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Production of Biogas from Different Ratios of Rice Husk and Kitchen Waste

Orhevba, B.A *, Onojitayoma, E. E **

Abstract— Production of biogas produced from different ratio of rice husk and kitchen waste was conducted under anaerobic conditions. The experiment included loading three different mix ratios of 3:1, 1:3 and 1:1 of rice husks and kitchen waste respectively diluted with the same amount of water before being mixed in varied proportions. 75g of rice husks and 25g of kitchen waste was mixed with water and loaded into digester A. 25g of rice husks and 75g of kitchen waste was mixed with water and loaded into digester B. Finally, 50g of rice husks and 50g of kitchen waste was mixed with water and loaded into digester C. Each treatment was performed once. Biogas production was measured for a period of 14 days and the volume of gas produced was determined by water displacement method at different temperatures. Biogas production started on the 2nd day, and reached apex on the 9th day for digester A. For digester B, biogas production started on the 1st day and attained maximum on 9th day. Production reached its peak on the 9th day for digester C. The total gas production for digesters A, B and C were 19.30ml, 28.42ml, and 24.94ml respectively at different temperature. The study shows that the largest volume of biogas production was obtained using the 1:3 mix ratio of rice husks and kitchen waste, while also the 1:1 mix ratio of rice husks and kitchen waste as compared to 1:3 mix ratio respectively has more yield. Therefore, kitchen waste is effective for the production of biogas than rice husks. Finally, for a developing country like Nigeria, where wastes are not productively used, wastes generated from animals and plant wastes can be effectively managed through conversion into biogas. Wastes are therefore turned to wealth which increases the income generation of the society.

Index Terms— Anaerobic condition, Biogas, Digester, Kitchen waste, Ratio, Rice Husk, Temperatureas.

1 Introduction

Biomass, especially agricultural residues is gaining popularity as one of the promising energy resources for developing and developed countries[1]. Rural and urban dwellers depend mainly on kerosene, petrol, diesel, and fuel woods as their main sources of energy for a long time[2]. Global warming has become an international concern. Global warming is usually caused by green house gasses which carbon dioxide is among the major contributors. It was shown that increased emissions of CO_2 have been drastically reduced owing to the fact that the rate of deforestation is higher than the aforestation effort in the country.

Agro waste is the most promising energy resource for developed and also developing countries like ours. The decreasing availability of crude oil and fuel woods has necessitated that efforts be made towards efficient utilization of agricultural wastes. These wastes have acquired considerably importance as fuels for many purposes, for instance, domestic cooking and industrial heating. Some of these agricultural wastes for example, rice husk, kitchen waste, animal's droppings, cow dung and wood wastes can be utilized directly as fuels.

Biogas is referred to as a gas produce by the biological breakdown of organic matter in the absence of oxygen which is called anaerobic digestion. From biogenic wastes Biogas production has been an alternative source of fuel in most developing and developed countries of the world[3]. Biogas is the mixture of colorless, flammable gases which is obtained by the anaerobic digestion of organic waste materials and it is mainly composed of Methane (CH_4) 50 → 70 %, Carbon dioxide (CO_2) 25 → 50%, Nitrogen (N_2) 0 → 10 %, Hydrogen sulfide (H_2S) 0 → 3%, Hydrogen (H_2) 0 → 1% and Oxygen (O_2) 0 → 2 %.

Biogas can also be called swamp, marsh and landfill or digester gas. The anaerobic digesters are usually called "biogas plant".

The importance of biogas is increasing rapidly today for a number of reasons; Fuel costs have been increasing for some number of years and the tax burden is also increasing as well, leading to a double load for the consumer to bear. Several attempts are now being made to improve the use of renewable energy sources, the gas produced mainly; methane is one of the major causes of the green house effect. The production is possible in small scale sites, obviating the need to supply energy outlying area.

Gas must be very clean and well composed to be accepted in the local distribution network. In this way, carbon dioxide, water, hydrogen sulphide and other particulates must be removed.

Methane is a very powerful greenhouse gas; its global warming potential is 23 times higher than that of $C0_2$. In this way, recovering of biogas is very interesting to limit the greenhouse effect.

Furthermore, biogas is a renewable energy form because biomass naturally releases biogas by decomposing. By using biogas as an energy source, we can reduce our dependency on fossil resources as coal, oil and natural gas.

One great advantage of biogas over fossil fuels is the fact that it does not harm the environment in any way. Contrary to fossil fuel extraction, production of biogas does not require any dramatic intervention into nature and does not pose any significant risk of pollution.

Biogas technology has also been used recently as a means of waste management and environmental pollution control. Agricultural livestock and agro-industrial wastes abound in the rural and sub-urban areas and contribute to the present problems of environmental pollution.

Many findings have been reported on the enhancement of gas production through processes such as co-digestion or blend-

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ing of organic wastes using rice husk, pig dung, poultry droppings and kitchen waste[4].

The production and utilization of biogas is now being seen as the best answer to energy needs of the rural communities which can be suited to meet the various family needs.

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2 Materials and Methods

The materials used for the experiment are rice husks, Kitchen wastes which comprises of chicken droppings, cabbages and cucumber. These were gotten from Gidan kwano village and Bosso market, Minna, Niger State, Nigeria.

Fairly dried Rice husks were collected from a rice mill at Gidan Kwanu village and kitchen waste was gotten from Bosso Market, and fowl droppings which acted as the substrate was gotten from Daji poultry, Tudun Fulani. A weighing balance was used to determine the weight of an empty plastic container (digester) and the weights of the rice husks, kitchen wastes and plastic bowl. 100g of rice husks and kitchen waste were put in digester A, B and C with 200g of water each to make slurry. The digester were then sealed with hose connected from the digester to the measuring cylinder, the experiment was then monitored and readings were taken from the three setup daily using water displacement method. The experiment lasted for 14days and the total amount of biogas produced was determined at the end of the experiment.

Experimental Setup

The experiment included loading varied mixture ratios of rice husks and kitchen wastes respectively diluted with the same amount of water. 75g of rice husk and 25g of kitchen waste was mixed with water and loaded into digester A. 50g of rice husk and 50g of kitchen waste was mixed with water and loaded into digester B. Finally, 25g of rice husk and 75g of kitchen waste was mixed with water and loaded into digester C. Three digesters of the same design and size were used in the study.

Preparation of Slurry

- The slurry of samples was prepared by mixing 100g of rice husks and kitchen waste with water in a ratio of 200g before being mixed in varying proportions indicated in Tables 3.2
- The mixed slurry was transferred into a two and half liter plastic container which was used as the digester
- An opening was made on the top of the digester using a cork
- A hose was inserted into the opening and sealed using a silicon seal and glue to prevent air from escaping to the environment
- The mixture was then stirred by shaking the mixture vigourously

The Flow Chart of the Biogas Production is shown below.

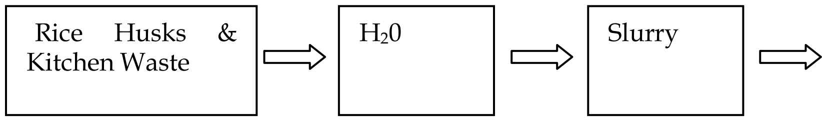

Plate 1.1 Biogas Setup

3 Results and Discussion

3.1 Results

The results of the daily biogas production at the different temperatures for different mixed ratios are shown in Tables 1 to 3.

Table 1: Biogas Production for Ratio 3:1 of rice husks and kitchen wastes

Days	Gas Produced(ml)	Temperature
1	-	31
2	0.12	29
3	0.26	28
4	1.02	29
5	1.26	29
6	2.15	31
7	2.24	30
8	3.10	30
9	4.08	33
10	1.27	29
11	2.03	29
12	1.05	30
13	0.48	28
14	0.24	29
Total gas produced =	19.30 ml	

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- *Dr. Orhevba B.A. is a senior Lecturer in the Department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna, Niger, state, Nigeria, PH- +2348061688880. E-mail:borhevba @yahoo.com*
- *Onojitayoma, E.E. jusgraduated from the Department of Agricultural and Bioresources Engineering, Federal University of Technology, Minna, Niger, state, Nigeria, E-mail: onojitee@yahoo.com*

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Table 2: Biogas Production for Ratio 1:3 of rice husks and kitchen wastes

Days	Gas Produced(ml)	Temperature
1	0.12	31
2	0.23	29
3	0.38	28
4	1.02	29
5	1.26	29
6	2.03	31
7	3.12	30
8	5.01	30
9	7.12	33
10	4.03	29
11	2.06	29
12	1.43	30
13	0.33	28
14	0.28	29
Total gas produced =	28.42 ml	

Table 3: Biogas Production for Ratio 1:1 of rice husks and kitchen wastes

Days	Gas Produced(ml)	Temperature
1	-	31
2	0.21	29
3	0.43	28
4	1.08	29
5	1.42	29
6	2.35	31
7	3.21	30
8	4.05	30
9	6.03	33
10	2.17	29
11	2.08	29
12	1.19	30
13	0.45	28
14	0.27	29
Total gas produced =	24.94 ml	

3. 2 Discussion of Results

It can be observed that digester B increased progressively from day one through to the 9th day and drops relatively on the 10th day. Optimum biogas production was attained in this case which is 7.12ml. Digester C rose progressively from 0.00ml from the start of the experiment to about 6.03ml and then decreases on the remaining days of the study. Optimum gas production could be said to be attained in the ninth day. Generally the study shows that, biogas production increased from the beginning of the study and as the days increases and reaches an optimum value in a given time and decreases after optimum gas production. From the gas production analysis, the total volume of biogas was maximum in digester B (Rh= 25%, Kw= 75%) produced 28.42ml, followed by digester C (Rh= 50%, Kw= 50%) which produced total biogas of 24.94ml and digester A (Rh= 75%, Kw=25%) producing least biogas of 19.30ml.

From the result obtained, kitchen wastes produced more gas as compared to rice husks, results obtained from the experiments are given in Tables 4.1 to 4.4 shows variation in Ph for the different experiment. The tables show that the volume of biogas generated from rice husks and kitchen wastes and the co-digestion of the rice husks with kitchen wastes fluctuating repeatedly.

Table 4.1 shows the volume of gas produced per day at ratio 3:1 of rice husks and kitchen wastes. It was observed that gas production did not start until the second day, which may be as result of the bacteria to adapt to the condition of the digester. The highest peak occurred on the 9th day at the temperature of 33^0C, and the total biogas produced at this temperature was 4.08ml. Table 4.2 shows the volume of gas produced per day at ratio 1:3 of rice husks and kitchen wastes. The production of biogas started on the first day of the experiment and the volume of gas produced at 33^0C was 7.12ml, producing a volume more than that of ratio 3:1and 1:1, the production of biogas from this treatment reached the peak on the 9th day.

However, it is seen that the digester B mixture produced the most significant highest volume of biogas and the production was in the order: B>C>A. Table 4.3 shows the volume of gas produced per day at ratio 1:1 of rice husks and kitchen wastes; it was observed that the highest peak occurred on the 9thday at the temperature of 33^0C in which the production of the gas started on the second day and the volume of gas produced at this temperature was 6.03ml.

4 CONCLUSION

Combining the pure samples of mixed rice husks and kitchen wastes generally increased biogas yield. The maximum biogas yield was attained with mixture in the proportion 1:3 (25g of rice husk and 75g of kitchen waste). At this proportion, there was an increase in biogas yield. Co-digestion of rice husks with kitchen wastes is therefore, one way of addressing the problem of lack of enough feedstock for biogas production.

The average gas production from 75%:25%, 25%:75% and 50%:50% of rice husks and kitchen wastes respectively were 19.30ml, 28.42ml and 24.94ml. A ratio of 25%:75% rice husks and kitchen wastes respectively, which described the composition of digester B in this experiment was found to yield the best result out of the three digesters and this, can be attributed to the presence of nitrogen and nutrients in kitchen wastes. Digester C which has the ratio of 50g of rice husks and50g of kitchen wastes respectively, was also seen to fare very well and can serve an alternative tool for production of biogas while digester A has the lowest volume. It can therefore be

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concluded that waste can be managed through conversion into biogas, turning waste into wealth which is a source of income generation for the society.

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