

# Biogas and Electrical Energy Production from Market Waste at Fixed Dome Bio-digester in Talang Banjar Jambi

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## ABSTRACT

The waste problem commonly is almost the same in every big city. When it is not managed properly, it will be piled up very quickly. The city of Jambi produces approximately 1,838.48 m<sup>3</sup>/day of waste. Organic waste originating from market waste in Jambi City is dominated by vegetable waste, so that its organic content can be converted into biogas energy. This abundant of waste is managed in *Talang Banjar* in Jambi City which is to be converted into biogas in order to reduce environmental pollution and also convert organic waste into useful materials what it is so called biogas that can be used by the community. This waste treatment used a fixed-dome type bio-digester. The purpose of the study was to analyze the production of biogas and electrical energy generated from waste processing at a fixed-dome bio-digester in Talang Banjar Jambi. Based on the results of the study, it found out that the average methane gas content produced was above 60% with an average biogas volume of 5 m<sup>3</sup>/hour, and the electrical energy produced 58.5 kWh/hour.

**Keywords:** Organic waste, fixed dome digester, biogas, electrical energy

## 1. INTRODUCTION

Based on Law No. 18 of 2008 that waste is part of something that is useless, disliked or something that must be thrown away, which is generally solid material. Regarding to its nature, waste is divided into organic waste and inorganic waste. Organic waste is easily decomposed such as food scraps, vegetables, dry leaves, and so on. It can be further processed into compost. Meanwhile, inorganic waste is waste that cannot be decomposed easily, such as plastic food packaging containers, paper, plastic toys, bottles and drinking glasses, cans and so on.

The City of Jambi, like other big cities, produces 1,838.48 m<sup>3</sup>/day of waste. The characteristics of waste from this place are dominated by market waste in the form of inorganic waste, average amount of 67.02%

and organic waste by 32.98% [1]. This organic waste is processed in *Talang Banjar* in Jambi City using an anaerobic digestion system. Anaerobic digestion is a process of decomposition of biodegradable materials under controlled conditions without oxygen and at temperatures suitable for *mesophilic* or *thermophilic* or facultative bacterial species to be converted into biogas and digestate products [2]. The most widely used anaerobic digestion technologies are Fixed dome digester, Floating drum digester, and Tubular digester. Fixed dome type anaerobic digestion technology is the type used in this study to treat market waste in *Talang Banjar* Jambi City. There are 4 anaerobic digestion reactors with a volume of 30 m<sup>3</sup>. The total processing capacity is 1 ton/day.

The fixed-dome digester design was first developed in China in 1936, and then widely developed around the world with 6 volumes, 8, and 10 m<sup>3</sup> [3,4,5]. The digester design consists of an underground digester section with a dome-shaped lid made of brick, stone or concrete. Another part is the slurry reservoir which is open to atmospheric pressure. The gas produced in the digester accumulates in the dome of the digester. The pressure from the biogas that is formed will press the slurry into the slurry reservoir. Examples of fixed-dome digesters are the Chinese fixed-dome digester and Indian-fixed dome (Deenbandu, Nepalese fixed dome (GGC-2047), etc. [6]. The Chinese fixed-dome digester can be seen in Figure 1. below:

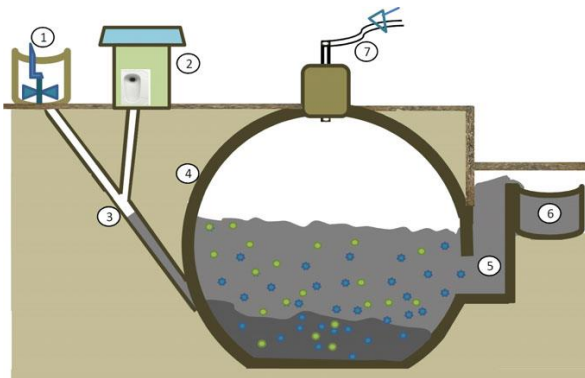


Figure 1 Chinese fixed-dome digester [6]

Based on working principle of the biodigester, organic waste or waste after being mixed with water in a certain ratio, in general such a 1:1 or 1:2 ratio is used and then the mixture is put into the biodigester. The effective volume of the biodigester is 80% filled with slurry and 20% is used for biogas to be produced from the anaerobic digestion process [7]. The working principle of a fixed-dome digester in general can be seen in Figure 2 below:

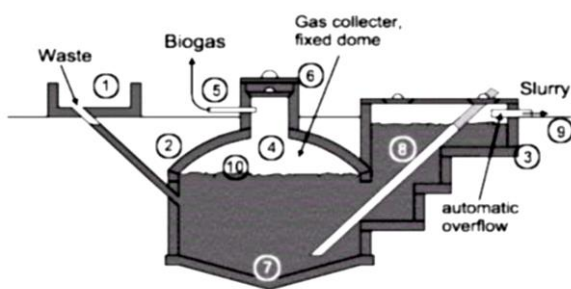


Figure 2 Working Principles of Fixed Dome Biodigester [7]

## 2. MATERIALS AND METHODS

### 2.1 Materials

The raw material for biogas production in this study was market organic waste which was dominated by cabbage and pineapple which were not suitable for consumption from the *Talang Banjar* market, Jambi City. While the equipment used was 1 unit of biogas processing owned by *Talang Banjar* Jambi City which consisted of 4 inlet tanks, 4 fixed dome digesters, gas bags, multi meter and biogas analyzer.



Figure 3 Biogas unit in *Talang Banjar* Jambi

### 2.2. Methods

The procedures for making biogas in *Talang Banjar* Jambi as follows:

1. First of all, organic waste such as cabbage and pineapples taken from the *Talang Banjar* market were sorted by separating plastic or other impurities. Then the organic wastes were chopped using a chopper machine;
2. After chopping the wastes were put into the inlet tub with the ratio between the chopped waste and water was 1: 1;
3. Then, it was stirred manually with long bamboo;
4. Each inlet tank was filled with mixed organic waste with a 7-day interval of filling, after that routinely in 1 week 3 times filling; on Tuesday, Thursday, and Saturday. Each inlet tub was connected to the digester.
5. The anaerobic digestion process will occur in the digester and produce biogas.
6. Biogas was then channeled and collected in storage bags/balloons.
7. Sampling of biogas was taken using a biogas sample bag or tedlar bag and brought to the laboratory for analysis its content.

2.3. Biogas analysis

Biogas analysis was carried out by first measuring the CH<sub>4</sub> content of biogas using a bosean gas analyzer. Furthermore, the volume of gas produced from the fixed dome digester unit was measured for 4 weeks. The results of the biogas volume data were then converted to energy using a source [8] where 1 m<sup>3</sup> of biogas was equivalent to 11.17 kWh of electricity.

3. RESULTS AND DISCUSSION

3.1. Concentration of methane gas from biogas

The results from measuring the quality of biogas, especially for the concentration of methane gas produced from the anaerobic digestion process at the Fixe Dome Digester in *Talang Banjar*, Jambi City, are shown in Table 1. below:

Table 1. Results of measuring the quality of CH<sub>4</sub>

Samples	Methane (CH <sub>4</sub> )
1	68%
2	64%
3	64%
4	69%
5	66%

Based on the data from the biogas test results in Table 1 above, in the test using a portable gas analyser on the first sample that the methane gas content was 68%, the second test decreased methane gas content by 64%, in the 3rd test the methane gas content was stable by 64%, in the 4th test the methane gas content increased by 69%, and in the 5th test was a 66% decreasing in methane gas content. In conclusion that the average methane gas content produced was above 60%. Meanwhile, from the same study used organic materials as materials for biogas production, methane gas was produced [9] in his research, the levels of methane gas using organic waste materials were 68.5% and the smallest was 67.75%. While in research [10] the content of methane gas using organic waste from the market was 52.8%. Thus the results of the biogas produced were line with theory [11] says the composition of biogas for methane (CH<sub>4</sub>) gas with a concentration range of 50-70%.

The biogas produced in the fixed dome digester in *Talang Banjar* Jambi City can be used directly by the surrounding community for biogas stoves and lighting lamps in the *Talang Banjar* market using biogas

generator. In the equivalence according to [12] for 1 m<sup>3</sup> of biogas equals to 0.46 kg of LPG, 0.62 liters of kerosene, 0.8 L gasoline, 2.5 kg of firewood and 0.52 diesel oil.

3.2. Volume and Electrical Energy of Biogas

From the results of measuring the volume of biogas formed during observations in April 2021, the following are the results of the average measurement of the volume of biogas obtained.

Table 2. Biogas volume

Week	Average Biogas Volume (m <sup>3</sup> /hour)
I	4,3
II	4,5
III	5,6
IV	5,6

Based on the data in Table 2. The volume of biogas produced in the fixed dome digester of *Talang Banjar* Jambi, in the first week of April, the average biogas volume was 4.3 m<sup>3</sup>, for the second week of April, the average biogas volume was 4.5. m<sup>3</sup>, then in the third week of April, the average biogas volume was 5.6 m<sup>3</sup> and at the end of the month or at fourth week, the biogas volume was 5.6 m<sup>3</sup>. So that, the average biogas production for four weeks was 5 m<sup>3</sup>.

From the biogas volume data obtained for 4 weeks of measurement, it can be calculated the amount of electrical energy produced. The following table 3 is the result of the conversion of biogas volume to electrical energy.

Table 3. Electrical Energy from Biogas (1 m<sup>3</sup> equals to 11.17 Kwh)

Week	Biogas Volume (m <sup>3</sup> )	Electric energy (Kwh)
I	4,3	50,31
II	4,5	52,65
III	5,6	65,52
IV	5,6	65,52

Based on Table 3. Electrical energy produced in *Talang Banjar* Jambi City, the average generated in the first week obtained electrical energy of 50.31 kWh, for the second week electrical energy was obtained at 52.65 kWh, for the third week obtained electrical

energy was 65.52 kWh, in the fourth week the average electrical energy was 65.52 kWh, so that the average electrical energy for four weeks was 58.5 kWh.

#### 4. CONCLUSION

Based on the research results of Biogas Production and Electrical Energy from Market Waste at Fixed Dome Biodigester in *Talang Banjar* Jambi, it was found that the methane gas content obtained exceeds 60% with an average biogas volume of 5 m<sup>3</sup>/hour, and the electrical energy produced was 58.5 kWh/hour.

#### AUTHORS' CONTRIBUTIONS

All authors in this publication have jointly carried out research activities and writing this article.

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