

**Aerobic Bioremediation of Water Contaminated with
Mixture of CAHs and BTEX**

by

Chen, Yiqin (Celery)

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

Master of Civil Engineering

2011



**Faculty of Science and Technology
University of Macau**

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Approved by _____ Prof. Hojae. Shim
Supervisor

Date _____

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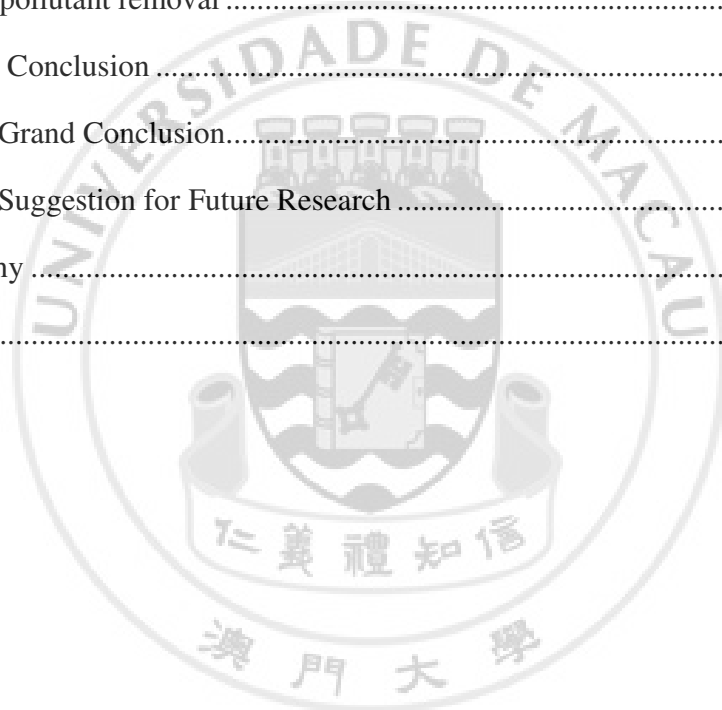
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VITA

Chen, Yiqin (Celery) was born in Lichuan, Hubei Province on 7 March 1986. She graduated from No. 1 senior high school in Lichuan in the year of 2004 and received the degree of Bachelor of Science in Civil Engineering from Three Gorges University in the year of 2009. 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:

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- Li, J., Zhang, J., Lu, Y., **Chen Y.**, Dong, S., & Shim, H. (2010). Determination of total petroleum hydrocarbons (TPH) in agricultural soils near a petrochemical complex in Guangzhou, China. *Environmental Monitoring and Assessment* DOI: 10.1007/s10661-011-1967-0. (co-author)

Conference/Symposium Presentation:

- **Y. Chen**, J. Li, C. Lei, & H. Shim (2011). Effects of Temperature, pH, and DO on the Bioremoval of Mixtures of BTEX/TPH/TCE from Contaminated Water. *International Conference on Environmental Pollution and Public Health (EPPH2011)*, Wuhan, China, May 10-12. (Poster)

- **Y. Chen**, J. Li, C. Lei, & H. Shim (2011). Interactions between BTEX, TPH, and TCE during their bio-removal from the artificially contaminated water. *Second International Conference on Bioenvironment, Biodiversity and Renewable Energies (BIONATURE)*, Venice, Italy, May 22-27. (Speaker)

- J. Li, **Y. Chen**, S. Dong & H. Shim (2011). Optimization of Aerobic Biodegradation of BTEX and CAHs in Soil. *The 2011 RemTEC Summit, Chicago, US. May 17-19*. (co-author)

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



University of Macau

ABSTRACT

Aerobic Bioremediation of Water Contaminated with Mixture of CAHs and BTEX

by

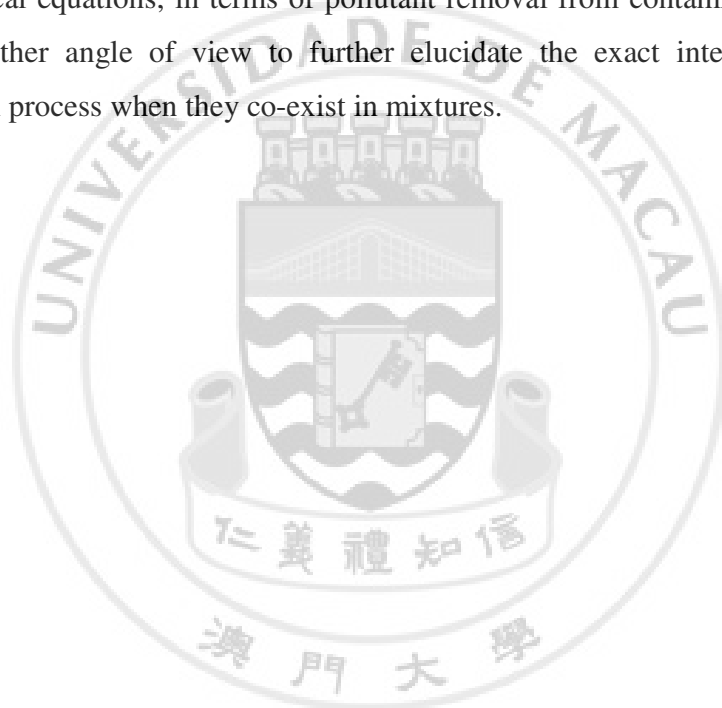
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Thesis Supervisor: Prof. Hojae Shim

Master of Science in Civil Engineering

Petroleum-based products and anthropogenic organic compounds have been continuously contaminating soil and groundwater ever since their usage began. As mixed wastes, such petroleum/gasoline compounds as benzene, toluene, ethylbenzene, and three isomers of xylene (BTEX) together with such chlorinated compounds as trichloroethylene (TCE) are among the most frequently found subsurface contaminants. Both BTEX and TCE are carcinogenic and would cause other serious health effects on humans. Even though lots of studies have been done with the removal of BTEX (singly and in mixtures), total petroleum hydrocarbons (TPH), or TCE (singly and in mixtures with other chlorinated aliphatic compounds; using such substrates as toluene) individually, unfortunately almost no study seems to have dealt with the interaction (stimulatory or inhibitory to each other's removal) among BTEX, TPH, and TCE when they exist in such mixtures as BTEX/TPH, BTEX/TPH/TCE, and BTEX/TCE, especially under different environmental conditions.

Seeing that knowing their detailed fates/behaviors during bioremoval process is essential even before the remediation technology can be applied on site for the successful remediation of contaminated environment, BTEX and TPH as the representative petroleum hydrocarbons and TCE as the representative chlorinated hydrocarbon were tested in lab-scale experiments under different conditions of contaminations concentration, pH, temperature, and amount of dissolved oxygen in this study. In the meantime, a central composite design (CCD) technique was also used to develop mathematical equations, in terms of pollutant removal from contaminated water, hoping giving another angle of view to further elucidate the exact interaction during their bioremoval process when they co-exist in mixtures.



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LIST OF ABBREVIATIONS



BH medium	Bushnell-Haas medium
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CCD	Central Composite Design
CV	Coefficient of Variance
DO	Dissolved Oxygen
D.W.	Distilled Water
EPA	Environmental Protection Agency
GC	Gas Chromatography
IC	Ion Chromatography
μL	Microliter
mL	Milliliter
mol	Molarity
MSM	Mineral Salts Medium
<i>mX</i>	<i>meta</i> -Xylene
NB	Nutrient Broth
OD	Optical Density
ORE	Overall Removal Efficiency
<i>oX</i>	<i>ortho</i> -Xylene
<i>pX</i>	<i>para</i> -Xylene
rpm	Revolutions Per Minute

TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
UV	Ultra Violet
v/v	Volume / Volume
w/w	Weight / Weight



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