Bioremediation of Polycyclic Aromatic Hydrocarbons in Soil at Former Manufactured Gas Plant Sites

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Outline

Manufactured Gas Plants
Hydrocarbons and PAH
Methods of Bioremediation
Microorganisms and Uptake
Enhancing Bioavailability
Effectiveness of Bioremediation
Future Directions
MGPs

Produced coal gas in late 19th, early 20th centuries
Waste – coal tar
Improper disposal
Pollutants leach into groundwater
Prevalence of problem
Hydrocarbons

Chain hydrocarbons

Cyclic hydrocarbons

Polycyclic hydrocarbons

Pyrene

Benzo(a)Pyrene
Methods of Bioremediation

In-situ
- Lower cost
- Reduced chance of spreading pollution

Ex-situ
- Higher cost
- More control over parameters
Microorganisms

Bacteria
  *Geobacter*
  Many others

Fungi
  *Phanerochaete*
  *Aspergillus*
Methods of Uptake

Bacterial degradation
  Hydrolysis of aromatic ring
  Dioxygenase enzymes
  Non-lygnolytic – cytochrome monoxygenase enzymes

Major products – CO$_2$, water, benign byproducts
Methods of Uptake

Fungal degradation
Lignolytic – woody material
Non-Lignolytic – soils

Common mechanism – oxidation of aromatic ring
Methods of Uptake

Source: Bamforth and Singleton (2005)
Enhancing Biodegradation

Surfactants – mixed results

Solvents – shown to be effective in desorbing PAH from soil
Enhancing Biodegradation

Fenton’s reaction – hydrolyzes PAH enhancing microbial action

Temperature and pH – tend to be situation and microbe specific

Nutrients – limiting component
Effectiveness

Case Study: Lee et al (2000)

Solvents improved availability
Effectiveness

Case Study: Nam et al (2000)
Bio + Fenton’s improved % removal
Effectiveness

Case Study: Li et al (2004)

Nutrients improved availability
Future Directions

Renewed use of MGPs
Enhancing effectiveness and bioavailability
Engineering microbes
Questions?