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Effect of NaOH on Biogas Production Under SSAD Conditions Along with Kinetics Studies

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ABSTRAK

Indonesia merupakan negara penghasil padi yang cukup besar dimana dari kegiatan tersebut menghasilkan limbah berupa sekam padi. Sekam padi tidak dapat terdegradasi dengan sendirinya akibat kandungan lignin yang terkandung dalam sekam padi tersebut. Oleh karena itu, dilakukan perlakuan untuk menghancurkan kandungan lignin dan memanfaatkannya sebagai energy alternative berupa biogas. Penelitian dilakukan pada skala laboratorium dengan suhu ruangan, perlakuan pendahuluan menggunakan NaOH 3% pada kondisi SSAD 27,5% TS untuk selanjutnya diukur produksi biogasnya setiap dua hari sekali selama 90 hari. Selanjutnya, hasil produksi biogas diamati antara biogas dengan NaOH dan tanpa NaOH dan dilakukan studi tentang kinetikanya. Dihasilkan bahwa produksi biogas dengan NaOH lebih tinggi, yaitu mencapai 59,2 mL/gTS sedangan tanpa NaOH sebesar 14,7 mL/gTS. Hal membuktikan bahwa NaOH mampu menghancurkan lignin sehingga mikroorganisme dapat mengurai sekam padi lebih mudah. Hasil studi kinetika menggunakan permodelan matematik melalui persamaan Gompertz, variable dengan NaOH diketahui produksi biogas maksimum sebesar 63,9 mL/gTS, laju produksi biogas harian 0,97mL/gTS.hari dan awal terbentuknya biogas secara signifikan pada hari ke 8.

***Kata kunci*:** Biogas, Sekam padi, NaOH, SSAD, Kinetika

ABSTRACT

Indonesia is a large rice producing country where from these activities it produces waste in the form of rice husk. Rice husk cannot be degraded by itself due to the lignin content contained in the rice husk. Therefore, treatment is carried out to destroy the lignin content and use it as alternative energy in the form of biogas. The study was conducted at a laboratory scale at room temperature, preliminary treatment using 3% NaOH under the SSAD conditions of 27.5% TS and then biogas production was measured once every two days for 90 days. Furthermore, the results of biogas production were observed between biogas with NaOH and without NaOH and carried out a study of the kinetics. The result is that biogas production with NaOH is higher, reaching 59.2 mL/gTS whereas without NaOH at 14.7 mL/gTS. This proves that NaOH is able to destroy lignin so that microorganisms can break down rice husks more easily. The results of kinetic studies using mathematical modeling through the Gompertz equation, the variable with NaOH is known to have a maximum biogas production of 63.9 mL/gTS, a daily biogas production rate of 0.97 mL/gTS.day and the initial formation of biogas significantly on the 8th day.

***Keywords*:** Biogas, Rice husk, NaOH, SSAD, Kinetics

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1. Introduction

The issue of developing renewable energy is an issue that is being warmly discussed by many parties. This is caused by the depletion of fossil energy reserves in various countries, one of which is Indonesia. Almost every country emphasizes to slowly switch to renewable energy so that many researchers conduct research and development in the sector, one of which is biogas energy. Biogas is no longer a renewable energy that is still new. Many researchers have developed to an industrial scale with raw materials for livestock manure (Putri, Saputro, & Budiyono, 2019). The latest is the development of biogas by using agricultural raw materials, one of which is rice husk (Hawali Abdul Matin & Hadiyanto, 2018). The development of biogas with rice husk as raw material is very suitable to be developed in Indonesia considering that Indonesia is a rice producing country that is large enough so that it also produces a lot of waste in the form of rice husk where its utilization is still low only as a planting medium and fuel for making bricks.

Biogas production with rice husk raw material is still at the research and development stage. Many obstacles are found such as biogas with low volume. This is partly due to the high lignin content in rice

husks so that anaerobic bacteria are very difficult to degrade and convert them into biogas. Therefore, through this research a study will be carried out to break up the lignin content in rice husks and proceed with mathematical modeling the Gompertz equation.

2. Materials and Methods

The raw material of this research is rice husks taken from grain mills in Rowosari Village, Tembalang District, Semarang City. As a source of anaerobic bacteria, using cow's rumen fluid taken from slaughterhouses in Plamongansari Village, Pedurungan District, Semarang City. This research was conducted at a laboratory scale with room temperature. Preliminary treatment using technical NaOH at a concentration of 3% (Chandra, Takeuchi, & Hasegawa, 2012) and also added a microbial consortium as a function to accelerate the biochemical process that is at a concentration of 6% (Matin & Hadiyanto, 2018). This study was also carried out under SSAD conditions after the Total Solid (TS) concentration was set at 27.5% and C/N ratio 35 (Matin & Hadiyanto, 2018). Biogas production was observed for 90 days with data collection every two days. The study was conducted for 90 days because on the 90th day, biogas was not produced significantly.

Biogas digesters are made in such a way as to be airtight because the research is carried out under anaerobic conditions, namely using bottles with plastic raw materials. The top end of the bottle is covered with thick rubber that matches the diameter of the bottle's tip. The rubber is also equipped with a valve that can be opened and closed to facilitate the biogas measurement process. Biogas is measured by means of the "liquid displacement method" (Nugraha, Syafrudin, Senduk, Matin, & Budiyono, 2018) as can be seen in Figure 1.

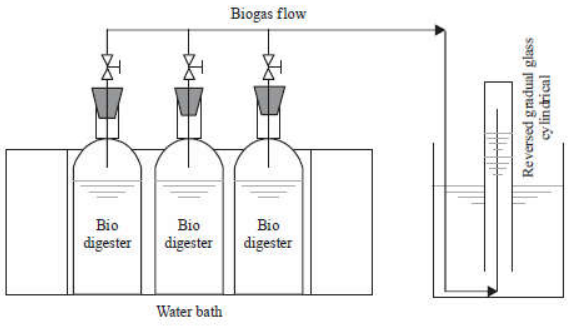

Figure 1. Schematic of the biogas measurement process

3. Results and Discussion

At this stage of the research aimed at studying the results of biogas production through preliminary treatment.aily and cumulative biogas yields are presented in Figure 2. At this stage, comparing biogas production under TS 27.5% and C/N ratio 35. In Figure 2 it is shown that biogas production starts to appear on 2nd day of 18 ml for variables with addition of NaOH, as well as variables without addition of NaOH began to appear on 2nd day with a higher value of 32 ml. Then, the variables with the addition of NaOH always have higher biogas results than the variables without the addition of NaOH. But on the 24th day, the variable without the addition of NaOH has a higher biogas yield which reaches 95 ml which is also the highest biogas yield value. Furthermore, biogas yield decreases gradually after being at its highest peak. Biogas yield on the variable with the addition of NaOH continued to increase until it reached its highest value on the 74th day with a biogas yield of 252 ml and continued with a slow through

decline in biogas production.

Biogas yield at 27.5% TS condition and C/N ratio 35 on the pretreatment variable with the addition of NaOH significantly affected the biogas production compared to without preliminary treatment using NaOH, can be seen in Figure 3. It can be seen that the total biogas yield at the variable using NaOH is greater, that is 3,672 ml and for the variable without using NaOH it is only 913 ml. In order to obtain cumulative biogas volume data for each TS unit for biogas yield by adding NaOH of 59.2 ml/gTS and for variables without adding NaOH a biogas yield of 14.7 ml/gTS is shown in Figure 4.

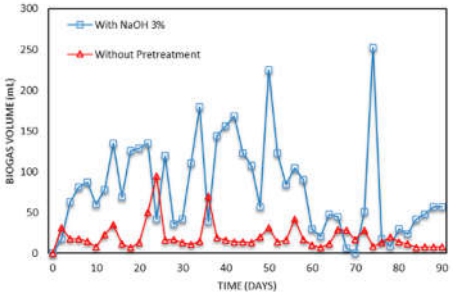

Figure 2. Daily biogas production

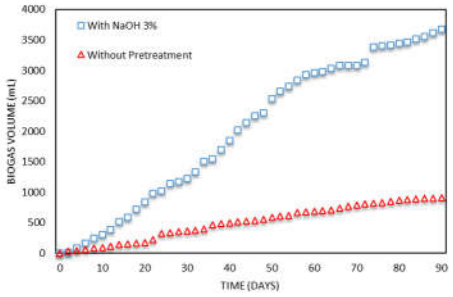

Figure 3. Cumulative biogas production

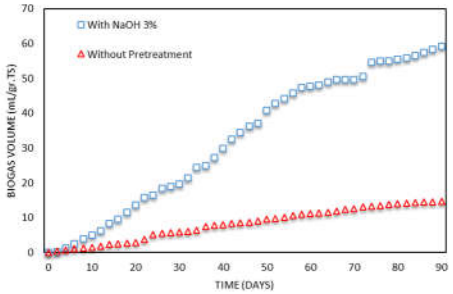

Figure 4. Cumulative biogas production per TS unit

Increased biogas production by chemical preliminary treatment using NaOH in accordance with previous studies, (F. Carrillo, M. J. Lis, X. Colom, M. López-Mesas, 2005) shows that the hydrolysis level of wheat straw with NaOH treatment is three times higher than with wheat straw without NaOH treatment. Biogas production with chemical preliminary treatment using NaOH 3% (120 hours) showed an increase in methane production reaching 132% with rice straw raw material in an L-AD atmosphere (Chandra, Takeuchi, Hasegawa, & Kumar, 2012). (Taherdanak & Zilouei, 2014) also found that lignin and hemicellulose in wheat plants were reduced using 8% NaOH. Recent research was also conducted by (Syafrudin, Dwi Nugraha, Hawali Abdul Matin, & Budiyono, 2017) where the addition of 3% NaOH for 24 hours can increase biogas production from rice husks under 21% TS conditions and a C/N ratio of 25. So it can be stated that chemical treatment with NaOH gives influence on biogas production compared without treatment with NaOH in an L-AD or SS-AD atmosphere.

The increase in biogas production results in variables with a preliminary treatment in the form of adding NaOH with a concentration of 3% for 24 hours occurred due to changes in the morphological structure of rice husks so that anaerobic bacteria can easily degrade rice husks and convert them into biogas (Matin & Hadiyanto, 2018).

Table 1. Kinetic Constants with and without 3% NaOH

Constants	NaOH	
	3%	0%
A (mL/gTS)	63.9	16.4
U (mL/gTS.day)	0.97	0.22
λ (day)	8.29	4.61

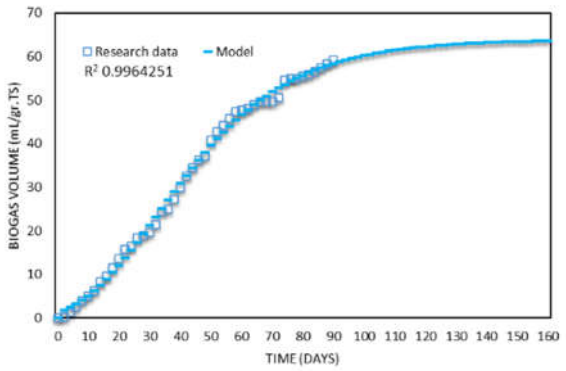

Figure 5. Cumulative biogas production per TS unit with kinetics study model on variables with 3% NaOH

Based on the results of mathematical modeling through the Gompertz equation using the help of the Polymath program, the variable with preliminary treatment using 3% NaOH is known that the maximum cumulative biogas production is 63.9 mL/gTS (set out in Figure 5) obtained on the 160th day of observation and on the variable without preliminary treatment known that the maximum cumulative biogas production is 16.4 mL/gTS. With mathematical modeling through the Gompertz equation can help researchers to determine the value of maximum biogas production without having to measure the volume of biogas until the biogas is no longer formed. In addition, data were also obtained in the form of daily biogas production rates

4. Conclusions

The implications of this study, it was found that the preliminary treatment in the form of soaking of rice husks for 24 hours using 3% NaOH can increase biogas production. This is due to the nature of NaOH which can change the morphological structure of rice husks so that anaerobic bacteria can easily degrade rice husks and convert them into biogas. This phenomenon is shown by the higher volume of biogas production in the variable with NaOH compared to the variable without NaOH, which is 59.2 mL/gTS and 14.7 mL/gTS, respectively, on the 90th day of direct observation in the laboratory. Furthermore, with mathematical modeling through the Gompertz equation, the variable with NaOH is known to have a maximum biogas production of 63.9 mL/gTS, a daily biogas production rate of 0.97 mL/gTS.day and the initial formation of biogas significantly on the 8th day.

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