APPLICATION OF MAGNETIC FIELD FOR SEWAGE PURIFICATION USING CONSTRUCTED WETLAND PLANTED WITH WATER HYACINTH

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Environmental Management)

Faculty of Civil Engineering
Universiti Technologi Malaysia

JANUARY 2017

Special thanks for my beloved father and mother,

Ayub Bin Md Jelal *and* ***Baria'ah Binti Bidin****,*

Thanks you for all the prayers and support you have given...

For my beloved siblings,

Mohd Roaizan Bin Ayub

Mohd Razif Bin Ayub

Rozana Binti Ayub

Mohd Ridzuan Bin Ayub

Mohd Rozi Bin Ayub

Thanks for the support and motivation to me…

To my dedicated lecturers and colleagues,

Thanks for any useful knowledge, encouragement and guidance you have done...

Thank you for everything

ACKNOWLEDGEMENT

First and foremost, thanks to Allah S.W.T because with the permission and blessings, I can accomplish my undergraduate project at a right time. I would like to express my greatest gratitude to my supervisors, Assoc. Prof. Dr Johan Bin Sohaili and Dr Shamila Binti Azman for providing their supervisions, encouragements, and advices to complete this project. In addition to that, I wish to extend my thanks to both my parents and family that has given endless support and love to me to ensure I could finish the project successfully. Thanks to my beloved colleagues who have provided guidance and cooperation during this project. Moreover, I am thankful to staffs of Laboratory of Environmental Engineering, Faculty of Civil Engineering, Universiti Teknologi Malaysia, especially to En Razale Bin Ismaun and Encik Shamsuddin who has provided assistance, cooperation and guidance throughout laboratory start up and experiments until the project is completed. I will always cherish the services you have given to me and only God alone could reward your kindness. Last but not least, I hope my project will give a lot of benefits to other researchers to conduct future research.

Thank you,

MUHAMMAD RAZI BIN AYUB

ABSTRACT

Nowadays, rapid growths in the urbanization process have caused an environmental problem which is sewage generation. Untreated sewage will threaten aquatic life and destroy the aquatic ecosystem when it released without proper treatment. To address this problem, a system called wetland system enhanced with magnetic field can be used. The objectives of this study are to examine the capability of water hyacinth in Free Water Surface Constructed Wetland System enhanced with magnetic field in removing pollutants and to investigate the removal performance of pollutants in constructed wetland system enhanced with magnetic field. The wetland systems were planted with *Eichhornia crassipes* and sewage was applied in the constructed wetland with continuously flow onto the system. Three stages of experiments were conducted which was to identify the best number of plants, to determine the best flow rate, and to examine the best strength of magnetic field in removing phosphorus, nitrate, and TSS. Based on the experiment that has been carried out, the performance removal of the pollutants were recorded highest with 92% removal of phosphorus, 87% of nitrate and 98% of TSS when the system was applied with 20 numbers of water hyacinths, 1 mL/s flow rate, and 0.55 Tesla of magnetic strength. The study concluded that, constructed wetland enhanced with magnetic field could increase the pollutants removal in sewage.

ABSTRAK

Pada masa kini, pertumbuhan yang sangat pesat dalam proses perbandaran telah menyebabkan masalah alam sekitar iaitu pengeluaran air kumbahan. Air kumbahan yang tidak dirawat akan mengancam hidupan dan ekosistem akuatik apabila dilepaskan tanpa rawatan yang sewajarnya. Bagi menangani masalah ini, sistem tanah bencah dilengkapi dengan medan magnet boleh digunakan. Objektif kajian ini adalah untuk mengkaji keupayaan keladi bunting dalam Sistem Tanah Bencah Air Permukaan yang dilengkapi dengan medan magnet untuk menyingkirkan bahan cemar dan untuk menyiasat prestasi penyingkiran bahan cemar dalam sistem tanah bencah yang dilengkapi dengan medan magnet sebagai penambahbaikan sistem. Sistem tanah bencah telah ditanam dengan *Eichhornia crassipes* (keladi bunting) dan air kumbahan telah dialirkan secara berterusan ke dalam sistem tanah bencah. Tiga peringkat eksperimen telah dijalankan iaitu untuk mengenal pasti bilangan tumbuh-tumbuhan yang terbaik, untuk menentukan kadar aliran yang optima, dan untuk memeriksa kekuatan medan magnet yang paling baik dalam menyingkirkan fosforus, nitrat, dan TSS. Berdasarkan eksperimen yang telah dijalankan, prestasi penyingkiran bahan pencemar tertingggi telah dicatatkan dengan 92% penyingkiran fosforus, 87% nitrat, dan 98% TSS apabila 20 bilangan keladi bunting, 1mL/s kadar alir dan 0.55 Tesla kekuatan magnet digunakan dalam sistem tanah bencah buatan. Berdasarkan kajian ini, dapat disimpulkan bahawa sistem tanah bencah buatan yang dilengkapi dengan medan magnet boleh meningkatkan penyingkiran bahan cemar dalam air kumbahan.

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LIST OF SYMBOLS AND ABBREVIATIONS

BOD	-Biochemical Oxygen Demand
COD	- Chemical Oxygen Demand
FDS	- Fixed Dissolved Solids
FSS	- Fixed Suspended Solids
FWS	- Free Water Surface
HRT	- Hydraulic Retention Time
mg/L	- milligram per liter
NO_3^-	- Nitrate
PO_4^{3-}	- Phosphorus
SS	- Suspended Solids
SSF	- Subsurface Flow
TDS	- Total Dissolved Solids
TFC	- Total Fixed Solids
TOC	- Total Organic Carbon
TS	- Total Solids
TSS	- Total Suspended Solids
TVS	- Total Volatile Solids
VDS	- Total Volatile Dissolved Solids
VSS	- Volatile Suspended Solids
%	- Percentage
°C	- Degree Celsius

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, there are rapid growths in the urbanization and industrialization process in order to satisfy with increase population growth. This has caused a lot of environmental problems to the world. One of the problems that occur regarding to this phenomenon is sewage generation. There are many ways people manage their sewage in their daily life. For example in rural areas, some people dispose sewage inappropriately. The sewage is being channel into river, discharges on a drain, and released on their backyard. Without any proper management of sewage, there are a lot of consequences that may occur. One of these is the infection from pollutants that can cause fatal diseases such as dengue and malaria.

Besides that in urban areas, there are many approaches in dealing with sewage for instance sewage treatment plant, septic tank and on-site wastewater management such as biofilter is used to treat the sewage. The most common method in disposing and managing the sewage is by using sewage treatment plant. However, sewage treatment plants use chemicals to facilitate the removal of pollutants which gives significant impact to the environment. With rapid development municipal activities, it will eventually generate massive amount of wastewater, and more sewage will be produced. Hence, more sewage treatment plants, septic tanks, and biofilter will be constructed to cater the problems. Sewage is very dangerous because it can disturb the aquatic ecosystem and kill the aquatic organism. Domestic wastewater can also cause groundwater quality to deteriorate because of harmful pollutants accumulation. Therefore, better management is required to ensure that sewage is fully treated before being released into target area.

For that reason, the solution of treating sewage using natural processes is a better option compared to conventional method. Constructed wetlands are efficient in treating municipal sewage and the role of constructed wetland in wastewater management seems to have higher popularity due to environmental sustainability. Besides that, constructed wetland is chemical-free and relatively low in cost. It is a natural process by plants to reduce pollution. However, essential knowledge and experience are required before a constructed wetland can be developed to achieve a successful treatment system to treat the sewage.

Magnetic treatment is another method in treating sewage. Magnet is very preferable because of lost operating cost, high safety and simplicity. Commonly magnetic field is used in separating metals solid and is rarely being used in wastewater treatment process. Magnetic field is also able to detoxify toxic compounds and increased the bacterial activity (Yavuz and Celebi, 2000). In addition, it also have special abilities to increase the rate of sedimentation of solids in wastewater (Johan *et al.*, 2004).

1.2 Problem Statement

Improper management of domestic wastewater contributes to a lot of environmental problems. One of the main problems is the production of untreated sewage. Sewage is harmful because it contains dangerous pollutants such as organic matters, heavy metals, and pathogens. Uncontrolled disposing and storing of sewage in a systematic way can promote the sewage to infiltrate to groundwater and affect drinking sources. Besides that, if it is not properly managed, it can gives harm to human body because of pathogens contained in the sewage (Akinbile and Yusoff, 2011).

Usually there are conventional methods in dealing with treatment of domestic sewage. Normally, approaches in treating domestic sewage is by oxidation pond and activated sludge but the systems require large land area and is expensive to operate (Shen *et al.*, 2013). Some of the treatment systems are not environmentally friendly, require the usage of electricity and large area in order to provide removal of pollutant from sewage. Therefore, by using constructed wetland enhanced with magnetic field, it could treat the sewage naturally and increase the rate of sedimentation of sewage.

Currently, there is less study conducted treatment of sewage using constructed wetland with magnetic field. Many applications on magnetic field have been used for sewage treatment but the potential combination of constructed wetland and magnetic field was not fully discovered. Therefore, this study will contribute to sewage treatment using constructed wetland and magnetic field, and it can give significant impact on the quality of effluent due to higher percentage removal of pollutants. This approach is easy to operate and conduct because the system requires minimum usage of electricity. In addition this system is also very environmental friendly because plants are used in treating the sewage. Therefore, this study is conducted to determine the efficiency of using magnetic field for sewage treatment using Free Water Surface (FWS) wetland planted with *Eichhornia crassipes*.

1.3 Objectives

The objectives of the study are to determine the performance of free water surface constructed wetland enhanced with magnetic field as the following:

i. To examine the capability of water hyacinth in constructed wetland system in removing pollutants
ii. To investigate the removal performance of pollutants in constructed wetland system with magnetic field

1.4 Scope of the Study

The experiments are carried out at the Environmental Engineering Laboratory, Faculty of Civil Engineering, University Technology Malaysia, Skudai. The type of system used in the constructed wetland is Free Water Surface (FWS) System. Sewage sample will be collected from Kolej 9 UTM Skudai. The initial water quality of the sewage will be analysed. The parameters used for this study are Nitrate, Total Suspended Solid, and Phosphorus. Different strength magnet will be used which is 0 (control), 0.13 Tesla, and 0.55 Tesla. The hydrophytic plant used in this study is *Eichhornia crassipes*.

1.5 Significant of the Study

This study is conducted to examine the performance of constructed wetland enhanced with magnetic field in treating sewage. Constructed wetland is popular because it is an environmentally friendly approach and relatively cheaper operating cost. Treatment by using magnetic field is very significant because it is a new potential technology and can provide an alternative for sewage treatment in Malaysia. Therefore, combination of both constructed wetland and magnetic field can be a promising solution to the treatment of sewage in a sustainable way.

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