Important Formulas in Gas Absorption & Stripping PDF

Formulas
Examples
with Units

List of 24
Important Formulas in Gas Absorption & Stripping

1) Absorption Factor Formula

Evaluate Formula

Formula

$$A = \frac{L_S}{\alpha \cdot G_S}$$

Example with Units

$$1.7037 = \frac{23\,\text{mol/s}}{1.5 \cdot 9\,\text{mol/s}}$$

2) Absorption Factor given Stripping Factor Formula

Evaluate Formula

Formula

$$A = \frac{1}{S}$$

Example

$$0.7143 = \frac{1}{1.4}$$

3) Corrected Murphree Efficiency Percentage for Liquid Entrainment Formula

Evaluate Formula

Formula

$$E_{MGE} = \left(\frac{\frac{E_{MG}}{100}}{1 + \left(\left(\frac{E_{MG}}{100} \right) \cdot \left(\frac{E}{1 - E} \right) \right)} \right) \cdot 100$$

Example

$$55.914 = \left(\frac{\frac{65}{100}}{1 + \left(\left(\frac{65}{100} \right) \cdot \left(\frac{0.2}{1 - 0.2} \right) \right)} \right) \cdot 100$$

4) Gas Flowrate for Absorption Column on Solute Free Basis Formula

Evaluate Formula

Formula

$$G_S = \frac{L_S}{\frac{Y_{N+1} - Y_1}{X_N - X_0}}$$

Example with Units

$$9.5319\,\text{mol/s} = \frac{23\,\text{mol/s}}{\frac{0.8 - 0.1}{0.3 - 0.0099}}$$

5) Gas Flowrate on Solute Free Basis for Inlet Conditions by Mole Fraction Formula

Evaluate Formula

Formula

$$G_s = G_{N+1} \cdot \left(1 - y_{N+1}\right)$$

Example with Units

$$18.9\,\text{mol/s} = 27\,\text{mol/s} \cdot \left(1 - 0.3\right)$$

6) Gas Flowrate on Solute Free Basis for Inlet Conditions by Solute Free Mole Fraction Formula

Evaluate Formula

Formula

$$G_s = \frac{G_{N+1}}{1 + Y_{N+1}}$$

Example with Units

$$15\,\text{mol/s} = \frac{27\,\text{mol/s}}{1 + 0.8}$$

7) Liquid Flowrate for Absorption Column on Solute Free basis Formula

Evaluate Formula

Formula

$$L_s = G_s \cdot \frac{Y_{N+1} - Y_1}{X_N - X_0}$$

Example with Units

$$21.7166\,\text{mol/s} = 9\,\text{mol/s} \cdot \frac{0.8 - 0.1}{0.3 - 0.0099}$$

8) Liquid Flowrate on Solute Free Basis for Inlet Conditions by Solute Free Mole Fraction Formula

Evaluate Formula

Formula

$$L_s = \frac{L_0}{1 + X_0}$$

Example with Units

$$24.7549\,\text{mol/s} = \frac{25\,\text{mol/s}}{1 + 0.0099}$$

9) Liquid Flowrate on Solute Free Basis for Inlet Conditions using Mole Fraction Formula

Evaluate Formula

Formula

$$L_s = L_0 \cdot \left(1 - x_1\right)$$

Example with Units

$$23.75\,\text{mol/s} = 25\,\text{mol/s} \cdot \left(1 - 0.05\right)$$

10) Maximum Gas Rate for Absorption Column Formula

Evaluate Formula

Formula

$$G_{smax} = \frac{L_s}{\frac{Y_{N+1} - Y_1}{\left(\frac{Y_{N+1}}{\alpha}\right) - X_0}}$$

Example with Units

$$17.1985\,\text{mol/s} = \frac{23\,\text{mol/s}}{\frac{0.8 - 0.1}{\left(\frac{0.8}{1.5}\right) - 0.0099}}$$

11) Minimum Liquid Rate for Absorption Column Formula

Evaluate Formula

Formula

$$L_{smin} = G_s \cdot \frac{Y_{N+1} - Y_1}{\left(\frac{Y_{N+1}}{\alpha}\right) - X_0}$$

Example with Units

$$12.0359\,\text{mol/s} = 9\,\text{mol/s} \cdot \frac{0.8 - 0.1}{\left(\frac{0.8}{1.5}\right) - 0.0099}$$

12) Minimum Operating Line Slope for Absorption Column Formula

Evaluate Formula

Formula

$$LsGs_{min} = \frac{Y_{N+1} - Y_1}{\left(\frac{Y_{N+1}}{\alpha}\right) - X_0}$$

Example

$$1.3373 = \frac{0.8 - 0.1}{\left(\frac{0.8}{1.5}\right) - 0.0099}$$

13) Murphree Efficiency of Absorption Operation Based on Point Efficiency for Plug Flow Formula

Evaluate Formula

Formula

$$E_{MG} = \left(A \cdot \left(\exp\left(\frac{E_{OG}}{A \cdot 100}\right) - 1\right)\right) \cdot 100$$

Example

$$90.9983 = \left(2 \cdot \left(\exp\left(\frac{75}{2 \cdot 100}\right) - 1\right)\right) \cdot 100$$

14) Murphree Tray Efficiency of Absorption Operation Formula

Evaluate Formula

Formula

$$E_{MG} = \left(\frac{y_n - y_{n+1}}{yn^* - y_{n+1}}\right) \cdot 100$$

Example

$$53.5 = \left(\frac{0.557 - 0.45}{0.65 - 0.45}\right) \cdot 100$$

15) Number of Absorption Stages by Kremser Equation Formula

Evaluate Formula

Formula

$$N = \log10\frac{\left(\frac{Y_{N+1} - (\alpha \cdot X_0)}{Y_1 - (\alpha \cdot X_0)}\right) \cdot \left(1 - \left(\frac{1}{A}\right)\right) + \left(\frac{1}{A}\right)}{\log10(A)}$$

Example

$$2.3534 = \log10\frac{\left(\frac{0.8 - (1.5 \cdot 0.0099)}{0.1 - (1.5 \cdot 0.0099)}\right) \cdot \left(1 - \left(\frac{1}{2}\right)\right) + \left(\frac{1}{2}\right)}{\log10(2)}$$

16) Number of Stages for Absorption Factor Equal to 1 Formula

Evaluate Formula

Formula

$$N = \frac{Y_{N+1} - Y_1}{Y_1 - (\alpha \cdot X_0)}$$

Example

$$8.2208 = \frac{0.8 - 0.1}{0.1 - (1.5 \cdot 0.0099)}$$

17) Number of Stripping Stages by Kremser Equation Formula

Evaluate Formula

Formula

$$N = \frac{\log10\left(\left(\frac{X_{0(Stripping)} - \left(\frac{Y_{N+1(Stripping)}}{\alpha}\right)}{X_{N(Stripping)} - \left(\frac{Y_{N+1(Stripping)}}{\alpha}\right)}\right) \cdot \left(1 - \left(\frac{1}{S}\right)\right) + \left(\frac{1}{S}\right)\right)}{\log10\left(S\right)}$$

Example

$$6.0205 = \frac{\log10\left(\left(\frac{0.225 - \left(\frac{0.001}{1.5}\right)}{0.01 - \left(\frac{0.001}{1.5}\right)}\right) \cdot \left(1 - \left(\frac{1}{1.4}\right)\right) + \left(\frac{1}{1.4}\right)\right)}{\log10\left(1.4\right)}$$

18) Operating Line Slope for Absorption Column Formula

Evaluate Formula

Formula

$$LG_{ratio} = \frac{Y_{N+1} - Y_1}{X_N - X_0}$$

Example

$$2.413 = \frac{0.8 - 0.1}{0.3 - 0.0099}$$

19) Overall Tray Efficiency for Absorption Column given Murphree Efficiency Formula

Evaluate Formula

Formula

$$E_O = \left(\frac{\ln\left(1 + \left(\frac{E_{MG}}{100}\right) \cdot \left(\left(\frac{1}{A}\right) - 1\right)\right)}{\ln\left(\frac{1}{A}\right)}\right) \cdot 100$$

Example

$$56.7041 = \left(\frac{\ln\left(1 + \left(\frac{65}{100}\right) \cdot \left(\left(\frac{1}{2}\right) - 1\right)\right)}{\ln\left(\frac{1}{2}\right)}\right) \cdot 100$$

20) Point Efficiency of Absorption Operation Formula

Evaluate Formula

Formula

$$E_{OG} = \left(\frac{y_{N,\,Local} - y_{N+1,\,Local}}{y_{local,\,eqm} - y_{N+1,\,Local}}\right) \cdot 100$$

Example

$$75 = \left(\frac{0.35 - 0.41}{0.33 - 0.41}\right) \cdot 100$$

21) Solute Free Mole Fraction of Gas in Inlet based on Mole Fraction Formula

Evaluate Formula

Formula

$$Y_{N+1} = \frac{y_{N+1}}{1 - y_{N+1}}$$

Example

$$0.4286 = \frac{0.3}{1 - 0.3}$$

22) Solute Free Mole Fraction of Liquid in Inlet based on Mole Fraction Formula

Evaluate Formula

Formula

$$X_0 = \frac{x_1}{1 - x_1}$$

Example

$$0.0526 = \frac{0.05}{1 - 0.05}$$

23) Stripping Factor Formula

Evaluate Formula

Formula

$$S = \frac{\alpha \cdot G_{s(Stripping)}}{L_{s(Stripping)}}$$

Example with Units

$$1.3948 = \frac{1.5 \cdot 25.2\,\text{mol/s}}{27.1\,\text{mol/s}}$$

24) Stripping Factor given Absorption Factor Formula

Evaluate Formula

Formula

$$S = \frac{1}{A}$$

Example

$$0.5 = \frac{1}{2}$$

Variables used in list of Important Formulas in Gas Absorption & Stripping above

- **A** Absorption Factor
- **E** Fractional Entrainment
- E_{MG} Murphree Efficiency of Absorption Column
- E_{MGE} Corrected Murphree Efficiency for Absorption
- E_O Overall Tray Efficiency of Absorption Column
- E_{OG} Point Efficiency of Absorption Column in Percent
- G_{N+1} Inlet Gas Flowrate *(Mole per Second)*
- G_s Gas Flowrate on Solute Free Basis *(Mole per Second)*
- $G_{s(Stripping)}$ Gas Flowrate on Solute Free Basis for Stripping *(Mole per Second)*
- G_{smax} Maximum Gas Flowrate on Solute Free Basis *(Mole per Second)*
- L_0 Inlet Liquid Flowrate *(Mole per Second)*
- L_s Liquid Flowrate on Solute Free Basis *(Mole per Second)*
- $L_{s(Stripping)}$ Liquid Flowrate on Solute Free Basis for Stripping *(Mole per Second)*
- L_{smin} Minimum Liquid Flowrate on Solute Free Basis *(Mole per Second)*
- LG_{ratio} Operating Line Slope of Absorption Column
- $LsGs_{min}$ Minimum Operating Line Slope of Absorption Column
- **N** Number of Stages
- **S** Stripping Factor
- X_0 Solute Free Mole Fraction of Liquid in Inlet
- $X_{0(Stripping)}$ Solute Free Mole Frac of Liquid in Stripping Inlet
- x_1 Liquid Inlet Mole Fraction
- X_N Solute Free Mole Fraction of Liquid in Outlet

Constants, Functions, Measurements used in list of Important Formulas in Gas Absorption & Stripping above

- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- 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: **log10**, log10(Number)
  The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.
- Measurement: **Molar Flow Rate** in Mole per Second (mol/s)
  Molar Flow Rate Unit Conversion

- $X_{N(Stripping)}$ Solute Free Mole Frac of Liquid in Stripping Out
- Y_1 Solute Free Mole Fraction of Gas in Outlet
- $y_{local, eqm}$ Local Eqm Mole Fraction of Vapor on Nth Plate
- y_n Average Mole Fraction of Vapour on Nth Plate
- $y_{N, Local}$ Local Mole Fraction of Vapor Leaving Nth Plate
- y_{n+1} Average Mole Fraction of Vapour at N+1 Plate
- y_{N+1} Gas Inlet Mole Fraction
- Y_{N+1} Solute Free Mole Fraction of Gas in Inlet
- $Y_{N+1(Stripping)}$ Solute Free Mole Frac of Gas in Stripping Inlet
- $y_{N+1, Local}$ Local Mole Fraction of Vapor Entering Nth Plate
- yn^* Average Mole Fraction at Equilibrium on Nth Plate
- α Equilibrium Constant for Mass Transfer

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