

การลดโอกาสการก่อตัวของสารไตรฮาโลมีเทนในน้ำที่นำกลับมาใช้ใหม่จากน้ำทิ้งในการนิคมอุตสาหกรรม



นายจรงค์พันธ์ ฤทธิกะวงศ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

สาขาวิชาการจัดการสิ่งแวดล้อม สหสาขาวิชาการจัดการสิ่งแวดล้อม

บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

ปีการศึกษา 2545

ISBN 974-17-2630-9

ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

REDUCTION OF TRIHALOMETHANES FORMATION POTENTIAL IN RECLAIMED WATER
FROM TREATED INDUSTRIAL ESTATE WASTEWATER

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Environmental Management

Inter-Departmental Program in Environmental Management

Graduate School

Chulalongkorn University

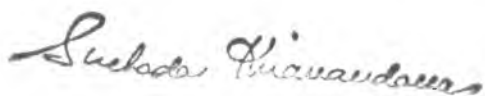
Academic Year 2002

ISBN 974-17-2630-9

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Thesis Title REDUCTION OF TRIHALOMETHANES FORMATION POTENTIAL
IN RECLAIMED WATER FROM TREATED INDUSTRIAL ESTATE
WASTEWATER
By Mr.Charongpun Musikavong
Field of Study Environmental Management
Thesis Advisor Assistant Professor Suraphong Wattanachira, D.Eng.

Accepted by the Graduate School, Chulalongkorn University in Partial
Fulfillment of the Requirements for the Master's Degree



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จรงค์พันธ์ มุสิกะวงส์: การลดโอกาสการก่อตัวของสารไตรฮาโลมีเทนในน้ำที่นำกลับมาใช้ใหม่จากน้ำทิ้งในการนิคมอุตสาหกรรม (REDUCTION OF TRIHALOMETHANES FORMATION POTENTIAL IN RECLAIMED WATER FROM TREATED INDUSTRIAL ESTATE WASTEWATER) อ.ที่ปรึกษา: ผศ.ดร.สุรพงษ์ วัฒนะจีระ, 112 หน้า. ISBN 974-17-2630-9

การลดโอกาสการก่อตัวของสารไตรฮาโลมีเทนในน้ำที่นำกลับมาใช้ใหม่จากน้ำทิ้งการนิคมอุตสาหกรรม เป็นการศึกษาโดยใช้น้ำทิ้งที่ผ่านการบำบัดแล้วจากการนิคมอุตสาหกรรมภาคเหนือมาทำการทดลองโคแอกกูเลชันในห้องปฏิบัติการ ด้วยการใช้ปริมาณสารส้มและเฟอร์ริกคลอไรด์ระหว่าง 0 ถึง 80 มก./ล. ภายใต้สภาวะการควบคุมค่าความเป็นกรดเป็นด่าง (pH) ระหว่าง 5 ถึง 6.5 และไม่ควบคุมค่า pH จากผลการศึกษาพบว่า ภายใต้สภาวะที่ไม่ควบคุมค่า pH ปริมาณสารส้มและเฟอร์ริกคลอไรด์ ประมาณ 10 มก./ล. สามารถลดความขุ่นได้เหลือประมาณ 3 NTU ส่วนความสัมพันธ์ระหว่างดัชนีตัวแทนสารอินทรีย์ธรรมชาติกับการก่อตัวของสารไตรฮาโลมีเทน (THMFP) พบว่า TOC เป็นดัชนีตัวแทนสารอินทรีย์ธรรมชาติที่มีความสัมพันธ์กับ THMFP ได้ดีที่สุด โดยมีค่า Pearson Correlation factor เท่า กับ 0.931 ($R^2 = 0.866$) และสมการที่สามารถใช้แสดงความสัมพันธ์ดังกล่าวได้คือ $THMFP = 238.552 + 33.886 (TOC)$ สำหรับปริมาณสารส้มและเฟอร์ริกคลอไรด์ที่ 40 มก./ล. พบว่าสามารถลด TOC จากค่าเฉลี่ย 6.12 มก./ล. ได้เหลือประมาณ 4.0 มก./ล. ที่ค่า pH ระหว่าง 5.5 ถึง 6.5 นอกจากนี้พบว่า Chloroform เป็นสารประกอบ THMFP ที่มีปริมาณมากที่สุดเมื่อเปรียบเทียบกับ dichlorobromoform, dibromochloroform และ bromoform คือ ประมาณ 65% ของ THMFP ทั้งหมดจากน้ำทิ้งที่ผ่านการบำบัดแล้วจากการนิคมอุตสาหกรรม และประมาณ 60 % ของ THMFP ทั้งหมด ในน้ำที่นำกลับมาใช้ใหม่ภายหลังการทำโคแอกกูเลชันแล้ว ส่วนการทำโคแอกกูเลชันพบว่าสามารถลดค่า THMFP ลงได้ประมาณ 25.25% และ 27.71% ด้วยการใช้ปริมาณสารส้มและเฟอร์ริกคลอไรด์เท่ากับ 50 มก./ล. ที่ค่า pH เท่ากับ 5.5 และ 5 ตามลำดับ

สาขาวิชาการจัดการสิ่งแวดล้อม
สาขาวิชาการจัดการสิ่งแวดล้อม
ปีการศึกษา 2545

ลายมือชื่อนิสิต.....
ลายมือชื่ออาจารย์ที่ปรึกษา.....

4489403520: MAJOR ENVIRONMENTAL MANAGEMENT

KEY WORD: TRIHALOMETHANE FORMATION POTENTIAL (THMFP) / COAGULATION /
ALUM / FERRIC CHLORIDE /

CHARONGPUN MUSIKAVONG: REDUCTION OF TRIHALOMETHANES
FORMATION POTENTIAL IN RECLAIMED WATER FROM TREATED INDUSTRIAL
ESTATE WASTEWATER. THESIS ADVISOR: ASSIST. PROF. SURAPHONG
WATTANACHIRA, D.Eng., 112 pp. ISBN 974-17-2630-9

This research was performed by using raw water from treated industrial estate wastewater of the Northern Region Industrial Estate, Thailand. Coagulation in jar-test experiments were carried out under the variations of alum and ferric chloride dosages ranged from 10 to 80 mg/L at the conditions of uncontrolled and controlled pH between 5 and 6.5. Trihalomethane formation potential (THMFP) and other natural organic matter (NOM) surrogates were determined so as to study its correlation and its reduction. The obtained results appeared that turbidity could be effectively removed to the level of as low as about 3 NTU by coagulation at the alum and ferric chloride dosages of approximately 10 mg/L without controlled pH. TOC and THMFP showed the best correlation comparing to those of between other surrogates and THMFP. The correlation between TOC and THMFP were established with a Pearson Correlation factor of 0.931 ($R^2 = 0.866$). The equation could be used to express such correlation was $THMFP = 238.552 + 33.886 (TOC)$. Regarding TOC reduction by alum and ferric chloride coagulation, it was found that at controlled pH between 5.5 and 6.5 TOC were gradually reduced from the average value of about 6.12 mg/L to the level of about 4.0 mg/L by alum and ferric chloride dosages of approximately 40 mg/L. Chloroform of approximately 65 and 60 percent of total THMFP were found as the predominant THMFP species in treated industrial estate wastewater and in reclaimed water, respectively in comparison with dichlorobromoform, dibromochloroform and bromoform species. With reference to percent removal of total THMFP by coagulation, the percent removal of 25.53 and 27.71 by using alum and ferric chloride dosages of about 80 mg/L at pH 5.5 and 5 were obtained, respectively.

Inter-department Environmental Management
Field of study Environmental Management
Academic year 2002

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ACKNOWLEDGEMENTS

The author is deeply indebted to his guide, Assistant Professor Dr. Suraphong Wattanachira, thesis advisor, for his valuable guidance, inspiration, utmost help, encouragement and advice through out the research. Special respect and thanks are also extended to Associate Professor Dr. Taha F. Marhaba, for his valuable suggestions and guidance as co-advisor.

The author wishes to express his gratitude to Assistant Professor Dr. Sutha Khaodhiar, Assistant Professor Dr. Chavalit Ratanatamskul and Assistant Professor Dr. Prasert Pavasant for their valuable advice.

The author is thankful to the Inter-department of Environmental Management Graduate School for financial support.

The author wishes to thank all staff and friends at the Department of Environmental Engineering, Faculty of Engineering, and Chaingmai University for kind support during his experiment.

Finally, the author wishes to express his deep sense of appreciation to his family and friend, Jongkol Iammi, for their strong encouragement and inspiration given him.

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ABBREVIATIONS AND SYMBOLS

| | |
|-------------------------------------------------|--------------------------------------------------|
| abs. | Absorbance |
| Al | Aluminium |
| Al(OH) ₃ | Aluminium hydroxide |
| Al ₂ O ₃ | Aluminium Oxide |
| Al ₂ SO ₄ | Aluminium Sulfate |
| AlCl ₃ | Aluminium Chloride |
| amu | apparent molecular unit |
| AMW | Apparent Molecular Weight |
| AWWA | American Water Works Association |
| °C | Degree Celsius |
| CaCO ₃ | Calcium Carbonate |
| CH ₄ | Methane |
| CHBr ₃ | Bromoform |
| CHCl ₂ Br | Bromodichloromethane |
| CHCl ₃ | Chloroform |
| CHClBr ₂ | Dibromochloromethane |
| Cl | Chlorine |
| cm | Centimeter |
| D/DBPs | Disinfection /Disinfection by-Products |
| DBPFP | Disinfection by Product Formation Potential |
| DBPs | Disinfection by-Products |
| DOC | Dissolved Organic Carbon |
| DOM | Dissolved Organic Matter |
| DPD | <i>N, N</i> -diethyl- <i>p</i> -phenylenediamine |
| ECD | Electron Capture Detector |
| EDTA | disodiummethylenediamine tetraacetate dehydrate |
| FAS | Ferrous Ammonium Sulfate |
| Fe ₂ (SO ₄) ₃ | Ferrous Sulfate |
| FeCl ₃ | Ferric Chloride |
| g/cm ³ | Gram/Cubic Centimeter |
| g/L | Gram/Liter |

| | |
|--------|-----------------------------------------------------|
| g/mol | Gram/Molar |
| GC | Gas Chromatograph |
| h | Hour |
| HAAs | Haloacetic acid |
| HANs | Haloacetonitrile |
| I | Iodine |
| KHP | Potassium Hydrogen Phthalate |
| KI | Potassium Iodine |
| L/mg-m | Liter/milligram-meter |
| m | Meter |
| M | Molar |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |
| µg/L | Microgram/liter |
| µm | Micrometer |
| mg/L | Milligram/Liter |
| MW | Molecular Weight |
| nm | Nanometer |
| NOM | Natural Organic Matter |
| NTU | Nepheo Turbidity Unit |
| POC | Particle Organic Carbon |
| ppm. | Part per Million |
| SS | Suspended Solid |
| SUVA | Specific Ultraviolet Absorption |
| THMFP | Trihalomethane Formation Potential |
| THMs | Trihalomethanes |
| TOC | Total Organic Carbon |
| TTHM | Total Trihalomethanes |
| USEPA | United States Environmental Protection Agency |
| UV | Ultraviolet |
| UV254 | Ultraviolet absorbtion at wave length 254 nanometer |
| UVA | Ultraviolet Absorption |