

**PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING**

Final Examination: Semester I

Academic Year: 2003

Date: 3 October, 2003

Time : 9:00 to 12:00 noon

Subject: 223-486; 835- 505 Hazardous Waste Management

Room: A 401

Instructions:

1. There are a total of seven (7) questions, **undergraduate students** must **answer any six (6)** questions. Total points = 300.
 2. **Master's degree students** need to **do all the seven (7)** questions; Total points = 350.
 3. Only dictionary and calculator are permitted for use during the examination.
 4. All questions need to be answered **in English**.
 5. Read all questions carefully and answer only what is required.
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1. (15 points) a. What type of hazardous wastes can be treated by biological treatment processes?

(15 points) b. An in-situ aerobic biological treatment process for remediation of hydrocarbon spill from a leaky underground tank is being planned. The aquifer underneath (about 5 m below the surface) has been contaminated with BTEX (components of gasoline) compounds . What ingredients must be supplied to the site to start the in-situ biodegradation process?

(20 points) c. Using a sketch to show one method of **delivery** of key ingredients to and **recovery** of end-products from the contaminated aquifer site to initiate in-situ biodegradation process.

2. (50 points) **Define or explain** the following:

a. Autotrophic microorganisms, also give an example

b. Explain how a Respirometer measures the aerobic biodegradability of a compound?

c. Explain Cometabolism? also give an example.

d. How is POHC chosen in a test burn of a Hazardous Waste ?

e. How does high organic content of soil affect its capacity to extract VOCs from it by Soil Vapor extraction process?

3. (50 points) Mark if the following statements are **True or False**

- a. Henry's law constant indicates the partition between solid and liquid phases in a soil sample. True..... False
- b. Air sparging is a process of forcing the vaporization of volatile organic compounds from a contaminated aquifer to the vadose zone by blowing air into it.True.....False
- c. Soil vapor extraction process is quite effective with soils that are very dry, i.e. very low moisture content.True.....False.
- d. One of the advantage of bioslurry reactor process to treat contaminated soil is that soils with high clay content can be treated successfully.True.....False.
- e. A packed bed reactor consists of a bed packed with media (stones or plastic materials) through which waste is passed. Biofilm containing microorganisms grows on the media causing the bio-oxidation of the waste ingredients. Such a treatment process is suitable for wastes containing high amounts of suspended solids.True.....False.

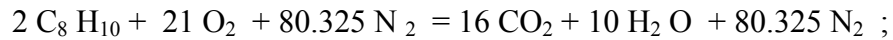
4. (40 points) a. A biotreatability study was conducted on a hazardous organic waste. It was found that the half-life for the organic compound in the waste under aerobic conditions was about 20 days at 25° C. Determine how many days will it take to treat the waste from an initial concentration of 25 mg/L to a desired concentration of 2 mg/L.

Assume that the waste biodegradation follows first order kinetics.

($dS/dt = -kS$; $\ln S_0 - \ln S = kt$; $t_{1/2} = 0.693/k$).

(10 points) b. If the temperature in the field drops to 10° C and the reaction rate constant k reduces by 50% in the system described in 4 a. above , what % removal of the organic compound will be obtained after 100 days of biodegradation treatment of the waste?

5.(50 points) A waste solvent is to be incinerated. The combustion reaction for the solvent is as follows:



[Given : Molecular weight : N₂ = 28; C = 12; O₂ = 32 ; H=1]

Determine the amount of air needed and the amount of CO₂ produced, both in kg per kg of solvent combusted.

6. (15 points) a. Name the steps involved to start a “Pump and Treat” option for cleaning a contaminated aquifer. (mention key words only)
- (15 points) b. What are the limitations of the “Pump and Treat” technology for cleaning a contaminated aquifer? (mention key words only)
- (10 points) c. Name two compounds in a contaminated aquifer that can be treated by zero valent iron (Fe^0) reactive barrier process .
- (10 points) d. Name another type of in-situ reactive barrier process that can be used to treat contaminated aquifer?

7. (25 points) a. Sketch a cross section of a hazardous waste landfill with a leachate collection system. Do show the liner system also.
- (15 points) b. What type of post-closure monitoring is needed for a hazardous waste landfill?
- (10 points) c. What would be a recommended process to treat landfill leachate containing soluble heavy metals?