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Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate

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List of 17 Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate

Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate

1) Feed Reactant Concentration

Open Calculator

fx $$C_{Ao} = \frac{F_{Ao}}{v_o}$$

ex $$0.5\text{mol/m}^3 = \frac{5\text{mol/s}}{10\text{m}^3\text{/s}}$$

2) Number of Moles of Reactant Fed using Reactant Conversion

Open Calculator

fx $$N_{Ao} = \frac{N_A}{1 - X_A}$$

ex $$30\text{mol} = \frac{9\text{mol}}{1 - 0.7}$$

3) Reactant Concentration of First Order Irreversible Reaction

Open Calculator

fx $$C = e^{-k' \cdot \Delta t} \cdot C_o$$

ex $$20.99974\text{mol/m}^3 = e^{-2.508\text{s}^{-1} \cdot 0.5333\text{s}} \cdot 80\text{mol/m}^3$$

4) Reactant Concentration of Second Order Irreversible Reaction with Equal Reactant Conc using Time

Open Calculator

fx $$C = \frac{1}{\left(\frac{1}{C_o}\right) + k'' \cdot \Delta t}$$

ex $$22.2595\text{mol/m}^3 = \frac{1}{\left(\frac{1}{80\text{mol/m}^3}\right) + 0.0608\text{m}^3/(\text{mol*s}) \cdot 0.5333\text{s}}$$

5) Reactant Concentration using Reactant Conversion

Open Calculator

fx $$C = C_o \cdot (1 - X_A)$$

ex $$24\text{mol/m}^3 = 80\text{mol/m}^3 \cdot (1 - 0.7)$$

6) Reactant Conversion using Molar Feed Rate of Reactant

Open Calculator

fx $$X_A = 1 - \frac{F_A}{F_{Ao}}$$

ex $$0.7 = 1 - \frac{1.5\text{mol/s}}{5\text{mol/s}}$$

7) Reactant Conversion using Number of Moles of Reactant Fed

Open Calculator

fx $$X_A = 1 - \frac{N_A}{N_{Ao}}$$

ex $$0.7 = 1 - \frac{9\text{mol}}{30\text{mol}}$$

8) Reactant Conversion using Reactant Concentration

Open Calculator

fx $$X_A = 1 - \left(\frac{C}{C_o}\right)$$

ex $$0.7 = 1 - \left(\frac{24\text{mol/m}^3}{80\text{mol/m}^3}\right)$$

9) Reacting Fluid Volume using Reaction Rate

Open Calculator

fx $$V_{fluid} = \frac{\Delta n}{r \cdot \Delta t}$$

ex $$2.500156\text{m}^3 = \frac{4\text{mol}}{3\text{mol/m}^3\text{*s} \cdot 0.5333\text{s}}$$

10) Reaction Rate based on Volume of Reacting Fluid

Open Calculator

fx $$r = \frac{\Delta n}{V_{fluid} \cdot \Delta t}$$

ex $$3.000188\text{mol/m}^3\text{*s} = \frac{4\text{mol}}{2.5\text{m}^3 \cdot 0.5333\text{s}}$$

11) Reaction Rate in Gas-Solid System

Open Calculator

fx $$r = \frac{\Delta n}{V_{solid} \cdot \Delta t}$$

ex $$2.988235\text{mol/m}^3\text{*s} = \frac{4\text{mol}}{2.51\text{m}^3 \cdot 0.5333\text{s}}$$

12) Reaction Rate in Reactor

Open Calculator

$$r = \frac{\Delta n}{V_{reactor} \cdot \Delta t}$$

$$3.012236 mol/m^3*s = \frac{4 mol}{2.49 m^3 \cdot 0.5333 s}$$

13) Reaction Time Interval of Gas-Solid System using Reaction Rate

Open Calculator

$$\Delta t = \frac{\Delta n}{r \cdot V_{solid}}$$

$$0.531208 s = \frac{4 mol}{3 mol/m^3*s \cdot 2.51 m^3}$$

14) Reaction Time Interval of Reacting Fluid using Reaction Rate

Open Calculator

$$\Delta t = \frac{\Delta n}{r \cdot V_{fluid}}$$

$$0.533333 s = \frac{4 mol}{3 mol/m^3*s \cdot 2.5 m^3}$$

15) Reaction Time Interval of Reactor using Reaction Rate

Open Calculator

$$\Delta t = \frac{\Delta n}{r \cdot V_{reactor}}$$

$$0.535475 s = \frac{4 mol}{3 mol/m^3*s \cdot 2.49 m^3}$$

16) Reactor Volume using Reaction Rate

Open Calculator

fx $$V_{reactor} = \frac{\Delta n}{r \cdot \Delta t}$$

ex $$2.500156 m^3 = \frac{4 mol}{3 mol/m^3*s \cdot 0.5333 s}$$

17) Solid Volume using Reaction Rate

Open Calculator

fx $$V_{solid} = \frac{\Delta n}{r \cdot \Delta t}$$

ex $$2.500156 m^3 = \frac{4 mol}{3 mol/m^3*s \cdot 0.5333 s}$$

Variables Used

- **C** Reactant Concentration *(Mole per Cubic Meter)*
- **C_{Ao}** Concentration of Key Reactant A in the Feed *(Mole per Cubic Meter)*
- **C_o** Initial Reactant Concentration *(Mole per Cubic Meter)*
- **F_A** Molar Flow Rate of Unreacted Reactant *(Mole per Second)*
- **F_{Ao}** Molar Feed Rate of Reactant *(Mole per Second)*
- **k'** Rate Constant for First Order Reaction *(1 Per Second)*
- **k''** Rate Constant for Second Order Reaction *(Cubic Meter per Mole Second)*
- **N_A** Number of Moles of Unreacted Reactant-A *(Mole)*
- **N_{Ao}** Number of Moles of Reactant-A Fed *(Mole)*
- **r** Reaction Rate *(Mole per Cubic Meter Second)*
- **V_{fluid}** Fluid Volume *(Cubic Meter)*
- **v_o** Volumetric Flow Rate of Feed to Reactor *(Cubic Meter per Second)*
- **$V_{reactor}$** Reactor Volume *(Cubic Meter)*
- **V_{solid}** Solid Volume *(Cubic Meter)*
- **X_A** Reactant Conversion
- **Δn** Change in Number of Moles *(Mole)*
- **Δt** Time Interval *(Second)*

Constants, Functions, Measurements used

- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Amount of Substance** in Mole (mol)
  Amount of Substance Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Molar Flow Rate** in Mole per Second (mol/s)
  Molar Flow Rate Unit Conversion
- Measurement: **Molar Concentration** in Mole per Cubic Meter (mol/m^3)
  Molar Concentration Unit Conversion
- Measurement: **Reaction Rate** in Mole per Cubic Meter Second (mol/m^3*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 ($m^3/(mol*s)$)
  Second Order Reaction Rate Constant Unit Conversion

Check other formula lists

- Basics of Chemical Reaction Engineering Formulas
- Basics of Parallel & Single Reactions Formulas
- Basics of Reactor Design and Temperature Dependency from Arrhenius Law Formulas
- Forms of Reaction Rate Formulas
- Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate
- Important Formulas in Constant and Variable Volume Batch Reactor
- Important Formulas in Constant Volume Batch Reactor for First, Second & Third Order Reaction
- Important Formulas in Design of Reactors & Recycle Reactors for Single Reactions
- Important Formulas in Potpourri of Multiple Reactions
- Reactor Performance Equations for Constant Volume Reactions Formulas
- Reactor Performance Equations for Variable Volume Reactions Formulas

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