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# Important Formulas in Gas Absorption & Stripping

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# List of 24 Important Formulas in Gas Absorption & Stripping

## Important Formulas in Gas Absorption & Stripping

### 1) Absorption Factor

Open Calculator

fx $$A = \frac{L_s}{\alpha \cdot G_s}$$

ex $$1.703704 = \frac{23\text{mol/s}}{1.5 \cdot 9\text{mol/s}}$$

### 2) Absorption Factor given Stripping Factor

Open Calculator

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

ex $$0.714286 = \frac{1}{1.4}$$

## 3) Corrected Murphree Efficiency Percentage for Liquid Entrainment

Open Calculator

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

ex $$55.91398 = \left( \frac{\frac{65}{100}}{1 + \left( \left( \frac{65}{100} \right) \cdot \left( \frac{0.2}{1-0.2} \right) \right)} \right) \cdot 100$$

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

Open Calculator

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

ex $$9.531857\text{mol/s} = \frac{23\text{mol/s}}{\frac{0.8-0.1}{0.3-0.0099}}$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

ex $$21.71665\text{mol/s} = 9\text{mol/s} \cdot \frac{0.8 - 0.1}{0.3 - 0.0099}$$

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

Open Calculator

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

ex $$24.75493\text{mol/s} = \frac{25\text{mol/s}}{1 + 0.0099}$$

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

Open Calculator

fx $$L_s = L_0 \cdot (1 - x_1)$$

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

## 10) Maximum Gas Rate for Absorption Column

Open Calculator

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

$$17.19852\text{mol/s} = \frac{23\text{mol/s}}{\frac{0.8-0.1}{\left(\frac{0.8}{1.5}\right)-0.0099}}$$

## 11) Minimum Liquid Rate for Absorption Column

Open Calculator

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

$$12.03592\text{mol/s} = 9\text{mol/s} \cdot \frac{0.8 - 0.1}{\left(\frac{0.8}{1.5}\right) - 0.0099}$$

## 12) Minimum Operating Line Slope for Absorption Column

Open Calculator

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

$$1.337324 = \frac{0.8 - 0.1}{\left(\frac{0.8}{1.5}\right) - 0.0099}$$

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

Open Calculator

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

ex $$90.99828 = \left(2 \cdot \left(\exp\left(\frac{75}{2 \cdot 100}\right) - 1\right)\right) \cdot 100$$

## 14) Murphree Tray Efficiency of Absorption Operation

Open Calculator

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

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

## 15) Number of Absorption Stages by Kremser Equation

Open Calculator

fx $$N = \log 10\frac{\left(\frac{Y_{N+1} - (\alpha \cdot X_0)}{Y_1 - (\alpha \cdot X_0)}\right) \cdot \left(1 - \left(\frac{1}{A}\right)\right) + \left(\frac{1}{A}\right)}{\log 10(A)}$$

ex $$2.353434 = \log 10\frac{\left(\frac{0.8 - (1.5 \cdot 0.0099)}{0.1 - (1.5 \cdot 0.0099)}\right) \cdot \left(1 - \left(\frac{1}{2}\right)\right) + \left(\frac{1}{2}\right)}{\log 10(2)}$$

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

Open Calculator

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

ex $$8.220787 = \frac{0.8 - 0.1}{0.1 - (1.5 \cdot 0.0099)}$$

## 17) Number of Stripping Stages by Kremser Equation

fx

Open Calculator

$$N = \frac{\log 10\left(\left(\frac{X_{0(Stripping)} - \left(\frac{Y_{N+1(Stripping)}}{\alpha}\right)}{X_{N(Stripping)} - \left(\frac{Y_{N+1(Stripping)}}{\alpha}\right)}\right) \cdot \left(1 - \left(\frac{1}{S}\right)\right) + \left(\frac{1}{S}\right)\right)}{\log 10(S)}$$

ex $$6.020492 = \frac{\log 10\left(\left(\frac{0.225 - \left(\frac{0.001}{1.5}\right)}{0.01 - \left(\frac{0.001}{1.5}\right)}\right) \cdot \left(1 - \left(\frac{1}{1.4}\right)\right) + \left(\frac{1}{1.4}\right)\right)}{\log 10(1.4)}$$

## 18) Operating Line Slope for Absorption Column

Open Calculator

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

ex $$2.412961 = \frac{0.8 - 0.1}{0.3 - 0.0099}$$

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

Open Calculator

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

ex $$56.70406 = \left( \frac{\ln\left(1 + \left(\frac{65}{100}\right) \cdot \left(\left(\frac{1}{2}\right) - 1\right)\right)}{\ln\left(\frac{1}{2}\right)} \right) \cdot 100$$

## 20) Point Efficiency of Absorption Operation

Open Calculator

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

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

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

Open Calculator

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

ex $$0.428571 = \frac{0.3}{1 - 0.3}$$

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

Open Calculator

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

ex $$0.052632 = \frac{0.05}{1 - 0.05}$$

## 23) Stripping Factor

Open Calculator

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

ex $$1.394834 = \frac{1.5 \cdot 25.2\text{mol/s}}{27.1\text{mol/s}}$$

## 24) Stripping Factor given Absorption Factor

Open Calculator

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

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

## Variables Used

- **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
- $X_{N(Stripping)}$ 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
- $\alpha$ Equilibrium Constant for Mass Transfer

# Constants, Functions, Measurements used

- Function: **exp**, exp(Number)
  *Exponential function*
- Function: **ln**, ln(Number)
  *Natural logarithm function (base e)*
- Function: **log10**, log10(Number)
  *Common logarithm function (base 10)*
- Measurement: **Molar Flow Rate** in Mole per Second (mol/s)
  *Molar Flow Rate Unit Conversion*

## Check other formula lists

- **Gas Absorption Formulas**
- **Important Formulas in Gas Absorption & Stripping**

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