Design & Development of Bio-Digester for Remote Location Adampur Chhawni

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Abstract: Biogas(methane and carbon dioxide) can be created in country regions in creating nations through anaerobic digestion. It tends to be used for the purpose of preparing meals and power age. In spite of the fact that the creation of biogas by the means of anaerobic digestion is anything but another idea business anaerobic digestion procedures are regularly worked at well beneath their optimal exhibition because of different reasons. one of them shortage of literature on the design of bio-digesters The study is aimed at designing biogas plant, which if adopted can reduce the bio-energy consumption by considerable levels For the research and design, Adampur Chhawni ,a colony in rural area is taken with 1480 households.. Consequently, this paper provides the important issues and analyses about the design of anaerobic digester. which could fulfill all the requirements of Adampur Chhawni.

Keywords :Anaerobic digestion,, Energy recovery, Renewable sources, Bio-digester design, Methane, Biogas .

1. **Introduction: .**

Anaerobic digestion is a process in which we obtain Biogas (methane and carbon dioxide) through the intensive action of a close-knit community of bacteria. on organic matter It has been traditionally used for waste treatment but is also utilized for modern or residential purposes to oversee squander or potentially to create fuels.

The four primary phases of anaerobic digestion in consecutive request are hydrolysis, in addition with acidogenesis, including the acetogenesis as well as methanogenesis. The general procedure can be depicted by the chemical response, where natural material, for example, glucose is biochemically processed into carbon dioxide (CO2) and methane (CH4) by the anaerobic microorganisms.

$$C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH_4 \text{ ----------1(1)}$$

1.1 Hydrolysis

By and large , biomass is comprised of huge natural polymers. This progression is significant since microorganisms or bacteria can't legitimately follow up on these natural polymers For the bacteria in anaerobic digesters to get to the vitality capability of the material, these chains should initially be separated into their littler constituent parts. These constituent parts, or monomers, for example, sugars, are promptly acted by

bacteria. The way toward breaking these chains and dissolving the littler atoms into arrangement is called hydrolysis. Through hydrolysis the mind boggling natural atoms are separated into, amino acids, and unsaturated fats. &simple sugars.

Liquefaction reactions ---------- (2)
Lipids → Fatty Acids
Polysaccharides → Monosaccharide's
Protein → Amino Acids
Nucleic Acids → Purines & Pyrimidines

1.2 Acidogenesis(fermentation)

Acidogenesis or Fermentation involves the conversion or breakdown of remaining component by acidogenic bacteria .VFA's are formed, along with carbon dioxide, ammonia and hydrogen sulfide and additionally the the associated side product items.

$C_6H_{12}O_6 + 2H_2O \rightarrow 2CH_3COOH + 2CO_2 + 4H_2$--- (3)
$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$ ---------- (4)
$C_6H_{12}O_6 + 2H2 \rightarrow 2CH_3CH_2COOH + 2H_2O$------- (5)

1..3 Acetogenesis

The third phase in reference to anaerobic digestion is the acetogenesis. Here, basic atoms made through the acidogenesis stage are additionally processed by acetogens to create for the most part acetic acid, just as carbon dioxide and hydrogen. The utmost required acid that is generated is acetic acid which has the formula as (CH3COOH), in addition with propionic acid (CH3CH2COOH), along with butyric acid which is expressed as (CH3CH2CH2COOH), as well as ethanol which in terms of formula is presented by (C2H5OH). The items shaped amid acetogenesis An acetogenesis response is demonstrated as follows:

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$---------- (6)

1.4 Methanogenesis:

The last phase comprising the anaerobic digestion is termed as methanogenesis. Here, methanogens use the products obtained as a result of acetogenesis and transform them in the form of water in addition with carbon dioxide as well as methane. This phase make up the maximum quantity of the biogas released comprising the complete system.

As per the category of substrate that is used by the source of methanogens, methanogenesis is further categorized into two prominent types

1.Hydrogenotrophic methanogenesis. carbon dioxide as well as hydrogen are transformed into methane as per the reactions depicted below:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O \text{ ---------- (7)}$$

2. Acetotrophic or aceticlastic methanogenesis. Methane is obtained by the change of acetate by the means of the reaction below:

$$CH_3COOH \rightarrow CH_4 + CO_2 \text{ ---------- (8)}$$

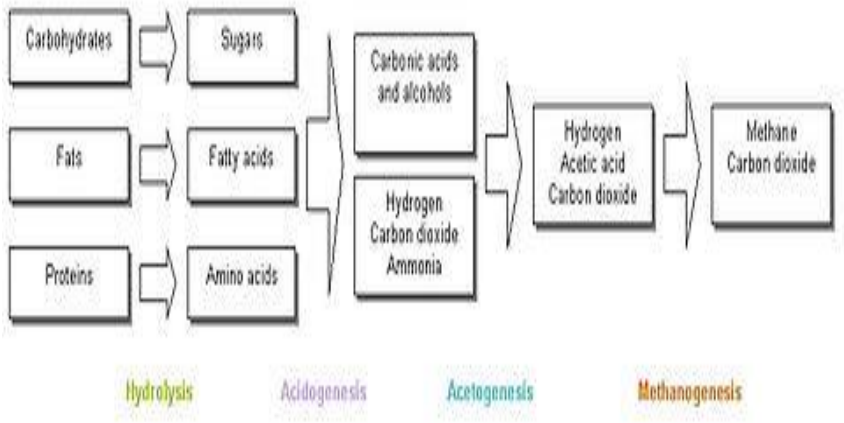

Figure-1 Stages of anaerobic digestion

2. Biogas Production

Biogas innovation gives substitute wellsprings of vitality in provincial India, a hailed as an adequate innovation that meets the essential requirement for cooking fuel in country territories. Biogas is created as landfill gas which is delivered by the breakdown of biodegradable waste inside a biogas plant because of synthetic responses and organisms, or as processed gas, created inside an anaerobic digester. The term biogas plant is constantly referred to as an digester of anaerobic type that gives structure wastes or vitality crops.

It tends to be delivered utilizing anaerobic digesters (impermeable tanks with various configurations).These plants can be bolstered with energy yields, for example, biodegradable wastes including ooze, sewage and nourishment waste. Amid the procedure biogas(mainly methane and carbon dioxide) is shaped by the activity of bacteria on biomass The bio gas is a sustainable power source that can be utilized for warming, power age and numerous different tasks.

2.1. Bio digester

The bio digester is a structure, normally denoted in reference to plant of biogas; it is also referred to as bio-reactor or anaerobic reactor. Because of various chemical in addition with microbiological reactions taking place within the bio digester the prime working operation of this structure is to give the condition for anaerobic digestion inside it. As a chamber, it ought to be air in addition with water sealed or tight. It is frequently produced from various development materials and in a few structures and size of different development materials and fit as a fiddle and size. Development of this structure frames a noteworthy piece of the venture esteem.

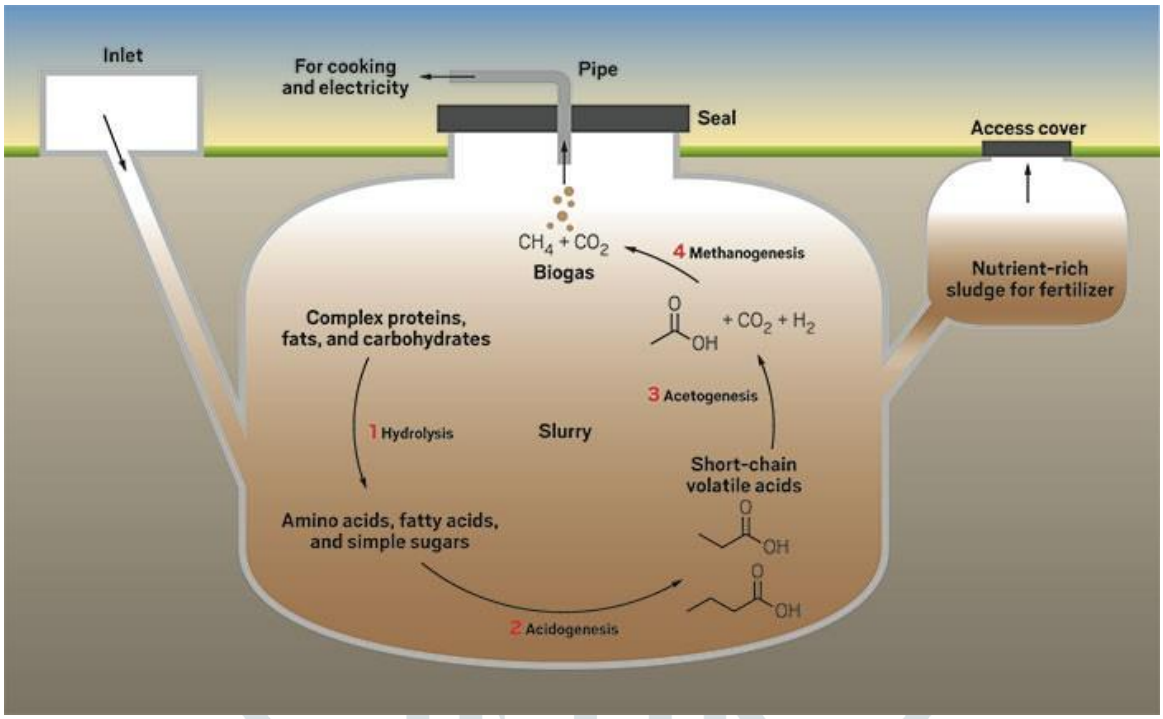

Figure 2 Bio- digester

2.2. Working Principle

Biogas is made in a biogas digester. It is an enormous vessel which contain bacteria that demonstrations natural waste and gives a combustible called Biogas. The bacteria in the biogas digester should be dealt with by. Bolstering the bacteria consistently with a blend of waste and water. The principal section comprising the system structure of biogas is huge size tank or often referred as digesters. Inside this tank, bacteria convert natural issue in to methane gas through the procedure of anaerobic digestion. Biogas framework bolsters the digester with biodegradable wastes, for example, kitchen waste, excrement, sewage, muck and compost from domesticated animals. Waste that has been completely processed ways out the biogas framework as natural manure.

3. Bio-Digester Design Considerations:

1. **Availability of Digester parts :** Availability of digester parts is very important aspects . Parts handiness is often restricted in rural areas with no road access. When parts break and maintenance is required, access to necessary parts is essential for continuous operation of the anaerobic digester. Handiness or availability of parts, will vary from country to country. resulting in design changes

2. **Local climate:** Another important aspect for consideration is is the local climate throughout the year .Mesophilic anaerobic digestion is perfect at 30º-38ºc

3 .**Ease of operation** of the anaerobic digester is an important aspect in Consideration while designing a digester

4 **.Amount of waste available:** The amount of waste & water available for Digesters are also important design considerations

5 Skilled labour : Since all seals in a anaerobic digester must be completely gas-tight in order to keep oxygen from entering the digester**.** In this way talented work is required for the development of an anaerobic digester.

3.1. Design parameters

To formulate a design in reference to volume comprising plant, the required prerequisite regarding the induced gas per day, quantity of number of cows available, and volume of slurry were the factors of interest. .

3.2. **Design calculation** A remote location Adampur Chhawni has a population of 7800 people Total no of households 1480 .So Design a bio -digester which can fulfill all all the requirements of Adampur locality. Each household using following electrical appliances

1. Four tube lights of 60 watt ratings glowing for 6 hrs daily.
2.Two fans of 100 watt ratings running for 6 hrs daily.
3.One water pump of 3 H.P running 1.5 hrs daily.

Biogas cooking needs one person =0.227 m^3 /day
So for 7800 persons =7800*0.227=1770.6 m^3/day

Electricity requirements

1. **For glowing of tube lights**
4*1480*60=355200*6*60*60= 7672320000 Joule/sec

2. **For running of fan**
2*1480*100*6*60*60==6393600000Joule/sec

3 For running of water pump
1*3*746*1.5*60*60=12085200Joule/sec

Total requirements =14078005200=14078 mega Joule

1m^3 biogas=23 megaJoule electricity

therefore for 14078megaJoule =14078/23=612.086/0.25*0.8= 3060.43m^3

Total Bio-gas needs for cooking & electricity =4831.03 $metre^3$

In Adampur Chhawni there are x nos of cows

1 cow gives 10 kg of cowdung

X no of cows gives 10x kg cowdung

70% cowdung is collectable
Collectable cowdung =7x kg

Dry solid content =18%= .18*7x =1.26xkg

Biogas yield rate =1kg cowdung =0.35m^3
1.26x*.35=.441xm^3
4831.03m^3=0.441xm^3

No of cows required =10954
Cowdung obtained=109540kg
Collectable cowdung =76678 kg
Same quantity of water is added to make slurry =76778*2=153356kg in wt of slurry is required

Density of slurry =1090kg/m3

Volume of slurry =153356/1090= 140.70m3

But since slurry volume is digestor's volume's 90 percent
Volume of digestor =140.70/.9=156.33m3

Diameter of Digestor=D=V*4/(∏*H/d)$^{1/3}$
156.33*4/(3.14*2/3)$^{1/3}$
=487.5 m

Height of digestor=H/D*D
=2/3*487.5=325m

4.Development

By the means of in depth survey of literature, it is discovered that Biogas plant framework with legitimate adjustments is effective in delivering biogas.. The substrate used for comparing the working efficiency of different types of biogas plants was cow dung diluted with water to make a slurry . The loading rate of fresh dung was kg/m3 per digester per day.

The volume of biogas produced was recorded in m3/day. .The type of digester used is continuous type digesters .So that waste cannot cause environmental problems

5. Conclusions

The biogas vitality, one of the significant choices, which may bit by bit supplant the oil in confronting the expanded interest for oil and might be in a propelled period in the coming century. The biogas generation from creature compost and agrarian biomass is of developing significance as it offers impressive ecological advantages and is an extra wellspring of salary for ranchers. A plan method for estimating an anaerobic digestion framework was introduced in this paper. There is significant extension in improving the exhibition of these digester models by making configuration changes Biogas showcase creation and logical achievements are expected to address biogas innovation difficulties which India is confronting at present. Generally there is a tremendous potential for biogas innovation in the nation. There is have to use biogas innovation as well as other sustainable power sources in blends for Indian just as worldwide splendid vitality future.

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