

Problem Set 4

TEXT CHAPTERS 9 & 10 AND UNSATURATED FLOW

Work these problems for Chapters 9 & 10

1. With regard to Chapter 9 of the textbook, "Hydrolytic Transformations of Organic Chemicals in the Environment," determine the half-life values of fenitrothion in Figure 9-1 (p. 233) at a pH value of 5.0 and at a pH value of 10.0. What is the ratio of the half-life values at pH 10.0 compared with pH 5.0? Is this reaction an example of acid-mediated or alkaline-mediated hydrolysis?
2. Reference Chapter 10, "Kinetics of Biodegradation in Soil" for this problem. The concentration of phenanthrene in soil decreased from 100 mg/kg to 10 mg/kg in 30 days, and the decrease was due to biodegradation alone. Based on a first-order kinetic model of biodegradation in soil, calculate: (1) the first order rate constant, (2) the half-life, and (3) the time required to decrease the target cleanup concentration to 1.0 mg/kg.

Considerations of Soil Moisture, Unsaturated Flow, and Contaminant Transport

1. Given: A sample of moist soil has a volume of 40.5 cc and weighs 59.2 gms. After drying it weighs 48.3 gms. The specific gravity of the solids is 2.68.

Find: the water content (dry basis), the porosity, and the void ratio. (Show Calculations)

2. Given: Unsaturated flow conditions and measurements of soil moisture with time to a depth of 150 cm from the soil surface. Values for moisture content (θ) with depth and time are provided in the table below.

Time (hr)	Depth (cm)	Moisture, θ (cc/cc)
0	0 - 50	0.21
0	50-100	0.20
0	100-150	0.19
20	0 - 50	0.20
20	50-100	0.18
20	100-150	0.15

- Find:
- (1) Flux (Darcy) from the land surface to a depth of 150 cm.
 - (2) Seepage velocity through the 150 cm depth.

3. Consider that benzene is present in the water in problem 2. moving through the soil toward groundwater within a soil matrix with a bulk density of 1.4 gm/cc and an organic carbon content of 1.5%. Depth to the ground water is 150 cm from the surface of the soil.

Find: (1) The time (Days) for the percolating water to reach the ground water.
(3) The time (Days) for benzene to reach the ground water.