Study Guide Test 2

In order to do well on the next test, you should be able to do the following:

1. Be able to derive the terms *Km, Vm* for different inhibition enzymatic kinetics (ie. competitive inhibition, uncompetitive inhibition, non-competitive inhibition) and understand how concentrations of inhibitor [I] affect Km and Vm using the Lineweaver-Burke plot.

2. Explain in your own words that the terms *space-time* and *space-velocity.*

3. Be able to apply the mass balance for any reactant (or product) in reactor.

4. Be able to derive performance equations for ideal batch and steady-flow reactors and their integrated expressions for various types of reactions (ie. enzymatic reactions, zero order, 1^{st} order, 2^{nd} order).

5. Be able to solve for the sizes, flow rates, and production rates (qC_0X) of mixed and plug flow reactors, and compare the performance of MFR and PFR for a given duty.

6. Be able to derive performance equations for single reactors in series (PFR, MFR) or combinations in terms of C_n and overall conversion, X, i.e. X = f(tau, k).

Practice problem:

8 MFR in series

All Same volume, $V = 10\,L$

$v = 1\ L/hr$, $C_0 = 10\ mol/L$, $k = 0.04\ \frac{1}{hr}$

What is overall conversion?

What are intermediate concentrations?

1st order rxn

$$C_1 = \frac{C_0}{1+k\tau} \qquad k\tau = (.04)\left(\frac{10}{1.0}\right) = 0.4$$

$$\text{So, } C_1 = \frac{C_0}{1+.4} = \frac{10}{1.4} = \underline{\underline{7.1429}}\ mol/L$$

$$C_2 = \frac{C_1}{1+0.4} = \frac{7.1249}{1.4} = \underline{\underline{5.102}}\ mol/L$$

etc.

$$C_8 = \frac{C_0}{(1+k\tau)^n} = \frac{C_0}{(1+0.4)^8} = 0.6776\ \frac{mol}{L}$$

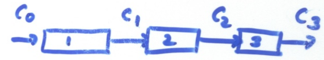
$$X = \frac{C_0 - C_8}{C_0} = \underline{\underline{0.9322}}$$

If conversion X is given, can we calculate tau and reactor size?

Multiple reactor systems

Plug flow

$$\tau = V/q = \int \frac{dc}{r}$$



$$\tau_1 = V_1/q = \int_{C_o}^{C_1} \frac{dc}{r}$$

$$\tau_2 = V_2/q = \int_{C_1}^{C_2} \frac{dc}{r}$$

$$\tau_3 = V_3/q = \int_{C_2}^{C_3} \frac{dc}{r}$$

$$\tau_{total} = \Sigma \tau_i = \frac{1}{q} \Sigma V_i = \int_{C_o}^{C_1} \frac{dc}{r} + \int_{C_1}^{C_2} \frac{dc}{r} + \int_{C_2}^{C_3} \frac{dc}{r}$$

$$= \int_{C_o}^{C_3} \frac{dc}{r}$$

For n reactors in series

$$\tau_{total} = \frac{1}{q} \sum_1^n V_i = \int_{C_o}^{C_n} \frac{dc}{r} = -C_o \int_0^{X_n} \frac{dx}{r}$$

∴ Series of pfrs is simply additive.

What is the overall conversion for 1st order reactions i.e. X = f(tau1, tau2, tau3, k).?