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Biological Treatment of Organic Waste for Poultry Farm in Hot Climate

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Abstract

Biogas is a byproduct of the decomposition of organic waste by anaerobic bacteria. Organic waste is put into a sealed tank called a digester (or bioreactor) where it is heated and agitated. In the absence of oxygen anaerobic bacteria consume the organic matter to multiply and produce biogas. Biogas is typically composed of 60% methane and 40% CO2. It is similar to natural gas which is composed of 99% methane. Biogas is a clean and renewable energy that may be substituted to natural gas for cooking, to produce vapor and hot water or to generate electricity. Organic waste is converted into compost using a method that does not produce bad smells. This paper highlight towards designing Organic waste management plants for poultry farm in hot climate. Hot climate is more effective for the decomposition of organic waste. This paper is mainly a critical review of related literature and previous research around the world. It is divided into two parts. The first part is review of different type of waste management plants and second part is critical effective analysis of methodology in use of waste management plant for poultry firm in hot climate. The result shows that 2 KW/h is enough energy to power 180 nos. 10 W light bulb for 12 hours in a poultry farm. It is important to raise public awareness about the programmed in order for communities to join for future. If people feel exposed to energy price fluctuation and people have an environmental conscience about waste management then biogas might be a sustainable solution for people.

Keywords: *Waste materials, Poultry firm, Organic waste, Hot climate*

1. Introduction

Biogas is a clean and renewable energy that may be substituted to the natural gas. Biogas is a byproduct of the decomposition of organic waste by anaerobic bacteria. It is a mixture of methane and carbon dioxide, produced by the breakdown of organic waste by bacteria without oxygen (anaerobic digestion). Organic waste is put into a sealed tank called a digester (or bioreactor) where it is heated and agitated. In the absence of oxygen anaerobic bacteria consume the organic matter to multiply and produce biogas. Biogas is typically composed of 60% methane and 40% CO2. It is similar to natural gas which is composed of 99% methane (Electrigaz 2006). The bubbles rising from a swampy marshy area that is naturally produced methane. Like the gas in liquid petroleum gas canisters, methane can be burnt for cooking or lighting. It can also be used to power combustion engines to drive a motor or generate electricity. 1m³ of biogas can be generate1.25 kilowatt hours of electricity (PACE). Chicken manure of poultry farm's waste products can be used to obtain energy. Row material of the biogas plants is the waste materials from poultry farms. This is a sustainable renewable energy plant for poultry farms. The temperature of the process is quite important because methane-producing bacteria to do their work best at temperatures between 30°C – 40°C or 50°C – 60°C. It takes from 2 to 8 weeks to digest a load of waste, depending on the temperature (PACE). According to climate and weather context hot arid climatic zone is more effective to produce biogas from organic waste. More organized poultry farms in rural areas can create greater amount of this green renewable energy generation in hot arid climate in the world to create a sustainable poultry farm. The three pillars of the sustainability concept imply complex relationships between economics, the environment and society. The three pillar concept also implies trade-offs between the social, environmental and economic aspects of sustainability. In terms of process, sustainability is perceived less as an ultimate outcome and more as a pathway to change (Norman, 2009). In addition the recognition of the poultry farm is that the social dimension is to be addressed by public participation and consultation in the use of biogas plant.

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2. Content

Biogas plants make clean renewable energy for user of poultry farm. After an initial investment in the plants for poultry farm, there is no need to spend money on fuel for running a generator to generate electricity for poultry farm lighting.
Biogas plants kill the bacteria in livestock manure. A poultry farm with a biogas system is a cleaner and safer place for worker and user.

Biogas plants produce excellent safe fertilizers for use on the farm to produces plants and vegetables. Biologically digested biomass becomes ecologically clear fertilizer that increases crops up to 40-50% (Md. Abdul Gufran, 2009).

Recycling biomass for energy and other uses cuts down on the need for landfill to hold garbage in poultry farm. Biogas plants can help in the fight against global warming by allowing to burn methane from organic waste of the poultry farm, instead of letting it escape into the atmosphere where it adds to the greenhouse effect.

3. Biogas plant's safety and maintenances policy for poultry farm

The plant is place under the earth in a separate room within poultry farm. So biogas plant is generally safe. The only danger is from explosion if it is mixed with air and lit by fire. However, it only explodes if mixed with air or oxygen with a lighted match or fire very close by. For example, you shouldn't ever lean into the tank with a lighted match! If you have a biogas leak and the room has good ventilation by windows, fresh air blowing through the space it should not pose much danger of explosion although you would lose your stored biogas. This is the important reason why good maintenance of plants is essential. It is important to receive training on the use and maintenance of biogas plants when it is installed. Local biogas promotion projects will usually train a team of local technicians, so that any problems can be solved quickly.

4. Different types of biomass and biogas plant

Biomass is otherwise considered as garbage. Some of these are just materials lying around- dead trees, tree branches, yard clippings, leftover crops, wood chips and bark and sawdust from lumber mills. It can even include used tires and livestock manure. Any organic waste is considered as biomass like- human excreta, manure, animal slurry, fruit and vegetable waste, slaughter house waste, meat packing waste, dairy factory waste, brewery and distillery waste, etc. Our household trash, paper products those cannot be recycled, other household wastes contains some form of biomass. Biogas is made by fermenting biomass in a biogas digester of plants. The size of a digester can vary from a small household system to a large commercial plant of several thousand cubic meters. Different types of plants are design for different type of waste with the local context. Where lots of animals are raised, the animals- like cattle, cows, and even chickens – produce manure. When manure decomposes, it also gives off methane gas similar to garbage. This gas can be burnt right at the farm to make energy to run the farm. Size of the digester also depend on how much biogas you need to meet your daily requirements, the availability and amount of livestock manure and water (water, number of cow, goats, Chicken or other livestock), and the materials available on site (bricks, etc) for construction of the digester. A regular supply of water is essential for operation of biogas plants. Rainwater harvesting could help with this biogas plants. There are three main types of simple biogas plants according to physical appearance are shown in Figure 1. The different types of biogas plants are depend on digester types- balloon plants, fixed-dome plants, floating-drum plants

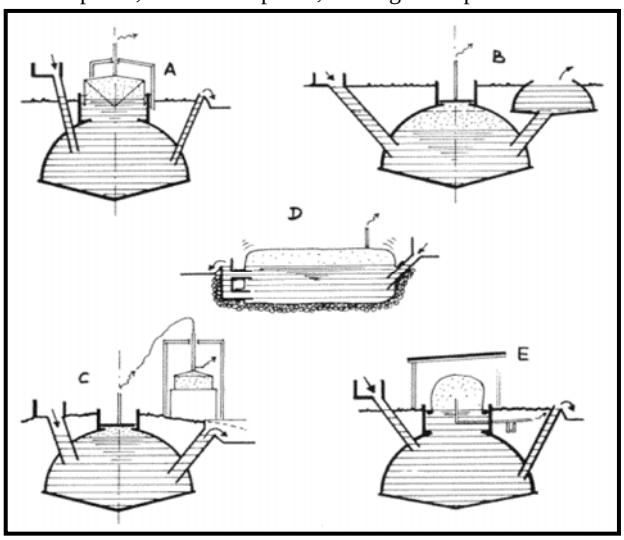

Fig. 1: Simple Biogas Plants. A) Floating -dram plant. B) Fixed-Dome Plant, C) Fixed-Dome Plant with separate Gas Holder, D) Ballon Plant, E) Channel-type digester with plastic sheeting and sunshade (Source- L. Sasse, GATE, 1988 p14)

Advantages are low cost, ease of transportation, low construction, sophistication, high digester temperatures, uncomplicated cleaning, emptying and maintenance.

Disadvantages can be the relatively short life span, high susceptibility to damage and little creation of local employment and, therefore, limited self-help potential. A variation of the balloon plant is the channel-type digester, which is usually covered with plastic sheeting and a sunshade (Figure1). Balloon plants can be recommended wherever the balloon skin is not likely to be damaged and where the temperature is even and high.

5. Fixed-dome plants

The fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester. When gas production starts, the slurry is displaced into the compensation tank. Gas pressure increases with the volume of gas stored and the height difference between the slurry level in the digester and the slurry level in the compensation tank.

Advantages are the relatively low construction costs, the absence of moving parts and rusting steel parts. If well constructed, fixed dome plants have a long life span. The underground construction saves space and protects the digester from temperature changes. The construction provides opportunities for skilled local employment.

Disadvantages are mainly the frequent problems with the gas-tightness of the brickwork gas holder (a small crack in the upper brickwork can cause heavy losses of biogas). Fixed-dome plants are, therefore, recommended only where construction can be supervised by experienced biogas technicians. The gas pressure fluctuates substantially depending on the volume of the stored gas. Even though the underground construction buffers temperature extremes, digester temperatures are generally low.

6. Floating-drum plants

Floating-drum plants consist of an underground digester and a moving gas-holder. The gasholder floats either directly on the fermentation slurry or in a water jacket of its own. The gas is collected in the gas drum, which rises or moves down, according to the amount of gas stored. The gas drum is prevented from tilting by a guiding frame. If the drum floats in a water jacket it cannot get stuck, even in substrate with high solid content. Advantages are the simple, easily understood operation - the volume of stored gas is directly visible. The gas pressure is constant, determined by the weight of the gas holder (ISAT).

7. Cost effectiveness study of biogas plant in poultry farm

In poultry farm to get rid of organic waste it always costs money. Otherwise, this wastes probably creating an environmental hazard. By putting a digester in waste treatment chain can introduce a potential renewable energy sources. In a poultry farm the manure is not considered to be a waste but a fertilizer also. By installing a digester the farmer can profit from the biogas by reducing smell and enhancing the fertilizing value of the manure. The biogas is used to reduce some energy cost in the poultry farm. Introduction of biogas technology in the poultry farm is the fact that rural populations often cannot afford the investment cost for a biogas plant. Biogas plants have already proven economically viable investment in many cases. Efforts have to be made to reduce construction cost but also to develop credit and other financing systems. The society as a whole can benefit from biogas. Financial support from the government can be possible as an investment of biogas plants in poultry farm to reduce future costs of energy use and inorganic fertilizers, through increasing costs for health and hygiene and through natural resource degradation.

8. Effective temperature range to produce biogas

Anaerobic fermentation is in principle possible between 3°C and approximately 70^0C. Differentiation is generally made between three temperature ranges:

- The psychrophilic temperature range lies below 20°C,
- The mesophilic temperature range between 20'C and 40°C and
- The thermophilic temperature range above 40 °C.

9. Minimal average temperature

The rate of bacteriological methane production increases with temperature. Since, however, the amount of free ammonia also increases with temperature; the bio-digestive performance could be inhibited or even reduced as a result. In general, unheated biogas plants perform satisfactory only where mean annual temperatures are around 20°C or above or where the average daily temperature is at least 18°C. Within the range of 20-28°C mean temperature, gas production increases over-proportionally. If the temperature of the bio-mass is below 15°C, gas production will be so low that the biogas plant is no longer economically feasible (ISAT).

10. Changes in temperature

The process of bio-methanation is very sensitive to changes in temperature. The degree of sensitivity, in turn, is dependent on the temperature range. Brief fluctuations not exceeding the following limits may be regarded as still un-inhibitory with respect to the process of fermentation:

- psychrophilic range: ± 2°C/h
- mesophilic range: ± 1 °C/h
- thermophilic range: ± 0.5°C/h

11. Biogas model for poultry farm

The amount of biogas can extract from waste depends on the waste itself and the design of the digester system. It all depends on waste quality, digester design and proper operation of the system. The result shows that each cubic meter (m^3) of biogas convert biogas to electricity, in a biogas powered electric generator, which produces 2 KW/h of useable electricity, the rest turns into heat which can also be used for heating applications. Biogas plants produce heat after cooling generator without any additional gas combustion. 2 kW/h is enough energy to power 180nos 10 W energy bulb for 12 hours in a poultry farm.

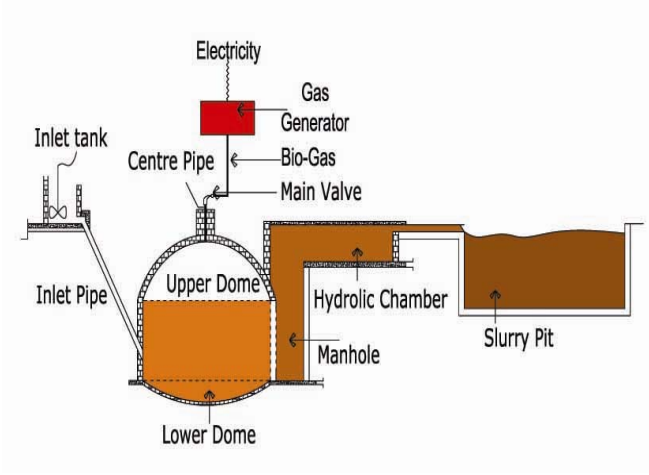

Fig. 2: Biogas plant model of a poultry firm

Every biogas system is unique, because everyone's waste quantity and quality is different. To ensure the economic viability of the biogas plant great care must go in the design, construction and operation of the biogas plant for poultry farm. The plant size is depends on number of chickens in poultry farm. Table 1 shows the ratio between row materials for plants as a unit. The incubators are supported to imitate and maintained optimal temperature for eggs. They are used to increase brooding efficiency.

Table 1: relationship between hours and volume of plant

Volume of plant (Daily Production of in m3)	No. of Poultry Birds waste	Amount of Poultry Birds waste daily (Kg)	Amount of water Daily (Kg)	kW Generator	Hrs
4.8	700	67	134	2	3.5
8	1200	115	230	2	6
17	2500	240	480	2	12.5
20	3000	288	576	2	15
27	4000	384	768	2	20

Biogas plant for 2500 chicken Waste in poultry farm

1 poultry (bird) waste =0.094 kg litre/day

2500 poultry (bird) waste= 235 kg litre/day

1 kg poultry litre can produce 2.6 cft gas

235 kg poultry litre can produce 611cft gas = 17.3 m^3

0.68 m^3 gas produce 1 kW/h

17.30388 m^3 gas produce 25 kW/h

Therefore, 2-kW generators can run 12.5 hrs

12. Biogas plant in poultry farm for conservation

The conversion of poultry farm's organic waste material into biogas and fertilizer helps protect the environment in different way those are state below,

- The generated biogas in poultry farm can replace traditional energy sources like firewood and animal dung, thus contributing to combat deforestation and soil depletion.
- Biogas can contribute to replace fossil fuels, thus reducing the emission of greenhouse gases and other harmful emissions from poultry farm.
- By tapping biogas in a biogas plant and using it as a source of energy, harmful effects of methane on the biosphere are reduced.
- By keeping waste material at a confined space in poultry farm, surface and groundwater contamination as well as toxic effects on human populations can be minimized.

By conversion of poultry farm's organic waste into a more convenient and high-value fertilizer ('Biogas slurry'), organic matter is more readily available for agricultural purposes, thus protecting soils from depletion and erosion (ISAT).

13. Public Awareness

Popularization of biogas technology is essential for actual construction of plants in the poultry farm. Without the public awareness of biogas technology in poultry farm, its benefits, do not get sufficient basis to application of biogas technology at grassroots level. At the same time, awareness within the government is essential. Since impacts and aspects of biogas technology concerns so many different governmental institutions. It is necessary to identify and include all responsible government departments in the public awareness-raising process for sustainable use of biogas technology in poultry farm.

14. Conclusion

Biogas plants are significant capital investments that require careful planning to maximize the chances of success. If poultry farm exposed to energy price fluctuation and an environmental conscience about its organic waste then biogas plants might be a sustainable solution for poultry farm. Biogas technology can substantially contribute to conservation and development, if the climatic conditions are favourable. However, the required high investment capital and other limitations of biogas technology should be thoroughly considered for sustainable poultry farm in hot climate. Now a day, all biogas plants are customized to fit all the needs.

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