Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction PDF

Formulas
Examples
with Units

List of 14
Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction

1) Rate Constant for First Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$K_{1st\ order} = -\frac{\ln\left(1 - X_A\right)}{t}$$

Example with Units

$$0.2235\,s^{-1} = -\frac{\ln\left(1 - 0.8\right)}{7.2\,s}$$

2) Rate Constant for First Order Irreversible Reaction using log10 Formula

Evaluate Formula

Formula

$$K_{1st\ order} = -2.303 \cdot \frac{\log10\left(1 - X_A\right)}{t}$$

Example with Units

$$0.2236\,s^{-1} = -2.303 \cdot \frac{\log10\left(1 - 0.8\right)}{7.2\,s}$$

3) Rate Constant of Second Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$k_2 = \frac{r}{C_A \cdot C_B}$$

Example with Units

$$0.0019\,m^3/(mol*s) = \frac{0.017\,mol/m^3*s}{1.1\,mol/m^3 \cdot 8.2\,mol/m^3}$$

4) Rate Constant of Second Order Irreversible Reaction with Equal Reactant Concentrations Formula

Evaluate Formula

Formula

$$k_2 = \frac{r}{\left(C_A\right)^2}$$

Example with Units

$$0.014\,m^3/(mol*s) = \frac{0.017\,mol/m^3*s}{\left(1.1\,mol/m^3\right)^2}$$

5) Rate Constant of Third Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$k_3 = \frac{r}{C_A \cdot C_B \cdot C_D}$$

Example with Units

$$0.0002\,m^6/(mol^2*s) = \frac{0.017\,mol/m^3*s}{1.1\,mol/m^3 \cdot 8.2\,mol/m^3 \cdot 12\,mol/m^3}$$

6) Rate Constant of Third Order Irreversible Reaction with Two Equal Reactant Concentrations Formula

Evaluate Formula

Formula

$$k_3 = \frac{r}{C_A \cdot \left(C_B\right)^2}$$

Example with Units

$$0.0002\,\text{m}^6/(\text{mol}^2*\text{s}) = \frac{0.017\,\text{mol/m}^3*\text{s}}{1.1\,\text{mol/m}^3 \cdot \left(8.2\,\text{mol/m}^3\right)^2}$$

7) Reactant Concentration of Second Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$C_A = \frac{r}{C_B \cdot k_2}$$

Example with Units

$$1.0366\,\text{mol/m}^3 = \frac{0.017\,\text{mol/m}^3*\text{s}}{8.2\,\text{mol/m}^3 \cdot 0.002\,\text{m}^3/(\text{mol}*\text{s})}$$

8) Reactant Concentration of Second Order Irreversible Reaction with Equal Reactant Concentrations Formula

Evaluate Formula

Formula

$$C_A = \left(\frac{r}{k_2}\right)^{0.5}$$

Example with Units

$$2.9155\,\text{mol/m}^3 = \left(\frac{0.017\,\text{mol/m}^3*\text{s}}{0.002\,\text{m}^3/(\text{mol}*\text{s})}\right)^{0.5}$$

9) Reactant Concentration of Third Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$C_A = \frac{r}{k_3 \cdot C_B \cdot C_D}$$

Example with Units

$$0.8638\,\text{mol/m}^3 = \frac{0.017\,\text{mol/m}^3*\text{s}}{0.0002\,\text{m}^6/(\text{mol}^2*\text{s}) \cdot 8.2\,\text{mol/m}^3 \cdot 12\,\text{mol/m}^3}$$

10) Reaction Rate of Second Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$r = k_2 \cdot C_A \cdot C_B$$

Example with Units

$$0.018\,\text{mol/m}^3*\text{s} = 0.002\,\text{m}^3/(\text{mol}*\text{s}) \cdot 1.1\,\text{mol/m}^3 \cdot 8.2\,\text{mol/m}^3$$

11) Reaction Rate of Second Order Irreversible Reaction with Equal Reactant Concentrations Formula

Evaluate Formula

Formula

$$r = k_2 \cdot \left(C_A\right)^2$$

Example with Units

$$0.0024\,\text{mol/m}^3*\text{s} = 0.002\,\text{m}^3/(\text{mol}*\text{s}) \cdot \left(1.1\,\text{mol/m}^3\right)^2$$

12) Reaction Rate of Third Order Irreversible Reaction with Two Equal Reactant Concentrations Formula

Evaluate Formula

Formula

$$r = k_3 \cdot C_A \cdot \left(C_B\right)^2$$

Example with Units

$$0.0148\,\text{mol/m}^3*\text{s} = 0.0002\,\text{m}^6/(\text{mol}^2*\text{s}) \cdot 1.1\,\text{mol/m}^3 \cdot \left(8.2\,\text{mol/m}^3\right)^2$$

13) Reaction Time for First Order Irreversible Reaction Formula

Evaluate Formula

Formula

$$t = -\frac{\ln\left(1 - X_A\right)}{K_{1st\ order}}$$

Example with Units

$$107.2959\,s = -\frac{\ln\left(1 - 0.8\right)}{0.015\,s^{-1}}$$

14) Reaction Time for First Order Irreversible Reaction using log10 Formula

Evaluate Formula

Formula

$$t = -2.303 \cdot \frac{\log10\left(1 - X_A\right)}{K_{1st\ order}}$$

Example with Units

$$107.3152\,s = -2.303 \cdot \frac{\log10\left(1 - 0.8\right)}{0.015\,s^{-1}}$$

Variables used in list of Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction above

- C_A Concentration of Reactant A *(Mole per Cubic Meter)*
- C_B Concentration of Reactant B *(Mole per Cubic Meter)*
- C_D Concentration of Reactant D *(Mole per Cubic Meter)*
- $K_{1st\ order}$ Rate Constant for First Order Reaction *(1 Per Second)*
- k_2 Rate Constant for Second Order Reaction *(Cubic Meter per Mole Second)*
- k_3 Rate Constant for Third Order Reaction *(Square Cubic Meter per square Mole per Second)*
- **r** Reaction Rate *(Mole per Cubic Meter Second)*
- **t** Reaction Time *(Second)*
- X_A Reactant Conversion

Constants, Functions, Measurements used in list of Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction above

- 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Molar Concentration** in Mole per Cubic Meter (mol/m³)
  Molar Concentration Unit Conversion
- Measurement: **Reaction Rate** in Mole per Cubic Meter Second (mol/m³*s)
  Reaction Rate Unit Conversion
- Measurement: **First Order Reaction Rate Constant** in 1 Per Second (s^{-1})
  First Order Reaction Rate Constant Unit Conversion
- Measurement: **Second Order Reaction Rate Constant** in Cubic Meter per Mole Second (m³/(mol*s))
  Second Order Reaction Rate Constant Unit Conversion
- Measurement: **Third Order Reaction Rate Constant** in Square Cubic Meter per square Mole per Second (m⁶/(mol²*s))
  Third Order Reaction Rate Constant Unit Conversion

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