BATIK WASTEWATER TREATMENT USING MEMBRANE BIOREACTOR (MBR)

SAIDAH MALIHAH BINTI MANSOR

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Universiti Malaysia Pahang

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ABSTRACT

Batik industry is one of our country's economy sources. However, this industry waste contributes to water pollution as the final stages of batik making discharges contaminated water which contains wax, dye, grease and others. The current treatment of the wastewater which is applied by this industry is activated sludge plant which needs stages of treatment. The aims of this research are to determine the characteristics of untreated and treated batik wastewater and to determine the effects of hydraulic retention time (HRT) to the batik wastewater .A laboratory-scale MBR was set up and fed up with batik wastewater with addition of municipal sludge from Taman Mahkota Aman treatment plant in order to assist the biodegradation of the batik wastewater. The MBR was operated at aeration intensity of 3liters/ minutes under room temperature. The pressure for 24 hours, 48 hours, 72 hours and 96 hours of the hydraulic retention times (HRT) were manipulated. At 24 hours of HRT, the flux was the highest with 19.290 x 10^{-5} m/s at 399.9761 milibar. The flux increased as the applied pressure increased and as the HRT increased, the flux value decreased. The suspended solid at 96 hours of HRT was 35 mg/l and decrease over HRT due to blocked pores of the membrane filter. While the MLSS in reactor increased over HRT as sludge yield in the reactor. Although the MBR has problem with fouling, the reliable data collected from the experiment could be used to improve the effectiveness of treating batik wastewater by using MBR.

ABSTRAK

Industri batik merupakan salah satu punca ekonomi negara. Walaubagaimanapun, industri ini menyumbang kepada pencemaran air kerana air yang tercemar oleh lilin, dai, gris dan lain-lain akan terhasil di akhir proses pembuatan batik ini. Rawatan air sisa batik yang digunakan sekarang adalah "activated treatment plant" yang memerlukan rawatan berperingkat.. Kajian ini bertujuan mengkaji cirri-ciri air sisa batik yang tidak dirawat dan yang telah dirawat serta kesan masa retensi hidrolik terhadap air sisa batik. Satu unit membrane bioreactor berskala makmal telah dicipta dan diisi dengan sisa air batik dengan penambahan lumpur dari pusat rawatan kumbahan Taman Indera Mahkota untuk membantu biodegrasi air sisa batik. MBR itu telah dikendalikan pada keamatan aerasi 3liters/minit dibawah suhu bilik. Tekanan pada masa 24 jam, 48 jam, 72 jam, dan 96 jam masa retensi hidrolik dimanipulasikan. Pada masa 24 jam retensi hidrolik, nilai flux pada tekanan 399.9761 milibar adalah tertinggi dengan nilai 19.290 x 10^{-5} m/s. Flux meningkat apabila tekanan yang dikenakan meningkat dan apabila masa retensi hidrolik meningkat, nilai flux berkurang. Bahan terampai pada masa retensi hidrolik 96jam adalah 35mg/l dan ia berkurang dengan HRT disebabkan liang membran telah tersumbat. Manakala, jumlah MLSS dalam MBR itu meningkat dengan peningkatan HRT kerana lumpur termendap. Walaupun MBR mempunyai masalah dengan fouling, data yang boleh dipercayai dari kajian ini boleh digunakan untuk meningkatkan keberkesanan sisa batik dengan menggunakan MBR.

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LIST OF ABBREVATIONS

ADMI	-	American Dye Manufacturers Institute
APHA	-	American Public Health Association
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
DO	-	Dissolved Oxygen
HRT	-	Hydraulic Retention Time
ISIC	-	International Standard Industries Classification
IWK	-	Indah Water Konsortium
MBR	-	Membrane bioreactor
MLSS	-	Mixed Liquor Suspended Solid
O_2	-	Oxygen
SEM	-	Scanning Electron Microscopic
SRT	-	Sludge Retention Time
SS	-	Suspended Solid
THM	-	Trihalomethane
UMP	-	Universiti Malaysia Pahang

LIST OF SYMBOLS

a	-	amount of ferrous ammonium sulphate titrant added to blank, *mL*
b	-	amount of titrant added to sample, *mL*
J	-	Flux, *m/s*
Q	-	Flow rate of filtered water, m^3/s
∀	-	Volume of sample, mL

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

Batik is one of Malay tradition clothes and being elevated and commercialized by Datin Seri Endon Mahmood to the entire world. In making batik, it will undergo a resist process of employing wax and dye. The cap method uses copper or zinc blocks dipped in melted wax and stamped onto two-meter lengths of white cotton. The cloth is repeatedly dyed and layered with wax until the finishing step which is the wax is boiled out of the cloth. Then, it is hung to dry on a clothesline and lastly folded for sale in the market. Batik by cap or block is a rapidly vanishing craft. It is produced entirely by hand in small family-owned factories on the east coast of Malaysia which are Kelantan, Terengganu and Pahang. 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 from wax and dye. Preliminary studies show that the wastewater from this homemade textile industries contains grease, wax, heavy metal, surfactant, suspended solid, and dyes (organic and inorganic) (Ahmad, A.L et al., 2002; Harris, W.A. et al., 2002; Syafiie et al., 2002; Ooi.B.S. et al., 2002). 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. Moreover, the microorganisms at this end will be physiologically more active than those at the other end. These defects are rectified in the complete mixing activated sludge process. While the membrane bioreactor is more efficient to treat water as the system does not require flocs to be formed to remove the solids by settlement and the process requires no primary or secondary settlement stages and no additional tertiary treatment or UV stages to achieve very high disinfection quality. Hence, the study of Batik wastewater treatment by using Membrane Bio-Reactor with addition of sludge to the effluent sample will be helpful to the environment as the treated wastewater is safe to be discharge.

1.2 Statement of Problem

The proposed project that we are looking at is the batik wastewater treatment by using Membrane Bioreactor (MBR) as the treatment of textile wastewater is one of the most difficult issues to be solved because its visibility and toxicity even at very low concentration of dyes (Pierce et al., 2003; Robinson et al., 2001; Banat et al., 1996). Since the water is a renewable and sustainable source, hence, it is not peculiar if in the future, the batik industries had to use back the purified recycled water from their industries for waxing and dyeing their textile.

In order to reduce environmental impact, discharge limits imposed on textile mills are becoming ever more stringent. Stricter regulations are forcing plant managers to upgrade existing waste treatment systems or to install new systems where none were needed in the past (Rott U, Minke R., 1999). Therefore, it is necessary for the industries to come out with a proper treatment of their wastewater by using membrane bioreactor as to keep a healthy environment and prevent the undesired history repeat again such as reported by Harian Metro, 23 August 1997 which titled as 'Industri Cemar Air' at Sungai Nerus, Terengganu which cause death to the nearby resident and aquatic life.

1.3 Objectives of the Study

The objectives of this study are:

1. To determine the characteristics of batik waste water.
2. To determine the effects of hydraulics retention time (HRT) to the batik wastewater quality.
3. To determine the characteristics of the treated batik waste water.

1.4 Scope of Study

1. This study is about to treat the batik wastewater from the batik industries.
2. The chosen area is at east coast of peninsular Malaysia which is Felda Bukit Sagu, Pahang.
3. The aeration intensity for this study is 3 liters/ minutes.
4. The hydraulics retention time (HRT) that was carried out in several of period observation for this study is taken at 24 hours, 48,72 hours and 96 hours.
5. The parameters for this study are the biological oxygen demand (BOD), chemical oxygen demand (COD), color (ADMI), and suspended solid (SS).

1.5 Significance of Study

The world population is ever increasing putting a considerable amount of stress on the environment. Water will continue to become major factor for the survival of humans and human activities. This is especially true in the industrialized areas. At present, approximately 50% of water is being used by households, and other 50% for industrial and agricultural activities. However, with an increasing population, there will be pressure for industries to reclaim and reuse some of its wastewater. This is due to the combine pressures of increasing water and wastewater costs and increasing stringent regulatory requirements of discharged wastewater (Tan, B.H, et al. 2000)

Water contamination from a variety of sources has become an increasingly serious problem in recent years. The rapidly growing industries in these areas of the world produce large quantities of effluents and the batik making is one of industry that produces wastewater which will become a part of water contamination source. Hence, this study will serve the good application of membrane bioreactor (MBR) in treating the batik wastewater as the wastewaters from printing and dyeing process are often rich in color, containing residual of dyes and chemical, and needs proper treatment before releasing into the environment. Preliminary studies show that the wastewater from this homemade textile industries contains grease, wax, heavy metal, surfactant, suspended solid, and dyes (organic and inorganic) (Ahmad, A.L et al., 2002; Harris, W.A. et al., 2002; Syafiie et al., 2002; Ooi.B.S. et al., 2002). Therefore, the membrane bioreactor is a good and convenient selection of technology in treatment the batik wastewater as the this system does not require flocs to be formed to remove the solids by settlement and the process requires no primary or secondary settlement stages and no additional tertiary treatment or UV stages to achieve very high disinfection quality. For this research, the batik wastewater will be added with the municipal sludge from Taman Mahkota Aman wastewater treatment plant in the MBR. Then, the sample will undergo the next step of treatment by using membrane bioreactor where it will be aerated with the aeration intensity for the reactor is 3 liters/minutes treatment and the pressure is manipulated during the samples taken at the hydraulic retention time (HRT). Thus, by using the membrane bioreactor, the batik wastewater have a better effective way than using activated sludge pond for discharging their wastewater and the water contamination can be reduce.

1.6 Expected Result

The expected results for this study are the characteristic of the parameters for the batik effluent which are biological oxygen demand (BOD), chemical oxygen demand (COD), color (ADMI), and suspended solid (SS) before and after the treatment is different and the results after treatment is better than the results before the treatment. While for different of hydraulics retention time (HRT) gives different effects to the batik wastewater quality so that it can be conclude that the MBR resembles a highly effective system for treating batik wastewater. From previous study, as membrane pressure increased, the flux value increased.

CHAPTER 2

LITERATURE REVIEW

2.1 Wastewater

Wastewater is also known as sewage which originates from domestic, agriculture and industrial area. The untreated wastewater usually contains organic matter, pathogenic microorganisms and a large number of potentially harmful compounds and if it were discharge directly into a watercourse, serious damage might results to the many form of life and would contribute potential risks of transmission of disease such as diarrhea, cancer, waterborne disease and etc.

2.1.1 Types of wastewater

Wastewater consists of four types main sources which are domestic water, agriculture wastewater, industrial wastewater and storm water.

2.1.1.1 Domestic wastewater

Domestics wastewater are the wastewater that come from residential, shop houses, offices, school etc. and normally is generated from toilets, bathrooms and sinks. The residential wastewater can be divided into two which are black water and gray water. Black water refers to toilet waste and gray water refers to the remaining wastewater from sinks, showers, laundry, etc. The septic tank provides primary treatment of both types of wastewater by settling out the solids and providing space for floating scum to be retained. Relatively clear, but not clean, water is discharged from the septic tank to the absorption field. The soil provides for further treatment when the wastewater percolates through the soil profile.

Untreated or improperly treated wastewater contains biological contaminants known to cause disease. These contaminants are known as germs or pathogens. Pathogens fall into five main categories: bacteria, viruses, protozoan, fungi and worms. Most of these pathogens use the fecal/oral route to spread disease. Fecal material, including human waste, contains pathogens. The usual method of infection requires you to touch the fecal material with your hands and then transfer it to your mouth, either directly or through food. Pathogens can also contaminate water supplies when the wastewater is allowed to reach the water table before adequate treatment occurs.

2.1.1.2 Agriculture wastewater

Agricultural wastewater is generated from a variety of farm activities including animal feeding operations and the processing of agricultural products, can pollute surface and ground water if not properly managed. Examples of agricultural wastewater include but are not limited to manure, milking center wash water, barnyard and feedlot runoff, egg washing and processing, slaughterhouse wastewaters, horse washing waters and runoff associated with composting. Additionally, runoff from croplands can contribute sediment, fertilizers and pesticides into surface waters. Agriculture wastes that flow directly into surface waters have a collective population equivalent of about two billion. Agricultural wastes are typically high in nutrients (phosphorus and nitrogen), biodegradable organic carbon, pesticide residues, and *fecal coliforms* bacteria (bacteria that normally live in the intestinal tract of warm-blooded animals and indicate contamination by animal wastes) (Ruth, F.W., Robin, M., 2003).

2.1.1.3 Industrial wastewater

Industrial wastewater is generated by industries. As industries are classified in many ways, e.g., from extraction to consumption, The International Standard Industries Classification (ISIC) system subdivides these uses into the following major categories (UN Statics Division, 2003):

i. Mining and quarrying
   - Mining of coal and lignite; extraction of peat
   - Extraction of crude petroleum and natural gas; service activities incidental to oil gas extraction, excluding surveying
   - Mining of uranium and thorium ores
   - Mining of metal ores
   - Other mining and quarrying

ii. Manufacturing
   - Manufacture of food products and beverages
   - Manufacture of tobacco products
   - Manufacture of textiles

- Manufacture of wearing apparel; dressing and dyeing of fur
- Tanning and dressing of leather; manufacture of luggage, handbags, saddler, harness and footwear
- Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- Manufacture of paper and paper products
- Publishing, printing and reproduction of recorded media
- Manufacture of coke, refined petroleum products and nuclear fuel
- Manufacture of chemicals and chemical products
- Manufacture of basic metal
- Manufacture of fabricated metal products, except machinery and equipment
- Manufacture of office, accounting and computing machinery
- Manufacture of electrical machinery and apparatus
- Manufacture of radio, television and communication equipment and apparatus
- Manufacture of medical, precision and optical instruments, watches and clocks
- Manufacture of motor vehicles, trailers and semi-trailers
- Manufacture of other transport equipment
- Manufacture of furniture
- Recycling (James L.W, Jr. and Gilbert F.W, 2003)

"Industrial effluent" means any waste in form of liquid or wastewater generated from manufacturing process including the treatment of water for water supply or any activity occurring at industrial premises [Environmental Quality (Industrial Effluent) Regulations 2009].

The industrial wastewater which is to be discharge must not exceed the standard A and the standard B below;

Table 2.1: Parameter limits of effluent of standards A and B

THIRD SCHEDULE

ENVIRONMENTAL QUALITY ACT, 1974

Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979

[Regulations 8(1), 8(2), 8(3)]

PARAMETER LIMITS OF EFFLUENT OF STANDARDS A AND B

PARAMETER	UNIT	STANDARD A	STANDARD B
a) Temperature	°C	40	40
b) pH value	-	6.0-9.0	5.5-9.0
c) BOD_5 or 20°C	mg/l	20	50
d) COD	mg/l	50	100
e) Suspended solid	mg/l	50	100
f) Mercury	mg/l	0.005	0.05
g) Cadmium	mg/l	0.01	0.02
h) Chromium, Hexavalent	mg/l	0.05	0.05
i) Arsenic	mg/l	0.05	0.10
j) Cyanide	mg/l	0.05	0.10
k) Lead	mg/l	0.10	0.5
l) Chromium, Trivalent	mg/l	0.20	1.0
m) Copper	mg/l	0.20	1.0
n) Manganese	mg/l	0.20	1.0
o) Nickel	mg/l	0.20	1.0
p) Tin	mg/l	0.20	1.0
q) Zinc	mg/l	2.0	2.0
r) Boron	mg/l	4.0	4.0
s) Iron (Fe)	mg/l	1.0	5.0
t) Phenol	mg/l	0.001	1.0
u) Free chlorine	mg/l	1.0	2.0
v) Sulphide	mg/l	0.50	0.50
w) Oil and grease	mg/l	Not detectable	10.0

*This standard applies to the industrial and development projects which are located within catctment areas (areas upstream of surface or above sub-surface water supply intakes, for the purpose of human consumption including drinking)

2.1.1.4 Storm Water

In most of the ASEAN countries, storm water is discharged into the nearest water course and not into the sanitation systems that are usually designed to receive runoff generated by tropical thunderstorms. In the less urbanization, storm water is allowed to seep into the ground and also discharged into the nearest watercourse.

Storm runoff water in most communities is collected in a separate storm sewer system, with no known domestic or industrial connections, and is conveyed to the nearest watercourse for discharge without treatment. Rain water washes contaminants from roofs, streets, and other areas. Although the pollution load of the first flush may be significant, the total amount from separated storm water systems is relatively minor compared with other wastewater discharges. Several large cities have a combined sewer system where both storm water and sanitary wastewaters are collected in the same piping. Dry weather flow in the combined sewers is intercepted and conveyed to the treatment plant for processing, but during storms, flow in excess of plant capacity is by-passed directly to the receiving watercourse. This can constitute significant pollution and a health hazard in cases where the receiving body is used for a drinking water supply (Mark J.H., Mark J.H. Jr., 2008)