Important Formulas in Mass Transfer Coefficient, Driving Force and Theories PDF

Formulas
Examples
with Units

List of 29
Important Formulas in Mass Transfer Coefficient, Driving Force and Theories

1) Average Mass Transfer Coefficient by Penetration Theory Formula

Evaluate Formula

Formula

$$k_{L\,(Avg)} = 2 \cdot \sqrt{\frac{D_{AB}}{\pi \cdot t_c}}$$

Example with Units

$$0.0285\,\mathrm{m/s} = 2 \cdot \sqrt{\frac{0.007\,\mathrm{m^2/s}}{3.1416 \cdot 11\,\mathrm{s}}}$$

2) Average Sherwood Number of Combined Laminar and Turbulent Flow Formula

Evaluate Formula

Formula

$$Sh = \left(\left(0.037 \cdot \left(Re^{0.8} \right) \right) - 871 \right) \cdot \left(Sc^{0.333} \right)$$

Example

$$1074.7799 = \left(\left(0.037 \cdot \left(500000^{0.8} \right) \right) - 871 \right) \cdot \left(12^{0.333} \right)$$

3) Average Sherwood Number of Flat Plate Turbulent Flow Formula

Evaluate Formula

Formula

$$Sh = 0.037 \cdot \left(Re^{0.8} \right)$$

Example

$$1340.8424 = 0.037 \cdot \left(500000^{0.8} \right)$$

4) Average Sherwood Number of Internal Turbulent Flow Formula

Evaluate Formula

Formula

$$Sh = 0.023 \cdot \left(Re^{0.83} \right) \cdot \left(Sc^{0.44} \right)$$

Example

$$3687.3358 = 0.023 \cdot \left(500000^{0.83} \right) \cdot \left(12^{0.44} \right)$$

5) Convective Mass Transfer Coefficient Formula

Evaluate Formula

Formula

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

Example with Units

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

6) Convective Mass Transfer Coefficient for Simultaneous Heat and Mass Transfer Formula

Evaluate Formula

Formula

$$k_L = \frac{h_{transfer}}{c \cdot \rho_L \cdot \left(L_e^{0.67}\right)}$$

Example with Units

$$4E\text{-}5\,\text{m/s} = \frac{13.2\,\text{W/m}^2\text{*K}}{120\,\text{J/(kg*K)} \cdot 1000\,\text{kg/m}^3 \cdot \left(4.5^{0.67}\right)}$$

7) Convective Mass Transfer Coefficient of Flat Plate in Combined Laminar Turbulent Flow Formula

Evaluate Formula

Formula

$$k_L = \frac{0.0286 \cdot u_\infty}{\left(Re^{0.2}\right) \cdot \left(Sc^{0.67}\right)}$$

Example with Units

$$0.0041\,\text{m/s} = \frac{0.0286 \cdot 10.5\,\text{m/s}}{\left(500000^{0.2}\right) \cdot \left(12^{0.67}\right)}$$

8) Convective Mass Transfer Coefficient of Flat Plate Laminar Flow using Drag Coefficient Formula

Evaluate Formula

Formula

$$k_L = \frac{C_D \cdot u_\infty}{2 \cdot \left(Sc^{0.67}\right)}$$

Example with Units

$$29.8009\,\text{m/s} = \frac{30 \cdot 10.5\,\text{m/s}}{2 \cdot \left(12^{0.67}\right)}$$

9) Convective Mass Transfer Coefficient of Flat Plate Laminar Flow using Friction Factor Formula

Evaluate Formula

Formula

$$k_L = \frac{f \cdot u_\infty}{8 \cdot \left(Sc^{0.67}\right)}$$

Example with Units

$$0.1565\,\text{m/s} = \frac{0.63 \cdot 10.5\,\text{m/s}}{8 \cdot \left(12^{0.67}\right)}$$

10) Convective Mass Transfer Coefficient of Flat Plate Laminar Flow using Reynolds Number Formula

Evaluate Formula

Formula

$$k_L = \frac{u_\infty \cdot 0.322}{\left(Re^{0.5}\right) \cdot \left(Sc^{0.67}\right)}$$

Example with Units

$$0.0009\,\text{m/s} = \frac{10.5\,\text{m/s} \cdot 0.322}{\left(500000^{0.5}\right) \cdot \left(12^{0.67}\right)}$$

11) Convective Mass Transfer Coefficient through Liquid Gas Interface Formula

Evaluate Formula

Formula

$$k_L = \frac{m_1 \cdot m_2 \cdot H}{\left(m_1 \cdot H\right) + \left(m_2\right)}$$

Example with Units

$$0.0068\,\text{m/s} = \frac{0.3\,\text{m/s} \cdot 0.7\,\text{m/s} \cdot 0.023}{\left(0.3\,\text{m/s} \cdot 0.023\right) + \left(0.7\,\text{m/s}\right)}$$

12) Fractional Resistance Offered by Gas Phase Formula

Evaluate Formula

Formula

$$FR_g = \frac{\frac{1}{k_y}}{\frac{1}{K_y}}$$

Example with Units

$$0.8497 = \frac{\frac{1}{90\,\mathrm{mol/s^*m^2}}}{\frac{1}{76.46939\,\mathrm{mol/s^*m^2}}}$$

13) Fractional Resistance Offered by Liquid Phase Formula

Evaluate Formula

Formula

$$FR_l = \frac{\frac{1}{k_x}}{\frac{1}{K_x}}$$

Example with Units

$$0.1837 = \frac{\frac{1}{9.2\,\mathrm{mol/s^*m^2}}}{\frac{1}{1.689796\,\mathrm{mol/s^*m^2}}}$$

14) Gas Phase Mass Transfer Coefficient by Two Film Theory Formula

Evaluate Formula

Formula

$$K_y = \frac{1}{\left(\frac{1}{k_y}\right) + \left(\frac{H}{k_x}\right)}$$

Example with Units

$$73.4694\,\mathrm{mol/s^*m^2} = \frac{1}{\left(\frac{1}{90\,\mathrm{mol/s^*m^2}}\right) + \left(\frac{0.023}{9.2\,\mathrm{mol/s^*m^2}}\right)}$$

15) Gas Phase Mass Transfer Coefficient using Fractional Resistance by Gas Phase Formula

Evaluate Formula

Formula

$$k_y = \frac{K_y}{FR_g}$$

Example with Units

$$90\,\mathrm{mol/s^*m^2} = \frac{76.46939\,\mathrm{mol/s^*m^2}}{0.84966}$$

16) Heat Transfer Coefficient for Simultaneous Heat and Mass Transfer Formula

Evaluate Formula

Formula

$$h_{transfer} = k_L \cdot \rho_L \cdot c \cdot \left(L_e^{0.67}\right)$$

Example with Units

$$3122.8939\,\mathrm{W/m^{2*}K} = 9.5\mathrm{e}{-3}\,\mathrm{m/s} \cdot 1000\,\mathrm{kg/m^3} \cdot 120\,\mathrm{J/(kg^*K)} \cdot \left(4.5^{0.67}\right)$$

17) Liquid Phase Mass Transfer Coefficient by Two Film Theory Formula

Evaluate Formula

Formula

$$K_x = \frac{1}{\left(\frac{1}{k_y \cdot H}\right) + \left(\frac{1}{k_x}\right)}$$

Example with Units

$$1.6898\,\mathrm{mol/s^*m^2} = \frac{1}{\left(\frac{1}{90\,\mathrm{mol/s^*m^2} \cdot 0.023}\right) + \left(\frac{1}{9.2\,\mathrm{mol/s^*m^2}}\right)}$$

18) Liquid Phase Mass Transfer Coefficient using Fractional Resistance by Liquid Phase Formula

Evaluate Formula

Formula

$$k_x = \frac{K_x}{FR_l}$$

Example with Units

$$9.2\,\mathrm{mol/s^*m^2} = \frac{1.689796\,\mathrm{mol/s^*m^2}}{0.183673}$$

19) Local Sherwood Number for Flat Plate in Laminar Flow Formula

Evaluate Formula

Formula

$$Sh_x = 0.332 \cdot \left({Re_l}^{0.5} \right) \cdot \left(Sc^{0.333} \right)$$

Example

$$0.5632 = 0.332 \cdot \left(0.55^{0.5} \right) \cdot \left(12^{0.333} \right)$$

20) Local Sherwood Number for Flat Plate in Turbulent Flow Formula

Evaluate Formula

Formula

$$Sh_x = 0.0296 \cdot \left({Re_l}^{0.8} \right) \cdot \left(Sc^{0.333} \right)$$

Example

$$0.042 = 0.0296 \cdot \left(0.55^{0.8} \right) \cdot \left(12^{0.333} \right)$$

21) 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

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

22) 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

$$10748.0617\,\mathrm{Pa} = \frac{10500\,\mathrm{Pa} - 11000\,\mathrm{Pa}}{\ln\left(\frac{10500\,\mathrm{Pa}}{11000\,\mathrm{Pa}} \right)}$$

23) Mass Transfer Boundary Layer Thickness of Flat Plate in Laminar Flow Formula

Evaluate Formula

Formula

$$\delta_{mx} = \delta_{hx} \cdot \left(Sc^{-0.333} \right)$$

Example with Units

$$3.7158 = 8.5\,\mathrm{m} \cdot \left(12^{-0.333} \right)$$

24) Mass Transfer Coefficient by Film Theory Formula

Evaluate Formula

Formula

$$k_L = \frac{D_{AB}}{\delta}$$

Example with Units

$$1.4\,\mathrm{m/s} = \frac{0.007\,\mathrm{m^2/s}}{0.005\,\mathrm{m}}$$

25) Mass Transfer Coefficient by Surface Renewal Theory Formula

Evaluate Formula

Formula

$$k_L = \sqrt{D_{AB} \cdot s}$$

Example with Units

$$0.0092\,\mathrm{m/s} = \sqrt{0.007\,\mathrm{m^2/s} \cdot 0.012\,\mathrm{1/s}}$$

26) Mass Transfer Stanton Number Formula

Evaluate Formula

Formula

$$St_m = \frac{k_L}{u_\infty}$$

Example with Units

$$0.0009 = \frac{9.5\text{e-}3\,\mathrm{m/s}}{10.5\,\mathrm{m/s}}$$

27) Overall Gas Phase Mass Transfer Coefficient using Fractional Resistance by Gas Phase Formula

Evaluate Formula

Formula

$$K_y = k_y \cdot FR_g$$

Example with Units

$$76.4694\,\mathrm{mol/s{*}m^2} = 90\,\mathrm{mol/s{*}m^2} \cdot 0.84966$$

28) Overall Liquid Phase Mass Transfer Coefficient using Fractional Resistance by Liquid Phase Formula

Evaluate Formula

Formula

$$K_x = k_x \cdot FR_l$$

Example with Units

$$1.6898\,\mathrm{mol/s{*}m^2} = 9.2\,\mathrm{mol/s{*}m^2} \cdot 0.183673$$

29) Sherwood Number for Flat Plate in Laminar Flow Formula

Evaluate Formula

Formula

$$Sh = 0.664 \cdot \left(Re^{0.5}\right) \cdot \left(Sc^{0.333}\right)$$

Example

$$1074.04 = 0.664 \cdot \left(500000^{0.5}\right) \cdot \left(12^{0.333}\right)$$

Variables used in list of Important Formulas in Mass Transfer Coefficient, Driving Force and Theories above

- **c** Specific Heat *(Joule per Kilogram per K)*
- **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)*
- **C_D** Drag Coefficient
- **D_{AB}** Diffusion Coefficient (DAB) *(Square Meter Per Second)*
- **f** Friction Factor
- **FR_g** Fractional Resistance Offered by Gas Phase
- **FR_l** Fractional Resistance Offered by Liquid Phase
- **H** Henry's Constant
- **$h_{transfer}$** Heat Transfer Coefficient *(Watt per Square Meter per Kelvin)*
- **$k_{L\ (Avg)}$** Average Convective Mass Transfer Coefficient *(Meter per Second)*
- **k_L** Convective Mass Transfer Coefficient *(Meter per Second)*
- **k_x** Liquid Phase Mass Transfer Coefficient *(Mole per Second Square Meter)*
- **K_x** Overall Liquid Phase Mass Transfer Coefficient *(Mole per Second Square Meter)*
- **k_y** Gas Phase Mass Transfer Coefficient *(Mole per Second Square Meter)*
- **K_y** Overall Gas Phase Mass Transfer Coefficient *(Mole per Second Square Meter)*
- **L_e** Lewis Number
- **m_1** Mass Transfer Coefficient of Medium 1 *(Meter per Second)*
- **m_2** Mass Transfer Coefficient of Medium 2 *(Meter per Second)*

Constants, Functions, Measurements used in list of Important Formulas in Mass Transfer Coefficient, Driving Force and Theories above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' 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.
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity Unit Conversion
- Measurement: **Heat Transfer Coefficient** in Watt per Square Meter per Kelvin (W/m²*K)
  Heat Transfer Coefficient 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

- m_aA Mass Flux of Diffusion Component A *(Kilogram per Second per Square Meter)*
- P_{b1} Partial Pressure of Component B in Mixture 1 *(Pascal)*
- P_{b2} Partial Pressure of Component B in Mixture 2 *(Pascal)*
- P_{bm} Logarithmic Mean Partial Pressure Difference *(Pascal)*
- **Re** Reynolds Number
- Re_l Local Reynolds Number
- **s** Surface Renewal Rate *(1 Per Second)*
- **Sc** Schmidt Number
- **Sh** Average Sherwood Number
- Sh_x Local Sherwood Number
- St_m Mass Transfer Stanton Number
- t_c Average Contact Time *(Second)*
- u_∞ Free Stream Velocity *(Meter per Second)*
- **δ** Film Thickness *(Meter)*
- δ_{mx} Mass Transfer Boundary Layer Thickness at x
- 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)*
- ρ_L Density of Liquid *(Kilogram per Cubic Meter)*
- δ_{hx} Hydrodynamic Boundary Layer Thickness *(Meter)*

- Measurement: **Molar Flux of Diffusing Component** in Mole per Second Square Meter (mol/s*m²)
  Molar Flux of Diffusing Component Unit Conversion
- Measurement: **Time Inverse** in 1 Per Second (1/s)
  Time Inverse Unit Conversion

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