e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 6, Issue 6, June 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 6, Issue 6, June 2023 |

Experimental Analysis of Institution Level Biogas Production

S. RAJAMURUGAN[1], M. PRASANTH[2]

Assistant Professor, Gnanamani College of Technology, Pachal, Namakkal, Tamilnadu, India[1]

PG Student, Gnanamani College of Technology, Pachal, Namakkal, Tamilnadu, India[2]

ABSTRACT: On our college campus, there are three distinct mess halls for boys, girls, and teachers, and a significant amount of food is wasted there that can be utilised to create biogas. The biogas that is released serves as a renewable energy source. Biogas, a priceless energy source, is produced by the anaerobic decomposition of kitchen waste. The establishment of biogas enables the production of more affordable, environmentally beneficial, and renewable energy capable biogas from an organic processing factory. In this study, food waste from the kitchen is used to produce biogas. The research study also examines the quantity of biogas produced from kitchen garbage and the viability of a biogas plant economically.

I. INTRODUCTION

A technology is appropriate if it gains acceptance. Biogas plants have untilnow gained little acceptance. Simple biogas plants have up to now apparently been inappropriate

A biogas plant is correctly operated and maintained if it satisfies the user's need for recognizing authority and convenience. He for his part is then prepared to accommodate to the needs of the biogas plant. Biogas plants are proper to the technical capability and economic capacity of Third World farmers. Biogas technology is actually appropriate to the ecological and economic demands of the future. Biogas technology is tolerant of change. However, a biogas plant rarely meets the owner's need for status and recognition. Biogas technology has a low self esteem ("Biogas plants are built by vision for needy people". If you do not want to see one of the indigent, you do not buy a biogas plant. The image of the biogas plant must be better. The designer makes his offering by supplying a good design. A “planner” that works. One that is built in conformity with modern day requirements and models. The biogas plant must be a symbol of social development. The biogas plant must be technically tolerant of change. A biogas plant as an excogitation is in competition with a bicycle, diesel pump, a buffalo or an extension to the farmhouse. The economic benefit of a biogas plant is greater than that of most ambitiousexpenditure.the fermentation broth tank should be designed and constructed decently. So giant pumpkins and flowers should grow around the plant. A good biogas plant is suitable. It is suited to the owner's needs and his skills and abilities. It is suitable for future needs.

II. PRODUCTION PROCESS

A representative of biogas system consists of the following components:

- Manure collection
- Anaerobic digester
- Effluent storage
- Gas handling
- Gas use.

III. PRINCIPLE OF PRODUCTION OF BIOGAS

Biogas is produced by decay of orgnic matter. Biogas is mainly collection of methane. It burns with insignificant smoke and leaves no remainder.

I. Typical Biogas Components

Gas	Formula	Unit	Prevalent (%)
Methane	CH4	%	50-65
Carbon dioxide	CO2	%	30-45
Hydrogen sulphide	H_2S	Mg/m^3	0-4500
Ammonia	NH3	%	0-0.045
Humidity	H_2O	%	3%(20℃)-6%(40℃)

II. Major Characteristics of Biogas

Characteristics	Value
Energy content	20-30 MJ/m3
Ignition Temperature	645-750℃
Density	1.25Kg/m3
Critical Pressure	75-90bar
Critical Temperature	180.65Kkelvin (-82.5℃)

IV. RESEARCH METHODOLOGY

Literature Review
↓
Problem identification
↓
Objective
↓
Model designing
↓
Compound purchasing
↓
Creation of working model
↓
Assembly of food waste
↓
Analysing the biogas production

V. SUMMARY OF THE LITERATURE

The determined disintegration of the research work are as described below,

1. Examination of Biogas manufacturing on small scale Biogas plant.
2. To study the biogas production potential of food waste.
3. Design and Experimental Analysis of Biogas production from food waste.

VI. OBIECTIVES

- The project focus to provide new and renewable source of renewable energy (biogas) and organic manure which is a high quality of manure and is much better than the chemical manure that have harmful effects on the soil and on health. It also abolishion the use of natural gas and saves money for households.
- Provide new, renewable and continuous source of energy for domestic utilizations.
- To Improve the properties of the soil through the high-quality organic manure.
- To reduce greenhouse gas emissions and the risk of pollution to waterways, organic waste can be removed and used to produce biogas, a renewable source of energy.
- The importance of fertilizer coming from the biogas plants for agriculture and crops.
- The influence of climate change on the environmental situation.

Fig.1 Food Waste Storage Tank

Fig.2 Liters Container

VII. EXPERIMENTAL WORK

In this stage three messes were selected for the data collection. Out of these three, one is located in central Halmstad, one is in Gothenburg and last one is in Falkenberg. Same data were collected from these three messes.

- Quality of waste produced in a day
- Type of waste and characteristics of the waste
- Monthly use of electricity for cooking

VIII. pH MEASUREMENT FOR COLLECTED FOOD WASTE

Sample	Reading
Messes 1	5.5
Messes 2	7.8
Messes 3	6.22

IX. DESIGN OF BIO DIGESTER

Mess 1 calculation

For mesophilic digestion condition, where temperature varies from 20˚C to 35˚C and HRT is greater than 20 days. Here additional heating is needed for the biogas digester and maintain amesophilic condition. Because of this determination time is 30 days (Biotech India). That means,
64.9 L/ day * 30 days = 1947 L= 1.9 m^3
Here every day 21.7 kg wet waste is considered. Normally total solids (TS) is taken as 20% of the wet waste.
Total solids TS = 20 % of 21.7 =4.33 kg
Volatile solids is estimated as 80% of total solids (TS)
80% of volatile solids = (80/100)* 4.33 = 3.4VS/day/64.9 L
This can be converted in m^3 = (3.4/64.9)*1000 = 53.37 kg VS/m^3

ORGANIC LOADING RATE
Organic loading rate (m^3/day) = Flow rate (Kg VS/m^3)*(concentration/ Reactor volume inm^3)

Flow rate is usually taken as 0.18 (Coursera)
= 0.18 *53.37/1.94
= 4.95VS/m^3

AMOUNT OF GAS
Normally biogas yield for food wastes is 0.67 m^3/Kg VS
Amount of gas = organic loading rate*normal biogas yield*feed stock quality Normally biogas consumption rate of stove is 0.4m^3/h.

Mess 2 Calculation

Here every day 14 Kg wet waste is considered. Normally total solids (TS) is taken as 20% of the wet waste
Total solids TS = 20 % of 14 = 2.8 Kg
Inflamable solids is estimated as 80% of total solids (TS)
80% of Inflamable solids = (80/100) * 2.8 = 2.2 VS/day/42 L
This can be derived in m^3 = (2.24/42) *1000 = 53.3 Kg VS/m^3

ORGANIC LOADING RATE

Organic loading rate (m^3/day) = Flow rate (Kg VS/m^3) *(concentration/ Reactor volume)(m^3)
Flow rate is usually taken as 0.18 (Coursera)
= 0.18 * 53.3/1.26
= 7.6VS/m^3

AMOUNT OF GAS

Normally biogas yield for food wastes is 0.67 m^3/Kg VS
Quality of gas = organic loading rate*normal biogas yield*feed stock grade
Normally biogas consumption rate of stove is 0.4m^3/h

Mess 3 Calculatiomn

Here every day 16.9 Kg wet waste is considered. Normally total solids (TS) is taken as 20% of the wet waste
Total solids TS = 20 % of 16.9 = 3.3 Kg
Inflamable solids is estimated as 80% of total solids (TS)
80% of Inflamable solids = (80/100)* 3.3 = 2.7 VS/day/42 L
This can be derived in m^3 = (2.7/50.7)*1000 = 53.2 Kg VS/m^3

ORGANIC LOADING RATE
Organic loading rate (m^3/day) = Flow rate (kg VS/m^3)*(concentration/ Reactor volume) (m^3)
Flow rate is usually taken as 0.18 (Coursera)
0.18 *53.2/1.2
= 7.6 VS/m^3

AMOUNT OF GAS PRODUCED
Normally biogas yield for food wastes is 0.67 m^3/Kg VS
Quality of gas = organic loading rate*normal biogas yield*feed stock quality Normally biogas consumption rate of stove is 0.4m^3/h

X. RESULTS AND DISCUSSION

MESS 1

In this study mainly 3 messes were included; the average amount of food wastes available in each day from these messes 1 is 21.7Kg/day. With the help of the pH meter pH of the substrate is found to be 5.98, which is in the required range. Out of three messes, messes 1 has more amount of waste and from the calculation, finds out that, amount of gas produced in this digester is 6.3m^3/day. Usually the biogas consumption rate of stove is0.4m^3/h. Biogas digester of messes1 is capable of supplying cooking fuel up to 15.75 hr for a single stove.

MESS 2

The most important point is that in this messes space for the installation of biogas plant is not an issue, lot of space is available. The average amount of food waste in these messes is 14Kg/day. From the pH calculation, pH of value is 6. Usually the biogas consumption rate of stove is 0.4m^3/h and amount of gas produced in this digester6.4m^3/day and is capable of supplying cooking fuel up to 16.05 hr for a single stove.

MESS 3

This model is developed by Bio-tech India. It is an agency working under the Renewable energy department of India. The average amount of food wastes in these messes is 18.71 Kg/day. While measuring the pH of the food waste from these messes was found as quite low and it is 4.22. This low value is due to the acidic nature of ingredients. In most of the savory they add tomato sauce. Usually the biogas expending rate of stove is 0.4m^3/h and amount of gas generated in this digester 6.4m^3/day and is capable of supplying cooking fuel up to 16.00 hr for a single stove
In this study mainly 3 messes were included,compare the analysis of 3 messes value because mess 3for the insertion of the biogas plant is a serious problem for this messes. Attributable to this reason fixed dome type digester is not suitable

XI. ECONOMIC BENEFITS

Through biogas production these three messes help to reduce the usage of fossil fuels and protect the environment. Apart from this they also generate economic benefits to these messes (Mohan et al., 2017). In messes 1, for the installation of this fixed dome digester 2500 US$ (approximately 20000SEK) is required. This type of digester has long lifespan, so its maintenance cost is very low. In present situation, this messes owner spends3500- 4000 SEK/ month for the cooking fuel, here natural gas is used as cooking fuel. Apart from this, the messes owner pays 1200-2000 SEK/month to the authorities for the waste management (3 SEK for one kilogram of waste) digestate or slurry obtained as a by-product during the biogas production can be sold to the farmers as bio-fertilizer and can be a pro fit according to the fertilizer market rate. However, the installation cost of the digester can pave off within a few months. In messes 2, the installation cost of the fixed dome digester is the same as that of themesses1. In messes 2, biogas production rate can be higher than in messes1, because here cooking oil is changed in every 2 days and this oil can also be used as raw material for biogas production.

This will enhance the biogas production considerably. Here electricity is used as the cooking fuel and the messes spend an average of 3000 SEK/month on electricity. Here amount spend for the waste management is quiet low, due its location and they spend 1000 -1400SEK every month. Bio-digestate or biogas- slurry can be easily sold from these messes because this messes is surrounded by a lot of agricultural lands, so transportation cost can be reduced. In messes3, fixed dome digester is not suitable because of the space constraint. Here an Indian model of digester could be used. The price of this type of model is 60000INRapproximately 9000SEK. In this messes natural gas is used as the cooking fuel today. In the present situation this messes spends approximately 3200 SEK per month for the cooking fuel. Apart from the cooking fuel the messes also spends 13001500 SEK per month to the authorities for the waste management. Through biogas production these expenses can be easily avoided, and additional income can be earned through bio digestate. Here bio-digestate can be sent to the nearby agricultural lands through transportation system Marketing is the other sections of economic benefits. These three messes can promote their name with the label of Green messes in this global warming situation.

These three messes can manage their own waste and they do not need any help from authorities for the organic waste management. Green restaurants are messes that are working in an environmentally friendly way. Here these messes do not use any type of fossil fuel for the cooking purpose. Apart from this they manage and process the organic waste from the messes and provide environmentally friendly bio fertilizer for the food production. These messes do not create any problems to the environment, and they help to reduce the global warming. These things can promote the marketing of these green messes. In such a way they can increase their income.

XII. CONCLUSION

In this study 3 messes were included. Through the data collection and analysis and calculation, it is find that three messes are capable for biogas production and they are able to supply biogas for working a single stove more than 15 hours The Biogas production(messes1 is 15.75h, messes2 and 3 is working up to 16.05 and 16 hours in a day). In the initial stage of the study various advantages and disadvantages of small-scale biogas production from food wastes were analysed and details were collected about different type of bio -digesters that would be suitable for the small-scale biogas production. Moreover, and components of biogas are also included in this study. During the study three staurants are visited in different locations of Sweden and food waste samples were collected for the analysis of pH.

Information was collected about the usage of cooking fuel, details about the amount of waste produced in a day and about the waste management system. This information was used for the design of suitable anaerobic digesters In this detailed study contain details about the small-scale biogas production using food waste in messes, relevance and importance for the global warming issue. Through small scale biogas production every messes can produce the cooking fuel for their own needs and also, they can easily manage the organic wastes through the disposal into the digesters. During the biogas production bio-slurry or digestive is obtained as a by-product and used as bio-fertilizer and as bio-pesticide.

One of the most important advantages with biogas production is that it does not create any harmful effects to the environment. Biogas production can even reduce methane emission to the atmosphere. Reduction in the usage of fossil fuel, (natural gas) will automatically lead to reduction of the impact of global warming. Economic benefits are the one of the noticeable point that was find out during this study. While analyzing the data from the three restaurants, each messes spend an average of 3000 SEK per month for the cooking fuel (messes 1 is 3500-4000SEK/month, messes

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 6, Issue 6, June 2023 |

2 is 3000SEK/month andmesses3 is 3200SEK/month) and more than 1000SEK per month (messes1 1200-2000SEK/month, messes2 is 1000-1400SEK/month, messes3 is 1300-1500SEK/month) to the authorities for the waste disposal. These costs can be avoided through the installation of biogas plants in messes.

REFERENCES

1. Rico, C., et al (2014) Biogas Production from Various Typical Organic Wastes Generated in the Region of Cantabria (Spain): Methane Yields and Co-Digestion Tests. Smart Grid and Renewable Energy, 5, 128-136.
2. Benjamin Blumenstein et.al [2015], Integrated Bioenergy and Food Production A German Survey on Structure and Developments of Anaerobic Digestion in Organic Farming Systems, Sustainability 2015, 7, 10709-10732.
3. Milan Koszel et.al [2015], Agricultural use of biogas digestate as a replacement fertilizers, Farm Machinery and Processes Management in Sustainable Agriculture, 7th internationalscientificSymposium,Agriculture and Agricultural Science Procedia 7 (2015) 119 – 124.
4. D Muthu et al 2017 IOP Conf. Ser.: Earth Environ. Sci. 80 012055.
5. Shalini sing, sushil Kumar, M.C. Jain, and Dinesh Kumar," The Increased Biogas Production Using Microbial Stimulants" 2000.
6. Karve .A.D, "Compact Biogas Plant, A Low Cost Digester for Biogas from Waste Starch". http://www.arti-india.org.
7. Lissens, G., Thomsen, A.B., Baere, L., Verstraete, W., and Ahring B. "Thermal Wet Oxidation Improves Anaerobic Biodegradability Of Raw And Digested Bio Waste". Environmental Science and Technology, vol.38, pp. 3418- 3424, 2004.
8. Hilkiah Igoni, M. F. N. Abowei, M. J. Ayotamuno and C. L. Eze, "Effect Of Total Solids Concentration Of Municipal Solid Waste On The Biogas Produced In An Anaerobic Continuous Digester", 2008.
9. A. Malakahmad, S M Zain, N E Ahmad Basri, S R Mohamed Kutty,and M H Isa, "Identification of Anaerobic Microorganisms for Converting Kitchen Waste to Biogas", World Academy of Science, Engineering and Technology, Vol:3, pp. 12- 20,2009
10. Peter Wieland," Biogas Production: Current State And Perspectives". Appl Microbial Biotechnol,vol. 85, pp. 849 – 860, 2010.

Impact Factor
7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com