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นางสาวอดิษฐ์สุดา จำเริญสาร

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ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

DEGRADATION OF FORMALDEHYDE BY FENTON AND
PHOTO-FENTON PROCESSES



Miss Aditsuda Jamroensan

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Environmental Management (Inter-Department)

Graduate School

Chulalongkorn University

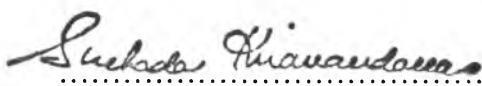
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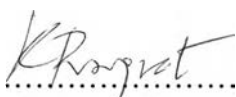
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Thesis Co-advisor Professor Ming-Chun Lu, Ph.D.

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อดิษฐ์ศุดา จำริญสาร : การย่อยสลายฟอร์มาลดีไฮด์โดยกระบวนการเฟนตันและโฟโต้เฟนตัน. (DEGRADATION OF FORMALDEHYDE BY FENTON AND PHOTO-FENTON PROCESSES) อ. ที่ปรึกษา : ผศ. ดร. พวงรัตน์ ขจิตวิษยานุกูล, อ.ที่ปรึกษาร่วม : Prof. Ming-Chun Lu, Ph. D. จำนวนหน้า 111 หน้า. ISBN 974-17-4409-9.

งานวิจัยนี้ได้ทำการศึกษาเกี่ยวกับการย่อยสลายฟอร์มาลดีไฮด์และเมทานอล โดยกระบวนการโฟโต้เฟนตันในระดับห้องปฏิบัติการ จากผลการศึกษาพบว่าฟอร์มาลดีไฮด์และเมทานอลสลายตัวแบบ 3 ขั้นตอน โดยในช่วงแรกของปฏิกิริยามีการย่อยสลายตัวอย่างรวดเร็วหลังจากนั้นอัตราการย่อยสลายจะลดลง จากการศึกษาผลกระทบของค่าพีเอชเริ่มต้น ความเข้มข้นเริ่มต้นของไฮโดรเจนเปอร์ออกไซด์ และเฟอร์รัสไอออนต่อปฏิกิริยาออกซิเดชัน พบว่าอัตราการย่อยสลายฟอร์มาลดีไฮด์และเมทานอลเพิ่มขึ้นอย่างเห็นได้ชัดเมื่อความเข้มข้นของไฮโดรเจนเปอร์ออกไซด์และเฟอร์รัสไอออนเพิ่มขึ้น ในขณะที่ค่าพีเอชเริ่มต้นมีผลต่อปฏิกิริยาเพียงเล็กน้อยเท่านั้น จากการศึกษาผลของเมทานอลต่อปฏิกิริยาออกซิเดชันพบว่าเมื่อเพิ่มความเข้มข้นของเมทานอลในปฏิกิริยา ปฏิกิริยาการย่อยสลายฟอร์มาลดีไฮด์จะถูกยับยั้งอย่างเห็นได้ชัด นอกจากนี้จากการศึกษายังพบว่าที่ความเข้มข้นของเฟอร์รัสไอออนสูงเกินไปจะทำให้ปฏิกิริยาถูกยับยั้งเช่นกัน ในงานวิจัยนี้ยังได้ศึกษาการย่อยสลายฟอร์มาลดีไฮด์โดยกระบวนการเฟนตันเพื่อเปรียบเทียบกับกระบวนการโฟโต้เฟนตัน จากผลการศึกษาพบว่าแสงยูวีจะเพิ่มประสิทธิภาพในการบำบัดสูงขึ้นไปซึ่งที่ความเข้มข้นของเฟอร์รัสไอออนเท่ากับ 0.0227 โมลา ที่ความเข้มข้นสูงกวานี้ ประสิทธิภาพในการบำบัดของกระบวนการเฟนตันและโฟโต้เฟนตันไม่แตกต่างกันอย่างมีนัยสำคัญ

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The degradation of formaldehyde and methanol by photo-Fenton method in a lab-scale reactor was investigated. It was found that formaldehyde and methanol decomposed with three stages. At the first stage, formaldehyde and methanol decomposed very rapidly and then were gradually slowed down at the second and the third stages. Three factors including initial pH, hydrogen peroxide concentration, and ferrous ions concentration were investigated in order to demonstrate their effect on the oxidation reaction. It indicated that the rates of formaldehyde and methanol oxidation were significantly increased with the increasing concentration of hydrogen peroxide and ferrous ions. While the initial pHs had slightly effect on the oxidation rate. In addition, at the higher concentration of methanol, the oxidation reaction of formaldehyde was obviously stopped. Moreover, the hydroxyl radical inhibition was occurred at the excess concentrations of ferrous ions. In this study, Fenton process was also conducted in order to compare with photo-Fenton process. It was found that UV-light had enhanced a higher oxidation efficiency at 0.0227 M of ferrous ions. With the exceeding concentration of ferrous ions, the oxidation efficiency of Fenton and photo-Fenton were insignificantly different.

Field of study Environmental Management
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Advisor's signature *Puangrat*

Co-advisor's signature.....

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photo-Fenton proc

- (a) Remaining rat
time.....
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- (e) Effect of [H₂C
of formaldehy
- (f) Effect of [H₂C
of methanol..

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Influence of [Fe²⁺]
and methanol

- (a) Remaining rat
time.....
- (b) Remaining rat
- (c) Remaining rat
- (d) pH variation v
- (e) Effect of [Fe²⁺
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NOMENCLATURE

VOC	=	Volatile Organic Compound
AOPs	=	Advanced Oxidation Processes
AOTs	=	Advanced Oxidation Technologies
UV	=	Ultraviolet
UV/H ₂ O ₂	=	Ultraviolet combined with hydrogen peroxide
UV/TiO ₂	=	Ultraviolet combined with titanium dioxide
Fe ²⁺ /H ₂ O ₂	=	Fenton
Fe ³⁺ /H ₂ O ₂	=	Fenton-like
UV/Fe ²⁺ /H ₂ O ₂	=	Photo-Fenton
BETX	=	Benzene, Ethylene, Toluene, and Xylene
COD	=	Chemical Oxygen Demand
BOD	=	Biological Oxygen Demand
TOC	=	Total Organic Carbon
EDTA	=	ethylenediamine tetra acetic acid
CH ₂ O: H ₂ O ₂	=	Molar ratio of formaldehyde to hydrogen peroxide
CH ₂ O	=	formaldehyde
[CH ₂ O]	=	Concentration of formaldehyde
CH ₃ OH	=	methanol
[CH ₃ OH]	=	Concentration of methanol
r _m	=	Initial rate of methanol
r _f	=	Initial rate of formaldehyde
r _m /r _f	=	Initial rate of methanol to formaldehyde
k	=	Rate constant
DNT	=	dinitrotoluene
TNT	=	trinitrotoluene
THM	=	trihalomethane
CO ₂	=	carbon dioxide
Fe ²⁺	=	ferrous ion
Fe ³⁺	=	ferric ion
[Fe ²⁺]	=	Concentration of ferrous ion
H ₂ O ₂	=	hydrogen peroxide

$[\text{H}_2\text{O}_2]$	=	Concentration of hydrogen peroxide
NaOH	=	sodium hydroxyl
Na_2SO_3	=	sodium sulfite
H_2SO_4	=	sulfuric acid
OH^\bullet	=	Hydroxyl radical
HO_2^-	=	Perhydroxyl ion
OH^-	=	Hydroxide ion
H^+	=	Hydrogen ion
CO_3^{2-}	=	Carbonate ion
PO_4^{3-}	=	Phosphate ion
HCO_3^-	=	Bicarbonate ion
SS	=	Suspended Solid