EFFICIENCY OF AERATION SYSTEM IN WASTEWATER TREATMENT PLANTS.

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DEDICATION

I would like to dedicate this project report to my parents (V. Amirthalingam and S.Sarojini Thevi), wife (Lily) and my beloved daughter (Sanjana Sri) for their constant love and encouragement

APPRECIATION

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ABSTRACT

The most important factor in selecting aeration equipment for a specific application is the oxygen transfer rate. Other factors that are equally important are reliability, serviceability, capital cost, system appurtenances and cost of operation and maintenance. Although there are many systems designed to aerate and mix the waste water, they vary in their effectiveness in providing uniform oxygen dispersion. It is the intention of the study to evaluate the performance of different types of aeration devices based on dissolved oxygen (DO) readings and costing. To achieve this objective, experimental work were carried out on five different aeration devices namely brush aerator, tornado, surface aerator, aspirator and diffusers on five different sewerage treatment plant with average PE of 2000. Through the experiment it was found that aspirator was able to achieve 1 to 2 mg/l dissolved level while meeting the regulators requirement on biochemical oxygen demand level. In the terms of electricity, aspirator needed the lowest consumption compared to the other type of device system. A detailed study on costing was done for the last 6 months in term of operating and maintenance on the aeration device and was found that aspirator was the cheapest to maintain compared to the others. While meeting the biochemical oxygen demand standard as require by the regulators, this outcome of the study would be a crucial factor when selecting a suitable aeration device in sewerage industry in future.

ABSTRAK

Kadar resapan oksigen merupakan faktor yang paling penting semasa pemilihan peralatan untuk pengudaraan Faktor-faktor lain termasuk realiabiliti, servisabiliti, kos pembelian, kos peralatan sampingan serta kos operasi dan penyelenggaran. Walaupun terdapat berbagai-bagai sistem direkabentuk untuk mengudarakan serta mengadunkan kumbahan, ia berbeza dari segi kecekapan dalam menghasilkan oksigen yang setara. Tujuan projek ini adalah untuk menilai kecekapan pelbagai jenis peralatan pengudaraan melalui bacaan oksigen terlarut serta perbelanjaan penyelenggaraan dan operasi setiap loji kumbahan. Untuk mencapai objektif ini satu kajian telah dijalankan terhadap lima jenis peralatan aeration yang berbeza iaitu "*brush aerator", "tornado", "surface aerator", "aspirator*" serta diffusers yang terdapat pada lima loji kumbahan tersebut yang mempunyai penduduk setara sekitar 2500. Melalui kajian ini, telah terbukti bahawa *aspirator* mampu mencapai oksigen terlarut "dissolved oksigen" sebanyak antara 1 mg/L hingga 2 mg/L. *Aspirator* juga menggunakan kadar elektrik yang rendah berbanding dengan peralatan pengudaraan yang lain. Satu kajian perbelanjaan terperinci telah dijalankan selama enam bulan untuk penyelenggaran peralatan pengudaraan dan terbukti bahawa *aspirator* merupakan peralatan yang paling murah untuk diselenggarakan. Keputusan dari kajian ini merupakan faktor terpenting dalam pemilihan peralatan pengudara "*aeration*" yang sesuai dalam industri pembetungan pada masa hadapan.

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INTRODUCTION

1.1 MALAYSIAN SEWERAGE SYSTEM

An effective sewerage system ensures sewage being treated and disposed in a safe manner. Sewage includes human waste, urine and wastewater from kitchens, bathrooms and laundries. Sewerage systems are designed to collect, transfer, treat and dispose of human waste and wastewater. The system serves government, domestic, commercial and industrial properties in economical and environmentally responsible manner.

In some countries the sewerage systems are designed to treat commercial and industrial sewage, toxic waste and manufacturing waste. However Malaysia's sewerage system treats only human waste and household wastewater. Industrial and trade waste is treated separately by on site industrial waste treatment plant. None of the industrial waste or trade effluent is allowed to be discharged into existing sewerage system.

1.2 IMPORTANCE OF A SEWERAGE SYSTEM

In certain places in Malaysia, where there are no sewerage systems, sewage ends up in waterways. This is usually due to toilets discharging straight into the waterways or sewer pipes discharging into the sea. Irrespective of the manner, in which the sewage ends up in our waterways, it can have detrimental effects on public health and the environment. Untreated human waste may carry infectious pathogenic organisms into our rivers. Such polluted rivers cause the spread of diseases like cholera, typhoid and hepatitis A. polluted rivers will contaminate sea life, particularly fish, cockles and prawns. People who eat this contaminated seafood can become seriously ill. Incidents of waterborne diseases such as these are not uncommon in Malaysia and have often been traced to sewage contaminated waters.

Other than the tremendous public health risk that untreated sewage poses, it also pollutes our environment. This is because sewage is able to consume oxygen normally found dissolved in river water, for example, will mean that eventually the river will lack sufficient oxygen to allow aquatic life and plants to survive.

As a result of this, there will be drop in supply of seafood and aquatic plants. Aquatic plants produce oxygen, which keep the river alive. This vicious cycle will eventually result in the river being “dead”. A dead river emits an unpleasant odor, is unsightly, poses a health risk and does not support any plant or animal life.

Sadly enough, today 72% of the rivers in Malaysia are polluted and 65% of all pollution loads has been identified as raw sewage. A step towards keeping our rivers clean is to treat all the sewage that is generated by the community.

1.3 SEWERAGE SYSTEM

A modern and efficient sewerage system is vital of a developing nation such as ours if we are to successfully move towards Vision 2020. A reliable system will not only ensure that our increasing population is kept away from unnecessary health risks but also that our water resources are preserved for future generations.

Sewage comprises of various pollutants that enter the sewerage system from domestic, commercial and industrial premises. It is more than just what goes down a toilet as it also includes wastewater from kitchen, bathrooms and laundries.

Many of our activities at home generate pollutants that find their way into the sewerage system. Unless treated at a sewage treatment plant, raw sewage and pollutants can end up in our drains, rivers and coastal water. It risks public health, contaminating water resources and polluting the environment.

In Malaysia, sewerage systems range from simple toilets providing little or no treatment to sewage to modern sewage treatment plants that employ mechanical means to treat large volumes of sewage to acceptable environmental standards.

WHAT ENTERS THE SEWERAGE SYSTEM FROM HOUSEHOLDS

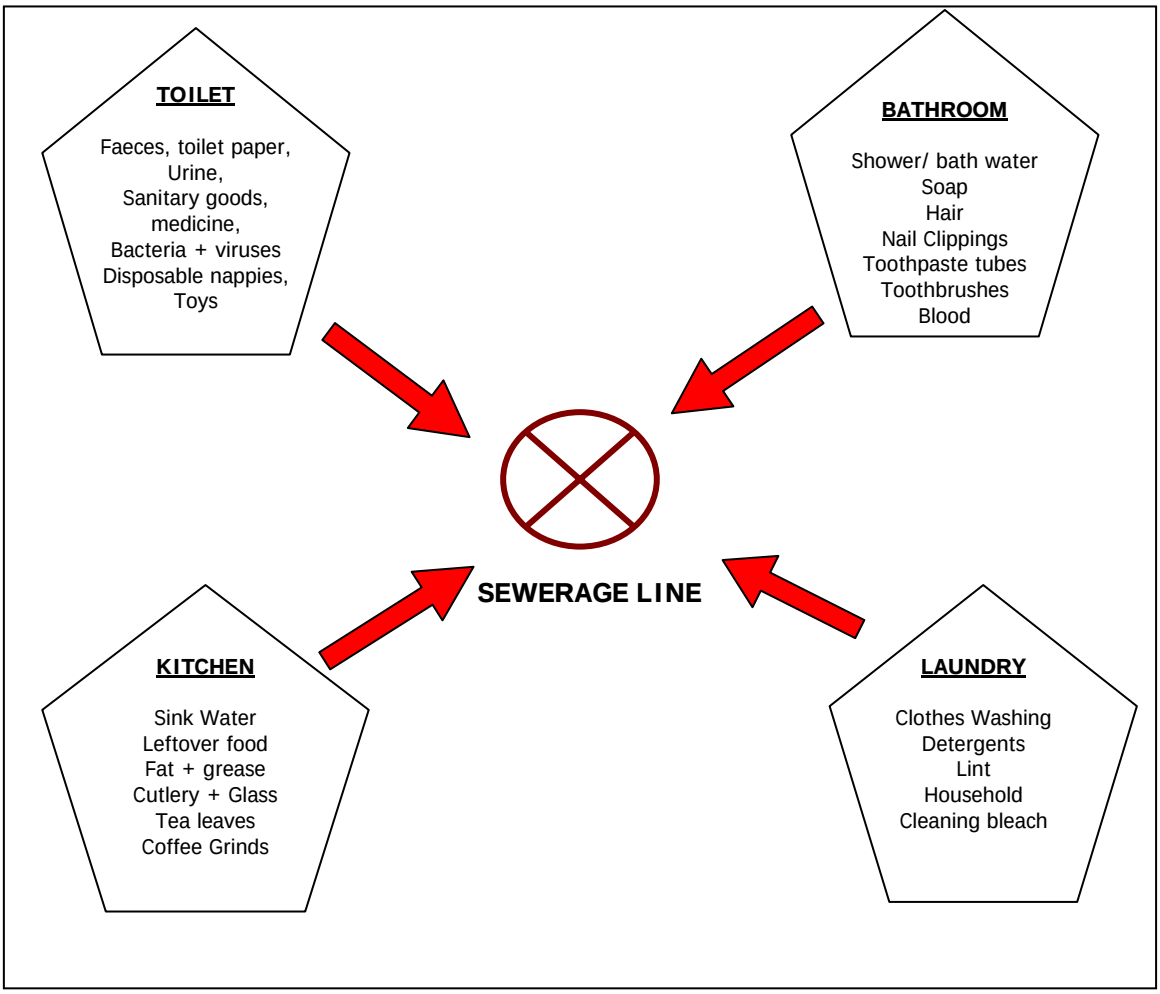

Figure : 1.1: - Source : Indah Water Konsortium 1998

There are various sewerage systems that produce effluent of different standards. There are simple toilets, where sewage undergoes no treatment causing it to be highly damaging to our environment, to the more modern mechanical plants that are able to produce Standard "A" effluent. Sewerage systems can be categorized into two board categories that are unconnected sewerage systems and connected sewerage system.

1.4. UNCONNECTED SEWERAGE SYSTEMS (TRADITIONAL TOILETS)

Simple toilets come under this category. These toilets were very popular before the modern day toilets came into the scene. Depending on its make, there are two types of traditional toilets. Firstly, toilets that do not treat the sewerage and secondly, toilets that partially treat the sewage.

1.5. CONNECTED SEWERAGE SYSTEMS

In connected sewerage systems, sewage outlets from a number of premises are connected to a sewage treatment plant via a network of underground sewer pipes. Modern and efficient sewage treatment plants are the best way to treat sewage. Connected sewerage system generally comprise of a network of underground sewer pipes, pump stations, sewage treatment plants and sludge treatment facilities. Connected sewerage system generally operates by gravity so sewage treatment plants should be located at the outlet of drainage catchments to capture all the sewage from the catchments without the need for costly pumping.

1.6. MECHANICAL PLANTS

In Malaysia, 11% of treatment plants are made up of various types of mechanical plants. These plants run on mechanical equipment that accelerates the breakdown of sewage. In the long term it is hoped that Malaysia's sewerage system will be made more efficient by standardising the types of plants used.

The diagram below shows an extended aeration plant where air is bubbled through sewage to accelerate the breakdown of sewage by bacteria.

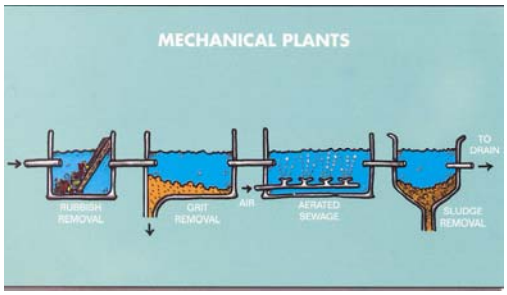

Figure : 1.2.: - Source : Indah Water Konsortium 1998

1.7. MONITORING EFFLUENT

Various pollutants in sewage are analyzed in order to understand how sewage should be treated and to examine the effect of treated sewage (effluent) on the environment.

Effluent from all sewage treatment plants is sampled at regular intervals and analyzed in modern laboratories to ensure it complys the required standards. These tests are carried out as part of a monitoring programmed to ensure that Indah Water meets its operational license conditions and that its' treatment processes are operating efficiently. This provides for a cleaner and safer environment that improves the living conditions of Malaysia.

The two most important parameters measured are biological oxygen demand (BOD) and suspended solids (SS). BOD is a measurement of the amount of oxygen sewage will consume over a given time. High BOD means that sewage will rapidly consume all the oxygen naturally dissolved in streams, rivers and lakes killing all aquatic life and turn the water septic and smelly. SS is a measurement of the undissolved material in sewage. High SS leads to sludge deposit in the waterways causing significant environmental degradation.

Table 1.1.: – Effluent Standard by Environmental Quality Act (1974)

	Biochemical Oxygen Demand (BOD)	**Suspended Solids (SS)**	**Oil & Grease**	**COD**
STANDARD A	20 mg/L	50 mg/L	0 mg/L	50 mg/L
STANDARD B	50 mg/L	100 mg/L	10 mg/L	100 mg/L

If the effluent is discharged upstream of a water supply intake point, it should meet Standard A. For effluent that is discharged downstream, it should meet Standard B. These standards are set by the Environmental Quality Act (1974).

1.8. OBJECTIVE

The objective of this study is to determine the most effective aeration device in wastewater industry by monitoring their oxygen transfer and costing which includes operational and maintenance cost, the capital cost and electricity consumption of each and every aeration device.

1.9. SCOPE OF STUDY

The study consists of a thorough experimental work at five sewerage treatment plants using five sewerage treatment plants with five different aeration devices. The five sewerage treatment plants were observed based on their oxygen transfer level. It was carried out by using dissolved oxygen meter on a daily basis for one week. During the experiment, five sewerage treatment plants sampling were carried out in order to monitor the BOD level. These would enable to verify the most efficient aeration device while meeting the Standard as required by the regulators.

There was also a study on the energy saving of different type of aeration device. It was carried out by monitoring the electricity consumption of aeration device for a period of six months. Capital cost and the operation and maintenance cost were also taken into consideration as factors before deciding the most effective aeration device.