

**Sirindhorn International Institute of Technology
Thammasat University**

Thesis EV-PhD-2009-01

LANDFILL LEACHATE TREATMENT BY WHITE ROT FUNGI

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**LANDFILL LEACHATE TREATMENT
BY WHITE ROT FUNGI**

A Thesis Presented

by

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Doctor of Philosophy
Environmental Technology Program
School of Bio-Chemical Engineering and Technology
Sirindhorn International Institute of Technology
Thammasat University

August 2009

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Submitted to

Sirindhorn International Institute of Technology

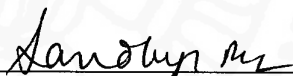
Thammasat University

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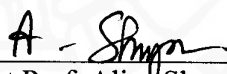
DOCTOR OF PHILOSOPHY

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August 2009

Acknowledgement

It is the great honor and special privilege for me to study and do research work in SIIT, Thammasat University, Thailand. I am greatly indebted to my advisor, Asso. Prof. Dr.Sandhya Babel, who intensively inspired me with her valuable advice and guidance, scientific and systematic approach, professionally technical writing skills, critical thinking, profound human wisdom, patience, kindness, positive courage and moral support during my doctoral study. Her progressive and sharp brainstorming undoubtedly gave me not only a new idea and sound knowledge on the research field of biological treatment, but also a strong impact on me to apply such skill for my professional development. Thanks for the in-depth knowledge she sincerely transferred to me day after day and for having a substantially productive and fruitful four-year in the Institute.

I also personally thanks to Dr.Alice Sharp, Dr.Sirindhornthep Towprayoon, and Dr.Chart Chiemchaisri for their valuable suggestions and for serving as Thesis Committee's members. A deeper sense of appreciation is also fully expressed to Prof. Chongrak Polprasert for his valuable suggestions as external committee's member.

Profoundly grateful thank to Ms.Salaya Punsiri, Mr.Chaiyaporn Imsapsangworn and other staff for their permission to use Asian Institute of Technology Ambient Laboratory space. Special thanks is also solely to Dr. Terry Avon for his persistent help in English correction for the author's thesis and research papers. Particularly thanks are given to all staffs of Environmental Technology program as well as EV Lab for their assistance, support and friendship. Thanks to the Nonthaburi Provincial Administration Organization for providing the Nonthaburi Landfill Leachate used in my dissertation.

Last but not least, my deepest gratitude, of course, is solely directed toward The Joint Graduate School of Energy and Environment (JGSEE), The King Mongkut's University of Technology, Thonburi (KMUTT), who has awarded me the scholarship, enabling me to accomplish my doctoral degree at SIIT.

I sincerely dedicate this piece of work to my beloved Saetang's family, my mother, Sangarun, and my father, Kimchai, who have given me encouragement, valuable suggestion, believe in my capability, pushed me and given me love and inspiration as well as those sacrifices, patience and endurance go beyond description. To my brother, Chatchawan and my sisters, Sirilak and Somrumpa, my heartfelt thanks for their love, support and encouragement. Special thanks to Mr.Arunthep Sangvareethip for his pray and encouragement by believing in my capability and experience. Thanks to my Christian brothers and sisters from the Church of Faith and friends for their love, prayers, encouragement and support.

Above all, my utmost gratitude goes to the JESUS CHRIST, Almighty God, who has given me eternal life through His Son Jesus Christ, and whose wisdom, knowledge and power enabled me to accomplish what seemed to be an insurmountable task. May His name be eternally praised!

Abstract

White rot fungi produces various isoforms of extracellular enzymes including laccase, manganese peroxidase and lignin peroxidase that can degrade the pollutants and, thus, can be used to treat wastewater, including landfill leachate. In this research, the treatment of leachate by using white rot fungi, namely *Trametes versicolor* BCC 8725 and *Flavodon flavus* BCC 17421 was studied. Four types of leachate were collected in different time period and different source from Nonthaburi solid waste disposal site, Thailand. Leachate differs in terms of color, BOD, COD. The fungi were immobilized on polyurethane foam (PUF). Glucose, corn starch and cassava were used as a co-substrate and were varied at different concentration. Batch experiments were done to determine the optimum pH, co-substrate and effect of contact time. Continuous experiments were carried out using vertical flow baffled reactor to observe the effect of organic loading, reuse of fungi in various cycles and its possibility to use in large scale leachate treatment. The effect of biomass growth was observed by immobilizing fungi on PUF for different time periods (for 4 and 15 days initially in Potato Dextrose Broth (PDB). The same immobilized fungi were used for four cycles of 5 days each to find the reuse of fungi. Leachate was diluted to see the effect of organic loading on color removal.

Results of batch experiment indicated that the optimum pH, where maximum color removal could be obtained, is 4 and glucose is the best co-substrate at 3 g/L with contact time of 15 days. *T.versicolor* BCC 8725 could decolorize 62-79% and BOD and COD of 43%-57% for various types of leachate used in this study when using 3 g/L of glucose. Laccase was the main enzyme which contributed to the decolorization of leachate by *T.versicolor* BCC 8725. Color removal rates were proportional to the enzyme activity.

In continuous experiment, the same immobilized fungi on PUF could be reused for at least 4 cycles (1 cycle of 5 days each). Dilution of leachate that collected from the pipe as discharged from the landfill to the stabilization pond did not significantly increase the removal efficiency when glucose was not added. About 8% and 15% higher color removal was obtained without and with glucose when using 5-time diluted leachate (600 mg/l of glucose, with 4-day immobilization). About 1-6% higher color removal efficiency was obtained when fungi was initially immobilized in PDB for 15-day as compared to 4-day immobilization. Removal efficiency was also calculated in terms of mg of COD and BOD removal per mg of biomass. Concentrated leachate (3 g/l glucose as co-substrate, with 4-day immobilization) gave the highest removal of 0.6 mg COD per mg of biomass and 0.45 mg BOD per mg of biomass. Thus, fungi are good in degradation of complex organic compounds that are not readily biodegradable as high COD removal was observed compared to the BOD.

This study demonstrated a novel process which provides an alternative way of managing leachate since it is the natural biological process. However, fungi used in this study cannot completely remove color, BOD and COD from leachate. Thus, it is required to couple with another treatment process.

Table of Contents

Chapter Title	Page
Signature Page	i
Acknowledgement	ii
Abstract	iii
Table of Contents	iv
List of Figures	vii
List of Tables	x
List of Symbols and Abbreviations	xi
List of Units	xii
1. Introduction	1
1.1 Problem Identification	1
1.2 Rationale of the Study	3
1.3 Objective of the Study	5
1.4 Scope of the Study	5
2. Literature Review	6
2.1 Leachate generation and its characteristics	6
2.1.1 Leachate generation	6
2.1.2 Leachate Characteristics	6
2.2 Treatment methods for landfill leachate	13
2.2.1 Physical-chemical treatment	13
2.2.2 Biological treatment	21
2.2.2.1 Aerobic biological treatment processes	22
2.2.2.2 Anaerobic biological treatment	24
2.2.3 Treated leachate discharge limits	25
2.3 Fungi	26
2.3.1 Fungal growth characteristics	26
2.3.2 Fungal growth condition	28
2.3.2.1 Physical requirements of microbial growth	29
2.3.2.2 Nutritional requirements of fungi	30
2.3.2.3 Effect of co-substrates for fungal growth	31
2.3.3 Modes of nutrients transport in fungi	33
2.4 White rot fungi	35
2.4.1 Degradation mechanisms	36
2.4.2 The lignin-degrading system	37
2.4.3 Immobilization of fungi	41
2.4.3.1 Entrapment	42
2.4.3.2 Attachment	42
2.4.4 Bioreactor configurations for white rot fungi cultures	43
2.4.4.1 Agitated growth processes	43
2.4.4.2 Agitated processes – suspended growth	43
2.4.4.3 Agitated processes - immobilized growth	44

Chapter Title	Page
2.4.4.4 Non-agitated immobilized growth processes	44
2.4.5 Treatment of wastewater by immobilized white rot fungi	44
3. Methodology	57
3.1 Material and Methods	57
3.1.1 Reagent preparation	57
3.1.2 Leachate collection	57
3.1.3 Fungi collection	58
3.1.4 Co-substrate preparation	58
3.1.5 PUF Foam preparation	58
3.2 Experimental Procedure	58
3.2.1 Sub-culture of Fungi	58
3.2.2 Leachate characterization before treatment	58
3.2.3 Mycelial suspension and immobilization of fungi on PUF	58
3.2.4 Analytical assays	59
a) Scanning Electron Microscope (SEM) image	59
b) Enzyme assays	59
3.2.5 Batch experiment	60
a) Biomass growth of immobilized and mobilized fungi	60
b) Effect of pH on color removal	60
c) Effect of co-substrates concentration and contact time	61
d) Reuse of immobilized <i>T.versicolor</i>	61
3.2.6 Continuous experiment	61
a) Continuous operation	61
b) Biomass growth of immobilized <i>T.versicolor</i>	62
3.2.7 Determination of leachate characteristics at optimum condition	62
4. Results and Discussion	65
4.1 Leachate characteristics	65
4.2 BOD and COD of co-substrate	67
4.3 Structure of <i>T.versicolor</i> BCC 8725 by SEM	67
4.4 Batch experiment	68
4.4.1 Leachate 1	68
4.4.1.1 Biomass growth of fungi	68
4.4.1.2 Effect of pH on color removal	69
4.4.1.3 Effect of co-substrates and contact time on color removal	70
4.4.1.4 Leachate characteristics after treatment	71
4.4.2 Leachate 2	73
4.4.2.1 Biomass growth of Fungi	73
4.4.2.2 Effect of pH on color removal	75
4.4.2.3 Effect of co-substrate and contact time on color removal	76

Chapter Title	Page
4.4.2.4 Leachate characteristics after treatment	78
4.4.2.5 Effect of carbon source concentration	78
4.4.3 Leachate 3	79
4.4.3.1 Effect of pH on color removal	79
4.4.3.2 Effect of co-substrates and contact time on color removal	80
4.4.3.3 Leachate characteristics after treatment	82
4.4.3.4 Biomass growth of mobilized fungi	83
4.4.3.5 Color removal of mobilized fungi	83
4.4.3.6 Reuse of immobilized fungi	85
4.4.4 Leachate 4	86
4.4.4.1 Biomass growth of fungi on PDB	86
4.4.4.2 Biomass growth of fungi on leachate 4	86
4.4.4.3 Effect of co-substrate on color, BOD and COD removal of leachate 4	87
4.4.4.4 Leachate characteristics after treatment	88
4.4.5 Leachate 4*	89
4.4.5.1 Biomass growth of leachate 4*	89
4.4.5.2 Effect of co-substrate on color removal of leachate 4*	89
4.4.5.3 Leachate characteristics after treatment	90
4.4.5.4 Enzyme analysis	91
4.4.6 Comparison of various types of leachate used in this study	93
4.5 Continuous experiment	94
4.5.1 Leachate 2	94
4.5.1.1 Characteristics of leachate 2 after dilution	94
4.5.1.2 Effect of organic loading	95
4.5.1.3 Biomass growth of fungi	96
4.5.1.4 Heavy metal analysis	97
4.5.2 Leachate 4	97
4.5.2.1 Effect of organic loading and degree of immobilization with and without co-substrate on removal efficiency	97
4.5.2.2 Comparison of color, BOD and COD after treatment at various conditions	101
5. Conclusion and Recommendations	104
5.1 Conclusion	104
5.2 Recommendations for future research	105
References	107
Appendices	135

List of Figure

	Page
Figure 1.1	3
Figure 2.1	6
Figure 2.2	27
Figure 2.3	38
Figure 2.4	39
Figure 2.5	40
Figure 3.1	62
Figure 3.2	63
Figure 3.3	64
Figure 4.1	67
Figure 4.2(a)	68
Figure 4.2(b)	68
Figure 4.3	69
Figure 4.4	69
Figure 4.5	70
Figure 4.6	70
Figure 4.7	71
Figure 4.8	72
Figure 4.9	72
Figure 4.10	72
Figure 4.11	74
Figure 4.12	75
Figure 4.13	75
Figure 4.14	76
Figure 4.15	76
Figure 4.16	77
Figure 4.17	78

List of Figure (Cont.)

		Page
Figure 4.18	COD removal of leachate 2 by <i>F.flavus</i> BCC 17421	78
Figure 4.19	Effect of glucose on color removal in leachate 2	79
Figure 4.20	Effect of pH on color removal by <i>T.versicolor</i> BCC 8725 in leachate 3	80
Figure 4.21	Effect of pH on color removal by <i>F.flavus</i> BCC 17421 in leachate 3	80
Figure 4.22	Color removal of leachate 3 by <i>T.versicolor</i> BCC 8725 at different co-substrate at optimum pH of 4 in 15 days	81
Figure 4.23	Color removal of leachate 3 by <i>F.flavus</i> BCC 17421 at different co-substrate at optimum pH of 4 in 15 days	81
Figure 4.24	BOD removal of leachate 3 at 3 g/L of co-substrates	82
Figure 4.25	COD removal of leachate 3 at 3 g/L of co-substrates	82
Figure 4.26	Biomass growth of mobilized <i>T.versicolor</i> BCC 8725 in leachate 3	83
Figure 4.27	Color removal of mobilized <i>T.versicolor</i> BCC 8725 using leachate 3	84
Figure 4.28	Reuse of immobilized <i>T.versicolor</i> BCC 8725 in leachate 3	85
Figure 4.29	Biomass growth of immobilized <i>T.versicolor</i> BCC 8725 in PDB with different types of co-substrate at 3 g/L	86
Figure 4.30	Biomass growth of immobilized <i>T.versicolor</i> BCC 8725 in leachate 4	87
Figure 4.31	Color removal of leachate 4 by immobilized <i>T.versicolor</i> BCC 8725	87
Figure 4.32	Biomass growth with and without glucose addition of leachate 4*	89
Figure 4.33	Color removal of leachate 4* by <i>T.versicolor</i> BCC 8725	90
Figure 4.34	BOD and COD removal of leachate 4* in batch experiment	90
Figure 4.35(a)	Extracellular enzymes and leachate decolorization by <i>T.versicolor</i> BCC 8725 without glucose	91
Figure 4.35(b)	Extracellular enzymes and leachate decolorization by <i>T.versicolor</i> BCC 8725 with glucose	91
Figure 4.36	Comparison of BOD and COD removal with the initial value with glucose and without glucose for various types of leachate used	93
Figure 4.37	Effect of organic loading (leachate 2) using <i>T.versicolor</i> BCC 8725 with glucose 3 g/L and air addition	95
Figure 4.38	Biomass growth of <i>T.versicolor</i> 8725 at different dilution in leachate 2	96
Figure 4.39	Percent removal and respective biomass growth in different cycles using concentrated leachate without glucose (4-day immobilization)	98

List of Figure (Cont.)

		Page
Figure 4.40	Percent removal and respective biomass growth in different cycles using concentrated leachate with glucose (4-day immobilization)	98
Figure 4.41	Percent removal and respective biomass growth in different cycles using 5-times diluted leachate with glucose (4-day immobilization)	99
Figure 4.42	Percent removal and respective biomass growth in different cycles using concentrated leachate without glucose (15-day immobilization)	99
Figure 4.43	Percent removal and respective biomass growth in different cycles using 5-times diluted leachate with glucose (15-day immobilization)	100
Figure 4.44	Comparison of color, BOD and COD removal in cycle 4 at various conditions	101
Figure 4.45	The ratio of mg of BOD and COD removed per unit of biomass	102

List of Tables

	Page	
Table 2.1	Relations between landfill age, leachate characteristics and efficiency of systems	7
Table 2.2	Variation of COD, BOD and BOD/COD with increasing landfill ages	8
Table 2.3	Nitrogen concentrations from various sources	8
Table 2.4	Physiochemical characteristics of wet, dry leachate samples of landfill in Nigeria	9
Table 2.5	Typical leachate quality data from large landfills worldwide	10
Table 2.6	Comparison of leachate characteristics of landfills surveyed in Asia, Europe and America	12
Table 2.7	Solubility of ozone in water	19
Table 2.8	Ozonation Results	20
Table 2.9	Advantages and drawbacks of some non-biological decolouration processes applied to textile wastewater	21
Table 2.10	Relative biodegradability of leachate	22
Table 2.11	Limiting concentrations for the discharge of treated leachate according to German Standards	25
Table 2.12	Indian Standards for discharging treated leachate	26
Table 2.13	Elemental requirements of fungal cells	31
Table 2.14	Effect of difference co-substrates on decolorization by <i>T. versicolor</i>	32
Table 2.15	Influence of supplements on fungal fermentation and decolorization of distillery and brewery waste	32
Table 2.16	Modes of nutrient transport in fungi	34
Table 2.17	Ligninolytic enzymes and their main reactions	41
Table 2.18	Dye decolouration by fungi immobilised on different supports	45
Table 2.19	Examples of fungi used to treat domestic sewage, starch processing and metal bleaching effluents. Optimal culture condition and the effect of fungal pretreatment	56
Table 3.1	Parameters for determining landfill leachate characteristics	57
Table 4.1	Landfill leachate characteristics	65
Table 4.2	Characteristics of leachate from Ram-Indra Transfer station, Bangkok, Thailand	66
Table 4.3	Percent BOD and COD removal of leachate 4 after treatment at optimum condition by <i>T.versicolor</i> BCC 8725	88
Table 4.4	Characteristics of leachate 2 after dilution	95
Table 4.5	Heavy metal concentration after treatment of leachate 2	97

List of Symbols and Abbreviations

AIT	Asian Institute of Technology
ABTS	2,2'-azinobis(3-ethylbenzthiazoline-6-sulfonate)
AOP	Advanced Oxidation Processes
BCC	Biotech Culture Collection
BOD	Biological Oxygen Demand
C	Cassava
COD	Chemical Oxygen Demand
Cd	Cadmium
Cr	Chromium
CS	Corn starch
<i>F.flavus</i>	<i>Flavodon flavus</i>
G	glucose
HCl	Hydrochloric acid
Hg	Mercury
HRT	Hydraulic Retention Time
ICP/MS	Inductively Coupled Plasma Mass Spectrometry
IPUF	Immobilized Polyurethane Foam
Lac	Laccase
LiP	Lignin Peroxidase
MnP	Manganese Peroxidase
Na	Sodium
NaOH	Sodium Hydroxide
Ni	Nickel
NH ₃	ammonia
OLR	Organic Loading Rate
Pb	Lead
PCD	Pollution Control Department
PDA	Potato Dextrose Agar
PDB	Potato Dextrose Broth
PUF	Polyurethane foam
TKN	Total Kjeldahl Nitrogen
<i>T.versicolor</i>	<i>Trametes versicolor</i>
TCLP	Toxicity Characteristic Leaching Procedure
SEM	Scanning Electron Microscope
SS	Suspended Solids
SBOD	Soluble Biological Oxygen Demand
SCOD	Soluble Chemical Oxygen Demand
WRF	White Rot Fungi
Zn	Zinc

List of Units

ADMI	American Dye Manufacturer Institute
cm	centimeter
d	day (s)
g	gram
g/l	gram per liter
kg	kilogram
h	hour(s)
min	minute
mg	milligram
mg/l	milligram per liter
ml	milliliter
ml/min	milliliter per minute
mm	millimeter
l	liter
rpm	round per minute
%	percent