Experimental Study of Anaerobic Digester Biogas Method Using Leachate from Landfill Municipal Waste

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Abstract
Leachate is a byproduct of landfill bioreactor system which is the process of generating biogas from municipal solid waste. Generally, the quality of leachate is lower and needs an examination to reduce the content of harmful substances that can pollute the environment. Usually leachate is collected in large pools and are not allowed to be discharged into the rivers before being processed. This research attempts leachate as a starter in the formation of biogas from organic waste by anaerobic digester method with fermentation process. After the fermentation process, the produced gases saved into plastic bag. Furthermore, these experiments measure the concentration of methane contained in the produced gas. The experimental results showed methane that produced by leachate digester reached 42.33%. It is slightly lower than the methane that produced by goat manure, methane content 49 %, and cow dung, methane content 45%.

Keywords: anaerobic digester, biogas, leachate, methane, starter

INTRODUCTION
Energy is one of the main needs of the human being in every activity. Globally, the consumption of the energy has been increasing as well as the total population and development of the technology in order to simplify the life of the human being. Nowadays, the needs of energy is mainly pointed at the fossil energy, even though the reserves of all fossil energies in the world is decreased, but the price is getting more expensive. It is definitely necessary to explore another alternative renewable source of the energy. Municipal waste system can be the one of energy sources which could be beneficial to produces more energy and keeps the stability of the environment. [1][2][3][4] The stranded waste that release the main greenhouse effect gasses will doubled the heat of the atmosphere which contains methane (CH4) and carbon dioxide (CO2) and caused the global warming. On the other way, the greenhouse gas could be utilized as the alternative biogas energy as well as it is done by Austrindo Company which have goals to reduce the emission of greenhouse gas in Landfill Municipal Waste (TPA) in Bagendung, Cilegon, Banten Indonesia. Due to the inappropriate installations, the composition of the absorbed methane is drastically decreased and unburned [5]. Therefore, another method to produce biogas from TPA Bagendung is implemented by putting some of the organic wastes to the anaerobic digester. The method is the waste put into airproof container where will be fermented in a condition of less oxygen whilst residue is the gasless biomass which called as digestate. The biogas production which used bio digester method for agriculture wastes by goat manure has been researched for increasing the quality of the biogas through the increasing of the ratio of carbon to the nitrogen.[6]. The anaerobic digestion is characterized by a series of biochemical transformations caused by the degradation of organic matter [7]. The whole process of methane formation are hydrolysis, acidogenesis, acetogenesis and methanogenesis.

![Anaerobic digestion pathway](image)
The experiment is conducted to evaluate the potential of organic wastes as a biogas starter, specifically using cow dung, goat feces, and leachate from TPA Bagendung Cilegon, Indonesia. The leachate is used to determine its potential as a starter compared to other organic materials.

**RESEARCH METHODOLOGY**

The experiment aims to investigate the characteristics of biogas production from anaerobic digesters. Figure 2 illustrates the experimental setup, which involves using a cylinder as a digester with added components such as a manometer hose, gas excretion, and a thermometer probe. The organic wastes are mixed and simplified for the fermentation process. The digester is covered and sealed using glue and clamps to ensure air-tight conditions for biogas formation.

The temperature and pressure data are collected every 6 hours for 40 days. Biogas production data is recorded daily, and gas composition samples are analyzed every 10 days. These data are compared to another starter, such as cow dung and goat manure.

**RESULTS AND DISCUSSIONS**

The experimental data is summarized in Table 1 below. The data includes average temperatures for 3 times of experiments, showing that the temperature inside the digester is higher than the surrounding environment, indicating effective biogas production. Methanogen bacteria work well in producing biogas. There are no significant differences in temperature between all digesters.

Table 2 presents the average pressure in anaerobic digesters with various starters. The highest pressure of 171.65 Pa is observed in the first 10 days of the experiment, with a significant decrease to 7.34, 4.51, and 4.01 Pa for cow dung, goat manure, and leachate, respectively for the 20th day's experiment.

Table 3 shows the average gas production in experiments with various starters. The highest gas production is observed from the digester with leachate as the starter, while the lowest production comes from cow dung.

According to Table 3, the highest gas production is achieved with leachate as the starter, while the lowest production is observed with cow dung.
Table 4: Average biogas composition (%) for 3 times experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Digester 1 (Cow dung)</th>
<th>Digester 2 (goat manure)</th>
<th>Digester 3 (leachate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>CH₄</td>
<td>CO₂</td>
<td>O₂</td>
</tr>
<tr>
<td>10</td>
<td>8.03</td>
<td>11.7</td>
<td>14.3</td>
</tr>
<tr>
<td>20</td>
<td>46</td>
<td>17.3</td>
<td>8.63</td>
</tr>
<tr>
<td>30</td>
<td>49</td>
<td>14</td>
<td>6.9</td>
</tr>
<tr>
<td>40</td>
<td>35.3</td>
<td>4.17</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 4 is show the results of the average of three trials which has done to the digester 1, 2, and 3. From the data above, it is taken that as the age of the gas in 10 days, the composition that contained of the biogas is dominated by balance (BAL), while the lowest composition is CH₄. In the 20 days experiment the composition of the CH₄ and CO₂ are increased but the composition of O₂ and BAL decreased. The other hand, in the 40 days experiment the composition of CH₄ and CO₂ are decreased but O₂ and BAL are increased while compared to the 30 days experiment. This phenomenon shows that the production of CH₄ by organism in the leachate is optimum in 30 days.

As shown in the graphic on the figure 2, digester with the starter of cow dung produces the biogas that quickly burned compared to other digesters which takes 20 days contained 46.03% - 49% while digester with the starters of leachate produces biogas which burned with 42.73%-42.33% on the 30 days to 40 days.

Figure 2: Methane composition in biogas product.

Figure 3 shows the mass product of gas by limitation time of experiment. It is known that the lowest biogas production is produced by the digester with cow dung as the starter. The mass total of the gas is 57.33 gram which the total amount of the burnable gas from the 20 days to the 30 days is 16.34 and the average daily production is 14.34 gram.

Figure 3: Mass product of biogas

Digester with the goat feces as the starter produced the biogas higher than the digester with cow dung which the mass total is 67.67 gram, but the burnable biogas from the 30 days in to the 40 days is only 7 grams and average daily production is 16.91 grams. The highest biogas production comes from the digester with leachate as the starter. The mass total is 77 grams and become the highest if compared to the other digesters by daily average production is 19.25 grams, and the burnable biogas from this digester is 10.67 grams that taken from the 30 days to the 40 days.

CONCLUSIONS

The experimental results showed that methane of biogas produced in the digester by using starter leachate reached 42.33%. This value is slightly lower than the methane of biogas produced in a similar way by using starter of goat manure, methane content 49 % and cow dung, methane content 45%. The digester using leachate is good results compared to the other starters during the 40 days of
observation. The result shows that the utilization of leachate as starter in the production of biogas in anaerobic digester is definitely applicable.

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REFERENCES