ASSESSMENT OF RAW AND COAGULATED LATEX WASTEWATER OF ENHANCE AERATION STABILIZATION BASIN (ASB)

: A BATCH STUDY

LUQMAN HAKIM BIN SHAWAL

SCHOOL OF CIVIL ENGINEERING
UNIVERSITI SAINS MALAYSIA
2019

ASSESSMENT OF RAW AND COAGULATED LATEX WASTEWATER OF ENHANCE AERATION STABILIZATION BASIN (ASB): A BATCH STUDY

By

LUQMAN HAKIM BIN SHAWAL

This dissertation is submitted to

UNIVERSITI SAINS MALAYSIA

As partial fulfilment of requirement for the degree of

BACHELOR OF ENGINEERING (HONS.)
(CIVIL ENGINEERING)

School of Civil Engineering,
Universiti Sains Malaysia

June 2019

UNIVERSITI SAINS MALAYSIA

SCHOOL OF CIVIL ENGINEERING
ACADEMIC SESSION 2017/2018

FINAL YEAR PROJECT EAA492/6
DISSERTATION ENDORSEMENT FORM

Title: Assessment of Raw and Coagulated Latex Wastewater of Enhance Aeration Stabilization Basin (ASB: A Batch Study

Name of Student: Luqman Hakim Bin Shawal

I hereby declare that all corrections and comments made by the supervisor(s) and examiner have been taken into consideration and rectified accordingly.

Signature:

____

Date :

Approved by:

____

(Signature of Supervisor)

Name of Supervisor :

Date :

Approved by:

____

(Signature of Examiner)

Name of Examiner:

Date :

ACKNOWLEDGEMENT

Alhamdulillah, I am able to finish my final year project with blessing of The Almighty. After all of the hardwork in this year, it is necessary to express my gratitude to my supervisor Dr. Mohamad Fared Murshed for willing to accept. His encouragement and cooperation really help me to finish my project successfully. His constructive comment plays an important part in enriched this research project. This study was supported by Universiti Sains Malaysia through Research University Grant (RUI), 1001/PAWAM/814259.

Besides that, I would also like to thank my parent as well for support and encouragement for me to complete the research. They always with me through thick and thin to kept goings to finish what I have started. Many thanks to my friends for teaching and help me a lot during laboratory works. Finally, really thanks to all technicians at environmental laboratory 1 and 2 for their guidance and knowledge in the laboratory works.

ABSTRACT

Kajian ini adalah kaedah rawatan pengudaraan untuk air sisa lateks mentah yang dihasilkan oleh produk pembuatan yang berasal dari syarikat peralatan pemprosesan lateks di Kamunting, Taiping. Air buangan lateks yang dihasilkan dalam kuantiti yang banyak tambahan kandungan COD dan BOD yang tinggi di mana boleh menyebabkan pencemaran air yang serius. Air buangan lateks adalah salah satu air sisa industry yang dihasilkan dari produk pembuatan yang berasal dari bahan pemprosesan lateks. Terdapat tiga proses rawatan untuk merawat air buangan iaitu rawatan fizikal, biologi dan kimia. Dalam kajian ini, hanya kaedah rawatan biologi dijalankan untuk merawat air buangan lateks dan kecekapan penyingkiran telah dibandingkan antara tiga keadaan proses pengudaraan. Proses pengudaraan telah dibahagikan kepada tiga keadaan iaitu pengudaraan sahaja, pengudaraan menggunakan bacteria dan pengudaraan selepas pembekuan. HRT yang ditetapkan untuk proses pengudaraan adalah 1 jam, 2 jam, 3 jam, 4 jam, 5 jam, 6 jam dan 24 jam. Proses pembekuan menggunakan ferric chloride sebagai koagulan. Semua efluen yang dirawat dari pengudaraan air kumbahan, pengudaraan air kumbahan dengan bakteria dan pengudaraan air sisa selepas proses pembekuan telah dibandingkan dengan pelepasan standard B untuk effluen perindustrian.

ABSTRACT

The study is a method of aeration treatment for raw latex wastewater produced by manufacturing product that originated from latex processing material devices companies in Kamunting, Taiping. Perak. Large quantities of raw latex wastewater which high in COD and BOD value causing serious water pollution. Raw latex wastewater is one of the industrial wastewater generated from manufacturing product that originated from latex processing material. There are three stages of wastewater treatment which is physical, chemical and biological treatment. In this study, only biological treatment was performed to treat latex wastewater and the efficiency of removal was compared between three condition aeration process. Aeration process divided into three different conditions which is aeration of wastewater, aeration of wastewater with bacteria and aeration of wastewater after coagulation. The hydraulic retention time (HRT) is fixed for the aeration process is 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours and 24 hours respectively. The coagulation process used ferric chloride as a coagulant. All the treated effluent from the aeration of wastewater, aeration of wastewater with bacteria and aeration of wastewater after coagulation process was compared to the standard B discharge for industrial effluent.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

HRT	Hydraulic Retention Time
COD	Chemical Oxygen Demand
BOD	Biochemical Oxygen Demand
SS	Suspended Solid
EM	Effective Microorganisms
DO	Dissolved Oxygen
DOE	Department of Environment
WW	Wastewater

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Malaysia is among the countries that produce largest amount of natural rubber in the world (Rosman et al., 2013) . Rubber industry plays an important role in social and economic aspect in Malaysia. Rubber industry plays an important role focussing on economy of Malaysia with foreign exchange by 30% derived from this crop (Mohammadi et al., 2010). Some environmental pollution due to daily discharge of about 80 milllion of untreated rubber effluent into the streams and rivers in Malaysia has been reported (Mohammadi et al., 2010).

The latex wastewater is one of the industrial production generated from manufacturing product that originated from latex processing material create large quantity of wastewater that causing serious water pollution. The large quantity of latex wastewater released in the water stream lead by drastic multiplication of rubber industries. Without proper treatment, the discharge of wastewater from rubber processing industries may cause a serious consequences. Therefore, higher effective treatment should be used for treating latex wastewater as this wastewater is heavily polluted with high in organic matter, BOD, COD, suspended solid, dissolved solids, heavy metal and odour (Omorusi and Irogue, 2013).

The treatment selected is Aerated Stabilization Basin (ASB) as a part of biological treatment of wastewater because of high efficiency treatment with low cost. ASB is manmade basins designed for the biological treatment of wastewater which is used to supply oxygen to the system where natural physical, chemical and biological process occur in ASB. Biological treatment of rubber wastewater is a method, which give the greatest reduction of BOD. Raw and natural rubber latex wastewater discharged from natural rubber manufacturing process is usually treated by stabilization pond known as aerobic pond at present (Hatamoto et al., 2012) . The model is designed focussing on aerobic condition and microbial action could reduce pollutant in wastewater.

1.2 Problem Statement

Latex wastewater production is one of the industrial waste that contributed to major water pollution. Latex industrial production such as medical device company usually produces wastewater that are causing serious polllution to water bodies and surrounding. Environmental pollution have been reported due to daily discharge of untreated rubber effluent about 80 million litres into the rivers in Malaysia (Babel and Rungruang, 2008). The wastewater were considered as heavy pollution because of high concentration of nitrogen in the effluent. The nitrogen content contributes to undesirable eutrophication, economic loses, mathemoglobinemia in infants and increase chemical and oxygen demands. The high levels of hyrogen sulphide (H_2S) cause malodour problem to surrounding. The odour can reach to several hundred miles downstream for the industrial place even at very low concentration (Mohammadi et al., 2010). The raw latex wastewater also have supended solid, acidity, high organic matter, nitrogen containing pollutant and smelly. The problem of biological treatment method is the dificulties on maintenance of microorganisms community. The maintenance of microorganisms is dificult because of high organic load of rubber processing wastewater causes microorganisms die. The microorganism must be observed carefully to prevent from die as influenced by many factor.

1.3 Objectives

From the problem statement, this research is expected to achieve following objectives:

a) To characterize raw and coagulated latex wastewater in aeration stabilization basin (ASB).

b) To determine the removal of Biochemical Oxygen Demand (BOD), Suspended Solid (SS), Turbidity and Color of raw and coagulated latex wastewater in aeration stabilization basin (ASB).

c) To compare the efficiency of removal for SS, BOD, Turbidity and Colour of three conditions of aeration which are aeration, aeration with bacteria and aeration after coagulation.

1.4 Scope of research

The study based on sample from the current Wastewaster Treatment Plant of Teleflex Medical Sdn. Bhd. in Kamunting, Taiping, Perak. The study focussing on the removal of BOD, Colour, SS and Turbidity among all three conditions of aeration process as stated previously in Section 1.3 based on different retention time. The experiment was conducted on a laboratory scale for aeration model tank.

1.5 Thesis Structure

The thesis for the reseach that has been carried out and divided into five chapter orderly. The first chapter is about introduction of research containing background study, problem statement, objectives and scope of research. Chapter 2 is about literature review that is related or similarity to research study. Then, Chapter 3 explained the research methodology of the research based on laboratory test and experiment were conduct during study to gain the data. Chapter 4 show the data and result from the experiments that have been done and evaluated to achieved the objective stated. Lastly, Chapter 5 provided recommendation for improvement in future and conclusion of the overall research study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Rubber industry plays an important role in Malaysia's economy as part of the main agaro-based industrial sectors currently. Malaysia was one of the world's biggest in productivity of natural rubber product alongside Thailand, Indonesia, Vietnam and India (Nguyen and Luong, 2012). Raw latex wastewater consider as wastewater that gives pollution to environment and lead to death of some aquatic organism living in water.The selection of the best combination of technologies to treat industrial effluent is a complicated process in which require some information must be taken into account such as expertise, human kind reasoning and experience (Ferella, 2018). Nowadays, Biological method and chemical method are frequently used to treat wastewater. Number of method of biological treatment processs like anaerobic-cum-facultative lagoon system, anaerobic-cum-aerated lagoon system, aerated lagoon system and oxidation ditch for the treatment of rubber wastewater have been developed. The performance of this method must be monitored frequently to achieved the standard of treated effluent and compatible with wastewater characteristics allowed.

2.1.1 Latex Wastewater Characteristic

Untreated latex concentrate effluent comprises a large quantity of water for washing and cleaning of raw materials, small amount of uncoagulated latex, and serum (protein, carbohydrate, lipid, carotenoids, and salt). Highly contaminated with serum contributed to high BOD, therefore this effluent when discharged into water course will deplete dissolved oxygen present in the water and eventually affect aquatic life (Idris et al., 2013).

Table 2.1 shows the result of characterization of raw latex wastewater from previous studies. The pH value showed that the raw latex characteristic can be alkaline and acidic too. Most of the highest value for BOD, COD and SS are obtained in a study by (Nguyen and Luong, 2012) which are 9536 mg/L, 18807 mg/L and1147 mg/L respectively. The elevated value of COD and BOD for raw rubber wastewater means the sample containing higher organic pollutant. Appropriate and efficient wastewater treatment is needed to treat the latex wastewater before it is released to water bodies. Discharging large amount of raw latex wastewater generated by latex industry directly into water bodies gave big impact to environment and also affected of human. In general, rubber wastewater has high concentration of ammonia, COD, BOD, phosporus, nitrate, organic matter and total solids. High level of ammonia and nitrogen could be contributes to undesirable eutrophication and lead to death of some aquatic organism living in water if discharged.

Table 2.1: Characterization of raw latex wastewater in previous study

Reference	**pH** **-**	**COD** **mg/L**	**SS** **mg/L**	**Colour** **PtCO**	**BOD** **mg/L**
Nguyen and Luong (2012)	8.74	18807	1147	-	9536
Mustafa (2018)	2.34-6.05	881-2222	91-433	611-4383	24-64
Idris *et al.* (2013)	3.7-5.5	3500-14000	200-700	-	1500-7000
Rosman *et al.* (2013)	7.5	2960	310	-	1380

2.1.2 Physical and chemical characteristic of wastewater

The latex wastewater can be characterized into biological, physical and chemical characteristics. The chemical characteristics of latex wastewater are Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), organic matter, pH and heavy metal concentration. Meanwhile, for physical characteristics of wastewater are temperature, turbidity, Suspended Solid (SS), colour and pH based on table 2.1. These parameter are among vital physical characteristic in wastewater to understand the condition of wastewater. Temperature and pH of sample needed to be taken on site as during transportation may change these two parameter. The rest characteristic be examined at the laboratory as there is no portable equipment available to measured these parameter. Colour is divided into two categories that are true color and apparent colour. Colour in the wastewater exists caused by dissolve and colloidal particle. Suspended solid is the particle which remain in suspension in water as a colloid due to the motion of water. Turbidity is cloudiness of a fluid caused by large amount of particle that invisible to naked eye. Chemical Oxygen Demand (COD) is the amount of specific oxidant that react with the sample under controlled. The quantity organic matter determined by rate of COD in wastewater. If the value of COD is higher means that sample comtaining higher organic pollutant. COD is recommended as its able to determine the toxicity and organic matter compared to BOD (Mohammadi et al., 2010). Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen demanded by aerobic biological organisms to break down organic material present in wastewater. BOD test require 5 days of incubation at $20^{o}C$ to determine oxygen uptake by bacteria comply standard condition.

2.2 Wastewater Treatment

Wastewater treatment is a process to convert the wastewater into an effluent that able to be reused and returned to the water cycle with also reduce minimum impact to surrounding and environment. There are three stages of treatment involves primary treatment, secondary treatment and tertiary treatment. The purpose of primary treatment is to remove solids. The settled and floating materials are removed and the remaining liquid discharged to secondary treatment. The function of secondary treatment is to remove dissolved and suspended biological matter from the treated wastewater. Tertiary treatment is focussing on final cleaning process that improves quality of wastewater before it is discharged to environment. .

The biological, physicals and chemical treatment have their advantages and disadvantages based on effectiveness of the operation, cost and maintenance. There are many technologies that can be use for latex wastewater treatment such as activated sludge, UASB and oxidation ditch. However, the Nitrogen-containing pollutant unable to remove completely by the technologies (Nguyen and Luong, 2012). It has found that the biological processes such as aerobic and anaerobic methods are most common treatment system eventhough had dificulties on maintenance microorganisms community due to high organic load in wastewater.

2.2.1 Biological Method

Biological method are widely used for treatment of rubber wastewater in Malaysia especially aerobic, anaerobic and facultative ponds (Mustafa, 2018). The advantages of this method are inexpensive and have high efficiency for organic load reduction but the it is dificult to keep the microorganisms in the treatment because of high organic load and causes decrement of microorganisms colony.

Biological treatment method are generally used to remove organic matter in the wastewater of natural rubber latex due to high efficiency and more economical rather than mechanical and chemical process (Nguyen and Luong, 2012). The biological pond uses natural and energy efficient processes to provide low cost wastewater treatment. These process divided into anerobic and aerobic process. Anaerobic is a process to digest organic matter without oxygen while aerobic is a process to digest organic matter with oxygen. There are a lot of treatment method using aeration method such as activated sludge process, aeration ponds and lagoons. This method works by changing the dissolved and colloidal organic contaminant to a biological sludge and removed by settling. From (Mohammadi et al., 2010) study reported that suspended solid removal capacities were low between 78% to 87% by using the activated sludge process method . The low efficiency of the method is because of insufficient oxygen concentration lead to rising sludge problem.

2.2.1(a) Pond technology

Pond technology is a method for treatment of effluents from the primary rubber industry in Malaysia (Mustafa, 2018). The biological ponds is used to remove organic matter in latex wastewater and this method is effective at removing pathogen from rubber wastewater There are two types of pond system that is high loaded anaerobic pond and low loaded aerobic pond. There is a latex trap and neutralization stage as pretreatment step before the pond treatment system. The removal of BOD from rubber wastewater can be over 95%. effluent with BOD level from 50 to 100 mg/L can be achieved by pond technology method (Lonholdt, 2015).

Size of the pond depending on avaibility of land area space near factory. Moreover, High maintenance needed to keep the pond produce the best result to treat wastewater. Cost for energy of surface aerator also need to be considered but save cost for other aspect. Those requirement that not be fulfilled produce low quality of the effluent which unable to meet the industrial effluent standard requirement. This kind of treatment only can be applied at open space because it produces bad odour.

2.2.1(b) Algal Pond

A study by Nguyen and Luong, (2012) showed the efficiency for removal of organic matter using algal pond method was very low approximately 11% of COD to make comparison with aerobic and anaerobic treatment, This method is less efficient compared to other treatment method. This study was perform for treatment of natural rubber wastewater in Vietnam. The hydraulic retention time (HRT) for algal pond was 7 days which considered enough duration to get best result for the method. The efficiency of the pond is more efficient in term of removal NH_3 nearly to 99%. This is proven by the assimilated ammoniac of the algal. Moreover, the algal pond able to partly oxidize the sulphate present in the wastewater.

2.2.1(c) Aerobic and anaerobic treatment

As previously discussed, the difference between aerobic and anaerobic is aerobic digest organic matter with oxygen while anaerobic digest organic matter without oxygen. This method provided high efficiency with inexpensive makes it as most common biological method used in Malaysia for treating rubber wastewater. To increase the microbial concentrations in the aeration tank, conventional treatment system are set up using aeration system with sludge recycling (Shamsudin, 2006). This system suggested and suitable for factories with small land area and also able to overcome malodour. Conventional treatment system are set up using aeration systems with sludge recycling to improve microbial concentration can remove 95% of BOD rubber wastewater (Mohammadi et al., 2010)It is not suggested for wastewater with higher nitrogen content as its not effective in removing nitrogen due to an insufficient supply of dissolved oxygen for nitrification.

2.2.1(d) Effective microorganisms (EM)

Effective microorganisms (EM) is a mixture of groups of organisms that have a reviving effect on humans, animals, and the natural environment which also been described as a multi-culture of coexisting anaerobic and aerobic beneficial microorganisms (Namsivayam *et al.,* 2010). EM have often been suggested as feasible in wastewater treatment plant or on-site wastewater treatment system to reduce volume of sewage sludge. The organisms are expected to eliminate the volumes of sludge produced, with the benefits of reduced sludge handling, resulting in lower cost and reduced environmental impact (Patterson, 2003). From research studied states the maximum removal of COD and TSS were 88% and 80% respectively in Hybrid Upflow Anaerobic Sludge Blanket (HUASB) reactor in the presence of EM with Organic Loading Rate (OLR) of 9kg.COD/m3/day. For HUASB reactor in the absence of EM only remove 76% and 68% of COD and TSS (Priya et al., 2015).

Microorganisms play a significant role in the decomposition of organic waste, but some microorganisms can cause human health concerns. EM anaerobic treatment facilities helped to reduce this decomposition's unpleasant byproduct and also reduced residual sludge production thus improving the quality of effluent (Priya et al., 2015). This proposed that following a period of EM application, conditions that might favour survival of the EM may be created. Throughout the monitoring and application period, conditions within the septic tanks were highly variable, which would have been affected by the quality of sewage. Another view states that the disturbance in microbial populations at one trophic level may impact upon the whole community and influencing the efficiency of wastewater treatment which give impact to pH and also another parameter.

2.3 Chemical method

Electrochemical method for treatment of rubber wastewater has been given more attention recently due to easy to control, less required HRT, cost and high efficiencies provided by the use of the new electrode material with compact biopolar electrochemical reactor (Vijayaraghavan *et al.*, 2008). The conventional biological method need longer HRT for rubber wastewater is the reason for the factories that want to get fast result of treatment switch to chemical method. Performing the electrolytic treatment by generation of chlorine and hypochlorous acid is the best alternative method. Therefore, there is some interest for developing a new method of wastewater treatment based on in situ hypochlorous acid generation as a part of electrochemical method. The result showed the efficiency of 99.9% and 98.8% for removal of CO and BOD (Vijayaraghavan *et al.*, 2008).

2.4 Physical methods

Rubber trap is one of the physical treatments at primary step used to obtain solid particles from the wastewater before proceeding to the secondary treatment. However, the removal of this rubber trap is lower (Mustafa, 2018). To enhance the effectiveness of rubber trap in the latex industry, the air flotation method has been evaluated. The result from the air flotation techniques in rubber trap method shows that the SS, turbidity, COD, BOD were 98%, 99%, 80% and 81% amd the pH value is 4.5 promoted higher treatment efficiency and rubber recovery from the rubber trap (Nguyen and Luong, 2012). This method can be a alternative way to treat latex wastewater.

2.5 Combined physical, chemical and biological methods

The combination of physical, chemical and biological processes in treatment of rubber wastewater in Malaysia were proven as one of the highest efficiency. By using aeration alone to remove the high levels of ammonia nitrogen from anticoagulants which is used in treating raw rubber of Asia-Pacific Region is not efficient (Iyagba *et al.*, 2008). In Malaysia, combination of physical and chemical treatment system followed by two-stage biological method was used for removal suspended solid and fibre. The system consist of fibre screening system, a dissolved air flotation system, aeration basin, a secondary clarifier and sludge dewatering system could produce an effluent which is consistent with the Standard A of DOE. Application of membrane technology involving gas injection techniques is another option for treatment of natural rubber effluent in Malaysia. Based on the result in term of permeate quality that showed that reduction were achieved of 67%, 77% and 95% for COD, BOD and TSS (Yusoff *et al.*,, 2004).

Table 2.2: Percentage removal of contaminant in wastewater treatment

Treatment	**BOD removal efficiency (%)**	**COD removal efficiency (%)**	**SS removal efficiency (%**	**Reference**
Pond technology	95	-	-	Lonholdt (2015)
Algal Pond	-	11	-	Nguyen and Luong (2012)
Aerobic filter	-	92	-	Anotai, *et al.*(2007)
Combined physical, chemical and biological methods	77	67	-	Yusoff *et al.* (2004)
Electrochemical method	98	99	-	Vijayaraghavan *et al.* (2008)

2.6 Physical and chemical method

Coagulation-flocculation is the conventional treatment method where the cationic inorganic metal salts are commmonly useas coagulants and long chain of non-ionic or anionic polymers are usually employed as flocculants (Wei et al., 2018). Coagulation and flocculation is one of the most commonly used techniques to achieve efficient separation process of solid-liquids for the removal of suspended solid, dissolved solid, colloids and organic matter present in industrial wastewater (Lee *et al.*, 2014). Coagulation is primarily induced by organic metal salts such as aluminium sulphate and ferric chloride. In some cases, these metal salts can be used in wastewater treatment with assistance of flocculants (WANG et al., 2011). Suspended particles in wastewater carry negative charge in aqueous medium. After addition of inorganic coagulant, metal salts will hydrolyse rapidly in wastewater at isoelectric point to form cationic species, which are adsorbed by negative collodial particles resulting in simultaneous reduction of the surface charge and formation of flocs (Suopajärvi et al., 2013).

However, the coagulation process is not always perfect as it can result in small flocs when coagulation occurs at low temperatures or produce fragile flocs which break up when they are subjected to physical forces. Hence, anionic or non-ionic polymeric flocculants are widely used to bring together and agglomerate the slow settling micro-flocs formed by coagulant to form larger and denser flocs, thereby facilitating their removal in subsequent sedimentation, floatation and filtration stages (K. E. Lee et al., 2012). The use of flocculants not only can increase the density and solidity of the flocs formed, it can also reduce the consumption of coagulants and increase the work reliability throughout capacity of treatment plant. Many studies have shown that the addition of a polymeric flocculant to an inorganic coagulant has been shown to be more effective in reducing environmental parameters (>90% in general) such as chemical oxygen demand (COD), total suspended solids (TSS), turbidity and colour, reducing the amount of coagulant used and thus reducing the amount of coagulant used and thus reduced the cost of the coagulation and flocculation process (Sher *et al.*, 2013).

2.6.1 Coagulation Jar Test Experiments

Jar test in one of the well-known method to determine coagulant material which show treatment efficiency in terms of suspended matter and organic matter removal. Chemical and coagulant materials are choosen and optimum operating conditions like pH and exact amount of coagulant materials are determined by jar testing. 100ml of natural rubber wastewater was inserted into the jars for the tests. Then, the coagulant material was added into into the beaker and mixed rapidly the mixture (100 rpm) for 2 minutes. After that, paddle velocity was decreased to 20 rpm for 20 minutes and ferric chloride as flocculant were added into the test. The particles could settle for a 30 minute period after the paddles were withdrawn (Massoudinejad *et al.*, 2015)

For another example, coagulation experiments using jar test were conducted in laboratory with a Bioblock flocculation that consisting of a six-paddle rotor for 500mL high shaped beakers which is in compliance to standards and all tests were conducted at room temperature. .The Jar test coagulation experiment was conducted separately using ferric chloride. 500 mL of latex concentrate effluent was poured into each of the six beakers. The paddles were then withdrawn and settling of flocs particles was observed and recorded. The mixture was left for 1 hour and then the supernatant was collected to be used to determine of the COD, SS, and turbidity using the standard method. The effect of pH was studied in the range of 2–11 and the effect of dosage was tested in the range from 200 mg/L to 800 mg/L. All analyses were conducted in triplicates and pH of wastewater samples was controlled by adding 1.0 M H2SO4 or 1.0 M NaOH (Idris et al., 2013).

2.6.2 Chemical coagulants and flocculants

The conventional chemicals that are commonly applied in industrial wastewater treatment can be classified into two major types that are inorganic mineral additives/metal salts which are used as coagulants and organic polymeric materials used as flocculants.

2.6.2(a) Inorganic coagulants

Inorganic salts of multivalent metals such as alum, polyaluminium chloride, ferric chloride, ferrous sulphate, calcium chloride and magnesium chloride have been widely used for decades as coagulant (Joo et al., 2007). This is due to its advantage of low cost, where their market price is much lower rather than chemical flocculants. Despite, the application of inorganic coagulants in wastewater is quite limited nowadays and has been decreased due to numerous disadvantages.

As reported in many studies, its usage would cause two serious environmental consequences which are the production of large volumes of metal hydroxide (toxic) sludge which will generate disposal issue and increasing in metal as example aluminium concentration in the treated water which may have human health implications. Minimise the drawbacks of inorganic flocculants, many factors have been taken into consideration to find the alternative and reduce the dosage of the harmful inorganic flocculants. Other drawbacks include large amount is required for effective flocculation, extremely sensitive to pH, inefficient towards very fine particles and in cold water for example polyaluminium chloride and applicable only to a few disperse systems (Sharma *et al.*, 2006). In order to minimise the drawbacks of inorganic flocculants, many variable have been taken into account in finding the option and reducing the dosage of the harmful inorganic flocculants.

2.6.2(b) Organic synthetic flocculants

Many synthetic polymers have been used as the main flocculants as coagulant aids in recent years which could enhance the coagulation and flocculation efficiency. Commercial organic flocculants are mostly linear water-soluble polymers based on repeating units of various monomers like acrylamide and acrylic acid which are derived from oil-based and non-renewable raw materials (Suopajärvi et al., 2013). Polymers may differ in molecular weight, structure (linear versus branched), amount of charge, charge type and composition but in general, the synthetic polymers are classified into four types which is cationic (positively charged), anionic (negatively charged), amphoteric (contains both cationic and anionic groups) and non-ionic (close to neutral). The nature of the charges is the main parameter that will have significant effect on the effectiveness of flocculation process followed by molecular weight and charge density.

Lee *et al.*, (2014) stated that the efficiency of the flocculation was normally measured based on the reduction of turbidity, TSS, COD and colour, and most of the studies reported that more than 90% removal could be accomplished under optimal conditions. The extensive use of polymers as flocculants is due to their difference characteristic attributes. The polymers are easy to use, immediately soluble in aqueous systems, and do not affect the medium's pH. With small quantities for example few miligrams per litre they are highly efficient and the floc formed during flocculation is bigger and stronger. Normally, an appropriate polyelectrolyte can increase floc size, and thus form strong and dense floc of regular shape which has good settling characteristics (Razali et al., 2011). By this way, the use of polymers results in a substantial reduction of coagulant dose required with a 40%-60% reduction is expected. The volume of sludge and ionic load of the wastewater cab be reduced.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter discusses on experiment that was carried out, analytical laboratory procedure to measure the characteristic of wastewater, equipment used, wastewater sampling, data collection and location selection to carry out the research. A medical devices company known as Teleflex Medical Sdn. Bhd located in Kamunting, Perak was selected. Most of Teleflex Medical Sdn. Bhd product originated from latex processing materials such as endotracheal tubes, balloon chaterers and cardio-thoraric drainage. For research purpose, the sample of raw latex wastewater from Teleflex wastewater treatment plant is used as in this research.

The aims of this study is focusing on condition of three aeration process in enhancing the performance of biological treatment. The aeration stabilization basin is designed for aerobic process which requires oxygen and microbial action to reduce COD, BOD, SS and Colour in wastewater. There are three aeration condition, which is aeration of wastewater only, aeration of wastewater with bacteria and aeration of wastewater after coagulation to compare the efficiency of main parameter. A rectangular model of aeration tank divided is into four compartments separated by three barriers. Each compartment provide with one pump to supply air into aeration basin. The air supplied by the pump to supply oxygen needed for metabolizing organic compound in the wastewater.

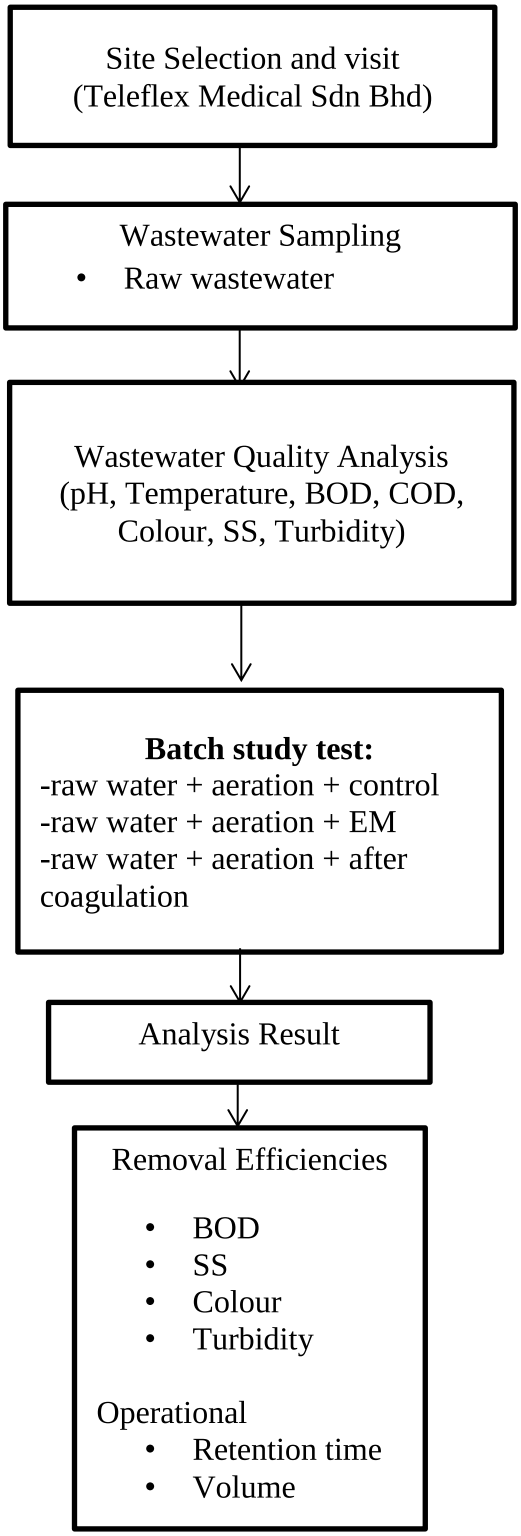

Figure 3.1: Flow chart of the research

3.2 Site Description

Teleflex Medical Sdn Bhd located in Kamunting, Perak and with coordinate longitude and latitude is about (4.8997^{o} N, 100.7109^{o} E). The company manufactured sterile disposal medical device for the urology, anaesthesia and respiratory markets. In other word, they develop brands in healthcare to treat patient in field of surgical, interventional, vascular access, anesthesia, cardiac care, emergency medicine and respiratory care. The company has two branches in Malaysia located at Jalan Perusahaan 4, 34600 Kamunting, Perak and Jalan Hi-tech 3, Kulim Hi-tech park, 09000 Kulim, Kedah. Teleflex Medical Sdn Bhd located at Kamunting, Perak is selected as the sampling site. The existing wastewater plant is currently incapable to treat all the effluent produced thus there is some amount of effluent is sent to external wastewater plant for treatment.

Figure 3.1: Site location of latex wastewater sampling

3.3 Sampling of wastewater

A sample of raw latex wastewater was collected from wastewater treatment plant of Teleflex Medical Sdn. Bhd., Kamunting. The samples need to be preserves as soon as possible by storing in the cool room after collection to maintain the integrity of the sample. A total of two sampling were performed during third research where each samples were brought to laboratory to conduct a set of wastewater characterization. Prior to laboratory test, each in-situ parameter is measured using professional plus multiparameter water quality instrument. The parameter measured from the device are temperature, pH and Dissolved Oxygen (DO). The sample brings to the laboratory for another measurement parameter data of wastewater. The purpose of preservation is to halt the biological process and hydrolysis of chemical compound.

The experiment are divided into several conditions that are aeration of wastewater, aeration of wastewater with bacteria and aeration of wastewater after coagulation. The efficiency comparison between each condition is measured based on removal of parameter namelly colour, turbidity, SS, COD and BOD among all three conditions. The Hydraulic Retention Time (HRT) was set for each condition are 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours and 24 hours.

Table 3.1: Summary of equipment and reagents of tested parameters

Parameter	Unit	Equipment	Method No.	Reagent
pH	-	Eutech pH 700	AHPA 4500-H^+ B	-
Colour	PtCO	DR 2800	HACH Method 8025	-
SS	mg/L	DR 2800	HACH Method 8006	-
BOD_5	mg/L	Eutech DO 2700	APHA 5210 B	• Magnesium Sulfate solution • Phospate Buffer Solution • Calcium Chloride Solution • Ferric Chloride
COD	mg/L	DR 2800	HACH Method 8000	• Potassium Dichromate • Silver Sulfate reagent (acid reagent)
Turbidity	NTU	2100N Turbidimeter	AHPA 2130 B	-