UNIVERSITAT DE BARCELONA

Universitat de Barcelona
Facultat de Química
Departament d'Enginyeria Química

COUPLED PHOTOCHEMICAL-BIOLOGICAL SYSTEM TO TREAT BIORECALCITRANT WASTEWATERS

Doctoral Thesis directed by Santiago Esplugas Vidal and
Esther Chamarro Aguilera

Jordi Bacardit Peñarroya

Barcelona, Maig de 2007

Programa de Doctorat d'Enginyeria del Medi Ambient i del Producte
Bienni 2003-2005

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Chapter 8: Index of Tables and Figures

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Chapter 9: Abbreviation and Notation

List of Abbreviations

2,4-D: 2,4-dichlorophenoxyacetic acid
2,4-DCP: 2,4-dichlorophenol
4-CP: 4-chlorophenol
AOPs: Advanced Oxidation Processes
AOS: Average Oxidation State (mol O_2.mol C^{-1})
AOTs: Advanced Oxidation Technologies
ASM1: Activated Sludge Model 1
ASTM American Society for Testing and Materials
ATP: Adenosine 5'-triphosphate
BOD: Biochemical Oxygen Demand (mg.L^{-1})
BOD_5: Biochemical Oxygen Demand after 5 days (mg.L^{-1})
CCD: Central Composite Design
COD: Chemical Oxygen Demand (mg.L^{-1})
COMMPS: Combined Monitoring-based and Modelling-based Priority Setting
DO: Dissolved Oxygen (mg.L^{-1})
EC: European Comission
EC_{50}: Median Effective Concentration (%)
EDCs: Endocrine Disrupting Chemicals
EPER: European Pollutant Emission Register
EU: European Union
HRT: Hydraulic Retention Time (hour; h)
ISA: Ion Strenght Adjustor
ISE: Ion Selective Electrode
NBCS: Non-Biodegradable Chlorinated Species
OC: Consumed Oxygen per unit volume (mg.L^{-1})
ODEs: Ordinary Differential Equations
OLR: Organic Loading Rate (mg.L^{-1}.h^{-1})
OUR: Oxygen Uptake Rate (mg.L^{-1}.h^{-1})
PAHs: Polycyclic Aromatic Hydrocarbons
Ph-F. Photo-Fenton
PPCPs: Pharmaceuticals and Personal Care Products
PSA: Plataforma Solar de Almería
POPs: Persistent Organic Pollutants

RSM:	Response Surface Methodology
SBR:	Sequencing Batch Reactor
SBBR:	Sequencing Batch Biofilter Reactor
SCWO:	Supercritical Wet Oxidation
SEM:	Scanning Electron Microscope
SHE:	Standard Hydrogen Electrode
SUR	Substrate Uptake Rate
TOC:	Total Organic Carbon ($mg.L^{-1}$)
TSS:	Total Suspended Solids (mass/unit volume)
TVSS:	Total Volatile Suspended Solids (mass/unit volume)
UV:	Ultraviolet radiation
Vis:	Visible light
WFD:	Water Framework Directive
WO:	Wet Oxidation
WPO:	Wet Peroxide Oxidation

Notation

$[4\text{-CP}]_0$:	4-chlorophenol initial concentration ($mg.L^{-1}$ or $mmol.L^{-1}$)
$[Fe^{2+}]_0$:	iron (II) initial concentration ($mg.L^{-1}$ or $mmol.L^{-1}$)
$[H_2O_2]_0$:	hydrogen peroxide initial concentration ($mg.L^{-1}$ or $mmol.L^{-1}$)
S_O:	concentration of oxygen in solution ($mg.L^{-1}$)
S_S:	concentration of biodegradable substrate in solution ($mg.L^{-1}$)
T:	Temperature (ºC)
t_{30W} :	normalized illumination time (min).
V_i :	irradiated volume (L).
V_T :	total system volume (L).
X:	concentration of microorganisms (mass/unit volume)
Q:	received or transmitted energy per volume ($kJ.L^{-1}$).

Notation in Mechanistic models (Section 3.5):

$(COD\text{-}BOD_5)$: Concentration of non-biodegradable compounds ($mg.L^{-1}$).

$[(COD\text{-}BOD_5)]_0$: Initial Concentration of non-biodegradable compounds ($mg.L^{-1}$).

$(COD\text{-}BOD_5)_r$: Concentration of non-biodegradable species recalcitrant to oxidation ($mg.L^{-1}$).

$[BOD_5]$: Concentration of readily biodegradable matter ($mg.L^{-1}$).

$[BOD_5]_0$: Initial concentration of readily biodegradable matter ($mg.L^{-1}$).

$[COD]$: Concentration of organic matter ($mg.L^{-1}$).

$[COD]_0$: Concentration of organic matter ($mg.L^{-1}$).

$[H_2O_2]_0$: hydrogen peroxide initial concentration ($mg.L^{-1}$).

$[H_2O_2]_t$: hydrogen peroxide concentration at time "t" ($mg.L^{-1}$).

k_i : pseudo-stoichiometric or pseudo-kinetic constants

K_{H2O2} : hydrogen peroxide half-saturation concentration ($mg.L^{-1}$)

k_{H2O2} : hydrogen peroxide decomposition pseudo-kinetic constant

Chapter 10: Related Publications and Works

Publications

Jordi Bacardit, Julia Stötzner, Esther Chamarro and Santiago Esplugas. *Effect of salinity on photo-Fenton process*. Accepted for its publication in the ACS's Industrial and Engineering Chemistry Research. Publication expected in November **2007**. DOI: 10.1021/ie070154o.

Jordi Bacardit, Isabel Oller, Manuel I. Maldonado, Esther Chamarro, Sixto Malato, and Santiago Esplugas. *Simple Models for the control of Photo-Fenton by monitoring H_2O_2*. Accepted for publication in the Journal of Advanced Oxidation Technologies (JAOT) in the July **2007** issue.

Jordi Bacardit, Verónica García-Molina, Bernardí Bayarri, Jaume Giménez, Esther Chamarro, Carme Sans, Santiago Esplugas. *Coupled photochemical-biological system to treat biorecalcitrant wastewater*. Published in the Proceedings book of the **2006** AOP4 Conference in Goslar, Germany. Submitted for its publication in the IWA's Water Science and Technology.

Jordi Bacardit, Anders Hultgren, Verónica García-Molina, Santiago Esplugas. *Biodegradability Enhancement of Wastewater Containing 4-Chlorophenol by Means of Photo-Fenton*. Journal of Advanced oxidation Technologies (JAOT), **2006**, Volume 9(1), 27-34.

Jordi Bacardit, Oscar González, Renato Falcao, Verónica García-Molina, Sandra Contreras, Ester Chamarro, Carme Sans, Santiago Esplugas. *Start-up of a Coupled chemical-biological system for the abatement of 4-chlorophenol. Preliminary Study*. Photocatalytic and Advanced Oxidation Processes for Treatment of Air, Water, Soil and Surfaces. Redox Technologies, Inc. **2005**. ISBN: 0-9738746-0-0.

Still in project:

- Mechanistic Models for the Oxidation by Photo-Fenton

- Characterization of a Sequencing Batch Biofilter Reactor (SBBR) combined with the AOP Photo-Fenton

Communications to Conferences

Jordi Bacardit, Julia Stötzner, Verónica García-Molina, Esther Chamarro and Santiago Esplugas. *Effect of salinity on photo-fenton process.* Poster presentation in the 4th European Meeting on Solar Chemistry and Photocatalysis: Environmental Applications (SPEA 4), Gran Canaria, Spain, November **2006**.

Jordi Bacardit, Verónica García-Molina, Bernardí Bayarri, and Santiago Espulgas. *Coupled photochemical-biological system to treat biorecalcitrant wastewater.* Poster presentation in the AOP4 - 4th Conference on Oxidation Technologies for Water and Wastewater Treatment. Goslar, Germany May **2006**.

Jordi Bacardit, Anders Hultgren, Oscar González, Renato Falcao, Carme Sans, Esther Chamarro and Santiago Esplugas. *Biodegradability Enhancement of wastewater containing 4-chlorophenol by means of photo-Fenton.* Presented as oral presentation in the Second European Conference on Oxidation and Reduction technologies for ex-situ and in-situ treatment of water, air and soil (ECOR-2)**.** Göttingen, Germany, 12-15 June, **2005.**

Jordi Bacardit, Óscar González, Verónica García-Molina, Renato Falcao, Sandra Contreras, Carme Sans, Esther Chamarro and Santiago Esplugas. *Start-up of a coupled chemical-biological treatment of aqueous solutions of 4-monochlorophenol.* Presented as a poster and in the 10th International Conference on Advanced Oxidation Technologies for Water and Air Remediation (AOTs-10), San Diego, California, USA, 24-28 October **2004**.

Jordi Bacardit, Renato Falcao, Verónica García-Molina, Esther Chamarro, Carme Sans and Santiago Esplugas. *Comparison between Photo-Fenton and Wet Peroxide Oxidation for the removal of 4-monochlorophenol.* Poster presentation in the 3rd European Meeting on Solar Chemistry and Photocatalysis: Environmental Applications (SPEA 3), Barcelona, Spain, 30 June-2 July **2004**.