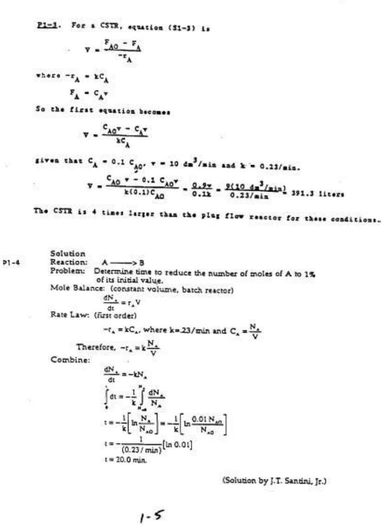

P1-3. For a CSTR, equation (S1-3) is

$$V = \frac{F_{A0} - F_A}{-r_A}$$

where $-r_A = kC_A$

$F_A = C_A v$

So the first equation becomes

$$V = \frac{C_{A0}v - C_A v}{kC_A}$$

given that $C_A = 0.1\ C_{A0}$, $v = 10\ dm^3/min$ and $k = 0.23/min$.

$$V = \frac{C_{A0}\ v - 0.1\ C_{A0}v}{k(0.1)C_{A0}} = \frac{0.9v}{0.1k} = \frac{9(10\ dm^3/min)}{0.23/min} = 391.3\ liters$$

The CSTR is 4 times larger than the plug flow reactor for these conditions.

P1-4 Solution

Reaction: A ——> B

Problem: Determine time to reduce the number of moles of A to 1% of its initial value.

Mole Balance: (constant volume, batch reactor)

$$\frac{dN_A}{dt} = r_A V$$

Rate Law: (first order)

$-r_A = kC_A$, where k=.23/min and $C_A = \frac{N_A}{V}$

Therefore, $-r_A = k\frac{N_A}{V}$

Combine:

$$\frac{dN_A}{dt} = -kN_A$$

$$\int_0^t dt = -\frac{1}{k}\int_{N_{A0}}^{N_A} \frac{dN_A}{N_A}$$

$$t = -\frac{1}{k}\left[\ln\frac{N_A}{N_{A0}}\right] = -\frac{1}{k}\left[\ln\frac{0.01\,N_{A0}}{N_{A0}}\right]$$

$$t = -\frac{1}{(0.23/\min)}[\ln 0.01]$$

t = 20.0 min.

(Solution by J.T. Santini, Jr.)

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