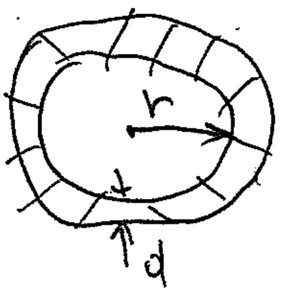
(Q4)



$V = \frac{4}{3}\pi r^3 \rightarrow r = 28.8\,cm$
for $100\,L = V$

<u>Assumptions</u>: (i) $d = 1\,cm << r = 28.8\,cm$, so curvature can be neglected.

(ii) There's equilibrium at the g-s interface

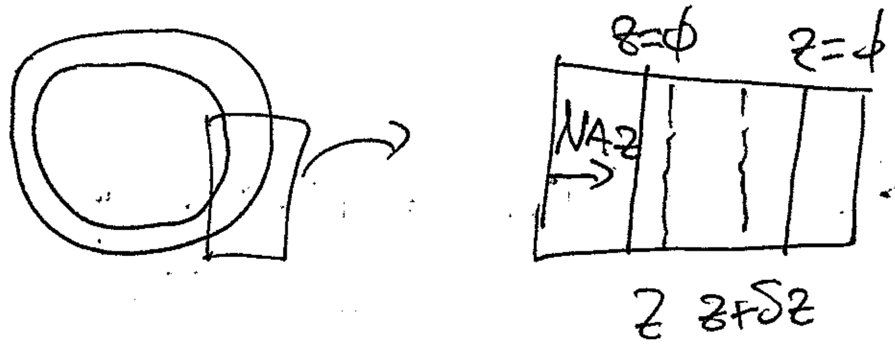
(iii) Ideal gas: $P = cRT$ (1) $\rightarrow$

$$\rightarrow \quad \frac{dP}{dt} = RT\frac{dc}{dt} \quad (2)$$

(iv) Considering that C_{A0} is the initial H_2 conc. in the tank, C_A is the conc. that has diffused through the walls, then:

$$C = C_{A0} - C_A \rightarrow \frac{dc}{dt} = \cancel{\frac{dC_{A0}}{dt}} - \frac{dC_A}{dt} \rightarrow$$

$$\rightarrow \frac{dc}{dt} = -\frac{dC_A}{dt} = -\frac{1}{V} * \left(\text{diffusion rate of } H_2 \text{ thru the walls}\right) \quad (3)$$



ⓐ **Mass Balance for the**

$$S\, N_{Az}\big|_{z+\Delta z} - S\, N_{A}\big|_{z} = \phi \xrightarrow[\text{and } \delta z \to \phi]{\text{divide by } S \cdot dz}$$

$$\rightarrow \frac{dN_{Az}}{dz} = \phi \quad (4)$$

assumptions: steady state, no rxn, stainless still is stagnant. $X_A \ll 1$ due to diffusion in solid

T, P constant inside the wall

Fick's law

$$N_{Az} = -c\, D_{AB} \frac{dx_A}{dz} + \cancel{X_A (N_{Az} + N_{Bz})}^{\phi}$$

$$\rightarrow N_{Az} = -D_{AB} \frac{dC_A}{dz} \quad (5)$$

$$(4) \xrightarrow{(5)} \frac{d^2 C_A}{dz^2} = \phi \quad (6)$$

BCs: for $z=\phi \rightarrow C_A = C_{A0}$

for $z=d \rightarrow C_A = C_{A_1} = \phi$ Because it's vacuum outside the tank.

Integrate (6) twice: $\frac{d^2 C_A}{dz^2} = \phi \rightarrow$

$$\rightarrow \frac{dC_A}{dz} = C_1 \rightarrow C_A = C_1 z + C_2 \quad (7)$$

from BC1: $C_2 = C_{A0}$ (8)

from BC2: $C_1 = \frac{C_{A1} - C_{A0}}{d} = \frac{-C_{A0}}{d}$ (9)

$$(7) \xrightarrow[(9)]{(8)} C_A - C_{A0} = -C_{A0}\frac{z}{d} \quad (10)$$

and $(5) \rightarrow N_{Az} = -D_{AB}\frac{dC_A}{dz} \xrightarrow{(10)}$

$$\Rightarrow \boxed{N_{Az} = D_{AB} C_{A0} / d.} \quad (11)$$

(b) The rate (in $\frac{gmol}{s}$), H_2 diffuses is equal to: $N_{Az} * 4\pi r^2$ (12)

From (3) and (12) $\rightarrow \frac{dc}{dt} = -\frac{1}{\frac{4}{3}\pi r^3} \frac{D_{AB} C_{A0}}{d} * 4\pi r^2$

$\longrightarrow$

$$\rightarrow \frac{dc}{dt} = -\frac{3 \cdot D_{AB} C_{A0}}{r \cdot d} \quad (13)$$

finally, (2) $\xrightarrow{(13)}$ $\boxed{\frac{dP}{dt} = -\frac{3 D_{AB} C_{A0}}{r \cdot d} RT}$