**Investigation and Estimation of Various Components of Bio-gas from Different Bio-wastes**

Nayan Jyoti Barooah  
M.Tech, ME  
Assam down town University  
nayanbarooah@gmail.com

Ridhiman Dutta  
Asst. Professor, ME  
Assam down town University  
ridhiman.dutta007@gmail.com

Manashj Borah  
Asst. Professor, ME  
Assam down town University  
manashppp@gmail.com

**ABSTRACT**

The world today is facing many problems like global climatic change and environmental degradation which are related with over-dependency on fossil fuels as energy sources. On the other hand, rise in natural gas and oil prices has increased the need of new investigations and researches towards alternative energy sources. Biogas is an alternative renewable energy source. It helps us lessen the dependence on fossil fuels. This study therefore is done to investigate the digestion of cow dung, pig wastes, chicken wastes, kitchen wastes and energy crops. Portable bio-digesters were constructed along with installed stirring mechanism which facilitates better agitation of the feedstock inside the bio digesters. This present study is based on anaerobic digestion using pig wastes(PW), cow dung (CD), chicken wastes(CW), kitchen wastes(KW), energy crops(EC) and fresh chicken rumen as source of methanogens together as substrate in five bio-digesters. The decomposition is carried out at temperature range of 25-32°C and pH range of 6.5-7.5 and is incubated for a period of 45 days. It has been found that the production of biogas was maximum in cow dung biogas (68%) as compared to that of the other bio-digesters.

**Keywords**  
Biogas, Portable bio-digesters, Cow dung, Pig wastes, Energy crops, Chicken wastes, Kitchen wastes, Methanogens, Anaerobic digestion, Methane concentration.

**1. INTRODUCTION**

Environmental pollution, degradation and climatic change can be concluded as a result of over-dependence on fossil fuels (as primary energy source). According to research and future predictions, the crude oil will run out within 40 to 70 years, and natural gas will be finished within 50 years. As the need of energy is increasing with each passing day hence biogas technology will be of good use as it is renewable as well as an alternative source to energy from fossil fuels. Biogas is an alternative renewable energy source. This technology if made better can be of various benefits. It will benefit us in various aspects from global climate change to environmental pollution. Biogas is colorless, odorless gas that like LPG which burns blue flame. Biogas is the gas obtained from the biological origin. Biogas typically consists mainly of methane, with a significant proportion of carbon dioxide, and smaller quantities of other gases such as nitrogen and hydrogen, which is mainly produced by the bacteria degrading waste materials. Anaerobic Decomposition is the breakdown of complex organic molecules into useful form of energy by microorganisms in absence of oxygen. Biogas production rate in batch condition is directly related to specific growth of methanogenic bacteria. The left over slurry after producing the biogas can be used as fertilizer which is rich in organic material.

**2. MATERIALS**

The materials that were used in the present study include plastic bio-digesters, inlet and exhaust pipes, mercury-in-glass thermometer, weighing balance, pH meter, mortar and pestle, bunsen burner, measuring cylinders, valves, beakers, funnel, polythene bag, chicken waste, energy crops(sugar cane & water hyacinth), cow dung, kitchen waste, pig waste, water, tyre tubes, NaOH, iron pellets, syringe, saline pipe, distilled water.

**3. METHODOLOGY**

There are several ways of producing biogas. One of these ways is the anaerobic digestion which is done in the absence of oxygen. The entire process includes many steps. The steps involved are shown in the flowchart below, figure 1 and explained in the next page.
3.1 Bio-digester design

The bio-digester vessels used here are five plastic containers of quantity 20 liters each. All the drums have diameter 26.3cm each and height 38.1cm. Four drills are made on each of the container with the help of drilling machine, chisel and hot rod. The drills are made for exhaust pipe, regulator, gas storage and water outlet. A stirring mechanism is also installed in the bio-digesters with 12 blades of length 11cm each with a stirrer handle of 20cm. This mechanism supports better mixing and it was used in the first 10 days after loading of the feedstocks at 50rpm. The 3-D design is shown in figure 2 and the final design is shown in figure 3 below.

3.2 Sample collection and feedstock preparation

Representative samples of chicken manure, pig manure, energy crop, kitchen waste and cow dung obtained from Narengi poultry farm, Veterinary College (Khanapara), Local market, House hold and Local cow shed respectively. The chicken manure, cow and pig dung collected was separately pretreated by sun drying and thereafter crushed mechanically using mortar and pestle to homogenised the dung and then weighed. The feeding of high particle size feedstock was avoided to reduce challenges with the agitation in the laboratory-scale digesters and with non-homogeneity of the digestive. In the course of the collection of the waste, necessary health precaution was taken by wearing hand gloves and nose cover. Slurry was prepared by adding and vigorously mixing dried cow dung, dried chicken excreta dried energy crop, kitchen waste and dried pig dung separately with an equivalent amount of water in the ratio 1:1 for maximum yield.

3.3 Inoculation and incubation

The prepared feedstock slurry is then inoculated in the bio-digester and the inlet was immediately blocked to ensure anaerobic condition in the bio-digester. The agitation process was performed with the installed stirring mechanism. The initial temperature is recorded and is around 25-32°C and pH reading is found to be neutral, around 6.5-7.5. Digestion is allowed for a period of 45days under mesophilic condition. This is shown in figure 4.
3.4 Flame test
For qualitative analysis of biogas, flame test was carried out using the gas produced from the bio-digester. The pipe connecting the bio-digester and the tyre tube was cut off and connected to a Bunsen burner and lighted. The flame test is shown in figure 6.

3.5 Test for reduction and estimation of \( \text{H}_2\text{S} \) and \( \text{CO}_2 \)

Reduction of \( \text{H}_2\text{S} \) by iron pellets
10 ml of sample was taken in a syringe. After that 250 ml of distilled water was taken in a measuring cylinder as well as in a bowl. The measuring cylinder was inversely placed over the bowl and the height of the water column inside the cylinder was recorded. The setup was done in such a way that there was no interference of other gasses. One end of a narrow pipe (saline pipe) was connected to the syringe, with a piece of a small hollow rubber tube as a mediator, and the other end to the bottom of the inverted measuring cylinder. In that rubber tube, iron pellets were added and after that the sample was injected from the syringe to the inverted measuring cylinder via the rubber tube mediator. After that the final height inside the water column was recorded.

Reduction of \( \text{CO}_2 \) by NaOH solution
10 ml of sample was taken in the syringe. After that 10gm of NaOH was added to 250 ml of distilled water and was taken in a measuring cylinder as well as in a bowl. The measuring cylinder was inversely placed over the bowl and the height of the water column inside the cylinder was recorded. The setup was done in such a way that there is no interference of other gasses. One end of a narrow pipe (saline pipe) was connected to the syringe, with a piece of a small hollow rubber tube as a mediator, and the other end to the bottom of the inverted measuring cylinder. Then the sample was injected from the syringe to the inverted measuring cylinder via the rubber tube mediator. After that the final height inside the water column as recorded.

4. RESULTS AND DISCUSSION

4.1 Change in pH
\( \text{pH} \) during the first week after inoculation of the slurry sample was found to be different in all the bio-digesters. The \( \text{pH} \) of the slurry was found to be neutral, around 7-7.5, and the temperature recorded in the process was around 25-32 °C from the date of incubation. Figure 5 shows the \( \text{pH} \) changes in the bio-digesters.

4.2 Flame test
It serves as a qualitative test for the detection of biogas (methane). For all the bio-digesters, it took about 45 days for the production of biogas. The test was carried out in a dark room and the gas was found to be flammable with a bright flame, which marks the presence of methane. It is shown in the figure below.

Figure 5: Chart showing \( \text{pH} \) change in the bio-digester.

The graph is showing \( \text{pH} \) value for the first 7 days of incubation. The value of \( \text{pH} \) for chicken waste, kitchen waste and energy crops (water hyacinth and sugarcane) is found to be 7 and the \( \text{pH} \) for cow dung and pig waste is found to be 7.5 after an incubation period of 7 days.

Figure 6: Flame test for the bio-digester. The gas was found to be flammable with a bright flame, which marks the presence of methane.
4.3 Concentrations of H$_2$S, CO$_2$ and CH$_4$ in the bio-digesters

The concentration of H$_2$S was found to be more (5%) in the bio-digesters with cow dung and energy crops as the feed stock, while CO$_2$ concentration was seen to be more in the bio-digester with kitchen waste as the feed stock.

In the study carried out by Otun T.F, Ojo O.M, Ajabde F.O. and Babatola, I.O on biogas production from the digestion and codigestion of animal waste, food waste and fruit waste, in the year 2015, the concentration of methane found was 79.8%, 77.4% and 76.4% for cow dung, food waste and fruit waste respectively.

Another study carried out by M. R. Sebola*, H. B. Tesfagjorgis and E. Muzenda on Methane Production from Anaerobic Co-digestion of Cow Dung, Chicken Manure, Pig Manure and Sewage Waste, in the year 2015, biogas production from anaerobic co-digestion of cow dung, chicken manure, pig manure, sewage waste was evaluated in laboratory batch scale at ratios 1:1:1:1, 2:1:1:1 and 3:1:1:1. Highest methane yields were achieved from cow dung to Chicken manure, pig manure and sewage waste at ratio of 1:1:1 (58% CH$_4$). Optimum temperature for anaerobic co-digestion was found to be 40 °C with the highest methane yield of 62% CH$_4$.

In the present study among all the five bio-digesters, the concentration of methane was found to be maximum (68%) in cow dung bio-digester followed by chicken waste bio-digester (67%). The chart below shows the differences in composition of the biogas from various wastes.

Figure 7: Above figure is of the reduction test, performed to find out the concentration of H$_2$S, CO$_2$ and CH$_4$.

Figure 8: Above chart shows concentrations of H$_2$S, CO$_2$ and CH$_4$. The concentration of CH$_4$(68%) was found to be maximum in the bio-digester with cow dung as the major feedstock followed by chicken waste bio-digester (67%). The concentration of CH$_4$ in the pig waste bio-digester, energy crop bio-digester and kitchen waste bio-digester was found to be 65%, 62% and 61% respectively. The concentration of H$_2$S was found to be more (5%) in the bio-digesters with cow dung and energy crops as the feed stock, while CO$_2$ concentration was seen to be more in the bio-digester with kitchen waste as the feed stock.

5. CONCLUSION

Biogas technology has significant potential to mitigate several problems related to ecological imbalance, minimizing crucial fuel demand, improving hygiene and health, and thus resulting in an overall improvement in the quality of life in rural and semi-urban areas. Biogas is a clean environment friendly fuel and it helps in achieving sustainable development. Biogas obtained by anaerobic digestion is a type of...
bacterial degradation of organic matter that occurs in the absence of oxygen and produces primarily, methane and carbon dioxide. Portable bio-digesters were constructed along with an installed stirring mechanism which facilitates well agitation of the feedstock inside the bio-digesters and was used after every loading of feed stocks. In this study anaerobic co-digestion of different bio-wastes like cow dung, pig waste, chicken waste, kitchen waste and energy crops was carried in five different bio-digesters. It was evaluated that the methane concentration was high in case of cow dung bio-digester. The concentration of methane so produced was found to be approximately 68% from CD, 67% from CW, 65% from PW, 62% from EC and 61% from KW bio-digester. Along with methane estimation the amount of H₂S and CO₂ present in the gas was also carried out. The amount of H₂S produced in the bio-digesters was 3-5% whereas the amount of CO₂ so produced was found to be 27-35 %.

6. REFERENCES


