Reactor Performance Equations for Constant Volume Reactions Formulas

List of 28 Reactor Performance Equations for Constant Volume Reactions Formulas

Reactor Performance Equations for Constant Volume Reactions

1) Initial Reactant Concentration for Second Order Reaction using Space Time for Mixed Flow

Open Calculator

$$C_o = \frac{X_{mfr}}{(1 - X_{mfr})^2 \cdot (\tau_{mixed}) \cdot (k_{mixed})}$$

$$277.2522 \text{mol/m}^3 = \frac{0.71}{(1 - 0.71)^2 \cdot (0.05\text{s}) \cdot (0.609 \text{m}^3/(\text{mol*s}))}$$

2) Initial Reactant Concentration for Second Order Reaction using Space Time for Plug Flow

Open Calculator

$$C_{o\ Batch} = \left(\frac{1}{k_{''} \cdot \tau_{Batch}}\right) \cdot \left(\frac{X_{A\ Batch}}{1 - X_{A\ Batch}}\right)$$

$$79.14833 \text{mol/m}^3 = \left(\frac{1}{0.608 \text{m}^3/(\text{mol*s}) \cdot 0.051\text{s}}\right) \cdot \left(\frac{0.7105}{1 - 0.7105}\right)$$

3) Initial Reactant Concentration for Zero Order Reaction using Space Time for Mixed Flow

Open Calculator

$$C_o = \frac{k_{\text{mixed flow}} \cdot \tau_{\text{mixed}}}{X_{\text{mfr}}}$$

$$79.22535 \text{mol/m}^3 = \frac{1125 \text{mol/m}^3\text{*s} \cdot 0.05 \text{s}}{0.71}$$

4) Initial Reactant Concentration for Zero Order Reaction using Space Time for Plug Flow

Open Calculator

$$C_{o\ \text{Batch}} = \frac{k_{\text{Batch}} \cdot \tau_{\text{Batch}}}{X_{\text{A Batch}}}$$

$$80.46587 \text{mol/m}^3 = \frac{1121 \text{mol/m}^3\text{*s} \cdot 0.051 \text{s}}{0.7105}$$

5) Rate Constant for First Order Reaction using Reactant Concentration for Mixed Flow

Open Calculator

$$k' = \left(\frac{1}{\tau_{\text{mixed}}}\right) \cdot \left(\frac{C_o - C}{C}\right)$$

$$46.66667 \text{s}^{-1} = \left(\frac{1}{0.05 \text{s}}\right) \cdot \left(\frac{80 \text{mol/m}^3 - 24 \text{mol/m}^3}{24 \text{mol/m}^3}\right)$$

6) Rate Constant for First Order Reaction using Reactant Concentration for Plug Flow

Open Calculator

fx $$k_{batch} = \left(\frac{1}{\tau_{Batch}}\right) \cdot \ln\left(\frac{C_{o\ Batch}}{C_{Batch}}\right)$$

ex $$24.80605\text{s}^{-1} = \left(\frac{1}{0.051\text{s}}\right) \cdot \ln\left(\frac{81.5\text{mol/m}^3}{23\text{mol/m}^3}\right)$$

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

Open Calculator

fx $$k' = \left(\frac{1}{\tau_{mixed}}\right) \cdot \left(\frac{X_{mfr}}{1 - X_{mfr}}\right)$$

ex $$48.96552\text{s}^{-1} = \left(\frac{1}{0.05\text{s}}\right) \cdot \left(\frac{0.71}{1 - 0.71}\right)$$

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

Open Calculator

fx $$k_{batch} = \left(\frac{1}{\tau_{Batch}}\right) \cdot \ln\left(\frac{1}{1 - X_{A\ Batch}}\right)$$

ex $$24.30588\text{s}^{-1} = \left(\frac{1}{0.051\text{s}}\right) \cdot \ln\left(\frac{1}{1 - 0.7105}\right)$$

9) Rate Constant for Second Order Reaction using Reactant Concentration for Mixed Flow

Open Calculator

$$k_{mixed} = \frac{C_o - C}{(\tau_{mixed}) \cdot (C)^2}$$

$$1.944444 m^3/(mol*s) = \frac{80 mol/m^3 - 24 mol/m^3}{(0.05 s) \cdot (24 mol/m^3)^2}$$

10) Rate Constant for Second Order Reaction using Reactant Concentration for Plug Flow

Open Calculator

$$k'' = \frac{C_{o\ Batch} - C_{Batch}}{\tau_{Batch} \cdot C_{o\ Batch} \cdot C_{Batch}}$$

$$0.611928 m^3/(mol*s) = \frac{81.5 mol/m^3 - 23 mol/m^3}{0.051 s \cdot 81.5 mol/m^3 \cdot 23 mol/m^3}$$

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

Open Calculator

$$k_{mixed} = \frac{X_{mfr}}{(1 - X_{mfr})^2 \cdot (\tau_{mixed}) \cdot (C_o)}$$

$$2.110583 m^3/(mol*s) = \frac{0.71}{(1 - 0.71)^2 \cdot (0.05 s) \cdot (80 mol/m^3)}$$

12) Rate Constant for Second Order Reaction using Space Time for Plug Flow

Open Calculator

$$k'' = \left(\frac{1}{\tau_{Batch} \cdot C_{o\ Batch}}\right) \cdot \left(\frac{X_{A\ Batch}}{1 - X_{A\ Batch}}\right)$$

$$0.590456\text{m}^3/(\text{mol*s}) = \left(\frac{1}{0.051\text{s} \cdot 81.5\text{mol}/\text{m}^3}\right) \cdot \left(\frac{0.7105}{1 - 0.7105}\right)$$

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

Open Calculator

$$k_{mixed\ flow} = \frac{X_{mfr} \cdot C_o}{\tau_{mixed}}$$

$$1136\text{mol}/\text{m}^3\text{*s} = \frac{0.71 \cdot 80\text{mol}/\text{m}^3}{0.05\text{s}}$$

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

Open Calculator

$$k_{Batch} = \frac{X_{A\ Batch} \cdot C_{o\ Batch}}{\tau_{Batch}}$$

$$1135.407\text{mol}/\text{m}^3\text{*s} = \frac{0.7105 \cdot 81.5\text{mol}/\text{m}^3}{0.051\text{s}}$$

15) Reactant Concentration for Zero Order Reaction using Space Time for Mixed Flow

$$C = C_o - (k_{\text{mixed flow}} \cdot \tau_{\text{mixed}})$$

Open Calculator

$$23.75\text{mol/m}^3 = 80\text{mol/m}^3 - (1125\text{mol/m}^3\text{*s} \cdot 0.05\text{s})$$

16) Reactant Concentration for Zero Order Reaction using Space Time for Plug Flow

$$C_{\text{Batch}} = C_{o\ \text{Batch}} - (k_{\text{Batch}} \cdot \tau_{\text{Batch}})$$

Open Calculator

$$24.329\text{mol/m}^3 = 81.5\text{mol/m}^3 - (1121\text{mol/m}^3\text{*s} \cdot 0.051\text{s})$$

17) Reactant Conversion for Zero Order Reaction using Space Time for Mixed Flow

$$X_{\text{mfr}} = \frac{k_{\text{mixed flow}} \cdot \tau_{\text{mixed}}}{C_o}$$

Open Calculator

$$0.703125 = \frac{1125\text{mol/m}^3\text{*s} \cdot 0.05\text{s}}{80\text{mol/m}^3}$$

18) Reactant Conversion for Zero Order Reaction using Space Time for Plug Flow

$$X_{\text{A Batch}} = \frac{k_{\text{Batch}} \cdot \tau_{\text{Batch}}}{C_{o\ \text{Batch}}}$$

Open Calculator

$$0.701485 = \frac{1121\text{mol/m}^3\text{*s} \cdot 0.051\text{s}}{81.5\text{mol/m}^3}$$

19) Space Time for First Order Reaction for Mixed Flow

Open Calculator

fx $$\tau_{mixed} = \left(\frac{1}{k'}\right) \cdot \left(\frac{X_{mfr}}{1 - X_{mfr}}\right)$$

ex $$0.097619\text{s} = \left(\frac{1}{25.08\text{s}^{-1}}\right) \cdot \left(\frac{0.71}{1 - 0.71}\right)$$

20) Space Time for First Order Reaction for Plug Flow

Open Calculator

fx $$\tau_{Batch} = \left(\frac{1}{k_{batch}}\right) \cdot \ln\left(\frac{1}{1 - X_{A\ Batch}}\right)$$

ex $$0.049406\text{s} = \left(\frac{1}{25.09\text{s}^{-1}}\right) \cdot \ln\left(\frac{1}{1 - 0.7105}\right)$$

21) Space Time for First Order Reaction using Reactant Concentration for Mixed Flow

Open Calculator

fx $$\tau_{mixed} = \left(\frac{1}{k'}\right) \cdot \left(\frac{C_o - C}{C}\right)$$

ex $$0.093036\text{s} = \left(\frac{1}{25.08\text{s}^{-1}}\right) \cdot \left(\frac{80\text{mol/m}^3 - 24\text{mol/m}^3}{24\text{mol/m}^3}\right)$$

22) Space Time for First Order Reaction using Reactant Concentration for Plug Flow

Open Calculator

$$\tau_{Batch} = \left(\frac{1}{k_{batch}}\right) \cdot \ln\left(\frac{C_{o\ Batch}}{C_{Batch}}\right)$$

$$0.050423s = \left(\frac{1}{25.09s^{-1}}\right) \cdot \ln\left(\frac{81.5mol/m^3}{23mol/m^3}\right)$$

23) Space Time for Second Order Reaction for Mixed Flow

Open Calculator

$$\tau_{mixed} = \frac{X_{mfr}}{(1 - X_{mfr})^2 \cdot (k_{mixed}) \cdot (C_o)}$$

$$0.173283s = \frac{0.71}{(1 - 0.71)^2 \cdot (0.609m^3/(mol*s)) \cdot (80mol/m^3)}$$

24) Space Time for Second Order Reaction for Plug Flow

Open Calculator

$$\tau_{Batch} = \left(\frac{1}{k_{''} \cdot C_{o\ Batch}}\right) \cdot \left(\frac{X_{A\ Batch}}{1 - X_{A\ Batch}}\right)$$

$$0.049528s = \left(\frac{1}{0.608m^3/(mol*s) \cdot 81.5mol/m^3}\right) \cdot \left(\frac{0.7105}{1 - 0.7105}\right)$$

25) Space Time for Second Order Reaction using Reactant Concentration for Mixed Flow

Open Calculator

fx $$\tau_{mixed} = \frac{C_o - C}{(k_{mixed}) \cdot (C)^2}$$

ex $$0.159642s = \frac{80mol/m^3 - 24mol/m^3}{(0.609m^3/(mol^*s)) \cdot (24mol/m^3)^2}$$

26) Space Time for Second Order Reaction using Reactant Concentration for Plug Flow

Open Calculator

fx $$\tau_{Batch} = \frac{C_{o\ Batch} - C_{Batch}}{k_{''} \cdot C_{o\ Batch} \cdot C_{Batch}}$$

ex $$0.051329s = \frac{81.5mol/m^3 - 23mol/m^3}{0.608m^3/(mol^*s) \cdot 81.5mol/m^3 \cdot 23mol/m^3}$$

27) Space Time for Zero Order Reaction for Mixed Flow

Open Calculator

fx $$\tau_{mixed} = \frac{X_{mfr} \cdot C_o}{k_{mixed\ flow}}$$

ex $$0.050489s = \frac{0.71 \cdot 80mol/m^3}{1125mol/m^{3*}s}$$

28) Space Time for Zero Order Reaction for Plug Flow

Open Calculator

$$\tau_{Batch} = \frac{X_{A\ Batch} \cdot C_{o\ Batch}}{k_{Batch}}$$

ex
$$0.051655\text{s} = \frac{0.7105 \cdot 81.5\text{mol/m}^3}{1121\text{mol/m}^3\text{*s}}$$

Variables Used

- **C** Reactant Concentration at given Time *(Mole per Cubic Meter)*
- **C_{Batch}** Reactant Conc at any Time in Batch Reactor *(Mole per Cubic Meter)*
- **$C_{o\ Batch}$** Initial Reactant Concentration in Batch Reactor *(Mole per Cubic Meter)*
- **C_o** Initial Reactant Concentration in Mixed Flow *(Mole per Cubic Meter)*
- **k'** Rate Constant for First Order Reaction *(1 Per Second)*
- **k''** Rate Constant for Second Order in Batch Reactor *(Cubic Meter per Mole Second)*
- **k_{batch}** Rate Constant for First Order in Batch Reactor *(1 Per Second)*
- **k_{Batch}** Rate Constant for Zero Order in Batch *(Mole per Cubic Meter Second)*
- **$k_{mixed\ flow}$** Rate Constant for Zero Order in Mixed Flow *(Mole per Cubic Meter Second)*
- **k_{mixed}** Rate Constant for Second Order in Mixed Flow *(Cubic Meter per Mole Second)*
- **$X_{A\ Batch}$** Reactant Conversion in Batch
- **X_{mfr}** Reactant Conversion in Mixed Flow
- **τ_{Batch}** Space Time in Batch Reactor *(Second)*
- **τ_{mixed}** Space Time in Mixed Flow *(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/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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