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Soil pollution

EXAMPLE

DDT (dichlorodiphenyltrichloroethane) is a known pesticide, now banned in many countries, and TCE (trichlorethylene) a solvent widely used in the industry and one of the contaminants most frequently found in contaminated soils.

Determine:

In view of the properties of both chemicals (Table 1) give all you can infer about the fate and transport of a spill of each of these substances in a particular field. Propose a suitable technique for a soil polluted with each chemical.

Data:

Table 1. Pollutants' properties

	Relative density	Solubility in water (mg/L)	K_{ow}	K_{oc} (mL/g)	K_H (atm·m ³ /mol)
DDT	1.56	0.002	960 000	238 000	5.20×10^{-5}
TCE	1.46	1100	195	28	9.1×10^{-3}

Table 2. Range of physical-chemical properties

Property	Range of parameters		
Solubility in water S (mg/L)	< 10	10-1 000	> 1 000
Octanol-water K_{ow}	>1 000	500-1 000	<500
Partition onto organic carbon K_{oc} (mL/g)	>10 000	1 000-10 000	<1 000
Hydrolysis $t_{1/2}$ (days)	> 90	30-90	<30
Photolysis $t_{1/2}$ (days)	> 90	30-90	<30
Volatility K_H (atm·m ³ /mol)	<10 ⁻⁷	10 ⁻⁷ -10 ⁻³	>10 ⁻³

DDT

Relative density = 1.56 > 1

- The density of DDT is higher than the density of water. In case of contact with a water body (the water table, or any surface water volume), it will tend to sink.

Solubility in water = 0.002 <<< 10 mg/L

- Solubilization potential is negligible.
- Leaching potential and surface runoff potential are very low.
- Biodegradation is probably slow.

Octanol-water (K_{ow}) = 960000 >> 1000

- Hydrophobicity is very high, which agrees with the low solubility.
- The Bioconcentration Factor (BCF) will be high so bioaccumulation of the pollutant in the organisms will be an important concern.
- As the pollutant tends to be adsorbed in organic particles, it will tend to be adsorbed onto the organic carbon of the soil (check with K_{oc})

Partitioning coefficient onto organic carbon (K_{oc}) = 238000 mL/g >> 10000 mL/g

- Very high adsorption potential in the soil.

Henry's constant (K_H) = 5.20×10^{-5} atm. m³/mol between 10^{-7} and 10^{-3} atm. m³/mol

- Volatilization potential is variable. It may be possibly significant.

Summary: DDT will be mainly adsorbed to the organic particles of the soil and it will hardly be found dissolved in water but might be found in vapor phase. Organisms will tend to bioaccumulate DDT. Biodegradation potential is probably low.

Considering the high adsorption on the soil, it will have a low mobility. Thus, most of the pollutant will probably be found in a narrow thickness of the surface of the soil. This suggests that a suitable treatment could be to excavate the contaminated soil and send it to a landfill.

TCE

Relative density = 1.46 > 1

- The density of TCE is higher than the density of water. In case of contact with a water body (the water table, or any surface water volume), it will tend to sink.

Solubility in water = 1100 > 1000:

- Solubilization potential is moderately high.
- Leaching potential and surface runoff potential are moderately high.
- Biodegradation might occur.

Octanol-water (K_{ow}) = 195 < 500:

- Sorption potential is low.
- The Bioconcentration Factor (BCF) will be low, so bioaccumulation of the pollutant in the organisms will not be an important concern.

Partition onto organic carbon (K_{oc}) = 28 << 1000:

- Low adsorption potential in the organic matter of the soil.

Henry's constant (K_H) = 9.1×10^{-3} > 10^{-3} :

- High volatilization potential.

Summary: An important portion of TCE may be found dissolved in water, while the portion attached on the soil particles will be low. If the amount of pollution is important, and it reaches the water level, the contaminant will pass through it and may accumulate on impermeable soil layers. It is also probable to find part of the pollution in vapor phase.

Considering the high solubilization potential, soil washing or soil flushing could be considered as potential techniques for soil remediation. The high volatilization potential suggests the possibility of considering the techniques of soil vapor extraction, air sparging and thermal desorption. It should not be discarded the possibility of biorremediation.