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Eni Budiyati

yang telah berpartisipasi sebagai

Penyaji Makalah

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Bismillahirrahmannirrohim

Pimpinan Fakultas Teknik Universitas Muhammadiyah Surakarta memberikan tugas kepada:

Nama : Eni Budiyati
NIK : 991

Untuk melaksanakan presentasi makalah dengan judul "*Effects of Fermentation Time and Additional Volume of water in Biogas Production Process*" pada seminar nasional Teknik Kimia Kejuangan 2014 pada tanggal 05 Maret 2014 di Prodi Teknik Kimia FTI UPN Yogyakarta.

Dekan,

Sri Sunarjono
NIK. 631230960901010 22

Pelaksana,

Eni Budiyati
NIK. 991

Telah dilaksanakan
Mengetahui,

(.....)

MENGETAHUI
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KETUA

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Effects of Fermentation Time and Additional Volume of Water in Biogas Production Process

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Abstract

Water hyacinth (Eichornia crassipes) is one type of crop or weeds that normally live in the water, floating in the water, and develop shallow roots in the mud. This plant can grow exponentially, giving rise to many problems. Water hyacinth biogas has the potential to be made because it has C/N ratio of 25. Biogas is an alternative energy that is obtained from the fermentation of organic matter by anaerobic bacteria assistance so as to produce a mixture of methane (50-75%), carbon dioxide (25-45%), and some hydrogen, nitrogen, and hydrogen sulfide. In this study the materials used are water hyacinth and water. This study aims to determine the effect of the fermentation time and the additional volume of water in biogas production. Result of research shows that the highest biogas is obtained at volume ratio of 1:3 (water hyacinth to water) within 5 weeks of fermentation as much as 44.562 mL. It can be concluded that adding more volume of water will increase the biogas produced.

Keywords: *biogas, fermentation, hydrolysis, time, water hyacinth*

Introduction

The increasing of Indonesia's population causing higher energy demand in the industrial field . The presence of increase of the public began to take advantage of alternative energy, renewable and environmentally friendly (Widodo, et al., 2006).

The last few years Indonesia has become one of negaraimportir fuel. By being in fuel importing countries emerging issues such as the price of oil becomes unstable, the higher fuel prices resulting in an increase of more than U.S. $ 70 per barrel. These problems led to Indonesia to spend around 170 billion foreign exchange per day and in remote areas experiencing fuel shortages. Therefore, the public should have been thought not to rely again the energy is not renewable , then switch to energy sources that are renewable by utilizing waste, vegetable sources, and organic wastes which is able to be processed into biofuels such as biogas (Hambali, et al., 2007).

Biogas is one way that can overcome the limitations of energy sources. Biogas is not only reduced but also is able to cope with environmental problems. In areas where there are swamps or dams as Purwodadi, Salatiga are places that generate a lot of water hyacinth. Water hyacinth (*Eichornia crassipes*) is a type of weed is a plant that can damage the environment, grow in large numbers and quickly within a period of 7-10 days and have the content of C/N (43.98). Because the results are abundant, underutilized and has a content of C/N (43.98) then this plant can be made into biogas. The advantages of the use of alternative energy biogas are:

a. Able to produce a gas that can be used in daily life .
b. Used waste can turn into a slurry which contains many nutrients that are well used for fertilizer (Hambali, et al., 2007) .
c. Reduce problems in the response to a substance that is considered to be the enemy of the human material useful and beneficial (Ihwan, 2003) such as water hyacinth is used as raw material. By the process of decomposition of organic materials that do microscopic bodies will be formed substances or simple compounds such as methane (CH_4).

During the formation process using the biogas digester reactor called or biodegester, because in this reactor organic materials capable digested by bacteria that aids in the fermentation process (Suyitno, 2010) . For this study discusses the effect of fermentation time and the composition ratio and water hyacinth in the formation of biogas.

The process is performed to determine the volume of gas produced in biogas production by using the influence of fermentation time and the addition of water volume.This study aims to determine the effect of fermentation time and the addition of the volume of water in biogas production. The expected benefits of this research are:

a. Determine the effect of fermentation time in biogas production.
b. Evaluate the effect of the volume of water in biogas production.

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Ancient times the use of biogas has been widely used by the Chinese and the Egyptians, and Ancient Rome which is used as a heater. The process of fermentation in biogas production was first discovered by Alessandro Volta in 1776. The study continued in 1806 to William Henry identified the gas as it can burn. The person who first showed that the formation of methane is derived from microbiology is Becham (1868), disciple of Louis Pasteur and Tappeiner (1882). In 1900 the first time the formation of anaerobic biogas-producing tool. Then at the end of the 19th century, research suggests that methane gas is biogas. Biogas is already used as a farmer driving a tractor since World War II (Zhang, et al., 1999).

Biogas is one type of gas that is a very interesting material to be developed as it can be updated and can be made with simple technology that is formed from organic materials such as cow manure, chicken manure, human waste, straw, water hyacinth, husks, leaves and rotten vegetables manner or fermentation process to produce a mixture of methane (50-75%), CO_2 (25-45%), and some H_2, N_2, and H_2S (Hambali, et al., 2007).

The content of the heating value of biogas can be medium or high, that is very dependent on very dependent on the CH_4 content therein. Biogas also has a density greater than the density of air. If biogas is burned will have a very low maximum speed, which is about 0.25 m/s.

Table 1. Biogas composition data (Kaltschmitt and Hartman, 2001)

No	Component	Concentration
1	methane	50-75% vol
2	carbon dioxide	25-45% vol
3	water	2-7% vol. (20-40°C)
4	hydrogen Sulfide	20-20.000 ppm
5	nitrogen	< 2% vol.
6	oxygen	<2% vol.
7	hydrogen	<1%vol.

Influential Factors in Formation of Biogas

a. Raw material

Raw materials used in this study are water hyacinth. Water hyacinth (*Eichornia crassipes*) is one type of crop or weeds that normally live in the water, be floating in the water, and develop shallow roots in the mud. The proliferation of water hyacinth plants very quickly both vegetative and generative. With vegetative breed hyacinth plants can multiply within 7-10 days. The characteristics of this plant has a height of approximately 0.4-0.8 m, has no stems, leaves are oval-shaped, tapered tip and base, the base of the leaf stalk bubbles, surface slippery leaves, flowers compound, shaped grains, shaped petals tube, the seeds are round and black, three bears fruit boxes and green, and has root fibers (Soemarwoto, 2011).

Image of water hyacinth plants can be seen in Figure 1 below

Figure 1. Image of water hyacinth plants

According to Malik (2006) the water hyacinth plant has a water content of 95%. The chemical composition of water hyacinth nutrient content is depending on where he grew up, and the absorption properties of these plants. Water hyacinth has good qualities, among others, can absorb heavy metals, sulfide compounds, other than that contained more than 11.5% protein, and contains cellulose which is higher than the non-cellulose such as lignin, ash, fat, and substance-lain. The water content in the water hyacinth as much as 95% is to be the hollow network, so it can be used as an energy producer by fermentation (Chanakya, et al., 1993).

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Here is the data the chemical content of fresh and dried water hyacinth. The data can be seen in Table 2.

Table 2. Chemical Ingredients Fresh Water Hyacinth (Anonymous, 1952)

No	Compound	Percentage (%)
1	water	92.6
2	ash	0.44
3	crude fiber	2.09
4	carbohydrate	0.17
5	fat	0.35
6	proteins	0.16
7	phosphorus	0.52
8	potassium	0.42
9	chloride	0.26
10	Alkaloids	0.22

b. Degree of acidity (pH)

Determination of pH is done by using a device called a pH meter or litmus paper. Determination of pH was done as much as 2 times that at the beginning of digestion and after the second or third week. At the beginning of the digestive fluid pH obtained may be lower as the pH decreased to 6. After 2-3 weeks the pH will rise, accompanied by the formation of methane bacteria. These bacteria will work with a maximum in the range of pH 6.8 to 8, due to the pH will result in optimal digestion. If the degree of acidity of the liquid does not match the range of the liquid will be acid (Paimin, 2001).

c. The temperature of dilution

In the formation temperature of biogas biogas suitable for use in the development of bacteria which ranges from 20-40°C with an optimum temperature of 30-35°C. Thus, in the formation of biogas temperature must be maintained (Paimin, 2001).

d. Dilution of raw materials

In the manufacture of biogas should pay attention to the raw materials used because if the raw material has a high water content needs to be molded pulp, and if the material has low moisture content needs to be added to the water with a certain ratio. Good stuffing material for the formation of biogas ranged 7-9%, because if too much additional water can not form biogas formation optimally.

The use of raw materials hyacinth should be made porridge as the water hyacinth has fairly high water content. Comparison used in the mixing of the water hyacinth and water 1:1 (Paimin, 2001).

e. Fermentation time

Formation of biogas occurs around 10 days after fermentation is done about 0.1-0.2 m^3/kg and the addition of fermentation time for 10 days to 30 days which serves to increase the yield of biogas production by 50%. In fermentation are formed three components: the upper layer containing biogas, then the middle layer is a layer of scum crust derived from the undigested stuffing materials usually contain a lot of lignin, the bottom layer is the largest layer of material is a liquid because water is an active field in gastrointestinal microbes 1 (Paimin, 2001).

Methodology

Tools and Materials

The tools used in this study are:

a. Drums/bottle
b. Erlenmeyer
c. Glass beaker
d. Measuring cup
e. Knife
f. Thermometer
g. Plastic hose

Materials used in this study are:

a. Water hyacinth
b. Water

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Research Procedures

The first phase of manufacture of biogas is the water hyacinth sized cut into small pieces approximately 1 cm, then the pieces of the water hyacinth is inserted into a drum that has been provided and added water with a ratio of 1:1.5, 1:2 , 1:3. The second stage is the stage of fermentation phase mixture of water hyacinth and water (slurry) to form biogas silenced. When the biogas formed, measure the gas volume. In scheme way of working can be seen in Figure 2.

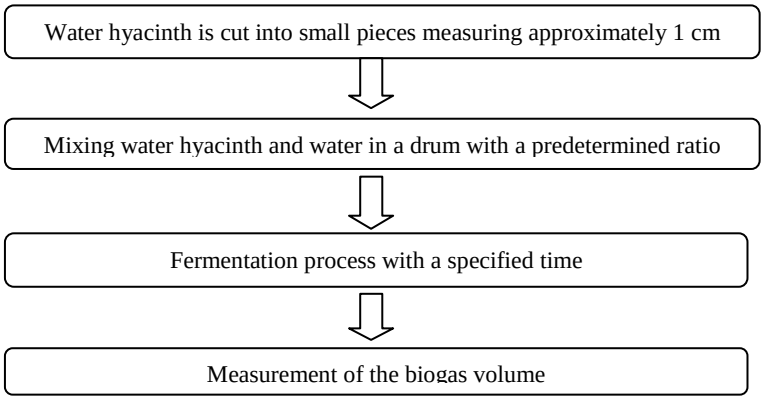

Figure 2. Stages of Manufacture of Biogas

Variables of Research

Fixed variables

In this study, the fixed variables are the mix of materials used in the manufacture of biogas, temperature (28^{o}C), pH (degree of acidity), stirring.

Free variables

In this study, the free variables are the fermentation time and the addition of water volume. Fermentation time (1, 2, 3, 4 and 5 weeks) as well as the composition of the raw material with water hyacinth (1:1.5, 1:2, and 1:3).

Results and Discussion

Biogas is an alternative energy that is obtained from the fermentation of organic matter by anaerobic bacteria assistance so as to produce a mixture of methane (50-75%), CO_2 (25-45%), and some H_2, N_2, and H_2S (Hambali, et al., 2007). fermentation process consists of four stages, namely:

a. Hydrolysis step is the decomposition of organic molecules into simpler compounds such as fatty acids, carbohydrates, and amino acids.
b. Acidogenesis phase is decomposition process produces ammonia, CO_2, and H_2S.
c. Acetagenesis stage is the process of decomposition of acidogenesis products into hydrogen, carbon dioxide, and acetate.
d. Methanogenesis phase is the last stage of the process, namely decomposition and synthesis products into methane (CH_4).

From the results of this study can be seen the effect of the additional volume of water on the formation volume of produced biogas in the following table:

Table 3. Effect of the Volume Biogas Fermentation Time

No	Fermentation time	Volume of biogas		
		Ratio of water : water hyacinth		
		1:1.5	1:2	1:3
1	Week-1	5.942	17.825	22.578
2	Week-2	10.695	21.984	26.737
3	Week 3	13.666	23.766	31.491
4	Week 4	17.825	28.519	35.649
5	Week 5	20.795	30.897	44.562

The table shows that the more addition of water will increase the volume of gas. The data can be seen in Figure 3.

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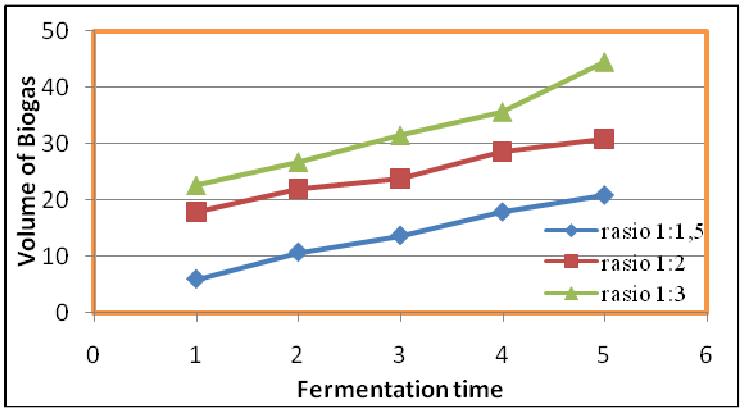

Figure 3. Correlation between fermentation time and the volume of biogas

From the graph above, it can be seen that there is increasing of the gas volume from the first week to the fifth week both comparison 1:1.5; 1:2; and 1:3. In the first week, the volume of biogas produced 5.942, 17.825, 22.578 mL and the fifth week obtained gas volume are 20.795, 30.897, 44.562 mL. The higest gas volume produced by 44.562 mL in water hyacinth and water ratio 1:3 and the least gas volume ratio of 1:1.5 by volume is 22.578 mL . This happens because the more volume of water added; the biogas produced is also growing. At this stage of hydrolysis is used to decompose organic molecules into simple molecules. Acetogenesis stage is asidogenesis decomposition process into carbon dioxide, hydrogen and acetate. Propionic acids, alcohols and other compounds are converted into acetic acid with the help of acetogenic bacteria. The next process of acidification process will be converted into methane gas. In the process of acidification of the water molecules are much needed because it will increase the formation of acetic acid to the process is the formation of methane gas methanogenesis. In addition, it also functions to facilitate the addition of mixing water, the flow of organic matter into the biodigester and facilitate the flow of gas that is formed on the bottom so it can flow to the top of the biodigester. If too few water is used can inhibit the fermentation process and cause the crust layer on the surface of the fiber stuffing material.

Other factor that affects the formation of biogas are fermentation time, stirring, temperature and pH (degree of acidity). In this study, the addition of volume of gas produced will decrease by the longer time; this is happen because decreasing content of C/N. The content of carbon (C) contained in the raw materials are being reduced because no additional feedstock bacteria that cause food can not be produced again. The content Nitrogen (N) to build structure of bacterial cells. Bacteria will take elements of the C 30 times faster than the elements of N. If the material contains more of the elements of N will be quickly depleted and the remaining elements of C will be much less causing bacteria is not active. The C/N ratio will work optimally at 20-30 . For the C/N ratio is too high need the addition of manure starter optimum working order. If the C/N ratio is too low led to elements of C will be quickly depleted, the fermentation process will be quickly depleted, and the elements of N will be much left by way of vaporized in the form of NH_3 (ammonia). In hyacinth biogas production is affected by the level of water contamination where he grew up. The higher the level of water pollution, the results generated biogas also higher. In this study hyacinth taken in the reservoir area Cengklik Surakarta, because the area is far from the city center and factory possibility of water contamination levels slightly so the biogas produced was few.

When compared with previous studies using the same raw material that is water: water hyacinth with a ratio of 1:3 with a 5-day fermentation period obtained yield was 38 mL. In this study, the same ratio is 1:3 with a time of 7 days fermentation biogas obtained as 22.578 mL. The volume of biogas produced is different because in this study water hyacinth small used in small cut whereas in previous studies that used blended water hyacinth in advance so that the particle size becomes smaller so that the wider the greater the contact surface and accelerate the rate of reaction.

Stirring once a day will have a higher temperature than without stirring, as occurs evenly distribute nutrients so that the bacteria can work well in the formation of biogas (Polprasert, 1989). This research was not designed with specific stirring and stirring tool is only done once at the beginning of the preparation of raw materials so that biogas produced is not maximal.

Conclusions

From the results obtained can be concluded that:

1. The more additional volume of water, the higher volume of biogas produced.
2. The longer the fermentation time, the total volume of biogas produced will be increase.
3. The difference of pretreatment of raw material (with a blend or just cut into small pieces) affect the outcome of biogas volume.

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Lembar Tanya Jawab
Moderator: Selastia Yuliati (Politeknik Sriwijaya)

1.	Penanya	:	Zainus S. (BATAN Serpong)
	Pertanyaan	:	• Apa saja komponen biogas? • Kalau enceng gondok sebagai bahan baku, reaksi pembentukannya bagaimana? • Apakah reaksi itu terbentuk dengan sendirinya?
	Jawaban	:	• Komposisi biogas: metana, CO_2 dan H_2S. H_2S kurang aman. • Reaksinya: Hidrolisis (pemecahan), acidogenesis (bentuk amoniak), asetogenesis, metanogenesis (merubah asam asetat menjadi amoniak) • Tanaman sudah ada bakteri disesuaikan kondisi operasinya. Rasio C/N : 20-25.
2.	Penanya	:	M. Fikri (TK UPN)
	Pertanyaan	:	Pengontrolan tekanan yang digunakan dalam penelitian ini?
	Jawaban	:	Debit sangat kecil, oleh karena itu tekanan tidak terlalu besar
3.	Penanya	:	Yohanah C.
	Pertanyaan	:	Semakin airnya tinggi mengapa semakin meningkat biogasnya?
	Jawaban	:	Air sangat dibutuhkan pada 2 proses dari 4 tahapan tersebut (hidrolisis dan asetogenesis)