UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF REPRODUCING DOMESTIC WASTEWATER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (MANUFACTURING PROCESS)

by

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I hereby, declared this report entitled "Investigation of Reproducing Domestic Wastewater" is the results of my own research except as cited in references.

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Date	:	17 MAY 2011

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the Degree in Bachelor of Manufacturing Engineering (Manufacturing Process). The member of the supervisory committee is as follow:

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ABSTRAK

Rawatan sisa air adalah penting pada masa kini kerana meningkatnya peningkatan populasi dunia dan meningkatnya pencemaran air bersih di seluruh dunia. Keadaan menjadi lebih buruk dengan penggunaan yang sewenang-wenangnya dan pembaziran air yang semakin menjadi-jadi. Jadi, rawatan air sisa amat penting dalam memastikan kewujudan air bersih di masa akan datang. Dengan adanya rawatan air bersih, penggunaan air bersih dalam penggunaan air luaran dapat digantikan dengan air sisa yang telah dirawat. Contoh penggunaan air luaran ialah basuh kereta, siraman kebun, pam tandas, dan basuh baju. Penggunaan luaran ini mengambil sebilangan besar peratusan penggunaan air harian. Walaubagaimanapun, untuk membina system rawatan air sisa, beberapa kajian dan eksperimen perlu dilakukan kerana Malaysia tidak terlalu terdedah kepada teknologi ini. Kajian yang boleh dilakukan dengan memerhati negara yang telah mengaplikasikan teknologi ini seperti Jerman, Australia, Belanda, dan Timur Tengah. Kajian ini dapat dijadikan garis panduan dalam membina system ini di Malaysia. Pembinaan system ini bermula dengan pembinaan system pengumpulan air sisa di tempat kajian. Selepas itu, beberapa sampel akan diambil dari air sisa itu. Sampel-sampel itu akan menjalani ujian pH dan ujian suhu untuk memastikan sama ada rawatan yang dilakukan berjaya atau tidak. Lebih rendah nilai pH dan suhu dari nilai air sisa yang sebenarnya adalah lebih baik. Data yang dikumpul akan dianalisis dan dikumpulkan ke dalam graf yang sesuai untuk menunjukkan hasil rawatan. Hasil rawatan dibincangkan dan beberapa cadangan diberikan untuk menambahbaik lagi projek ini di masa akan datang.

ABSTRACT

Wastewater treatment is a very crucial nowadays due to the increased of world population and the increased of clean water pollution around the world. To make matter worst people keep using the clean water with careless and wasting it. Thus, wastewater treatment is very crucial in maintaining the existence of clean water. With wastewater treatment water usage in external used can be converted by using the treated water. Example of external usage of water is car washing, garden irrigation, toilet flushing, and laundry. These external usages took large sum of percentage in daily water consumption. However, to construct a wastewater treatment, some research and experiments need to be done because Malaysia has not been exposed with this technology. The research can be done by observing the countries that have applying this technology such as Germany, Australia, Netherlands, and Middle East. The research can be guidelines to construct the system in Malaysia. The system construction started with construction the wastewater harvesting system in test site. Then, some samples will be taken from the wastewater that is collected. After that, the samples will undergo pH and temperature testing to determine whether the treatment done was successful or not. The lower the pH and temperature value from the original value, the better the treatment testing done. Then, clear test was done to do visual comparison between the sample before and after wastewater treatment. The data collected then were analyzed and group into suitable graph to show the outcome of the treatment. The results were discussed and some recommendations stated to improve the project in the future.

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DEDICATION

I want to dedicate this report to my beloved father Kamaruddin Ab. Rashid, my mother Rohana Binti Hamat, my sister Nor'amilin and Noor Ain Aziantie, my brother Noor Azmin, Noor Arief Hakimie and Noor Aliff Fitri for giving me constant support, love strength, confidence and guidance that I could not do without.

Never to forget my classmates of 4 BMFP that have always be by my side for the past 4 years of my life in UTeM, with them I have been through a lot of hardship in completing my life as students in UTeM. With them I am able to know myself better and I have known many more wonderful friends. Thank you guys and to my best friends, Ana, Min, Nisa', Pah, Shakirin and Suzie who always be by side share tears and laughter together. May Allah bless all of you.

Besides that, I am also dedicate this to all the lecturers know me and give their knowledge to me. With that I am very grateful because I will never able to repay it. Please bless me with your knowledge.

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LIST OF ABBREVIATIONS

BOD	-	Biochemical Oxygen Demand
cfu	-	colony form units
COD	-	Chemical Oxygen Demand
E.coli	-	Endotherms coli
EPA	-	Environment Protection Agency
EU	-	Europe United
GAC	-	Granular activated carbon
MPN	-	Most probable number
NWS	-	New South Wales
PAC	-	Powdered activated carbon
ppm	-	Parts per million
SS	-	Suspended solids
TBN	-	To be nominated
TKN	-	Total kjeldahl nitrogen
TOC	-	Total organic carbon

CHAPTER 1
INTRODUCTION

This chapter will describe the background of the research with the problem that initiated the research. Besides that, this chapter also consists of the objectives, importance of the research and expected result from the result. This chapter will describe a little bit about the research and what to expect in the next chapter.

1.1 Background

Wastewater is used-water from kitchens, bathrooms, laundry, toilets and similarly used rooms. Wastewater can be divided into two groups which are blackwater and greywater. Blackwater is the drain from toilets, which contains urine and faeces. Greywater is other part of wastewater. It is the drain from laundry, bathtubs and shower trays and kitchen wastewater. Greywater is the parts of the wastewater that will be treated into recycle water for external usage.

Acording to fbr association, greywater is chosen due to its high volume produced daily about 70 L(c*d). According to Draft Guidelines for the Reuse Greywater in Western Australia, greywater can be divided into three streams which are bathroom greywater that contributes 55%, laundry greywater contributes 34% and kitchen greywater contributes 11% of total greywater production. However, greywater production and its degree of pollution are mainly determined by the habits of the consumers and result of products of personal hygiene. Basically, greywater contain soaps, detergents, fibers from clothes, hair, suspended solids, dissolved solids, food particles, grease and oil.

Possible usages of treated greywater are believed to be toilet flushing, laundry, irrigation and infiltration. However, some experiments have to be done to obtain the quality requirement for each possible usage to determine whether it is compatible or not. Thus, a suitable water treatment should be generated to collect the greywater and treat it to achieve the respective quality requirement and water standard. The treatment consists of chemical and mechanical treatments.

Therefore, a greywater harvesting system should be constructed to collect greywater from pilot house. Then, the collected greywater will be treated with selected chemical and mechanical treatment until the quality requirement and water standard are achieved.

1.2 Problem Statement

Nowadays global water resources seem to be unable to support the needs of almost seven billion of world population. This situation worsens with the increase demand for domestic, industrial and irrigation needs and to add it up with severe rivers pollution around the world. Thus, there are some parts of the world that people cannot access to safe drinking water. According to National Water Resources Study 2000, Malaysia's water requirement will increase by 63% from 11 billion m^3 (2008) to 17.7 billion m^3 (2050). Thus, the study showed that, even Malaysia is blessed with abundant of rainfall; a precaution measure should be taken to prevent clean water scarcity in the future.

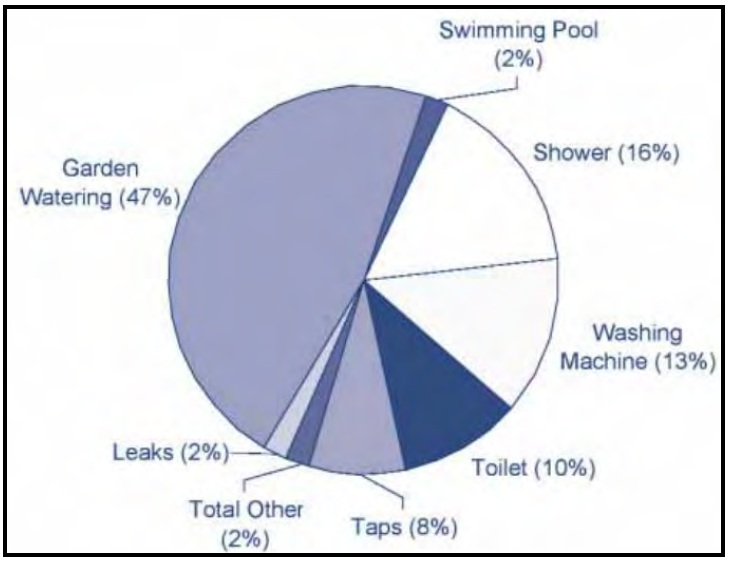

Figure 1.1: Household water usage volumes according to Water Corporation (2002)**.**

From Figure1.1 above, it showed that 90% of household water usage is used for external use. Therefore, 900 liters of wastewater will be discharged each day into raw sewage (approximately 1000 liters distributed to a house). Hence, if there are 1000 houses, there will be 900 000 liters of wastewater each day. It such a waste because the wastewater can be recycled and reused for external usage such as toilet flushing, garden watering, car washing, and laundry. By doing this, clean drinking water can be saved and conserve the existing clean water resources.

1.3 Objective

The objectives of this research are:

1. To construct wastewater harvesting system;
2. To treat wastewater to its respective quality requirement according to its intended used;
3. To reduce river pollution by treating the wastewater before discharge it into the river; and
4. To reduce clean drinking water usage in the external water usage area.

1.4 Scope

This research includes the study on wastewater parameter, quality, composition and characteristics. Besides that, rules and regulations regarding wastewater treatment are being investigated to understand the guidelines of the system. The quality requirement for treated wastewater regarding the intended usage need to be studied of and come out with a system that able to improve the wastewater quality. The wastewater testing decided were pH testing, temperature testing, parts per million (ppm) calculations and clear test. Then, the result of each testing will be transform into graph

1.5 Importance of Study

The primary concern in this research is the ability to achieve the quality requirement stated for each intended usage. Even if this research succeeds in achieving the quality requirement, there are some rules and regulations that need to be obeyed to avoid any danger to human, animal and plants. Besides that, there are some chemical experiments that need to be done without any mistakes to ensure the validity of the experiments. Furthermore, the harvesting system also needs to be monitored from time to time to maintain its quality.

1.6 Expected Result

At the end of the research, the study and the experiment is expected to successfully produce treated water that can be used in toilet flushing, laundry and able to be discharge into surface water. Besides that, the usage of the treated water also will not harm any human being, animals and plant.

CHAPTER 2

LITERATURE REVIEW

This chapter will focus on the facts, data, equipments and processes related to project. With this chapter, the reader will be able to understand scientific terms, equipments used, and processes used. For this project, this chapter will discussed about water parameter definition, rules and regulations regarding wastewater treatment, wastewater quality and its compositions, possible usage of the treated wastewater, and quality requirements according to applications.

2.1 Water Parameter Definition

Water parameter is a limiting factor in water quality where the parameter is used to indicate the water quality. The parameter will indicate the range that suitable according to its intended use. Thus, the range will be differ accordingly because differ water application require different range of parameter. For example, toilet flushing's water parameter range will be differ from land irrigation. All the water parameter definition used in this research is stated in Table 2.1.

Table 2.1: Table of water parameter definition (Mehlhart et al, 2005).

Parameter	**Definition**
Biochemical Oxygen Demand (BOD)	The amount of dissolved oxygen consumed by microbiological action when a sample is incubated usually for 5 days at 20^{o}C, expressed in miligrams per litre (mg/L).
Suspended solids (SS)	Solids retained after filtration either through glass fibre filter paper followed by washing and drying at 105^{o}C, or by

	centrifuging followed by washing and removal of the supernantant liquid expressed in miligrams per litre (mg/L).
Thermotolerant coliforms	Aerobic and facultative anaerobic, gram negative, non-spore forming, rod shaped bacteria, distinguished from non-faecal coliform organisms by incubation at 44.5^{o}C.
Total kjeldahl nitrogen (TKN)	A method for measurement of total nitrogen including organic nitrogen and ammonia based on wet oxidation expressed in miligrams per litre (mg/L). It is used in lieu of dissolved oxygen for intermittent process assessment.
Disinfection	A process which reduces the number of micro-organisms but does not sterilise or remove all micro-organisms.
Pathogens	Disease causing microbes eg. viruses, bacteria, helminths and protozoa.
pH	An indicator used to identify whether a liquid is acidic or basic.
Coliform bacteria	The commonly used bacteria indicator of sanitary quality of foods and water.
Faecel coliform	As indicator of water quality. In general, increased level of faecel coliforms provide a warning of failure in water treatment, a break in the integrity of the distribution system or possible contamination with pathogen.
Pseudomonas aeruginosa	A common bacteria that can cause disease in human and animals.
Chemical Oxygen Demand (COD)	The chemical oxygen demand is a measure of the oxidizability of a substance, expressed as the equivalent amount in oxygen of an oxidizing reagent consumed by the substance under fixed laboratory conditions.
Turbidity	Turbidity is a measure of the amount of particulate matter that is suspended in water. Water that has high turbidity appears cloudy or opaque. High turbidity can cause increased water temperatures because suspended particles absorb more heat and can also reduce the amount of light penetrating the water.
Temperature	Water temperature affects the ability of water to hold oxygen, the

	rate of photosynthesis by aquatic plants and the metabolic rates of aquatic organisms.
Total organic carbon (TOC)	The amount of carbon bound in an organic compound and is often used as a non-specific indicator of water quality or cleanliness of pharmaceutical manufacturing equipment.
E. coli	A Gram negative rod-shaped bacterium that is commonly found in the lower intestine of warm-blooded organisms (endotherms). Most E. coli strains are harmless, but some, such as serotype, can cause serious food poisoning in humans.
Conductivity	The ability or power to conduct or transmit heat, electricity, or sound. Pure water is not a good conductor of electricity. Ordinary distilled water in equilibrium with carbon dioxide of the air has a conductivity of about 10 x 10-6 W-1*m-1 (20 dS/m). Because the electrical current is transported by the ions in solution, the conductivity increases as the concentration of ions increases.
Total phosphorus	Total phosphorus is the measure of the total concentration of phosphorus present in a water sample.

2.2 Rules and Regulations Regarding Wastewater Treatment

In constructing a wastewater treatment system, there are some rules and regulations that need to be followed in order to construct a success and reliable system. The rules and regulations constructed by the New South Wales (NSW) Health Department with the title of Domestic Greywater Treatment System Guidelines. The rules and regulations are under Part 4, Clause 43(1), Local Government (Approval) Regulation, 1999. The rules and regulations are as in Table 2.2:

Table 2.2: Table of rules and regulations regarding wastewater treatment (Domestic Greywater Treatment System Guidelines, 2005).

Criteria	Rules and Regulations
Health and Safety Requirement	Greywater systems (does not include bucketing) must be dispose of greywater below the ground surface unless treated and disinfected to an appropriate standard.
	Greywater system must be designed and operated without direct contact with human and animal except for maintenance.
	No cross connection with the clean drinking water supply.
	Greywater must not be allowed to enter any stormwater drainage system.
	Greywater shall not be in direct contact with edible plants and fruits but it can be used to irrigate fruits plants.
	No opportunity for mosquito breed exists in any part of the greywater system.
Design Criteria	Chemical disinfectant usage shall be incorporated with separate disinfection contact chamber and effluent holding chamber to allow sufficient contact time for disinfectant.
	The system shall be designed to treat greywater waste stream from a minimum of eight persons and a maximum of ten persons, based on minimum daily flow of 90 liters per person daily.
	The system shall be designed to treat all nominated greywater streams arising from domestic premises.
	If the system is intended to install in a sewered area, the system shall be capable of connection to the sewer such that: - An overflow to the environment will not occur; - The operator may direct greywater to the sewer during raining season or circumstances adverse.
	The system shall be constructed according to design specifications and good trade practises to ease the maintenance