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Small Scale Biogas Production in a Dairy Farming at Kaligondo Sub-district, Banyuwangi, East Java

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Abstract. A biogas production in a dairy farming is an anaerobic digester that generates biogas from cow waste. The group of dairy farmers, Sumber Lumintu and Susu Segar Kita, has developed a small scale biogas plant at a commercial dairy farm at Kaligondo sub-district, Banyuwangi, East Java. The purpose of this projet which funded by Ministry of Research, Technology and Higher Education of the Republic of Indonesia is to encourage green technology and zero waste concepts on dairy farming as well as to mitigate adverse effects on the environment due to unsystematic management of cows waste disposal. The biogas produced is used as biogas rice cooker, biogas lamp, and liquid fertilizer. The output of biogas digester is connected to the biogas reservoir in order to supply cooking appliances for dairy products. A biogas plant in a dairy farming is one of the green technology applications because it not only produces renewable gas whereas minimizes greenhouse gas emissions and environmental pollution. Furthermore, the residual solid waste produced at the end of the process can be dried or be liquidated to be used as organic fertilizer.

Keywords–biogas, biogas production, cows waste, cooking, organic fertilizer, green technology

1. Introduction

The livestock industry has become a main supporting sector in agricultural at Banyuwangi, East Java. As a part of the agricultural sector, development of dairy farming at Kaligondo sub-district has grown as the main center of sustaining livestock industry in Banyuwangi to meet the need of the Nestle industry, local needs, and various dairy products. However, there are two problems of concern due to unsystematic management of cow waste disposal, namely environmental pollution like smells and water pollution, and greenhouse effect. Therefore, the effective solution to mitigate its adverse affects to the surrounding environment is to implement biogas technology for dairy farming at Kaligondo sub-district. Biogas is a source of clean and green technology, a renewable energy, and accessible to low-income dairy farming or households through anaerobic digestion of readily available organic waste. The use of biogas is more cheaper than other energy sources like petrol, diesel, and coal [1]. However, the major obstacles faced by farmers at Kaligondo sub-district for biogas implementation is lacking knowledge for waste processing and high costs of investment in the construction of biogas technology. To overcome this problems, the community service team of State Polytechnic of Jember funded by Ministry of Research, Technology and Higher Education of the Republic of Indonesia makes an applicable of low-cost biogas technology as a source of cooking and liquid fertilizer producer for plants.

Generally, a biogas production is built for the purpose of producing biogas for cooking, generating electricity and heat. The amount of biogas produced by dairy farming depends on the amount of cow waste available for processing and the capacity of biogas digester. The production of biogas is resulted from anaerobic digestion of cow waste by anaerobic bacteria with the absence oxygen inside the biogas digester.

Table 1. Composition of Biogas.

Compound	Chemical Symbol	Content (%)
Methane	CH_4	50-75
Carbon Dioxide	CO_2	25-45
Left	O_2	< 2
Right	N_2	< 2
Gutter	H_2S	< 1
Header	H_2	< 1
Footer	H_2O	< 1

Composition of biogas is shown in Table I in which the biggest composition of biogas is Methane (CH_4) at 50-75%. Secondly, biogas contains 25-45% Carbon Dioxide (CO_2) while composition of Oxygen (O_2), Nitrogen (N_2), Hydrogen Sulfide (H_2S), Hydrogen (H_2), and water vapor (H_2O) are less than 2% [2]. Methane is a colorless and odorless gas but it is 21 times more harmful than carbon dioxide. The uncontrolled emission of methane gas tends to trap heat in the atmosphere and lead to the greenhouse effect or global warming [3]. Therefore, the implementation of a biogas production in a dairy farming at Kaligondo sub-district is to mitigate adverse effect on the environment.

2. Design and Construction

Biogas production can be planned and constructed as low-cost unit with balloon digester. The size of balloon digester is depending on the amount of cow waste available and the amount of gas needed [4]. Fig. 1 shows the design of biogas system that has been built in a dairy farming at Kaligondo sub-district, Banyuwangi, East Java. There are some steps to construct a small scale biogas system in a dairy farming at Kaligondo sub-district as follows:

2.1. Selecting Biogas Location

A location of the biogas installation is selected adjacent to the source of cow waste to facilitate waste material requirements. Therefore, biogas location is placed behind the cow shed as shown in Fig. 2. The cow dung sewer is connected to the inlet of digester.

2.2. Materials and Tools

Materials and tools are needed to build biogas system as follows: balloon digester 1500 litter, gas storage 1000 litter, PVC pipe, knee L ½ inch, knee L, biogas stove, pipe glue, EM-4.

2.3. Inlet Chamber

Firstly, cow waste is collected to inlet chamber as shown in Fig. 3 to mix with water as slurry materials to obtain methane (known as biogas). The composition of cow waste against water is 1:2. To accelerate or increase methane quality is by adding a Effective Microorganism (EM)-4/EM-4. EM-4 can produce organic acids and enhance decomposition of organic material. A mixture of cow waste, water, and EM-4 are channeled to the biogas digester through inlet digester.

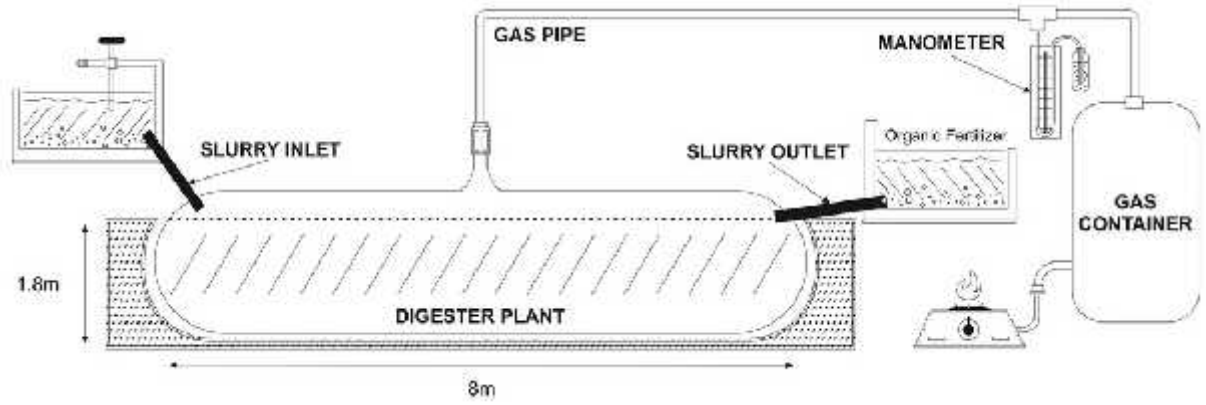

Figure 1. Design of a biogas system at Kaligondo sub-district, Banyuwangi

2.4. Biogas Digester

The installation of biogas digester is used balloon reactor, called balloon digester. It consists of a plastic or rubber digester bag, where in the upper part of which the gas is stored. The inlet and outlet are attached directly to the skin of the balloon. The gas is moved from the balloon to where it will be used by the pressure build up inside the balloon and can be enhanced by placing weights on the balloon. The fermentation slurry is agitated slightly by the movement of the balloon skin. The balloon digester is constructed below ground with a width of 2 meters, height of 2 meters, and long of 8 meters as shown in Figure. 4. The initial charge of balloon digester is carried out to the optimum outlet channel or 60% of the volume of the balloon digester.

Furthermore, the slurry of cow waste is left for 13-20 days with the outlet position of the gas valve of balloon digester in closed condition. This condition makes sure that the process of fermentation of organic materials by microorganisms in anaerobic conditions. The results of the fermentation process will be seen on day 14 and usually methane gas has accumulated at the top of the digester. The first gas output formed must be released into the air because it contains a mixture of gas and air.

Figure 2. Biogas location behind the cow shed

Figure 3. Inlet chamber

Figure 4. Balloon digester

Figure 5. Outlet chamber

2.5. Outlet Chamber

Outlet chamber as shown in Fig 5. is a slurry container that does not contain biogas. Slurry is collected from remains of fermentation process in the balloon digester and used for liquid fertilizer producer for plants.

2.6. Installation of Gas Pipelines

The next step of biogas installation is to connect outlet gas pipe of balloon digester to the gas container. The gas container is also made from plastic materials installed by hanging on the roof of a cow shed as shown in Fig. 6. The gas pipeline connected to the gas outlet of balloon digester is connected to the water trap made from a used plastic bottle containing water to release excess gas pressure. To know the pressure of gas is used a manometer to measure the pressure of gases that are close to or below atmospheric pressure because atmospheric pressure is used as a gauge for comparison.

To maintain the availability of biogas everyday for cooking activities as shown in Fig. 7, the balloon digester must be filled with cow waste mixed with water and EM-4 every day with a ratio of 1: 2. It makes the biogas will be produced continuously in a dairy farming at Kaligondo sub-district.

Figure 6. Gas pipelines and gas container

Figure 7. Utilization of biogas for cooking

3. Conclusion

In conclusion, biogas is an excellent source of energy and the implementation of biogas production in a dairy farm at Kaligondo sub-district, Banyuwangi is an alternative method in order to mitigate environmental pollution and global warming due to unsystematic management of cow waste disposal. Furthermore, there are a lot of advantages of implementing biogas production at dairy farms. For instance, it can open rural economics with the incorporation of green technology, relieve cost through lesser dependence on paying for non-renewable fuels, produce organic fertilizer for agriculture and circulation of knowledge and skills. The simplicity of implementing a biogas production in a dairy farm makes it one of the most environmentally sound energy sources especially for rural needs.

4. References

[1] Mehta, A. (2002). The economics and feasibility of electricity generation using manure digesters on small and mid-size dairy farms.

[2] Al Seadi, T., Rutz, D., Prassl, H., Köttner, M., Finsterwalder, T., Volk, S., & Janssen, R. (2008). Biogas Handbook.–University of Southern Denmark Esbjerg. ISBN 978-87-992962-0-0.

[3] Widodo, T. W., & Hendriadi, A. (2005, October). Development of biogas processing for small scale cattle farm in Indonesia. In Conference Proceeding: International Seminar on Biogas Technology for poverty Reduction and Sustainable Development. Beijing (pp. 255-261).

[4] Singh, K. J., & Sooch, S. S. (2004). Comparative study of economics of different models of family size biogas plants for state of Punjab, India. Energy Conversion and Management, 45(9-10), 1329-1341.

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