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Investigation and Analysis on Biogas Plant Digester

Neeraj Kumar[1], Er. Jitender Panchal[2]

[1]*M.Tech. Scholar, Department of Mechanical Engineering, MIET, Mohri, India*

[2]*Head & Assistant Professor, Department of Mechanical Engineering, MIET, Mohri, India*

Abstract

This paper includes the constructions of the biogas plants digester as well as the small and household units which gives a clear description of the structures and constructions of the Biogas plants (Anaerobic Digesters). Ultimately, in this paper gives a brief study of biogas digester types and its Sizes, Ultimately This paper describes the operation of biogas plant digester. In this paper we study the types of biogas digester and material used.

Keywords: Digester, Biogas plants, Building material, House hold unit, Gas holder, Waste.

1. Introduction

Biogas plants are many types in which we are used different types of wastes. Biogas is a renewable source of energy .The design & construction of biogas plants digester is easy .as day by day the conventional source of energy are low in ratio from the earth. so to overcome this problem we are developed a biogas plants .in this paper we are designing biogas plants and several steps involving to construction of plants.

This paper describes the construction steps and operation of biogas plant, which include

(a) Planning the biogas plant layout and designing the digesters
(b) Running the biogas plant including the mechanization of the biogas plant

2. Components of bio-gas plant

2.1 The components of a biogas plants are:

1. Reception tank
2. Digester or fermenter
3. Gas holder
4. Overflow tank

2.2 Size of biogas plants

There are the several factors which depends on the Size of Biogas plants:
1. The type of organic waste and its amounts to be disposed in the digester
2. The objective of organic waste (the production of energy and/or organic fertilizer)
3. The Demand of natural gas and consumption pattern
4.The nature of the soil and the level of ground water
5.The Air temperature in the region and wind direction throughout the different seasons
6. The staff Traning on farm and home regarding operation of biogas plants

The amount of organic waste fed into a digester each day has an important effect on its operation. This is measured by volume added in relation to the volume of the digester, but the actual quantity fed to the digester also depends on the temperature at which the digester is maintained. In order to determine the unit size of a biogas plant, the following mathematical equation must be achieved:

Digester size = Daily feed-in (day-1) x Retention time (day) (1)

The digester size can be defined as the total size of the biogas unit, which includes the effective size of any volume occupied by the fermented material and the volume of gas storage. Size of the daily feed-in is the size of a mixture of dung with water added to the digester once daily or several times and the average concentration of total solids of 10%, where mixing the organic wastes with water depends on its water content. Storage capacity has to be calculated by average live weight of animals kept in husbandry systems, amount of added water, periods of no fertilization of crops, and the animal species.

3. Digester System

3.1 Types of digester

During the last century a number of different types of flows in simple digester have been developed and they can be of the following kinds: (1) batch flow, (2) continuous flow, (3) continuously expanding, (4) plug flow, and (5) contact flow.

The conventional digesters are those utilized to process liquid raw materials with a high content in solids, also called rural digesters, the fermentation chamber having a volume below 100 m3. Conventional digesters are installed without any type of mechanism to reduce the retention time during which the biomass remains inside are predominant; these systems are fed discontinuously and known as discontinuous-flow i.e. batch digesters, or fed periodically and known as continuous-flow digesters. Batch digesters are loaded at once, maintained closed for a convenient period, and the organic matter is fermented and then unloaded at a later time. It is quite a simple system with small operational requirements. Installation can be made in an anaerobic tank or in a series of tanks, depending on the biogas demand, availability and amount of raw materials to be utilized. Batch flow is most suitable for dry organic matters (solid materials), e.g. solid vegetable waste.

This type of biowastes is fed into the digester as a single batch. The digester is opened, digestate is removed to be used as biofertilizer and the new batch replaces the digestate. The tank is then resealed and ready for operation. Depending on the waste material and the operating temperature, a batch digester will slowly start producing biogas and increase the production with time and then drop-off after 4 to 8 weeks. Batch digesters are therefore best operated in groups, so that at least one digester is always producing biogas. Continuous digesters are usually requiring daily loading and residue management. The process is referred to as continuous since to every daily load corresponds a similar volume load of fermented material. The biomass inside the digester moves through by the difference in hydraulic heat, between the substrate entering the digester and the digestate coming out when unloading. Each load requires a retention time, usually between 14 to 40 days. Continuous digesters can have their retention period reduced by the introduction of agitation and heating. The disadvantage of these models is that the raw material needs to be diluted. The great advantage of these digesters over the batch type is that a single unit allows a continuous supply of biogas and biofertilizer and the continuous treatment of small amounts of waste. Biogas production can be accelerated by continuously feeding the digester with small amounts of waste daily. If such a continuous feeding system is used, then it is essential to ensure that the digester is large enough to hold all the material that will be fed into the digester in the whole digestion cycle.

Two simple biogas digester designs have been developed, the Chinese fixed dome digester and the Indian floating cover biogas digester. The digestion process is the same in both digesters but the gas collection method is different in each. In the Indian-type digester, the water sealed cover of the digester rises as gas is produced and acts as a storage chamber, whereas the Chinese-type digester has a lower gas storage capacity and requires efficient sealing in order to prevent gas leakage. Both have been designed for use with animal waste or dung. Additionally, there are also Philippine and Sri Lankan digesters.

3.2 Indian digester

The Indian-type digester basically is comprised of a cylindrical body, gasometer, feed pit and outlet pit. The digester is made using burnt-clay bricks and cement. The cylindrical dome is made of metal sheets and moves up and down as it stores and releases the biogas. The digester is operated in continuing method and often vertically, almost cylindrical built. The putridity space filled the ground and it has a dividing wall. This dividing wall improves and holds back the fresh slime gush again through short way. The gas is gathered in floating gas lock. The steel gas lock is provided with stir elements.

This type is suitable for the homogeneous materials, as for the animals' excrements that do not tend to build sinking layers. The green waste must be split. If it is mixed with huge allotments, then it will threat the digester with blockage. Generally, there are several designs of Indian digesters, thereof: floating gas holder type biogas plant (KVIC model), Deenbandhu model, and Pragati model. The KVIC model is composite unit of a masonry digester and a metallic dome, where the maintenance of constant pressure by upward and downward movement of the gas holder. The Deenbandhu model consists of segments of two spheres of different diameters joined at their base, where this model requires lower costs in comparison to KVIC model. The Pragati model is a combination of Deenbandhu and KVIC designs, where the lower part of the digester is semi spherical with conical bottom and the floating drum acts as gas storage.

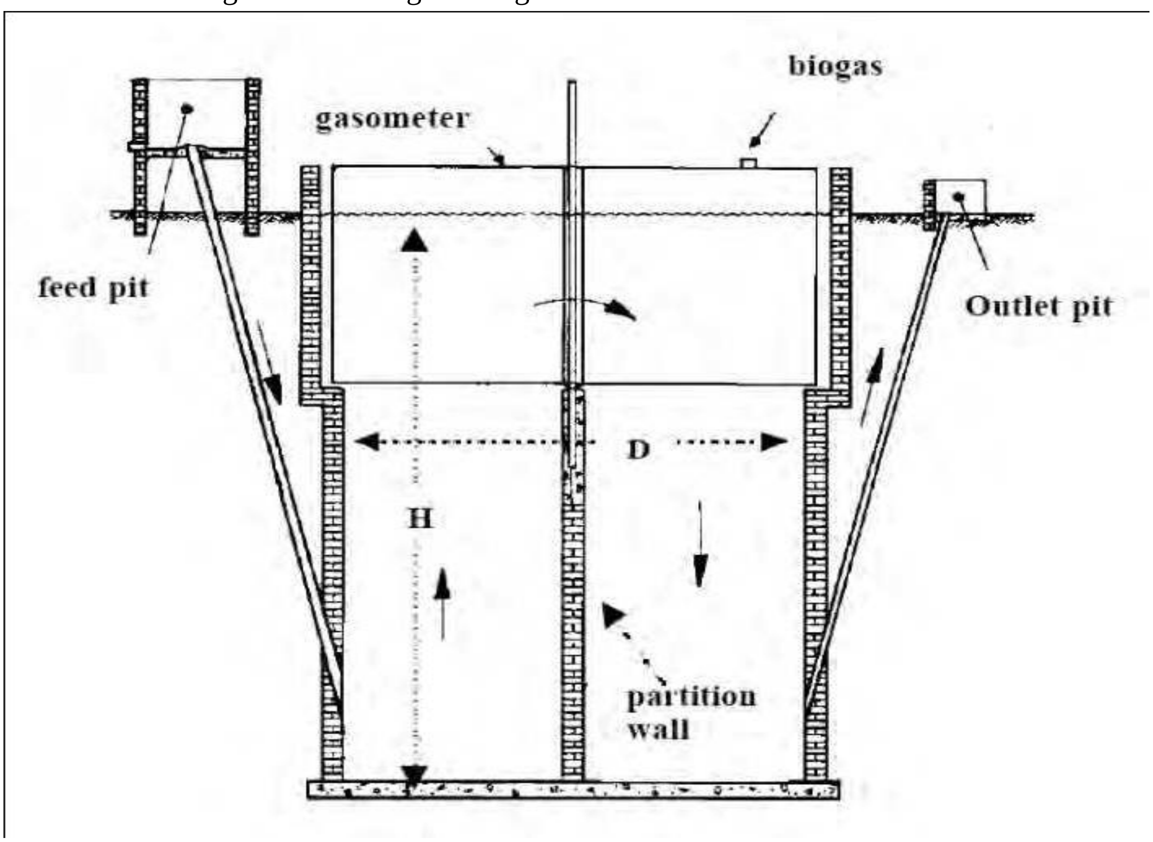


Fig.3.1 Indian-type digester

3.3 Chinese digester

The Chinese-type model digester is comprised of a cylindrical body, two spherical domes, inlet pit, outlet pit and an inspection opening . The digester is made using cement and bricks and it is a permanent structure. Just as in the Indian digester this has two drains to feed waste and to collect the composted waste.

The biogas is collected in the upper chamber and the waste decomposes in the lower chamber. If the gas pressure exceeds the atmospheric pressure (1 bar) and there is no gas extracted from the dome, then the rot substrate squeezed from the reactor into the filled pipe, but often in the pool of counterpoise. If the produced gas is more than the up used gas, then the slime level will increase. If the up used gas is more than the produced gas during the gas extraction, then the slime level will sink and the rot slime will flow back. The volume of the counterpoise pool must be huge so that the repressed rot substrate can be digested at the highest gas volume. The gas pressure is not constant in the practice. It increases with the quantity of the stored gas. The gas must be regularly produced; therefore the gas pressure organizer or the swimming gas repository room is important. Owing to the fact that the biogas dome digesters are completely buried underground, the fermentation temperature should be under a day/night temperature change, only in a tolerance range from about ± 2 ºC. The difference between summer and winter is large and is subject to the climate zone. The biogas dome digester can be provided with stir. In small family household units, a mix concoction for the biogas dome digester is installed. Different building and construction forms of biogas dome digesters were proved for the Chinese digesters; so that there is a big number of building methods are used.

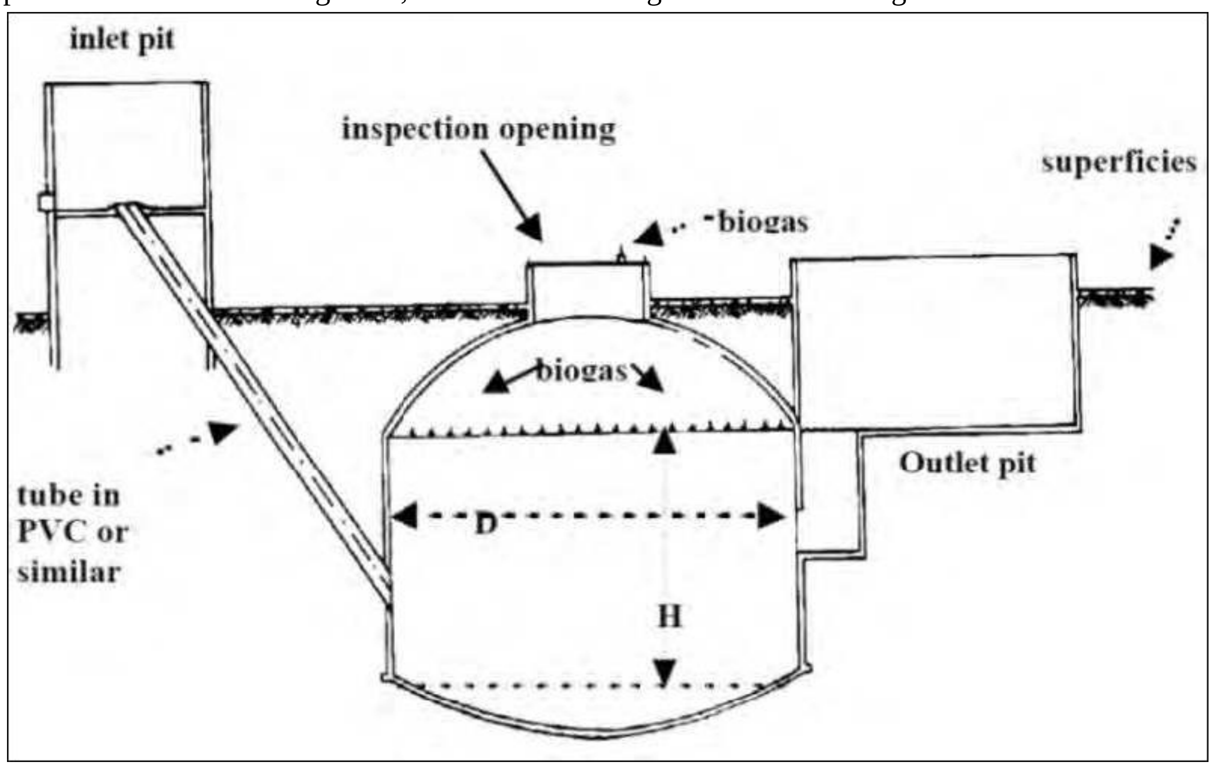
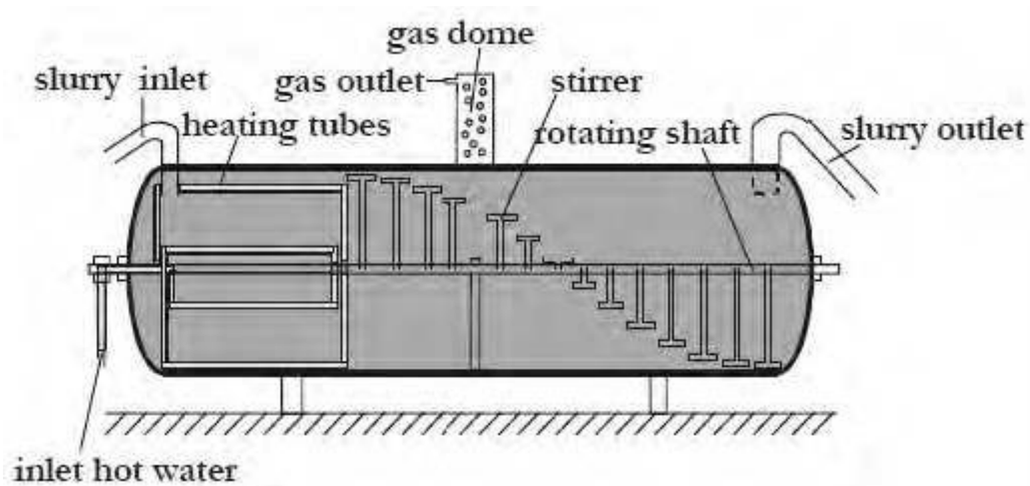


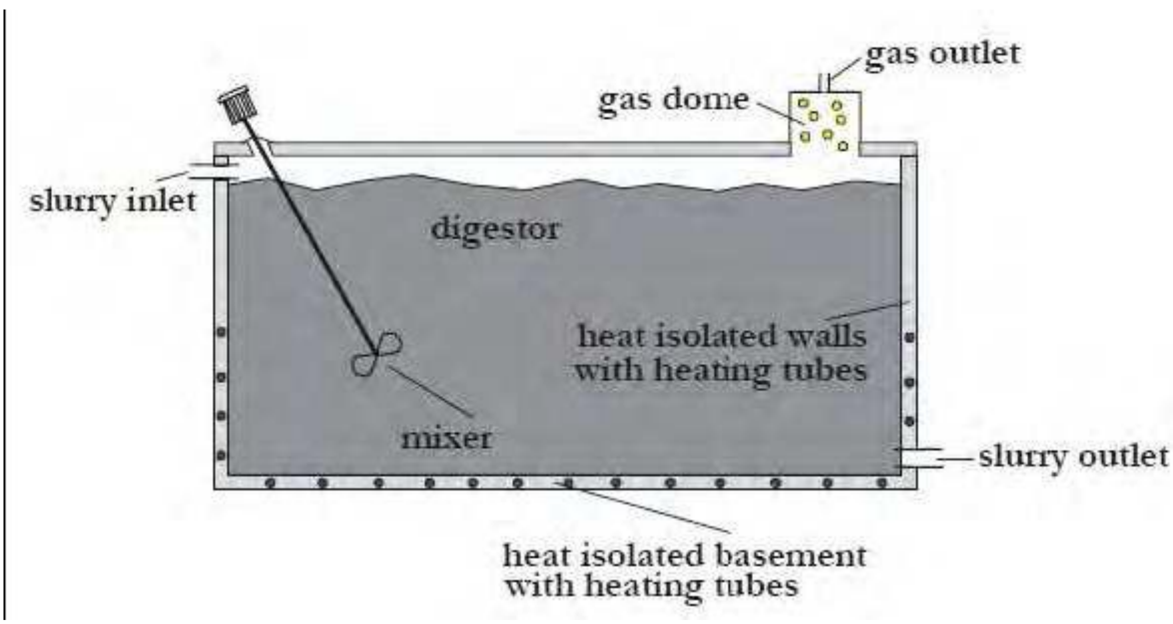
Fig.3.2 Chinese-type digester

4. Designs of digester

The most common digester design is cylindrical. Digesters can be classified in horizontal and vertical designs . Currently, vertical concrete or steel digesters with rotating propellers or immersion pumps for homogenization are widespread. Vertical tanks simply take feedstock in a pipe on one side, whilst digestate overflows through a pipe on the other side. In horizontal plug-flow systems, a more solid feedstock is used as a plug that flows through a horizontal digester at the rate it is fed-in. Vertical tanks are simpler and cheaper to operate, but the feedstock may not reside in the digester for the optimum period of time. Horizontal tanks are more expensive to build and operate, but the feedstock will neither leave the digester too early nor stay inside the digester for an uneconomically long period.



(a)



(b)

Fig.4.1 Horizontal (a) and vertical (b) digester

Anaerobic digesters can be built either above or under the ground. An alternative is that a part of the digester can be buried. Anaerobic digesters constructed above ground are steel structures to withstand the pressure; therefore, it is simpler and cheaper to build the digester underground. Maintenance is, however, much simpler for digesters built above ground and a black coating will help provide some solar heating.

4.2 Building materials and dimensions

Reinforced concrete is obtained by adequately mixing specific proportions of aggregates (gravels and sand), cement, and water. The water:cement ratio is 0.53 L kg-1 and the cement:sand:gravel mass ratio is 1:2.2:3.7 for floors, driveways, structural beams, and columns . Cylindrical cast-in-place concrete tanks are commonly used in biogas plants for storing liquid manure during long periods. A serviceable tank should be watertight to prevent groundwater pollution and corrosion of the reinforcing rods. Therefore, these tanks should be designed to withstand different design loads, i.e. the loads of the soil outside the digester which is buried underground level and loads of the liquid stored inside the digester. Liquid manure is often stored in large cylindrical concrete tanks, which are partially underground. The dimensions of these tanks vary from 18 to 33 m in diameter with heights from 2.4 to 4.9 m and a uniform wall thickness varying from 150 to 200 mm. The internal volume of the tank can be calculated by multiplying the volume of substrates that should be stored in the tank by 1.10 in order to consider 10% as headspace. The cement mass (kg), gravels volume (m3), and sand volume (m3) required to build the tank can be calculated by multiplying the concrete volume of the tank by the constants C, G, and S, respectively, where C represents the mass of cement required to make 1 m3 of concrete (325 kg m-3), G is the volume of gravel required for 1 m3 concrete (0.8 m3 of gravel per m-3 of concrete), and S is the volume of sand required for 1 m3 concrete (0.4 m3 of sand per m-3 of concrete). The type of iron rods should be selected. The different types (NØD m-1, where N is the number of iron rods per meter length, and D is the diameter of the iron rod) are 6Ø6 m-1 (0.666 kg m-1) and 6Ø8 m-1 (0.888 kg m-1). In the case of constructing a tank without a concrete top, both types can be used. On the other side, in the case of building a tank with a concrete top, the type 6Ø8 m-1 must be used with two iron grids. The thickness of digester wall should be 35 cm and is built using reinforced concrete to bear the loads of the materials stored in the digester. the required quantities of construction materials to build the digester, and the quantities of the substrates.

5. Conclusion

There is flexibility in the types of digester designs available. Digester types and designs are selected for the types of feed stocks to be digested. There are general approaches to tank design, mixing systems, and electrical generation systems. There are different construction quality approaches for household and farm-based in comparison to commercial digesters. With the help of this paper we make a biogas plant digester. It increases the knowledge of researchers and students at college level.

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