CE 5364 Groundwater Transport Phenomena
Exercise Set 3

Exercises

1. (Problem 6-7, pg. 588)

   An instantaneous release of biodegradable constituients occurs in a 1-D aquifer. The mass released is 1.0 kg over a 10 m^2 area normal to the flow direction, $\alpha_l = 1.0\ m$, the seepage velocity is 1.0 $\frac{m}{day}$, and the half-life of the decaying constituient is 33 years.

   Determine:

   (a) Sketch the system.

   (b) The maximum concentration at 100 meters from the source.

   (c) Plot a concentration history (annual intervals) for a 40 year period from release date for a location 100 meters from the source.

2. (Problem 6-9, pg. 589)

   Discharge from a point source introduced 10 kg of contaminant to an aquifer. The seepage velocity is 0.1 $\frac{ft}{day}$ in the $+x$ direction. The longitudinal and transverse dispersion coefficients are $D_x = 0.01\frac{ft^2}{day}$, and $D_y = D_z = 0.001\frac{ft^2}{day}$, respectively.

   Determine:

   (a) Sketch the system.

   (b) The maximum concentration at $x = 100\ ft$ and $t = 5\ years$.

   (c) The concentration at $(x, y, z, t) = (200\ ft, 5\ ft, 2\ ft, 5\ years)$

3. (Problem 6-10, pg. 589)

   Using the Domenico and Schwartz (1998) planar source model (pg. 182) to a continuous source that has been leaking contaminant into an aquifer for 15 years. The source had width $Y = 6\ m$ and depth $Z = 6\ m$. The source concentration is 10 $\frac{mg}{l}$. The seepage velocity is 0.057 $\frac{m}{day}$. The longitudinal, transverse, and vertical dispervities are 1 m,0.1 m, and 0.01 m respectively.

   Determine:

   (a) Sketch the system.

   (b) The contaminant concentration history at a location $x = 200\ m$ from the source using 1-year increments for 30 years.

4. (Data Analysis)

   A batch isotherm test was performed with several 1-L solutions of the chemical of interest and one soil type, 20 g in each solution container. The initial and final solution concentrations are shown in Table 1. Fit the linear, Freundlich, and Langmuir isotherm equations to this data.

Table 1: Isotherm Observations

Initial Concentration (mg/L)	Equilibrium Concentration (mg/L)
7.10	6.71
4.53	4.18
1.89	1.63
1.31	1.10
1.03	0.85

   Determine:

   (a) The Linear isotherm equation for these data (i.e. fit the isotherm model to the data), plot the isotherm and data

   (b) The Freundlich isotherm equation for these data, plot the isotherm and data

   (c) The Langmuir isotherm equation for these data, plot the isotherm and data

   (d) Which isotherm model produces the best fit for these data?

   Show calculations and identify all fitted parameter values.

5. (Data Analysis)

   The following table (Table 2)has data from a column test with bromide (conservative) and chromium (sorbed). The porosity of the soil was 0.485, the bulk density was 1.85 g/cc, velocity was 0.244 cm/min, and the column was 25.4 cm long with a diameter of 2.54 cm.

Table 2: Effluent Breakthrough Observations

Time (min)	Bromide $\frac{C}{Co}$	Chromium $\frac{C}{Co}$
0	0.000	0.000
15	0.000	0.000
30	0.005	0.000
45	0.003	0.000
60	0.013	0.000
75	0.075	0.000
90	0.137	0.000
105	0.530	0.000
120	0.841	0.000
135	1.000	0.000
150	1.000	0.000
165	1.000	0.009
180	1.000	0.186
195	1.000	0.595
210	1.000	0.791
225	1.000	0.875
240	1.000	0.913
255	1.000	0.946
270	1.000	0.946
285	1.000	1.000
300	1.000	1.000
315	1.000	1.000
330	1.000	1.000
345	1.000	1.000
360	1.000	1.000

   Determine:

   (a) Sketch the system.

   (b) The dispersivity in cm

   (c) The retardation coefficient for Cr.