

**มหาวิทยาลัยสงขลานครินทร์**  
**คณะวิศวกรรมศาสตร์**

การสอบกลางภาค ประจำปีการศึกษาที่ 1

ปีการศึกษา 2547

สอบวันที่ 6 สิงหาคม 2547

เวลา 09:00-12:00 น

วิชา 223-491 Waste Geotechnics

ห้องสอบ A400

ชื่อ..... รหัส.....

**คำชี้แจง**

- ข้อสอบมี 4 ข้อ 100 คะแนน ให้ทำทุกข้อ
- อนุญาตให้นักศึกษานำเครื่องคิดเลข และ กระดาษ Note ขนาด A4 เขียนด้านเดียว

Problem 1: Short Answers (15 points)

- Explain the use of landfill and its main components. Also describe the function of each the components.
- What is isomorphous substitution and how does it affect the efficiency of clay as a landfill liner?
- Explain the theory of diffuse double layer and also explain how does it affect the hydraulic conductivity of clay?

Problem 2: Adsorption (30 points)

Batch adsorption tests were conducted on a sample of moderately to highly plastic clay that is being considered as a lining material for a pond used to contain process water containing cadmium chloride. The batch tests were conducted by adding 1 g of dry clay to 40 ml of solution prepared with deionized water and copper chloride,  $CdCl_2$  (atomic weight of Cd = 112.41 g, atomic weight of Cl = 35.453 g). Four flasks were prepared. The following concentrations were measured before the soil was added ( $C_0$ ) and after tumbling the flasks for 48 hours ( $C_1$ ).

Sample	$C_0$ (mg/l)	$C_1$ (mg/l)
1	3542	2599
2	3042	2100
3	2151	1466
4	1151	781
5	0	0

Plot the isotherm. Estimate the partition coefficient (l/kg) for cadmium with the soil. Estimate CEC (meq/100 g).

Problem 3: Contaminant Transport (35 points)

A hazardous waste landfill liner is being designed, a leachate of concern contains a variety of metals, but cadmium and lead are the primary contaminants. The concentrations of cadmium and lead in the leachate are 100 and 25 mg/l. A GM-compacted clay composite liner being designed consists of a 0.6 m compacted clay ( $K = 1e-7$  cm/s) overlain by a 1.5-mm-thick HDPE geomembrane with a maximum depth of leachate of 0.3 m. Partition coefficients for cadmium and lead from batch tests were 0.261 and 0.435 l/kg, respectively. The diffusion coefficients for zinc and copper were  $4e-6$  and  $2.5e-6$  cm<sup>2</sup>/s. The porosity of clay was 0.4. Retardation factors for cadmium and lead are 2.5 and 3.5 respectively. Determine mass flux (kg/ha-yr) of both metals at 5 years. Also, determine the time required for getting maximum mass flux for both metals. Assume that size of hole = 5 mm and 10 holes/ha

Problem 4: Hydraulic conductivity of compacted clay (20 points)

Hydraulic conductivity tests were conducted on specimens of a moderate plastic clay prepared with reduced (RP), standard (SP), and modified (MP) proctor efforts. Results of the tests are summarized in the following table. Develop an acceptable zone for compaction control that will achieve hydraulic conductivity less than  $10^{-7}$  cm/s. Note that to obtain the requirement of shear strength and desiccation, the water content should be greater than 8% and following equation

$$\gamma_d > 0.05w + 19.0$$

where  $\gamma_d$  is in kN/m<sup>3</sup> and w is in percent.

W(%)	$\gamma_d$ (kN/m <sup>3</sup> )	CE	K (cm/s)	W(%)	$\gamma_d$ (kN/m <sup>3</sup> )	CE	K (cm/s)
8.0	16.9	RP	2.1e-6	11.3	20.0	SP	3.2e-8
10.1	18.0	RP	7.5e-7	15.0	18.6	SP	9.4e-8
13.3	18.6	RP	9.8e-8	3.6	19.7	MP	4.2e-7
14.5	18.5	RP	8.1e-8	6.0	20.6	MP	9.4e-8
16.5	17.7	RP	2.3e-7	9.0	21.2	MP	3.2e-8
17.8	17.2	RP	5.3e-7	11.2	20.8	MP	1.1e-8
5.4	19.0	SP	5.7e-7	12.6	20.1	MP	1.8e-8
8.6	20.1	SP	7.8e-8				