

9/30/2019

Recap

$$f_y = -\frac{u l}{6} \frac{\partial b}{\partial y} ; f_y = -D \frac{\partial b}{\partial y}$$

$$D = \frac{u l}{6}$$

$u \equiv c$ molecular velocity

$l \equiv \lambda$ "smallest jump distance"
or in Gas Kinetic Theory, λ is referred to the "mean free path" between collisions

Gas Kinetic Theory

$$c = \left(\frac{8RT}{\pi M} \right)^{\frac{1}{2}} = \left(\frac{8k_B T}{\pi m} \right)^{\frac{1}{2}}$$

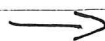
$$\lambda = \frac{RT}{\sqrt{2} \pi d^2 N_A P} = \frac{k_B T}{\sqrt{2} \pi d^2 P}$$

$k_B = 1.38 \times 10^{-23} \text{ J/K}$ (Boltzmann constant)

$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ (Avogadro Number)

$M = \left(\frac{1}{M_A} + \frac{1}{M_B} \right)^{-1}$ (convoluted molar mass) [kg/kmol]

$R = 8.314 \text{ J/K} \cdot \text{mol}$ (ideal (universal) gas constant)



(2)

more parameters in Gas Kinetic Theory:

$$d = \frac{1}{2} (d_A + d_B) \quad \text{convoluted molecular diameter [m]}$$

$$m = \left(\frac{1}{M_A} + \frac{1}{M_B} \right)^{-1} \quad \text{convoluted molecular weight [kg]}$$

As per Deen (p. 15), the gas kinetic theory yields for the transport coefficients:

$$k = \rho C_p \alpha = \frac{1}{3\pi^{3/2}} \frac{(m k_B T)^{1/2} C_p}{d^2}$$

$$D_{AB} = \mathcal{D} = \frac{1}{3\pi^{3/2}} \frac{(k_B T)^{3/2}}{d^2 m^{1/2} P}$$

$$\mu = \rho \nu = \frac{1}{3\pi^{3/2}} \frac{(m k_B T)^{1/2}}{d^2}$$

with $\mathcal{D} = \nu = \alpha$

Note $1 \text{ Da (Da)} = 1.661 \times 10^{-27} \text{ kg}$