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Important Formulas in Solid-Liquid Extraction

Calculators! Examples! Conversions!

List of 31 Important Formulas in Solid-Liquid Extraction

Important Formulas in Solid-Liquid Extraction

1) Area of Contact for Batch Leaching Operation

Open Calculator

fx $$A = \left(-\frac{V_{Leaching}}{K_L \cdot t}\right) \cdot \ln\left(\left(\frac{C_S - C}{C_S}\right)\right)$$

ex $$0.166279\text{m}^2 = \left(-\frac{2.48\text{m}^3}{0.0147\text{mol/s*m}^2 \cdot 600\text{s}}\right) \cdot \ln\left(\left(\frac{56\text{kg/m}^3 - 25\text{kg/m}^3}{56\text{kg/m}^3}\right)\right)$$

2) Beta Value based on Ratio of Solvent

Open Calculator

fx $$\beta = \frac{b}{a}$$

ex $$2.857143 = \frac{30\text{kg}}{10.5\text{kg}}$$

3) Concentration of Solute in Bulk Solution at Time t for Batch Leaching

Open Calculator

fx $$C = C_S \cdot \left(1 - \exp\left(\frac{-K_L \cdot A \cdot t}{V_{Leaching}}\right)\right)$$

ex $$23.61621\text{kg/m}^3 = 56\text{kg/m}^3 \cdot \left(1 - \exp\left(\frac{-0.0147\text{mol/s*m}^2 \cdot 0.154\text{m}^2 \cdot 600\text{s}}{2.48\text{m}^3}\right)\right)$$

4) Fraction of Solute as Ratio of Solute

Open Calculator

fx $$\theta_N = \frac{S_{N(Wash)}}{S_{Solute}}$$

ex $$0.001 = \frac{0.01\text{kg}}{10\text{kg}}$$

5) Fraction of Solute remaining based on Solvent Decanted

Open Calculator

fx $$\theta_N = \left(\frac{1}{\left(1+\left(\frac{b}{a}\right)\right)^{N}\_\{\text{Washing}\}}\right)$$

ex $$0.001171 = \left(\frac{1}{\left(1+\left(\frac{30\text{kg}}{10.5\text{kg}}\right)\right)^{5}}\right)$$

6) Fractional Solute Discharge based on Ratio of Overflow to Underflow

Open Calculator

fx $$f = \frac{R-1}{\left(R^{N+1}\right)-1}$$

ex $$0.188304 = \frac{1.35-1}{\left((1.35)^{2.5+1}\right)-1}$$

7) Fractional Solute Discharge based on Recovery of Solute

Open Calculator

fx $$f = 1 - \text{Recovery}$$

ex $$0.2 = 1 - 0.8$$

8) Fractional Solute Discharge Ratio based on Solute Underflow

Open Calculator

fx $$f = \frac{S_N}{S_0}$$

ex $$0.203046 = \frac{2\text{kg/s}}{9.85\text{kg/s}}$$

9) Number of Equilibirum Leaching Stages based on Fractional Solute Discharge

Open Calculator

fx $$N = \frac{\log 10\left(1 + \frac{R-1}{f}\right)}{\log 10(R)} - 1$$

ex $$2.370828 = \frac{\log 10\left(1 + \frac{1.35-1}{0.2}\right)}{\log 10(1.35)} - 1$$

10) Number of Equilibrium Leaching Stages based on Recovery of Solute

Open Calculator

fx $$N = \frac{\log 10\left(1 + \frac{R-1}{1-\text{Recovery}}\right)}{\log 10(R)} - 1$$

ex $$2.370828 = \frac{\log 10\left(1 + \frac{1.35-1}{1-0.8}\right)}{\log 10(1.35)} - 1$$

11) Number of Stages based on Original Weight of Solute

Open Calculator

fx $$N_{Washing} = \left(\frac{\ln\left(\frac{S_{Solute}}{S_{N(Wash)}}\right)}{\ln(1+\beta)} \right)$$

ex $$4.982892 = \left(\frac{\ln\left(\frac{10kg}{0.01kg}\right)}{\ln(1+3)} \right)$$

12) Number of Stages based on Solvent Decanted

Open Calculator

fx $$N_{Washing} = \left(\frac{\ln\left(\frac{1}{\theta_N}\right)}{\ln\left(1+\left(\frac{b}{a}\right)\right)} \right)$$

ex $$5.117134 = \left(\frac{\ln\left(\frac{1}{0.001}\right)}{\ln\left(1+\left(\frac{30kg}{10.5kg}\right)\right)} \right)$$

13) Original Weight of Solute based on Number of Stages and Amount of Solvent Decanted

Open Calculator

fx $$S_{Solute} = S_{N(Wash)} \cdot \left(\left(1+\left(\frac{b}{a}\right)\right)^{N} \_\{Washing\} \right)$$

ex $$8.537459kg = 0.01kg \cdot \left(\left(1+\left(\frac{30kg}{10.5kg}\right)\right)^{5} \right)$$

14) Ratio of Solute Discharged in Underflow to Overflow

Open Calculator

fx $$R = \frac{L}{S}$$

ex $$1.333333 = \frac{0.5\text{kg/s}}{0.375\text{kg/s}}$$

15) Ratio of Solution Discharged in Overflow to Underflow

Open Calculator

fx $$R = \frac{V}{W}$$

ex $$1.346667 = \frac{1.01\text{kg/s}}{0.75\text{kg/s}}$$

16) Ratio of Solvent Discharged in Underflow to Overflow

Open Calculator

fx $$R = \frac{V - L}{W - S}$$

ex $$1.36 = \frac{1.01\text{kg/s} - 0.5\text{kg/s}}{0.75\text{kg/s} - 0.375\text{kg/s}}$$

17) Recovery of Solute based on Fractional Solute Discharge

Open Calculator

fx $$\text{Recovery} = 1 - f$$

ex $$0.8 = 1 - 0.2$$

18) Recovery of Solute based on Solute Underflow

Open Calculator

fx $$\text{Recovery} = 1 - \left(\frac{S_N}{S_0}\right)$$

ex $$0.796954 = 1 - \left(\frac{2\text{kg/s}}{9.85\text{kg/s}}\right)$$

19) Solute Discharged in Overflow based on Ratio of Overflow to Underflow and Solution Discharged

Open Calculator

fx $$L = V - R \cdot (W - S)$$

ex $$0.50375\text{kg/s} = 1.01\text{kg/s} - 1.35 \cdot (0.75\text{kg/s} - 0.375\text{kg/s})$$

20) Solute Discharged in Underflow based on Ratio of Overflow to Underflow and Solution Discharged

Open Calculator

fx $$S = W - \left(\frac{V - L}{R}\right)$$

ex $$0.372222\text{kg/s} = 0.75\text{kg/s} - \left(\frac{1.01\text{kg/s} - 0.5\text{kg/s}}{1.35}\right)$$

21) Solute Underflow Entering Column based on Ratio of Overflow to Underflow

Open Calculator

fx $$S_0 = \frac{S_N \cdot \left(\left(R^{N+1}\right) - 1\right)}{R - 1}$$

ex $$10.62113\text{kg/s} = \frac{2\text{kg/s} \cdot \left(\left((1.35)^{2.5+1}\right) - 1\right)}{1.35 - 1}$$

22) Solute Underflow Entering Column based on Recovery of Solute

Open Calculator

$$S_0 = \frac{S_N}{1 - \text{Recovery}}$$

$$10\text{kg/s} = \frac{2\text{kg/s}}{1 - 0.8}$$

23) Solute Underflow Leaving Column based on Ratio of Overflow to Underflow

Open Calculator

$$S_N = \frac{S_0 \cdot (R - 1)}{\left(R^{N+1}\right) - 1}$$

$$1.854794\text{kg/s} = \frac{9.85\text{kg/s} \cdot (1.35 - 1)}{\left((1.35)^{2.5+1}\right) - 1}$$

24) Solute Underflow Leaving Column based on Recovery of Solute

Open Calculator

$$S_N = S_0 \cdot (1 - \text{Recovery})$$

$$1.97\text{kg/s} = 9.85\text{kg/s} \cdot (1 - 0.8)$$

25) Solution Discharged in Overflow based on Ratio of Overflow to Underflow and Solute Discharged

Open Calculator

$$V = L + R \cdot (W - S)$$

$$1.00625\text{kg/s} = 0.5\text{kg/s} + 1.35 \cdot (0.75\text{kg/s} - 0.375\text{kg/s})$$

26) Solution Discharged in Underflow based on Ratio of Overflow to Underflow and Solute Discharged

Open Calculator

$$W = S + \left(\frac{V - L}{R}\right)$$

$$0.752778 \text{kg/s} = 0.375 \text{kg/s} + \left(\frac{1.01 \text{kg/s} - 0.5 \text{kg/s}}{1.35}\right)$$

27) Solvent Decanted based on Original Weight of Solute and Number of Stages

Open Calculator

$$b = a \cdot \left(\left(\left(\frac{S_{\text{Solute}}}{S_{\text{N(Wash)}}}\right)^{\frac{1}{N_{\text{Washing}}}}\right) - 1\right)$$

$$31.30125 \text{kg} = 10.5 \text{kg} \cdot \left(\left(\left(\frac{10 \text{kg}}{0.01 \text{kg}}\right)^{\frac{1}{5}}\right) - 1\right)$$

28) Solvent Remaining based on Original Weight of Solute and Number of Stages

Open Calculator

$$a = \frac{b}{\left(\left(\frac{S_{\text{Solute}}}{S_{\text{N(Wash)}}}\right)^{\frac{1}{N_{\text{Washing}}}}\right) - 1}$$

$$10.06349 \text{kg} = \frac{30 \text{kg}}{\left(\left(\frac{10 \text{kg}}{0.01 \text{kg}}\right)^{\frac{1}{5}}\right) - 1}$$

29) Time of Batch Leaching Operation

Open Calculator

fx $$t = \left(-\frac{V_{Leaching}}{A \cdot K_L}\right) \cdot \ln\left(\left(\frac{C_S - C}{C_S}\right)\right)$$

ex $$647.8416s = \left(-\frac{2.48m^3}{0.154m^2 \cdot 0.0147mol/s^*m^2}\right) \cdot \ln\left(\left(\frac{56kg/m^3 - 25kg/m^3}{56kg/m^3}\right)\right)$$

30) Volume of Leaching Solution in Batch Leaching

Open Calculator

fx $$V_{Leaching} = \frac{-K_L \cdot A \cdot t}{\ln\left(\left(\frac{C_S - C}{C_S}\right)\right)}$$

ex $$2.296858m^3 = \frac{-0.0147mol/s^*m^2 \cdot 0.154m^2 \cdot 600s}{\ln\left(\left(\frac{56kg/m^3 - 25kg/m^3}{56kg/m^3}\right)\right)}$$

31) Weight of Solute remaining based on Number of Stages and Amount of Solvent Decanted

Open Calculator

fx $$S_{N(Wash)} = \frac{S_{Solute}}{\left(1 + \frac{b}{a}\right)^{N} \_ \{Washing\}}$$

ex $$0.011713kg = \frac{10kg}{\left(1 + \frac{30kg}{10.5kg}\right)^{5}}$$

Variables Used

- **a** Amount of Solvent Remaining *(Kilogram)*
- **A** Area of Leaching *(Square Meter)*
- **b** Amount of Solvent Decanted *(Kilogram)*
- **C** Concentration of Solute in Bulk Solution at Time t *(Kilogram per Cubic Meter)*
- C_S Concentration of Saturated Solution with Solute *(Kilogram per Cubic Meter)*
- **f** Fractional Solute Discharge
- K_L Mass Transfer Coefficient for Batch Leaching *(Mole per Second Square Meter)*
- **L** Amount of Solute Discharge in Overflow *(Kilogram per Second)*
- **N** Number of Equilibrium Stages in Leaching
- $N_{Washing}$ Number of Washings in Batch Leaching
- **R** Ratio of Discharge in Overflow to Underflow
- **Recovery** Recovery of Solute in Leaching Column
- **S** Amount of Solute Discharge in Underflow *(Kilogram per Second)*
- S_0 Amount of Solute in Underflow Entering Column *(Kilogram per Second)*
- S_N Amount of Solute in Underflow Leaving Column *(Kilogram per Second)*
- $S_{N(Wash)}$ Weight of Solute remaining in Solid after Washing *(Kilogram)*
- S_{Solute} Original Weight of Solute in Solid *(Kilogram)*
- **t** Time of Batch Leaching *(Second)*
- **V** Amount of Solution Discharge in Overflow *(Kilogram per Second)*
- $V_{Leaching}$ Volume of Leaching Solution *(Cubic Meter)*
- **W** Amount of Solution Discharge in Underflow *(Kilogram per Second)*
- β Solvent Decanted per Solvent Remaining in Solid
- θ_N Fraction of Solute Remaining in Solid

Constants, Functions, Measurements used

- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- 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: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s)
  Mass Flow Rate Unit Conversion
- Measurement: **Mass Concentration** in Kilogram per Cubic Meter (kg/m^3)
  Mass Concentration Unit Conversion
- Measurement: **Molar Flux of Diffusing Component** in Mole per Second Square Meter ($mol/s*m^2$)
  Molar Flux of Diffusing Component Unit Conversion

Check other formula lists

- **Counter Current Continuous Leaching for Constant Overflow (Pure Solvent) Formulas**
- **Important Formulas in Solid-Liquid Extraction**

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