Design and Development of Anaerobic Biodigester for Individual House in Kolagallu village, Ballari District using Available Biodegradable Domestic Waste

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***Abstract*: One of the main environmental problems of today‘s society is the continuously increasing production of organic and inorganic wastes. Most of the families in India depend on LPG for cooking or other purpose and the demand is increasing day by day. Any material which can be decomposable by the action of microorganisms in a short period of time is called biodegradable Mostly food waste; vegetable peels and fruit pulp are biodegradable. These materials readily mix with the soil by the action of bacteria. During decomposition,these materials release carbon dioxide, methane, ammonia and hydrogen sulphide into the environment thereby contributes to air pollution and odour pollution. The gases that are released during the decay of biodegradable wastes can be captured for the economic utility and as well as to save the environment. An attempt is being made in thistechnical research paper to demonstrate the possibilities energy recovery from biodegradable kitchen waste that is collected from residential societies which can be utilized for the benefits of the society [2].Cow dung as a renewable source of energy supply has been proven to be very efficient. This study investigated the production of biogas using Biodegradable organic waste and cow dung from Kolagallu village, also investigated the production of biogas by comparing different proportion of cow dung and Biodegradable organic waste (kitchen waste). Maximum average methane gas produced in reactor 1 and reactor 2 at 21 days were 890 grams (0.89 kg) and 1300 grams (1.3kg). By abserving reactor 2, higher proportion of cow dung produced more biogas, this may be the presence of more number of anaerobic microorganisms in reactor 2. on the basis of results it was observed that production of biogas is 12.97 kg/house/month in reactor 2 and reactor 1 is 8.86 kg/house/month. By comparing the reactor 1 and reactor 2, reactor 2 gives more yield. Hence reactor 2 is suitable design for Kolagallu village.Thus biogas production from cow dung and kitchen waste is a good and cheap alternative source of energy. The use of biogas will not only serve as a source of fuel but will also help in the management of waste. The biomass generated after digestion can be used to improve soil fertility, a combustion test was also carried out which showed that for blue flames were produced without soot.**

Keywords: Anaerobic digestion, Biodegradable Domestic waste, Cow dung, Biogas.

INTRODUCTION

Due to scarcity of petroleum and coal it threatens supply of fuel throughout the world also problem of their combustion leds to research in different corners to get access the new sources of energy, like renewable energy resources. Solar energy, wind energy, different thermal and hydro sources of energy, biogas are all renewable energy resources. Kitchen waste is organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several order of magnitude as said earlier. It means higher efficiency and size of reactor and cost of biogas production is reduced. Also in most of cities and villages , kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases like malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences, it not only leads to polluting surface and groundwater through leachate and further promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it emits unpleasant odour & methane which is a major greenhouse gas contributing to global warming **[1].** Anaerobic digestion process has been used in order to decrease the use of fossil energy. Anaerobic digestion is a biological process converting organic matter into the main products methane (CH_4) and carbon dioxide (CO_2), usually referred to as biogas. A few percentages of nitrogen (N_2) and ppm levels of ammonia (NH_3) and hydrogen sulfide (H_2S) are also formed. The organic matter used come from sewage sludge, animal wastes, household wastes, industrial wastes and industrial wastewater. Biogas produced from manure, a commonly used source of organic matter, generates roughly 60-70% CH_4 and 30-40% CO_2**[4].** the effluent of this process is a residue rich in essential inorganic elements like nitrogen and phosphorus needed for healthy plant growth known as bio fertilizer which when applied to the soil enriches it with no detrimental effects on the environment. There are various types of waste materials available from different sources, but not all waste materials are biodegradable. only biodegradable waste materials can produce biogas. Again, the biogas generation capacity is not the same for all biodegradable waste materials .The content of biogas varies with the material being decomposed and the environmental conditions involved. Potentially, all organic waste materials contain adequate quantities of the nutrients essential for the growth and metabolism of the anaerobic bacteria in biogas production. we have tried to develop a anaerobic biodigester for the available domestic waste from the Kolagallu village, Bellari district. The wastes that has been utilized for biogas production and they include; animal wastes, kitchen waste

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II. MATERIALS AND METHODOLOGY

Materials :

Empty Water cans 20ltrs capacity:To be used as digester tank.

M-seal:M-seal is a multipurpose sealant with four main applications –Sealing, joining, fixing and building it can be used to fill gaps, cracks and plug leaks in pipes and joints.

Gas collection pouch:To be used for collection of bio gas

PVC Pipe 0.5’’(Length-1.5mtr):To be used for inlet and outlet for the reactors.as effluent pipe.

Cape:0.5” (to seal effluent pipe).

Gas pipe :For gas output, (1-2 m)

Valves:To be used for controlling bio gas.

T joints :Used for Divert gas from gas pouch to burner.

Electronic weighing balance:Used for weighing the bio gas collected in pouch.

Methodology:

A 20litres capacity plastic cans will act as the digester unit. Funnel will be used for feeding the waste, PVC pipe are fixed with the digestion chamber and it will be used as inlet and outlet chamber. Inlet pipe is fixed at the top of reactor for feeding the mixed slurry and outlet chamber for discharging the unwanted slurry from the reactor. then the whole set up is sealed and made air tight and allowed to check for water leackage. There are two reactors were fabricated, one digester was fed with 50% cow dung and 50% kitchen waste. The other digester was fed with 85% of cow dung and 25% of kitchen waste. Optimum pH range in an anaerobic digestion process is another important parameter that has a significant effect on the digestion process. the optimum ph range in an anaerobic digester is 6.8 to 7.0 however the process can tolerate a range of 6.5 to 8.0, In this study, Using Sodium bicarbonate ($NAHCO_3$), pH was maintained within the range. The daily variation in temperature and pH was measured in the lab. The study of biogas production was carried out for 28 days. The production of gas was made to collect in the pouch which was connected to the digester and the measurement of biogas production was carried out in the Environmental Engineering Laboratory of the Civil Engineering Department, Rao Bahadur Y. Mahabaleshwarappa Engineering College Bellari.

Reactor 1 (25%CD+75%KW) Reactor 2 (50%CD+50%KW)

Figure 1: Collection of Biogas from different Biodigesters

III. DESIGN OF BIODIGESTER:

Step I : Preliminary Survey

Table 1: Preliminary Survey

Preliminary survey	
No of gas cylinders	1800 Nos
No of cows	500 Nos
Solar systems	3 Nos
Kitchen waste	5000 ltrs
Usage of kerosene/wood	200/405
Population	10,399 Nos
Households	2,005 Nos

STEP II:Design of Bioreactor [3]

Diameter of the reactor (D) = 25cm

Height of the reactor (H) = 40.8 cm

Volume of the reactor (V) = $\pi/4 \times d^2 \times h$

$= \pi/4 \times 25^2 \times 40.8$

$= 20027.6\ cm^3$

$V=20.00 m^3$

Working volume of the reactor = 18 litre

$V = (\pi/4) \times d^2 \times h$

$18 \times 10^3 = (\pi/4) \times 25^2 \times h$

$18 \times 10^3 = 490.87 \times h$

H = 36.66 cm

H =0.0366 m^3

Actual height = 40.8 cm

Working volume height = 36.66 cm

Actual height for free gas circulation (h) = 40.8 – 36.66

h= 4.14 cm

Step III: Calculation of Biogas Production

Reactor 1

Amount of domestic waste fed to the reactor = 18 litre × 80%

= 18 x 0.8

= 14.4 litre

Amount of cow dung fed to the reactor = 18 litre× 20%

= 18 x 0.2

= 3.6 litre

Reactor 2

Amount of domestic waste fed to the reactor = 18 litre × 50%

= 18 x 0.5

= 9 litre

Amount of cow dung fed to the reactor = 18 litre × 50%

= 18 x 0.5

= 9 litre

Now,

Maximum average methane gas produced in reactor 1 at 21 days is 890 grams Maximum average methane gas produced in reactor 2 at 21 days is 1300 grams.

By considering one person discharges 700 grams of solid waste per day [6]

But domestic / kitchen waste is about 80 % of solid waste

Therefore, Domestic /kitchen waste = 0.8 x 700

= 560 grams/day/person

= 0.56 kg/day/person

By assuming 6 persons for one house

Therefore, Quantity of domestic/kitchen waste discharge from one house = 560 x 6

= 3360 grams/day/house
=3.36 kg/day/house
Kolagallu village has 2005 houses
Therefore,
Quantity of domestic /kitchen waste discharge from Kolagallu village=2005 x 3360
=6736800 grams/day
=6736.8 kg/day
By preliminary survey on an average one cow discharges 10 kg to 12 kg of cow dung per day **[5]**
On a an average we assume 10 kg of cow dung per day
Number of cows in Kolagallu village = 600
Therefore,
Amount of cow dung discharged by 600 cows = 600 x 10
= 6000 kg/day
Total waste generated from kolugallu villege =12000 kg

Reactor 1:
20% of total cow dung =1200 kg and 80% of total domestic/kitchen waste=4800kg
Total waste = 6000 kg
Amount of Biogas obtained from the fabricated reactor (18kg) = 0.89 kg
Amount of Biogas that should be obtained for 6000 kg =296.67kg
Amount of Biogas per house = 296.67/2005
= 0.14 kg/house/day
= 4.43 kg/house/month
But the total discharge quantity = 12000 kg
= 4.43 x 2
= 8.86 or 9 kg/house/month
Therefore, Amount of biogas obtained from reactor 1 is 8.86 or 9 kg/house/month.

Reactor 2
50% of total cow dung =6000kg and 50% of total domestic/kitchen waste=6000kg
Total waste = 12000 kg
Amount of Biogas obtained from the fabricated reactor for 18kg = 0.89 kg
Amount of Biogas that should be obtained for 12000 kg =866.66 kg/day
Amount of gas per house = 866.66/2005
= 0.43 kg/house/day
Amount of gas for a month = 0.43 x 30
= 12.97 or 13 kg/house/month
Therefore, Amount of biogas obtained from reactor 2 is 12.97 or 13kg/house/month.
But we know that amount of LPG present per cylinder is 14.2 kg,
Hence
By Designing reactor 2, we provide about 90% of biogas to kolugallu villege.

IV. RESULTS AND DISCUSSIONS:

Methane production in Reactor 1 and Reactor 2:

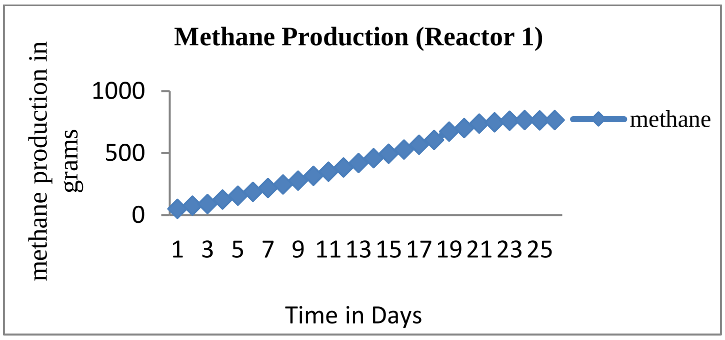

Fig.1: Methane production in Reactor 1

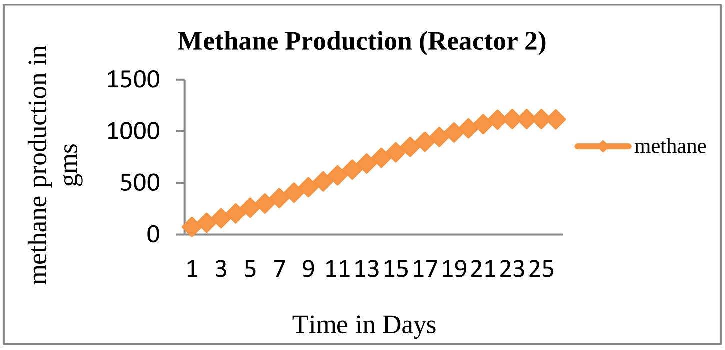

Fig.1: Methane production in Reactor 1

Above figure shows the graph of Number of days v/s methane gas production in both reactor 1 & 2. The generation of biogas will increase day by day, Microorganisms will break down the organic matter, they can utilize it as a food source under anaerobic condition and produce the methane gas. After 21 days, the generation of methane gas will shows consistence results in both reactor 1 and reactor 2. The maximum average methane gas generation in reactor 1 was about 890 grams/day and 1300 grams/day in reactor 2. pH was goes on changing from 7.3 to 6.6 , it will shows decreasing the pH from day 1 to day 26, this is because of microorganisms will utilize the organic matter.

CONCLUSION

1. The maximum average methane gas generation in reactor 1 was about 890 grams/day and in reactor 2 was 1300 grams/day.
2. Amount of biogas obtained from reactor 1 is 8.86 or 9 kg/house/month and Amount of biogas obtained from reactor 2 is 12.97 or 13kg/house/month, But we know that amount of LPG present per cylinder is 14.2 kg
3. By Designing reactor 2, we provide about 90% of biogas to kolugallu village.
4. By comparing the reactor 1 and reactor 2, reactor 2 gives more yield. Hence reactor 2 is suitable design for Kolagallu village.

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REFERENCES:

[1] Prof.Krishna Parmanik, Suyog Vij, "Biogas Production from Kitchen Waste", National Institute of Technology, Rourkela. 2010-2011.
[2] Srinvasa Reddy.N.et al, "Bio Gas Generation from Biodegradable Kitchen Waste", International Journal of Environment, Agriculture and Biotechnology (IJEAB), Vol-2(2) ,pp 689-694, 2017.
[3] Prof G M Hiremath, Sunil.Umachagi, "Impact of Electrode Configurations on Hydraulic Retention Time (HRT) in Treatment of Sugar mill Wastewater using Microbial Fuel Cell". IJIRSET, Vol 6(7),pp 13539-1354, 2017.
[4] Robin Karlsson, "Anaerobic digestion of biological sludge from the pulp and paper industry", Department of Thematic Studies, Water and Environment Linköping University, pp 1-70, 2009.
[5] Preliminary survey data from Kolugallu village.
[6] www.indiawaterportal.org.