International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 19 (2017) pp. 9112-9115

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

Caturwati Ni Ketut[a*], Agung Sudrajad[a], Mekro Permana[a], and Heri Haryanto[b]

[a]Mechanical Engineering Department- University of Sultan Ageng Tirtayasa,
[b]Electrical Engineering Department- University of Sultan Ageng Tirtayasa,
Jl. Jend.Sudirman Mm.3, Cilegon 42435, Indonesia.
**Corresponding Author*
**Orcid ID: 0000-0003-1107-1499*

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. Us ually 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 (CH_4) and carbon dioxide (CO_2) 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.

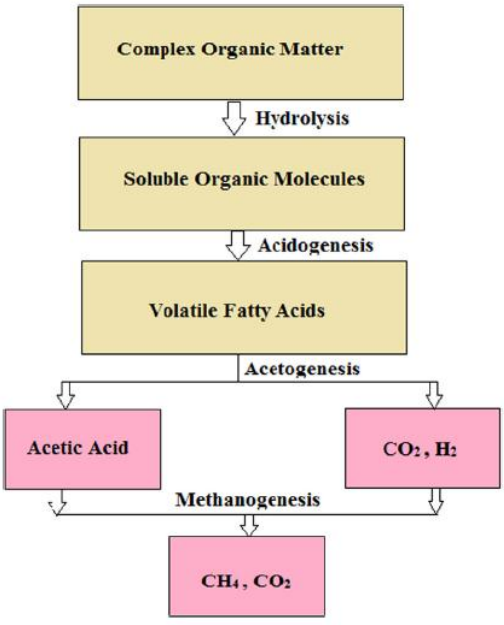

Figure 1: Anaerobic digestion pathway[7]

The experiment is conduct of organic wastes were proceed in anaerobic digesters with some of starters: cow dung, goat feces, and leachate that comes from TPA Bagendung Cilegon Indonesia. The utility of the leachate is used to learn more about the leachate potentials as the starter of the biogas compared by another starter.

RESEARCH METHODOLOGY

The experiment is attempt to know the characteristic of biogas by anaerobic digesters. Figure 2 presents the experimental design by using a cylinder as a digester which modified by adding some extra components, such as hole for the manometer hose, gas excretion, and canal for thermometer probe. After that, adding some organic wastes as the filling and starters to the digester make all of the ingredients are mixed and simplified the bacteria to do the fermentation process. Cover the digester and locked it up by glues and clamps, then it will create the airproof as the requirements of biogas forming.

The temperature and pressure data is taken by every 6 hours in a day. The biogas production data with the digital scale once in a day of 40 days. Take sample of biogas production for testing the gas composition by using the biogas analyzer once in every 10 days of 40 days. The data wil compare with another starter of gas such as cow dung and goat feces.

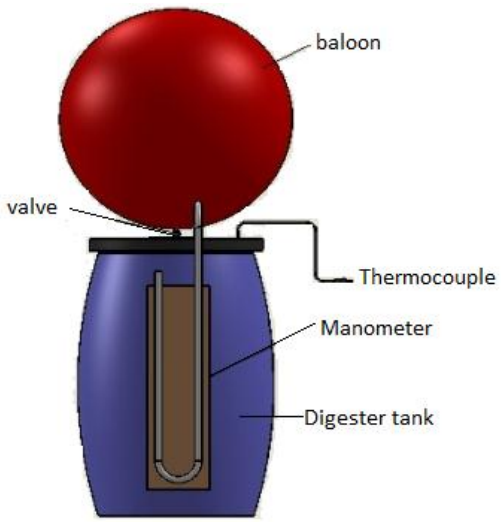

Figure 2: Experimental design

RESULTS AND DISCUSSIONS

The experimental data is shown in table 1 below. The data is taken from the average daily temperature which grouped per 10 days. Temperature of the surrounded environment during the research is among 29.85 C – 30.38 C. According to the data, temperature inside of the digester is higher than the environment temperature. It shows that methanogen bacteria work very well in producing biogas. There are no significant differences of the temperatures from all of the digesters.

Table 1: Average digester temperature for 3 times experiments.

Days of	$T_{ambient}$ (^{0}C)	$T_{d,Cow}$ (^{0}C)	$T_{d,\ Goat}$ (^{0}C)	$T_{d,\ leachate}$ (^{0}C)
1-10	30,38	30,82	30,68	30,68
11-20	29,85	30,64	30,68	30,71
21-30	29,92	30,44	30,46	30,21
31-40	30,09	30,47	30,49	30,46

Table 2: Average pressure in annaerobic digester with various starter

Experiment Days	*Digester* 1 (*Cow dung*) Pa	*Digester* 2 (goat manure) Pa	*Digester* 3 (*leachate*) Pa
1-10	126,16	102,31	171,65
11-20	7,34	4,51	4,01
21-30	11,13	9,02	3,85
31-40	7,93	8,36	12,22

Table 2 shows the average pressure in anaerobic digester. The highest pressure of the data is 171.65 Pa at the first 10 days, then at the 20 days experiment the data shows drastic decreases into 7.34, 4.51 and 4.01 Pa for cow dung, goat manure and leachate, respectively.

Table 3: Average gas productions with various in the experiments

Experiment Days	*Digester* 1 (*Cow dung*) gr	*Digester* 2 (goat manure) gr	*Digester* 3 (*leachate*) gr
1-10	28	42,34	55,67
11-20	5,34	4,34	3
21-30	16,34	14	7,67
31-40	7,67	7	10,67
Total	57,34	67,67	77

According to the table 3, it is known that the highest gas production is resulted from the digester with leachate as the starter while the lowest gas production is the digester from cow dung.

Table 4: Average biogas composition (%) for 3 times experiments

Experiment Days	*Digester* 1 (*Cow dung*)				*Digester* 2 (goat manure)				*Digester* 3 (*leachate*)			
	CH_4	CO_2	O_2	BAL	CH_4	CO_2	O_2	BAL	CH_4	CO_2	O_2	BAL
10	8,03	11,7	14,3	66	0,9	20,2	15,3	64	0,5	11,3	16,5	71,73
20	46	17,3	8,63	28	30,93	27,3	8,8	33	15,2	23	14	47,9
30	49	14	6,9	30,1	44,9	11,3	8,3	36	42,3	10,5	8,57	38,7
40	35,3	4,17	14	44,5	42,73	5,67	12	40	42,3	4,23	13,5	40

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 CH_4. In the 20 days experiment the composition of the CH_4 and CO_2 are increased but the composition of O_2 and BAL decreased. The other hand, in the 40 days experiment the composition of CH_4 and CO_2 are decreased but O_2 and BAL are increased while compared to the 30 days experiment. This phenomenon shows that the production of CH_4 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.

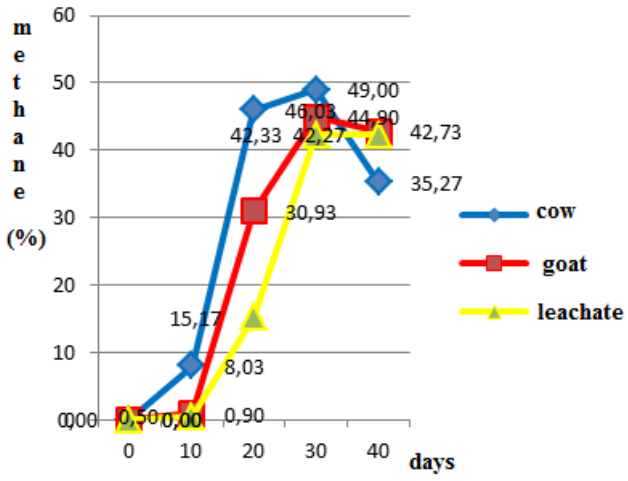

Figure 2: Methane composition in biogas product.

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.

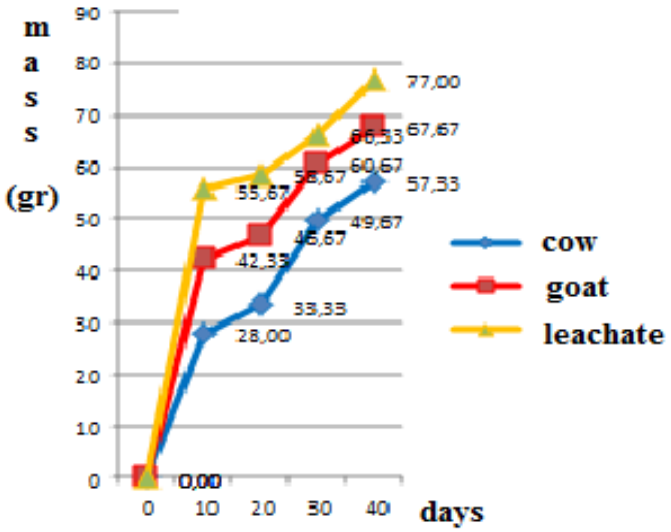

Figure 3: Mass product of biogas

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.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Research Technology and Higher Education Indonesia for financial supports through the Research Innovation Grant 2017.

REFERENCES

[1] Sherwin Amini, "Investigation of biogas as renewable energy source," *Int. J. Agric. Crop Sci.*, pp. 1453–1458, 2013.

[2] A. M. Sunil Kumar, Chart Chiemchaisri, "Bioreactor landfill technology in municipal solid waste treatment: An overviewbioreactor landfill technology.pdf." Informa healthcare USA,Inc, USA, pp. 77–79, 2011.

[3] R. Arthur, M. F. Baidoo, and E. Antwi, "Biogas as a potential renewable energy source: A Ghanaian case study," *Renewable Energy*, vol. 36, no. 5, pp. 1510–1516, 2011.

[4] S. G. Nzihou Jean Fidele, Koulidiati Jean, "Potential and Feasibility of Solid Municipal Waste Treatment with Gasifiers in a Developing Country : A Review for Burkina Faso," *Br. J. Appl. Sci. Technol.*, vol. 4, pp. 450–464, 2014.

[5] N. Caturwati, A. Sudrajad, H. Haryanto, P. Mekro, and Aminullah, "Effect of Temperature on the Production of Biogas in Municipal Waste Cilegon Banten Indonesia" , Proceeding of National Conference *UNIMAL 2016*, 2016, pp. 364–371.

[6] T. Zhang *et al.*, "Biogas Production by Co-Digestion of Goat Manure with Three Crop Residues," *PLoS One*, vol. 8, no. 6, pp. 1–8, 2013.

[7] Abdur Raheem et al, "Bioneregy from anaerobic digestion in Pakistan; Potential development and prospects" , Renewable and Sustainable Energy Reviews 59 (2016), pp. 264-275