Important Molar Diffusion Formulas PDF

Formulas
Examples
with Units

List of 17
Important Molar Diffusion Formulas

1) Convective Mass Transfer Coefficient Formula

Evaluate Formula

Formula

$$k_L = \frac{m_a}{\rho_{a1} - \rho_{a2}}$$

Example with Units

$$0.45\,\mathrm{m/s} = \frac{9\,\mathrm{kg/s/m^2}}{40\,\mathrm{kg/m^3} - 20\,\mathrm{kg/m^3}}$$

2) Logarithmic Mean of Concentration Difference Formula

Evaluate Formula

Formula

$$C_{bm} = \frac{C_{b2} - C_{b1}}{\ln\left(\frac{C_{b2}}{C_{b1}}\right)}$$

Example with Units

$$12.3315\,\mathrm{mol/L} = \frac{10\,\mathrm{mol/L} - 15\,\mathrm{mol/L}}{\ln\left(\frac{10\,\mathrm{mol/L}}{15\,\mathrm{mol/L}}\right)}$$

3) Logarithmic Mean Partial Pressure Difference Formula

Evaluate Formula

Formula

$$P_{bm} = \frac{P_{b2} - P_{b1}}{\ln\left(\frac{P_{b2}}{P_{b1}}\right)}$$

Example with Units

$$9571.8088\,\mathrm{Pa} = \frac{10500\,\mathrm{Pa} - 8700\,\mathrm{Pa}}{\ln\left(\frac{10500\,\mathrm{Pa}}{8700\,\mathrm{Pa}}\right)}$$

4) Mass Diffusing Rate through Hollow Cylinder with Solid Boundary Formula

Evaluate Formula

Formula

$$m_r = \frac{2 \cdot \pi \cdot D_{ab} \cdot l \cdot \left(\rho_{a1} - \rho_{a2}\right)}{\ln\left(\frac{r_2}{r_1}\right)}$$

Example with Units

$$9333.7372\,\mathrm{kg/s} = \frac{2 \cdot 3.1416 \cdot 0.8\,\mathrm{m^2/s} \cdot 102\,\mathrm{m} \cdot \left(40\,\mathrm{kg/m^3} - 20\,\mathrm{kg/m^3}\right)}{\ln\left(\frac{7.5\,\mathrm{m}}{2.5\,\mathrm{m}}\right)}$$

5) Mass Diffusing Rate through Solid Boundary Plate Formula

Evaluate Formula

Formula

$$m_r = \frac{D_{ab} \cdot \left(\rho_{a1} - \rho_{a2} \right) \cdot A}{t_p}$$

Example with Units

$$10666.6667\,\text{kg/s} = \frac{0.8\,\text{m}^2\text{/s} \cdot \left(40\,\text{kg/m}^3 - 20\,\text{kg/m}^3 \right) \cdot 800\,\text{m}^2}{1.2\,\text{m}}$$

6) Mass Diffusing Rate through Solid Boundary Sphere Formula

Evaluate Formula

Formula

$$m_r = \frac{4 \cdot \pi \cdot r_i \cdot r_o \cdot D_{ab} \cdot \left(\rho_{a1} - \rho_{a2} \right)}{r_o - r_i}$$

Example with Units

$$12666.9016\,\text{kg/s} = \frac{4 \cdot 3.1416 \cdot 6.3\,\text{m} \cdot 7\,\text{m} \cdot 0.8\,\text{m}^2\text{/s} \cdot \left(40\,\text{kg/m}^3 - 20\,\text{kg/m}^3 \right)}{7\,\text{m} - 6.3\,\text{m}}$$

7) Molar Flux of Diffusing Component A for Equimolar Diffusion with B based on Mole Fraction of A Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{[R] \cdot T \cdot \delta} \right) \cdot \left(y_{a1} - y_{a2} \right)$$

Example with Units

$$56.5038\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s} \cdot 400000\,\text{Pa}}{8.3145 \cdot 298\,\text{K} \cdot 0.005\,\text{m}} \right) \cdot \left(0.6 - 0.35 \right)$$

8) Molar Flux of Diffusing Component A for Equimolar Diffusion with B based on Partial Pressure of A Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D}{[R] \cdot T \cdot \delta} \right) \cdot \left(P_{a1} - P_{a2} \right)$$

Example with Units

$$163.0609\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s}}{8.3145 \cdot 298\,\text{K} \cdot 0.005\,\text{m}} \right) \cdot \left(300000\,\text{Pa} - 11416\,\text{Pa} \right)$$

9) Molar Flux of Diffusing Component A through Non-Diffusing B based on Concentration of A Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{\delta}\right) \cdot \left(\frac{C_{a1} - C_{a2}}{P_b}\right)$$

Example with Units

$$41.4492\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2/\text{s} \cdot 400000\,\text{Pa}}{0.005\,\text{m}}\right) \cdot \left(\frac{0.2074978578\,\text{mol/L} - 0.2\,\text{mol/L}}{101300\,\text{Pa}}\right)$$

10) Molar Flux of Diffusing Component A through Non-Diffusing B based on Log Mean Partial Pressure Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{[R] \cdot T \cdot \delta}\right) \cdot \left(\frac{P_{a1} - P_{a2}}{P_b}\right)$$

Example with Units

$$643.8732\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2/\text{s} \cdot 400000\,\text{Pa}}{8.3145 \cdot 298\,\text{K} \cdot 0.005\,\text{m}}\right) \cdot \left(\frac{300000\,\text{Pa} - 11416\,\text{Pa}}{101300\,\text{Pa}}\right)$$

11) Molar Flux of Diffusing Component A through Non-Diffusing B based on Mole Fractions of A Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{\delta}\right) \cdot \ln\left(\frac{1 - y_{a2}}{1 - y_{a1}}\right)$$

Example with Units

$$271884.3768\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2/\text{s} \cdot 400000\,\text{Pa}}{0.005\,\text{m}}\right) \cdot \ln\left(\frac{1 - 0.35}{1 - 0.6}\right)$$

12) Molar Flux of Diffusing Component A through Non-Diffusing B based on Mole Fractions of A and LMMF Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{\delta}\right) \cdot \left(\frac{y_{a1} - y_{a2}}{y_b}\right)$$

Example with Units

$$215384.6154\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2/\text{s} \cdot 400000\,\text{Pa}}{0.005\,\text{m}}\right) \cdot \left(\frac{0.6 - 0.35}{0.65}\right)$$

13) Molar Flux of Diffusing Component A through Non-Diffusing B based on Mole Fractions of A and LMPP Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot \left(P_t^{\ 2}\right)}{\delta}\right) \cdot \left(\frac{y_{a1} - y_{a2}}{P_b}\right)$$

Example with Units

$$552813.4255\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s} \cdot \left(400000\,\text{Pa}^{\ 2}\right)}{0.005\,\text{m}}\right) \cdot \left(\frac{0.6 - 0.35}{101300\,\text{Pa}}\right)$$

14) Molar Flux of Diffusing Component A through Non-Diffusing B based on Mole Fractions of B Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{\delta}\right) \cdot \ln\left(\frac{y_{b2}}{y_{b1}}\right)$$

Example with Units

$$776324.8422\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s} \cdot 400000\,\text{Pa}}{0.005\,\text{m}}\right) \cdot \ln\left(\frac{0.4}{0.1}\right)$$

15) Molar Flux of Diffusing Component A through Non-Diffusing B based on Partial Pressure of A Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{[R] \cdot T \cdot \delta}\right) \cdot \ln\left(\frac{P_t - P_{a2}}{P_t - P_{a1}}\right)$$

Example with Units

$$306.7792\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s} \cdot 400000\,\text{Pa}}{8.3145 \cdot 298\,\text{K} \cdot 0.005\,\text{m}}\right) \cdot \ln\left(\frac{400000\,\text{Pa} - 11416\,\text{Pa}}{400000\,\text{Pa} - 300000\,\text{Pa}}\right)$$

16) Molar Flux of Diffusing Component A through Non-Diffusing B based on Partial Pressure of B Formula

Evaluate Formula

Formula

$$N_a = \left(\frac{D \cdot P_t}{[R] \cdot T \cdot \delta}\right) \cdot \ln\left(\frac{P_{b2}}{P_{b1}}\right)$$

Example with Units

$$42.5027\,\text{mol/s*m}^2 = \left(\frac{0.007\,\text{m}^2\text{/s} \cdot 400000\,\text{Pa}}{8.3145 \cdot 298\,\text{K} \cdot 0.005\,\text{m}}\right) \cdot \ln\left(\frac{10500\,\text{Pa}}{8700\,\text{Pa}}\right)$$

17) Total Concentration Formula

Evaluate Formula

Formula

$$C = C_a + C_b$$

Example with Units

$$26\,\text{mol/L} = 12\,\text{mol/L} + 14\,\text{mol/L}$$

Variables used in list of Molar Diffusion Formulas above

- **A** Area of Solid Boundary Plate *(Square Meter)*
- **C** Total Concentration *(Mole per Liter)*
- **C_a** Concentration of A *(Mole per Liter)*
- **C_{a1}** Concentration of Component A in 1 *(Mole per Liter)*
- **C_{a2}** Concentration of Component A in 2 *(Mole per Liter)*
- **C_b** Concentration of B *(Mole per Liter)*
- **C_{b1}** Concentration of Component B in Mixture 1 *(Mole per Liter)*
- **C_{b2}** Concentration of Component B in Mixture 2 *(Mole per Liter)*
- **C_{bm}** Logarithmic Mean of Concentration Difference *(Mole per Liter)*
- **D** Diffusion Coefficient (DAB) *(Square Meter Per Second)*
- **D_{ab}** Diffusion Coefficient When A Diffuse with B *(Square Meter Per Second)*
- **k_L** Convective Mass Transfer Coefficient *(Meter per Second)*
- **l** Length of Cylinder *(Meter)*
- **m_a** Mass Flux of Diffusion Component A *(Kilogram per Second per Square Meter)*
- **m_r** Mass Diffusing Rate *(Kilogram per Second)*
- **N_a** Molar Flux of Diffusing Component A *(Mole per Second Square Meter)*
- **P_{a1}** Partial Pressure of Component A in 1 *(Pascal)*
- **P_{a2}** Partial Pressure of Component A in 2 *(Pascal)*
- **P_b** Log Mean Partial Pressure of B *(Pascal)*
- **P_{b1}** Partial Pressure of Component B in 1 *(Pascal)*
- **P_{b2}** Partial Pressure of Component B in 2 *(Pascal)*

Constants, Functions, Measurements used in list of Molar Diffusion Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- constant(s): **[R]**, 8.31446261815324
  Universal gas constant
- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s)
  Mass Flow Rate Unit Conversion
- Measurement: **Molar Concentration** in Mole per Liter (mol/L)
  Molar Concentration Unit Conversion
- Measurement: **Mass Flux** in Kilogram per Second per Square Meter (kg/s/m²)
  Mass Flux Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Diffusivity** in Square Meter Per Second (m²/s)
  Diffusivity Unit Conversion
- Measurement: **Molar Flux of Diffusing Component** in Mole per Second Square Meter (mol/s*m²)
  Molar Flux of Diffusing Component Unit Conversion

- P_{bm} Logarithmic Mean Partial Pressure Difference *(Pascal)*
- P_t Total Pressure of Gas *(Pascal)*
- r_1 Inner Radius of Cylinder *(Meter)*
- r_2 Outer Radius of Cylinder *(Meter)*
- r_i Inner Radius *(Meter)*
- r_o Outer Radius *(Meter)*
- T Temperature of Gas *(Kelvin)*
- t_p Thickness of Solid Plate *(Meter)*
- y_{a1} Mole Fraction of Component A in 1
- y_{a2} Mole Fraction of Component A in 2
- y_b Log Mean Mole Fraction of B
- y_{b1} Mole Fraction of Component B in 1
- y_{b2} Mole Fraction of Component B in 2
- δ Film Thickness *(Meter)*
- ρ_{a1} Mass Concentration of Component A in Mixture 1 *(Kilogram per Cubic Meter)*
- ρ_{a2} Mass Concentration of Component A in Mixture 2 *(Kilogram per Cubic Meter)*

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