WASTEWATER TREATMENT USING COMBINATION OF STAINLESS STEEL MEMBRANE AND ADSORPTION SYSTEM

SITI SARRAH BINTI RIDZUAN

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Bachelor of Chemical Engineering

FACULTY OF CHEMICAL ENGINEERING AND NATURAL RESOURCES
UNIVERSITY COLLEGE OF ENGINEERING AND TECHNOLOGY
MALAYSIA

JANUARY 2006

I declare that this thesis entitled "wastewater treatment using combination of stainless steel membrane and adsorption system" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	: ....
Name	: SITI SARRAH BINTI RIDZUAN
Date	: 27 NOVEMBER 2006

To my beloved mother, father and friends

ACKNOWLEDGEMENTS

First of all, I would like to express my highest gratitude to ALLAH S.W.T for showing me the right direction, gave me the strength, and allow me to complete this Final Year Project.

I would like to thank the project supervisor, Mdm Azilah binti Abd. Aziz@Ajit for being very helpful all this times. All her advices, encouragement, help and flexibility will be very much appreciated.

I would also like to thank my father and my mother for all the support and encouragement they gave me in all my way to finish this final year project. I also like to thank my brothers and sisters for gave me many support from early stages until I finish this project.

I would like to save this last fragment of appreciation to course mates and friends especially Faradilla and Hazlila for their guidance, encouraging words and most importantly always give me moral support.

ABSTRACT

A fabricate design of combination membrane filtration and absorption system was used to treat palm oil waste to comply with standard B in regulation of environment act, 1974. This systems as adopted was found to be an efficient method to remove parameters in palm oil waste. The parameters that involves in this study are BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), pH, TDS (Total Dissolve Solid) and turbidity. From this experiment, the comparison effectiveness between only using membrane filtration and using a combination of stainless steel membrane (membrane filtration) with adsorption columns (adsorption system) can be proven. The adsorbents used in the columns were activated carbon, activated alumina, rice husk and wood waste. The best types of adsorption columns can be determine from this experiment. The columns having a diameter of 6 cm with bed depth 500 cm could treat COD and BOD at average 81.3 % and 79.55%. Effect of flow rate, blank concentration and amount adsorb were studied.

ABSTRAK

. Dalam penyelidikan ini, satu alat telah direka dengan menggabungkan sistem penapisan membran dan kolum penyerapan bertujuan merawat air buangan industri kelapa sawit supaya mematuhi Peraturan Kualiti Alam Sekitar Piawaian B, 1974. Sampel bahan buangan ini di ambil dari Kilang Kelapa Sawit di Lepar Hilir. Sistem ini telah dikaji dan merupakan salah satu cara yang berkesan dalam mengurangkan parameter yang terdapat di dalam buangan kelapa sawit. Parameter yang terlibat dalam penyelidikan ini adalah BOD, COD, pH, TDS dan kadar telus cahaya (turbidity).Dari eksperimen yang dijalankan, perbandingan di antara keberkesanan sistem penapisan membran dan gabungan di antara membran besi tahan karat (penapisan membran) dan kolum penyerapan(sistem penyerapan) dapat dibuktikan.Agen-agen yang digunakan pada kolum adalah karbon, alumina, hampa padi dan sisa kayu. Kolum penyerapan yang terbaik boleh didapati. Parameter yang digunakan dalam penyelidikan ini adalah BOD, COD, pH, kadar telus cahaya(turbidity). Dari eksperimen ini, keefektifan menggunakan membran sahaja atau kombinasi membran dan kolum penyerapan dapat diketahui. Selain itu, kolum penyerapan terbaik juga dapat dikesan melalui eksperimen ini. Kolum-kolum ini mempunyai diameter 60 cm dan ketinggian 500 cm; dapat merawat COD dan BOD pada kadar purata 81.3 % dan 79.55%. Kesan kadar halaju, kepekatan asal bahan dan jumlah kadar penyerapan turut dikaji.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

µl	-	Microliter
ml	-	Mililiter
°C	-	Degree Celcius
w/v	-	Weight per Volume
%	-	Percentage
g	-	gram

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Introduction

Wastewater from industry and agriculture has an impact on environmental conditions in rivers and coastal waters. Discharges of wastewater add to the general nutrient load contribute to eutrophication problems in rivers and coastal waters. The impacts of industry and agriculture wastewater include the unsightly littering of the rivers, creating foul smells and potential health hazard. Continued pollution may threaten the survival of aquatic life in rivers. Wastewater treatment is important to keep environment healthy and clean.

In this study, wastewater sample is collected from Lepar Hilir Palm Oil Industry. This study was focus on treated the wastewater samples to comply with standard B in regulation of environment quality act, 1974 before it can be release to discharge. This waste is treated using membrane filtration and adsorption system. A filtration through a stainless steel membrane and an adsorption system with adsorption columns will be applied in this study. This method gets rid of almost all bacteria, reduces turbidity and color, removes odors and removes most other solid particles that remained in the water. Organic particles in the wastewater also can be removed.

For the filtration system, a stainless steel membrane is used. Membrane is a micro-filtration material. It can remove solid and heavy metal that are common found in wastewater. This membrane – filter technique can be used to reduces the amount of dissolved solid.

The adsorption columns are design to remove the suspended and floatable materials and also to treat of biodegradable organic in the domestic wastewater. The column will be design due to the characteristic of absorbents and the flow rate of feed. There are four adsorption columns with four different adsorbents.

1.2 Problem Statement

Waste needs to be treated in order to keep our environment clean. Untreated waste also may lead to an unhealthy environment for human and living things. In this research the waste samples are collected from Lepar Hilir Palm oil Industry. Palm oil waste may not save to release to environment if it doesn’t treat. To solve this problem, waste need to be treated before it is allowed to release to the drain system. A treatment using a fabricate design of a membrane filtration and adsorption system had been suggested in this research.

1.3 Objective

To treat a palm oil waste by using combination of stainless steel membrane and absorption system to comply with standard B in regulation of environment act, 1974.

1.4 Scope

To achieve this objective scopes have been made;

1) Compare the effectiveness between only using membrane filtration and using a combination of membrane filtration with adsorption system.

2) To develop a numbers of adsorption column and find the most effective adsorption column in treating the wastewater to comply with standard B.

CHAPTER II

LITERATURE REVIEW

2.1 What is palm oil wastewater?

Wastewater is the combination of liquid and water-transported wastes from homes, commercial buildings, industrial facilities, and institutions, along with any groundwater infiltration and surface water inflow that may enter the drain and sewage system. Palm oil industry requires a large amount of water for its operation and discharges considerable quantities of wastewater. Wastewater from palm oil mills is often discarded in disposal ponds, resulting in the leaching of contaminants that pollute the groundwater and soil.

2.1.1 Characteristic of wastewater

Physically, wastewater is characterized by color, odor, solids and temperature. Wastewater usually smells like rotten egg and the color is typically gray. Total solids of wastewater can be further classified as *suspended* (nonfilterable) or *dissolved* (filterable) when all the matter lost during evaporation and not defined as solid. Wastewater temperatures normally range between 10 and 20 ^oC.

Chemically, characteristic of domestic wastewater is present in gases, organic and inorganic matter. Organic compounds are normally composed of a combination of carbon, hydrogen, and oxygen, together with nitrogen in some cases. The principal groups of organic substances found in wastewater are proteins (40 to 60 percent), carbohydrates (25 to 50 percent), and fats and oils (10 percent). The concentrations of inorganic substances in water are increased both by the geologic formation with which the water comes in contact and by the wastewaters, treated or untreated, that are discharged to it. Gases commonly found in untreated wastewater are nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), hydrogen sulfide (H_2S), ammonia (NH_3) and methane (CH_4).

2.2 Wastewater Treatment

Currently palm oil wastewater is being treated using several combination or modified unit operations and processes to form a wastewater treatment system, which suited the requirements of palm oil mill under consideration.

Wastewater treatment methods may be classified into three which are;

a) Physical unit operations

b) Chemical unit processes

c) Biological unit processes.

Preliminary or Primary Treatment refers to physical unit operations and is the first stage of treatment applied to any sewage or domestic wastewater. Preliminary sewage treatment is defined as the removal of sewage. This includes screening and comminuting (grinding) for the removal of debris and rags, grit removal by sedimentation and flotation for the removal of excess oil and grease. It removes some of the suspended solids and organic matter. The effluent from primary treatment will contain high amounts of organic matter.

Secondary Treatment refers to biological and chemical unit processes. Secondary wastewater treatment is directed at the removal of biodegradable organic and suspended solids, mainly using biological unit processes. Disinfections may be included in secondary wastewater treatment.

Tertiary refers to combinations of all three. It includes the removal of nutrients, toxic substances including heavy metals and further removal of suspended solids and organic. Effluent from tertiary treatment is of a high standard and suitable for reuse. There is no plan to build tertiary treatment systems in Malaysia.

2.3 Adsorption

Adsorption is a chemical process that takes place when a one or more component liquid or gas (adsorbate) accumulates on the surface of a solid (adsorbent), forming a molecular or atomic film and the separation is complete. The process of adsorption involves separation of a substance from one phase accompanied by its accumulation or concentration at the surface of another. The adsorbing phase is the adsorbent, and the material concentrated or adsorbed at the surface of the phase is adsorbate.

The binding to the surface is usually weak and reversible. Just about anything including the fluid that dissolves or suspends the material of interest is bound, but compounds with color and those that have taste or odor tend to bind strongly. From Figure 2.1, it shows a separation of molecules when it pass through adsorption filtration process. The dissolved organics are bounding to the adsorbent while amount of dissolved inorganics, particles and bacteria is reduced.

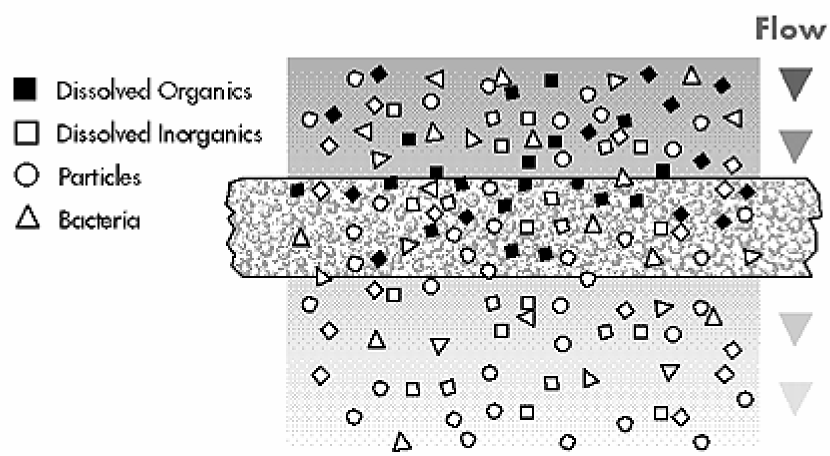

Figure 2.1: Adsorption process (Source: Freedrinkingwater html)

Adsorption phenomena are operative in most natural physical, biological, and chemical systems. Adsorption operations employing solids such as activated carbon and synthetic that is widely used in industrial applications and for the purification of waters and wastewaters. Decolorization can be wonderfully efficient by adsorption and with negligible loss of other materials.

2.3.1 Adsorption System

The configuration of the adsorption system, which the fluid (feed) and solid (adsorbent) are contacted; is divided into three main categories:

a) Batch

The use of an adsorbent in a batch process represents the simplest possible mode of operation. However, it's inefficient. Batch adsorption is often used when the quantities treated are small in amount, as in the pharmaceutical or other industries.

In its simplest form the process consists of contacting a whole volume of feed solution with a quantity of adsorbent in a vessel. The mixture is stirrer or otherwise agitated to facilitate mass transfer. After a prescribes period of time, generally when equilibrium has been attained, the adsorbent and solution are separated, usually by filtration, decantation or centrifugation. (Fox and Kennedy, 1985)

b) Fixed bed

The fixed bed which is vessels and columns, holds the adsorbent in a fixed position. In fixed bed, adsorbate is continuously in contact with a given quantity of fresh adsorbent thus providing the required concentration gradient between adsorbent and adsorbate for adsorption. Adsorption beds may be arranged in series or parallel.

c) Moving bed

Solid liquid adsorption can be carried out in pulsed bed or moving bed in which some carbon is removed from the bottom of the column at a constant time intervals and are replaced by fresh adsorbent. This type has an advantage of better utilization of adsorbent, because the adsorbents were kept for regeneration as soon as the adsorbent gets saturated.

The moving bed adsorption column is a steady state countercurrent operation since the adsorbent solid is moving downward through the column while the liquid is flowing upward. It is a common method of operation and is most widely used in most of wastewater treatment plants

2.3.2 Adsorption column

In this study, a fixed-bed adsorption column will be used in research design. In a down flow mode, where the column will perform dual operation of adsorption and filtration. Adsorption column is comment used in adsorption. There are advantages and also disadvantages in this method.

Advantages

- Equipment is simple and relatively inexpensive to fabricate.
- Minimal attraction of adsorbent occurs when it remains fixed in position
- Lead bed can be exhausted fully so it will be more cost-effectively in achieving a desired system.

Disadvantages

- As fluid is passed through a fixed bed of adsorbent the transfer of adsorbate molecules from the feed to the solid initially occurs at the bed entrance. Once the adsorbent in this region becomes saturated with adsorbate molecules, the zone in which the mass transfer occurs moves progressively through the bed towards the exit.

- Adsorption is always an exothermic process and desorption can therefore be affected by raising the temperature of the adsorbent.

2.4 Adsorbent

An adsorbent is a substance, usually porous in nature and with a high surface area that can adsorb substances onto its surface by intermolecular forces. The adsorbents are used usually in the form of spherical pellets, rods, moldings or monoliths with hydrodynamic diameter between 0.5 and 10 mm The most common industrial adsorbents are activated carbon, silica gel, and alumina, because they present enormous surface areas per unit weight.

2.4.1 Activated Carbon

Carbonaceous materials have long been known to provide adsorptive properties that could used to remove tastes, colors and odors from water. They are highly porous with a large specific surface area and have excellent adsorption properties. Activated carbons are used widely in industrial applications that include decolorizing sugar solutions, personnel protection, solvent recovery, volatile organic compound control, hydrogen purification and water treatment.

Bulk Density	22-34 lb/ft^3
Heat capacity	0.27-0.36 Btu-lb^0F
Pore volume	0.56-1.20 cm^3/g
Surface area	600-1600 m^2/g
Average pore diameter	15-25 A
Regeneration temperature	100-14^0C
Maximum allowable temperature	150^0C

Table 2.1: Properties of activated carbon

Table 2.1 shows the properties of activated carbon. Activated carbon have a large surface area which contribute to a high adsorb capacity. There are various types of activated carbon in market due to size categories as shows in Figure 2.4.

Figure 2.2: Activated carbon (Source: Indiamart html)

2.4.2 Activated alumina oxide

Activated alumina is a porous high area form of aluminium oxide with the formula $Al_2O_3.nH_2O$. Its surface is more polar than that of silica gel and, reflecting the atmphoteric nature of aluminium, has both acidic and basic characteristics. Because activated alumina has a higher capacity for water than silica gel at elevated temperatures it is used mainly as a desiccant for warm gases including air. Gases for which activated alumina is suitable include argon, helium, hydrogen, low molecular weight alkanes (C_1-C_3), chlorine, hydrogen chloride, sulphur dioxide, ammonia and fluoroalkanes. Other uses for alumina include chromatography and drying of liquids such as kerosene, aromatics, gasoline fractions and chlorinated hydrocarbons

Bulk Density	38-42 lb/ft^3
Heat capacity	0.21-0.25 Btu-lb^{0}F
Pore volume	0.29-0.37 cm^3/g
Surface area	210-360 m^2/g
Average pore diameter	18-48 Armstrong
Regeneration temperature	300-250^{0}C
Maximum allowable temperature	500^{0}C

Table 2.2: Properties of Activated Alumina

From table 2.2, the advantage of using activated alumina is it can operates at a high temperature as high 500 ^{o}C. Granural activated carbon as shows at Figure 2.5 is an example of activated alumina that available in market

Figure 2.3: Granular activated alumina (Source: Indiamart html)

2.4.3 Wood-based

Biomass material is an economic way to produce an activated carbon. Activated carbon can be produce by various of carbonaceous material. It made by thermal decomposition followed by activation process. The table below showed the characteristic of activated carbon based on wood.

Table 2.3: Properties of wood-based activated carbon

Bulk density (kg/m^3)	290-390
Surface area (m^2/g)	882
Mean pore diameter (A^o)	30.61
Micropore vol (cm^3)	0.34
Mean diameter (μm)	19.72
Iodine number (mg/(g min))	900

2.4.4 Rice Husk

Rice Husk is one of the biomass that can be easily found in Malaysia. It’s one of carbonaceous material. Rice husk as a possible source of highly porous carbon adsorbent. Preliminary results show relatively high surface area with a high percentage of microporous structure. Table 2.3 below showed the characteristic of activated carbon based on rice husk.

Bulk density (kg/m^3)	350-500
Surface area (m^2/g)	1198.6
Mean pore diameter (A^o)	30.41
Micropore vol (cm^3)	0.067
Mean diameter (μm)	34.15
Iodine number (mg/(g min))	900

Table 2.4: Properties of rice husk activated carbon

2.5 Membrane

The word membrane is a Latin's word which is membrana and its means skin. Membranes are used in solid-liquid separation in two different manners. For one, impermeable rubber or plastic membranes are employed in the mechanical press demoisturing of sludges in membrane filter presses. Alternatively, permeable membranes are used as porous filter medium in microfiltration and ultrafiltration. The pore size is generally located in the sub-μm region. Filtration membranes are offered in a large varity of materials and have to be carefully adjusted to the product to be filtered, in order not to clog too early and thus become inoperable.

2.5.1 Membrane Separation Process

Membrane separation is the most advanced filtration technology utilized for removal of micron, sub-micron and ionic species that pollute any water stream. Semi-permeable membrane of different materials, pore sizes and configurations are typically utilized to "filter" out the undesirable impurities. Membrane materials such as Cellulose Tri-acetate (CTA), Thin Film Composite (TFC), Polyamide (PA), Polysulfone, etc. are most common. Membrane Pore Size range from 1-10 Angstrom for Reverse Osmosis (RO) membrane to 10^3 - 10^4 Angstrom for the Micro Filtration (MF) membrane. There are several membrane element configurations commercially available, such as Spiral Wound (SP), Hollow Fine Fiber (HFF) and Tubular type.

2.5.2 Crossflow Filtration

This is a process in which organics and dissolved salts are removed. Because the feed and concentrate flow parallel to membrane surface instead of perpendicular to it, the process is called "Crossflow" or "Tangential Flow". Crossflow filtration as shows in Figure 2.6 is achieved using a semi-permeable membrane in which feedwater flows under pressure, parallel to the membrane surface. A portion of the feedwater permeates (or Filters) through the membrane, forming the Permeate (or Filtrate) stream, which represents the Product Water, and leaving the majority of dissolved solids and organics filtered behind to form higher concentrations in the feedwater stream. The balance of feedwater becomes enriched with dissolved solids and organics as more permeate is formed. The balance of concentrated feed flows tangential to the membrane surface, forming the Concentrate (Reject) stream.

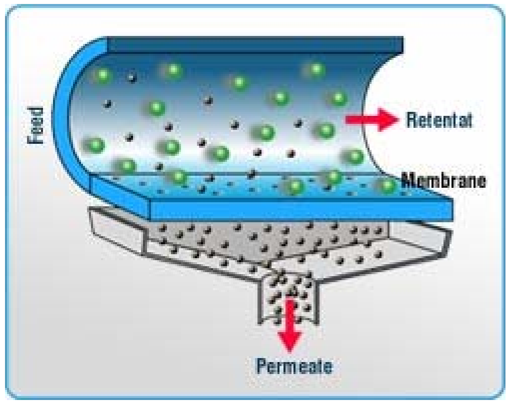

Figure 2.4: Crossflow filtration (Source: Alting html)

Depending on the membrane pore size, Crossflow filters are effective in the range of high ions rejection as in the case of Reverse Osmosis, selective ion rejection for Nanofiltration, low ion rejection for Ultrafiltration, or no ion rejection but suspended solids removal for Microfiltration.

a) Microfiltration

A type of surface filtration where porous membranes, generally with a pore diameter of less than 5µm, are employed either in crossflow or dead end made of operation. Microfiltration is applied in polishing and concentrating of suspensions that contain a large amount of submicron size particles.

b) Nanofiltration

Also known as "Membrane Softening" process. It employs less tight skin membranes with larger pore size, where 60-80% of all ions are rejected, 90-95% of Divalent Ions are removed, and Organic compounds in the 300 to 1000 molecular weight range are eliminated. In the Nanofiltration process more water normally passes at a lower pressure, compared to the RO process. Pressure in the in the order of magnitude of 100 to 200 psig is typically required to economically soften water without the pollution of salt-regeneration experienced with the resin softening process.

c) Reverse Osmosis

Also known as "Hyperfiltration" process. It employs the tightest skin membranes with smallest pore size, where 90-99% of all Ions are rejected, more than 99.9% of Viruses, Bacteria and Pyrogens are removed, and virtually all Organics are eliminated. Pressure in the order of magnitude of 200 to 1,200 psig is normally required, for applications ranging from brackish water purification to seawater desalination.

d) Ultrafiltration

Is similar to the RO and NF processes, but is defined as a cross flow process that has no significant rejection of dissolved solids. It employs loose skin membranes with a relatively large pore size, where virtually no ions are rejected, but contaminants in the range of 10 Angstrom (0.1 Micron) such as Organics, Bacteria, and Pyrogens size are rejected, while most ions and small organics such as glucose are allowed to pass the membrane porous structure. UF process requires a much lower operating pressure in the range of 10 to 100 psig for the separation process to take place.

2.6 Parameters

2.6.1 Biochemical Oxygen Demand (BOD)

BOD is not a specific pollutant. BOD is a measure of the amount of oxygen required by bacteria and other microorganisms to oxidize any organic matter in the water biochemically. So BOD is an indirect measure of the concentration of organic contamination in the water. The more organic matter present, the greater the amount of oxygen that microorganisms will consume in oxidizing the wastes to CO_2 and H_2O. This process is called waste stabilization. BOD analysis dose not oxidize all of the organic matter present in the waste. Only the organics that are biochemically degradable during the standard 5 day time are oxidized. A very low mount of BOD would indicate either clean water, or that the available microorganisms are uninterested in consuming the available organic compounds, or that the microorganisms are dead or dying.

Temperature has a pronounced effect on oxygen uptake, because metabolic activity increases significantly at higher temperature. The time allotted for the test is also important, since the amount of oxygen used increases with time. Light is also an important variable since most natural waters contain algae and oxygen that can be replenished in the bottle if light is available.

The BOD test has been standardized to be run in the dark at incubator at 20 °C for 5 days. The 5-day BOD, or BOD_5 is the oxygen used by microorganisms in the water sample during the first 5 days after sampling. Scientifically, 5 days is a compromise between running the test long enough to get reproducible results and running it so long that anaerobic material and mold in the BOD bottles interferes. The BOD test is usually carried out in standard BOD bottle, about 300 ml volume. The test is begun by measuring the initial DO and final DO after 5 days.

2.6.2 Chemical Oxygen Demand (COD)

The equivalent amount of oxygen required to oxidize any organic matter in a water sample by means of a strong chemical oxidizing agent is called chemical oxygen demand. Because nearly all organic compounds are oxidized in the COD test and only some are decomposed during the BOD test, COD values are always higher than BOD values. One example of this is wood pulping waste, in which compounds such as cellulose are easily oxidized chemically (high COD) but are very slow to decompose biologically (low BOD).

Potassium dichromate ($K_2Cr_2O_7$) is generally used as an oxidizing agent, in a moderately concentrated sulfuric acid (H_2SO_4). These were added to a measured amount of sample, a catalyst (silver sulfate) is added to assist in the reaction and a complexing agent, mercuric sulfate. This mixture is boiled at 105°C for 2 hours, a process termed chemical digestion. This oxidize practically all of the organic carbon to CO_2 and H_2O. However, as in the BOD analysis ammonia is not oxidized. In this reaction, the oxidizing agent is hexavalent chromium, which is itself reduced to trivalent chromium. The reaction, which includes excess oxygen is

$$C_xH_yO_z + Cr_2O_7^{2-} + H^+ \longrightarrow CO_2 + H_2O + Cr^{3+}$$

Where $C_xH_yO_z$ is ageneral expression for the organic compounds in question. The carbonate equilibrium results in some carbonate escaping from the reaction mixture as CO_2. After boiling the excess Cr^{+6} remaining is titrated against a reducing agent, usually ferrous ammonium sulfate. The difference between the Cr^{+6} initially added as dichromate and the Cr^{+6} remaining is the chromate used to oxidize the organic compounds. COD is then proportional to the chromate Cr^{+6} used. [To determine the amount of COD present in the sample, measure the Cr^{+6} remaining after the digestion and compare this amount to the initial amount of Cr^{+6}. The difference between the two is the COD of the sample.

The preservation of COD is same with BOD where it needs to use a plastic or glass container and need to preserve in cool condition which is 4 ^{o}C but in COD condition H_2SO_4 need to be added to reach pH under 2. The maximum of holding time of COD sample is 28 days while for BOD is 48 hours,

2.6.3 PH

PH is measured in order to know the acidity of the wastewater. A high acidity or low may be harm for human even to any living things. In standard B, the parameter limit is 5.5 – 9.0 pH. The parameter needs to be measure at the sampling point.

2.6.4 Temperature

Wastewater temperatures normally range between 10 and 20°C. In general, the temperature of the wastewater will be higher than that of the water supply. This is because of the addition of warm water from households and heating within the plumbing system of the structure. Depending on the geographic location, the mean annual temperature of wastewater varies.

The temperature of water is a very important parameter because of its effect on chemical reactions and reaction rates, aquatic life, and the suitability of the water for beneficial uses. Increased temperature, for example, can cause a change in the species of fish that can exist in the receiving water body.

In addition, oxygen is less soluble in warm water than in cold water. The increase in the rate of biochemical reactions that accompanies an increase in temperature, combined with the decrease in the quantity of oxygen present in surface waters, can often cause serious depletion in dissolved oxygen concentrations in the summer months.

Optimum temperatures for bacterial activity are in the ranges from about 25 to 35°C. Aerobic digestion and nitrification stop when the temperature rises to 50°C. When the temperature drops to about 15°C, methane-producing bacteria become quite inactive, and at about 5°C, the autotrophic-nitrifying bacteria practically cease functioning. In standard B, the parameter limit of effluent is 40 ^{o}C.

2.6.5 TDS (Total Dispense Solid)

Analytically, the Total solids content of a wastewater is defined as all matter that remains as residue upon evaporation at 103 to 105°C Matter that has a significant vapor pressure at this temperature is lost during evaporation and is not defined as a solid. Settleable solids are those solids that will settle to the bottom of a cone-shaped container, called an Imhoff cone.

Total solids can be further classified as suspended (nonfilterable) or dissolved (filterable), by passing a known volume of sample through a glass-fiber filter (Whatman GF/C). If suspended solids are to be determined, the filter is dried and preweighed, a measured volume of sample is drawn through it, and it is dried and reweighed. The increase in weight divided by the volume of the sample yields the concentration of suspended solids. A measured volume of the filtrate may be evaporated to dryness and the residue weighed to determine the dissolved solids mass. This, divided by the sample volume, will give the dissolved solids concentration.

Each of the categories of solids may be further classified on the basis of their volatility at 550 ± 50°C. The organic fraction will oxidize and will be driven off as gas at this temperature, and the inorganic fraction remains behind as ash. Thus the terms volatile suspended solids and fixed suspended solids refer, respectively, to the organic and inorganic (or mineral) content of the suspended solids.
In this study, the parameter is focus on suspended solid. In standard B, the limit of effluent is 100 mg/L. this parameter is monitor by on-site where the parameter is measured at the sampling point.

2.6.6 Turbidity

Turbidity, a measure of the light-transmitting properties of water, is another test used to indicate the quality of waste discharges and natural waters with respect to colloidal and residual suspended matter.

The measurement of turbidity is based on comparison of the intensity of light scattered by a sample as compared to the light scattered by a reference suspension under the same conditions. Turbidity is monitoring by on-site which the parameter is measure at the sampling point.

CHAPTER III

METHODOLOGY

3.1 Introduction

Fabrication and experimental are the methods that used in this research. In this study, a fabrication on the research design is done by combining a membrane filtration with an adsorption system. The design is divided into two systems; system I and system II. System 1 is for membrane filtration system while system II is for adsorption system. A stainless steel membrane and adsorption columns are used in this system. There are 4 types of columns that contain different adsorbents which include bio-mass adsorbent and industrial adsorbents. In the experimental method, several experiments are done to determine the characteristic of the wastewater. It been done before and after running through the design equipment. The sample of wastewater is taken from Lepar Hilir Palm Oil industry which is a palm oil waste. The sample will be treated to comply with the standard B of environment quality act, 1974.