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

Formulas
Examples
with Units

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

1) Feed Reactant Concentration Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Number of Moles of Reactant Fed using Reactant Conversion Formula

Evaluate Formula

Formula

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

Example with Units

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

3) Reactant Concentration of First Order Irreversible Reaction Formula

Evaluate Formula

Formula

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

Example with Units

$$20.9997\,\text{mol/m}^3 = e^{-2.508\,\text{s}^{-1} \cdot 0.5333\,\text{s}} \cdot 80\,\text{mol/m}^3$$

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

Evaluate Formula

Formula

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

Example with Units

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

5) Reactant Concentration using Reactant Conversion Formula

Evaluate Formula

Formula

$$C = C_o \cdot \left(1 - X_A\right)$$

Example with Units

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

6) Reactant Conversion using Molar Feed Rate of Reactant Formula

Evaluate Formula

Formula

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

Example with Units

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

7) Reactant Conversion using Number of Moles of Reactant Fed Formula

Evaluate Formula

Formula

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

Example with Units

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

8) Reactant Conversion using Reactant Concentration Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Reacting Fluid Volume using Reaction Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$2.5002\,\text{m}^3 = \frac{4\,\text{mol}}{3\,\text{mol/m}^3\text{*s} \cdot 0.5333\,\text{s}}$$

10) Reaction Rate based on Volume of Reacting Fluid Formula

Evaluate Formula

Formula

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

Example with Units

$$3.0002\,\text{mol/m}^3\text{*s} = \frac{4\,\text{mol}}{2.5\,\text{m}^3 \cdot 0.5333\,\text{s}}$$

11) Reaction Rate in Gas-Solid System Formula

Evaluate Formula

Formula

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

Example with Units

$$2.9882\,\text{mol/m}^3\text{*s} = \frac{4\,\text{mol}}{2.51\,\text{m}^3 \cdot 0.5333\,\text{s}}$$

12) Reaction Rate in Reactor Formula

Evaluate Formula

Formula

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

Example with Units

$$3.0122\,\text{mol/m}^3\text{*s} = \frac{4\,\text{mol}}{2.49\,\text{m}^3 \cdot 0.5333\,\text{s}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$0.5312\,\text{s} = \frac{4\,\text{mol}}{3\,\text{mol/m}^3\text{*s} \cdot 2.51\,\text{m}^3}$$

14) Reaction Time Interval of Reacting Fluid using Reaction Rate Formula

Evaluate Formula

Formula

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

Example with Units

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

15) Reaction Time Interval of Reactor using Reaction Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5355\,s = \frac{4\,mol}{3\,mol/m^3*s \cdot 2.49\,m^3}$$

16) Reactor Volume using Reaction Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$2.5002\,m^3 = \frac{4\,mol}{3\,mol/m^3*s \cdot 0.5333\,s}$$

17) Solid Volume using Reaction Rate Formula

Evaluate Formula

Formula

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

Example with Units

$$2.5002\,m^3 = \frac{4\,mol}{3\,mol/m^3*s \cdot 0.5333\,s}$$

Variables used in list of Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate above

- **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 in list of Important Formulas in Basics of Chemical Reaction Engineering & Forms of Reaction Rate above

- constant(s): **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

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