CHARACTERIZATION OF HOUSEHOLD WASTEWATER

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CHARACTERIZATION OF HOUSEHOLD WASTEWATER

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This project is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science with Honours (Resource Chemistry)

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DECLARATION

No portion of the work referred in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

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CHARACTERIZATION OF HOUSEHOLD WASTEWATER

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ABSTRACT

The objective of this study was to determine selected physical and chemical characteristics of household wastewater from four housing areas at Kuching, Sarawak. The quality of the household wastewater was obtained from this study. This study was carried out at difference housing areas differentiated on their social-economy status. This study was carried out at four housing areas at Kuching, namely, Taman Malihah, Tabuan Jaya, Taman Satria Jaya and the Village Grove condominiums. This housing areas were categories into three difference groups that is low, medium and high-income groups. This study investigated into two types of parameters, which were In-situ parameters and laboratory parameters. Wastewater samples were taken at the selected main drain once a month from October to February. The In-situ parameters were temperature, pH, and dissolved oxygen while the parameters analyzed in the laboratory were nitrate concentrations and phosphate concentrations. This study found that the phosphate concentration 12.5mg/l was highest at Taman Malihah compared to the other housing areas. The higher concentration of phosphate at Taman Malihah was caused by washing activities that used a lot of detergent. The nitrate concentration was high at the high-income group, i.e. at the Village Grove condominiums. As a conclusion, main factors affecting this concentration in the wastewater from households was from the daily activities such as washing activities and eating habits.
ABSTRAK

CHAPTER I
INTRODUCTION

1.1 Wastewater
Wastewater is water that can contribute to water pollution. It enters streams, rivers, lakes and seas via point and non-point sources. A point source is when the pollutants are converged to a single outlet before being discharged into the surface water. Non-point sources are contributing sources most often associated with surface runoff such as urban storm water runoff. Non-point sources contribute less than 50% of pollution load and although their effect is slow it is persistent. Household wastewaters are one of the examples of point source pollution and are typically generated as a result of household activities. It is divided into 2 categories, which is black (faeces and urine) and grey (kitchen, bath, laundry etc.) water. As a matter of fact, household wastewater effluent is very much related to water consumption. However not all water consumed is discharged as wastewater.

1.2 Scope of Study
This study involves the characterization and quantification of certain constituents of wastewater from domestic households in certain areas in Kuching. These areas consist of different types of income group residences, namely, low-cost single storey terrace houses, medium-cost double-storey terrace houses and condominiums which are categorized into low, middle and high income residential groups respectively.
1.3 Objectives of Study

1. To determine the physical parameters and water quality parameters of household wastewater in low, middle and high income residential areas.

2. To determine the water quality of the household wastewater

3. To compare the water quality of the wastewater between low, middle, and high income residential areas.
2.1 Domestic Wastewater

2.1.1 Domestic Water Utilization

Water furnished to houses, hotels, etc. is used for sanitary, culinary and other purposes. Water usage varies with the economic status of the consumer, the range being 75 to 380 L (20-100 gal) per capita per day. These figures include water used for air containing and watering of lawns and gardens a practice which may have a substantial effect upon total water use in some parts of the country. Domestic consumption is typically about 50% of the total, but represents a large fraction where the total consumption is small (McGhee, 1991). Table 1 and Table 2 show the typical distribution of residential interior water use of European households. The water consumption in the household is an important part of waste generation. It is agreed that 60-90 % of the per capita water consumption becomes wastewater (Metcalf and Eddy, 1991).

<table>
<thead>
<tr>
<th>Table 1. Fraction of water consumption (Henze, 1997)</th>
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</thead>
<tbody>
<tr>
<td>Use</td>
</tr>
<tr>
<td>Toilet</td>
</tr>
<tr>
<td>Bath</td>
</tr>
<tr>
<td>Kitchen</td>
</tr>
<tr>
<td>Wash</td>
</tr>
<tr>
<td>Infiltration</td>
</tr>
<tr>
<td>Total</td>
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</tbody>
</table>


Table 2. Typical distribution of residential interior water use. (Henze, 1997)

<table>
<thead>
<tr>
<th>Use</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath</td>
<td>8.9</td>
</tr>
<tr>
<td>Dishwashers</td>
<td>3.1</td>
</tr>
<tr>
<td>Faucets</td>
<td>11.7</td>
</tr>
<tr>
<td>Showers</td>
<td>21.2</td>
</tr>
<tr>
<td>Toilets</td>
<td>28.4</td>
</tr>
<tr>
<td>Toilet leakage</td>
<td>5.5</td>
</tr>
<tr>
<td>Washing machines</td>
<td>21.2</td>
</tr>
</tbody>
</table>

2.1.2 Inputs Constituting Composition of Domestic Wastewater

Wastewater or water-born waste is water used by urban population for drinking, washing, cleaning or by industry for cooling, washing, processing (Welch, 1992). It is discharged carrying unwanted and uncovered substances. Henze (1997) defined that waste production from households normally consist of liquid waste (wastewater), solid waste and airborne waste. He said that household waste comprises wastewater and solid waste from households that originated from various sources within the household. Van der Wijst and Groot-Marcus (1999) said that domestic wastewater is wastewater coming from households and the amount of pollution is partly defined by household characteristics as well as development in consumption or consumption patterns. Wastewaters are often classified according to their use. The first of these is commonly called sanitary or domestic wastewater, which is wastewater discharged from the residential, institutional and similar facilities, the second is industrial waste while the third includes infiltration, inflow, and storm water. Wastewaters enter streams, rivers, lakes and seas via point and non-point sources. Wastewater from households is one of the examples of point source pollution. It is categories into 2 groups which is black (faecal and urine) and grey water (wastewater from bath, kitchen etc.). These are shown in Figure 1. Grey water contributed 18.5%
of domestic wastewater in urban drainage while black water contributed 9.3% out of a total of 540 l/Ed wastewater in sewers. Household wastewater discharged is mainly contributed by water-using facilities and appliances, especially, water closets/toilets, baths/showers, kitchen sinks, wash basins and washing machines.

![Diagram of pollution fluxes in urban drainage in Kuching](image)

Figure 1. Fluxes of pollution in urban drainage in Kuching. (Adapted from Herman and Klaus, 1997)
2.1.3 Factors Affecting Wastewater Discharge

The average daily per capita water consumption in American cities varies from 130 to 2000 L (35 to 350 gal). Local use depends upon such factors as the size of the community, presence of industries, quality of the water, its cost, its pressure, the climate, characteristics of the population, whether supplies are metered and the efficiency with which the system is maintained (McGhee, 1991). Besides that, behaviour of an individual also plays an important role in affecting water use and hence wastewater generation. The main factors of concern in relation to wastewater discharge in terms of quality and quantity are the number of people in an area and the economic status of the population. According to Metcalf and Eddy (1991), in a small community, the rate of use fluctuates over a wider range with higher peak flows (as compared to average use) and lower minimum flow. Types of housing development particularly affect exterior water use as the need for landscaping watering is much higher in the houses with yards or garden compounds. Terrace houses, condominiums and apartments are the attributes of the density of development. It was suggested that as the assessed value of property increase, so does water use and wastewater flow rate (Geyer and Lentz, 1962). Economic status of a community also can affect the amount of water use and thus the wastewater flow rates. Higher incomes have a higher ability to own water-using appliances such as washing machines that increase water consumption of a household. As such, growth in water use from washing clothes is due to the higher frequency of washing and the fact that washing machine is also used when it is only partly filled with textiles (Van der Wijst and Groot-Marcus, 1999).
2.2 Domestic Sewerage System Wastewater and their Discharge

The sewerage system is divided into septic tank and Imhoff tank. In Malaysia most of the sewerage systems use septic tanks and Imhoff tanks are usually found only at condominiums or apartments housing areas (Malaysian Standard- MS 1228 Code of Practice for Design and Installation of Sewerage Systems).

2.2.1 Septic Tanks

This tank is usually located in the backyard of the house. The septic tank provides partial treatment of sewage and it needs to be desludged at a regular basis to ensure it functions efficiently. It usually comprises two chambers known as the settlement tanks. The maximum sludge that it can store is about a third of its total volume. That is the reason why it requires regular desludging. When the sewage flows into septic tanks, they produced 2 layers. The scum such as oil and grease from the sewage float to the top and form a layer at the surface and the solid matter or sludge forms a second layer below. An anaerobic process occurs as scum prevents oxygen from dissolving in the sewage. As a matter of fact, to breakdown the solid matter, the sewage has to be retained for at least twenty-four hours to allow for anaerobic digestion. The sewages can overflow if desludging is not carried out during a period of time. Retention time for the sewage can decrease when the sludge achieves the maximum level of the tank. This will result in an incomplete breakdown of sewage and thus, untreated sewage and sludge will be released into the drain from the septic tank. Because of this there is an effect on public health. In addition, the accumulation rate of sludge should be included in the calculation of septic tank sizing. The septic tank volume to be allocated to each user is 730 liters so as to maintain a 50% minimum...
volume for the settling of the wastewater (Philip et al., 1993). The suitable size of the tanks will accommodate at least 24 hours of wastewater flows while allowing for sludge and scum retention time. This is because the design and construction of septic tanks influence their water tightness and effectiveness at retaining sludge and scum. Figure 2 shows a typical household system for wastewater generation, collection, treatment and disposal. While such systems may be called by various names such as septic tanks or subsurface treatment and disposal systems they are similar.

Figure 2. Typical household wastewater treatment systems with problems. Illustration by Andy Hopfensperger, University of Wisconsin-Madison Department of Agricultural Engineering (http://waterhome.brc.tamu.edu/index.html)
2.2.2 Imhoff Tanks

This type of tank is usually constructed at condominiums and apartments. An Imhoff tank provides connected sewage service and consists of a sedimentation tank. Sewage from the connected premises flows to the sedimentation tank where settlement of solids occurs. Sludge forms as heavier solids settle at the bottom of the tank. On the other hand, liquid effluent from the sedimentation tank seeps through a rock filter bed that comprises of different sizes of stone and rocks. Organisms living on the rock filter treats the sewage while the effluent is discharged into the drain. Similar to the maintenance of septic tanks, the sedimentation tank of the Imhoff tank also need to be desludged regularly.

2.2.3 Nature of Discharge

In Sarawak, septic tanks typically discharged effluent into municipal storm water drains without monitoring their effectiveness in treating effluents (Memon and Murteza, 1999). Rivers and drains act as combined sewers collecting all types of wastewaters such as septic tank effluent, grey water as well as liquid industrial waste. The contaminated flows directly discharge to the nearest surface water may become a source of pathogens to the downstream users as the subsequent decomposition of wastewater creates nuisance conditions as well as disrupts the aquatic ecosystem. The reduction of the effect of wastewater discharge has become important because this shortcoming has come to the limelight and out of this concern it has been realized that the wastewater must first be treated to remove the bulk of the contaminants before it is discharged into the watercourses. According to Hermann and Klaus (1997), the drainage system is a diluting system while the treatment plant is a concentrating machine. As a measured towards waste treatment, the total pollutant load to receiving water bodies is often determined and
allocated for present and future discharges. This waste load allocation is used to customize the
treatment at each discharge point. Total suspended solids (TSS), biochemical oxygen demand
(BOD), nutrients (N and P) and pathogenic bacteria are the important constituents of domestic
wastewater that are targeted to be removed during the treatment. Wastewater treatment has been
separated into preliminary, primary, secondary and advanced systems. The preliminary system
includes measurement and regulation of the incoming flow and removal of large floating solids,
grit and perhaps grease. Primary treatment processes were originally designed to remove
suspended solids in wastewater prior to its discharge, since these were the most obvious source of
pollution. The secondary treatment system is intended to remove the soluble and colloidal organic
matter which remains after primary treatment.

2.3 Wastewater Characteristics

Wastewater is characterized in terms of its physical, chemical and biological composition.

2.3.1 Physical Characteristics

Physical characteristics include the colour, odour, total solids and temperature.

2.3.1.1 Colour

Wastewater is usually light brownish to grey in colour. The colour of the wastewater changes
from grey to dark grey and ultimately to black when anaerobic conditions develop. At this stage,
the black coloured wastewater is described as septic.
2.3.1.2 Odour
Odours in wastewater are caused by the decomposition of the organic matter or by substances added to the wastewater. Fresh wastewater has distinctive, musty but not offensive odour, which is less objectionable than to the odour of the wastewater that has undergone anaerobic decomposition. The stale sewage odour of hydrogen sulfide is pronounced. This offensive odour of stale or septic wastewater is caused by the activity of anaerobic microorganisms in reducing sulfate to sulfide.

2.3.1.3 Total solids
Sewage contains about 99% of water, solid suspended in sewage composed of floating matter, settle able matter, colloidal matter and matter in solution. Fresh sewage contains recognizable solid of considerable size. As the waste ages, its contains smaller but still occasionally recognizable solids. Floatable solids are important when the sewage is discharged directly into rivers, lakes or seas.

2.3.1.4 Turbidity
Turbidity is the one of the indicators of the quality of waste discharges and natural waters with respect to colloidal and residual suspended matter. There is the relationship between turbidity and the concentration of the suspended solids in untreated wastewater. Fresh wastewater is generally turbid or cloudy.