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Observation of temperature and pH during biogas production from water hyacinth and cow manure

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Abstract **-** Biogas is generated from biological process of organic material by bacterial engaged. Biogas can be derived from manure, municipal waste, agricultural waste and other biomass resources. In addition to the use of cow manure as raw material for biogas production, it can also be derived from biomass containing cellulose which one is water hyacinth as an organic material that contains quite large cellulose. The abundance of water hyacinth found in Rawapening causing several negative impacts. The purpose of this study is to observe temperature and pH on the biogas production generated from water hyacinth of Rawapening and cow manure. Biogas production process begins by chopping the leaves and stems of water hyacinth, and then mixed with cow manure and water. The results of substrate variation of water hyacinth, cow manure and water reaches optimally at 40:80:480 respectively, which produce the highest point of biogas amounted 176.33 ml on the day 20 in 1L sized digester, the temperature of the biogas production is at 32°C. At the initial fermentation, digester temperature of 30°C has increased over the course of the fermentation process, a peak at day 20 and then decreased to 27°C at the end of fermentation. There is a decrease in pH starting from initial fermentation at pH 6-7 and then the pH began to decline until the end of fermentation as amount of pH 5.
Keywords: Water hyacinth, biogas, pH, temperature, Rawapening

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1. Introduction

Energy crisis is one of the world's problems in the past recent years. Utilization of energy derived from fossil considered no longer effective because the limited resource and cannot be renewed. Indonesia began to promote alternative energy resources to cope with the scarcity of fuel, which is biogas. Biogas is generated from biological process of organic material by bacterial engaged. Biogas produced from anaerobic fermentation is considered cheap and will be able to overcome the dependence on fossil fuels.

Biogas can be derived from manure, municipal waste, agricultural waste and other biomass resources. The use of biogas in Indonesia is still in the household scale by utilizing household waste and animal manure as a feedstock. In addition to the use of cow manure as raw material for biogas production, it can also be derived from biomass containing cellulose which one is water hyacinth as an organic material that contains quite large cellulose. The abundance of water hyacinth found in Rawapening could cause negative impact such as siltation, marsh ecosystems detriment, water flow hampering, and the nests of a variety diseases vector.

Biogas produced from fermentation of organic materials due to anaerobic bacteria activity. Biogas energy are predominantly by methane (50% - 70%), carbon dioxide (40% - 30%) and some other gases in smaller quantities. Anaerobic digestion is the decomposition process of organic compounds by microorganisms under anaerobic conditions. This process can be used to treat a variety of organic waste to produce biogas.

Biogas, being a renewable resource of energy has the potential of supplementing other available energy sources in a bid to encouraging the principles of sustainable development, and reduces the practice of total dependence on fossil oil that are finite (Mohamed, 2008). According to Wellinger and Lindenberg (2000), the composition of the biogas produced depends on the type of feedstock used. However, the main composition of biogas is methane (CH_4) and carbon dioxide (CO_2) with a few amount of hydrogen sulfide (H_2S).

There are a lot of factors which able to affect the biogas production. The supporting factor that can speed up the fermentation process is optimal environmental conditions for decomposer bacteria growth. The main

factor that affects the biogas production by Simamora (2006), is a pH and temperature. Acidity affects the microorganism life with the optimal amount at 6.8 to 7.8. Meanwhile, according to Mohamed (2008), the optimal temperature for anaerobic digestion process is 30-40ºC (mesophilic) and 50-60ºC (thermophilic).

Animal manure from cows, buffaloes, pigs and horses can be a source of biogas energy because manure as a source of decomposing organisms (starter) which contains high methane content. For each cattle such as cow/buffalo is able to produce approximately ± 2 m^3 of biogas per day (Ministry of Environment, 2009). In addition to using cow manure, organic material that can be utilized as a biogas energy resource is water hyacinth. Utilization of water hyacinth for biogas production due to have a considerable hemicellulose compared with other single organic components. Hemicellulose is a complex polysaccharide that is a polymer mixture which, when hydrolyzed able to produce a mixture of derivatives that can be processed with anaerobic digestion method for generating a simple mixture of two compounds in the form of methane and carbon dioxide called biogas (Ghosh, 1984).

Rawapening is freshwater marsh ecosystem in Central Java where located 45 km south of Semarang and 9 km northwest of Salatiga, in triangle of Yogyakarta, Solo (Surakarta) and Semarang. Rawapening located at 7°04' SL - 7°30' SL and 110°24'46" LE - 110°49'06" LE surrounded by four districts namely Tuntang, Bawen, Ambarawa and Banyubiru. Rawapening is undergoing many changes which seen in the growth of aquatic weeds associated with eutrophication process (Soeprobowati et al., 2010). Rawapening is one of 15 national priority lakes of 2010-2014. Determination of lakes national priorities based on vulnerability to environmental change, have high benefits as a source of freshwater, food production, and flood control (Ministry of Environment, 2010).

Water hyacinth give effect to the aquatic environment, which are able to inhibit the smooth of water flow, accelerate the process of silting due to the ability to hold the particles contained in the water, fertilize the waters with organic waste that allow the growth of other plants and being a nest of various disease vectors, such as mosquitoes. Surrounding environment is become less clean, especially the water (Ministry of Environment, 2009).

The study aims to observe temperature and pH in biogas production derived from Rawapening water hyacinth and cow manure.

2. Materials and methods

Materials and Equipments

The process of biogas production utilizes raw materials such as water hyacinth, cow manure and water. The equipments used in this study include the 1 liter of biogas reactors size as many as 37 pieces, clear plastic hose, knives, measuring glass, blenders, thermometers and pH meters.

Methods

1. Research Stage
   - Preparation of reactors series
     Reactors use 1 liter bottles of capacity as much as 37 pieces (including three times repetitions) which has lid inside of each reactor. Bottle caps modified to place the thermometer, in a way perforated first and then glued. Rubber septum bottle cap is previously drilled, then inserted with plastic hose, later glued. End of the hose is clamped by using paper clips so that the gas will not going to be wasted.
   - Acquisition Process of Water Hyacinth
     Water hyacinth is taken directly from Rawapening, which only take the leaves and stems that to be shredded and blended.
   - Acquisition Process of Cow Manure
     Cow manure acquired directly from the cow byre.
   - Materials Mixing Process
     Mixing of raw materials conducted between water hyacinth, cow manure and water in accordance with a predetermined ratio.
   - Temperature Measurement
     Temperature measurement is done by using a thermometer that has been installed in the digester. Measurements were conducted every day.
   - pH Measurement
     Measurement utilizes a pH meter done at the beginning and the end of experiment.
   - Gas Volume Measurement
     Gas volume measurements conducted on every day from the beginning until the constant gas formation. Calculation of the amount of gas produced is done by observing the air space in the reservoir bottle filled with water (water volume reduction).

Analysis of Results

Analysis of the results in this study consisted of testing the amount of biogas produced, measurement of temperature and pH.

3. Results and discussion

In Figure 1, it is seen that the variation of the substrate between the water hyacinth, cow manure and water at the optimal variation of 40:80:480.

On the above mentioned variation, biogas produced amounted 176.33 ml on day 20 in 1L sized digester. The biogas has begin to formed on day 18 for all variation and then start raising on the day 20, decreasing of biogas production occurred until the end of fermentation.

Variations in the composition of the substrate forming biogas showed that the more substrates are used the greater the volume of biogas produced. According to Subramanian (1978) and Jonathan (2012), state that the amount of biogas produced depends on the number of substrate.

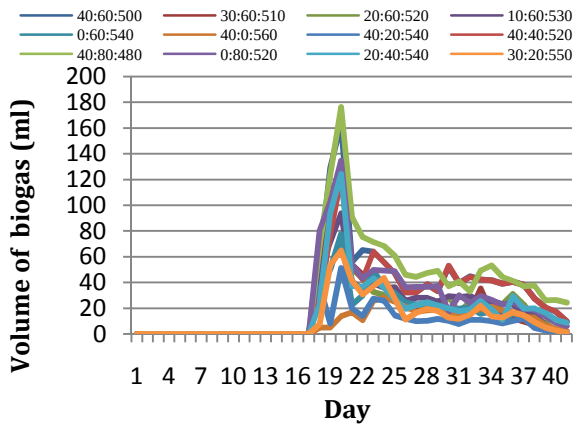

Figure 1. Biogas production per day

Bacteria have a response to temperature changes; this will affect the rate of reaction or population changes. In Figure 2, the temperature significantly influence the production of biogas that is at a temperature of 32°C on day 20 which is the highest biogas yield due to higher temperatures. In the substrates comparison of 40:80:480 generate 176,33 ml of biogas. At the initial fermentation, digester temperature of 30°C has increased over the course of the fermentation process, a peak at day 20 and then decreased to 27°C at the end of fermentation. According to Mohamed (2008), methanogens bacteria are inactive when the temperature of inside digester is too high or low. Optimal temperature in the process of anaerobic digestion is 30-40°C (mesophilic) and 50-60°C (thermophilic).

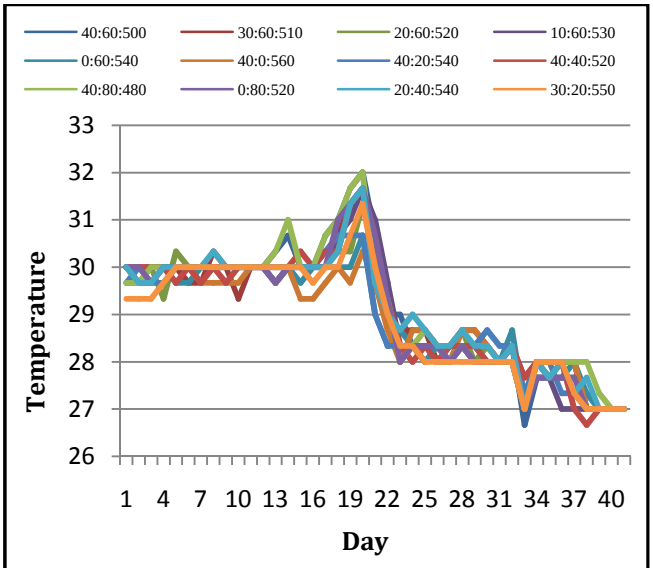

Figure 2. Temperature of digester during fermentation

The rate of a biogas fermentation decreases at temperatures below 20°C, 40°C whereas for most mesophilic bacteria is the optimum temperature, but optimum conditions for thermophilic bacteria is achieved at a temperature of 60°C. Effective temperature on the operation of the biogas digester is also determined by many factors including the climate, the conversion rate, nutrients conversion and certain substrates formation from the breakdown of originate substrate (Judoamidjojo and the Dervish, 1990).

According to Figure 3, There is a decrease in pH starting from initial fermentation at pH 6-7 and then the pH begins to decrease until pH 5. Neutral pH spurs the growth of methane bacteria (methanogens) so that the the acetic acid decomposer bacteria grow and develop optimally, this affects the biogas generated. At approximately pH 5 indicate that there is no biogas produced because the environment is too acidic so that methanogens bacteria died (Jonathan, 2012).

pH factor plays an important role in the anaerobic decomposition process because at the unconformity pH range causing decomposer bacteria cannot maximally growth and can even lead to death which in turn may inhibit the acquisition of methane gas. The optimum acidity for the life of microorganisms is 6.8 to 7.8 (Simamora, 2006).

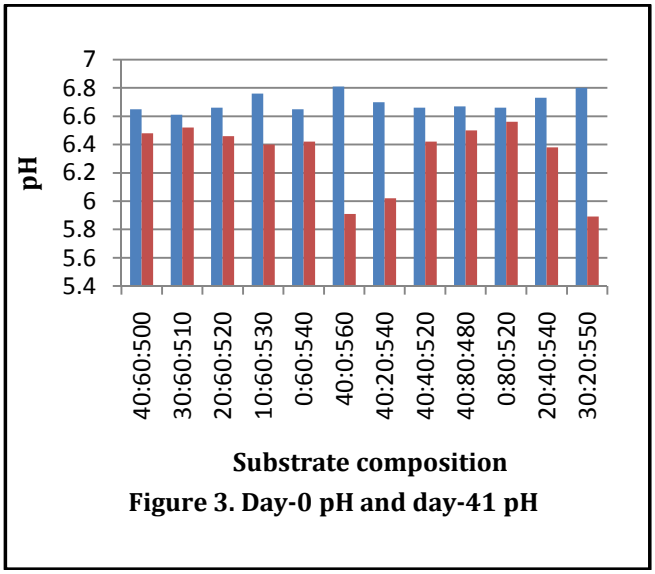

Figure 3. Day-0 pH and day-41 pH

4. Conclusion

There is a decrease in pH starting from initial fermentation at pH 6-7 and then the pH begins to decrease until pH 5. Temperature is significantly influence the optimal biogas production at 32°C on day 20 which is the highest biogas yield due to higher temperature, then the biogas production decreases along with decreasing temperature.

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