Bioremoval Kinetics of toluene and trichloroethylene mixture by *Burkholderia vietnamiensis* G4

by

Dong Shanshan (Emily)

A thesis submitted for partial fulfillment of the requirements for the degree of

Master of Civil Engineering

2012

Faculty of Science and Technology
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Approved by ________________________________ Prof. H. Shim
Supervisor

Date ________________________________
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VITA

Dong Shanshan (Emily) was born in Beijing on 26 December 1987. She graduated from Yao Hua high school in Tianjin in the year of 2005 and received the degree of Bachelor of Science in Civil Engineering from University of Macau in the year of 2010. She continued her studies since then at the University of Macau and did her master degree under the supervision of Professor Hojae Shim.

Related Publications:

Journal paper:


Conference/Symposium Presentation:


ABSTRACT

Bioremoval Kinetics of toluene and trichloroethylene mixture by *Burkholderia vietnamiensis* G4

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Thesis Supervisor: Prof. H. Shim
Master of Science in Civil Engineering

Toluene is one of the BTEX (benzene, toluene, ethylbenzene, and xylenes) which, also known as methylbenzene is a clear, water-insoluble liquid with the typical smell of paint thinners, redolent of the sweet smell of the related compounds benzene. Toluene is an aromatic hydrocarbon which is widely used as an industrial feedstock as a solvent.

Trichloroethylene (TCE) is a chlorinated aliphatic hydrocarbon (CAH) that has been widely used as an ingredient in industrial cleaning. TCE is one of the most frequently detected contaminants in groundwater which considered as a suspected carcinogen.

Trichloroethylene (TCE) can be co-metabolic degraded under aerobic condition using toluene as growth substrate. Study of *Burkholderia vietnamiensis* G4 has demonstrated aerobic co-metabolic TCE degradation. Using bioremediation technology to remove TCE is considered as a cost-effective method compared to chemical treatment.
The objective of this study is to investigate the bioremoval kinetics of toluene/TCE mixture using *B. vietnaiensis* G4. Studies were performed on different parameters (toluene/TCE concentrations, microbial inoculation amount, hydrogen peroxide concentration and percentage of powdered activated carbon). Different toluene concentrations at 20, 50 mg/L and TCE concentration at 0.2 mg/L were used. Microbial inoculation amount with initial optical density 1 and 3 were used. DO concentrations caused by hydrogen peroxide and PAC 1% & 3% (w/v) were considered. Depending on the conditions, specific growth rate and half saturation constant were considered to analyze the bioremoval kinetics.

Investigating the kinetics of contaminates with their detailed fates/behaviors during bio-removal process is essential even before the remediation technology can be applied on site for the successful remediation of contaminated environment. Since the kinetics of cometabolism are not entirely understood and can be quite complex, this kind of study can be good candidates for bioremediation of the wastes-contaminated sites.
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LIST OF ABBREVIATIONS

BDL       Below Detection Limit
BH medium  Bushnell-Haas medium
CAHs      Chlorinated Aliphatic Hydrocarbons
MCl       Chloride free mineral medium
Concn     Concentration
DMF       Dimethylformamide
DO        Dissolved Oxygen
EPA       Environmental Protection Agency
FID       Flame Ionization Detector
GC        Gas Chromatography
HPLC-MS   High-performance Liquid Chromatography-Mass Spectrometry
IC        Ion Chromatography
μL        Microliter
mL        Milliliter
M, mol    Molarity
MSM       Mineral Salts Medium
NB        Nutrient Broth
OD        Optical Density
ORE       Overall Removal Efficiency
ppb       parts per billion, μg/L
ppm       parts per million, mg/L
<table>
<thead>
<tr>
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<th>Description</th>
</tr>
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<tr>
<td>PAC</td>
<td>Powdered Activated Carbon</td>
</tr>
<tr>
<td>rpm</td>
<td>Revolutions Per Minute</td>
</tr>
<tr>
<td>TCE</td>
<td>Trichloroethylene</td>
</tr>
<tr>
<td>v/v</td>
<td>Volume / Volume</td>
</tr>
<tr>
<td>VOCs</td>
<td>Volatile Organic Compounds</td>
</tr>
<tr>
<td>w/v</td>
<td>Weight / Volume</td>
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<td>w/w</td>
<td>Weight / Weight</td>
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