Sustainable ways of biogas production using low-cost materials in environment

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Abstract. Biogas production is an anaerobic process involving various microbes such as methanogenic bacteria and Clostridium acteinum, Bacteriodes ruminicola, Lactobacillus spp, Streptococcus spp. Farmers of Indonesia are not interested in biogas production due to higher costs in establishing biogas plants. In our present research was focused on production of biogas and biofertilizers from biogas plants in separate studies. Our research forms a basis for production of biogas from low cost material available in environment. Important factors determining good quality biogas are: waste quality, digester design, temperature, system operation, presence of oxygen. In our present study, we have considered two factors as different wastes and design of biogas plants. Further, different kinds of wastes including plant wastes were used. Two designs of digester were used in the present study Raw materials used in our present study are chicken manure, chicken manure while from plants used straw (Oryza sativa), cabbage (Brassica oleracea) waste and water hyacinth (Eichhornia crassipes). Materials for biogas plant were gallon water cylinder, plastic bag, plastic hose, water faucet, motorcycle tyre and glue. The biogas plant differed in being an anaerobic fermentation unit. One biogas plant using motor tires as a gas container of anaerobic fermentation process while others uses plastic bags. Refinement of the other part is carried out during the study such as inlet and outlet holes where there were 4 points and to be 2 hole points. Reducing the hole on biogas plant can reduce the leakage of the resulting gas. The parameters measured are the length of the gas produced by the flame test, gas volume in 15 days and the fire color. The total volume of mixture is 12 liters, its contain of 6 liters’ water and 6 liters the mixture manure and plant. Ratio of mixture between animal manure and plant are 6:0; 4:2; 3:3; 2:4; 0:6. The result show that the using of biogas plant with plastic bag is better than the using of motorcycle tires. From statistical analysis generally showed that the best mixture of yield was 3: 3 mixture based on gas production parameters and flame color. Comparatively, mixture chicken manure and goat manure had the best result for gas production.

1. Introduction
Biogas production is an anaerobic process involving various microbes such as methanogenic bacteria and Clostridium acteinum, Bacteriodes ruminicola, Lactobacillus spp, Streptococcus spp [2]. Biogas has the potential to replace the fossil fuel positions with limited supply. Biogas in addition to renewable can also reduce waste dirt problem in various places [3][4]. Among farmer in Indonesia Biogas is not popular for some reasons. The first is the expensive cost to build a biogas plant. The second reason is the cheapness of the price of fossil fuels. These conditions cause less a flourishing biogas in Indonesia compared to other countries like China and India [5]. It is the occurrence of the slowdown of biogas development in Indonesia although Indonesia has great potential to develop in
this field. To build simple biogas plant the farmer need minimal funds Rp. 8.000.000 equivalent to US $ 615, and that amount fund is is felt big enough for farmers generally. For that reason, that causes farmers to switch to fossil fuels.

This study looks for solutions to solve problems by reducing the cost of making biogas plant by designing biogas plants with cheap materials available in the environment. Biogas plant design is adapted from an existing simple biogas plant design that is refined to produce low-cost biogas plant but produces quality biogas. Another goal of the study is to look for biogas mixtures that can produce large amounts of gas and good gas quality.

2. Methodology
In this study the use of research materials used for 2 things that is for the manufacture of biogas plant and digester. The materials used for biogas plant in this research are motorcycle tire, plastic bag, plastic hose 10 mm inner diameter, t-shaped valve, on-off valve, adhesive, auto sealer, gallon water cylinder. All materials are arranged like the attached picture so that simple biogas plant is formed. Biogas plant refinement was performed during the experiment (fig 1, fig.2 and fig.3). The material for biogas digester consists of a mixture of water and organic material with a ratio of 6 Kg: 6 Kg so that the total ingredients in the gallon as much as 12 kg of liquid material.

The manipulated mixture is a mixture of 6 kg of organic material which is then mixed with 6 kg of water. There are several mixed groups of rice straw mixture and chicken manure, a mixture of water hyacinth and chicken manure, a mixture of cabbage and chicken manure, and a mixture of goat manure and chicken manure. The ratio of mixtures between animal and plant waste from 6 kg of organic matter is 6:0; 4:2; 3:3; 2:4; 0:6 in heavy percentages. The parameters measured are the gas volume and the flame color. All the experiments were measured all the parameters after 15 days apart there was additional data measured every day ie the room temperature and pH of the digester material was measured before it was inserted into the biogas plant tube.

3. Result and Discussion
The cost of making the biogas plant designed in this study is cheaper than the biogas grown in the soil and casted. The cost of making biogas plant using materials available in the environment is about Rp 250.000 is cheaper than the cost of making a biogas plant that was casted amounted to Rp.8.000.000. It attracts chicken farmers to join in research activities after seeing the cheapness of making biogas plant using mineral water gallon bottle. But we must search the best mixture of material to rise the gas production. This study is still preliminary to make suitable biogas reactor. But from this form of bioreactor have to develop to produce more biogas.

The design for the biogas plant undergoes refinement (fig. 1, fig.2, fig.3) during the activity and then observes the parts that need to be repaired as well as the parts that need to be removed. The biogas plant initially had 4 holes (fig. 1) after experimental testing showed a weak point at the leakage level due to strong pressure during the biogas formation process.

![Figure 1. Biogas plant with 4 holes and motorcycle tire as storage tank](image)

Then to reduce the level of leakage only made two holes consisting of inlets and outlets in one hole and hole to accommodate the gas product resulting from the biogas process stored in the tire motorcycle (fig. 2). Motorcycle tire as a gas storage of biogas forming process is
replaced by plastic bag because the leak from the motorcycle tire is still possible to occur in comparison with the use of plastic bag (fig. 3). It can be seen from the result that the gas formed in the two gas containers there is a difference where the volume of gas stored in the plastic bag more than that stored in motorcycle tires.

**Figure 2.** Biogas plant with 2 holes and motorcycle tire and plastic bag as storage tank

As we can see in fig. 4 and 5 the result of gas production using different biogas plant with different gas storage. Biogas plant with plastic bag as storage gas more accommodated gas compared with the use of motorcycle tires. Biogas plant that uses plastic bag can produce gas above 20,000 cm³ while biogas plant with motorcycle tire produce gas no more than 2000 cm³. Generally, the mixture at 3:3 produces the best gas volume from statistical analysis and on the 3:3 mixture produces a blue flame color. Comparatively, mixture chicken manure and goat manure had the best result for gas production at mixture 4:2.

At Figure 3 we can see mix chicken manure mix with cabbage had best result by comparing with mix between chicken manure and hyacinth. The mater for biogas is nitrogen that make compound as methane, therefore it’s very important that nitrogen in its content. From Sukarni et al. (2019) showed that water hyacinth almost little portion in its chemical element [7]. In cabbage has content of nitrogen in protein as study of Rezende et al. [5]. At Figure 5, we have seen that mix goat and chicken manure portion (4:2) had the best result with the both had high N content and in the chicken manure had higher N portion content.

**Figure 3.** Comparison of plant manure and animal manure on biogas production (CH= chicken manure CB = cabbage HY = hyacinth).
Figure 4. Comparison of mixture from plant manure and animal manure and between animal manure on biogas production (CH = chicken manure ST = straw G = goat manure).

4. Conclusion
From the Result showed that the modification of biogas reactor should be done in order to produce better production of Biogas. The mix of manure had different result for producing biogas. We should to search appropriate mix between animal manure and plant manure. Its mean that the preliminary study must be continue to get best result.

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