JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

BIOGAS FROM ORGANIC WASTE

SAGARI A

to

The APJ Abdul Kalam Technological University

in partial fulfillment of the requirements for the award of the Degreeof

Master of TechnologyIn

Environmental Engineering

Department of civil engineering

Malabar college of engineering and technology

ABSTRACT

The mini project aims to explore the potential of biogas production from organic waste materials and its various applications. The project will involve collecting and analyzing organic waste materials such as food scraps, agricultural residues, and animal manure to determine their potential for biogas production. This will be done through laboratory testing and analysis to assess the composition and energy content of the waste materials.Once the potential for biogas production is determined, a biogas digester will be constructed and operated to facilitate the decomposition process and production of biogas. The amount of biogas produced will be measured and quantified, evaluating its energy content and potential for use in various applications.One of the main applications that will be investigated is the use of biogas as a source of energy for cooking and heating purposes. The efficiency and environmental impact of biogas compared to traditional fuels will be assessed through experiments and analysis .Furthermore, the feasibility of using biogas to generate electricity will be explored. This will involve assessing the technical requirements and potential benefits of this application, such as reducing reliance on fossil fuels and reducing greenhouse gas emissions. The project will also evaluate the nutrient content and effectiveness of the digestate produced as a by product of the biogas production process. The digestate will be studied for its potential as a fertilizer for sustainable agriculture practices.

Key words: Biogas, fertilizer, compost, gasmeter

1.INTRODUCTION

Biogas, a renewable source of energy produced from the decomposition of organic waste materials in the absence of oxygen, has gained significant attention in recent years. This mini project aims to explore the production of biogas from organic waste and its various applications.

The project will commence by collecting organic waste materials, including food scraps, agricultural residues, and animal manure. These waste materials will then be placed in a biogas digester, a sealed container where the decomposition process occurs. Inside the digester, bacteria break down the organic matter and produce biogas as a by product.

Biogas, the main output of this process, can be used as a source of energy in various applications. One of its primary uses is for cooking and heating purposes. Biogas can be burned in stoves and boilers to provide heat for cooking and space heating. This can be particularly advantageous in rural areas with limited access to traditional fuels like firewood or LPG.

Moreover, biogas can also be used to generate electricity. By employing a biogas generator, the biogas can be converted into electrical energy, which can power homes, farms, or even small industries. This offers a sustainable and environmentally friendly alternative to fossil fuel-based electricity generation.

Additionally, the byproduct of the biogas production process, known as digestate, can be used as a nutrient-rich fertilizer for agricultural purposes. This helps close the loop in the organic waste management cycle by returning valuable nutrients back to the soil, promoting sustainable agriculture practices.

In conclusion, this mini project aims to emphasize the potential of biogas as a renewable energy source and its applications in various sectors. By utilizing organic waste materials, we can not only reduce waste and environmental pollution but also harness a clean and sustainable source of energy. The project will provide insights into the production process of biogas and its diverse applications, including cooking and heating, electricity generation, and agricultural use. Ultimately, the project aims to raise awareness about the benefits of biogas and encourage its adoption as a viable solution for sustainable energy production.

1.1 Objectives

1. Construct and operate a biogas digester to facilitate the decomposition process and production of biogas and find its applications

2. Find the composition of biogas in different period of time

1.2 Scope

The project aims to explore the feasibility and effectiveness of producing biogas from organic waste in a household setting, specifically using a biogas digester system constructed from a drum.

The project will focus on utilizing commonly available organic waste materials such as kitchen scraps, food waste, and agricultural residues to produce biogas.

The gas meter will be connected to the biogas outlet of the drum to monitor and record the volume of biogas generated over a specific period.

2.LITERATURE REVIEW

2.1. Conduct a literature review on biogas production from organic waste and the use of drums as biogas digesters. Identify suitable organic waste materials for the project, such as food scraps, animal manure, and agricultural residues. Collect organic waste samples from households and farms to be used as feedstock for biogas production. Set up a biogas digester system using a drum as the anaerobic reactor. Modify the drum by installing inlet and outlet pipes, a gas collection system, and a gas meter for measurement.

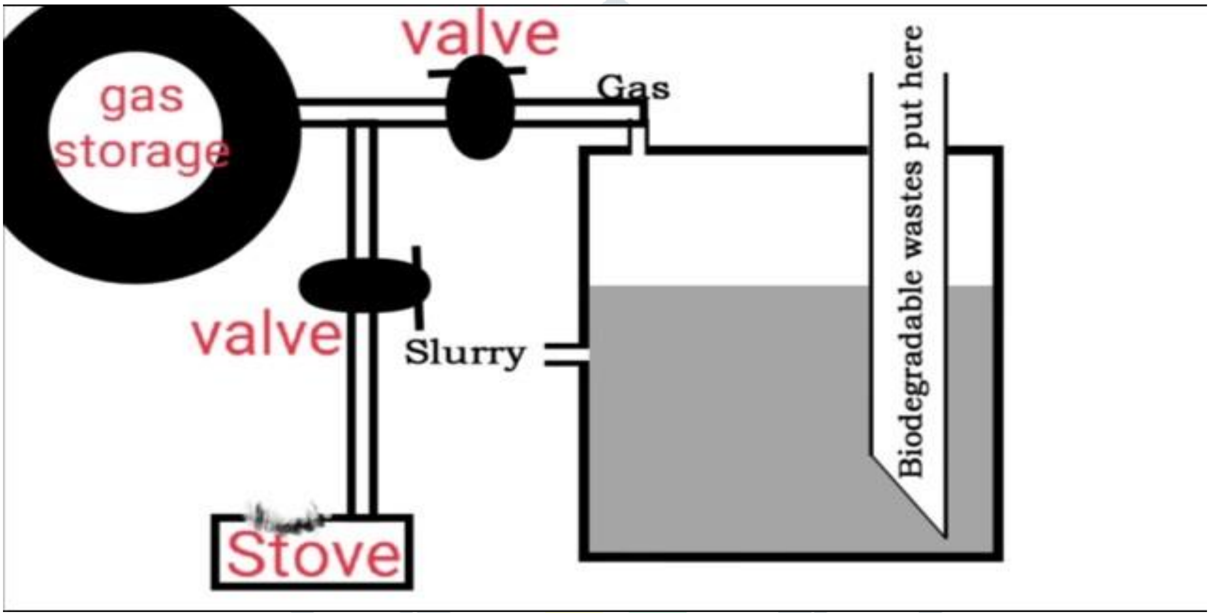

Figure 2.1 Model of biogas plant

Measure the initial volume and composition of the organic waste samples.

Load the organic waste into the drum and seal it to create an anaerobic environment.

Monitor the temperature inside the drum using a thermometer to ensure optimal conditions for biogas production.

Adjust the pH of the organic waste mixture if necessary, using appropriate additives Add a few amount of cowdung

Mix the organic waste regularly to facilitate fermentation and biogas production.

Measure the volume of biogas produced using the gas meter at regular intervals.

Then use its by product as biofertilizer, compost etc.

Figure 2.2: Gas meter

Gas meter

Measures the volume of biogas produced in cubic meters or cubic feet. Knowing the exact volume of biogas produced, operators can determine the efficiency of the system and compare it to previous measurements.Evaluate the environmental benefits of biogas production, including reduced greenhouse gas emissions and waste diversion from landfills. Monitor and record any challenges or limitations encountered during the project, such as maintenance requirements and gas leakage. Implement safety protocols throughout the project to ensure proper handling and storage of biogas.Gas meters are designed to provide real-time data on biogas production, allowing for monitoring and optimization of the system.Collect data on biogas production rates and system performance to quantify the effectiveness of the drum-based digester system.Assess the scalability and applicability of household biogas systems using drums as digesters.

PROPERTIES OF BIOGAS

1. Change in volume as a function of temperature and pressure.
2. Change in calorific value as function of temperature ,pressure and water vapour content.
3. Change in water vapour as a function of temperature and pressure.

FACTORS AFFECTING YIELD AND PRODUCTION OF BIOGAS

Many factors affecting the fermentation process of organic substances under anaerobiccondition are,

- The quantity and nature of organic matter
- The temperature
- Acidity and alkanity (PH value) of substrate
- The flow and dilution of material

BENEFITS OF BIOGAS TECHNOLOGY :

- Production of energy.
- Transformation of organic wastes to very high quality fertilizer.
- Improvement of hygienic conditions through reduction of pathogens.
- Environmental advantages through protection of soil, water, air etc.
- Micro-economical benefits by energy and fertilizer substitutes.
- Macro-economical benefits through decentralizes energy generation and environmentalprotection.

2.2 CHARACTERSTICS OF BIOGAS

Composition of biogas depends upon feed material also. Biogas is about 20% lighter than air has an ignition temperature in range of 650 to 750 0C.An odorless & colourless gas that burns with blue flame similar to LPG gas. Its caloric value is 20 Mega Joules (MJ) /m3 and it usuallyburns with 60 % efficiency in a conventional biogas stove.

This gas is useful as fuel to substitute firewood, cow-dung, petrol, LPG, diesel, & electricity,depending on the nature of the task, and local supply conditions and constraints.

Biogas digestor systems provides a residue organic waste, after its anaerobic digestion (AD) that has superior nutrient qualities over normal organic fertilizer, as it is in the form of ammonia and can be used as manure. Anaerobic biogas digesters also function as waste disposal systems, particularly for human wastes, and can, therefore, prevent potential sources of environmental contamination and the spread of pathogens and disease causing bacteria. Biogas technology is particularly valuable in agricultural residual treatment of animal excreta and kitchen refuse(residuals).

2.3 APPLICATIONS

- The project aims to provide a sustainable solution for household waste management by utilizing organic waste to produce biogas.
- By focusing on commonly available organic waste materials, the project ensures that the process can be easily replicated and implemented in households.
- The use of a drum-based biogas digester system makes it a cost-effective and accessible option for households to adopt.

- The project will help reduce the dependence on fossil fuels by providing an alternative source of energy in the form of biogas.
- Measurement aspect of the project using a gas meter ensures accurate monitoring of the biogas production, allowing for data-driven analysis and optimization of the system.
- Monitoring the volume of biogas generated over a specif ic period helps in assessing the ef ficiency and effectiveness of the drum-based biogas digester system.
- Project promotes environmental sustainability by reducing greenhouse gas emissions from organic waste decomposition and providing a renewable energy source.
- Knowledge gained from this project can be shared with communities, encouraging wider adoption of biogas production from organic waste at the household level.

Figue 2.3 Biogas fertilizer applied on field

2.4

M. R. Atelge et.al (2020), Biogas from Organic Waste - A Case Study, Anaerobic digestion (AD) from organic waste has gained worldwide attention in reducing greenhouse gas emissions, lowering fossil fuel combustion, and facilitating a sustainable renewable energy supply. , the study demonstrates, through material balance analysis of the plant's operation, that the amount of produced methane and hence, generated electricity can be further increased by optimising the operation of the plant.

Leena Sahlström et.al(2002) ,Biogas production from organic waste: recent production and progressives: Anaerobic digestion is one way of handling biowaste and generating energy in the form of methane (biogas). The digested residue may be used as fertiliser on agricultural land. Biowaste is known to contain pathogenic bacteria such as Salmonella and other microorganisms that may be a health risk for both people and animals.

Davide Papurello et.al(2015), Anaerobic treatment and biogas production from organic waste: Organic waste collection from local municipal areas with subsequent energy valorization through CHP systems allows for a reduction of waste disposal in landf ill. Pollutant emissions released into the atmosphere are also reduced in this way. Solid oxide fuel cell (SOFC) systems are among the most promising energy generators, due to their high electrical ef ficiency (>50%), even at part loads. In this work, the local organic fraction of municipal solid waste has been digested in a dry anaerobic digester pilot plant and a biogas stream with methane and carbon dioxide concentrations ranging from 60–70 and 30–40% vol., respectively, has been obtained.

Angelidaki et.al (2003),Biogas production and utilization technologies from organic waste: Centralized biogas plants in Denmark codigest mainly manure, together with other organic waste such as industrial organic waste, source sorted household waste, and sewage sludge. Today 22 large-scale centralized biogas plants are in operation in Denmark, and in 2001 they treated approx 1.2 million tons of manure as well as approx 300,000 of organic industrial waste. Besides the centralized biogas plants there are a large number of smaller farm scale plants.

3.METHODOLOGY

3.1 A 200 ml drum is a small container used in biogas plants to store and transport biogas produced from organic waste. The drum can be made of plastic or metal and has a tight-fitting lid to prevent gas leakage. It is an essential component in the production of bio gas.

Solid organic waste, such as food waste, agricultural waste, and sewage sludge, used as feedstock for biogas production. The waste is first collected and then fed into an anaerobic digester, where it is broken down by microorganisms in the absence of oxygen. This process produces biogas, which can be used as a renewable energy source. The remaining material, called digestate, can be used as a fertilizer or soil conditioner.here we taken 10 kg.

Cow dung is a commonly used feedstock for biogas production. It is collected and mixed with other organic waste in an anaerobic digester, where it is broken down by microorganisms to produce biogas. The remaining material, called digestate, can be used as a high-quality fertilizer.10 ml of cowdung is added and made it to observation for 10 days.Finally collected the waste coming from the plant and solid waste and liquid waste are differentiated

Figure 3.1: The biogas plant done

3.2 ANALYTICAL METHODS & CALCULATIONS

TOTAL SOLIDS (TS %) - It is the amount of solid present in the sample after the waterpresent in it is evaporised.

The sample, approximately 10 gm is taken and poured in foil plate and dried to aconstant weight at about 105 0C in furnace.

$$TS\ \% = (Final\ weight/Initial\ weight) * 100$$

VOLATILE SOLIDS (VS %) – Dried residue from Total Solid analysis weighed and heated incrucible for 2hrs at 500 0C in furnace. After cooling crucible residue weighed.

$VS\ \% = [100-(V3-V1/V2-V1)] * 100$

V1= Weight of crucible.

V2= Weight of dry residue & crucible.

V3= Weight of ash & crucible (after cooling)

VOLATILE FATTY ACID (VFA) - Volatile fatty acids (VFA's) are fatty acids with carbon chain of six carbons or fewer. They can be created through fermentation in the intestine. Examples include: acetate

, propionate , butyrate. There are many titration method for VFA measurement. I had used two method for VFA measurement.

3.2.1 Method 1

1. Take 100 ml sample in beaker
2. Filter the sample.
3. Check pH of filterate.
4. Take 20 ml of filterate and add 0.1M HCl until pH reaches 4

5.Heat in the hot plate for 3 mins

6.After cooling titrate with 0.01M NaOH to take pH from 4 to 7.

Amount of HCl & NaOH recorded

Total VFA content in mg/l acetic acid = (Volume of NaOH titrated) * 87.5

3.2.2 Method 2:

Titration procedure for measurements of VFA and alkalinity according to Kapp :

- Before analysis, the sample needs to be filtered through a 0.45µm membrane filter.
- Filtered sample (20-50ml) is put into a titration vessel, the size of which is determined bythe basic requirement to guarantee that the tip of the pH electrode is always below the liquid surface.
- Initial pH is recorded
- The sample is titrated slowly with 0.1N sulphuric acid until pH 5.0 is reached. The addedvolume A1 [ml] of the titrant is recorded.
- More acid is slowly added until pH 4.3 is reached. The volume A2 [ml] of the addedtitrant is again recorded.
- The latter step is repeated until pH 4. 0 is reached, and the volume A3 [ml] of addedtitrant recorded once more.
- A constant mixing of sample and added titrant is required right from the start to minimize exchange with the atmosphere during titration.

❖ **Calculation scheme according to Kapp:**

$$Alk = A * N * 1000 / SV$$

Alk = Alkalinity [mmol/l], also referred to as TIC (Total Inorganic Carbon).

A = Consumption of Sulphuric acid (H_2SO_4, 0.1N) to titrate from initial pH topH 4.3 [ml]. A= A1 + A2 [ml].

N = Normality [mmol/l].

SV = Initial sample volume [ml]

$$VFA = (131340 * N * B / 20) - (3.08 * Alk) – 10.9$$

VFA = Volatile fatty acids [mg/l acetic acid equivalents].N = Normality [mmol/l]

B = Consumption of sulphuric acid (H_2SO_4 , 0.1N) to titrate sample from pH 5.0to pH 4.0 [ml], due to HCO_3/CO_2 buffer. B = A2 + A3 [ml]

SV = Initial sample volume [ml]Alk = Alkalinity [mmol/l]

❖ **A/TIC-ratio**

The A/TIC-method was developed at the Federal Research Institute for Agriculture (FAL) in Braunschweig, Germany. Used as an indicator of the process stability inside the digester, it expresses the ratio between Volatile Fatty Acids and buffer capacity (alkalinity), or in other words the amount of Acids (A) compared toTotal Inorganic Carbon (TIC).

A [mg/ l] = VFA [mg/ l]

ORGANIC CONTENT – Organic dry matter weigh the sample and weigh remaining ashesOrganic content = {Mass of TS - Mass of ashes}/Mass of TS

4.RESULTS & DISCUSSIONS

4.1

- **Biofertilizer**: The organic matter left after the biogas is extracted is used as a nutrient-rich fertilizer for agriculture. It helps improve soil fertility, increase crop yield, and reduce the need for chemical fertilizers.

- **Compost**: The residual biomass can be composted to produce high-quality organic compost. This compost can be used in gardening, landscaping, and agricultural applications.

- **Water conservation**: Helps to conserve water by treating and reusing wastewater from various sources. This reduces the strain on freshwater resources and provides a sustainable solution for wastewater management.

- 10 kg of sludge is obtained from organic waste

4.2 COMPOSITION OF BIOGAS OBSERVED AS :

Component	% after 5 days	% after 10 days
Methane	52	60
Carbon dioxide	33	38
Nitrogen	2	2.5
Water vapour	0.2	0.5

5.CONCLUSIONS

In conclusion, the project on biogas production from organic waste using a drum-based biogas digester system and its measurement using a gas meter in households has several important implicationsIt provides a sustainable solution for household waste management by utilizing organic waste to produce biogas.The focus on commonly available organic waste materials ensures easy replication and implementation in households.The cost-effectiveness and accessibility of the drum-based biogas digester system make it an attractive option for households to adopt.The project helps reduce dependence on fossil fuels by providing an alternative source of energy in the form of biogas.The use of a gas meter ensures accurate monitoring of biogas production, allowing for data-driven analysis and optimization of the system.Monitoring the volume of biogas generated over time helps assess the efficiency and effectiveness of the drum-based biogas digester system.The project promotes environmental sustainability by reducing greenhouse gas emissions from organic waste decomposition and providing a renewable energy source.The knowledge gained from this project can be shared with communities to encourage wider adoption of biogas production from organic waste at the household level.Overall, this project offers a practical and sustainable solution for household waste management while also contributing to reducing carbon emissions and promoting renewable energy sources.

5.1. Future scope

- The project aims to explore the feasibility and effectiveness of producing biogas from organic waste in a household setting, specifically using a biogas digester system constructed from a drum.
- The project will focus on utilizing commonly available organic waste materials such as kitchen scraps, food waste, and agricultural residues to produce biogas.
- The gas meter will be connected to the biogas outlet of the drum to monitor and record the volume of biogas generated over a specific period.

6.REFERENCES

[1] Kale, S.P and Mehele, S.T. kitchen waste based biogas plant.pdf. Nuclear agriculture and Biotechnology/ Division. *" Journal of Environmental Management , vol. 104, pp. 166-174, 2012.*

[2] Karve .A.D. (2007), Compact biogas plant, a low cost digester for biogas from waste starch.

"Biocycle anaerobic digester: performance and benefits," *Waste and Resource Management , vol. 164, no. 1, pp. 141-150, 2011.*

[3] Shalini sing, sushil kumar, M.C. Jain, Dinesh kumar (2000), the increased biogas production using microbial stimulants.*" Renewable Energy, vol. 32, pp. 1243-1257, 2007.*

[4] Hilkiah Igoni, M. F. N. Abowei, M. J. Ayotamuno and C. L. Eze (2008), Effect of Total Solids Concentration of Municipal Solid Waste on the Biogas Produced in an Anaerobic Continuous Digester. *Waste Manage Res., vol. 20, p. 234–242, 2002.*

[5]Tanzania Traditional Energy Development and Environment Organization (TaTEDO), BIOGAS TECHNOLOGY- Construction, Utilization and Operation Manual.*Methane Metabolism, Part A Methanogenesi, Elsevier Inc., 2011.*

[6] The University of Southampton and Greenfinch Ltd. - Biodigestion of kitchen waste A comparative evaluation of mesophilic and thermophilic biodigestion for the stabilisation and sanitisation of kitchen waste. *" Biomass and Bioenergy vol. 33, pp. 1046-1054, 2009.*

[7] Ranjeet Singh, S. K. Mandal, V. K. Jain (2008), Development of mixed inoculum for methane enriched biogas production , *Socio-Economic Impact and the Way Forward. In Biogas Production; Springer: Cham, Switzerland, 2020; pp. 415–445.*