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EFFECT OF POME AND SLUDGE RATIO ON ACCLIMATION PROCESS OF BIOGAS PRODUCTION FROM PALM OIL MILL EFFLUENT

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ABSTRACT

Biogas fermentation process of POME is take place at pH > 7.5, while POME has a low pH (4-5), so addition of POME will cause the system to collapse. The purpose of this study is to determine the ratio of POME and sludge mix proper for acclimation process of biogas production from POME. The study was started by determining characteristics of POME, sludge, and a mixture of POME and sludge. The study was conducted at a temperature of 35-40^{o}C and stirring speed of 75-80 rpm. The treatment in the study is the ratio of sludge and POME = 25 % : 75 % ; 50 % : 50 % ; 75 % : 25 % ; and 100 % : 0 %. Observations were carried out on the production of biogas and pH. Results of the study are (1) Addition of POME into the sludge turned down the activity of microorganisms forming biogas and (2) the formulation of a mixture of sludge and proper POME is fermented with 100 % sludge or without the addition and the addition POME done gradually in area of biogas generation.

Keywords: POME, sludge, biogas, acclimation

INTRODUCTION

Background

Palm oil mill effluent (POME) is a by-product of palm oil industry that the volume are very large. POME reached 2.5-3 tons produced for every tonne of CPO production (Wu et al., 2010) or 1.5 m3 / tonne of CPO (Kongnoo et al., 2012). Estimated number POME produced in Indonesia is 3 ton / ton of CPO (Ditjen Perkebunan, 2012). In 2011 the estimated number of POME generated in Indonesia reached 70.57 million tons (Ditjen Perkebunan, 2012).

By now, the treatment of the POME are spontaneous fermentation systems, such as the ponding system, as liquid fertilizer (land application), and watering for empty fruit bunches in the manufacture of organic fertilizers. POME spontaneous fermentation causing foul odors and cause methane emissions. Methane is a greenhouse gas (GHG) with a power of 20-30 times (Porteous, 1998). Actually, methane gas (biogas) the results of the process of anaerobic decomposition of organic material has a high energy content and can be used as an energy source (Khemkhao et al., 2012).

Many research results state that making biogas from POME is very unfavorable, this is due to the methane gas produced is very small (0.28 L / g COD) and takes a long time (Sarono et al., 2013). The longer time of the biogas formation from POME is probably caused by the excessive addition of POME into bioreactor so that the fermentation process is collapsed. The cause of the collapse of the fermentation system is the drastic change in pH due to the addition POME.

Biogas fermentation process of POME take place at pH> 7.5, while POME have a level of acidity (pH) is low (4-5) and high content of organic material (Zinatizadeh et al., 2006), so the addition cause the system to collapse. Therefore it is necessary to do research on the addition POME into the system so that the optimum process of fermentation in the bioreactor remains stable.

Research Objective

Objective of this study was to determine the formulation of sludge and POME proper for the acclimation process of making biogas from POME.

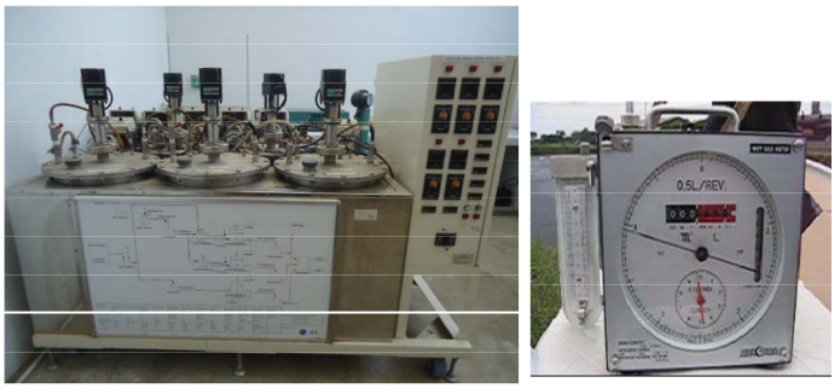
MATERIAL AND METHOD

Research had been conducted at the Analysis Laboratory of State Polytechnic of Lampung and Waste Management Laboratory of Agro-Industry Department of THP UNILA. POME and sludge samples were taken from the MCC PTPN 7, Business Unit Bekri Central Lampung.

The method used is the method description by presenting observations in the form of tables and graphs and then analyzed descriptively. The study was conducted in an anaerobic bioreactor Bench Scale Advance Methane Fermentation; Model AR-50L-3 with a capacity of 50 L equipped with a stirrer (CSTR bioreactor) (Figure 1a), gasflow meter types Wet Gas Meter Model W-NK 0:58 (Figure 1.b).

Research conducted in stages, as can be seen in Figure 2. The study begins by determining the characteristics POME, sludge, and the sludge mixture POME and appropriate treatment. Observations on the characterization include pH value, COD, Total Suspended Solid (TSS), and Volatile Suspended Solid (VSS). The study was conducted at a temperature of 35 - 40^{o}C and stirring speed of 75-80 rpm. The contents of the bioreactor circulation is done every day by removing the contents of the bioreactor of 0.5 liters and replace it with POME.

The study was conducted with four treatments, namely (a) the ratio of sludge and POME = 25%: 75%; (b) the ratio of sludge and POME = 50%: 50%; (c) the ratio of sludge and POME = 75%: 25%; and (d) the ratio of sludge and POME = 100%: 0%. Observations were made on the production of biogas and pH daily.



(a) **(b)**

Figure 1. (a) Anaerobic bioreactors "*Bench Scale Advance Methane Fermentation" (50 L capacity)* ; (b) Gas Flow Meter.

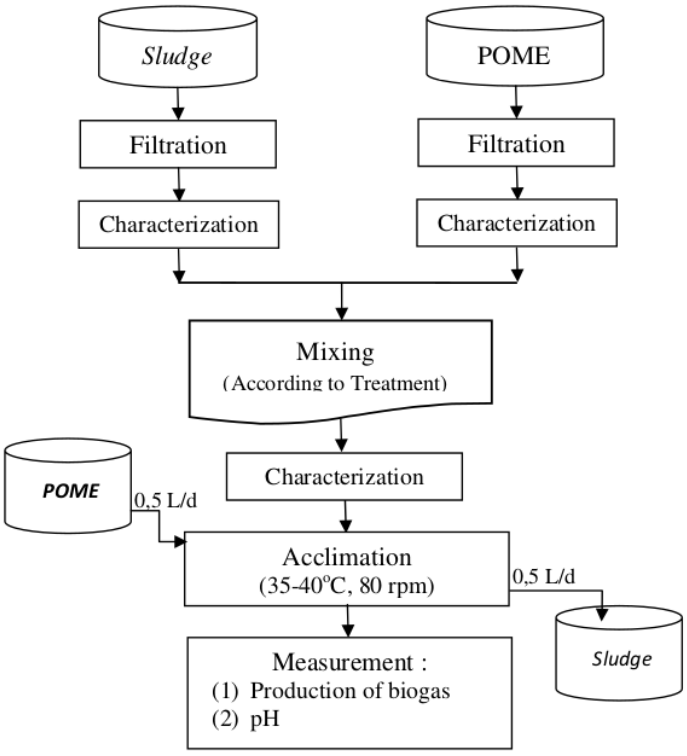


Figure 2. Stages Research

RESULTS AND DISCUSSION

Characterization POME and Sludge

Palm oil mill effluent (POME) used is palm oil mill effluent coming out of the exhaust pipe plant oil palm. Sludge used is derived from a pool of sludge aerobic sewage treatment units palm oil mill. Characterization POME and sludge that were used for research is showed on Table 1.

Table 1 Results of Characterization POME and Sludge

parameter of the observation	POME	*Sludge*
Temperature (^{o}C)	55 - 70	25 - 27
pH	5,12 - 5,54	7,81 - 7,88
COD (mg/L)	45.000 - 52.000	20.500 - 30.750
TSS (mg/L)	48.185 - 56.340	22.400 - 55.640
VSS (mg/L)	14.305 - 22.550	7.760 - 11.450
Color	milk chocolate	dark black
Odor	Typical (not smelly)	Smells and sting

Table 1 shows that POME parameters COD, TSS, VSS, and the pH value exceeds the threshold to be discharged into public waters ((MENKLH RI, 1995). The table also shows that a high COD value, ie above 45,000 mg / L, have the potential as well as the potential environmental pollutants produce methane gas as a source of energy. According to calculations perfect stoichiometry 1 kg COD degradation will produce 0.35 m3 of methane gas at room temperature (Romli, 2010). According to Susanto and Walandouw (2012), a palm oil mill with a capacity of 60 tons / hour which resulted in POME amounted to 21,500 m3 capable of generating electrical energy by two MW.

From Table 1 also shows that the POME has a pH between 5,12 to 5,54. According to Ahmad et al. (2012), POME a brown colloidal milk with a pH 4-5, the pH value POME much influenced by the quality of raw materials ie fresh fruit bunches (FFB). The pH value is very important for the growth mikrooirganisme biogas formation. According to Choi et al. (2013) pH optimum for fermentation POME under anaerobic conditions is from 6.8 to 7,2.

Acclimation process

The results showed that the higher the percentage POME turns down the activity of microorganisms biogas formation (Figure 3). In the Figure shows that the percentage increase of 25% at the beginning of fermentation POME, keep lowering the formation process biogas or fermentation remains kolep. It is suspected POME 25% increase in sludge lowers the pH of the media, so the biogas-forming microorganisms are dying.

At the beginning of the fermentation without the addition POME or 100% sludge, the addition of bait POME 0.5 liter /day of biogas formation can run well, even an increase in the formation of biogas until day five. This shows that the sludge that is used has to contain a number of active consortium of microorganisms that produce biogas.

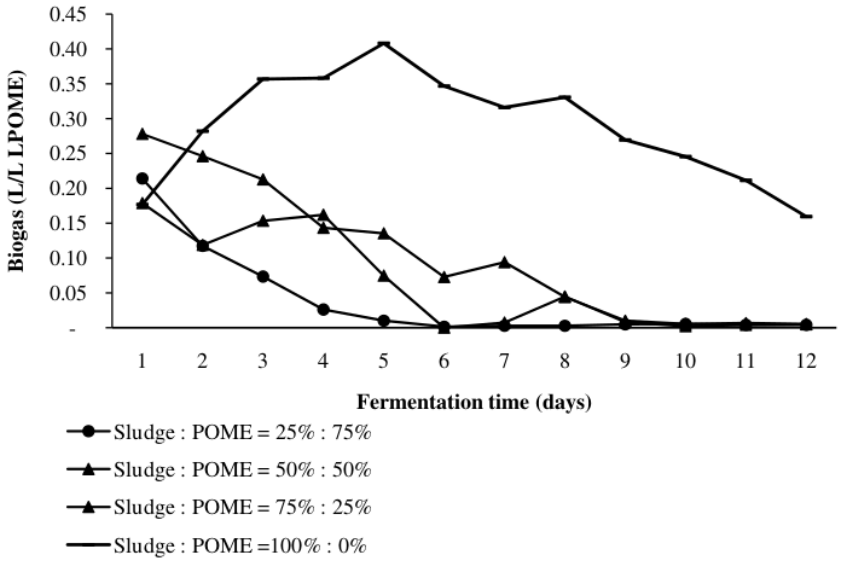


Figure 3. Effect of the Addition POME Biogas Production Process During Acclimation

The increase in biogas formation until the fifth day allegedly because the fermentation is done at a temperature of 35 – 40°C, which is the temperature for growth mikroorgaanisme optimam forming biogas. This indicates that the active microorganisms to revamp the group of thermophilic anaerobic microorganisms such as Methanosarcina, Methanococcus, Methanobacterium, and Methanobacillus (Badiei et al., 2012). Choorit and Wisarnwan (2007) states that the fermentation process POME at thermophilic temperatures four times faster compared to fermentation at mesophilic temperatures.

Sarono et al. (2013), stated that the process of acclimation at 45°C faster than room temperature as in Figure 4. From the figure can be seen also that the biogas production after a dormant period at 45°C also faster than at room temperature.

Medium pH changes are very significant to the activity of microorganisms forming biogas (Choi et al., 2013). POME characterization results shown that the pH of acid approaching POME used is between 5.12 to 5.54; while the sludge is used a pH between 7.81 to 7.88. A mixture of sludge and POME with a composition of 25%: 75% had a pH of 5.41; composition of 50%: 50% had a pH of 6.13; 75%: 25% had a pH of 6.73, and the composition of a 100%: 0% has a pH between 7.81 to 7.88. The fourth treat every day do the contents of the bioreactor circulation by using POME 0.5 liters / day and fermented for 12 days, then the result can be seen in Figure 5.

From Figure 5, it appears that differences in pH occurs because POME ratios and different sludge. While circulation or replacement of the contents of the bioreactor with POME as much as 0.5 liters per day does not affect the pH changes during the 12 days of fermentation. This is presumably because the biogas forming bacteria have not been able to work optimally in singakat time (12 days). Research results Sarono et al. (2013),

shows that the change in pH occurred after day 28 for the fermentation POME at 45^{o}C and after a day to 100 for fermentation POME at room temperature (Figure 6).

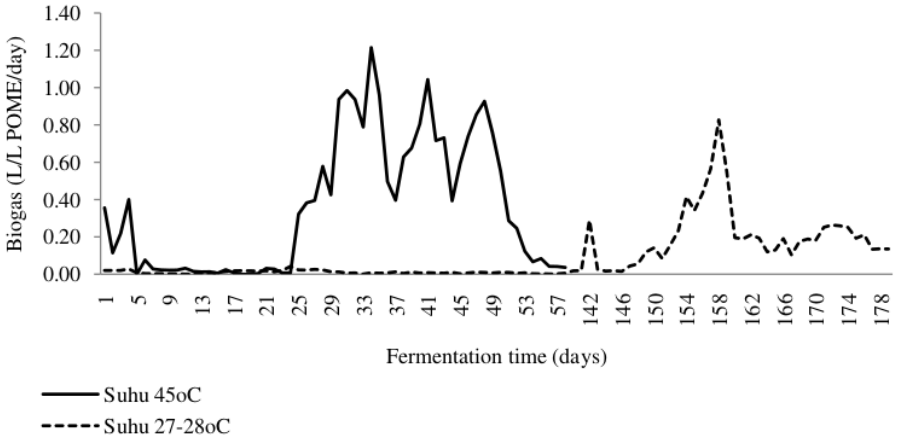


Figure 4. Pattern POME production of biogas fermentation at different temperatures (Sarono et al. 2013)

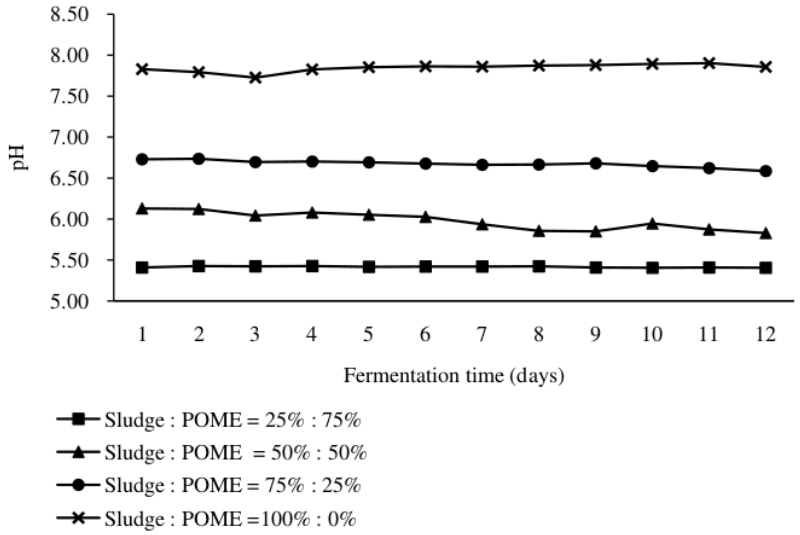


Figure 5. Changes in pH of Various Treatments for Acclimation Process

This is presumably because each group of microorganisms has an optimum temperature for growing different. In the group of thermophilic microorganisms such as Methanosarcina, Methanococcus, Methanobacterium, and Methanobacillus optimum temperature around 50-60^{o}C, so that at these temperatures the process of degradation of

macromolecules (proteins, fats, and carbohydrates) into mikromolekul and organic acids more rapidly, so that the pH quickly drops. According to Choi et al. (2013) pH optimum for fermentation POME under anaerobic conditions is from 6.8 to 7.2.

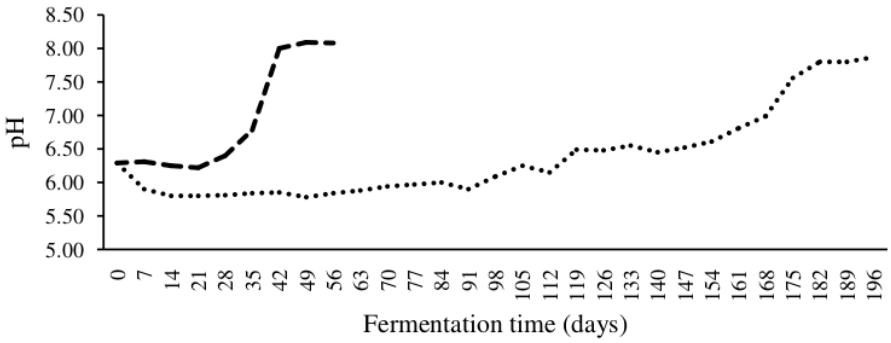


Figure 6. Changes in pH value POME for Fermentation Process at Different Temperatures (temperature 45^{o}C; temperature 27-28^{o}C)

According Badiei et al. (2012), many microorganisms thrive at mesophilic temperatures (40-50^{o}C) is a group of Streptococcus about 50%, about 30% Lactobacillus group, and the group of Clostridium approximately 20%. Mesophilic microorganisms such groups is slower than the thermophilic in the conversion of organic matter into organic acids. In addition, the temperature rises to a certain extent will accelerate the process of conversion reactions of macromolecules into micromolecules.

CONCLUSION

(1) Addition of POME into the sludge turns down the activity of microorganisms forming biogas.
(2) Formulation mixture of sludge and POME the best is fermented with 100% sludge or without the addition POME and the addition POME done gradually in area of biogas generation.

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