

Problem Set 5

BIOREMEDIATION ENGINEERING TECHNOLOGY

1. **Given:** It is desired to use a soil bioremediation system for oxygen transfer. The spill occurred at a gasoline station in the middle of a residential neighborhood. Contamination of 2 acres of vadose zone from 10 feet to 25 feet below the surface of the ground has been determined.

20,000 gallon fuel spill = 142,000 pounds fuel

Use hexane as representative of the composition of the fuel

- Find: (1) Amount (pounds) of oxygen required to be delivered (stoichiometric amount) to remediate all of the fuel at the site
(2) Amount (pounds) of nitrogen, as ammonia (NH₃), required
(3) Amount of microorganisms produced as a result of the remediation

2. **Methanotrophic bioremediation** of a trichloroethylene (TCE) contaminated aquifer will be accomplished by adding methane to the aquifer to generate cometabolism of the TCE. You have been requested to do an engineering design analysis of a soil in-situ (in-place) remediation system using bioremediation. TCE is uniformly distributed in soil at a site (see definition sketch). The following information is known about the site:

soil = sand (65%), silt (20%), clay (15%) soil organic carbon = 0.5 % (dry weight)

= 22% air

= 21% water

= 57% soil

soil dry bulk density = 1.5 g/cc

spill of 100 moles of TCE into site

There is no NAPL at the site

(a) Calculate the overall stoichiometric relationship for the growth of methanotrophs that takes into account reduction of electron acceptor as well as synthesis for methanotrophs, as described in the handout by Criddle, Alvarez, and McCarty. Use nitrate (NO₃⁻) for the nitrogen source for methanotrophs growing on methane (CH₄).

(b) Determine the oxygen requirement per pound of methane.

(c) Determine the nitrogen requirement per pound of methane.

3. **Evaluate** the following biological characteristics with regard to the design of an in situ bioremediation system for remediation of an organic chemical spill in the unsaturated subsurface. Biological treatment characteristics:

$K_s = 1 \text{ mg/L}$

$b = 0.01/\text{day}$

$Y_m = 0.5 \text{ mg/mg}$

$k_m = 0.6/\text{day}$

Specifically determine:

(a) S_{min}

(b) If the chemical contaminant is present at a concentration of 50 micrograms per liter, is the chemical a primary substrate or a secondary substrate. Why is this important to know with regard to the design of a bioremediation system? (Explain)