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PUP PUMP: PROCESSING OF HUMAN FECES AS A ALTERNATIVE BIOENERGY POWER PLANT ZERO WASTE

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ABSTRACT

OPEC (Organization of the Petroleum Exporting Countries), predicts world oil and gas consumption to increase from year to year (Sebayang, 2018). In 1999, Indonesia was one of the 2nd largest oil producers in the Asia Pacific (Dzulfaroh, 2020). However, now the situation has reversed, Indonesia's oil reserves are very depleted and it is predicted that they will only be able to last for less than 10 years (RI, 2021). Meanwhile, the demand for oil and natural gas is still high, especially for power generation. Therefore, a new alternative that is environmentally friendly is needed (Kholiq, 2015). One of them is by utilizing biogas. Biogas is a gas produced by methanogenic bacteria, by degrading (decomposing) organic compounds under anaerobic conditions. One of the compounds that can be used as a source of biogas is feces. Usually human feces will only accumulate and settle at the bottom of the septic tank. This fecal sediment must be drained for 2-5 years (Sudarmadji, 2013). If this waste is managed properly, it has the potential as an alternative power plant, through the biogas it produces. Furthermore, this biogas is connected to the gas storage box. In the box is also equipped with a pressure detector. If the pressure is appropriate, then the gas will be released to the generator that has been assembled coupled with a biodigester. The generator converts heat energy into kinetic energy, then into mechanical energy, and finally into electrical energy (Biogas, 2018). 1 m3 of biogas is able to produce electricity equivalent to 1.25 Kwh or the equivalent of turning on a light for 6 hours (Talakua, 2019). Meanwhile, biogas processed waste (slurry) contains organic material with complete nutrition (Muanah, 2019), so it can be used as fertilizer. In addition, slurry can also be used as raw material for bricks (Syaifuddin, 2018).

Keywords: Alternative, Bioenergy, Organic Material, Biogas

1 INTRODUCTION

1.1 Background

OPEC predicts world oil and gas consumption to increase by 7.3 million barrels per day (bpd) from 2017 to 2023, with an estimate of nearly 104.5 million bpd in 2023 and predicted to reach 120 million barrels in 2040. (Shadow, 2018). From this we can know that the consumption of petroleum continues to increase from year to year. In 1999, Indonesia was one of the oil producers with the 2nd largest oil reserves in Asia Pacific(Dzulfarah, 2020). But now the situation has reversed, Indonesia's oil reserves are running low. According to the Minister of Energy and Mineral Resources (ESDM), Arifin Tasrif, Indonesia's oil reserves will only be sufficient for the next 9.5 years, with a total of around 4.17 billion barrels. Meanwhile, Indonesia's natural gas reserves are only sufficient for another 19.9 years, with a total of approximately 62.4 trillion cubic feet.(RI, 2021). If oil and natural gas (oil and gas) continue to be explored and exploited, it is very likely that the energy of oil and natural gas (oil and gas) will run out.

Concrete efforts are urgently needed to reduce the rate of consumption of oil and natural gas (oil and gas). In Indonesia, oil and gas is one of the main sources of energy for life. Efforts to find and promote the use of renewable and environmentally friendly alternative energy must be intensified. Indonesia has so many potential energy resources that can be used as alternative energy resources. Such as geothermal, peat, water, biomass, sun, wind, biogas, and various other sources(Kholiq, 2015).

Various conservation efforts have been made. One of them is by utilizing waste which is then processed into biogas. Biogas is an environmentally friendly bioenergy. Biogas raw materials can be obtained from the surrounding environment such as livestock waste, agriculture, and other organic materials, so that biogas has the potential to be used as an alternative renewable energy source.(Prihutama et al., 2017).

The application of utilizing waste into biogas can be applied in the processing of human feces. Stool that has been processed into biogas, can be used as an alternative source of electrical energy for a building, especially in an environmentally friendly campus. Furthermore, biogas waste (slurry) can also be used as organic fertilizer for plants. So that the processing of human feces into zero waste.

However, this potential has not been managed seriously, the utilization of human feces is still not maximized and is only wasted in the septic tank. Raw materials from human feces collected in septic tanks can actually be used as alternative energy production. The drain pipe from each septic tank will collect human feces in a centralized reservoir and there will be a fermentation process that produces methane gas. This methane gas will then be converted into gas and electrical energy. According to Nagami and Ramasamy (in Talakua, 2019), human feces can produce 28 L/Kg of biogas. In 1 m3 of biogas, it is capable of turning on the lamp for 6 hours with 60-100 watts, cooking three times. All of that is equivalent to 1.25 Kwh of electricity.

Human feces have the same potential as cow dung in producing biogas. There is a possibility that the biogas potential from human feces is equal to or higher than that of manure and the methane content in the biogas can reach 70%. Human feces have a pH of about 7.3 which is the optimum pH for biogas production. Therefore, we propose an innovation "Pup Pump: processing human feces as an alternative bioenergy for zero waste power plants".

1.2 Research purposes

The purposes of writing this idea are:

1. As a strategy to process human feces into zero waste
2. Making biogas from human feces as an alternative bioenergy to replace electrical energy sources

1.3 Research Benefits

The benefit of writing this idea is to make human feces as an alternative power plant from biogas, which can slowly replace the use of oil and gas as the main material for power generation.

2. DISCUSSION

2.1 Sewage Treatment in Septic Tank

A septic tank is a place to store household waste or a place to dispose of feces. Apart from being a shelter, the septic tank also functions to process feces (dung). The treated liquid will be discharged through the pipe, while the sludge will settle to the bottom of the tank and must be drained every 2-5 years(Sudarmadji, 2013). Communal septic tanks are used to accommodate and treat fecal waste at a slow flow rate, so that the separation process between solids and liquids can be more stable. The septic tank has several supporting parts such as buffels, manholes, and ventilation pipes. The function of the buffel is to separate the first sediment tank and the second sediment tank. Manhole is a hole that serves to check or clean the communal septic tank. The ventilation pipe is a very important component, because if it is not there it can cause an explosion in the communal septic tank due to the buildup of gas in it.(Septic & Design, 2016).

Domestic wastewater treatment system

Is a series of domestic wastewater management activities in a system equipped with facilities and infrastructure. Domestic wastewater management systems are classified into two types, namely local domestic wastewater management systems and centralized domestic wastewater management systems. In the local system, domestic wastewater is treated directly at the source location and the remaining processing in the form of sludge will be transported to the sewage treatment plant. The main advantage of this system is its low cost. In a centralized system, domestic wastewater is first channeled to a central treatment system before being treated and discharged to surface water bodies.

IPALD (Domestic Wastewater Treatment Plant) is a facility and infrastructure in centralized treatment(Di & Blitar, 2019).

Septic tank system

According to Sudamadji (2013), using a septic tank is a good way of treating waste. But in reality it is not, because it can cause pollution through water seepage.

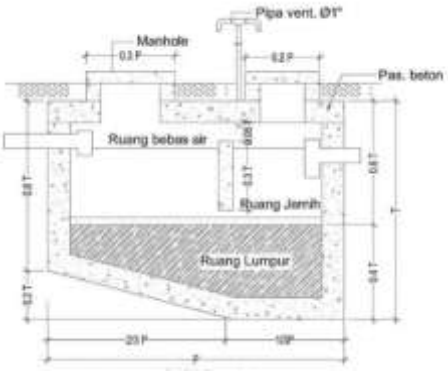


Figure 1.
One-compartment septic tank

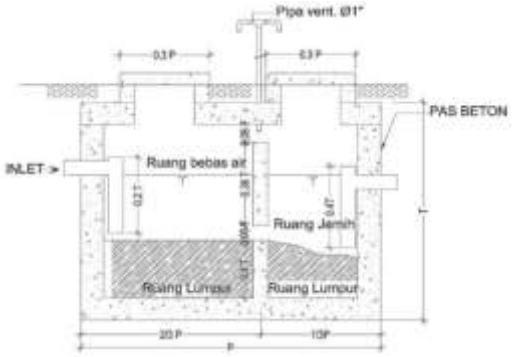


Figure 2.
Two-compartment septic tank

2.2 biogas

Biogas is gas produced by methanogenic bacteria which is the result of decomposition of organic waste under anaerobic conditions. In general, biogas consists of methane gas (CH4) as much as 50 to 70%, carbon dioxide gas (CO2) as much as 30-40%, hydrogen (H2) as much as 5-10%, and other gases in small amounts. It can be concluded that the gas that contains the most biogas is methane (Wahyuni, 2013). Biogas has a heating value of 39 MJ/m3 of manure(Widagdo, 2007).

The amount of methane gas contained in biogas can cause it to burn easily so that it can be used as an energy source for cooking, lighting, and even on a large scale it can produce electrical energy. Biogas is one of the renewable energy sources that can answer the need for alternative energy that can be used to overcome the shortage of petroleum. To produce biogas, a biogas reactor (digester) is needed which is an airtight installation so that the decomposition process of organic matter can run optimally. In addition, the digester can also decompose methane gas emissions as one of the causes of the greenhouse effect, which can lead to global warming (Wahyuni, 2013).

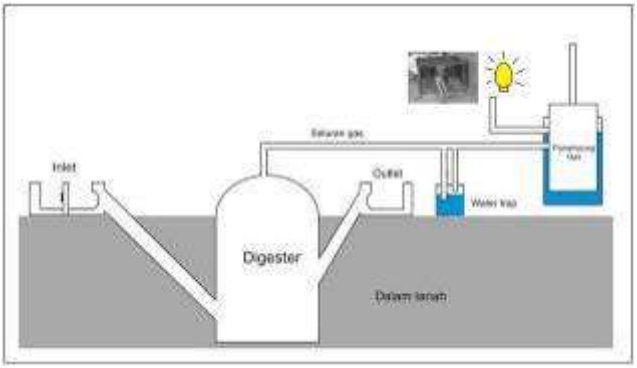


Figure 3. Biodigester design (Care, 2021)

The advantages of biogas compared to other alternative energy sources are:

1. Produce gas that can be used for daily needs as an alternative energy source.
2. *Slurry* biogas can be used as an excellent organic fertilizer.

3. Can reduce levels of pathogenic bacteria in feces that have the potential to cause disease if piled up like that.
4. The processing cost is relatively cheap when compared to fuel oil.
5. Can reduce forest damage and biogas is also smoke free.

The formation of biogas includes three stages, namely:

1. **Hydrolysis**
   At this stage the decomposition of soluble organic materials occurs and Digestion of complex organic matter into simple, changes in the shape of the polymer structure into monomers.

2. **Acidification**
   At this stage the monomer component that has been formed will become food for acidic bacteria. The end products of this stage include acetic acid, propionic acid, formate, lactate, alcohol, carbon dioxide, hydrogen and ammonia.
3. **Methanogenic**
   At this stage the process of methane gas formation occurs. The sulfate reducing bacteria present in this process serve to reduce sulfate and other sulfur components to hydrogen sulfide.

In the biogas digester there are two types of bacteria that play a very important role, namely acidogenic bacteria and methanogenic bacteria. Both of these bacteria must be kept in balance. These bacteria convert organic matter into methane gas and other gases in their life cycle. If the population of methanogenic bacteria is not balanced against acid bacteria, there will be a failure in the anaerobic digestion process in the biogas digester. This imbalance causes the environment to become very acidic which further inhibits the survival of methanogenic bacteria. Optimal acidity conditions in anaerobic digestion are around pH 6.8 to 8, the rate of digestion will decrease at lower or higher pH(Usman et al., 2020).

Sumber	Jumlah Kotoran/hari/kg	% Air	% *Dry Matter*	Biogas m^3/kg kotoran kering
Sapi	20 – 30	80	20	0,023 – 0,040
Sapi Perah	20 – 30	80	20	0,023 – 0,040
Kerbau	30 – 40	83	20	0,023 – 0,040
Ayam	0,15 – 0,20	72	28	0,065 – 0,116
Babi	3,00 – 4,00	67	33	0,04 – 0,059
Manusia	0,10 – 0,40	77	23	0,02 – 0,028

Figure 4. Comparison of Raw Materials and Produced Biogas (Ardiansyah, 2017)

2.3 Processing biogas into power plants

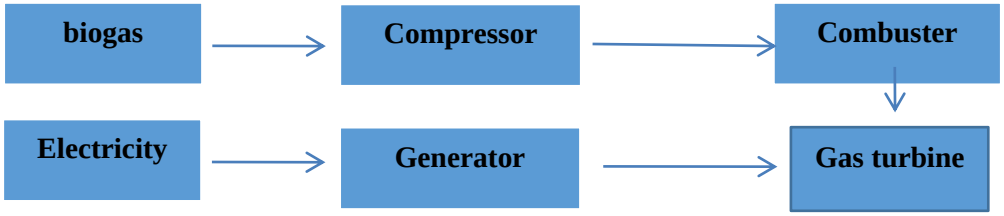
One of the tools that can convert biogas energy into electrical energy is a biogas generator set, also known as a biogas generator. This tool uses biogas fuel and is used to produce electrical energy. On the inside of the biogas generator, there are two devices, namely a generator and a propulsion engine. The combustion of gas fuel makes the engine moveable because it produces mechanical energy. The combination of mechanical energy and generator will convert the mechanical energy into electrical energy.

The biogas generator has four main components, namely:

1. ***Compressor,*** is a mechanical power generator to generate heat energy from the atmosphere. This energy will help the gas combustion in the gas combustion chamber. Other tools used to assist the compressor operation process are the intake air filter and the inlet gate fan.

2. ***Combuster***or combustion chamber, is a heat energy generator from gas fuel. To support the operation process, the combuster requires other tools such as gas station, control system, fuel nozzle, and ignitor system.
3. ***Gas turbine***, is a component for converting heat energy into kinetic energy, then into mechanical energy. To support the operation process, gas turbines require other tools, namely lubricating oil system, control oil system, turning motor, pony motor, starting motor, cooling water system, exhaust duck system, and turbine supervisory instrument.
4. ***Generator***, is a device for converting mechanical energy into electrical energy.

The stages of the conversion process from biogas energy into electrical energy can be seen in the following diagram.



(Biogas & Dusun, 2018)

One of the energy conversion technologies available in the market is the 2500 Watt Genset (Yusuf S & Arfah Z, 2014). To convert it into electrical energy, biogas is used as fuel for a generator set (genset). The generator has a gas engine that functions as a generator driving motor. Gas engines require oxygen from free air and biogas as fuel in the combustion process. The combustion gases can be carbon dioxide and water vapor. Thus, the generator will produce electrical energy that is ready for use(Aji, 2019).

Utilization of biogas into electrical energy can be done in various ways, such as using turbines, fuel cells, and motors. Using a driving motor as a driving tool is the most widely used method in small-scale power plants. The combustion engine is a propulsion engine that functions as a driving force. The combustion engine consists of a motor with alternating work and a motor with rotary work. In a motor with alternating work, it has a gasoline motor and a diesel motor(Pertiwiningrum, 2015).

2.4 Biogas slurry processing

Biogas that has been processed will produce waste called slurry. Slurry biogas is a by-product in the form of semi-solid material (tends to be solid) produced from the anaerobic decomposition of organic material in a closed room. The constituent materials come from biomass, the results of the metabolism of living things as well as organic material waste from human activities such as agriculture, plantations, industry, and waters. Slurry has the following characteristics:

1. Light brown or green in color and tends to be dark
2. Little or no gas bubble content
3. Odorless and does not contain insects
4. Has a sticky, sticky and, not shiny texture(Singgih & Yusmiati, 2018).

Even though it has become waste, the biogas slurry still has many nutrients that are beneficial to the soil. Therefore, biogas slurry can be used as a natural fertilizer. The fertilizer that can be obtained from the biogas slurry can be in the form of liquid organic fertilizer and also solid organic compost. Manufacture of fertilizer from biogas slurry is by separating solids and liquids. The slurry solids are then dried in the sun or aerated to dry to obtain solid fertilizer. As for liquid fertilizer, the slurry liquid is contacted with air using an air pump for 24 hours to remove gas and stabilize the liquid(Sari, 2019). Slurry biogas has a carbon source of 1.12% w/w and a N content of 0.01%(Effendi, 2018).

In addition to containing a lot of organic matter that is nutritionally complete, biogas slurry also contains probiotic microbes that help fertilize the land and control soil diseases. The impact is of course the soil will become more fertile and healthy so that crop yields increase. The microbes contained in the biogas slurry include cellulytic microbes which are useful for composting, nitrogen fixing microbes which are useful for capturing and providing nitrogen, phosphate solubilizing microbes which are useful for dissolving and providing ready-to-absorb phosphorus, and Lactobacillus sp microbes which play a role in controlling attacks. soil borne disease(Muanah et al., 2019).

Slurry biogas has many benefits as follows:

1. Able to repair soil structure that has been damaged.
2. As a natural pesticide
3. Save on plant maintenance costs
4. Reduce household waste

In its application, the liquid biogas slurry can be used directly for fertilizer in the yard of the house in small quantities. Meanwhile, for hilly or sloping land, solid biogas slurry can be used to facilitate handling and transportation. Slurry biogas can be used directly on plants or diluted with water in a ratio of 1:1 or 1:2. Soil that is given a biogas slurry becomes more friable and easily binds nutrients and water. Slurry biogas can also increase the population and activity of soil microorganisms. The average nitrogen content of slurry biogas in liquid form is higher than in solid form(Singgih, 2018).

Apart from being a fertilizer, solid slurry biogas can also be used to make bricks. The process of making bio-slurry bricks is with a composition of 1 cement : 3 sand : 1 bio-slurry. According to Sari (2019), the bio-slurry brick has a compressive strength of 33.28 kg/cm2. It shows that the bio-slurry brick is in category 4, based on SNI 03-0348-1989 (Syaifuddin, 2018).

2.5 Implementation plan

The working principle of the pup pump is the same as the biogas biodigester in general. But at the end of the gas reservoir, it is connected directly to the biogas generator. Furthermore, the results of processing the biogas slurry can be used as fertilizer or raw material for making bricks.

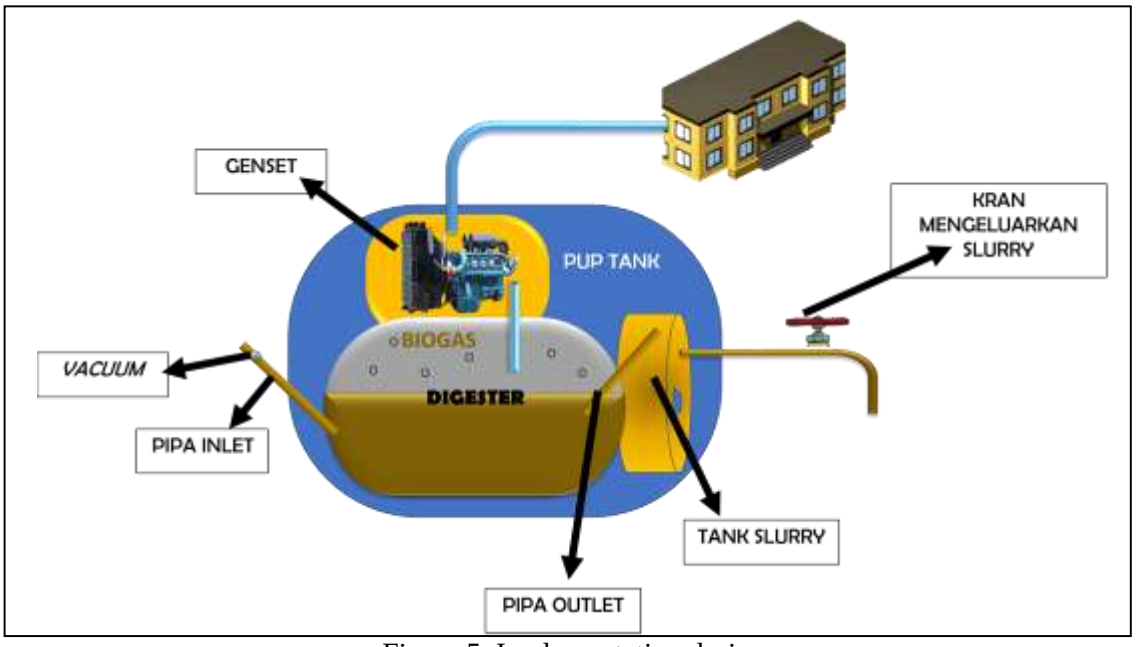


Figure 5. Implementation design

2.6 Strategic Steps in Implementing Ideas

In realizing this idea, several steps can be taken, such as:

1. Making biodigesters and their various components

2. Biogas generator assembly
3. Utilization of biogas slurry

3. CLOSING

Pup pump is one of the innovations as an alternative to zero waste power plants. In the condition of the depletion of Indonesia's oil and gas reserves, various other environmentally friendly alternative energies are needed. Utilization of biogas in the pup pump is one solution. Biogas is used as a new energy reserve for power generation. The working principle of the pup pump is the same as the biogas biodigester in general. However, the advantage compared to the usual biogas biodigester is that the pup pump uses a vacuum to facilitate the suction of the feces in the inlet pipe, so that the maximum amount of feces can be sucked into the digester. In addition, the pup pump is connected directly to a biogas generator which will convert it into electrical energy.

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