Reactor Performance Equations for Variable Volume Reactions Formulas

List of 17 Reactor Performance Equations for Variable Volume Reactions Formulas

Reactor Performance Equations for Variable Volume Reactions

1) Initial Reactant Concentration for Second Order Reaction for Mixed Flow

Open Calculator

fx $$Co_{MixedFlow} = \left(\frac{1}{\tau_{MFR}} \cdot k''_{MFR}\right) \cdot \left(\frac{X_{MFR} \cdot (1 + (\varepsilon \cdot X_{MFR}))^2}{(1 - X_{MFR})^2}\right)$$

ex $$10.32254 \text{mol/m³} = \left(\frac{1}{0.0612 \text{s}} \cdot 0.0607 \text{m³/(mol*s)}\right) \cdot \left(\frac{0.702 \cdot (1 + (0.21 \cdot 0.702))^2}{(1 - 0.702)^2}\right)$$

2) Initial Reactant Concentration for Second Order Reaction for Plug Flow

Open Calculator

fx $$Co_{PlugFlow} = \left(\frac{1}{\tau_{pfr} \cdot k''}\right) \cdot \left(2 \cdot \varepsilon_{PFR} \cdot (1 + \varepsilon_{PFR}) \cdot \ln(1 - X_{A\text{-}PFR}) + \varepsilon_{PFR}^2 \cdot X_{A\text{-}PFR} + \left((\varepsilon_{PF\ldots}\right.\right.$$

ex $$1016.209 \text{mol/m³} = \left(\frac{1}{0.05009 \text{s} \cdot 0.0608 \text{m³/(mol*s)}}\right) \cdot \left(2 \cdot 0.22 \cdot (1 + 0.22) \cdot \ln(1 - 0.715) + (0.22)^2 \cdot 0.715 + \ldots\right.$$

3) Initial Reactant Concentration for Zero Order Reaction for Mixed Flow

Open Calculator

fx $$C_{o\text{-}MFR} = \frac{k_{0\text{-}MFR} \cdot \tau_{MFR}}{X_{MFR}}$$

ex $$89.01026 \text{mol/m³} = \frac{1021 \text{mol/m³*s} \cdot 0.0612 \text{s}}{0.702}$$

4) Initial Reactant Concentration for Zero Order Reaction for Plug Flow

Open Calculator

fx $$C_{o\ pfr} = \frac{k_0 \cdot \tau_{pfr}}{X_{A\text{-}PFR}}$$

ex $$78.46266 \text{mol/m³} = \frac{1120 \text{mol/m³*s} \cdot 0.05009 \text{s}}{0.715}$$

5) Rate Constant for First Order Reaction for Mixed Flow

Open Calculator

$$k1_{MFR} = \left(\frac{1}{\tau_{MFR}}\right) \cdot \left(\frac{X_{MFR} \cdot (1 + (\varepsilon \cdot X_{MFR}))}{1 - X_{MFR}}\right)$$

$$44.16638 s^{-1} = \left(\frac{1}{0.0612s}\right) \cdot \left(\frac{0.702 \cdot (1 + (0.21 \cdot 0.702))}{1 - 0.702}\right)$$

6) Rate Constant for First Order Reaction for Plug Flow

Open Calculator

$$k_{plug\ flow} = \left(\frac{1}{\tau_{pfr}}\right) \cdot \left((1 + \varepsilon_{PFR}) \cdot \ln\left(\frac{1}{1 - X_{A\text{-}PFR}}\right) - (\varepsilon_{PFR} \cdot X_{A\text{-}PFR})\right)$$

$$27.43311 s^{-1} = \left(\frac{1}{0.05009s}\right) \cdot \left((1 + 0.22) \cdot \ln\left(\frac{1}{1 - 0.715}\right) - (0.22 \cdot 0.715)\right)$$

7) Rate Constant for Second Order Reaction for Mixed Flow

Open Calculator

$$k^{MixedFlow''} = \left(\frac{1}{\tau_{MFR}} \cdot C_{o\text{-}MFR}\right) \cdot \left(\frac{X_{MFR} \cdot (1 + (\varepsilon \cdot X_{MFR}))^2}{(1 - X_{MFR})^2}\right)$$

$$13774.73 m^3/(mol^*s) = \left(\frac{1}{0.0612s} \cdot 81 mol/m^3\right) \cdot \left(\frac{0.702 \cdot (1 + (0.21 \cdot 0.702))^2}{(1 - 0.702)^2}\right)$$

8) Rate Constant for Second Order Reaction for Plug Flow

Open Calculator

$$k^{PlugFlow''} = \left(\frac{1}{\tau \cdot C_o}\right) \cdot \left(2 \cdot \varepsilon \cdot (1 + \varepsilon) \cdot \ln(1 - X_A) + \varepsilon^2 \cdot X_A + \left((\varepsilon + 1)^2 \cdot \frac{X_A}{1 - X_A}\right)\right)$$

$$0.708811 m^3/(mol^*s) = \left(\frac{1}{0.05s \cdot 80 mol/m^3}\right) \cdot \left(2 \cdot 0.21 \cdot (1 + 0.21) \cdot \ln(1 - 0.7) + (0.21)^2 \cdot 0.7 + \left((0.21 + 1\right.\right.$$

9) Rate Constant for Zero Order Reaction for Mixed Flow

Open Calculator

$$k_{0\text{-}MFR} = \frac{X_{MFR} \cdot C_{o\text{-}MFR}}{\tau_{MFR}}$$

$$929.1176 mol/m^3{}^*s = \frac{0.702 \cdot 81 mol/m^3}{0.0612s}$$

10) Rate Constant for Zero Order Reaction for Plug Flow

Open Calculator

$$k_0 = \frac{X_{A\text{-}PFR} \cdot C_{o\ pfr}}{\tau_{pfr}}$$

$$1170.493 \text{mol/m³*s} = \frac{0.715 \cdot 82 \text{mol/m³}}{0.05009 \text{s}}$$

11) Reactant Conversion for Zero Order Reaction for Mixed Flow

Open Calculator

$$X_{MFR} = \frac{k_{0\text{-}MFR} \cdot \tau_{MFR}}{C_{o\text{-}MFR}}$$

$$0.771422 = \frac{1021 \text{mol/m³*s} \cdot 0.0612 \text{s}}{81 \text{mol/m³}}$$

12) Reactant Conversion for Zero Order Reaction for Plug Flow

Open Calculator

$$X_{A\text{-}PFR} = \frac{k_0 \cdot \tau_{pfr}}{C_{o\ pfr}}$$

$$0.684156 = \frac{1120 \text{mol/m³*s} \cdot 0.05009 \text{s}}{82 \text{mol/m³}}$$

13) Space Time for First Order Reaction using Rate Constant for Mixed Flow

Open Calculator

$$\tau_{MFR} = \left(\frac{1}{k1_{MFR}}\right) \cdot \left(\frac{X_{MFR} \cdot (1 + (\varepsilon \cdot X_{MFR}))}{1 - X_{MFR}}\right)$$

$$0.068257 \text{s} = \left(\frac{1}{39.6 \text{s}^{-1}}\right) \cdot \left(\frac{0.702 \cdot (1 + (0.21 \cdot 0.702))}{1 - 0.702}\right)$$

14) Space Time for First Order Reaction using Rate Constant for Plug Flow

Open Calculator

$$\tau_{pfr} = \left(\frac{1}{k_{plug\ flow}}\right) \cdot \left((1 + \varepsilon_{PFR}) \cdot \ln\left(\frac{1}{1 - X_{A\text{-}PFR}}\right) - (\varepsilon_{PFR} \cdot X_{A\text{-}PFR})\right)$$

$$0.034788 \text{s} = \left(\frac{1}{39.5 \text{s}^{-1}}\right) \cdot \left((1 + 0.22) \cdot \ln\left(\frac{1}{1 - 0.715}\right) - (0.22 \cdot 0.715)\right)$$

15) Space Time for Second Order Reaction using Rate Constant for Mixed Flow

Open Calculator

fx $$\tau_{MixedFlow} = \left(\frac{1}{k''_{MFR}} \cdot C_{o\text{-}MFR}\right) \cdot \left(\frac{X_{MFR} \cdot (1 + (\varepsilon \cdot X_{MFR}))^2}{(1 - X_{MFR})^2}\right)$$

ex $$13888.19\text{s} = \left(\frac{1}{0.0607\text{m}^3/(\text{mol*s})} \cdot 81\text{mol}/\text{m}^3\right) \cdot \left(\frac{0.702 \cdot (1 + (0.21 \cdot 0.702))^2}{(1 - 0.702)^2}\right)$$

16) Space Time for Zero Order Reaction using Rate Constant for Mixed Flow

Open Calculator

fx $$\tau_{MFR} = \frac{X_{MFR} \cdot C_{o\text{-}MFR}}{k_{0\text{-}MFR}}$$

ex $$0.055692\text{s} = \frac{0.702 \cdot 81\text{mol}/\text{m}^3}{1021\text{mol}/\text{m}^3\text{*s}}$$

17) Space Time for Zero Order Reaction using Rate Constant for Plug Flow

Open Calculator

fx $$\tau_{pfr} = \frac{X_{A\text{-}PFR} \cdot C_{o\ pfr}}{k_0}$$

ex $$0.052348\text{s} = \frac{0.715 \cdot 82\text{mol}/\text{m}^3}{1120\text{mol}/\text{m}^3\text{*s}}$$

Variables Used

- $C_{o\ pfr}$ Initial Reactant Concentration in PFR *(Mole per Cubic Meter)*
- C_{o} Initial Reactant Concentration *(Mole per Cubic Meter)*
- $C_{o\text{-}MFR}$ Initial Reactant Concentration in MFR *(Mole per Cubic Meter)*
- $Co_{MixedFlow}$ Initial Reactant Conc for 2nd Order Mixed Flow *(Mole per Cubic Meter)*
- $Co_{PlugFlow}$ Initial Reactant Conc for 2nd Order Plug Flow *(Mole per Cubic Meter)*
- k_{0} Rate Constant for Zero Order Reaction *(Mole per Cubic Meter Second)*
- $k_{0\text{-}MFR}$ Rate Constant for Zero Order Reaction in MFR *(Mole per Cubic Meter Second)*
- $k_{plug\ flow}$ Rate Constant for First Order in Plug Flow *(1 Per Second)*
- k''_{MFR} Rate Constant for Second Order Reaction in MFR *(Cubic Meter per Mole Second)*
- k'' Rate Constant for Second Order Reaction *(Cubic Meter per Mole Second)*
- $k^{MixedFlow''}$ Rate Constant for 2ndOrder Reaction for Mixed Flow *(Cubic Meter per Mole Second)*
- $k^{PlugFlow''}$ Rate Constant for 2nd Order Reaction for Plug Flow *(Cubic Meter per Mole Second)*
- $k1_{MFR}$ Rate Constant for First Order Reaction in MFR *(1 Per Second)*
- X_{A} Reactant Conversion
- $X_{A\text{-}PFR}$ Reactant Conversion in PFR
- X_{MFR} Reactant Conversion in MFR
- ε Fractional Volume Change in Reactor
- ε Fractional Volume Change
- ε_{PFR} Fractional Volume Change in PFR
- τ Space Time *(Second)*
- τ_{MFR} Space Time in MFR *(Second)*
- $\tau_{MixedFlow}$ Space Time for Mixed Flow *(Second)*
- τ_{pfr} Space Time in PFR *(Second)*

Constants, Functions, Measurements used

- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- 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

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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