17.9

$SO_2Cl_2 \rightarrow SO_2 + Cl_2$

$A \rightarrow B + C$

$k = 2{,}2 \cdot 10^{-3} \cdot s^{-1}$

$V = ?$ $\quad \eta = 0{,}9$

$p = 0{,}101 \cdot 10^6$ Pa

$\dot{m}_{A0} = 50$ kg/h

$r = k \cdot c_A$

$T = 320 + 273{,}15 =$

$\dot{n}_A = \dot{n}_{A0} \cdot (1 - \eta)$

$\dot{n}_B = \dot{n}_{A0} \cdot (\eta)$

$\dot{n}_C = \dot{n}_{A0} \eta$

$\dot{n} = \dot{n}_A + \dot{n}_B + \dot{n}_C = \dot{n}_{A0} \cdot (1 + \eta)$

$0 = \dot{n}_A(x) - \dot{n}_A(x+\Delta x) - k \cdot c_A \cdot A \cdot \Delta x \quad / : \Delta x$

$\lim_{\Delta x \to 0} \dfrac{\dot{n}_A(x+\Delta x) - \dot{n}_A(x)}{\Delta x} = -k \cdot c_A \cdot A$

$\dfrac{d}{dx} \dot{n}_A = -k \cdot c_A \cdot A$

$\dfrac{d}{dx}\left[\dot{n}_{A0} \cdot (1 - \eta)\right] = -\dot{n}_{A0} \dfrac{d\eta}{dx} = -k \cdot c_A \cdot A$

$p \dot{V} = \dot{n} R T$

$\left[\dfrac{mol}{m^3}\right] \quad c = \dfrac{\dot{n}}{\dot{V}} = \dfrac{p}{RT}$

$c_A = x_A \cdot c = \dfrac{\dot{n}_A}{\dot{n}_A + \dot{n}_B + \dot{n}_C} \cdot \dfrac{p}{RT} = \dfrac{\dot{n}_{A0} \cdot (1 - \eta)}{\dot{n}_{A0} \cdot (1 + \eta)} \cdot \dfrac{p}{RT}$

$$A \cdot dx = d \cdot (A \cdot x) = dV$$

$$\dot{n}_{A0} \cdot \frac{d\eta}{dx} = k \cdot \frac{1-\eta}{1+\eta} \cdot \frac{p}{RT} \cdot A$$

$$\int_0^{\eta} \frac{1+\eta}{1-\eta}\, d\eta = \int_0^{L} \frac{k \cdot p}{RT} \cdot A \frac{1}{\dot{n}_{A0}} \cdot dx = \int_0^{V} \frac{k \cdot p}{RT} \frac{1}{\dot{n}_{A0}} \cdot dV$$

$$X = 1 - \eta \Rightarrow \eta = 1 - X$$

$$dX = -d\eta$$

$$\int_{X_1}^{X_2} -\frac{1+1-X}{X}\, dX = \int_{X_1}^{X_2} -\frac{2}{X}\, dX + \int_{X_1}^{X_2} 1 \cdot dX$$

$$= \left[-2 \cdot \ln(X) \right]_{X_1}^{X_2} + \left[X \right]_{X_1}^{X_2} =$$

$$= \left[-2 \ln \cdot (1-\eta) \right]_0^{\eta} + \left[1-\eta \right]_0^{\eta} =$$

$$= 2 \cdot \ln \frac{1}{1-\eta} + 1 - \eta - 1 = \left(2 \ln \frac{1}{1-\eta} - \eta \right) = \frac{k \cdot p \cdot V}{RT \cdot \dot{n}_{A0}}$$

$$M = \frac{m}{n} \qquad \dot{n}_{A0} = \frac{\dot{m}_{A0}}{M} = \frac{50}{134{,}97} = 0{,}3704 \frac{kmol}{h} \Rightarrow 0{,}1029 \frac{mol}{s}$$

$$\frac{k \cdot p}{R \cdot T \cdot \dot{n}_{A0}} = \frac{2{,}2 \cdot 10^{-3} \cdot 0{,}101 \cdot 10^{6}}{8{,}314 \cdot (320 + 273{,}15) \cdot 0{,}3704} = 0{,}4379 \frac{s^{-1} \cdot Pa \cdot mol \cdot K \cdot h}{J \cdot K \cdot kmol}$$

$$2 \ln \frac{1}{1-0{,}9} - 0{,}9 = 3{,}705$$

$$V = \frac{4{,}42}{0{,}4379} = 8{,}46\ m^3$$