INCREASE THE VOLUME OF BIOGAS MIXTURE OF HORSE FECES AND WATER HYACINTH (EICCHORNIA CRASSIPES)

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RESEARCH ARTICLE

INCREASE THE VOLUME OF BIOGAS MIXTURE OF HORSE FECES AND WATER HYACINTH (EICCHORNIA CRASSIPES)

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ABSTRACT

The existence of horse manure around the neighborhood can lead to pollution. This condition is still existed in the Babakan Loa Cimahi settlement. The application of appropriate technology with horse manure can be processed to produce biogas. In addition to horse feces, water hyacinth (Eicchornia crassipes) can be utilized in the production of biogas because it has a large hemicellulose content. The aim of the research is to find out the effect of water hyacinth addition to the volume of biogas generated from horse manure. The research hypothesis shows that there is an effect of water hyacinth addition to the gas volume production. The populations are all horse manures taken from stables in Babakan Loa and water hyacinths on the paddies, while the samples are partially taken from the population with temporary sampling technique. The type of research is quasi-experimental research with one group pre and post test design. Data collection is done by measuring the gas volume produced. The collected data is processed and analyzed using t dependent test. The result shows that the biogas volume produced without the addition of water hyacinth ranged from 0.7 to 3.1 liters, while with addition of water hyacinth ranged from 1.4 to 11.9 liters. There is a significant difference between the volume of biogas without and with the addition of water hyacinth.

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INTRODUCTION

Energy scarcity problems in Indonesia are getting special attention from the government. This drives the government to release a policy to reduce the consumption of fossil fuel and increase the use of renewable energy as outlined in National Energy Mix 2025's primary form of target. One of the efforts made to meet that target is the use of biomass as an energy source. One source of biomass energy is biogas, this is because biogas belong to the energy derived from organic materials (material non-fossil) is generally derived from a variety of organic waste, such as human waste, animal waste, plant remnants and so forth. One of the efforts to fulfill the target is to use biomass as an energy source. Biogas is one source of biomass energy, this is because biogas essentially derived from from organic materials that generally come from organic waste e.g. human feces, livestock manure, plant remnant and so forth. The existense of organic wastes are easily accessible, guaranteed continuity, and the most important of all is that it is environmentally friendly.

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This can be one of the main factor that biogas is considered as a future energy source (Wiratmana, Ketut and Putu Ngurah 2012). Livestock manure can be converted to biogas with one unit of biogas builder tool with capacity of 100L with the mixture of livestock manure and water that can produce 2.700-3.000 L of biogas per day (Mara, I Made dan Ida Bagus Alit 2011). The existence of horse manurearound the neighborhood can lead to pollution especially water and air pollution. The application of appropriate technology with horse manure can be processed to produce biogas. In addition to horse feces, water hyacinth (*Eicchornia crassipes*) can be utilized in the production of biogas because it has a large hemicellulose content. The aim of the research is to find out the effect of water hyacinth addition to the volume of biogas generated from horse manure. Biogas is a renewable energy that can be used as alternative fuel to substitute fossil-based fuel such as kerosene and natural gas (Allo Padang, Yesung 2011). Biogas is a mixture of several gases and classified as fuel gas which is the result of fermentation of organic matter under anaerobic condition and with predominantly compound of methane (CH_4 50–70%), carbon dioxide (CO_2 30-40%), hydrogen sulfide (H_2S 0-3%), water (H_2O 0.3%), oxygen (O_2 0.1-0.5%), hydrogen (H 1-5%) and other gases in small quantities (Eliantika, Efriza Fitri 2009).

The amount of energy in biogas depends on the contain of methane (CH_4) concentration (Agung, N. Pambudi2011). Factors that influence the formation of biogas are pH, alkalinity and temperature. Acidity heavily affects on anaerobic decomposition process due to bacteria related to the process only survive at pH interval of 6.5-8.0. The acid produced by acetogenic bacteria is used by metanogenic bacteria which ultimately result in a constant pH. Optimum temperature for the process of anaerobic decomposition is 35˚C. If the temperature is too low, the activity of bacteria will drop and will result in biogas production reduction (Agung, N. Pambudi, 2011). Water hyacine (*Eicchornia crassipes*) contains nutrients required for the growth of microorganisms such as protein, cellulose, potassium and sodium. Cellulose content in water hyacinth can be used as an alternative fuel such as biogas. Water hyacinth can be utilized in biogas production due to its large hemicellulose content. Hemicellulose is a complex polysaccharide that is a mixture of polymers that produce a derivative mixture product when its hydrolyzed. This mixture can be processed by the method of anaerobic digestion to produce two simple compounds in form of methane and carbon dioxide which commonly refered to biogas (Yonathan, Arnold, Avianda Rusba Prasetya, and Bambang, Pramudono 2013).

A research conducted by mixing cow manure and water hyacinth with composition of 2.5% of cow manure by the weight of water hyacinth, produce biogas with the largest volume (Wahyudi, Akbar and Iskandar R. 2013). Water hyacinth contains 95% of water with spongy stalks has a high energy, consisting of a material that can be fermented and have enermous potential to produce biogas (Malik 2006). Besides water hyacinth, organic waste also can produce methane gas (L. Gareso, Paulus, S. Dewang, S.P., and Abd. Wahih Wahab 2010). Based on research of Winarni, Panggih, the optimum composition of water hyacinth and cow manure is 75% : 25% (Panggih, Winarni, Yulinah Trihadiningrum and Soeprijanto 2010). I Made Mara has conducted a research on the analysis of biogas quantity from various livestock manure (horse, cow, and buffalo) with different composition ratio of water and the manure. The result shows that biogas production is higher with composition ratio of 1:1 (Mara, I Made and Ida Bagus Alit 2011). Carbon and nitrogen ratio (C/N ratio) can affect the process of biogas production. Carbon and nitrogen are energy source for micro organism. C/N ratio found in horse manure is 25% higher than C/N ratio found in cow manure (18%) (Darmanto, Ardyanto, Sudjito Soeparmanand Denny Widhiyanuriawan 2012).

Horce manure processing in to biogas as application of appropriate technology gives a positive impact on residential area. The benefits for biogas application in residential area such as to reduce methane and carbon dioxide gas emission significantly, odor elimination, and also produce highly rich in nutrient compost and fertilizer (Elizabeth and Rusdiana 2010). Livestock manure processing with utilization technique of methane energy in form of biogas can reduce 70% methane emission to the atmosphere. Currently, there are many communities that exploit the biogas technology on household scale. Gas produce from the biogas can be used as fuel or electricity.

It is faster to boil water with biogas than using firewood or kerosene. Biogas energy have more advantages than firewood or coal because its not produce smoke and environmentally friendly so the sanitaton environment of residential area is maintained (Hastuti, Dewi 2009).

MATERIALS AND METHODS

The type of research is quasi-experimental research with one group pre and post test design. The research design including preliminary research (pre-test) at treatment group followed with intervention/treatment at treatment group and performed post-test after the treatment (Murti, Bhisma, 2008). The aim of the research is to find out the effect of water hyacinth addition to the volume of biogas generated from horse manure. There are two treatments on this research, which is biogas production sourced only from horse manure and from a mixture of horse manure and water hyacinth. Biogas production process takes between 2 to 4 weeks.

The research was conducted in laboratory workshop of Environmental Health Department of Health Ministry Polytechnic, Bandung in June to November 2015. The populations are all horse manures taken from stables in Babakan Loa and water hyacinths on the paddies around Cianjur area, while the samples are partially taken from the population with temporary sampling technique. Sample sizes is determined based on the number of performed treatment and repetition. The research use two type of treatments, which is biogas production sourced only from horse manure and from a mixture of horse manure and water hyacinth. For biogas production process with only using horse manure, each treatment requires 20kg of horse manure. For biogas production process using mixtured subtance, the amount of horse manure required for each treatment is 5kg and 15 kg of water hyacinth for each repetition.

The steps used in this research are as follow:

- Set up a simple biogas digester from plastic drums (gallons) that specificaly design for this task,
- Prepare the horse manure and water hyacinth,
- Put the maunre that have been mixed with water at a ratio of 1:1 into the biogas digester (for treatment 1),
- Put the manure and water hyacinth into the biogas digester (for treatment 2).

Data collection technique conducted by means of:

- Measure the biogas volume produced before the addition of water hyacinth,
- Measure the biogas volume produced after the addition of water hyacinth,
- Measure the temperature and pH at the beginning and the end of observation.

The data collected analyzed using unvariate analysis to see the average gas volume before and after the addition of water hyacinth. Then, bivariate analysis with dependent test-t is used to determine the effect of water hyacinth addition on horse manure biogas production.

RESULTS AND DISCUSSION

Process of biogas formation in this research is occured after 12 days as seen from the constant state of gas produced. Observation process of biogas formation in this research is conducted for six times. Observation data result on biogas volume from horse manure with and without the addition of water hyacinth is shown in the Figure 1. Based on the graph above, the average biogas volume produced without addition of water hyacinth is 0.7L, and with the addition of water hyacinth is 1.4L. The largest biogas volume produced at observation number 6. The results of measurement of temperature and pH in biogas production process from horse manure with and without the addition of water hyacinth is shown in Table 1.

In addition, horse manure and water hyacinth mixture decomposition process by bacteria in biodigester is not similiar even though the characteristic of the mixture and the treatment or repetition is conducted in the same manner. There is a rise of pH and temperature in the beginning of observation compared to in the end of observation. Acidity level (pH) is heavily influence the micro organism condition in the biogas production process. The optimum pH level for micro organism life is 6, 8-7,8. In the beginning of fermentation of organic matter there will an acid (organic acid) formed that will decrease the pH level. The biogas will start produced at pH of 5 and keep increasing until pH of 7 and will decreased at pH of 8. Good biogas production occured at pH level of 6, 8-8,0, neutral pH enhances the methane bacteria development so the bacteria that decompose acetic acid will grow and develop

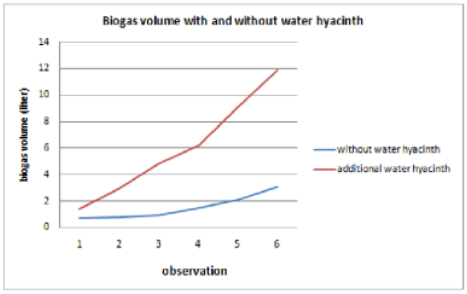

Figure 1. Biogas volume production sourced from horse manure with and without the additon of water hyacinth in six times observations

Table 1. Temperature and pH measured at the beginning and in the end of observation

Biodigester	Initial Observation		Final Observation	
	Temperature	pH	Temperature	pH
1 (without water hyacinth)	25^0 C	6,6	27^0 C	6,7
2 (with water hyacinth)	25^0 C	6,6	29^0 C	7,1
3 (with water hyacinth)	25^0 C	6,6	29^0 C	7,0
4 (with water hyacinth)	25^0 C	6,6	27^0 C	6,8
5 (with water hyacinth)	25^0 C	6,6	29^0 C	7,0
6 (with water hyacinth)	25^0 C	6,6	27^0 C	6,7
7 (with water hyacinth)	25^0 C	6,6	29^0 C	7,0
8 (with water hyacinth)	25^0 C	6,6	29^0 C	7,0
9 (with water hyacinth)	25^0 C	6,6	29^0 C	7,1
10 (with water hyacinth)	25^0 C	6,6	29^0 C	7,0

Based on Table 1, the temperature shown is 25^0C with pH of 6,6 at the beginning of trial. As for final observation, the temperature is ranged from 27^0C to 29^0C with pH ranged from 6,7 to 7,1. Based on the result of six times of observations, it show that there is a difference between biogas volume with and without water hyacinth addition. There is a escalation of biogas volume at every observation, although there is a variation of biogas volume produced especially at third repetition that the biogas volume produce is lesser than the other repetition. Many factors influenced the variation of biogas production. Anaerob condition have to be sustained due to biogas produced from fermentation process of organic matter is done by anaerob micro organism (Simamora, S., Salindik, Sri Wahyuni and Sarajudin 2006). Leaking balloon condition can affect biogas volume produced, unproper tied balloon can also affect biogas volume that entered the balloon. optimally. Temperature have an important role in regulating the metabolism reaction of bacteria. Biogas volume production increased proportionally with temperature level. Ambient temperature that higher than tolerated temperature level will lead to protein break down and dying essential cell component (Yonathan, Arnold, Avianda Rusba, and Bambang Pramudono 2013). Similiarly, if the ambient temperature is below the tolerance limit, nutrient transport will be hampered and cell life process will stop. Biogas production will be decline rapidly because of a sudden temperature change in the processor. Research conducted by Ardyanto shows that biogas production in thermophilic condition is higher than in mesophilic (35^0C) condition (Darmanto, Ardyanto, Sudjito Soeparman and Denny Widhiyanuriawan 2012). Practical efforts to stabilize the temperature is to put the biogas installation in to the ground (Darmanto, Ardyanto, Sudjito Soeparman and Denny

Widhiyanuriawan 2012). Biogas is an end product of digestion or anaerobic degradation of organic materials by anaerobic bacteria in oxygen-free or air environment. In principle, anaerobic process is a biological process that occured in a free-oxygen environment by a specific micro organism that capable to converting organic compound into methane. This process has been developed to process animal/human waste or waste water with high organic matter. Generally, anaerobic process consist of four stages such as hydrolysis, acid formation, acet at formation and methane formation. Anaerobic process is controlled by two groups of micro organism. Hydrolitic bacteria can disintegrate a complex organic compound into a simpler compound. This simple compound then converted by acid-forming bacteria into fatty acid with low molecular weight such as acetic and butryc acid. Furthermore, methanogenic bacteria transform those acids into methane.

Biogas sourced from water hyacinth produced from fermentation process. The fermentation process causes various complex reaction and interaction assisted by anaerobic bacteria. The result of the reactin and interaction produces methane gas (CH_4) that can be used for daily needs (Wahyuni, Sri 2009). Water hyacinth contains 95% of water with spongy stalks has a high energy, consisting of a material that can be fermented and have enermous potential to produce biogas (Gunnarson, Carina C. Petersen, and Cecelia 2006). Factors that influence anaerobic process is temperature. Anaerobic process can occured in two conditions i.e. mesophilic (20–45^{0}C) and thermopilic (50–65^{0}C) conditions.

Optimum temperature from anaerobic process shall be maintained constantly to support the level of gas production. In general, anaerobic process will produce methane gas. Biogas (gas bio) is a gas produced from decomposition of organic matter by bcteria grown in anaerob condition. pH level also a key factor in micro organism growth. Most micro organism cannot tolerate ph level above 9,5 or below 4,0. In general, optimum pH eve for bacteria growth is between 6,5 and 7,5 (Taufikurrahman 2011).

Conclusion

The research result shows that the biogas volume produced without the addition of water hyacinth ranged from 0.7 to 3.1 liters, while with the addition of water hyacinth ranged from 1.4 to 11.9 liters. There is a significant difference between biogas volume produce with and without water hyacinth addition.

Recommendation

Further research is required to see the energy produced from horse manure biogas with the addition of water hyacinth.

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GENERAL COMMENTS

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