PRETREATMENT OF PALM OIL MILL EFFLUENT FOR WATER RECLAMATION

[1]WANWIJI TTIMTHAN, [2]CHARONGPUN MUSIKAVONG, [3]CHAISRI SUKSAROJ

[1,2,3]Faculty of Environmental Engineering, Prince of Songkla University
E-mail: wanwijit.p@gmail.com, mcharongpun@eng.psu.ac.th*, schaisri@eng.psu.ac.th

Abstract- Palm oil mill effluent (POME) contain high organic compound that can't be discharged into public water resource and reuse. Some palm oil industryuse membrane for treat POME but found problem of membrane fouling. This study aims to treatment POME for membrane fouling control by coagulation, land treatment, and filtration.It was found that thecoagulation enabled the reduction of suspended solid chemical oxygen demand (COD) and color. It was considered to be the suitable treatment method formembrane foulingcontrol.

Keywords- Palm oil mill effluent, Coagulation, Land Treatment, Filtration, Reclamation.

I. INTRODUCTION

Oil palm is one of the most important economic crop in Thailand commonly used to extract the palm oil.There are several stages of wet processing for the extraction of palm oil from fresh fruit bunches. These include sterilization, bunch stripping, digestion, pressing, clarification and purification(Wu et al., 2010). Wet process of palm oil milling consumes a large amount of water. The palm oil mill effluent generated was 0.55 m^3/Tonof fresh fruit bunches. Most palm oil industry used pond systemfor POME treatment. This is an open system and used a large land area. The treated water can'tbe discharged into the public water resource. there is the contamination of colors and organic compounds such as lignin, tannin, carotene, phenolic and melanoidin(Kongnooet al., 2011; Ahmad et al., 2006; Limkhuansuwan and Chaiprasert, 2010; Rakamthong and Prasertsan, 2011). Which obstructs the transmission of light; aquatic plants can't produce oxygen from photosynthesis and cause water pollution. Palm oil industry used treated POME to wateringoil palm garden or leave to evaporate naturally. But in the rainy season especially in the southern Thailand, There is a long fall. Allow some water to overflow into the environment because the soil in the plantation can't be absorbed quickly or no space for water softening for some industry.To prevent the pollution would be occurred in the surrounding environment, this wastewater should be treated before discharged but the quality must lower the maximum allowable discharge value for the discharge standards of industrial wastewater. The methods have been used to treatment such as coagulant,adsorption by activated carbon,land treatment and membrane technology.

The Palm Oil industry in Trang province, Thailand used Microfiltration (MF) pore size 5 µm and Reverse osmosis (RO)for treatment POME. However, membrane systems typically have a blockage of the plant was found to this problem as well. Due to the requirement of often backwash and changing membrane, the cost is quite high. This problem can be solved by the best pretreatment.

This research studied the pretreatment methods for membrane life times longer and reducesfouling by coagulant, land treatment andfiltration in order to reduce color and organic compound in the POMEprior entering membrane system. Membrane technology is capable of improving the quality of effluent and reused again (Ahmad et al, 2003; Ahmad et al, 2006), which would help offset the cost of water production facility.

II. MATERIALS AND METHOD

A. Characterization of POME
POME in this study was obtained from final pond system of palm oil industry in Trang province, Thailand and the characterization was done in the laboratory.

B. Treatment POME by coagulation
The coagulant Jar test (Fig 1)was performed using Aluminium sulfate (Alum) and Poly aluminium chloride (PACl). After the desired amount of coagulant was add to the suspension, the beakers were agitated at various mixing times and speeds, which consist of 100 rpm for 1 min, 30 rpm for 30 min and settle for 1 hr.pH was optimized for each coagulantdosdage.

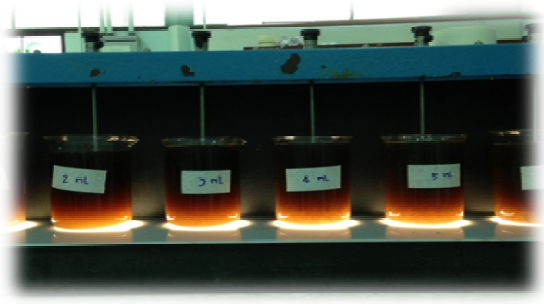


FIGURE 1: Coagulation by Jar test

C. Treatment POME by land treatment (Adsorption mechanism)

Undisturbed soilsamples were collected in the palm garden of every 20 cm depth as layer depth 100 cm. The experiment series were conducted, each series usedweight soil of 1, 2, 5, 10 and 20 g for POME volume 100 mL andthe control used 100 mL of distilled water.The shaking speed was 200 rpm at the reactor was leave at room temperature for 5 hrs.ofsettlementafter that the supernatant was collected. The COD analysis was done forplot the adsorption isotherm

D Treatment POME by sand filtration

The sand filtermedia with effective size of 0.65 mm and uniformity coefficient at1.73 was packed in Deep bed filter column (Fig 2) thatwas controlled by filtration rate of 3, 5, 9 and 12 m^3/m^2-hr. The water samples were collected at 5, 10, and 30 min after that at 1 hr interval until 10 hr.



FIGURE 2: Deep bed filter column

III. RESULTS AND DISCUSSION

A.Characteristics of POME

POME is dark brown,contains 150 - 200 mg / L of suspended solidand 900 - 1,300 mg / L of COD which exceeds the quality standards of dischargeable industrial wastewater. The others characteristics was shown in Table 1.The analysis techniques using FEEM and FTIR showed that POMEwas contaminated by humic and fulvic.Kongnooet al. (2011) reported that a functional group of OH stretching, C=O stretching, CH aliphatic bending and C-O stretching can be found among these functions in lignin, hemicellulose and polysaccharidewhich is the cause of color in POME (Buharuddinet al, 2011; Alriolset al., 2009).

TABLE 1: The characteristics of POME

Parameter	Unit	POME	standards of industrial wastewaterdischarge
pH	-	8.3 – 8.5	5.5 – 9.0
Turbidity	NTU	110 -130	-
Suspended solid	mg/L	150 - 200	50
Chemical oxygen demand	mg/L	900 – 1,300	120
Color	ADMI	1,640	
UV-254	-	10 – 12	-

B. Result of POME treatment by coagulation

The optimalAlum dosage at 3.5 g/L controlled pH 5.5 can reduce the turbidity and suspended solid by 96.7% and 86.5%. The optimal PACl dosage was 5 g/L,pH control at 6.5 that can reduce turbidity and suspended solid by 97.3% and 86.7%as shown in Table 2.The identification of organic compounds with FEEM techniques detected position of the humic at 330 nm Ex_{max} / 410 nm Em_{max} and fulvic at 240 nm Ex_{max} / 410 nm Em_{max}The decline in the function of the C=O stretching, CH aliphatic bending, CO stretching by FTIR analysis was found as same as same as that found in the POME. But after the coagulation, the peaks of aromatic functional groups can't be detected, so the coagulant can treat aromaticthat causes the color in the POME.

The POME treatment by alum coagulation save costs and can eliminate suspended solids up to 90% of the particles size distribution 3.372 μmand silt density index 5 units can reduce fouling on surface Microfiltration.

TABLE 2: The characteristics of POME treated by coagulation for alum dosage 3.5 g/L pH 5.5 and PACl dosage 5 g/L pH 6.5

Parameter	Unit	Treated by alum coagulant	Treated by PACl coagulant
Turbidity	NTU	3.75	3.10
Suspended solid	mg/L	23	22.7
Chemical oxygen demand	mg/L	236.06	209.83
Color	ADMI	270	209
UV-254	-	2.272	2.245

C. Result of POME treatment treatment by land treatment (Adsorption mechanism)

The isotherm is not related to the Batch Langmuir and Freundlichisotherm because the soil is chemically mixed.

The physical characteristic of different chemical makes it difficult to explain the mechanism of adsorption. Moreover, the amount of soil and exposure time increased adsorption capacity. The efficiency obtained in this study may not be sufficient but it is interesting for further study. The POMEwas passed through the spaces of the soil where the adsorption mechanism, filtration and microbial degradation occurred. However, the performance may depend on various factors such as type of soil, hydraulic loading rate, and contact time.

D.Result of POME treatment by sand filtration

The sand filtration at filtration rate of 9 m^3/m^2-hr can reduce the turbidity, suspended solids and COD by 23.83%, 40.82% and 66.74%, respectively, which can be filtered along period of 10 hr. This method may not be suitable to be used as a pretreatment formicrofiltration because of the removal of suspended solids is less. For further study, the effect of sand media size reduction should be investigated in order to enhance the filtration efficiency.

CONCLUSIONS

The POME treatment process using alum coagulationatalum dosage 3.5 g/L, pH 5.5 can reduce 90% of suspended solid that enhanced the POME quality prior microfiltration. The land treatment(adsorption mechanism)was ineffective for POME pretreatment prior to microfiltration because they can't remove of suspended solids. The sand filtration at 9 m^3/m^2-hr reduced suspended solids by 40.82% and COD by 66.74% therefore it should be replaced by the slow rate filtration and reduce the size of the sand in order to have a more effective filter. Therefore, the comparing ofpretreatment method before entering the membrane showed the most suitable method was alum coagulation, its effectiveness in suspended solid reduction in POME would result the fouling control on surface of microfiltration menbrane.

ACKNOWLEDGEMENT

This research was supported by the TRF – MASTER RESEARCH GRANTS (MAG WINDOW I) and Graduate School, Prince of Songkla University.

REFERENCES

[1]. Ahmad, A.L., Chong, M.F., Bhatia, S., Ismail, S.. 2006. Drinking Water Reclamation from Palm Oil Mill Effluent (POME) Using Membrane Technology. Desalination 191, 35-44.

[2]. Ahmad, A. L., Ismail, S., Bhatia, S. 2003. Water Recycling from Palm Oil Mill Effluent Using Membrane Technology. Desalination 157, 87-95.

[3]. Alriols, M.G., Tejado, A., Blanco, M.,Labidi, J. 2009. A Gricultural Palm Oil Tree Residues as Raw Material for Cellulose, Lignin and Hemicelluloses Production by Ethylene Glycol Pulping Process.Chemical Engineering journal 148. 106 – 114.

[4]. Buharuddin, A.S., Rahman, N.A.A., Shah, U.K.M., Hassan, M.A., Wakisaka, M. Shirai, Y. 2011. Evaluation of Processed Shredded Empty Fruit Bunch (EFB)- Palm Oil Mill Effluent (POME) Anaerobic Sludge Based Compost Using Fourier Transform Infrared (FTIR) and Nuclear Magnetic Resonance (NMR) Analysis. African Journal of Biotechnology.10(41). 8082 -8089.

[5]. Hassan, M.A.A. and Puteh, M.H. 2007. Pre-Treatment of Palm Oil Mill Effluent (POME): A Comparison Study Using Chitosan and Alum. Malaysian Journal of Civil Engineering 19(2) : 38-51

[6]. Kongnoo, A., Suksaroj, T., Intharapat, P., Promtong, T. and Suksaroj, C. (2011). Decolorization and Organic Removal from Palm Oil Mill Effluent by Fenton's Process. Environmental engineering science. Vol 29. 855 – 859.

[7]. Limkhuansuwan, V. and Chaiprasert, P. (2010). Decolorization of Molasses Melanoidins and Palm Oil Mill Effluent Phenolic Compoumds by Fermentative Lactic Acid Bacteria. Journal of environmental sciences.22 (8). 1209 – 1217.

[8]. Norulaini, N.A.N., Zuhairi, A.Z., Muhamad Hakimi, I. andMohd Omar, A.K. 2001. Chemical Coagulation of Settleable Solid – Free Palm Oil Mill Effluent for Organic Load Reduction.Journal of industrial technology.10(11). 55 – 72.

[9]. Rakamthong, C. and Prasertsan, P. 2011. Decolorizationand Phenol Removal of Anaerobic Palm Oil Mill Effluent by Phanerochaetechrysosporim ATCC 24725. TIChE International conference.

[10]. Wu, T.Y., Mohammad, A.W., Jahim, J.M. and Anuar, N. 2010. Pollution Control Technologies for the Treatment of Palm Oil Mill Effluent (POME) Through End-of-Pipe Processes. Journal of Environmental management 91.1467 – 1490.

★★★