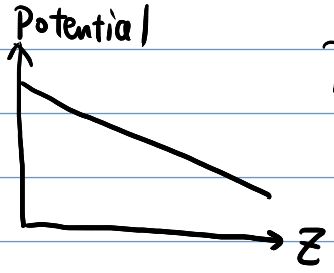
CHE 318 L01 Introduction

Slide 24/25 meaning of negative sign



Def: $\text{potential}\big|_{\text{Left}} > \text{potential}\big|_{\text{Right}}$

↳ Flux J towards +z

As driving force

Def: $\text{gradient} = \dfrac{\text{potential}\big|_{\text{right}} - \text{potential}\big|_{\text{left}}}{z_{\text{right}} - z_{\text{left}}}$

↳ gradient < 0

Flux = − Coefficient × Driving Force

Why coefficients have unit $[m]^2 \cdot [s]^{-1}$?

$$[\text{Flux}] = -[\text{coeff}] \cdot [\text{gradient}]$$

$$\Downarrow \qquad \Downarrow$$

$$\frac{[\text{property}]}{[\text{Area}] \cdot [\text{time}]} \qquad \frac{[\text{property}]}{[\text{volume}]} \; \frac{1}{[\text{length}]}$$

Must have unit $[\text{volue}][\text{length}] / ([\text{Area}] \cdot [\text{time}])$

$$\Downarrow$$

$$m^2 \cdot s^{-1}$$

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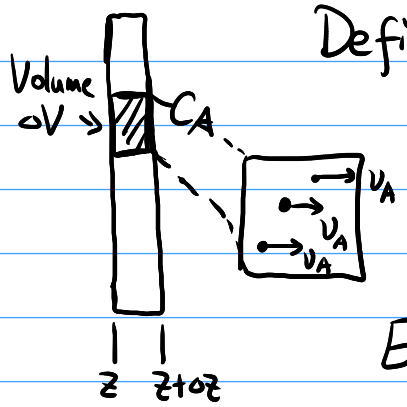
Velocity form of mass transfer



Definition of flux $\frac{[\text{amount of A}]}{[\text{Area}][\text{time}]}$

For short time Δt

Each A molecule move by $\Delta z = v_A \Delta t$

Consider area S $\Rightarrow$ volume moved $= \Delta V = S\Delta z = S v_A \Delta t$

total amount of A moved $= \Delta n_A = C_A \Delta V = C_A S v_A \Delta t$

Flux by definition $\text{Flux} = \frac{\Delta n_A}{S \Delta t} = C_A v_A$

If flux is fully diffusive

$J^*_{Az} = C_A v_{Ad}$ → reference frame relative to fluid

Additive velocity

convective v_m

diffusive v_{Ad}

v_A

We use N_A for total flux of A

$N_A = C_A \cdot v_A$

$= C_A \cdot v_{Ad} + C_A \cdot v_m$

$= J^*_{Az} + C_A \cdot v_m$

what's this?

Let's consider $N_A + N_B = N$ (total flux)

$N = J^*_{Az} + C_A \cdot v_m + J^*_{Bz} + C_B \cdot v_m$

$= (J^*_{Az} + J^*_{Bz}) + (C_A + C_B) v_m$

$\Downarrow$

C_T

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Relation between J_{Az}^* & J_{Bz}^*

interdiffusivity

$$J_{Az}^* = -D_{AB}\frac{dC_A}{dz} \quad ; \quad J_{Bz}^* = -D_{BA}\frac{dC_B}{dz}$$

Binary mixture, generally $D_{AB} = D_{BA}$

$$\frac{dC_A}{dz} = \frac{d(C_T - C_B)}{dz} = -\frac{dC_B}{dz}$$

$$\therefore J_{Az}^* + J_{Bz}^* = 0$$

$$N = N_A + N_B = C_T \cdot v_m$$

To an observer at stationary point, total flux is just driven by fluid velocity