Production of Biogas from Poultry Wastes

JOMAR G. NAVARRO[1], FELIX E. ERAS III[2],DR. VINYL H. OQUIÑO[3]
[1, 2] Eastern Visayas State University – Ormoc City, Philippines
[3] Eastern Visayas State University – Tacloban City, Philippines

Abstract - Biogas is one of the least destructive sources of renewable energy. Animal feces and other organic wastes make up its composition. This study focuses on anaerobic digestion processes that can turn poultry feces into sustainable energy. Fixed-dome, floating-drum, tubular, and garage-style digesters are among other technologies that can be used for this procedure. Digestate and biogas will be the outputs. This study will let all poultry owners make use of the manure from their animals and produce their own electricity in a more environmentally friendly manner.

Indexed Terms- Biogas, Manure, Digester, Anaerobic digestion, Poultry wastes

I. INTRODUCTION

Biogas is a versatile and sustainable fuel utilized as a fuel for transportation as well as for cooking, heating, and producing power. It is thought of as a renewable resource because it is produced from organic matter that it also respects the environment and can be refilled as it does not contribute to greenhouse gas emissions.

Depending on the type of organic waste available and the intended end use, biogas may be produced in a variety of methods. Biogas is produced by the anaerobic digestion process. Microbes decompose organic substances, such as animal dung, agricultural waste, and food waste, in the absence of oxygen.

According to the study in Small-scale biogas production in the province of Pampanga, Philippines, animal manure and food waste are two underutilized sources of energy that could be used to create biogas. Carbon dioxide (CO2), methane (NH4), nitrogen (N2), and other trace gases are all components of biogas. Methane makes roughly 50–70% of the biogas and is the predominant combustible gas component. It occurs naturally when organic materials decompose anaerobically in places like landfills, wetlands, sea bottoms, wildfires, and more. Both large- and small-scale biogas capture and use are possible. In place of fossil fuels, biogas can be used for heating, lighting, power, and automobile fuel. It can require extra post-treatment, such as upgrading (raising the methane content), depending on consumption.

According to the study in Analysis of Environmental Impact and Waste Management of Egg Poultry Industry in the Philippines, in Batangas province, San Jose is recognized as "The Egg Basket of the Philippines" for its extensive egg production. This study used qualitative descriptive analysis to gather data. As of 2021, there were approximately 376 poultry farms in the municipality, but the exact number of poultry owners was unknown. Ten poultry owners and the municipal agriculturist were interviewed. Significant waste management challenges were identified by the study, including manure disposal, water and air pollution, odor disturbance and insects, weather patterns, and viral outbreaks (bird flu). SDGs 6 (Clean Water and Sanitation) and 12 (Responsible Consumption and Production) were the two that the study specifically addressed. The environmental concern from waste disposal over the previous few decades is still present. Resolution 164 of 2008, Resolution 341 of 2016, and Resolution 348 of 2016/Ordinance 007 series of 2016 were all adopted by the municipal government as resolutions or ordinances pertaining to poultry. Although it has been determined that these activities and policies are environmentally benign, most poultry owners are unaware of them.

One of the least harmful renewable energy sources is biogas. It is made up of organic waste, such as animal manure. This study focuses on poultry waste that would benefit from conversion into renewable energy. In order to make it into energy, there are ways to use it, like aerobic digestion. There are also some technologies for these processes, such as fixed dome digesters, floating-drum digesters, tubular digesters, and garage-type digesters. There are two outputs after being digested by aerobic bacteria: biogas and digestate. This study would be beneficial to all poultry owners to utilize the manure or dung of their livestock.

A flexible and sustainable fuel, biogas may be used for heating, power generation, transportation, and even for cooking. It is regarded as a renewable energy source since it is derived from replenishable organic material and is ecologically benign because it does not create greenhouse gas emissions.

Depending on the type of organic waste readily available and the desired end use, biogas is a sustainable energy source that may be produced in a variety of methods. Through the process of anaerobic digestion, biogas is produced. Microbes decompose organic material like animal dung, agricultural waste, and food waste when there is no oxygen present.

The ability of biogas to lower carbon emissions and lessen the consequences of climate change is one of its main advantages. The creation of biogas can also open up options for the management of waste, notably food and agricultural waste that can be turned into biogas instead of being dumped in landfills.

Additionally, it is recognized as a sustainable energy source since it is created from organic waste that would otherwise be burned or disposed in landfills, which emits harmful greenhouse gases into the environment. Additionally, biogas has a lower carbon footprint than fossil fuels because the carbon dioxide that is released during burning is balanced by the carbon dioxide that is absorbed by the organic matter as it grows. It is also feasible to produce biogas locally, which may help increase energy security and reduce dependency on imported fossil fuels. It also creates jobs in the industry that produces biogas, providing an opportunity for sustained growth.

This study focused on how poultry waste can be useful in terms of converting it to renewable energy. Specifically, this study sought to:

1. What kind of poultry wastes can be converted into biogas?
2. How are poultry wastes converted into biogas?
3. What anaerobic digestion technologies can be used to produce biogas?

II. METHODS

A flammable gas called biogas is created when organic materials like cow dung, food scraps, and industrial effluent are digested. The method comprises feeding feedstock into a manure digester, which transforms part of it into methane. While chicken and pig feces are possible alternatives, most farmers generate biogas from cow dung.

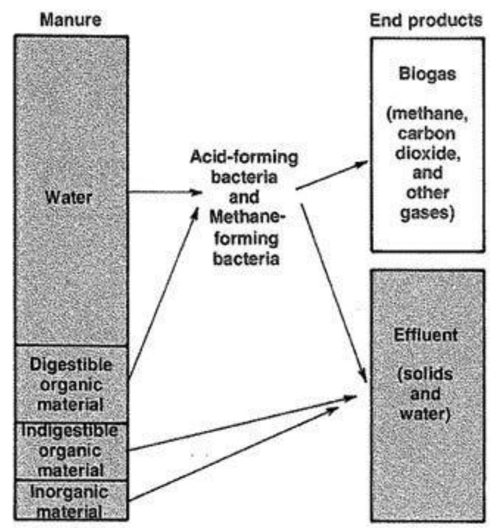

Figure 1. Anaerobic digestion process

Anaerobic digestion is the common method of biogas production. It entails the decomposition of organic matter in the absence of oxygen, such as animal waste, food waste, and agricultural residues. The procedure is carried out in an anaerobic digester, which is an airtight vessel. The microorganisms that decompose the organic matter to produce biogas thrive in an environment created by mixing the organic matter with water and heating it to a temperature of about 35–40°C. Anaerobic digestion produces biogas that is typically composed of about 50-70% methane, 30-50% carbon dioxide, and trace amounts of other gases.

The Anaerobic Digester System

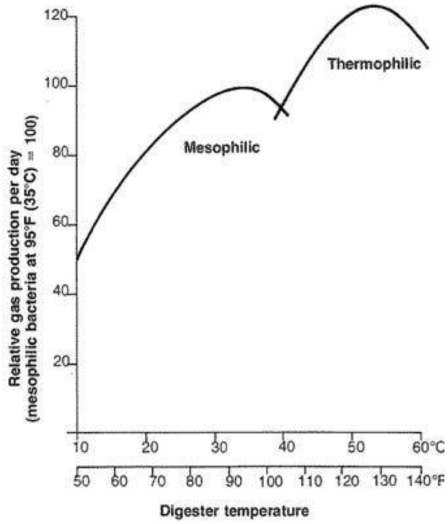

Figure 2. Effect of temperature on gas production rate. (Roediger,H.Dieanaerobe alkalische Schlammfaulung. *Wasser-Abwasser*, H.1, Verlag R. Oldenbourg, Muchen u. Wien. 1967.)

There are two temperature ranges where gas production is most effective. Thermophilic bacteria grow in the 120°F to 140°F (49°C-60°C) range, while mesophilic bacteria prefer temperatures about 95°F (35°C). Figure 2 demonstrates that when the bacteria are exposed to temperatures outside of these ranges, gas production declines. Although thermophilic bacteria create a little bit more gas, the energy required to raise the digester's temperature from 95°F (35°C) to 120°F (49°C) is frequently not worth the extra gas.

Biogas digesters are most efficient when processing organic waste with a neutral pH, and the optimal temperature is around 35 degrees Celsius. The feedstock should have a carbon to nitrogen ratio of 20:1 to 30:1. The majority of animal manure has a 25:1 ratio, which makes it perfect for biogas production. Additionally, the solid concentration has to be low to promote microbial access and improved mixing.

Anaerobic digestion technologies

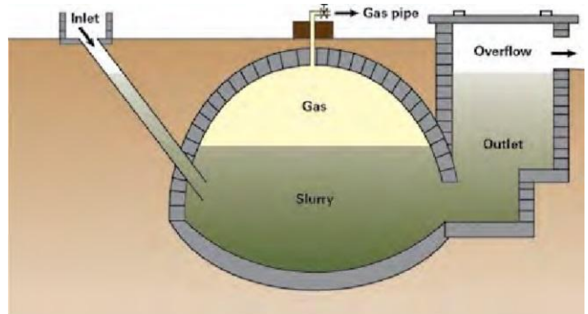

Figure 3. Fixed-dome digester

A fixed-dome plant consists of a closed dome-shaped digester, a feedstock input, a displacement pit (also known as the compensation tank), and the plant's gas holding, which is immobile and stiff. In the upper section of the reactor, the digester's gas is kept in storage. If the gas valve for the exit is closed, increased gas output raises the gas pressure inside the digester, which forces the digestate into the compensation tank. When the gas valve is opened for gas consumption, gas pressure decreases and a proportional amount of sediment from the compensation tank flows back into the digester. Considering this design, the gas pressure fluctuates continuously based on gas production and consumption. Typically, this type of facility is constructed underground, shielding the digester from low temperatures at night and during the winter. The surrounding soil counteracts the internal pressure in the digester (normally 0.1–0.15 bar, Werner et al., 1989) up to the ceiling of the gas-filled space.

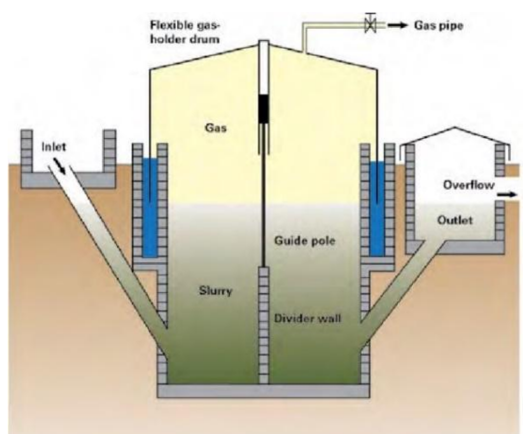

Figure 4. Floating-drum digester

The components of a floating-drum biogas plant are a cylindrical digester and a movable, floating gasholder (drum).Typically, the digester is constructed underground, whereas the floating gasholder is constructed above ground. Smaller residential systems may also be completely aboveground. Typically, bricks, concrete, or quarry-stone masonry is used to construct the digester section of the reactor, which is then plastered. Typically, the gasholder is made of metal and coated with oil paints, synthetic paints, or bitumen paints to prevent corrosion. To ensure continued use, however, annual derusting and application of the protective coating are required. In humid climates, a properly maintained metal gas holder can be expected to last between 3 and 5 years, and in arid climates, between 8 and 12 years. A suitable alternative to standard grades of steel are fiberglass reinforced plastic or galvanized sheet metal (Nzila et al., 2012)

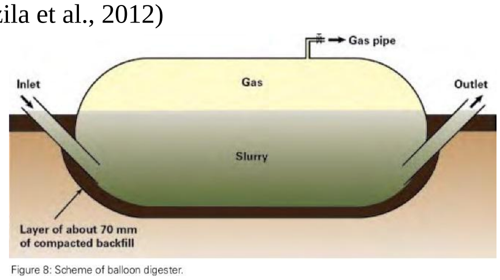

Figure 5. Tubular digester

In a tubular biogas plant, the digester and gas holder are combined into one longitudinally formed, heat-sealed, weather-resistant plastic or rubber bag (balloon). The top of the balloon is where the gas is kept. The balloon's skin is immediately connected to the intake and outflow. Since tubular digesters normally lack a stirring device, active mixing is constrained and digestate flows through the reactor in, a plug-flow fashion. However, the longitudinal design prevents short-circuiting from happening. Weights can be put on the balloon to raise the gas pressure while being careful not to harm it.

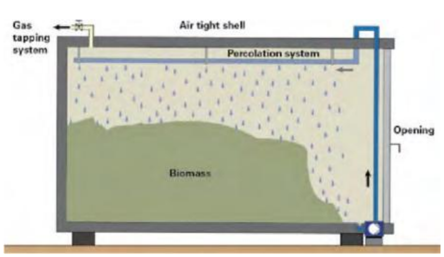

Figure 6. Garage-type digester

The garage-type digester, unlike the three previously described digester types, operates in group mode and through a dry digestion process. The entire organic waste stream is added in batches to a simple digester with an impermeable door that resembles a garage. Once the door is closed, there is no need to transport or rotate the material during the procedure.

The term "dry digestion" is misleading, as water is essential to all biological processes. All AD microbes require a moist environment because they are only active in the liquid phase of the substrate. The term dry digestion therefore refers to a high total solids content above 15% (Li, Park & Zhu, 2011) compared to wet systems. However, the main criterion is the feedstock stickability.

RESULTS AND DISCUSSIONS

One of the most prevalent sources of digester feedstock is dairy waste. As an illustration, 100 cows generate 6.25 tons of trash per day. However, there is a lot of water in the biogas made from cow manure. 20–30% of volatile chemicals are converted to biogas by the bacteria in the digester. The sole feedstock for your digester can be cow manure.

An adult pig produces about 5 kilograms of manure. This garbage may generate 4.8 cubic feet of biogas per day and is 90% water and 7% volatile solids. Pig manure has a high nitrogen level and a low carbon content, thus using it alone is not advised. Because of its high alkalinity, it has the ability to prevent microorganisms that produce methane from growing. Methanogens favor an acidic environment. However, combining pig manure with biomass or cow dung can enhance the biogas production process.

Chicken manure is an appropriate feedstock for digesters. Due to the fact that 100kg of chicken litter will yield about 20m3 of biogas. However, the high nitrogen content of poultry manure makes it difficult for the bacteria in a biogas plant to digest it. By combining chicken waste with carbon-rich materials, such as biomass or cow dung, you can improve the quality of poultry biogas.

- Anaerobic Digester Outputs

Anaerobic digestion produces two valuable outputs: biogas and digestate.

- Biogas

Biogas is mostly constituted of methane (CH4), the major component of natural gas (50 to 75 percent), carbon dioxide (CO2), hydrogen sulfide (H2S), water vapor, and trace quantities of other gases. Biogas energy may be utilized similarly to natural gas to supply heat, create electricity, and power cooling systems, among other things. Biogas may also be processed to yield renewable natural gas (RNG) by eliminating inert or low-value ingredients (CO2, water, H2S, and so on). This can then be sold and injected into the natural gas distribution system, compressed and used as car fuel, or further processed to produce alternative transportation fuel, energy products, or other advanced biochemicals and bioproducts.

- Digestate

Digestate is the leftover residue from the digestive process. It is made up of both liquid and solid components. These are frequently segregated and treated separately since they each have value that may be achieved with differing degrees of post-processing.

With proper treatment, digestate solids and liquids can be used in a variety of beneficial applications, including animal bedding (solids), nutrient-rich fertilizer (liquids and solids), a foundation material for bio-based products (e.g., bioplastics), organic-rich compost (solids), and/or simply as soil amendment (solids), the latter of which may include the farm spreading the digestate on the field as fertilizer. Digestate products can be a source of revenue or cost savings, and they are frequently pursued in order to maximize the financial and net-environmental value of an AD/biogas system.

Adoption of these digesters would have a significant influence on the environment. The ecosystem and aquatic bodies extend further. It is estimated that every day, 140 tons of pig excrement from home farms is discharged. Various levels of pathogens and eutrophication would be significantly reduced if digestate was employed as a fertilizer. Better animal and water ecosystems will result from the use of fertilizer. It would be beneficial. implications on human health; fewer deaths as a result of decreased interaction with the uncooked pig feces and gas emissions. Applying AD across the entire province may result in recycling 3 tons of nitrogen and 0.7 tons of phosphorus as fertilizer.

This study did not take installation costs into account. Nonetheless, it is said to have financial motivations, as it saves money on both LPG and chemical fertilizers, with a life expectancy of at least 5 years.

- Consumption of biogas

The most efficient digesters generate biogas that contains 60% methane and 40%carbon dioxide. Manure biogas contains 60% the energy capacity of natural gas. As a result, it may be used to replace traditional fuels in power generating and centralized heating systems. According to comparative studies, it is competitive with most fossil fuels and nearly on level with LPG and natural gas. If you wish to use manure-derived biogas to heat boilers and cook, remove the water vapor by installing condensation traps along the gas pipes.

- Handling the waste

Because only 25% of the feedstock is turned into biogas, there will be plenty of effluent when the volatile solids are depleted. The digestate can be used as fertilizer. Because of its high nitrogen content, this fertilizer is more nutritious than raw manure. It is also simpler to absorb by crops than raw manure.

The digester turns more than 80% of the nitrogen in trash into ammonium nitrate, much above the 25% and 50% observed in deep litter and slurry, respectively. Plants can use this type of nitrogen considerably more easily. However, because ammonia is prone to leaks, you should store any waste that you do not intend to utilize immediately in an ammonia tank.

CONCLUSION

When there is a shortage of energy, the production of biogas and bioconversion are practical, user-friendly, and environmentally benign methods of generating energy. To lessen carbon emissions and the environmental effects they have, such as global warming and climate change, it may be desirable to use such clean energy generation technology.

REFERENCES

[1] Afolabi, A. (2021). Backyard Biogas Production from Animal Manure: Process and Utilization.

[2] Afolabi, A. (2021). Manure digestion for biogas from cow/pig/chicken manure.

[3] Mohammad Roman Miah, A. K. (2016). Production of biogas from poultry litter mixed with the co-substrate cow dung.

[4] Rajendra Singh, A. B. (2008). Production of Biogas from Poultry Waste.

[5] Studies, A. D. (2014). Yvonne Vögeli, Christian Riu Lohri,Amalia Gallardo, Stefan Diener, Christian Zurbrügg.

[6] Trosgård, E. (2015). Small-scale biogas production in the province of Pampanga, Philippines.

[7] Younes Noorollahi, M. K. (n.d.). Biogas production potential from livestock manure in Iran.