



# 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

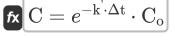
$$\left| \mathbf{f}_{\mathbf{A}} \right| \mathrm{C}_{\mathrm{Ao}} = rac{\mathrm{F}_{\mathrm{Ao}}}{\mathrm{v}_{\mathrm{o}}}$$

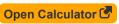
$$ex 0.5 \text{mol/m}^3 = \frac{5 \text{mol/s}}{10 \text{m}^3/\text{s}}$$

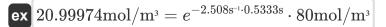
#### 2) Number of Moles of Reactant Fed using Reactant Conversion

$$N_{
m Ao} = rac{N_{
m A}}{1-X_{
m A}}$$

#### 3) Reactant Concentration of First Order Irreversible Reaction







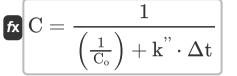






4) Reactant Concentration of Second Order Irreversible Reaction with

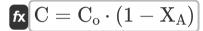
# Equal Reactant Conc using Time



Open Calculator

 $ext{ex} egin{aligned} 22.2595 ext{mol/m}^3 &= rac{1}{\left(rac{1}{80 ext{mol/m}^3}
ight) + 0.0608 ext{m}^3/( ext{mol*s}) \cdot 0.5333 ext{s}} \end{aligned}$ 

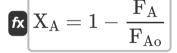
## 5) Reactant Concentration using Reactant Conversion



Open Calculator

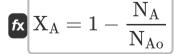
 $ext{ex} 24 ext{mol/m}^3 = 80 ext{mol/m}^3 \cdot (1 - 0.7)$ 

6) Reactant Conversion using Molar Feed Rate of Reactant



Open Calculator 🗗

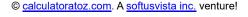
#### 7) Reactant Conversion using Number of Moles of Reactant Fed



Open Calculator 🗗

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







#### 8) Reactant Conversion using Reactant Concentration

Open Calculator

Open Calculator 🖸

Open Calculator

Open Calculator

 $X_{
m A} = 1 - \left(rac{
m C}{
m C_o}
ight)$ 

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

# 9) Reacting Fluid Volume using Reaction Rate

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

4mol  $2.500156 \text{m}^{_{3}} = \frac{41101}{3 \text{mol/m}^{_{3}} \text{*s} \cdot 0.5333 \text{s}}$ 

# 10) Reaction Rate based on Volume of Reacting Fluid

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

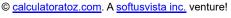
 $oxed{ex} 3.000188 \mathrm{mol/m^3*s} = rac{4 \mathrm{mol}}{2.5 \mathrm{m^3} \cdot 0.5333 \mathrm{s}}$ 

## 11) Reaction Rate in Gas-Solid System 🖸

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

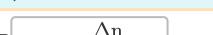
 $\mathbf{ex} \ 2.988235 \mathrm{mol/m^3*s} = rac{4 \mathrm{mol}}{2.51 \mathrm{m^3 \cdot 0.5333s}}$ 







#### 12) Reaction Rate in Reactor 🔽

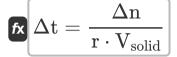


Open Calculator 🚰

 $\mathbf{r} = \frac{\mathbf{r}}{\mathbf{V}_{\mathrm{reactor}} \cdot \Delta \mathbf{t}}$ 

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

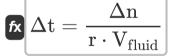
# 13) Reaction Time Interval of Gas-Solid System using Reaction Rate



Open Calculator

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

## 14) Reaction Time Interval of Reacting Fluid using Reaction Rate 🗹



Open Calculator 🚰

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

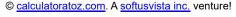
#### 15) Reaction Time Interval of Reactor using Reaction Rate



Open Calculator

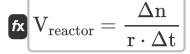
 $0.535475s = rac{4mol}{3mol/m^3*s \cdot 2.49m^3}$ 







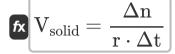
#### 16) Reactor Volume using Reaction Rate



Open Calculator

ex 
$$2.500156 \mathrm{m}^{_3} = \frac{4 \mathrm{mol}}{3 \mathrm{mol/m}^{_3} \mathrm{*s} \cdot 0.5333 \mathrm{s}}$$

#### 17) Solid Volume using Reaction Rate



Open Calculator

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



#### Variables Used

- C Reactant Concentration (Mole per Cubic Meter)
- CAO Concentration of Key Reactant A in the Feed (Mole per Cubic Meter)
- Co Initial Reactant Concentration (Mole per Cubic Meter)
- F₄ Molar Flow Rate of Unreacted Reactant (Mole per Second)
- FAO 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<sub>△</sub> Number of Moles of Unreacted Reactant-A (Mole)
- N<sub>AO</sub> Number of Moles of Reactant-A Fed (Mole)
- r Reaction Rate (Mole per Cubic Meter Second)
- V<sub>fluid</sub> Fluid Volume (Cubic Meter)
- Volumetric Flow Rate of Feed to Reactor (Cubic Meter per Second)
- V<sub>reactor</sub> Reactor Volume (Cubic Meter)
- V<sub>solid</sub> Solid Volume (Cubic Meter)
- X<sub>▲</sub> Reactant Conversion
- **\Delta n** Change in Number of Moles (Mole)
- Δt Time Interval (Second)





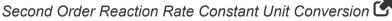
#### Constants, Functions, Measurements used

- 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 (m³)
   Volume Unit Conversion
- Measurement: Volumetric Flow Rate in Cubic Meter per Second (m³/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/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<sup>-1</sup>)

  First Order Reaction Rate Constant Unit Conversion
- Measurement: Second Order Reaction Rate Constant in Cubic Meter per Mole Second (m³/(mol\*s))







#### **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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