BIOGAS GENERATION AND FACTORS AFFECTING GLOBAL WARMING

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Abstract - *Increase in the no of automobiles and increasing pollution has led everyone to find an alternative to the above problem. One among them is biogas and it has positive effect on the environment. Biogas is produced by anaerobic digestion of organic waste in the absence of oxygen. Converting waste into biogas reduces air, water and land pollution. Along with these it also reduces global warming by converting methane into energy. Most of the vehicles use fossil fuels for their energy production and this has led to the shortage of fuel and resulted in energy crisis. The reformation of natural sources may take so many years, because of that the demand and supply balance will be lost which ultimately led to the price hike. The best way to reach the balance is by using alternative energy i.e. renewable energy. The present review paper deals with the production and utilization of biogas from sugarcane waste.*

Keywords: *Biogas, Anaerobic digestion, Organic wastes, Global warming.*

1. INTRODUCTION:

Biogas**,** typically a mixture of methane and inert carbonic gas. It might also contain small proportion of hydrogen sulphide, moisture and siloxanes. Biogas is quite corrosive in nature mainly due to the presence of hydrogen sulphide. It is produced by the breakdown of various organic products in the absence of oxygen. These organic products include raw materials like agricultural waste, municipal waste products, sewage as well as green or food wastes etc [1]. Biogas is generally produced by fermentation of anaerobic materials i.e the anaerobic microorganisms breakdown the organic waste in a digester in the absence of oxygen to give biogas. The major advantage of biogas is that it's a renewable source of energy and has a very low carbon footprint, thus making it highly environment friendly [2]. Also its high energy release capacity enables it to be used as a fuel in internal combustion engines, for heating and cooking purposes, electricity generation at power plants etc. Natural gas is widely being substituted these days by compressed biogas or mainly bio methane by the local gas distribution networks.

Moreover, promoting the use of biogas reduces the responsibility of organic waste disposal. Thus on a whole the use of biogas as an energy sources helps us combat global warming, greenhouse effect and ozone layer depletion. Also it helps us in limiting the use of fossil fuels [3].

Tab 4. Percentage of chemical components[4]

Compound	Percentage
Methane(CH_4)	50-75
Carbondioxide (CO_2)	25-50
Hydrogen Sulphide(H_2S)	0-3
Hydrogen	0-1
Nitrogen	0-10

2. BIOGAS PRODUCTION PROCESSES

The mostly widely used method for production of biogas is through anaerobic digesters. The process involves feeding the plant with the raw materials i.e. the biodegradable wastes[5]. The waste dumped into the digester gets compressed by the weight of the waste products deposited above it thus preventing oxygen to reach the materials and hence creating suitable conditions for anaerobic bacteria and microbes to thrive. The digester is isolated from the surrounding and hence all the products remain blocked inside it. Along with the biogas evolved the bacteria also produces a byproduct called digestate, which is highly rich in nutrients essential for soil conditioning. Hence all the products obtained from the digester can be completely utilized without producing any waste remains[6].

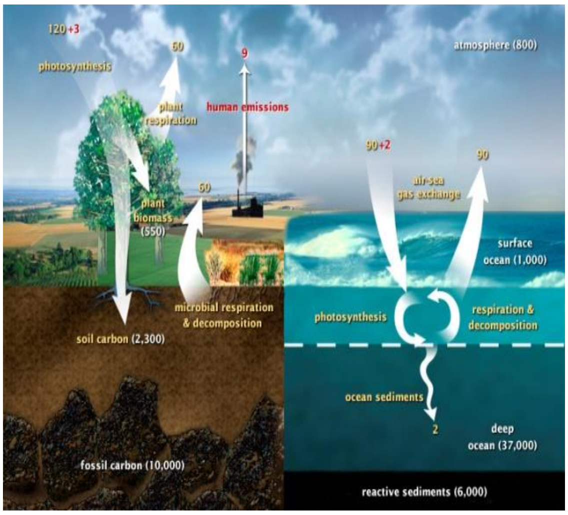

Fig 1. Carbon Cycle

3. ANAEROBIC DIGESTION SYSTEMS

The overall process of anaerobic digestion involves certain steps.

- **Manure collection and its handling-** This involves ensuring the correct proportion of water and inorganic solids in the organic waste collected.
- **Pretreatment-** The waste collected might have to undergo certain screenings before it gets into the digester. The kind of pretreatment performed depends on the digestion technology selected. Some of the major treatments performed include screening, grit removal, and mixing and flow equalization [7]. Pretreatment is performed in the collection tank present before digester.
- **Anaerobic digestion-** This is the most crucial step which involves the breakdown of organic wastes by the bacteria to obtain biogas and digestate. This operation is performed in the digester.
- **By-product recovery and effluent use-** the byproducts obtained are called as digestate and are rich in soil nutrients. These can be used for soil conditioning.
- **Biogas recovery-** The biogas generated during the process rises above the wastes decomposed and bubbles up to the top of the digester. From here it gets transferred to the gas handling systems through pipes which are generally made up of plastic [8].
- **Biogas handling -** The biogas might undergo processing to remove extra moisture, hydrogen sulphide and/or carbon dioxide. It is through such processing processes that we obtain bio methane. Following the processing the gas is either compressed or pumped depending upon its use, then either stored for future use or directly filled into the gas running equipment.

4. ANAEROBIC DIGESTION PROCESS

The entire process of anaerobic digestion can be broadly divided into 2 stages.

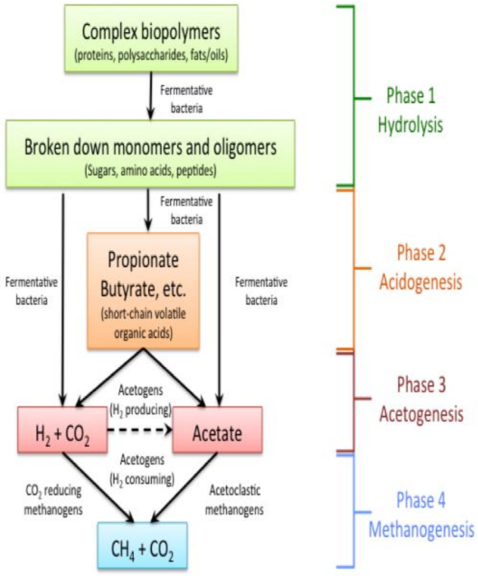

Fig 2. Stages of production of biogas[1-2]

Stage 1: this stage involves decomposition action by the fast growing, acid forming bacteria. All the components containing carbohydrates, proteins, cellulose etc. break down, hydrolyzed and metabolized to form short chain fatty acids. The by-products obtained being carbon dioxide and hydrogen gases. This stage involves development of effusive and noticeable odors due to the decomposition products formed [9].

Stage 2: This stage involves metabolization of the small chain organic acids, the hydrogen gas evolved as well as all the other by-products to give the aimed result i.e. biogas. The methanogenic bacteria that perform this operation are slow growing and highly sensitive in nature.

The average amount of time for which manure remains in a digester is defined as the hydraulic retention time [10]. It is expressed as the digester volume divided by the daily influent volume and is expressed generally in days.

4.1. LANDFILL GAS PRODUCTION

This basically involves three processes:

- Evaporation of volatile organic compounds.
- Chemical reaction between waste components.
- Methanogenesis

Step 1 and 2 basically depend upon the nature of biomass. Depending upon its nature various sorting, filtering and digester selection operations are performed. The 3rd step involves anaerobic decomposition of the biomass by bacteria resulting in formation of biogas. The evolution of gases takes place according to the kinetic pattern. The formation of methane carbon dioxide mixture is obtained after about six months of decomposition. The evolution of gas reaches its maximum at about 20 years followed by gradual decline in production [11].

4.2. AMBIENT TEMPERATURE COVERED LAGOON

These digesters are useful for dilute wastes that have less than 2% solids. These are basically dairy manures, flushed hog manures etc. The temperature of the lagoon is not varied externally. However the biogas production depends largely on the surrounding temperature. The solid animal waste are separated in the pretreatment process [5-6]. These lagoons are not suitable for operating in colder regions due to absence of requisite temperature.

4.3. CSTR DIGESTER SYSTEM

The most widely used biogas digester is called a CSTR DIGESTER SYSTEM. It basically consists of an air tight, upright, cylindrical container called the digester vessel. The mixing of its contents is performed by a vertical low speed agitator having a high circulation rate. It is attached to the vessel and ensures proper mixing of the entire content of the digester[4-9]. The low rotation speed makes sure that the anaerobic microbes are handled gently and the continuous mixing ensures optimal substrate transportation for the continuous and uniform degradation of the wastes. This mechanism is suitable for treating mainly all kind of biodegradables wastes, however is used mainly for treating the higher solid materials such as bio-waste's sludge. It is also helpful for the scum developing materials[8]. The construction size of a CSTR digester can be as large as 1.9 million gallons.

4.4. PLUG FLOW DIGESTERS

These kind of digesters are generally used for thick wastes i.e the wastes containing 11-13% solids. These are basically wastes from ruminant animals. Plug flow digesters consist of unmixed, heated rectangular tanks. The operation performed by the tank is horizontal displacement of old materials by the new materials[5-7]. The new materials are pumped in while the old ones are ejected from the other end of the digester.

5. FACTORS AFFECTING ANAEROBIC DIGESTION EFFICIENCY

Anaerobic digestion occurs at a faster rate and is more effective at higher temperatures. Even at warmer climates the output of biogas production is lower than that of heated digesters.

- THERMOPHILIC CONDITION- The digestion occurs at a temperature range of 125-135F. Time taken for biogas generation is higher. However a large proportion of energy generated is used to maintain the thermophilic conditions in the digester.
- MESOPHILIC CONDITION- the anaerobic digestion occurs at a temperature range of 95-105F. The time taken for the biogas generation is comparatively more than thermophilic[10].

It has been observed that the gas production efficiency of complete mix and plug flow digesters tend to be higher than that of ambient temperature covered lagoons. This is because the former two generally involve use of external heating techniques.

6. ENVIRONMENTAL IMPACTS OF ANAEROBIC DIGESTION

The biogas generated has a wide range of applications in our day to day life from electricity generations, cooking purposes to use as vehicle fuel. It has various other environmental benefits that include[11]:

- Reduced greenhouse gas emission
- Odor control
- Combat Ozone layer depletion
- Pathogen and weed seed control
- Improved water quality
- Fossil fuel depletion

7. CONCLUSION

Biogas is green, degradable and eco-friendly fuel which can be easily produced by anaerobic digestion. The digestate which is left after the process is high in protein content and it is used as manure for agricultural lands. The waste produced contain a high methane potential when treated anaerobically .The waste water that is produced from the slaughter house and poultry litter has a high potential of generating 2.472 m3/m3 of biogas .It was also found out that if slaughter house waste is fed with poultry litter that would be a best way as more amount of methane is produced and that too maintain C: N ratio.

References

[1] Garba, B. Zuru, A and Sambo, A.S (1996). Effect of slurry concentration on biogas production from cattle dung. Nigeria journal of Renewable Energy .4(2) : 38-43.

[2] Itodo, L N; Lucas EB; Kucha E1(1992). The Effect of Media Material and its Quality on Biogas Yield. Nigerian Journal of Renewable Energy 3, Nos. 1 and 2 pp. 45-49.

[3] Godliving, Y; Mtui, S (2007).Trends in Industrial and Environmental Biotechnology Research in Tanzania, African Journal of Biotechnology Vol. 6 No. 25 pp 2860-2867.

[4] Jain, MK; Sigh, R; Taure, P(1981).Anaerobic Digestion of Cattle Waste, Agricultural Waste 3, pp. 65-73.

[5] Ganiyu, O . (2005). Isolation and characterization of amylase from fermented cassava waste water. African journal of Biotechnology 4 (10): 117-1123.

[6] Turkenburg WC, Beurskens J, Faaij A, Fraenkel P, Fridleifsson I, Lysen E, et al. Renewable energy technologies. World Energy Assess. Energy Chall Sustain 2000:221.

[7] McKendry P. Energy production from biomass (part 2): Conversion technologies. Bioresour Technol, 83; 2002. p. 47–54. http://dx.doi.org/10.1016/ S09608524(01)00119-5.

[8] Demirbas A. Biofuels sources, biofuel policy, biofuel economy and global biofuel projections. Energy Convers Manag 2008;49:2106–16. http://dx.doi. org/10.1016/j.enconman.2008.02.020.

[9] Deublein D, Steinhauser A. Biogas from waste and renewable resources: An Introduction. Germany: Wiley-VCH; 2008.

[10] Kranert M, Kusch S, Huang J, Fischer K. Anaerobic Digestion of Waste. In: Karagiannidis A, editor. Waste to Energy Oppor. Challenges Dev Transient Econ. London: Springer-Verlag; 2012. p. 107–36.

[11] Appels L, Baeyens J, Degrève J, Dewil R. Principles and potential of the anaerobic digestion of waste-activated sludge. Prog Energy Combust Sci 2008;34:755–81. http://dx.doi.org/10.1016/j.pecs.2008.06.002.