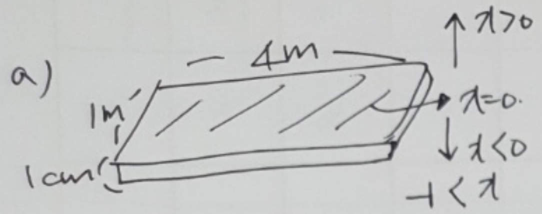
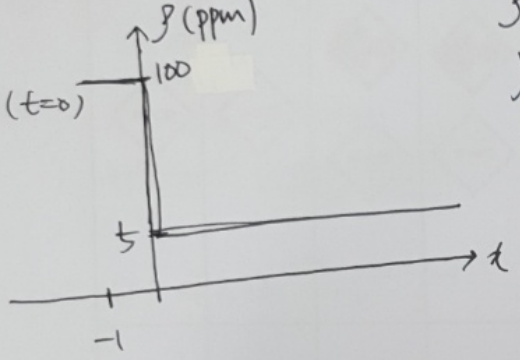
20202238 권지혜

1. a)



initial condition



$\rho(-1<x<0,\ t=0) = 100\,\text{ppm}$

$\rho(\ x>0,\ t\ ) = 5\,\text{ppm}$

$$\frac{d\rho}{dt} = D\frac{\partial^2\rho}{\partial x^2}$$ (높이방향 x 안 고려)

b) Superposition Principle, thin film source.

$$C(x,t) = \frac{A}{\sqrt{t}}\exp\left(-\frac{x^2}{4Dt}\right),\quad M = \int_{-\infty}^{\infty} C(x,t)\,dx \rightarrow A = \frac{M}{\sqrt{4\pi D}}$$

$$\rho(x,t) = \int_{-1}^{\infty}\rho_i(x,t)\,d\alpha = \int_{-1}^{0}\frac{100}{\sqrt{4\pi Dt}}\exp\left(-\frac{(x-a)^2}{4Dt}\right)da + \int_{0}^{\infty}\frac{5}{\sqrt{4\pi Dt}}\exp\left(-\frac{(x-a)^2}{4Dt}\right)da$$

$\langle$ Assumption) $\frac{x-a}{\sqrt{4Dt}} = \eta$, $da = -\sqrt{4Dt}\,d\eta$ $\rangle$

$$= -\frac{100}{\sqrt{\pi}}\int_{\frac{x+1}{\sqrt{4Dt}}}^{\frac{x}{\sqrt{4Dt}}}\exp(-\eta^2)\,d\eta - \frac{5}{\sqrt{\pi}}\int_{\frac{x}{\sqrt{4Dt}}}^{-\infty}\exp(-\eta^2)\,d\eta$$

$$= 50\left(\text{erf}\left(\frac{x+1}{4Dt}\right) - \text{erf}\left(\frac{x}{4Dt}\right)\right) + \frac{5}{2}\left(\text{erf}\left(\frac{x}{\sqrt{4Dt}}\right) + 1\right)$$

$$= 50\,\text{erf}\left(\frac{x+1}{\sqrt{4Dt}}\right) - \frac{95}{2}\text{erf}\left(\frac{x}{\sqrt{4Dt}}\right) + \frac{5}{2}.$$

$*\ \text{erf}(x) = \frac{2}{\sqrt{\pi}}\int_0^z e^{-\eta^2}d\eta.$

c) $\rho(-0.5, t) = 50\,\mathrm{erf}\left(\frac{0.5}{\sqrt{4Dt}}\right) - \frac{95}{2}\mathrm{erf}\left(\frac{-0.5}{\sqrt{4Dt}}\right) + \frac{5}{2}$

-1 ~ 0 의중간에
위치하여 2연관값 가진다.

$= \frac{195}{2}\mathrm{erf}\left(\frac{1}{4\sqrt{Dt}}\right) + \frac{5}{2} = \frac{100}{2} = 50$ (ppm)

$\downarrow$

$\mathrm{erf}\left(\frac{1}{4\sqrt{Dt}}\right) = \frac{95}{195} = \frac{19}{39}$

$D = 4\times10^{-7}\,cm^2 s^{-1}$

$\therefore \frac{1}{4\sqrt{Dt}} = \frac{19}{39} \Rightarrow t = 658527\ s \approx 182.9\ hr.$

d) $\frac{1}{4\sqrt{Dt}} = \frac{\rho_0}{2} \rightarrow t = \left(\frac{1}{2\rho_0}\right)^2 \cdot \frac{1}{D}$

D라 ρ_0에 반비례하다. ∴ 더 짧은 t 소요.

2. a) Distance $\propto (\text{time})^{1/2}$.

At $T = 1173K$. $D = 1.1965 \times 10^{-9}\ cm^2/sec$.

For D (total) = 1000 μm. total time (24hr = 86400sec)

Injection time (hr)	distance (μm)
0	0
2.37	30.3
4.74	42.5
7.11	50.5
9.47	60.6
11.84	70
14.21	70
16.58	80
18.95	90
21.32	90
23.69	90.

b)

temperature (K)	distance (μm)
1173	90
1273	171.7
1373	293
1473	480

(At time 23.96h)

$D \propto \text{Temperature}^2$ 관계 성립.

c) $l \propto \sqrt{Dt}$. $D = D_0 \exp(-\frac{Q}{RT})$ 에서

$T_1 = 1173$.
$T_2 = 1473$.
같은시간 (23.96h)

$$\frac{l_1}{l_2} = \sqrt{\frac{\exp(-\frac{Q}{RT_1})}{\exp(-\frac{Q}{RT_2})}} = \sqrt{\exp\left\{-\frac{Q}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)\right\}} = \frac{3}{16}$$

$\therefore Q = 160313J$