International Journal of Science and Mathematics Education
Volume 1, Nomor 4, Tahun 2024
e-ISSN: 3062-7214; p-ISSN: 3062-7206, Hal 39-44
DOI ; https://doi.org/10.62951/ijsme.v1i4.99
Available online at: https://international.arimsi.or.id/index.php/IJSME

Effect of pH on COD Reduction in Biogas Formation

Nadiareta Sitorus [1] , Desniorita [2]
[1,2] Politeknik ATI Padang, Indonesia

Jln. Bungo Pasang Tabing, Padang, West Sumatra, 25171, Indonesia
Correspondence e-mail: nadiaretasitorus08@gmail.com

***ABSTRACT** : Biogas is a mixture of gases formed from the decomposition of organic materials with the help of bacteria through an anaerobic fermentation process (airtight) to produce biogas in the form of methane gas (CH4) that can be managed. In biogas production, pH is one of the factors that affects the production process where an inappropriate pH will cause the performance of microorganisms in degrading organic matter into biogas to be less than optimal. This can be seen from the COD reduction produced, namely COD reduction will increase when operating conditions are at optimal pH, for this reason, conditioning the operating process according to the optimum pH is needed. So that in order to maximize the production of biogas produced, research was conducted to determine the optimum pH in the biogas production process carried out at PT AMP Plantation. In this study, biogas production data was collected so that the optimum pH in the production process carried out was known. From the research that has been carried out, the optimum pH for the biogas production process is 7, which produces the highest COD reduction of 91.78%.*

***Keywords** : Biogas, pH, COD Reduction.*

INTRODUCTION

Indonesia produces 59% of the total palm oil production or 45.5 million per year. In 2022, Indonesia exported 25.01 million tons of CPO and its derivative products (BPS, 2022). According to Shintawati et al. (2017), the results of the palm oil industry used as a raw material for other industries such as food, cosmetics, and soap. Therefore, the processing of Fresh Fruit Bunches (FFB) of oil palm into crude palm oil requires a lot of water up to 1-2 m3 / ton of FFB. Therefore In addition, the processing of Fresh Fruit Bunches (FFB) contains by-products such as Palm Oil Mill Liquid Waste (LCPKS).

Liquid waste from palm oil mills is generally high temperature, brownish in color, contains dissolved and suspended solids in the form of colloids and oil residue with high BOD (*biological oxygen demand*) and COD (*chemical oxygen demand*) of 48,000 mg/L with a neutral pH of 6-7 (F. Sosanty Lubis, 2013).

Currently, one of the POME processing is processing POME into biogas or anaerobic fermentation process. Anaerobic fermentation in COD decomposition carried out by anaerobic microbes in the digester lagoon (closed reactor) through several stages, namely the hydrolysis process is the process of decomposing complex compounds (proteins, carbohydrates, fats) into simpler compounds (glucose) by microorganisms. This decomposition process occurs anaerobically and the process occurs due to the reaction between water and long-chain polymers (complex compounds) to form monomers that are soluble in water. Microorganisms that play a role in this stage are hydrolytic bacteria such as *clostridium, bacillus, collulomonas,*

Received Oktober 09, 2024; Revised November 21, 2024; Accepted Desember 10, 2024;
Published Desember 30, 2024

and *bacteriodes ruminococcus* . The acidification process is the process of decomposing monomers and polymers into acetic acid, CO_2 and short-chain fatty acids and alcohol. The acetogenesis process is the process of forming acetic acid, carbon dioxide and hydrogen by converting fatty acids and alcohols resulting from the acidification process. Microorganisms that play a role in this stage are acetogenic bacteria such as *desufomonas, desulfotomaculum, and desulfovibrio.* The last stage of methanogenesis is the change of compounds into methane gas (CH_4) which is the biogas produced. Microorganisms that play a role in this process are methanobacterium, methanococcus (Darisa, 2014).

Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize organic substances in water. COD is one of the important parameters in determining the level of water pollution by organic substances that can be naturally oxidized through microbiological processes. Decreasing COD values can increase biogas production, while pH that is too high can have a negative impact on the methanogenic bacterial population, thus affecting the rate of biogas formation. The results of the study showed that the best COD removal efficiency was obtained at a pH between 6.5 - 7.3.

The pH factor plays a very important role in anaerobic decomposition because at an inappropriate pH range, microbes cannot grow optimally. Ultimately, this condition can inhibit the acquisition of methane gas. The optimum acidity level for the life of microorganisms is 6.5-7.3 (Simamora et al., 2006). Over time, the digester will experience a decrease in its performance effectiveness. Based on the background above, the author is interested in conducting research entitled "The Effect of pH on COD Reduction in Biogas Formation"

The purpose of this study was to determine the effect of pH on COD Reduction in the biogas formation process at PT AMP Plantation.

LITERATURE REVIEW

Palm Oil Mill Effluent (POME)

Palm oil mill liquid waste or *Palm Oil Mill Effluent* (POME) is one type of organic industrial waste in the form of water, oil and organic solids originating from the by-products of the processing of fresh fruit bunches (FFB) of oil palm to produce *Crude Palm Oil* (CPO). Liquid waste from palm oil mills is generally high temperature, brownish in color, contains dissolved and suspended solids in the form of colloids and oil residues with high BOD (biological oxygen demand) and COD (chemical oxygen demand) of 48,000 mg/L with a neutral pH of 6 - 7. If the waste is directly discharged into the water, some of it will settle, decompose slowly, consume dissolved oxygen, cause turbidity, emit a sharp odor and can

damage the aquatic ecosystem. Before this liquid waste can be discharged into the environment, it must first be must first be processed to comply with the established waste quality standards (F.Sosanty Lubis, 2013).

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize organic substances in water. COD is one of the important parameters in determining the level of water pollution by organic substances that can be naturally oxidized through microbiological processes. A decrease in COD values can increase biogas production, while a pH that is too high can have a negative impact on the population of methanogenic bacteria, thus affecting the rate of biogas formation (Nugrahini, 2020).

pH

The pH factor plays a major role in anaerobic decomposition because at an inappropriate pH range, microbes cannot grow optimally. Ultimately, this condition can inhibit the acquisition of methane gas. The optimum acidity level for the life of microorganisms is 6.5-7.3 (Simamora et al., 2006). Over time, the digester will experience a decrease in its performance effectiveness.

Biodigester

Biodigester is a tool that functions as a place for the fermentation process of organic waste with the help of microorganisms to produce biogas. *Palm Oil Mill Effluent* (POME) waste is collected in the biodigester during the decomposition process or in other words until the waste produces biogas. The average residence time in *the cover lagoon* is 30 days.

METHODOLOGY

Tools and materials

The raw materials used in this study were industrial liquid waste in the form of POME, COD reagent , and distilled water obtained from PT AMP Plantation. The equipment used was a measuring flask, beaker, *photometer with* COD, and pH meter.

COD Sample Testing Technique

The stages carried out for sample testing are as follows:

a. Prepare the tools and materials to be used
b. Take samples from each unit

c. Label the reagent high for POME and medium for *effluent.*
d. Put 2.5 ml of each POME sample and biodigester effluent into a measuring flask.
e. Add distilled water until the meniscus brick and homogenize.
f. Add the POME solution in the measuring flask to the high I reagent as much as 0.2 ml.
g. Add 0.2 ml of distilled water into high reagent 2 as a blank.
h. Add 2 ml of the effluent solution to the measuring flask into medium I reagent.
i. Add 2 ml of distilled water into reagent medium 2 as a blank.
j. Heat all reagents in the COD reactor at a temperature of 150 ^{0}C for 2 hours.
k. Cool the reagent to room temperature, then record the COD value on the photometer *with* COD.

Data collection technique

The data obtained to determine the effect of pH on COD Reduction in biogas formation was obtained by observing the gas analyzer. Data collection was carried out at the methane capture of PT AMP Plantation from November 9 to December 21, 2023. Data collection was carried out by analyzing COD content in the laboratory and measuring pH using a pH meter.

RESULTS AND DISCUSSION

Results

The data from observations were carried out using a pH meter and *Chemical Oxygen Demand* (COD) analysis in the PT AMP Plantation laboratory.

Table 1 Observation data

Day 2-	POME feed (m^3)	pH	COD in (mg/l)	COD out (mg/l)	COD Red (%)	Ch4 (%)
1	735	6.30	63.840	14.490	77.30	53.76
2	735	5.89	52.900	13.580	74.33	42.90
3	735	7.24	47.320	4.220	91.08	57.24
4	735	7.27	35.530	2.920	91.78	58.90
5	735	7.05	46,280	7,081	84.70	55.55
6	735	6.51	40,000	4,880	87.80	56.65
7	735	6.45	52,140	8,330	84.02	54.07

Source: Researcher, 2023

Discussion

Palm Oil Mill Effluent is a liquid waste produced in the palm oil processing process. POME contains a lot of organic matter that can be processed into biogas through an anaerobic process. The anaerobic process is a process of anaerobic degradation of organic matter by the

activity of anaerobic bacteria in conditions without oxygen. The product produced from this anaerobic POME process is called biogas. Biogas is the final gas product of digestion or anaerobic degradation of organic matter by anaerobic bacteria in an oxygen-free or air-free environment.

pH is one of the factors that influences the biogas formation process, because the activity of enzymes produced by microorganisms is greatly influenced by the pH value (Anugrah, et al., 2017).

Chemical Oxygen Demand (COD) value is a food material for microorganisms for the hydrolysis process and acid formation anaerobically, then the acid formed will be utilized by microorganisms to produce biogas. The decrease in COD value emphasizes the need for oxygen for chemistry where the compounds measured are materials that are not broken down biochemically (Ginting, 2007).

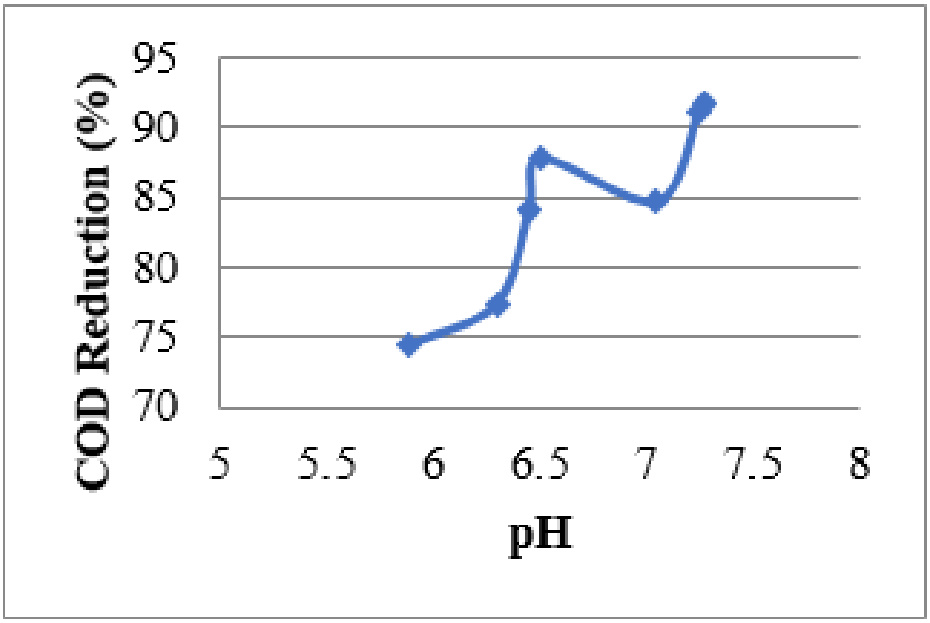

Figure 1 shows the graph of pH against COD reduction in biogas formation.

Based on the graph above, it can be seen that the gas formed first was 42% with a decrease in COD reduction (%) value of 74% at pH 5.8 then the decrease in COD reduction (%) value increased to 87% with gas formed of 56% at pH 6.5. However, biogas formation decreased to 55% with a decrease in COD reduction (%) value of 84% at pH 7. The decrease in the value of biogas formation produced was caused by external factors, namely engine trip,

where this condition caused the production process to stop. Then the decrease in COD reduction (%) value increased to 91% with gas formed of 58% at pH 7.2.

From the data above, it is known that the biogas concentration is influenced by COD reduction (%) where the higher the COD reduction (%) the higher the CH4 concentration , because COD indicates the amount of organic matter that can be degraded into biogas.

In addition, pH will also affect the amount of CH4 formation . According to (Hudson, 2010) the optimum pH for biogas formation is 6-7.2. This is also in accordance with the research that has been done. Where, the highest biogas concentration is 58% at pH 7.2 and at pH 5.8 only produces 42% biogas. This happens because the pH that is too acidic causes a decrease in the performance of microorganisms in biogas formation.

CONCLUSION

After conducting Internship Lecture (KKP) activities for approximately 8 months at PT AMP Plantation, the following conclusions were obtained, namely:

1. Students carry out 8 (eight) competencies that must be achieved during the Practical Work Lecture (KKP) activities at PT AMP Plantation, namely: *Intrusion* , Bioprocess Unit (*biological/chemical*), Separation Unit, Heat Transfer Unit, Solid, Liquid and Gas Transportation Unit, *Maintenance* , Process and *Quality Control, Engineering Design.*
2. *Palm Oil Mill Effluent (POME)* as raw material at PT AMP Plantation.
3. Students can complete the tasks given by the field supervisor.
4. Based on the data obtained, the highest COD reduction was 91.78% with a pH of 7.2 with biogas formation of 58.90%.

BIBLIOGRAPHY

Ahmad, AL, Sumathi, S., Hameed, BH 2005. *Adsorption of residue oil from palm oil mill effluent using powder and flake chitosan: equilibrium and kinetic studies.* WaterRes Volume 39 Pages 2483-2494.

Melisa, Apriyanto, & Mulono. (2020). “Palm Oil Factory Liquid Waste Processing (Case Study at PT. Tri Bakti Sarimas PKS 2 Ibul, Riau) Food Technology Students, Indragiri Islamic University. *Journal of Agricultural Technology*, 9(2),86 -93.

Nugrahini, P., & Parningotan, R. (2020). THE EFFECT OF NPK ADDITION IN DEGRADATION OF PALM OIL LIQUID WASTE USING ANAEROBIC BAFFLED REACTOR. 8(3). http ://journalbalitbangdalampung.org

Nurhidayat, Achmad. (2013). “The Effect of Volume Fraction on the Manufacture of Waste HDPE Composite-Cantula and Various Types of Adhesives in the Manufacture of Laminate.” *Thesis, Sebelas Maret University 1-71.*

Rahayu, AS, Karsiwulan, D., Yuwono, H., Trisnawati, I., Mulyasari, S., Rahardjo, S., Hokermin, S., Paramita, V. (2015) POME to Biogas Conversion Guidebook, Project Development in Indonesia. Winrock International.

Simamora, S., Salundik, Sri Wahyuni and Sarajudin. 2006. Making Biogas as a Substitute for Fuel Oil and Gas from Animal Waste. Argomedia Pustaka. Jakarta.