A STUDY ON THE PERFORMANCE OF LIMESTONE FILTER FOR THE TREATMENT OF DOMESTIC WASTEWATER

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ABSTRACT

Alternative wastewater treatment systems combat many on-site disposal problems, but no incentives are given to householders to improve the domestic wastewater quality disposal. Untreated wastewater has harmful effects on the environment. Household wastewater or sewage may has disease-causing bacteria, infectious viruses, and household chemicals. If too much untreated sewage is released to the environment, dissolved oxygen level may drop and some species of fishes and other aquatic life may die. There are many methods and techniques involved in treating domestic wastewater. The present study is to investigate the ability of limestone to treat the domestic wastewater in reducing the quality of pollution before it can be discharge to environment. Sample of wastewater was taken from sewerage treatment plant at Taman Melayu Gambang. The wastewater quality analysis has been carried out to obtain the characteristic of wastewater such as turbidity, suspended solids, BOD, COD, pH and heavy metal. This operating system involved the used of limestone drains with the constant flow. The size of limestone were vary ranging from the small size (3.35mm and 6.35mm), medium size (10.0mm) and large size (15 mm and 20mm). The experimental results indicate that limestone filter has removed turbidity ranging from of 8.31% to 19.658%,pH increase ranging from 6.26% to 19.658%,total suspended solid removed from 24% to 84.82%, BOD removed from 11.37% to 53.38%, manganese removed from 96.47% to 99.7%,zinc removed from 83.87% to 99.63%, lead removed from 83.58% to 100%, copper removed from of 83.58% to 100 % and Ferum remove from 42.09 % to 94.39%.The removal efficiency of limestone filter depends on the size of filter media and contact times with the wastewater. The bigger size of filter media gave the

lower removal efficiency than smaller filter media. At higher contact times (60 min), the removal efficiency was higher than at lower contact times (30 min) . Overall, filtration using limestone is an appropriate technic for the treatment of wastewater because it could reduce organic solids and heavy metal which offer low cost investment.

ABSTRAK

Alternatif sistem pemprosesan air sisa banyak mengatasi masalah pembuangan di tempat, namun tiada insentif yang diberikan kepada pemilik rumah untuk meningkatkan kualiti pembuangan air sisa domestik. Air sisa yang tidak dirawat mempunyai kesan berbahaya pada alam sekitar. Kumbahan dari air sisa domestik dari rumah mengandungi bakteria penyebab penyakit, virus berjangkit dan bahan kimia rumah. Jika terlalu banyak air sisa tidak terawat dilepaskan ke persekitaran, kadar oksigen terlarut akan menurun dan spesis ikan dan hidupan akuatik lain mungkin akan mati. Terdapat banyak kaedah dan teknik yang terlibat dalam merawat sisa air domestik. Kajian ini dijalankan untuk menyelidik kemampuan batu kapur untuk merawat air sisa domestik dalam mengurangkan kualiti pencemaran sebelum dilepaskan ke persekitaran. Sampel air sisa untuk tujuan kajian diambil dari kolam pengoksidaan di Taman Melayu Gambang. Analisis air sisa adalah untuk mendapatkan kekeruhan, pepejal terampai, BOD, COD, pH dan logam berat (Pb,Zn,Cu,Mn dan Fe). Sistem operasi menggunakan saluran air dari batu kapur dengan had laju adalah tetap. Saiz batu kapur yang digunakan melibatkan 3 ukuran ditetapkan yang berbeza iaitu ukuran kecil (3.35mm dan 6.35mm), ukuran sederhana (10mm) dan ukuran besar (15mm dan 20mm). Keputusan eksperimen menunjukkan bahawa penapis dapat menyingkirkan kekeruhan antara 8.31% hingga

19.658%, meningkatkan pH 6.26% hingga 19.658%,pepejal terampai dapat dikurangkan sebanyak 24% hingga 84.82%, menyingkirkan BOD 11.37% hingga 53.38%, menyingkirkan mangan 96.47% hingga 99.7%, zink dikurangkan 83.87% hingga 99.63%, Pb 83.58% hingga 100%, Cu 83,58% hingga 100% dan Ferum 42.09% hingga 94.39%. Kecekapan penyingkiran penapis batu kapur bergantung pada saiz media penapis dan masa dedahan dengan air sisa. Saiz besar media penapis memberikan kecekapan penyingkiran yang lebih rendah dari media penapis yang lebih kecil. Pada waktu dedahan yang lebih tinggi, kecekapan penyingkiran yang lebih tinggi diperolehi dari pada waktu dedahan yang lebih rendah. Secara keseluruhan, penapisan menggunakan kapur adalah teknik yang sesuai untuk rawatan air sisa kerana boleh mengurangkan pepejal organik dan logam berat dalam air sisa sebelum digunakan semula atau dibuang.

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APHA	-	American Public Health Association
AMD	-	Acid Mine Drainage
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
Cu	-	Copper
DO	-	Dissolved Oxygen
Fe	-	Ferum
H^+	-	Hydrogen ion
HCO_3^-	-	Bicarbonate ion
H_2S	-	Hydrogen Sulfide
Mn	-	Manganese
OLD	-	Oxic Limestone Drainage
Pb	-	Lead
TSS	-	Total Suspended Solid
STP	-	Sewerage Treatment Plant
WHO	-	World Health Organisation
Zn	-	Zinc

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CHAPTER 1

INTRODUCTION

1.1 Preamble

Wastewater is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources. Wastewater also known as sewage originates from residential commercial and industrial area.

Sewage is correctly the subset of wastewater that is contaminated with feces or urine, but is often used to mean any wastewater. "Sewage" includes domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer or similar structure, sometimes in a cesspool emptier. If this wastewater were discharged directly into a watercourse, serious damage might result to the many form of life and would contribute potential risks and would contribute potential risks transmission of the disease.

Treatment of domestic wastewater is important in order to reduce the transmission of excreta related diseases and reduce water pollution and the consequent damage to aquatic biota (David Duncan Mara,2003). In developing countries only a small proportion of the wastewater produced by sewered communities is treated. In Latin America, for example, less than 15 per cent of the wastewater collected in sewered cities and towns is treated prior to discharge (Pan American Health Organization,2000). Often the reason for the lack of wastewater treatment is financial, but it is also due to ignorance of low cost wastewater treatment processes and of the economic benefit of treated wastewater reuse.

Beside that, the purpose of wastewater treatment is to remove pollutants that can harm the aquatic environment if they are discharged into it. Because of the deleterious effects of low dissolved oxygen (DO) concentrations on aquatics life, wastewater treatment engineers historically focused on the removal of pollutant that would deplete the DO in receiving waters (C. P. Leslie Grady, *et al.*, 1999) .Also untreated waste water harmful to health and also harm to breeding sites for insects, pests and micro organisms.

For that reason, roughing filtration is use. The slow sand filters constructed in rural communities show that many of these filters have short filter run and produce turbidity in the excess of the WHO guideline values for drinking water (Ali, 1998). Reliable operation for sand filtration is possible when the raw water has low turbidity and low suspended solids (Graham, 1988). For this reason, when surface waters are highly turbid, ordinary sand filters could not be used effectively. Therefore, the roughing filters are used as pretreatment systems prior to sand filtration (Jayalath and Padmasiri, 1996). Furthermore, roughing filters could reduce organic matters from wastewater. Therefore, roughing filters can be used to polish wastewater before it is discharged to the environment.

Although roughing filtration technology is used as pretreatment to remove turbidity and followed by slow sand filtration, it may be used without slow sand filtration if raw water originates from well protected catchment and if it is free from bacteriological contamination (Wegelin, 1996). Roughing filters make natural purification processes and no chemicals are necessary. Besides these filters could be built from local materials and manpower . These filters will work a long time without maintenance (Wegelin, 1986). Therefore, roughing filters are appropriate and economical for rural water supply schemes.

1.2 Problem Statement

Surface water and ground water are subjected to contamination from many sources, which could cause risk to human health. Therefore, treatment of wastewater is required to remove those contaminants. As rainfall runs over the surface of structures and grounds, it may pick up various contaminants including soil particles, organic compounds and animal wastes and so on. Sometimes, it is required to receive some level of treatment before being discharged to the environment. Especially household wastewater or sewage includes disease-causing bacteria, infectious viruses, and household chemicals. If too much untreated sewage is released to the environment, dissolved oxygen level may drop and some species of fishes and other aquatic life may die. Therefore, wastewater also needs to be treated before it is discharged to the environment (Barnes *et al.*, 1986).

Roughing filtration is to protect slow sand filters by reducing influent turbidity and suspended solids to a level that is effective for operation. Roughing filtration presents a promising method for improving raw water quality without using any chemicals. Filtration is one of the oldest and simplest methods of removing those contaminants. Generally, filtration methods include slow sand and rapid sand filtration.

Limestone is used as the filter because the cost is very cheaper compare to other filtration's material and also is inexpensive to construct.

1.3 Objectives of the Study

The objectives of the study are:

i. To determine the effectiveness of limestone in adjusting turbidity, suspended solids, BOD, COD and pH from domestic wastewater.

ii. To explore the effect of different size limestone in removal of heavy metal.

iii. To determine the effective contact time in removal of heavy metal.

1.4 Scope of Study

Scopes of this study include the following procedures:

i. Laboratory testing to obtain turbidity, suspended solids, biochemical oxygen demand, COD, pH and heavy metal from wastewater using limestone roughing filter.

ii. The size of lime stone used is 3.35mm, 6.35mm, 10mm, 15 mm and 20mm.

iii. Sampling wastewater was taken from oxidation pond at Taman Melayu, Gambang and the limes stone will be obtained from Bukit Sagu. Quarry

iv. The contact time used for each water sample is 30 minutes and 60 minutes.

CHAPTER II

LITERATURE REVIEW

Wastewater treatment is designed to use the natural purification processes (self-purification processes of stream and rivers) to the maximum level possible. It is also designed to complete these processes in a controlled environment rather than over many miles of stream or river. Moreover, the treatment plant is also designed to remove other contaminants that are not normally subjected to the natural processes as well as treating the solids that are generated through the treatment unit steps. The typical wastewater treatment plant is designed to achieve many different purposes such as protect public health, protect public water supplies, protect aquatic life, preserve the best uses of the waters and protect adjacent lands.(Mackenzie Leo Davis *et al.*, 2004).

2.1 Importance of Wastewater Treatment

The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. Irrigation with wastewater is both disposals and utilization and indeed is an effective form of wastewater disposal (as in slow-rate land treatment). However, some degree of treatment must normally be provided to raw municipal wastewater before it can be used for agricultural or landscape irrigation or for aquaculture. The quality of treated effluent used in agriculture has a great influence on the operation and performance of the wastewater-soil-plant or aquaculture system. In the case of irrigation, the required quality of effluent will depend on the crop or crops to be irrigated, the soil conditions and the system of effluent distribution adopted. Through crop restriction and selection of irrigation systems which minimize health risk, the degree of pre-application wastewater treatment can be reduced. A similar approach is not feasible in aquaculture systems and more reliance will have to be placed on control through wastewater treatment (Frank R.Spellman,1999).

The most appropriate wastewater treatment to be applied before effluent use in agriculture is that which will produce an effluent meeting the recommended microbiological and chemical quality guidelines both at low cost and with minimal operational and maintenance requirements (Arar,1988).

Adopting as low a level of treatment as possible is especially desirable in developing countries, not only from the point of view of cost but also in acknowledgement of the difficulty of operating complex systems reliably. In many locations it will be better to design the reuse system to accept a low-grade of effluent rather than to rely on advanced treatment processes producing a reclaimed effluent which continuously meets a stringent quality standard.

Nevertheless, there are locations where a higher-grade effluent will be necessary and it is essential that information on the performance of a wide range of wastewater treatment technology should be available. The design of wastewater treatment plants is usually based on the need to reduce organic and suspended solids loads to limit pollution of the environment. Pathogen removal has very rarely been considered an objective but, for reuse of effluents in agriculture, this must now be of primary concern and processes should be selected and designed accordingly (Hillman 1988). Treatment to remove wastewater constituents that may be toxic or harmful to crops, aquatic plants (macrophytes) and fish is technically possible but is not normally economically feasible. Unfortunately, few performance data on wastewater treatment plants in developing countries are available and even then they do not normally include effluent quality parameters of importance in agricultural use.

The short-term variations in wastewater flows observed at municipal wastewater treatment plants follow a diurnal pattern. Flow is typically low during the early morning hours, when water consumption is lowest and when the base flow consists of infiltration-inflow and small quantities of sanitary wastewater. A first peak of flow generally occurs in the late morning, when wastewater from the peak morning water use reaches the treatment plant, and a second peak flow usually occurs in the evening. The relative magnitude of the peaks and the times at which they occur vary from country to country and with the size of the community and the length of the sewers. Small communities with small sewer systems have a much higher ratio of peak flow to average flow than do large communities. Although the magnitude of peaks is attenuated as wastewater passes through a treatment plant, the daily variations in flow from a municipal treatment plant make it impracticable, in most cases, to irrigate with effluent directly from the treatment plant. Some form of flow equalization or short-term storage of treated effluent is necessary to provide a relatively constant supply of reclaimed water for efficient irrigation, although additional benefits result from storage (Frank R.Spellman,1999).

2.2 Domestic Wastewater Sources

The principal sources of domestic wastewater in a community are the residential areas and commercial districts. Other important sources include institutional and recreational facilities and storm water (runoff) and groundwater (infiltration). Each source produces wastewater with specific characteristic. Figure 2.1 shows for the typical sources of domestic wastewater.

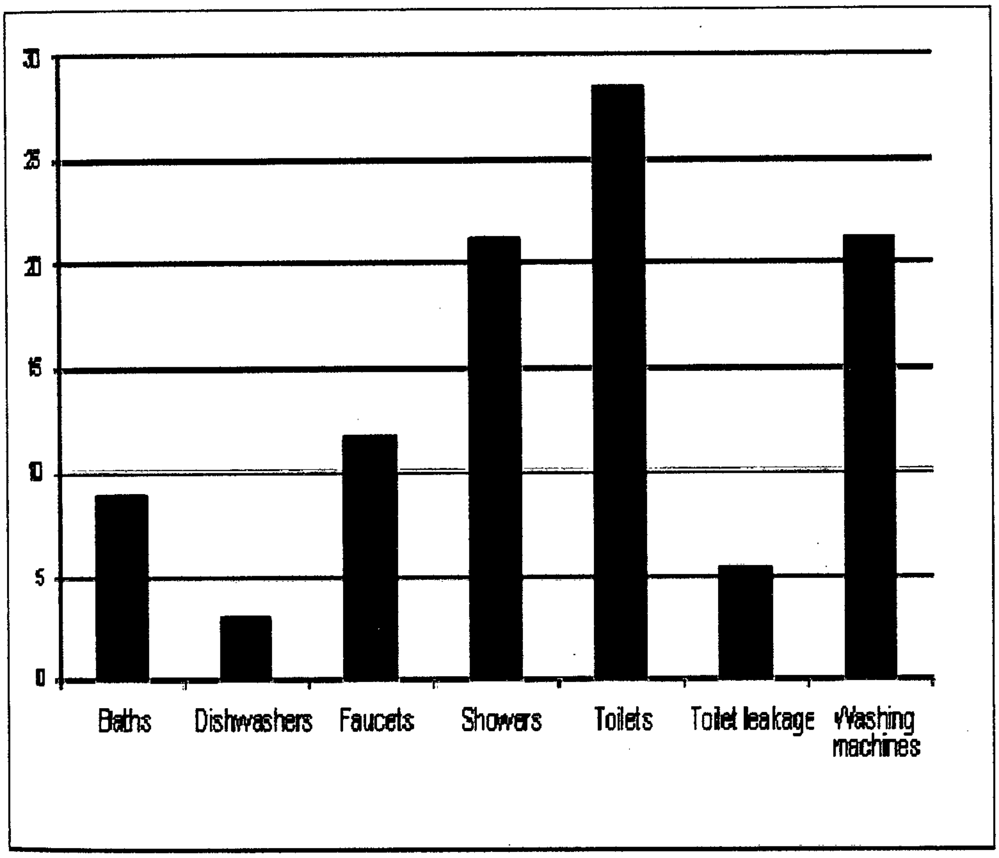

Figure 2.1:. Typical sources of domestic wastewater.

The domestic wastewater is characterized in terms of its physical, chemical and biological composition. The composition changes depending on the location of the source, seasonal variation, climate, time of day, water consumption and population. Composition refers to the actual amounts of physical, chemical and biological constituents present in wastewater. These constituents cause permanent damage to the environment. For this reason, all of these constituents' values should be reduced acceptable levels before discharging. Typical data on the individual constituents found in domestic wastewater are reported in Table 2.1.

Table 2.1:. Typical composition of untreated domestic wastewater [Metcalf and Eddy, 1991].

	Concentration (mg/lt.)		
Contaminants	Weak	Medium	Strong
Total Solids (TS)	350	720	1200
Total Dissolved Solid (TDS)	250	500	850
Suspended Solid (SS)	100	220	350
Settleable Solid	5	10	20
Biological Oxygen Demand (BOD_5)	110	220	400
Total Organic Carbon (TOC)	80	160	290
Chemical Oxygen Demand (COD)	250	500	1000
Nitrogen (total as N)	20	40	85
Organic	8	15	35
Free ammonia	12	25	50
Nitrites	0	0	0
Nitrates	0	0	0
Phosphorous (total as P)	4	8	15
Chlorides	30	50	100
Sulfate	20	30	50
Alkalinity (as $CaCO_3$)	50	100	200
Grease	50	100	150
Total coliform (no/100 ml)	10^6-10^7	10^7-10^8	10^7-10^9

2.2.1 Generation Of Domestic Wastewater

Wastewater is generated by five major sources that is human and animal wastes, household wastes, industrial wastes, storm water runoff and groundwater infiltration. Human and animals wates contains the solid and liquid discharges of humans and animals and is considered by many to be the most dangerous from a human health viewpoint. The primary health hazard is presented by the millions of bacteria, viruses and other microorganisms (some of which may be pathogenic) present in the wastestream. Household wastes are wastes other than human and animal wastes, discharged from the home. Household wastes usually contain paper, household cleaners, detergents, trash, garbage and other substances the homeowner discharges into the sewer system. Storm water runoff many collection systems are designed to carry the waste of the community and strom water runoff. In this type of system, when a strom event occurs, the wastestream can contain large amounts of sand, gravel and other grit as well as excessive amounts of water. Groundwater infiltration will be older improperly sealed collections systems through cracks or unsealed pipe joints. Not only can this add large amounts of water to wastewater but also additional grit.

2.3 Domestic Wastewater Characteristics

Domestic wastewater contains many different substances that can be used to characterize. The specific substances and amounts or concentrations of each will vary, depending on the source. Thus , it is difficult to "precisely" characterize wastewater. Instead ,wastewater characterization is usually based on and applied to an average domestic wastewater.