



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 9, Issue 10, October 2020

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



9940 572 462



6381 907 438



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Biomethanation Energy: A Way to Empower Every Indian Village

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ABSTRACT: Some of the Indian village are in dire need of electricity where the connection from grid is uneconomical and mostly dependent on primitive method (Chula system) for cooking which in many ways is harmful for health and also for the environment.

Therefore, this project focuses on making every Indian village self-sustainable by providing them clean fuel for cooking in addition to electricity around 6-7 hours per day using agro,dung and providing manure from bio digester, thus protecting the environment from degradation. We visited some Indian villages some of them are situated near banks of River Ganga in district of Uttar Pradesh having lack of transportation during rainy season. Therefore, we have implemented a plant model that is not only flood resistant but also easy to maintain by the villagers providing them clean gas for cooking. Our project also aims on improving the livelihood and health conditions of villagers by doing proper waste management including swamp or stagnant water.

KEYWORDS: Electricity, Waste, Plant, Self-Sustainable, flood.

I. INTRODUCTION

Biomethanation is a process by which organic material can be converted to biogas through anaerobic digestion of microorganisms. Three main physiological groups of microorganisms are involved: fermenting bacteria, organic acid oxidizing bacteria, and methanogenicarchaea. Microorganisms feed on organic matter via cascades of biochemical conversions to methane and carbon dioxide. Biomethanation has high potential for the production of energy from organic residues and wastes. It will greatly help to reduce the use of fossil fuels and thus reduce carbon dioxide emission, thus protecting the environment [1].

Generally, Biomethanation plants can be implemented everywhere i.e. either in urban or in rural areas, as population is present there either in small or a large scale, and if there is population, there is waste and if these wastes treated properly are a great source of methane production which can be used accordingly either for production of electricity, gas and biodiesel according to requirement. These plants not only will help in generating gas and electricity but will also help in waste management which in major problem of the 21st century due to ever increasing population, and not to forget Biomethanation is sustainable form of energy, therefore will help in reducing the use of fossil fuels.

Feedstock for digesters are cow dung, agriculture waste, bagasse, stagnant water, jaggery which can be mixed in appropriate composition such that maximum biogas production takes place. Majority of population in India resides either in towns or villages and these villages are source of various crops and these crops when cultivated or processed gives the by-products in a large scale (like bagasse from sugarcane, wheat crush and many more) which can be used in a bio gas digester to produce methane and nutrient rich manure, these manure can be used for crops cultivation replacing highly rich chemical manures on large scale to increase overall farm yeild and methane gas can be used for cooking gas and electricity.

II. RELATED WORK

Some of the Indian village are in dire need of electricity and gas - as the connections from grid is uneconomical and uses primitive method (Wood-Coal Chula system) for cooking which in many ways is harmful for their health and environment causing deforestation. Some of these villages are also flood prone so providing clean gas and electricity here is a great challenge.

Therefore, our vision is to make every Indian village self-sustainable by providing them gas for about 3 hours approximately and electricity for about 2 hours approximately.

Our prototype is divided into two phases.

In our first phase we are working on a prototype model which will give gas for about 1 and half hours for two house, so we could analyse the production of gas and plant performance on a daily basis to calculate the volume of the gas production and defects that could occur in main digester including the safety measures. Therefore we have decided to work on a plug flow PVC type bio digester which will be portable, easy to carry and economically efficient.

After proper completion of phase 1, in phase 2 we aim to provide electricity in addition to gas.

Biomethanation plants are proven and tested in technological terms and requires less maintenance and village locals can be trained easily for operating and maintaining the plant. Through this, every village can get electricity along with clean fuel gas for cooking on a small scale. Our project also aims on improving the livelihood and health conditions of villagers by doing proper waste management including swamp or stagnant water.

III.METHODOLOGY

Our prototype (phase1) consist of 2 system

1. Bio digester for gas generation
2. Distribution system of that bio gas to concerned houses

BIO DIGESTER

We have used 3 layers PVC to make balloon type digester for our prototype. Our prototype digester is cylindrical in shape having length of 1.33 metres and diameter of 1.5metres, having a volume of approximately 2.35 cubic metres. Initial feeding of bio digester is 160 L of slurry (having 80 kg of cow dung and 80 kg of water),with regular feeding of 80L of slurry(having 40 kg of dung, vegetable waste and 40 Litre of water).

Purging out is done either by slanting the digester or by removing the outlet from digester making it portable for working.



Figure 1 Prototype model

DISTRIBUTION SYSTEM: Our distribution system consist of bubbler, PVC and flexible pipes, and floating drum. Gas generated in digester will be taken to a floating drum for gas storage and pressure regulation through half inches flexible pipe, from floating drum pressurised gas will be taken to bubbler through half inches flexibles pipe where the gas is filtered, to protect Chula from rust cause by hydrogen sulphide, filtered methane gas from bubbler is taken to bio stove in houses for cooking.

We have used flexible pipes in our distribution network as these pipes can be connected easily to digester when villagers re install the plant, protecting the distribution network from flood.

Differentiating factors (Innovation made):

- 1.Portable
- 2.Low cost
- 3.Pressure Regulation
- 4.Suitable for most environment conditions.
- 5.Easy to assemble and disassemble for maintenance purposes.
- 6.Light weight and durability of Bio digester.

7. Artificial filtering of gas at very low cost.

Safety measures taken:

1. Again for the backfire being a potential risk Bubbler along with floating drum can handle it efficiently.
2. The pipelines should also be installed properly which would be flexible and underground so that children, or ignorant people don't mishandle it.

IV. EXPERIMENTAL RESULTS

A. Phase 1 experiment: Conducted an experiment on 4 different types of wastes keeping waste to water ratio 1:1 except the agriculture waste which was 1:2 in ratio and analyse the formation of gas for 1 week.

Apparatus used: 25 L Can, 12 L Motorcycle tubes, PVC pipes for inlet and outlet.

Observations:

1. Quantity of gas In LITRE collected for 1 week
2. On day 2 seals of digester 1st and 2nd was burst and slurry came out of digester, tube of digester 1 was change on day 1 only.
3. Vegetable waste consist of cabbages, brinjals, tomatoes, onions and potatoes peels.

Result:

1. Experiment didn't go well as we predicted, as seals were broken of two digester (1st and 2nd and digester came in contact of oxygen, no methane was formed, hence the flame test failed in both digesters.
2. Digester 3 had shown methane to pass the flame test
3. Digester 4 didn't pass the methane test, so our test on plastic fail.
4. Also all the digester except 3 had some odour smell, so we can also confirm methane was not formed except in digester 3.
5. As the onion peels were present in some quantity, hence gave acidic character, when we checked PH on 8th day was around 4-5.

B. Phase 2 experiment : Keeping water to waste ratio 1:1. Begasse and jaggery are new inclusion to our experiment and analyse the gas for one week. Our experiment is conducted in a sealed container.

Apparatus used: 25L can, gas pipe 15L motorcycle tubes, gas testing valve.

Observations:

1. Quantity of gas In LITRE collected for 1 week
2. JAGGERY HAD INCREASED THE PRODUCTION OF GAS AS COMPARED TO PHASE 1 EXPERIMENT.
3. SWAMP HAS ALSO INCREASED QUANTITY OF GAS AS COMPARED TO FRESH WATER, BECAUSE IN DIGESTER 4 SWAMP WAS ONLY USED IN INSTEAD OF FRESH WATER. BAGASSE IF USED IN MORE QUANTITY CAN ALSO INCREASE THE PRODUCTION OF GAS.
4. PH OF SWAMP WATER IS 8.2.
5. AGRICULTURE WASTE GENERALLY CONSISTS OF POTATOES, CABBAGE AND TOMATOES PEELS AND KITCHEN WASTE CONSISTS OF LEFTOVER OF HOSTEL MESS.
6. ROOM TEMPERATURE WAS AROUND 21.3 DEGREE CENTIGRADE.

Result:

1. Flame test of digester 1, 2, 4 was successful and have odourless smell.
2. Digester 3 don't have enough gas to give flame test.
3. Digester 5 when gone under flame test in day 3 but was not successful.
4. PH of digester which give positive flame test was around 7.5-8.5.
5. PH of digester doesn't give flame test was around 4-5 and having strong foul odour.



Figure 2. Digesters with different waste samples samples(phase1)



Figure 3. Digesters with different waste (PHASE 2)

TABLE 1.
Sample of gas generated from different waste (phase 1)

DIFFERENT TYPES OF WASTE	GAS GENERATED FROM THESE WASTE PER DAY						
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
1.AGRICULTURE WASTE (5 KG)	10.31 L	11 L	10.23 L	4 L	NO CHANGE	NO CHANGE	NO CHANGE
2.AGRICULTURE PLUS DUNG WASTE (8 KG)	8 L	10 L	7 L	2 L	2.5L	NO CHANGE	NO CHANGE
3.DUNG WASTE (10 KG)	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE	1 L	4 L
4.MIXED WASTE (2KG INCLUDING PLASTIC WASTE)	2 L	500 ML	300 ML	500 ML	200 ML	NO CHANGE	NO CHANGE



Table2
Sample of gas generated from different waste (phase 2)

DIFFERENT TYPES OF WASTE	GAS GENERATED FROM THESE WASTE PER DAY						
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
1.DUNG WASTE(9kg)+JAGGERY 100gram	4 L	2 L	2 L	0.5 L	0.5 L	300 L	NO CHANGE
2.AGRICULTURE(6KG) PLUS DUNG WASTE(6KG)	1 L	14 L	6 L	6 L	6 L	4 L	3.5 L
3.DUNG(4.5KG) + AGRICULTURE(2.5KG) +KITCHEN(2KG)+BEGASSE(0.5KG)	1.5 L	2L	1 L	1.5 L	0.5 L	200 ML	NO CHANGE
4.DUNG(5KG)+AGRICULTURE(5KG)+SWAMP(4KG)+BEGASSE(2KG)	6 L	5L	4.5 L	1.5 L	3 L	1 L	4 L
5.COW DUNG(5KG)+KITCHEN WASTE(5KG)+INNOCULUM(0.5KG)	0.5L	0.5L	2.2L	NO CHANGE	200 ML	100 ML	NO CHANGE

V.RESULT AND DISCUSSION

Our model mainly depend upon the technology which we are using for production of biogas in flood prone areas, because locals residing here are majorly tribals and don't have proper facilities for living, but having an abundant quantity of waste in the form of cow dung and bagasse, if utilised properly can be used for production of cooking gas and electricity.

Therefore we successfully installed a 2 m³ bio digester including all the safety measures in Inchhawala, Bijnor District of Uttar Pradesh, India, providing .5-.6m³ odourless gas of blue flame for approximately one and half hours to two houses at a pressure of 1.5 atm having a PH around 7-7.5 which is perfect for biogas production. If acid formation is there PH can be maintained by making a buffer solution using baking soda and jaggery can be used from time to time or on a daily basis for production of gas on a rapid rate. Our prototype have easily operated on mesophilic temperature range 30-40 degree centigrade due to its construction fully in the land, also in summer the sun heat cannot deep penetrate deep into the digester and in winter heat cannot easily escape or release and we are getting nutrient rich manure for cultivation of crops. Also purging out of waste can be done easily from the bio digester end making it suitable for flood.

VI. CONCLUSION

Our idea of Biomethanation can revolutionize the way gas and electricity is produced wherewe dream to see gas, light and fan running in every village household at minimum cost. Our project is not only lucrative but also brings a social impact as we tried to generate gas and electric energy and sell the "waste" i.e. manure which is an excellent fertilizer. It is safe and do not require an expert to run it.

Also,if affixed with solar energy or any of the renewable sources of energy then it can have far reaching consequences as far as generating energy is concerned.



Figure4. Formation of gas in bio digester



Figure5. Formation of blue flame

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INNO SPACE
SJIF Scientific Journal Impact Factor

**Impact Factor:
7.512**

ISSN INTERNATIONAL
STANDARD
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