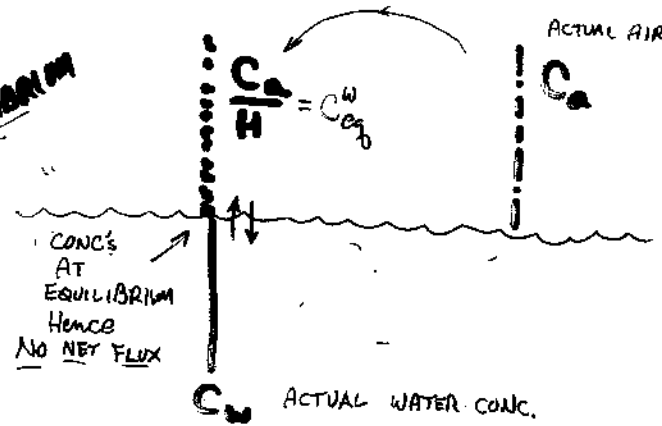
WILL BE NET LOSS OF VOLATILIZATION FROM WATER IN TO AIR

FLUX DENSITY THAT RESULTS:

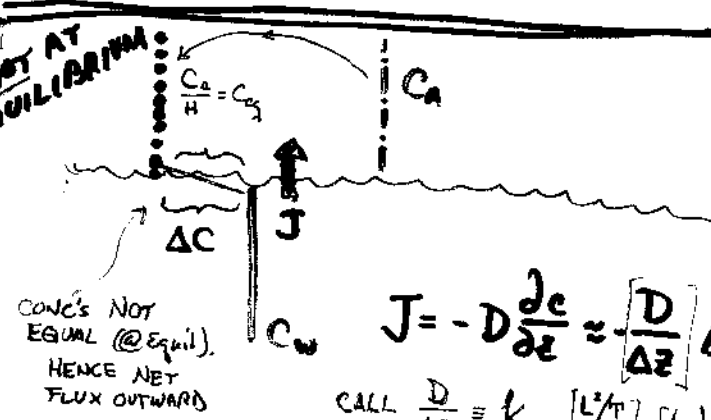
$$J = -k_w [C_w - C_{equil}] = -k_w [C_w - \frac{C_A}{H}]$$

ANALYZE THAT EQN A BIT...

AT EQUILIBRIUM



NOT AT EQUILIBRIUM



$$J = -D \frac{dc}{dz} \approx -\left[\frac{D}{\Delta z} \right] \Delta C$$

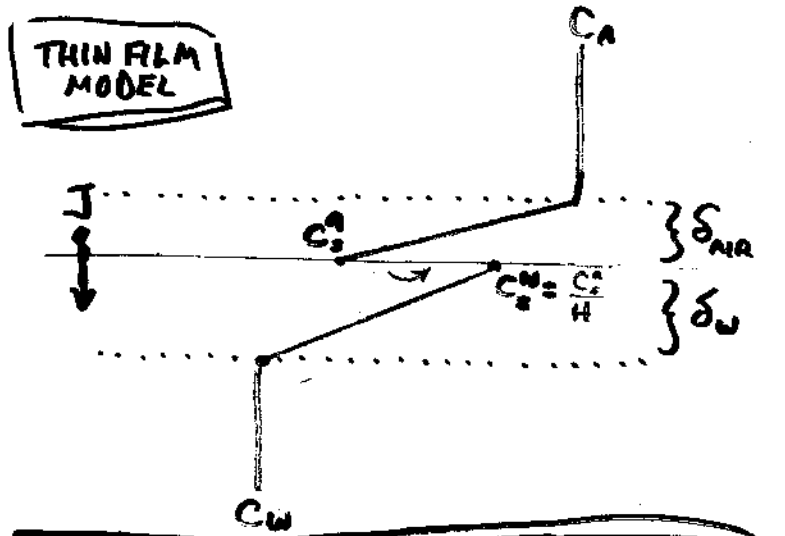
CALL $\frac{D}{\Delta z} = k_w \left[\frac{L^2/\tau}{L} \right] = \left[\frac{L}{\tau} \right]$

$$J = -k_w [C_w - C_{eq}] = -k_w [C_w - \frac{C_A}{H}]$$

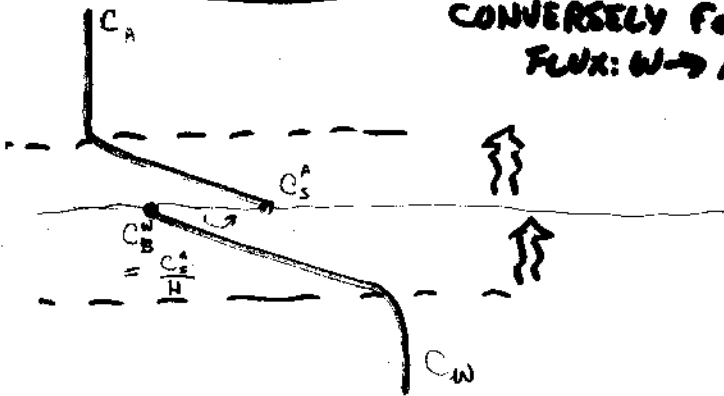
"PISTON VELOCITY"

NET FLUX AIR \rightarrow WATER

THIN FILM MODEL



CONVERSELY FOR
FLUX: W \rightarrow A



ONE SIDE IS USUALLY THE "BOTTLENECK"

$$H = k_{L,A} / k_{L,W}$$

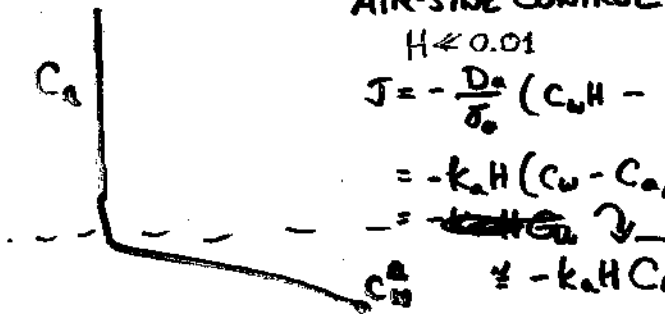
AIR-SIDE CONTROL

$$H \ll 0.01$$

$$J = -\frac{D_a}{\delta_a} (C_w H - C_a)$$

$$= -k_a H (C_w - C_a / H)$$

$$= -k_a H C_w$$



WATER-SIDE CONTROL

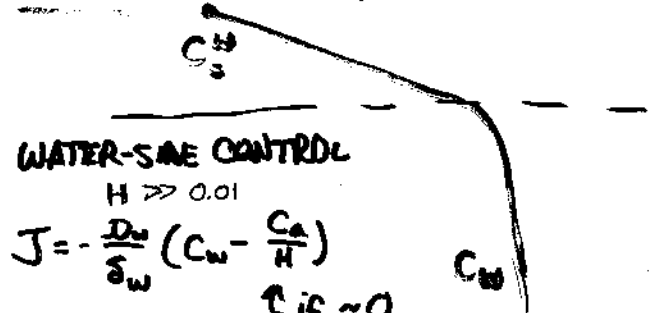
$$H \gg 0.01$$

$$J = -\frac{D_w}{\delta_w} (C_w - \frac{C_a}{H})$$

\uparrow if ~ 0

$$J = -k_w C_w$$

NEED
k only for
water



In General

$$J = - \left[\frac{1}{\frac{\delta_w}{D_w} + \frac{\delta}{D_a H}} \right] \left[C_w - \frac{C_a}{H} \right]$$

Can use this

1. For general case of no one phase controlling

2. To inspect possible (advance) simplifications)

ESTIMATING k_w

$$\frac{k_a}{k_b} = \frac{D_a}{D_b} \approx \frac{\sqrt{MW_b}}{\sqrt{MW_a}}$$

E.g. Use propane in a river or lake & convert to gas of interest

GRAHAM'S LAW OF DIFFUSION

For an IDEAL GAS:

$$K.E. = \frac{1}{2} m v^2$$

And TEMPERATURE is defined as a measure of the mean kinetic energy of molecules

$$\therefore \overline{K.E.} \propto T$$

So if two gases at same T , they have same $\overline{K.E.}$

$$\overline{K.E.}_1 = \overline{K.E.}_2 \rightarrow \frac{1}{2} m_1 v_1^2 = \frac{1}{2} m_2 v_2^2$$

$$\frac{v_1^2}{v_2^2} = \frac{m_2}{m_1}$$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{m_2}{m_1}}$$

GRAHAM LAW

$$HCl: FW = 36.5$$

$$NH_3: FW = 17.0$$

$$\frac{v_{NH_3}}{v_{HCl}} = \sqrt{\frac{36.5}{17.0}} = \underline{\underline{1.46}}$$

VOLATILIZATION FROM PURE PHASE

E.g. a SPILL OF LIQUID



$$J = - \frac{D_a}{\delta_a} C_a^s$$

VAPOR PRESSURE
CONVERTED TO
CONC (say, mg/L)

$\uparrow k$ (piston velocity) $\left\{ \begin{array}{l} \cdot \text{Molec. Weight} \\ \cdot \text{Size of spill} \end{array} \right.$

Gas-phase
Xfr coeff:

$$v = 0.029 v_{wind} L^{-0.11} Sc^{-0.62}$$

$$\text{Schmidt No.} \equiv \frac{\nu \leftarrow \text{Kin. viscosity}}{D \leftarrow \text{Diffus. Coeff}}$$

But exponents are small so often
neglect L & Sc factors

Schmidt Number

$$Sc = \frac{\nu_B}{D_{AB}}$$

KINEMATIC VIS
OF FLUID B

DIFFUSION COE
A IN FLUID B

