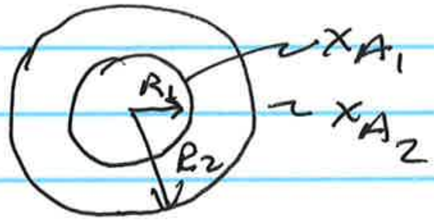
POD 17



liquid A is evaporating. What is the flux?

$$\frac{\partial C_A}{\partial t} + \underset{\sim}{\nabla} \cdot \underset{\sim}{N}_A = R_A$$

($\frac{\partial C_A}{\partial t} \to 0$ (pseudo SS), $R_A \to 0$)

$$\therefore \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 N_{Ar}\right) = 0$$

or $r^2 N_{Ar} = \underline{\underline{cst}}$

Now $\underset{\sim}{N}_A = x_A(\underset{\sim}{N}_A + \underset{\sim}{N}_B) - c\mathcal{D}_{AB}\underset{\sim}{\nabla} x_A$

($N_B \to 0$ (doesn't dissolve!))

so $N_{Ar}(1-x_A) = -c\mathcal{D}_{AB}\frac{\partial x_A}{\partial r}$

or $r^2 N_{Ar} = \frac{-c\mathcal{D}_{AB}}{1-x_A} r^2 \frac{\partial x_A}{\partial r} = \underline{cst}$

Now we have $x_B = 1 - x_A$

$$\therefore \frac{+c\mathcal{D}_{AB}}{x_B} r^2 \frac{\partial x_B}{\partial r} = cst = C_1 \equiv R_1^2 N_{Ar_1}$$

$$c \mathcal{D}_{AB}\, d \ln x_B = c_1 \frac{dr}{r^2} = -c_1\, d(1/r)$$

$$\therefore\ c \mathcal{D}_{AB} \ln x_B = \frac{-c_1}{r} + c_2$$

we have $x_{B_1} = 1 - x_{A_1}$, $x_{B_2} = 1 - x_{A_2}$

and $x_B\big|_{r=R_1} = x_{B_1}$, $x_B\big|_{r=R_2} = x_{B_2}$

so $c \mathcal{D}_{AB} \ln x_{B_1} = \dfrac{-c_1}{R_1} + c_2$

$c \mathcal{D}_{AB} \ln x_{B_2} = \dfrac{-c_1}{R_2} + c_2$

subtracting:

$$c \mathcal{D}_{AB} \ln \frac{x_{B_1}}{x_{B_2}} = -c_1 \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\text{so } c_1 = \frac{c \mathcal{D}_{AB} \ln \frac{x_{B_2}}{x_{B_1}}}{\frac{1}{R_1} - \frac{1}{R_2}} = R_1^2 N_{Ar}\big|_{R_1}$$

$$\therefore\ 4\pi R_1^2 N_{Ar}\big|_{R_1} = \frac{4\pi R_1 R_2}{R_2 - R_1} c \mathcal{D}_{AB} \ln \frac{x_{B_2}}{x_{B_1}}$$

(↳ loss of A from drop)

$$= \frac{4\pi R_1 R_2}{R_2 - R_1} c \mathcal{D}_{AB} \ln\left(\frac{1 - x_{A_2}}{1 - x_{A_1}}\right)$$

Now if $x_{A_1}, x_{A_2} \ll 1$

and $R_2 - R_1 \ll R_1$ (small layer)

Then $4\pi R_1^2 N_{Ar}\Big|_{R_1} \cong 4\pi R_1^2 \mathcal{D}_{AB} \frac{c_{A_1} - c_{A_2}}{R_2 - R_1}$

Which would be the "flat earth limit"

In general, x_{A_1} (eq. conc at drop surface) depends on Temp. Evaporation cools the drop! Thus you get a combined mass & energy transport problem.