Remediation of soil and groundwater
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Problem set #1: contaminant properties

Problem 1:
A closed bottle contains 10 mL of air and 90 mL of water. Suspended in water is 36 mg of particulate (solid) matter having a solids density of 1 g/cm^3 and an organic carbon fraction of 0.1. The bottle contains 10 mg of tetrachloroethene (CCl_2=CCl_2) also known as perchloroethylene (PCE), which has the following properties:

MW= 166 g/mol; K'_H= 0.6; log K_{OW}= 2.67

The following relationship links K_{OW} and K_{OC}:
Log K_{OC}=0.989 log K_{ow} -0.346 (K_{OC} units are m^3/g in this case)

Calculate the mass distribution of PCE between the air, the aqueous solution and the suspended solids.

Problem 2:
You have prepared 100 mL of a combined aqueous standard containing 100 µg/L each of benzene, toluene, ethylbenzene and p-xylene (BTEX). You store this solution in a 1L bottle. Calculate the equilibrium concentration (µg/L) of each component in the water. Can you suggest a better storage alternative?

K_H'=0.214 benzene, K_H'=0.235 toluene, K_H'=0.322 ethylbenzene, K_H'=0.313 p-xylene

Problem 3:
A contaminated soil is placed in a sealed reactor with a capacity of 500 m^3 and amended with water. The soil contains 900 mg benzene/kg dry soil. The following information is available:

K_D=0.02 m^3/kg; K_H'=0.214 benzene

Solids concentration in reactor: 40 kg dry soil/m^3 slurry; Volume of slurry: 500 m^3
Soil dry solid density ρ_s=2,000 kg/m^3

a- Calculate the volume of soil and water in the reactor.
b- Calculate the concentration of benzene in the water.

Problem 4:
The Karickhoff relationship links K_{OW} and K_{OC} in the following manner:
$K_D = 0.63 * 10^{-6} * f_{OC} * K_{OW}$ (K_D units are m^3/g in this case).

A- Rivers typically contain suspended solids (floating particles) in the concentration C_{SS} = 1 to 100 mg/L where C_{SS} is the solids concentration expressed as (mg dry solids/L). What is the fraction of PCBs (polychlorinated biphenyls) in the solid? Given: K_{ow} (PCB)=10^6; C_{SS}= 10 mg/L; f_{OC}= 0.1; ρ_s= 1 g/cm^3. Note: high f_{OC} because particles contain lots of biological matter such as algae.

B- Calculate the distribution coefficient K_D for the partitioning of CCl_4 between water and solids given that K_{OW}=440 and the organic carbon content of the solid phase is f_{OC}=0.02. Calculate the dimensionless ratio of solid and aqueous concentrations given that the density of solids is ρ_s= 1.1 g/cm^3

C- Calculate the distribution of CCl_4 mass between the solid and solution phases given that the solid phase is suspended in the water column and occupies 0.01% of the total volume.