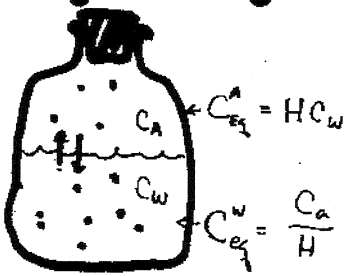
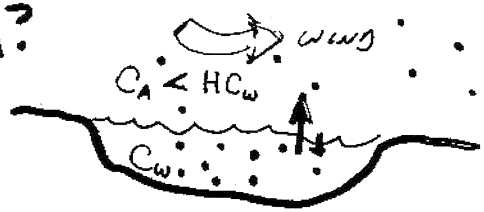
# AIR-WATER EXCHANGE

AT FULL EQUILIBRIUM: Henry's Law governs:

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




BUT WHAT IF SYSTEM NOT AT EQUILIBRIUM?

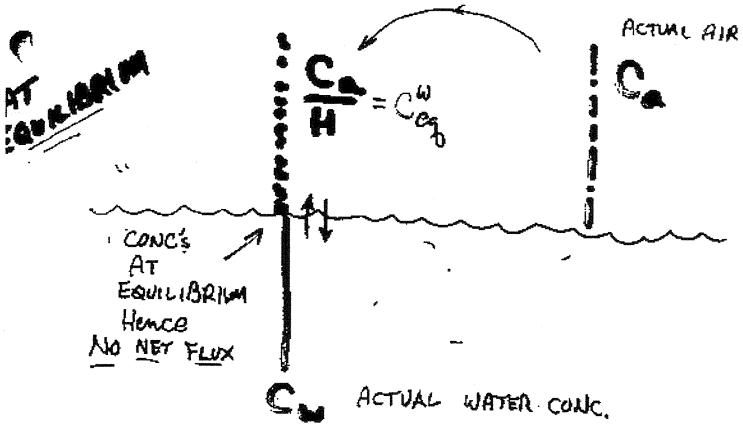


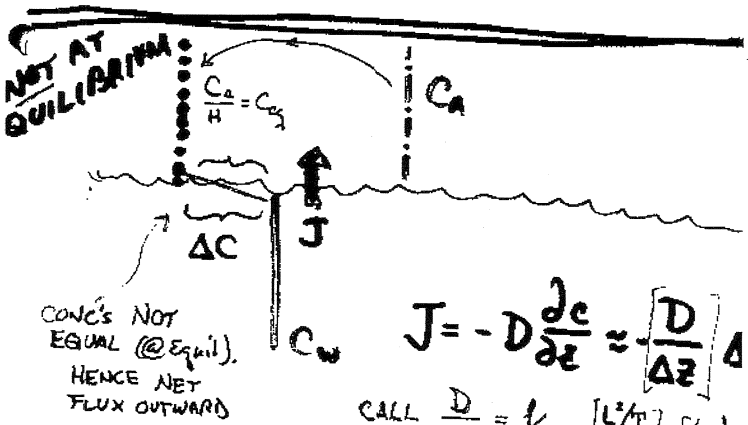

WILL BE NET LOSS OF VOLATILIZATION FROM WATER IN TO AIR

FLUX DENSITY THAT RESULTS:

$$J = -k_w\left[C_w - C_{equil}\right] = -k_w\left[C_w - \frac{C_a}{H}\right]$$

# ANALYZE THAT EQN A BIT...



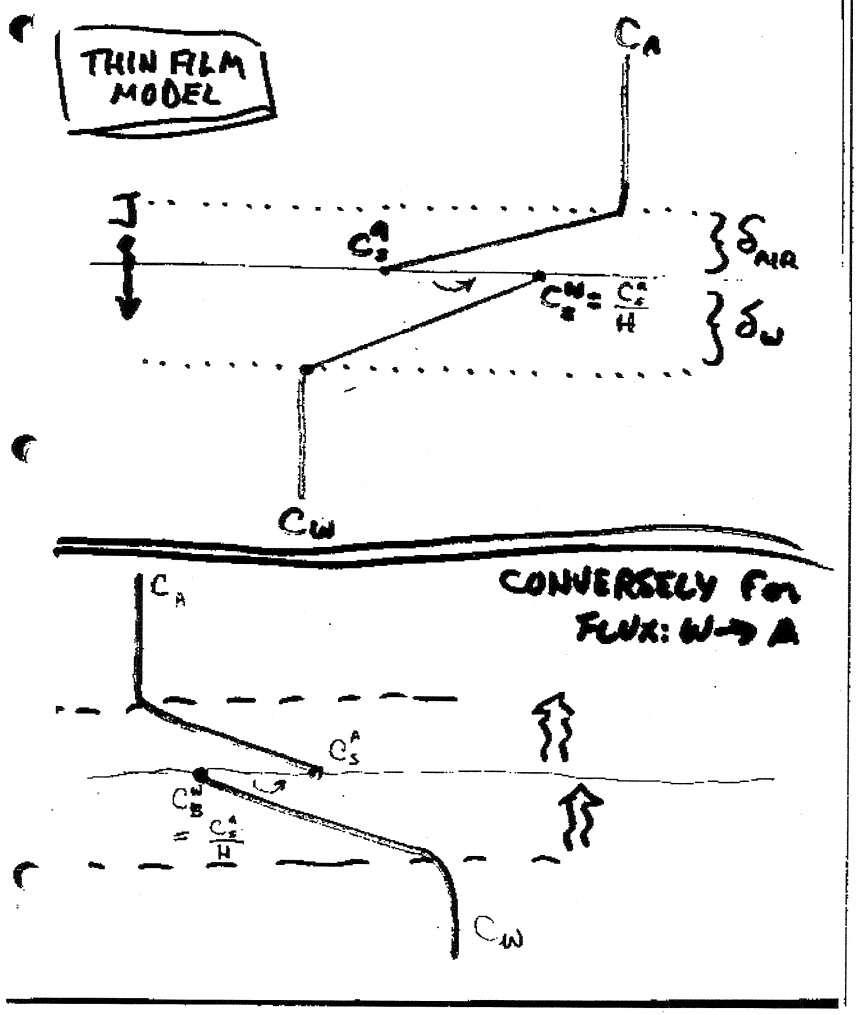

$$J = -D\frac{\partial c}{\partial z} \approx -\left[\frac{D}{\Delta z}\right]\Delta$$

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

$$J = -k_w\left[C_w - C_{eq}\right] = -k_w\left[C_w - \frac{C_a}{H}\right]$$

"PISTON VELOCITY"

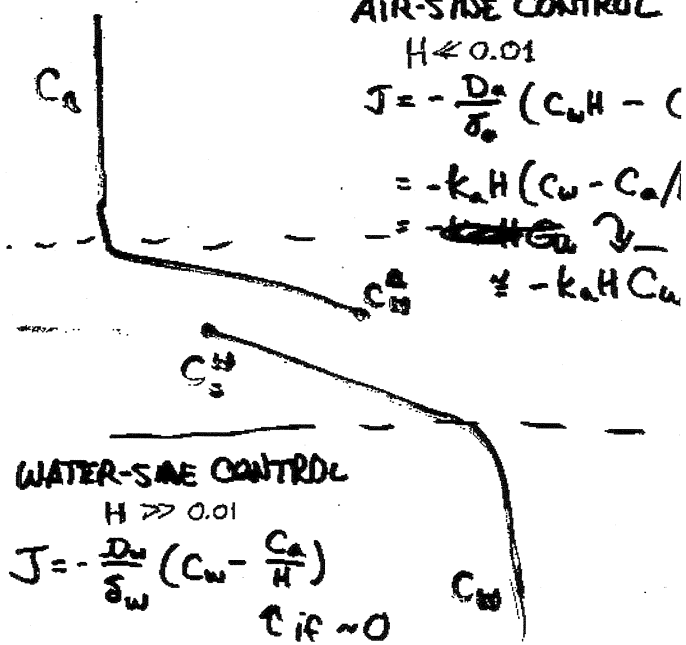
NET FLUX AIR → WATER




CONVERSELY FOR FLUX: W → A

ONE SIDE IS USUALLY THE "BOTTLEN

$H = k_{w\to a}/k_{a\to w}$




AIR-SIDE CONTROL

$H \ll 0.01$

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

$= -k_a H (C_W - C_a/$

$= -k_a H C_W$

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 $k_w$

$$\frac{k_a}{k_b} = \frac{D_a}{D_b} \simeq \frac{\sqrt{MW_b}}{\sqrt{MA_a}}$$

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

## GRAHAM'S LAW OF DIFFUSI

For an IDEAL GAS:

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

And TEMPERATURE is defined as a measu of the mean kinetic energy of mole

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

So if two gases at same T, they have s

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

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

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

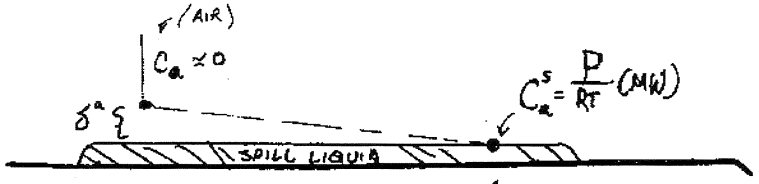
$HCl$: FW = 36.5

$NH_3$: FW = 17.0

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

# VOLATILIZATION FROM PURE PHASE

## E.g. a SPILL OF LIQUID




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

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

↑ k (piston velocity) { • Molec. Weight • Size of spill

Gas-phase xfr coeff: $v = 0.029\, v_{WIND}\, L^{-0.11} Sc^{-0.67}$

$$\text{Schmidt No.} \equiv \frac{\nu}{D}$$ ← $\nu$ = KIN. VISCOSITY, $D$ ← DIFFUSN COEFF

But exponents are small so often neglect L & Sc factors

# Schmidt Number

$$Sc = \frac{\nu_B}{D_{AB}}$$ ← $\nu_B$ KINEMATIC VIS OF FLUID B; $D_{AB}$ ← DIFFUSION COE A IN FLUID