

$$j_1|_{x=0} = \sqrt{\frac{D}{\pi t}} (c_{10} - c_{1\infty})$$

The concentration at the surface is given by Henry's Law:

$$c_{10} = \frac{p}{H} = \frac{0.93 \text{ atm}}{37000 \frac{\text{cm}^3 \text{ atm}}{\text{mol}}} = 2.5 \cdot 10^{-5} \frac{\text{mol}}{\text{cm}^3}$$

Since we have a semiinfinite slab we assume $c_{1\infty} = 0$. To find the flux over the total time t , we integrate:

$$N_1 = \int_0^t A j_1|_{x=0} dt = A \int_0^t \sqrt{\frac{D}{\pi t}} (c_{10} - 0) dt = A c_{10} \sqrt{\frac{D}{\pi}} \int_0^t \frac{dt}{\sqrt{t}} = 2 A c_{10} \sqrt{\frac{D}{\pi}} \left[\sqrt{t} \right]_0^t = 2 A c_{10} \sqrt{\frac{Dt}{\pi}}$$

Assuming an ideal gas, the flux N_1 is given by:

$$N_1 = \frac{PV}{RT} = \frac{(0.93 \text{ atm})(0.82 \text{ cm}^3)}{\left(82.06 \frac{\text{cm}^3 \text{ atm}}{\text{K} \cdot \text{mol}}\right)(289 \text{ K})} = 3.2 \cdot 10^{-5} \text{ mol}$$

Solving for D , we have:

$$D = \left(\frac{N_1}{2 A c_{10}} \right)^2 \cdot \frac{\pi}{t} = \left[\frac{3.2 \cdot 10^{-5} \text{ mol}}{(36.3 \text{ cm}^2) \left(2.5 \cdot 10^{-5} \frac{\text{mol}}{\text{cm}^3} \right)} \right]^2 \cdot \frac{\pi}{180 \text{ s}} = 5.4 \cdot 10^{-6} \frac{\text{cm}^2}{\text{s}}$$

4. Permeability of water across a polymer film

The rate of water loss can be found by linear regression or by simply using the first and last data points:

$$N_1 = \frac{14.0153 \text{ g} - 13.5256 \text{ g}}{16 \text{ days}} = 0.031 \frac{\text{g}}{\text{day}}$$

The molar flux is given by:

$$j_1 = \frac{N_1}{A} = \frac{0.031 \frac{\text{g}}{\text{day}} \cdot \frac{1 \text{ mol}}{18.015 \text{ g}} \cdot \frac{1 \text{ day}}{24 \text{ hr}} \cdot \frac{1 \text{ hr}}{3600 \text{ s}}}{85.6 \text{ cm}^2} = 2.3 \cdot 10^{-10} \frac{\text{mol}}{\text{cm}^2 \text{ s}}$$

From Eq. (2-2.10) we have:

$$j_1 = \frac{DH}{\ell} \Delta c_1$$

We need to find Δc_1 . We first calculate the difference in the partial pressure of water across the film. From a steam table we find that at 35 °C, $p_{\text{sat}} = 0.0555 \text{ atm}$. Since the air inside the bag is saturated, we have:

$$\Delta p_1 = p_{\text{sat}} - 0.75 p_{\text{sat}} = 0.25 p_{\text{sat}} = 0.25(0.0555 \text{ atm}) = 0.0139 \text{ atm}$$

Assuming an ideal gas, the concentration difference is:

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Kathleen Armour



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