PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester I — Academic Year: 2005
Date: October 7, 2005 — Time: 09:00 -12:00
Subject: 223-486 Hazardous Waste Management — Room A 401

---

1. Answer any six (6) questions
2. Total points = 120
3. Text books and lecture note are not allowed.
4. Calculator and dictionary are allowed.
5. All questions should be answered in English;
6. Read the questions carefully and answer only what is being required.

---

1. (20 points)
   a. A waste sample has a pH of 12.5 and it needs to be neutralized to a pH of 7.5. A 50 mL sample was titrated with 22 mL of 0.05 N HCl to pH 7.5. Determine the amount of HCl (kg/d) needed to neutralize a waste flow stream of 150 m^3/d. (15 points)
   (Given: Molecular weight of H = 1; Cl =35.5)
   b. List four factors that are important for selecting an acid as a neutralizing agent? (5 points)

2. (20 points)
   State if the following statements are **True** or **False** by marking at the appropriate place.
   a. Leaching tests are performed on solidified waste materials to determine if the solid material releases any hazardous wastes under certain test conditions.
   ……**True** …….**False**.
   b. Staged precipitation process is needed when two or more heavy metals are being precipitated at different pH conditions.
   ……..**True** ……**False.**
   c. The energy source of an autotrophic microorganism may be from the oxidation of an organic compound. ……. **True** ……..**False**.
   d. In a plug flow reactor there is mixing in the entire reactor so that the concentration of the reactants is same at all locations.
   ……**True** ……**False** .
   e. Organic compound that have halogen substituents and have highly branched type molecular structure are generally less biodegradable.
   ……**True** ……**False**

3. (20 points)
In the following equation, state what is being oxidized and what is being reduced. (5 points)

$$2CrO_3 + H_2SO_3 = Cr_2(SO_4)_3 + H_2O$$

Also state what is the oxidation number for Cr in CrO_3 and S in H_2SO_3. (10 points)

Is the equation balanced? If not balance it. (5 points).

4. (20 points)
The kinetic equation for microorganism growth [x] with substrate [S] is given by:

$$d[x]/dt = (\mu_m [S][x]) / (K_s + [S])$$

where [x] = concentration of microorganism, mg/L
[S] = concentration of substrate, mg/L

What is μ_m and K_s? (15 points)

Draw a graph showing the relationship between x and time t, i.e. growth of microorganism mass with time as substrate is being consumed. At time zero $x = x_o$, (5 points).

5. (20 points) Answer any four of the followings:
a. Sketch a schematic diagram for the incineration of hazardous wastes.
b. Name some incineration products that may be emitted from the incinerator when combusting sulfur and chlorinated hazardous compounds.
c. What does POHC stand for during trial burn of a hazardous waste?
d. Soil vapor extraction process is suitable for what type of wastes?
e. If the soil has a lot of natural organic matter present, will it improve soil vapor extraction of hydrocarbons contaminants present?

6. (20 points)
The Fruendlich equation for adsorption for an organic compound on charcoal in an aqueous solution was found to be : $x/m = 1.5C_e^{0.9}$;

Where: x/m = amount of organic compound adsorbed per unit mass of charcoal. mg/g;
C_e = equilibrium concentration of organic compound, mg/L

How much charcoal will be needed per liter to reduce the initial concentration of the compound from 10 mg/L to 1 mg/l after equilibrium has been reached?

7. (20 points)
A vadose zone area has been contaminated with petroleum hydrocarbon from a leaky underground storage tank. The zone of contamination spreads from 1 to 4 m depth and over a hectare surface area. You are planning to use an in-situ bioremediation process for treating the contaminated soil. The ground water table is about 10 m below the surface at the site. Sketch the bioremediation process for the site showing what will be needed to get the job done.

Prof. S. K. Banerji