TREATMENT OF TENUN DYE WASTEWATER USING MEMBRANE BIOREACTOR (MBR)

RADHIATUL ASMA BINTI ABDUL RASHID

Thesis submitted in fulfilment of the requirements
for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2014

ABSTRACT

The Textile Industry makes a big contribution to the economic growth due to high demands locally and from abroad. But, textile industry is one of the most chemically intensive industries on the earth and the major polluter of portable water. Wastewater from dyeing in textile plant is often rich in colour, containing residual of dyes and chemical. This wastewater needs proper treatment before releasing into the environment. The purpose of study is to determine the characteristic of treated tenun dye wastewater and effect of Hydraulic Retention Time (HRT) of 24hours, 48 hours and 72 hours. Membrane Bioreactor (MBR) is used to treat tenun dye wastewater with addition activated sludge to assist biodegradation of tenun dye wastewater. Membrane bioreactor is process combination of activated sludge treatment and membrane filtration. Activated sludge is an active biological material produced by activated sludge plants, especially in aerobic, anaerobic and aeration system. The parameters that have observed were COD, BOD, TSS, Colour and MLSS. The results show that the COD value is decrease on 48 hour and increase in 72 hour. While BOD results show that from initial value, the value for 24 hour is decrease and then the value increase in 72 hour. The value of BOD supposed to decrease with increasing time. The TSS value is decrease since the particle cannot pass through the filter as the particle blocked in time during filtration. Then the MLSS is increase due to growth of microorganism. The high percentage color removal is 24%. It is show that MBR has potential to remove the particles that available in tenun dye wastewater. The data collected is used to improve the effectiveness of the research of dye treatment using MBR.

ABSTRAK

Industri Tekstil banyak menyumbang kepada pertumbuhan ekonomi negara kerana sambutan yang tinggi di dalam dan dari luar negara. Tetapi , industri tekstil adalah salah satu industri yang paling kimia intensif di bumi dan yang mencemarkan alam sekitar utama air mudah alih. Air sisa daripada pencelupan di kilang tekstil sering kaya dengan warna , yang mengandungi sisa pewarna dan kimia. Air sisa ini memerlukan rawatan yang betul sebelum dilepaskan ke alam sekitar. Tujuan kajian adalah untuk menentukan ciri tenun pewarna air sisa dan kesan Hydraulic Retention Time (HRT) daripada 24jam , 48 jam dan 72 jam. Membrane Bioreaktor (MBR) digunakan untuk merawat air sisa pewarna tenun dengan tambahan diaktifkan enapcemar untuk membantu biodegradasi daripada tenun pewarna air sisa. Membran bioreaktor adalah gabungan proses rawatan enapcemar teraktif dan penapisan membran. Enapcemar teraktif merupakan bahan biologi aktif yang dihasilkan oleh tumbuh-tumbuhan enapcemar diaktifkan, terutamanya dalam aerobik, anaerobik dan sistem pengudaraan. Parameter yang diperhatikan adalah COD , BOD, TSS, Colour dan MLSS. Keputusan menunjukkan bahawa nilai COD adalah menurun dalam tempoh 48 jam dan meningkat dalam tempoh 72 jam. Walaupun keputusan BOD menunjukkan bahawa dari nilai awal , nilai untuk 24 jam adalah penurunan dan kemudian meningkat nilai dalam 72 jam. Nilai BOD sepatutnya berkurang dengan masa meningkat. . Nilai TSS menurun memandangkan zarah tidak boleh melalui penapis seperti zarah disekat masa dalam penapisan. Kemudian MLSS meningkat disebabkan oleh pertumbuhan mikroorganisma. Peratusan yang tinggi penyingkiran warna adalah 24%. Ia menunjukkan bahawa MBR mempunyai potensi untuk mengeluarkan zarah yang terdapat di tenun pewarna air sisa. Data yang dikumpul digunakan untuk meningkatkan keberkesanan penyelidikan tenun pewarna menggunakan MBR.

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CWA	Clean Water Act
EPA	Environmental Protection Agency
HRT	Hydraulic Retention Time
IWK	Indah Water Konsortium
MBR	Membrane Bioreactor
MLSS	Mixed Liquor Suspended Solid
RAS	Return Activated Sludge
TSS	Total Suspended Solid
WWTP	Wastewater Treatment Plant

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter describes about the background of study, statement of problem, scope of study, objective of study, significant of study, and expected outcome.

Wastewater is a term applied to any type of water that has been utilize in some capacity that negatively impacts the quality of the water. Wastewater also had been adversely affected in quality by anthropogenic influence.

There are some components of wastewater which are domestic or sanitary wastewater, industrial wastewater, infiltration and inflow, and storm water. Most of water source in this world have been contaminated with varies physical, chemical and biological parameter especially pollutant from industrial sector. A scarcity of clean water and present a lot of biological pathogens that very harmful and cannot be remove only by boil the water cause the need water treatment plant.

Industrial wastewater can pose serious hazards to municipal systems because the collection and treatment systems have not been designed to carry or treat them. The wastes can damage sewers and interfere with the operation of treatment plants. They may pass through the wastewater treatment plant (WWTP) untreated or they may

concentrate in the sludge, rendering it a hazardous waste. The clean water act (CWA) gives the U.S Environmental Protection Agency (EPA) the authority to establish and enforce pre-treatment standard for discharge of industrial wastewater into municipal treatment system.

Textile industry includes a large variety of chemical addition and dyes that make the environmental challenge for textile industry not only as liquid waste but also in its chemical composition

1.2 BACKGROUND OF STUDY

Royal Pahang Weave simply called 'Tenun Pahang' is a type of worm silk fabric which is famous and popular in the state Pahang. Silk weaving in Pahang originated from the Malay people of Bugis descent. When the Dutch conquered Makassar Island, the sought refuge in the Riau Island of Indonesia and later they migrated to Pahang to avoid the fighting and war in Riau. The arts of hand-weaving have originated from the Pahang Royal town, Pekan. In Pekan, the Centre of hand-woven facility is in Kampung Soi. Kampung Soi plays a major role in the development of hand-woven products along with 6 other smaller hand-weaving facilities in the state of Pahang.

Cotton and silk threads were used to weave sarong of sampin cloth. The ancient people were coloured the threads using plant-derived dyes such as daun taram or known as *marsdenia tinctoria* (blue), kulit sepang known as *caesalpina sappan* (red) and *turmeric* (yellow). Belimbing buluh known as *averrhoa bilimb* and asam gelugur known as *garcinia atroviridis* are also natural fixatives.

The decorative elements in Royal Pahang Weave cloth are fairly simple and regular. The textile utilize tie and dye technique, which was thought to have been an influence originating from Sulawesi though modified to suit local tastes.

The checkered or striped designs are sometimes interspersed with some gold or silver threads, introduced as an additional decorative element. This is the uniqueness of its design. The design is usually named after one of its wearers, for example the Tun Razak pattern, the Toh Puan Muda pattern and so forth.

The process of making batik industry is starting from the reparation of raw material, cloth and the suitable equipment until drying process. the process of batik painting start with the preparation of fabrics, dyes, waxes, chemical and the equipment and tools which are the canting tool and stove. This process consumes large volume of water for washing. Then it continued with the application of wax on the fabric.

The Batik Industry makes a big contribution to the economic growth due to high demands locally and from abroad. However, this industry produces wastewater which contributes to water pollution since it utilizes a lot of chemicals. Wastewater from drying in textile plant is often rich in colour, containing residual of dyes and chemical. The direct discharge of this wastewater may affect ecological status, so industries are finding solutions for developing technologies that can diminish the environmental damage (Verma, Dash, and Bhunia, 2011). Membrane bioreactor is more efficient to treat water. The system does not require flocs to be formed to remove the solids by settlement. The process also requires no primary or secondary settlements stage. It is also no additional tertiary treatment.

1.3 STATEMENT OF PROBLEM

The textile industry produces wastewater which contributes to water pollution since it utilizes a lot of chemicals. Similarly, textile industry is one of the most chemically intensive industries on the earth and the major polluter of portable water (Verma et al., 2011). The wastewater from these homemade textile industries contain grease, wax, heavy metal, surfactant, suspended solid and dyes which are organic and inorganic (Ahmad, Harris, Syafie, Ooi, 2002) This wastewater needs proper treatment before releasing into the environment. Many techniques have been used for treatment of textile industry wastewater. The techniques used such as adsorption biological treatment, oxidation, coagulation or flocculation. Coagulation is one of the most commonly used techniques. A chemical substance is added to an organic colloidal suspension to cause destabilization by the reduction of forces that keep them apart. It involves the reduction or surface charges responsible for particle repulsions. Coagulation of dye-containing wastewater has been used for many years as main treatment or pre-treatment due to its low capital cost. This reduction in charge causes

flocculation. This technology usually needs additional chemicals which produce a huge volume of sludge. Besides that at the end of the process, usually the wastewater is being removed into an activated sludge plant. The activated sludge plant is not really suitable because it has disadvantages too which are the incoming effluent is introduced at one end of the tank, the BOD value will be higher at this end than the other (Saidah Malihah, 2010). The researcher also said the microorganisms at this end will be higher at this end than the other end.

1.3 OBJECTIVE OF STUDY

i. To determine the characteristic of the treated Tenun Dye Wastewater.
ii. To determine the effect of Hydraulic Retention Time (HRT)

1.4 SCOPE OF STUDY

i. The chosen area is in Pahang Weaving Centre, Kg Soi,Pekan Pahang.
ii. The Tenun dye of wastewater sample will be collected in this chosen area.
iii. The other chosen area is at Treatment Wastewater Plant, Kuantan to collect sample of activated sludge.
iv. The study is about to treat of Tenun Dye wastewater.
v. The Hydraulic Retention Time is 24hr, 48hr 72hr.
vi. The parameters that will observed are BOD, COD, Total Suspended Solid (TSS), Colour (ADMI), MLSS.

1.5 EXPECTED OUTCOME

The expected outcome of this study is the characteristic of parameters for dye of Tenun Pahang before and after the treatment and the result after treatment is better. The

different of HRT gives different affect to the Dye Tenun Wastewater quality. To prove that the MBR is resembles a highly effective system for treating Tenun Dye Wastewater.

1.6 SIGNIFICANT OF STUDY

Tenun Dye is threads that were coloured to weave sarong and sampan cloth in art of Royal Pahang Weave. The treatment if textile wastewater is one of the most difficult issues to be solved. It is because of its visibility and toxicity even at the very low concentration of dyed. (Yun et al., 2006; Pierce et al., 2003; Robinson et al., 2001; Banat et al., 1996). The treatment of Tenun Dye is by using Membrane Bioreactor. Membrane Bioreactor (MBR) is the combination of a membrane process like microfiltration or ultrafiltration with growth bioreactor. MBR are being increasingly used for wastewater treatment that requires excellent effluent quality. The Membrane Bioreactor process can help remove organic, nitrogen removal and water recycling. So it will avoid environment pollution.

CHAPTER 2

LITERATURE REVIEW

2.1 WASTEWATER

Wastewater is water that has been adversely affected in quality by anthropogenic influence. The wastewater is consist four main sources which are domestic water, agricultural wastewater, industrial wastewater and storm water. Wastewater is essentially a combination of liquid or water carried waste removed from residences, institutions, as well as commercial and industrial entities.

According to Wang et al., (2011) wastewater from dying is often rich in color, residues of reactive dyes and chemicals, high chroma, high COD and BOD concentration as well as much more hard-degradation materials. This wastewater is direct discharge into the lakes and river that pollutes the water and affects the flora and fauna. For protecting the environment, there are effective ways of dye wastewater treatment. Several studies have been performed on chemical, physical and biological method. Dye wastewater from textile industry is a serious pollution problem because it is high in both colour and organic content. A dye is a coloured substance that can be applied in solution or dispersion to a substrate in textile manufacturing, thus giving a colour appearance to textile materials.

2.2 TREATMENT OF TEXTILE WASTEWATER

The wastewater from the textile finishing industry contains various undesirable chemicals and dye materials. The major colour effluent comes from the dyeing and printing process (Tan, Teng & Mohd Omar, 2000). This colour effluent has to be decolored before being fed to the subsequent treatment units, such as adsorption and the biological treatment. The textile dyeing industry consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and finishing process. Effluent from textile mills also contains chromium, which has a cumulative effect, and higher possibilities for entering into the food chain. Due to usage of dyes and chemicals, effluents are dark in color, which increases the turbidity of water body. (Joseph, 2007)

There researchers have done some research and study to treat textile wastewater. According to Tan, Teng and Mohd Omar (2000), magnesium chloride as compared to alum and polyaluminium chloride (PAC) is a less commonly used coagulant in the field of wastewater treatment. So the removal of dyes and industrial dye wastes is by using magnesium chloride. A study on chemical precipitation technique has been carried out by using coagulant and produces flocs together with dye materials. The flocs are then separated from the aqueous solution by means of physical sedimentation.

In the past several decades, many techniques have been develop to find an economic and efficient way to treat the textile dyeing wastewater, including physicochemical, biochemical, combined treatment processes and other technologies. These technologies are usually highly efficient for the textile dyeing wastewater. (Wang et al., 2011)

According to Charoenlaarp and Choyphan, (2009) .Many techniques have been used for treatment of textile wastewater, such as adsorption, biological treatment, oxidation, coagulation and flocculation. In coagulation, a chemical substance is added to an organic colloidal suspension to cause its destabilization by responsible for particle repulsions.

The conventional processes such as coagulation, flocculation and biological methods adopted for decolouration of effluent containing reactive -dyes are no longer able to achieve adequate colour removal (Santhy & Selvapathy, 2006).

2.3 MEMBRANE BIOREACTOR (MBR)

Membrane application in surface water treatment provides many advantages over conventional treatment (Zularisam, Ismail, Salim, 2006). Membrane technology is also used in industrial processes and in industrial wastewater treatment, and this technology has moved into the area of treating secondary and tertiary municipal wastewater (Nicolaisen, 2002). Membrane bioreactor are promising process combination of activated sludge treatment and membrane filtration for biomass retention.

According to Chang, Bag, and Lee (2000) it is possible to treat wastewater effectively in absolute retention of all microorganisms by a membrane bioreactor. The application of membrane bioreactor is process for solid-liquid separation is a promising technology to improve the conventional activated sludge process (Melin et.al, 2006). According to Meng et al. (2009), MBR allow high concentrations of mixer liquid suspended solid (MLSS) and low production of excess sludge; enable high removal efficiency of biological oxygen demand (BOD) and chemical oxygen demand (COD), and water reclamation. There are feature advantages of MBR compared to conventional activated sludge plants in term of effluent quality, reflected in lower values for organics, nutrients and micro-organism (Melin et.al, 2006).

2.3.1 Advantage of Membrane Bioreactor

Membrane Bioreactor allow high concentration of mixed liquor suspended solids (MLSS) and low production of excess sludge, enable high removal efficiency of biological oxygen demand (BOD) and chemical oxygen demand (COD), and water reclamation (Meng et al., 2009). Besides that, membrane bioreactor is more automated,

making them ideal for decentralized treatment because they are simpler to operate (Francis A. DiGiano et al. 2004).

2.3.2 Disadvantage of Membrane Bioreactor

Membrane fouling and high cost of membrane are major obstacle to the wide application of MBR. MBR membrane have to be cleaned periodically to minimize biological and chemical fouling (Francis A. DiGiano et al. 2004). Large scale used of MBR in wastewater treatment will require a significant decrease in price of the membrane (Meng F. et al. 2009)

2.4 SLUDGE

Sludge is a generic term for a solids separated from suspension in a liquid. Commonly sludge refers to the residual, semi-solid material left from industrial wastewater, or sewage treatment process. It can also refer to the settled suspension obtained from conventional drinking water treatment, and numerous other industrial process. sludge also can define as the bulk of residual generated from wastewater by physical primary and biological (secondary) treatment process and must be treated before properly disposed off.

2.4.1 Activated Sludge

Activated sludge is a process for treating sewage and industrial wastewaters using air and a biological floc composed of bacteria and protozoa. The combination of wastewater and biological mass is commonly known as mixed liquor. In all activated sludge plants, once the wastewater has received sufficient treatment, excess mixed

liquor is discharged into settling tanks and the treated supernatant is run off to undergo further treatment before discharge. Part of the settled material, the sludge, is returned to the head of the aeration system to re-seed the new wastewater entering the tank. This fraction of the floc is called return activated sludge (RAS)

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter is explain about flow chart about process of reserch, experimental study, experimental model design, equipment used , sample preparation and procedure of experiment.

3.2 FLOW CHART

The methodology process flow chart for treatment of tenun dye wastewater using Membrane Bioreactor as illustrated in Figure 3.1. The flow chart is including selection of material, equipment, experimental design, preparation of sample and testing method.

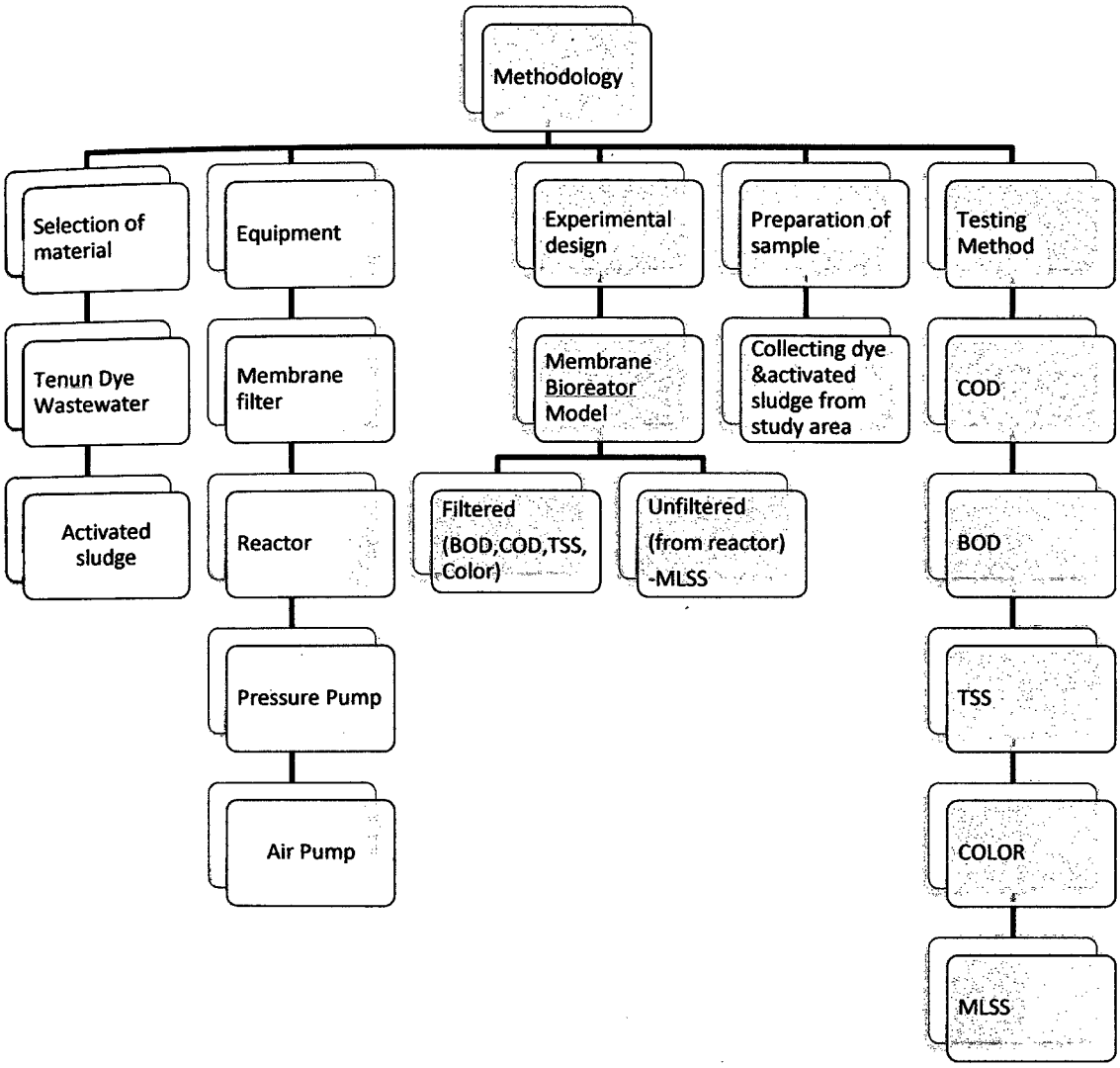

Figure 3.1: Methodology Process Flow Chart

3.3 MATERIAL SELECTION

The materials selections for this research study are tenun dye wastewater and activated sludge.

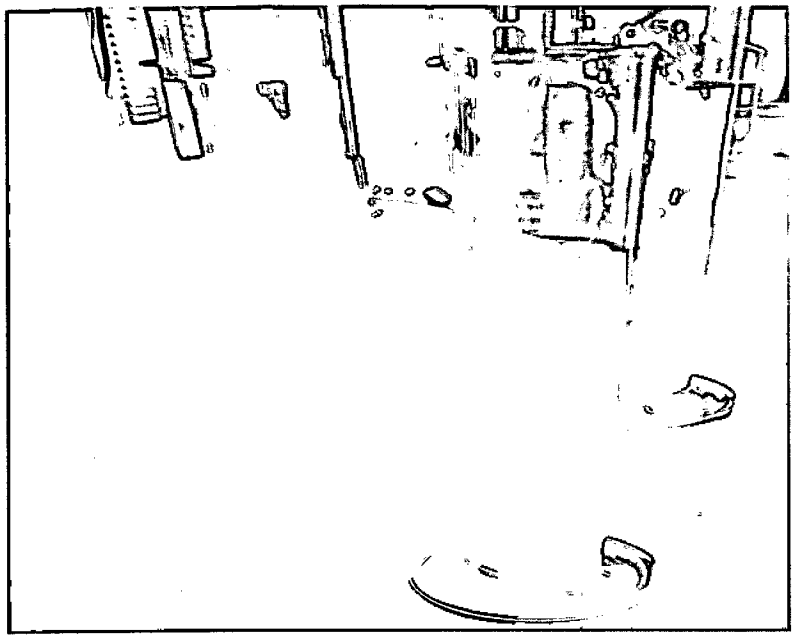

Figure 3.2: Sample of Tenun Dye Wastewater

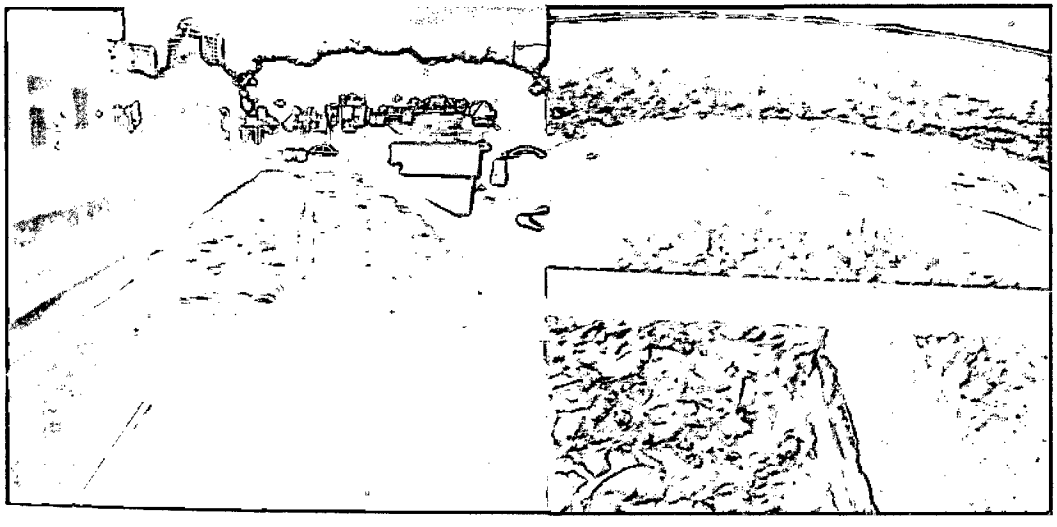

Figure 3.3: Sample of activated sludge

3.4 SAMPLE COLLECTION

In this study, the tenun dye wastewater is collected in textile industry which in Pahang Weaving Centre, Kg Soi, Pekan. The tenun dye sample is taken after coloring

process. The tenun dye wastewater is then put into container. While, the activated sludge is taken at Wastewater Treatment Plant near to Megamall, Kuantan , under Indah Water Konsortium supervision.

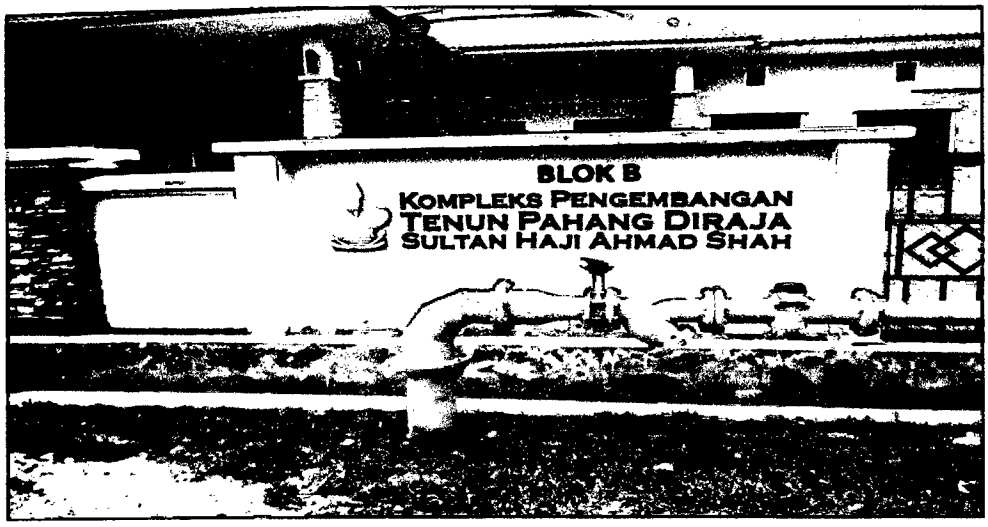

Figure 3.4: Pahang Weaving Centre, Kg Soi

3.5 APPARATUS PREPARATION

There are some apparatus that use in preparation of membrane bioreactor model. The apparatus is pressure pump, air pump, reactor and membrane filter.

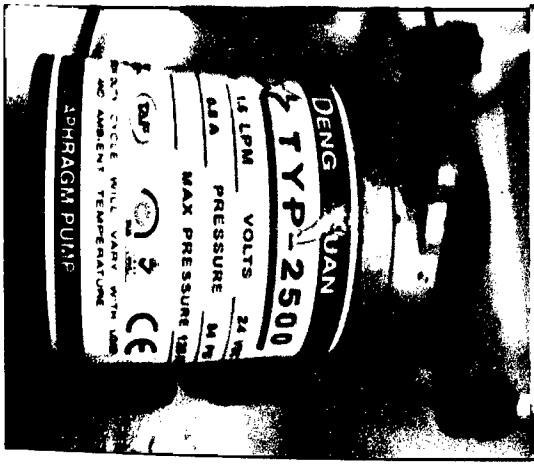

Figure 3.5: Pressure Pump

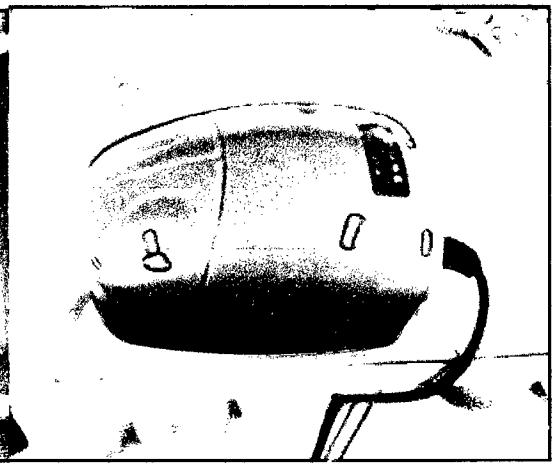

Figure 3.6: Air Pump

Figure 3.7: Membrane Filter

Table 3.1: Pressure pump characteristic

Pressure Pump	Characteristic
Open Flow	1.6 LPM
AMP	0.8A
Volts	2.4 VDC
Pressure	180 PSI
Max Pressure	125 PSI

Table 3.2: Membrane filter characteristic

Membrane Filter	Characteristic
Maximum Flow	3.8 LPM
Maximum Temperature	113°F (45°F)
Micron Size	0.1-0.4 μ
Pressure	8.0 Kgf/cm^2