

Remediation of soil and groundwater
Rizlan Bernier-Latmani
Problem set #2: microbial processes and monitoring

Problem 1:

Vinyl chloride (VC) as a chlorinated solvent and is a common contaminant in the subsurface. It is degraded to ethene, a harmless compound via reductive dechlorination with H_2 as an electron donor by *Dehalococcoides* sp. An environmental engineer collected the following data for VC dechlorination with excess H_2 with *Dehalococcoides*. The degradation rate constant of VC by this microorganism was determined to be $18 \mu\text{mol}/(\text{day} \cdot \text{mg protein})$ in a separate study.

Growth rate (d^{-1})	VC conc ($\mu\text{mol/L}$)
3.5	1
5	1.8
6	3
7	5
9	11
9.3	15
9.5	20
9.8	22
10	28

time (days)	X (mg protein/L)
0	0.31
1	0.42
2	0.55
3	0.63
4	0.78
5	0.85
6	0.95
7	1.08
8	1.12
9	1.18
10	1.2
11	1.2
12	1.2
13	0.96
14	0.77
15	0.61

What is the minimum concentration of the substrate that would support growth?

Problem 2:

A batch experiment was conducted to follow the biodegradation of the polynuclear aromatic hydrocarbon phenanthrene in a liquid culture. An inoculum of exponentially growing bacteria was introduced and the following results obtained.

- a- Assuming first-order rate kinetic apply and the microorganisms do not grow on phenanthrene, find the biodegradation rate constant k .
- b- Based on the results of this experiment, what is the half-life of phenanthrene?

Time (days)	C (mg/L)
0	500
2	450
5	375
7	350
10	298
15	215

Problem 3:

An experiment is being carried out at the Edwards Air Force Base in Southern California to remediate the TCE contamination. The strategy is to stimulate the aerobic cometabolic degradation of TCE with the addition of toluene and O_2 . The scientists would like to verify that they are supplying sufficient oxygen so that the major biological process is aerobic cometabolism (faster and carried out by the enzyme toluene monooxygenase) rather than reductive dehalogenation (slower and carried out by the enzyme dehalogenase). What could they do to be sure that the degradation of TCE is cometabolic?