PERFORMANCE OF CONSTRUCTED WETLANDS USING *VETIVERIA ZIZANIODES* FOR SEWAGE TREATMENT

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To my respected and beloved mak and ayah,
Habsah bt. Ahmad and Ahmad b. Md Hassan
Thanks for your valuable sacrifice.....

To my family, especially my dearest sister, Noraliza Ahmad
To my dearest friend and encouragement, Nor faizah
Thank you for support and always there for me....
Love u all...

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"In the name of Allah, the most gracious, the most compassionate"

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ABSTRACT

Sewage is one of the major problems to overcome in managing the domestic sewage. Treatment that low cost, need less maintenance and environmental friendly are among target on how to treat the domestic sewage. This research was focused on the capability of the *Vetiveria zizaniodes* plant to remove pollutant through the constructed wetland. The study carried out through two type HRT systems, which were HRT-5 and HRT-0. The constructed wetlands were planted with *Vetiveria zizanoides* in different population for every cell which is cell control, less population and more population. The efficiency of the systems to reduce the concentration of oil and grease, ammoniacal nitrogen (NH^3-N), Biochemical Oxygen Demand (BOD), total suspended solid (TSS), and orthophosphate (PO_4^{3-}) were analyzed. The performance of dissolved oxygen (DO) and pH are also considered. From the study it was found that the constructed wetlands using *Vetiveria zizaniodes* is significantly contributed in removal efficiency of BOD, orthophosphate and ammoniacal nitrogen on HRT-5 while on HRT-0 it's contributed in removal efficiency of TSS. The results showed the ability of constructed wetland using the *Vetiveria zizaniodes* to reduce up to 56% of ammoniacal nitrogen removal, 79% of orthophosphate, 53% of BOD and 51% oil & grease after 7 days of treatment for HRT-5. On the other side wetland was able to remove 62% of TSS after end of experiment for HRT-0 on day 7 of treatment. It can be conclude that *Vetiveria zizaniodes* posed a great role in removing orthophosphate, ammoniacal nitrogen, BOD, TSS and oil and grease in different hydraulic retention time.

ABSTRAK

Sisa kumbahan adalah salah satu masalah besar yang semakin berleluasa di dalam pengurusan sisa kumbahan perumahan. Kaedah yang rendah kos, kurang penyenggaraan dan mesra alam merupakan matlamat di dalam pengurusan sisa kumbahan. Kajian ini menfokuskan keatas kemampuan tumbuhan Vetiveria zizaniodes untuk menyingkirkan bahan cemar melalui tanah becah buatan. Kajian ini melibatkan dua jenis sistem masa tahanan (HRT) yang mana HRT-5 dan HRT-0. Tanah becah buatan di tanam dengan populasi rumput vetiver yang berbeza-beza yang mana sel kawalan, sel kurang dan sel lebih populasi. Kajian ini menunjukkan rumput vetiver mampu mengurangkan kepekatan gris dan minyak, nitrogen ammonia (NH^3-N), permintaan oksigen biokimia (BOD), jumlah pepejal terampai (TSS), dan orthophosphate (PO_4^{3-}) telah dianalisis. Perubahan oksigen terlarut dan nilai pH juga di ambil kira. Daripada kajian, dapat dilihat bahawa tanah becah buatan menggunakan *Vetiveria zizaniodes* menyumbang terhadap penyingkiran BOD, orthophosphate, dan ammonia nitrogen pada HRT-5 manakala HRT-0 menyumbang terhadap penyingkiran TSS. Keputusan menunjukkan kemampuan tanah becah menggunakan *Vetiveria zizaniodes* untuk mengurangkan sehingga 56% ammonia nitrogen, 79% orthophosphate, 53% BOD dan 51% gris dan minyak selepas hari ke-7 rawatan menggunakan HRT-5. Manakala bagi HRT-0 ianya dapat menyingkirkan TSS sehingga 62% selepas hari ke-7. Ini dapat disimpulkan bahawa *Vetiveria zizaniodes* merupakan salah satu tanaman yang mempunyai potensi untuk mengurangkan pencemaran dalam nilai masa tahanan yang berbeza.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURE

LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOE	Department of Environmental
HRT	Hydraulic Retentions Time
NH_3	Ammonia
NH_4^-	Ammonium Ion
NH_3-N	Nitrogen Ammonia
OH^-	Hydroxide Ion
PO_4^{3-}	Orthophosphate
TSS	Total suspended solid
UTM	Universiti Teknologi Malaysia
FWS	Free water surface
FWSCW	Free water surface constructed wetland
HRT	Hydraulic retention time
mg/l	milligram per litre
N_2	dinitrogen
N_2O	Nitrous oxide
NO^{3-}	Nitrate
NO^{2-}	Nirite
NO_2	Nitric oxide
ppm	Part per million
SSF	Sub-surface flow
SSFCW	Sub-surface flow constructed wetlands
TSS	Total suspended solid

VF	Vertical Flow
IWK	Indah Water Konsortium

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Overview

Over the last years, the high population growth rate, industrialization and urbanization, have been the causes for several environment all over the world. Nowadays, wastewater treatments are the most important problems that we are facing. The developments have impact on the Malaysian wastewater treatment and management system. Even though, conventional treatment method that have been used and practiced for long is suitable and still efficient nowadays but still can be improved by focusing to the nutrients, organic, organic matters and heavy metal removal, a methods to polish the effluent from sewage treatment plant prior discharge into river or other water courses

There are two categories of wetlands, which are natural wetlands and constructed wetland. The constructed wetlands have been used at most of the country as secondary treatment after oxidation pond or sewage treatment plant (STP). Liehr *et al.,* (2000), reported that there are two types of constructed wetlands i.e. surface flow wetland (SFW) and subsurface flow wetland (SSF). According to the Ayob and Supiah, (2005), this method not only used for treating wastewater but also for Best Management Practice (BMP) for flood management, small urban drainage and so on.

Wetlands is a natural wastewater treatment where all the organic matters and nutrients are removed using vegetative plants with helps of other nature elements such as sunlight, temperature and oxygen at surrounding of wetlands. In term of cost it's cheaper than other conventional sewage treatment plant because no any mechanical devices were applied in this process, (Kadlec and Knight, 1996)

Olson (1992) and Mitsch (1992) stated that constructed wetlands have been used as an attractive low-cost method for controlling water pollution from both point and nonpoint sources. (Dundabin and Bowmer (1992) also reported that constructed wetland show good potential for removal metals from industrial wastewaters. Wetlands were also reported have potential to prevent the contamination of groundwater or to prevent groundwater from infiltrating into the wetland (Kadlec et al., 2000). As reported by Olson (1992), wetlands can contribute in reducing heavy metal and nutrient significantly in wastewater to improve the water quality. On the other hand, constructed wetlands are also used to improve or restore some water bodies such as rivers and water basins (Nairn and Mitsch, 2000; Mitsch *et al*., 2005 and Mitsch and Day, 2006).

Among the aquatic treatment systems, constructed wetlands have a greater potential in wastewater treatment because they can tolerate higher organic loading rate and shorter hydraulic retention time with improved effluent characteristics (Chongrak and Lim, 1998).

1.2 Objective of Study

There are two objectives that are outlined for this study, as the followings:

i. To investigate the performance of the constructed wetland with *vetiveria zizaniodes* in treating sewage under different hydraulic retention time HRT-0 (no flow) and HRT-5days;

ii. To examine the effect of the constructed wetland system on sewage quality for pH, Dissolve Oxygen (DO), Total Suspended Solids (TSS), Biological

Oxygen Demands (BOD), oil and grease, Ammonia Nitrogen (NH_3-N), and Orthophosphate (PO_4^{3-})

1.3 Scope of Study

The experiment of removing the organic matters, total suspended solid, and nutrients in sewage using subsurface flow constructed wetland was conducted at Environmental Engineering Laboratory, Faculty of Civil Engineering, Universiti Teknologi Malaysia (UTM). Sewage is taken from the oxidation pond at Kolej Tun Canselor (KTC) UTM Skudai. The parameters used for analyses are organic matters i.e. BOD, oil & grease, TSS, and nutrients i.e. ammonia nitrogen and phosphate.

1.4 Problem of Statement

As cities are growing in size with a rise in the population, the amount of waste generated is increasing becoming unmanageable. As an alternative, constructed wetlands are suitable for treating wastewater which can be very harmful to living things if not properly treated. The problem with wastewater treatment is that wastewater changes in terms of strength, biodegradability, and toxicity as the generation of wastewater is depend on the number of population, cultures, type of sewer etc.

1.5 Significance of the Study

The findings of the study are important to discover the performance of constructed wetlands in treating and removing organic matters, and nutrients in the sewage. From the analyses we can evaluate the efficiency of wetland in treating sewage and determine the benefits of using wetland. Constructed wetlands can be used as a new method of treatment that could be applied to treat sewage which is more environmentally friendly, and less operating cost.