

PE Environmental Site Assessment and Remediation

$$\frac{1}{C_A} - \frac{1}{0.25 \frac{\text{mol}}{\text{L}}} = 0.05 \frac{\text{L}}{(\text{mole})(\text{min})} \times 15 \text{ min}$$

$$\frac{1}{C_A} = \cancel{0.05} \frac{\text{L}}{(\text{mole})} + \frac{1}{0.25 \frac{\text{mol}}{\text{L}}} = 11.5 \frac{\text{L}}{(\text{mole})}$$

$$C_A = 0.21 \text{ mol/L}$$

3.10. Problem#11

The following second order reaction occurs in a constant-volume Batch reactor with a rate constant of $0.05 \text{ L}/(\text{mol} \cdot \text{min})$:



$$k = 0.05 \frac{\text{L}}{\text{mol min}}$$

$$\frac{dC_A}{dt} = kC_A^2$$

What will it take for half of the original solution to decompose?

Solution:

Constant volume batch reactor, second order reaction,

$$k = 0.05 \frac{\text{L}}{(\text{mole})(\text{min})}$$

$$C_{A0} = 0.25 \frac{\text{mol}}{\text{L}} \times 1$$

C_A half of the solution to decompose = $0.125 \text{ mol/L} = x_2$

C_A

$$kt = \frac{1}{C_A} - \frac{1}{C_{A0}}$$

$$0.05 \frac{\text{L}}{(\text{mole})(\text{min})} \times t \text{ min} = \frac{1}{0.125 \frac{\text{mol}}{\text{L}}} - \frac{1}{0.25 \frac{\text{mol}}{\text{L}}}$$

$$\frac{1}{C_A(t)} - \frac{1}{C_{A0}} = kt$$

$$\frac{C_{A0}}{C_A(t)} - \frac{C_{A0}}{C_{A0}} = kt \quad t \text{ min} = \frac{\frac{1}{0.125 \frac{\text{mol}}{\text{L}}} - \frac{1}{0.25 \frac{\text{mol}}{\text{L}}}}{0.05 \frac{\text{L}}{(\text{mole})(\text{min})}} = 80 \text{ min}$$

$$\frac{(x_2 - x_1)}{\Delta t} = 0.05 \frac{\text{L}}{\text{mol min}} (x_2)^2$$

$$\frac{x_2 - 2x_2}{\Delta t} = 0.05 \frac{\text{L}}{\text{mol min}} (x_2)^2$$

$$\frac{0.125 - 0.25}{\Delta t} = 0.05 \frac{\text{L}}{\text{mol min}} (0.125)^2$$

$$\Delta t = 80 \text{ min}$$

$$\frac{dC_A}{dt} = kC_A^2$$

3.11. Arrhenius Equation

(RIIB 1.2, Page 97)

$$\frac{C_{A0} - C_A}{\Delta t} = k C_{A0}$$

$$k = Ae^{-E_a/RT}$$

$$\frac{dC_A}{dt} = kC_A^2$$

$$\frac{C_A - C_{A0}}{\Delta t} = k C_A^2$$

Where,

$$\frac{C_A - C_{A0}}{\Delta t} = k C_{A0}$$

If you use kC_{A0} you get 80 min

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