Fixed Dome Biogas Digester Installation in Kenya

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The continued use of fossil fuels, as well as the environmental impact of greenhouse gases (GHGs), has prompted research into the production of alternative fuels from natural sources. (Achinas, Achinas, & Euverink, 2017). Due to the increased cost of living and inflation in today's society, there is a necessity for the development of alternative sources of energy. Cooking accounts for 90 percent of energy consumption in developing-country households. Furthermore, access to electricity is limited in rural areas. As such, biogas is an energy-efficient alternative to firewood and cattle dung that can meet the needs of the rural population. Biogas is a renewable energy source that can be used in place of natural gas or liquefied petroleum gas (Rajendran, Aslanzadeh, & Taherzadeh, 2012). Biogas is a source of energy, one which is economically friendly if conserved and utilized. As such, there is need for the construction of systems that are compatible with biogas consumption. One such mechanism is the fixed dome biogas digester. This article provides an overview of a fixed dome biogas digester including production, construction, materials used, and size of the system. The article further outlines a summary of the comparison between the fixed dome and floating drum biogas digesters.

An Overview of Fixed Dome Biogas Digester

The fixed dome digester was designed to be low-cost, long-lasting, and low-maintenance. It is made up of an underground reactor or digester with a fixed cover where the gas and input slurry are stored, as well as an effluent displacement tank or expansion chamber with an outlet (Uche, Emmanuel, Paul, Olawale, Frank, Rita, & Martin ,2020).

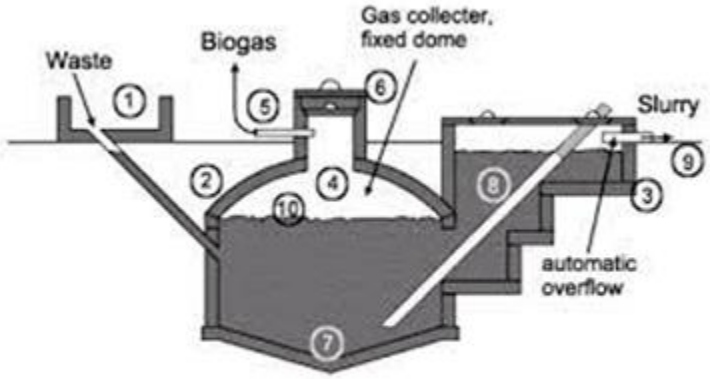
Biogas production

Many factors, including pH, temperature, and microbial population are found to have an impact on biogas production (Eze, & Agbo, 2010). The most common designs are fixed dome, floating drum, and plug flow. Biogas produced by anaerobic digestion can be used for cooking, lighting, and electricity generation (Rajendran, et al., 2012).

Construction

Fixed dome digesters are typically constructed underground. The size of the digester is determined by its location, the number of households, and the amount of waste available on a daily basis (Rajendran, et al., 2012).

The digester is filled through the inlet pipe (1) until the level reaches the expansion chamber's bottom level (7). The biogas produced is accumulated in the upper part of the digester known as the storage part. (4). A gas pressure is created by the difference in level between the slurry inside the digester and the expansion chamber (6). The gathered gas takes up space and presses a portion of the substrate into an expansion chamber. The biogas is then emitted to serve the connected sources (5). The process repeats itself all over. The figure below illustrates a fixed dome system.



Source: Ranisha and Romas, 2016
Fixed dome biogas digester illustration

Source: KENPRO, 2021
Field fixed dome biogas digester system

As shown in the figure, there is an underground reactor/ digester (7). This is where water and the animal waste reacts, releasing biogas in the process.

There is also expansion chamber (4). This is where the biogas accumulates after being dispensed from the digester.

Slurry on the other hand, is a watery mixture of insoluble matter coming from the digester.

Materials and Size of Fixed dome digesters

Materials used in the construction of household digesters are determined by geological, hydrological, and local conditions, as well as locally available materials. Stones, bricks, PVC and polythene materials may be used in the construction of a biogas plant (Rajendran, et al., 2012).

The size of the biogas plant depends on several factors: The amount and type of organic waste to be disposed in the digester. The nature of the excreta, be it animal refuse or kitchen waste; the demand of natural gas and the consumption pattern. This depends on the number of people the biogas plant is servicing; the level of ground water and the site of the soil. Some areas are preferred due to the nature and odor of the biogas. For better integration, it should be put in a considerable distance far from people; Air temperature in the region and wind direction. This determines the speed of the biogas decomposition and the interaction of the community with the biogas plant and the objective treating of organic waste. How the waste will be processed (Samer, 2012).

Comparison between Fixed Dome and Floating Drum Biogas Digesters

Fixed dome and floating drum biogas digesters are two types of biogas digesters which have been in use in Kenya for some time. Table 1 shows a comparison summary of the two types of biogas digesters.

Table 1
Comparison between fixed dome and floating drum biogas digesters

Fixed dome biogas system	Floating drum digesters
Equivalent gas output	Equivalent gas output
Relatively easier to maintain	Harder to maintain in terms of comparison
Comparatively difficult to estimate the amount of gas available for use	It is relatively easier to estimate the gas available for use
In terms of comparison, it is less expensive	More expensive in comparison
Better insulated, with the option of internal heating	Less insulated than fixed dome biogas system in comparison
Higher life expectancy	Relatively lower life expectancy in comparison

Pros and Cons of Fixed Dome Biogas System

Pros of Fixed Dome Biogas System include: Solidly built and easy to construct with low-cost materials; well insulated - the underground design, combined with typically porous building materials, allows the bio digester to remain productive for longer periods of time; provides an alternative source of energy to fuel and electricity, and is relatively cheaper than fuel or electricity.

Cons of Fixed Dome Biogas System include: Anaerobic digestion is a slow process that necessitates a lengthy period (more than 30 days). This increases the volume and cost of the digester; Low loading rates and slow recovery after a failure; Difference in the year-round temperature variation. The year has varying climatic periods, with each resulting to a fluctuation in temperature; Leakage from biogas digesters increases methane and

carbon dioxide emissions into the environment. When methane leaks from the digester, another disadvantage is the fire explosions in homes connected to biogas supplies (Rajendran, et al., 2012).

Conclusion

A fixed dome biogas system is one of the ways of incorporating a biogas infrastructure. However, there is a need to adopt biogas technology as a sustainable renewable energy solution at household and institutional levels despite the issues of cost implications and policy gaps.

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