

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

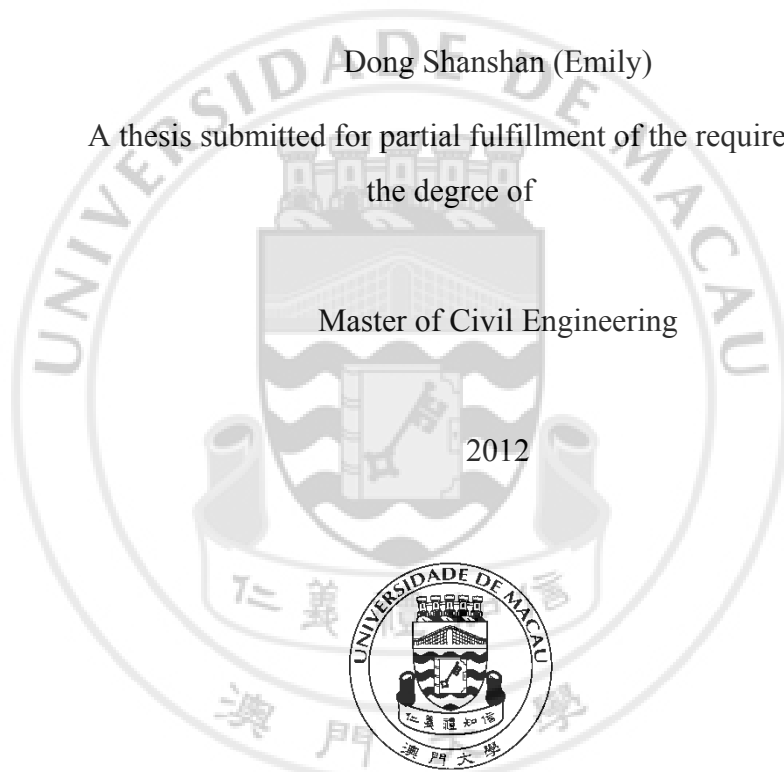
by

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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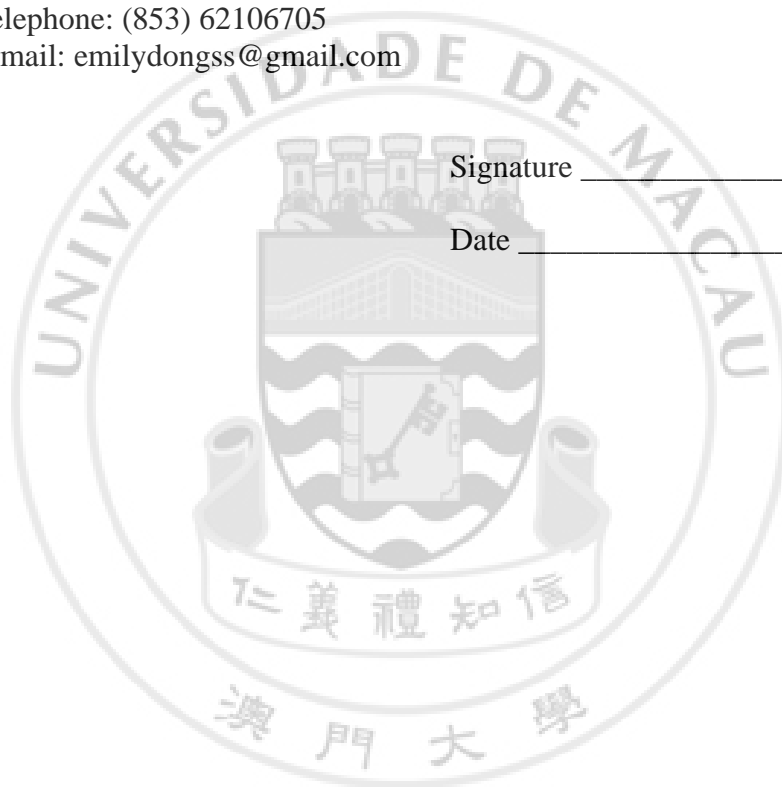
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Supervisor

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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:

-Li, J., Zhang, J., Lu, Y., Chen, Y., **Dong, S.**, & H., Shim. (2012). Determination of total petroleum hydrocarbons (TPH) in agricultural soils near a petrochemical complex in Guangzhou, China. *Environmental Monitoring and Assessment*. Vol. 184(1), pp.281-287. (co-author)

- Li, J., Lei, C., **Dong, S.**, & H., Shim. (2011). Bioremediation of mixed wastes (BTEX, TPH, TCE, and *cis*-DCE) contaminated water. *Journal of Hazardous, Toxic, and Radioactive Waste*. Vol. 15(3), pp.160-165. (co-author)

Conference/Symposium Presentation:

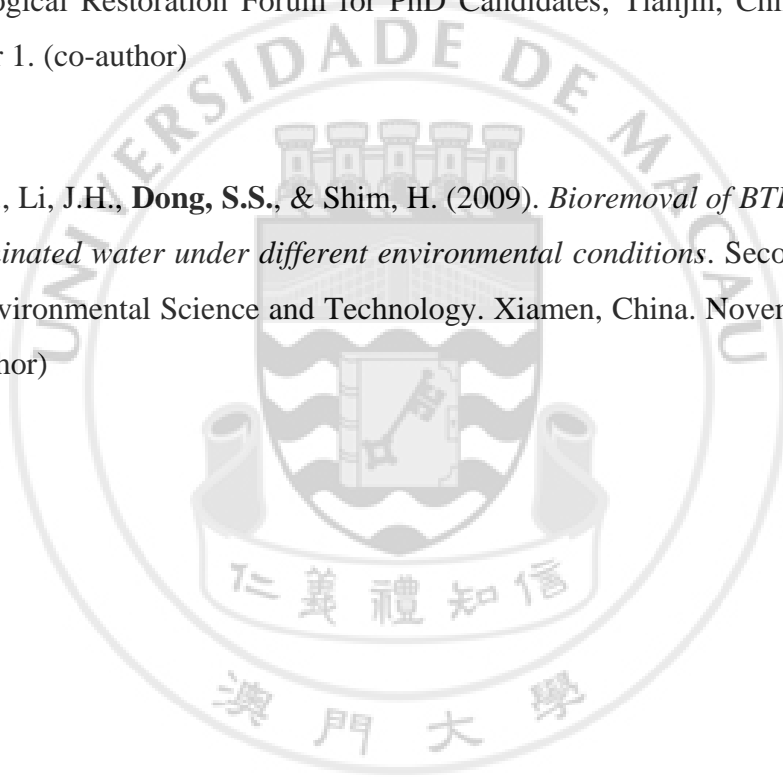
-J. Li, **S. S. Dong**, Y. Q. Chen and H. Shim. (2011). *Aerobic bioremoval of BTEX, cis-DCE, and TCE mixtures from the contaminated environment*. 18th International Petroleum Environmental Conference, Houston, Texas, U.S.A. Nov 8-11. (as presenter)

-Li, J., Chen, Y., **Dong, S.**, & Shim, H. (2011). *Optimization of nutrients and inocula concentrations toward the aerobic bioremoval of BTEX/CAHs mixture from soil*. 5th International Congress of Chemistry and Environment. Port Dickson, Malaysia. May 27-29. (co-author)

-Li, J., Lei, C., **Dong, S.**, & Shim, H. (2010). *Bioremediation of mixed wastes (BTEX, TPH, TCE, and cis-DCE) from contaminated water*. BIT's 1st Annual World Congress of Petroleum Microbiology (WCP). Dalian, China. July 24-27. (co-author)

-J. Li, C. Lei, **S. Dong** & H. Shim. (2009). *Interactions of BTEX, TPH, and CAHs during their bio-removal under different environmental conditions*. 1st Environmental Criteria and Ecological Restoration Forum for PhD Candidates, Tianjin, China, November 29-December 1. (co-author)

-Lei, C.K., Li, J.H., **Dong, S.S.**, & Shim, H. (2009). *Bioremoval of BTEX, TPH, and TCE in contaminated water under different environmental conditions*. Second Symposium on Urban Environmental Science and Technology. Xiamen, China. November 28-December 1. (co-author)



University of Macau

ABSTRACT

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

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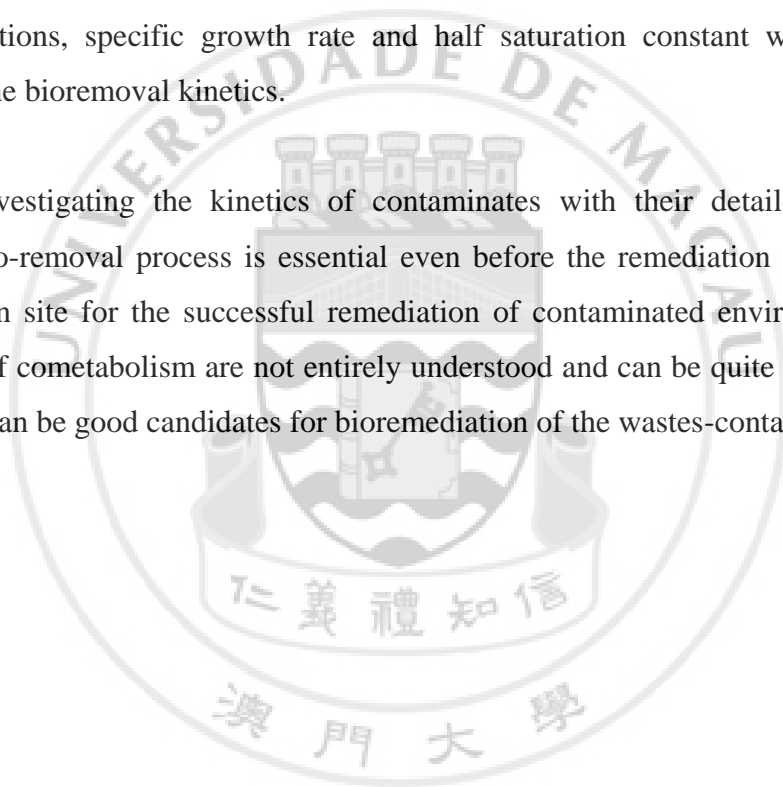
Toluene is one of the BTEX (benzene, toluene, ethylbenzene, and xylenes) which, also known as methylbenzene is a clear, water-insoluble liquid with the typical smell of paint thinners, redolent of the sweet smell of the related compounds benzene. Toluene is an aromatic hydrocarbon which is widely used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



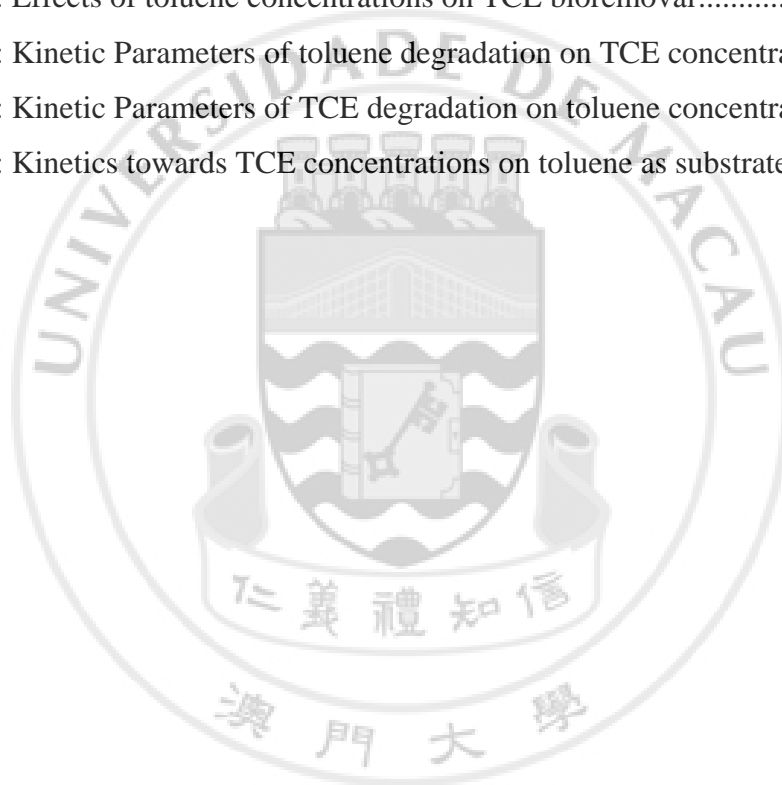
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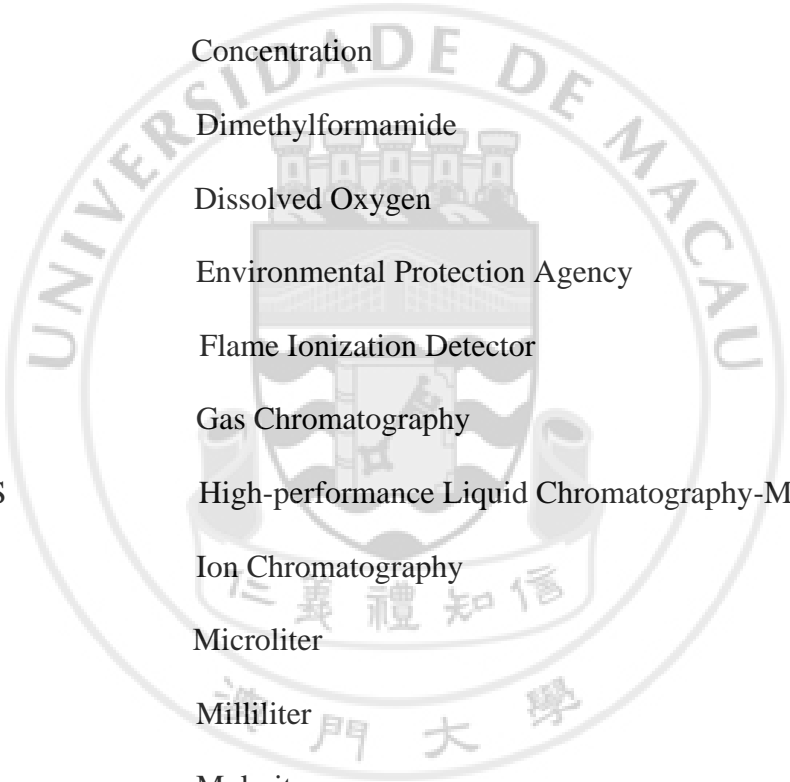
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LIST OF ABBREVIATIONS



BDL	Below Detection Limit
BH medium	Bushnell-Haas medium
CAHs	Chlorinated Aliphatic Hydrocarbons
MCI	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

PAC	Powdered Activated Carbon
rpm	Revolutions Per Minute
TCE	Trichloroethylene
v/v	Volume / Volume
VOCs	Volatile Organic Compounds
w/v	Weight / Volume
w/w	Weight / Weight



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