TECHNICAL NOTE

CHARACTERIZATION OF PALM OIL MILL SECONDARY EFFLUENT (POMSE).

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Abstract: This paper reports on the characteristics of the Palm Oil Mill Secondary Effluent (POMSE) in four different period of sampling. The aim of this study was to measure the value of the Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD_5), color, total suspended solid (TSS), turbidity, iron ferrous, and total iron in POMSE. These basic parameters are crucial in determining a suitable treatment system to be acted on the wastewater so that the optimum condition of the treatment could be obtained. Results obtained in this study indicated that BOD_5 concentration lies between 249 to 267mg/L; COD reading were between 3234 to 3624mg/L; Color were between 3860 to 5350ADMI ; total iron were between 0.24 to 1.75mg/L; ferrous iron were 1.75mg/L; TSS were between 1635 to 1875 and turbidity, 2865 to 2894NTU. Results suggest that aerobic and anaerobic treatment were not sufficient in reaching the standard discharged limit set by Department of Environment (DOE) Malaysia.

Keywords: *Characterization, palm oil mill secondary effuent, wastewater treatment, COD, Color.*

1.0 Introduction

Malaysia is known as the second largest producer of palm oil mill after Indonesia. This important industries, however has created other major disposal problem in disposing the lignocelluloic biomass such as oil palm trunks (OPT), oil palm fronds (OPF), empty fruits bunches (EFB) and palm pressed fibres (PPF), palm shells and palm oil mill effluent (POME) (Abdullah and Sulaiman, 2013). Amongst all waste produced, researchers had concluded that POME is the most difficult waste to handle due to its high volume generated (Madaki and Seng, 2013) and difficulties in handling the

treatment (Rupani *et al.*, 2010). Although it was said that POME is not toxic, however, the abundance of POME in water stream could lead to oxygen depletion in water stream as POME contains high amount of N,P,K, Mg, and Ca which later on could lead to plant growth in aquatic region (Embrandiri, Ibrahim and Singh, 2013). The treatment of POME produced biogas (methane), excessive sludge, required lots of labor, require huge land and space and also long hydraulic retention time (HRT) (Madaki and Seng, 2013).

According to Wu *et al*., (2010) and DOE (1999), POME is produced in the palm oil mill process that consists of sterilizer condensate (36%), separator sludge (60%) and hydrocyclone (4%). POME consists of 95-96% water, 0.6-0.7% of oil and 4-5% and total solid (including 2-4% suspended solid). In addition, the acidic condition of POME (4 to 5 pH) is the results of the volatile acids contained (Ma *et al*., 2000; Md Din *et al*., 2012). The treatment of POME in Malaysia, generally undergo ponding system, open tank digester and extended aeration system, or closed anaerobic digester and land application system (Wu *et al*., 2010). POMSE is the result of biological treatment of POME and is characterized by having a thick, brownish color, bad odor, higher pH (7 to 9pH), and have lower BOD and COD compared to POME.

Although POME was claimed to be treated with one of these three major systems, this conventional system, however often found to exceed the standard discharge limit set by both Department of Environment (DOE) Malaysia and Environment Quality Act (EQA) 1974. Table 1 showed the standard discharged limit set by DOE and EQA.

Table 1: Environmental Quality Act 1974 for POME Discharged (Law of Malaysia, 1994).

Parameters	DOE discharged limit(1986 onwards)[a]	Environmental Quality Act[b]
BOD_3 (mg/L)	50	100
COD (mg/L)	1000	1000[c]
Total solids(mg/L)	1500	1500[c]
Suspended solids (mg/L)	400	400
Oil and grease (mg/L)	50	50
Ammoniacal nitrogen (mg/L)	100	150[c]
Total nitrogen (mg/L)	200	200[c]
pH	5.0	5.0-9.0
Temperature (^oC)	45	45

a. Malaysia Department of Environment (DOE)

b. Parameters Limit of Environmental Quality (Prescribed Premises) (Crude Palm Oil) (Amendment) Regulation 1997

c. No new value stipulated since 1982

(Sources: Aris et al., 2008; Belo et al., 2013)

Although law on discharged limit has been implemented by government, several studies showed that COD and BOD of POMSE is higher that the permitted level (Aqilah *et al.*, 2013; Omar, 2008; Siew, 2006).

Table 2: Measured physic-chemical parameters by other studies.

Parameter	(Siew, 2006)	(Omar, 2008)	(Aqilah *et al*., 2013)
BOD (mg/L)	160	N/A	160
COD (mg/L)	1854	579	1600
TSS (mg/L)	1138	62.9	14787
pH	8.1	8.58	9.0
Color (ADMI)	N/A	547	N/A
TOC (mg/L)	N/A	179	N/A
Total iron (mg/L)	N/A	0.418	N/A

Characterization of POMSE is considered as a vital part before any biological or chemical treatment is implemented for wastewater treatment because the concentration of pollution and organic contained could affect the performance of the treatment. Therefore, the characterization of POMSE is one of the crucial steps in order to design any further treatment plant. The aim of this study was to characterize POMSE sample taken by determining the average range of COD, BOD_5, color, TSS, turbidity, iron ferrous, and total iron taken from different times of sampling.

2.0 Materials and Methods

2.1 Materials and Reagents

DRB280 Reactor, COD Reactor (TR125, Orbeco Hellige), DR5000 Spectrophotometer, Turbidity Meter (Digimed), COD Digestion Reagent Vials(High range, 20-1500mg/l), FerroVer Iron Powder Pillow, 1,10-Phenanthroline (Ferrous Iron Reagent), Bod Nutrient Buffer Pillows, and Polyseed capsule.

2.2 Sampling of POMSE

Samples were obtained from the second treatment pond (also known as final discharged pond before being used for irrigation purposed) in one of oil palm mills in Kuala Selangor. The grab sampling were done at 10.30am-12.30pm in five different months, July, December, March, May and November. Samples collected were placed in the polypropylene container and were directed transported from the mill to the laboratory without any delay. The analyses were done on the same day it is collected.

2.3 Methodology

COD was digested by using COD reactor and determined using Hach Digital Reactor Block (DRB280) according to Method 8000-Reactor Digestion Method. Color was determined by using Hach DR5000U Spectrometry based on 10048-ADMI Weighted Ordinate Method. Total iron in supernatant was determined based on method 8146 and 8008-Ferrover Method respectively, both provided by Hach. TSS were done according to gravimetric procedure. Turbidity were determine by using turbidity meter. COD were determined after being diluted by dilution factor(df) of 3. All the test were according to standard method and is approved by USEPA for wastewater analysis.

3.0 Results and Discussion

3.1 Comparing POMSE Characteristics on Different Sampling Period.

Table 3 lists the characteristics of POMSE at five different sampling periods; July, December, March, May and November.

Table 3: Characteristics of POMSE from five different sampling periods at Palm Oil Mills.

Parameter	July 2013	December 2013	March 2014	May 2014	November 2014
COD (mg/L)	4044	3324	3234	3624	3309
BOD (mg/L)	249	266	250	267	270
Color (ADMI)	4810	5350	4508	3860	6270
pH	7.86	7.9	8.3	8.0	7.95
Fe^{2+}(mg/L)	0.7	0.0	0.0	0.0	0.05
Total Fe (mg/L)	1.75	0.0	0.0	0.24	0.06
TSS(mg/L)	N/A	N/A	1875	1635	1724
Turbidity (NTU)	N/A	N/A	2894	2865	2843

*N/A= not available

It is concluded that the COD values from the palm oil mill was fallen in the range between 3000 to 5000 mg/L as the results obtained for July' 2014, December' 2014, March' 2014, May'2014 and November' 2014 were recorded as 4044, 3324, 3234, 3624 and 3309mg/L, respectively. The color obviously seen as dark brown color and cloudy, that comes from the high amount of suspended solid. The color recorded for July'2014, December'2014, March'2014, May'2014 and November'2014 were 4810, 5350, 4508, 3860 and 6270ADMI respectively. The TSS for March'2014, May'2014 and November'2014 demonstrated 1875, 1635mg/L and 1724mg/L respectively while turbidity were all higher than 2800NTU. The pH of POMSE was found to be in the range of 7 to 8. BOD_5 reading for these five month, is accumulated up to 249, 266, 250,

267 and 270mg/L respectively. Ferrous iron and total iron concentration were not detected in every sampling time; however, in July'2013 it was found the highest as compared to other month, which are 0.7 and 1.7mg/L respectively.

It is worth to mention that different characteristic of POME may caused by the various source of the wastewater. According to Wu *et al*., 2010, there are several factors that could affect the characteristics of POME. The different batches or days, different oil extraction techniques, the quality of the palm fruits, the different in climate and the different in cropping season of the oil palm could affect the quantity and quality of POME produced, the treatment efficiency conducted to POME, and eventually affect the quality and the characteristics of POMSE.

The fluctuate results on the ferrous iron and total iron may be the results of the different time of sampling and also the stirring effect of the pond itself. In this experiment, the time taken for sampling was randomly and not according to fixed HRT time, thus causes the different in the reading. According to Zakaria *et al*., 1995, there are different in nutrient content in pond digestion and tank digestion with agitation effect. In pond digestion process, nitrogen and potassium will go down and settled with sludge solid while in tank digestion with agitation and stirring effect, they are negligible effect to the nutrient as the agitation only will breaks down the complex organic solid for enhancing nutrient uptakes by plant.

The high COD and color obtained from this palm oil mill is expected because in respect of achieving the zero discharged from the palm oil residue, irrigation of POMSE to the plantation sub-soil falls to the second choice that been applies by many palm oil mill. Treatment that been conducted by the oil palm mill are both the anaerobic and aerobic (open tank digestion and extended aeration) treatment system. Usually, the times taken for anaerobic-aerobic treatment were between 30-60 days. Yacob *et al*., (2006) stated that open tank digester were able to remove up to 80% of initial COD within 20 days of HRT before the effluent being further treated in extended aeration pond for the next 10 days (Ugoji, 1997) or 40 days (Chan *et al*., 2010).

In the other hand, reports by Gobi and Vadivelu (2013) mentioned that these techniques are considered as lame and obsolete as POME is not treated effectively. In addition, Ahmad *et al*., (2003) found that the ineffective of the treatment is because of the sensitivity of the microorganism present towards the temperature changes and pH fluctuation. Other than that, high organic content, silting, and the short circuiting in aerobic and anaerobic treatment may lead to some challenging to reach the standard discharge limit (Abdullah and Sulaiman, 2013). Yet, this type of treatment is still the most popular choice because it is economical. Figure 1 showed the typical color of POMSE.

Figure 1: The color of POMSE.

4.0 Conclusions

This study has characterized POMSE based on BOD_5, COD, TSS, turbidity, total iron and ferrous iron. Although POMSE has been treated with conventional treatment, it is found that there are still high value for COD, BOD, TSS and color as also been reported by other studies. It is concluded that the COD values from the palm oil mill were in the range of 3000 to 5000mg/L; BOD 200 to 300mg/L; color 3000 to 6000 ADMI; pH 7.8 to 8.5; ferrous iron 0 to 0.7mg/L; total iron 0 to 1.7mg/L; TSS 1500 to 2000mg/L and turbidity 2000 to 3000NTU.

5.0 Acknowledgements

The authors are pleased to thanks and acknowledge the financial support from Ministry of Higher Education (MOHE) under the Research Acculturation Grant Scheme (600-RMI/RAGS 5/3 (59/2012), Universiti Teknologi MARA, Universiti Teknologi Malaysia and oil palm miller for facilitating this study.

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