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Synthesis of Methane Gas from the Different Type of Domestic Wastes and Animal Dung

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Abstract: *Biogas is one of the reliable alternative fuels. Nowadays, it is widely used in all over the world. It is a renewable type of energy. The biogas can be produced by anaerobic digestion of biodegradable elements. Many research works focused on the biogas preparation from the bio wastes. Vegetable wastes, food wastes, kitchen waste, animal waste are some of the bio wastes. Mostly, in urban areas, the cooking has been carried out by the use of biogas. Biogas can be used as the alternative fuel for the following sectors in industries for boilers and power plants, in transports for buses. Water hyacinths are naturally available in ponds and lakes. Since, Plants such as Milkweed are of no use can be used for the extraction of biogas. Food wastes and kitchen waste also a good biogas producer. This paper investigates the possibility of producing biogas from a mixture of water hyacinth and cow dung, milk weed, food waste and analysing the methane concentration. The biogas consists of methane as a major constituents and traces of other gases which includes CO, H_2S, and NH_3.To increase the yield of methane gas cow dung is mixed with water hyacinths.*

Keywords: Biogas

I. INTRODUCTION

Biogas is a renewable energy source produced by the breakdown of organic matter by certain bacteria under anaerobic conditions. It is a mixture of methane, hydrogen, and carbon dioxide. It can be produced by agricultural waste, food waste, animal dung, manure, and sewage. The process of biogas production is also known as anaerobic digestion. Biogas recycles the waste products naturally and converts them into useful energy, thereby, preventing any pollution caused by the waste in the landfills, and cutting down the effect of the toxic chemicals released from the plants. Biogas converts the harmful methane gas produced during decomposition, into less harmful carbon dioxide gas.

The organic material decomposes only in a wet environment. The organic matter or the waste dissolves in water and forms a sludge which is rich in nutrients and used as a fertilizer.

Fig. 1. Kitchen Waste

II. GENERAL WASTE FROM KITCHEN

Kitchen waste like leftover organic matter from household kitchens, restaurants, etc. and food waste, also termed as plate waste, that is the food which has been served but has not been eaten completely, stale food, etc. are ubiquitous in all communities. They contain a high amount of organic matter and hence should be considered a major source for producing value-added products. Biogas generation for harnessing energy and bioconversion for producing fertilizers are specific examples of value-added products. They are faced with issues including the heterogeneous nature of waste and an increased level of moisture, which are essential to be addressed.

III. BIOGAS

Biogas production is a well-established technology primarily for the generation of renewable energy and also for the valorisation of organic residues. Biogas is the end product of a biological mediated process, the so-called anaerobic digestion, in which different microorganisms, follow diverse metabolic pathways to decompose the organic matter. The process has been known since ancient times and was widely applied at domestic households providing heat and power for hundreds of years. Nowadays, the biogas sector is rapidly growing and novel achievements create the foundation for constituting biogas plants as advanced bioenergy factories. In this context, the biogas plants are the basis of a circular economy concept targeting nutrients recycling, reduction of greenhouse gas emissions and biorefinery purposes. This review summarizes the current state-of-the-art and presents future perspectives related to the anaerobic digestion process for biogas production. Moreover, a historical retrospective of biogas sector from the early years of its development till its recent advancements gives an outlook of the opportunities that are opening up for process optimisation.

Table-1: Typical composition of Biogas

Composition of Biogas

• Methane	50-70%
• Carbon dioxide	30-45%
• Hydrogen	0-1%
• Nitrogen	0-1%
• Water	0.1%
• Hydrogen sulphide	0-1%
• Oxygen	0-1%

IV. PROPERTIES OF BIOGAS

methane, colourless, odourless gas that occurs abundantly in nature and as a product of certain human activities. Methane is the simplest member of the paraffin series of hydrocarbons and is among the most potent of the greenhouse gases. Its chemical formula is CH_4.

Methane is lighter than ., having a of 0.554. It is only slightly soluble in water. It burns readily in air, forming and water vapour; the flame is pale, slightly luminous, and very hot. The of methane is −162 . (−259.6 °F) and the point is −182.5 °C (−296.5 °F). Methane in general is very stable, but mixtures of methane and air, with the methane content between 5 and 14 percent by volume, are explosive. Explosions of such mixtures have been frequent in coal mines and collieries and have been the cause of many mine disasters.

V. MICROBIOLOGY OF BIOGAS PRODUCTION

Microbiology of biogas production is the study of microorganisms involved in the anaerobic fermentation of biodegradable materials that produce a mixture of gases, primarily methane and carbon dioxide, along with traces of other gases. The process of biogas production is known as methane fermentation and consists of four stages of anaerobic decomposition 1. The production of biogas from organic material under anaerobic conditions involves a sequence of microbial reactions. During the process, complex organic molecules present in the biomass are broken down to sugar, alcohols, pesticides, and amino acids by acid-producing bacteria. The resultant products are then used to produce methane by another category of bacteria 2. The efficiency of the digestion depends on how far the digestion happens in these three stages. Better the digestion, shorter the retention time and efficient gas production.

$$CH_3COOH \rightarrow CH_4 + CO_2$$

Acetic acid → Methane + Carbon dioxide

$$2CH_3CH_2OH + CO_2 \rightarrow CH_4 + 2CH_3COOH$$

Ethanol + Carbon dioxide → Methane + Acetic acid

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

Carbon dioxide + Hydrogen → Methane + Water

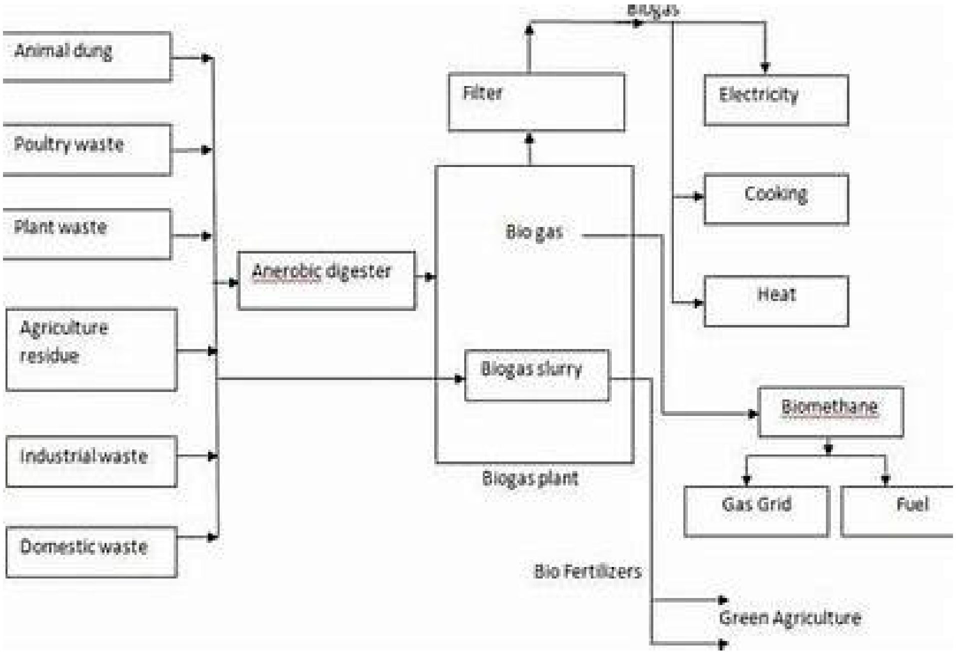

Fig. 2. Biogas Plant

VI. KITCHEN WASTE

Kitchen waste is defined as left-over organic matter from restaurants, hotels and households. Tons of kitchen wastes are produced daily in highly populated areas. Kitchen wastes entering the mixed-municipal waste system are difficult to process by standard means, such as incineration, due to the high moisture content. Furthermore, organic matter can be transformed into useful fertilizer and biofuel. New disposal methods that are both environmentally and economically efficient are being developed which rely on various forms of microbial decomposition.

Kitchen waste is a nutrient rich, or eutrophic, environment containing high levels of carbohydrates, lipids, proteins, and other organic molecules which can support abundant populations of microorganisms. The anaerobic nature of kitchen wastes is typical for a eutrophic environment, because aerobic bacteria deplete oxygen through respiration at a faster rate than oxygen can be replenished by diffusion. Although the presence of water is essential for bacteria growth, the high moisture content in kitchen waste exacerbates the anaerobic condition as oxygen is insoluble in water and it is hard for oxygen to diffuse through water. Kitchen waste is usually acidic due to the action of acid fermentation bacteria such as lactic acid bacteria. As lactic acid can act as an uncoupler in acidic environment, it is toxic to other bacteria, thus a buffer is usually added into kitchen wastes to make the environment less acidic. Overall, the high moisture and nutrient level make kitchen waste an ideal environment for anaerobic biodegradation.

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Fig. 3. Other Kitchen Waste

VII. KITCHEN WASTE BASED BIOGAS PLANT

The main objectives of this research work is to set-up biogas digester to produce huge amount of biogas by using Kitchen waste, food waste and Vegetable market waste dropping as biomass and monitoring characteristics of influent, effluent, gas production and utilizing this data for biogas digester design.

Fig. 4. Set up Biogas Plant in Laboratory

Process of biogas generation from kitchen waste is given below: An amalgam of finely ground Domestic waste and water is made in 1:1 proportion. For 1 liter of solid organic waste (800 gm kitchen waste and 200 gm other waste), 1 liter of water is used as feed to the mesophilic tank. Adding sufficient amount of water to the organic matter is essential as it creates a suitable environment for easy degradation and provides the substrate with fluid properties. A constant temperature of 36 degree Celsius is maintained using a solar heater. Production of biogas due to bacterial action will occur within 45-50 days with the complete decomposition of the substrate. Furthermore, to improve degradation and improve gas production regular stirring is done. The gas gets collected in the dome while the substrate commences to move towards the balancing tank due to the pressure difference. The substrate is directed through the outlet pipe towards the second tank where it undergoes thermophilic reaction. Thus, remaining gas production takes place which is drawn through the gas valve. Slurry is then taken out from the draining pipe from the bottom of the tank.

VIII. EXPERIMENTAL PROCESS

Fresh 200 gm Hen dung, 800 gm kitchen waste and rest water is collected and mixed by hand and poured into 2 lit. bottle digester. As it contains the required microorganism for anaerobic digestion. After the inoculation digester is kept for some days and gas production and ph value is checked. During checking the production of biogas, we found that generation is increased with the day and when the slurry become dry the generation also reduced so increase the generation of biogas we mixed the water with the slurry.

Day	ph	Temprature	Gas(ml)
1	6.5	40	0
2	7.1	42	60
3	6.4	41	200
4	6.6	43	120
5	6.5	39	350
6	6.3	44	600
7	6.9	42	800
8	6.7	45	1100
9	7.1	44	1420
10	6.3	43	1800
11	6.6	44	2130
12	6.7	42	2400
13	6.5	44	2800
14	6.4	43	3100
15	6.8	42	3230
16	6.3	44	3500
17	6.5	43	3730
18	6.9	45	3840
19	6.5	44	3950
20	6.2	45	4100

Table-2: Generated Values of Biogas with Their pH Values

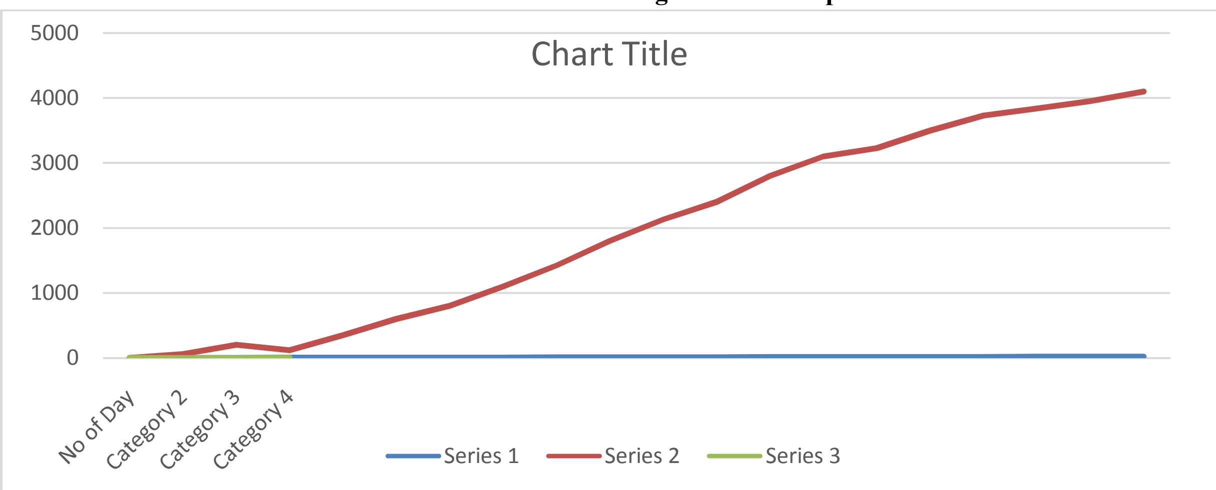

Fig. 4. Gas Production V/S Day

IX. RESULTS

The conversion of Domestic waste into biogas reduces production of the greenhouse gas methane, as efficient combustion replaces methane with carbon dioxide. Given that methane is nearly 25 times more effective in trapping heat in the atmosphere than carbon dioxide, biogas combustion results in a.

X. FACTORS AFFECTING THE PRODUCTION OF BIOGAS

Biogas is environmentally friendly, relatively cheap and a renewable energy source which occurs as a result of anaerobic fermentation of wastes and organic wastes. Temperature has a very large impact on biological systems. The metabolic activities of methane bacteria changes in regard to carbon / nitrogen so this ratio is important in producing biogas. The C / N ratio should be less than 10/1 or more than 23/1. In the process of producing biogas is essential to mix slurry and wastes to react with each other. In this study, factors affecting biogas, loading rate, retention time, the C / N ratio of the ambient operating temperature, pH, mixing are discussed. The proportion of these factors, speed and operating conditions have been examined and advantages and disadvantages of biogas production have also been demonstrated. Most of the data are shown in tables and graphs. In this work, emphasize on the importance of biogas and the biogas production factors, is intended to contribute public awareness about biogas.

XI. USES AND ADVANTAGES OF BIOGAS

Biogas is safe and cheap; hence, it is used for cooking, lighting, etc. Biogas cooking burns with blue flame without any odour or soot, which is considered a vital advantage compared to old cooking fuel like firewood and cow dung cakes.
Biogas mantle lamps consume 2-3 cft per hour, having a lighting capacity
equivalent to 40 W electric bulbs at 220 volts.
Biogas can be used as engine fuel.
It is easy to generate since the technology used is cost-effective (low cost).
Biogas is an eco-friendly and renewable source of energy.
It reduces pollution.
The waste left after the biogas production can be used as natural or organic fertilizer for plants.

XII. CONCLUSION

The study evaluates biogas production from the kitchen waste through anaerobic digestion of 2L capacity designed and built in lab. In the duration of 20 days, biogas production started from the 2nd day. The total amount of gas production recorded up to 45 days. Kitchen waste getting converted in the biogas not only becomes an alternative source of energy but also burning the biogas help in reducing the methane production from organic waste which is one of the green house gases. From our study it is kitchen waste can become a good feedstock for the biogas production. Kitchen waste contain more biodegradable solid (9.5%), with higher volatile sold (95.6%) than cow dung. Thus biogas production from kitchen waste higher than the biogas produced from cow dung and other waste.

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