EVE 290

Introduction to Environmental Engineering

HW #11

1. In a first order process, a blue dye reacts to form a purple dye. The amount of blue dye at the end of 1 hr is 480 g and at the end of 3 hr is 120 g. Graphically estimate the amount of blue dye present initially. **(Ans: approx. 960 g)**

2. A reaction of great social significance is the fermentation of sugar with yeast. This is a zero-order reaction, where the yeast is a catalyst. If a 0.5 L bottle contains 4 g of sugar, and it takes 30 min to convert 50% of the sugar, what is the rate constant? **(Ans: 0.133 g/L-min)**

3. Integrate the differential equation in which A is being made at a rate k_1 and simultaneously destroyed at a rate k_2:

$$\frac{dA}{dt} = k_1 A - k_2 A$$

4. A batch reactor (we'll discuss these later) is designed to remove a pollutant by adsorption. The data are as follows:

Time (min)	Pollutant conc. [mg/L]
0	170
5	160
10	98
20	62
30	40
40	27

   What order of reaction does this appear to be? Graphically estimate the rate constant.

5. A radioactive nuclide is reduced by 90% in 12 minutes. What is its half-life? Hint: What is the "order" of the reaction process that is associated with radioactivity? **(Ans: 3.6 minutes)**

6. Initially, a bacteria culture that grows according to zero-order kinetics contains 1250 bacteria. The count increases to approximately 12,500 bacteria 6 hours later. What is the doubling time (t_d) for this bacterium? **(Ans: 0.67 hr)**

7. Repeat problem 6, assuming that 2nd order kinetics governs the bacterial growth. **(Ans: 3.33 hrs)**

8. Provide reaction rate expressions for the shaded species by combining the two methods discussed in class for writing the *total rate*. Assume that reactions (a-d) are elementary and either uni-, bi-, or termolecular.

   a. $\mathbf{O} + O_2 + M \rightarrow O_3 + M$

   b. $C_2H_6 + \mathbf{OH}^{\cdot} \rightarrow H_2O + C_2H_5$

   c. $OH^{\cdot} + CH_4 \rightarrow \mathbf{CH_3}^{\cdot} + H_2O$

   d. $OH^{\cdot} + CO \rightarrow CO_2 + \mathbf{H}^{\cdot}$