Evaluation of the quantity of biogas produced from the cow box in an experimental digester

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ABSTRACT

The present experimental research was carried out at the Energy Department of the Scientific and Oceanographic Research Center of Rogbané in Conakry, from 15/10 to 03/11/2018. It focused on evaluating the amount of biogas produced from cow dung in a 4.5 liters plastic fermenter, placed in an environment of 33°C average temperature. The amount of cow dung used is 2 kg, diluted with 2.5 liters of water. During twenty (20) days of digestion the average temperature in the digester was 36.75°C, the average pH (7.20) and the average daily and cumulative productions are respectively (2 liters/day and 42 liters). Extending digestion time to full substrate depletion would increase the amount of biogas. This research generally shows the evolution of certain anaerobic digestion parameters and in particular the biogas potential of cow dung.

Keywords: *Evaluation, Biogas, Digester, Cow Dung, Anaerobic Digestion.*

1. Introduction

Methanation is the process of anaerobic digestion of the organic fraction of carbon-rich substrates. It produces biogas rich in methane. This deterioration of the material is usually carried out in a digester, which aims to control the methanation and store the biogas temporarily before being valorized in different forms of energy [1]. Biogas with a methane content between 40 and 75% is one of the renewable forms of energy that has been in use for decades and is used as a substitute for fossil fuels [2, 3]. Methane is the main component of biogas with a heating value in the range of 21 to 24 MJ / m3 (6 kWh / m3) [4]. The temperature of the combustion flame of the biogas is a function of its methane content, it is between 800 ° C and 1100 ° C [5].

The production of biogas from organic matter of various origins: vegetable matter, animal droppings, by-products of the food industry, sludge from purification plants, household waste, etc. by the anaerobic fermentation process in appropriate digesters (anaerobic digestion), allows better waste management, preservation of the environment and diversification of energy resources (alternative energies) [6]. In addition, this anaerobic fermentation allows the local level to produce energy at lower cost for cooking, heating, lighting and fertilizers with high potential [7].

The objective pursued in this research is to make an experimental evaluation of the amount of biogas produced by the cow dung of the Coléah abattoir in Conakry. Achieving this goal will make it possible to evaluate the total amount of biogas produced in slaughterhouses in the capital Conakry.

2. Materials and method

2.1 Materials and sampling

The experiment was carried out at the Energy Department of the Scientific and Oceanographic Research Center of Rogbané in Conakry, from 15/10 to 03/11/2018. During this experiment, we used the following materials: an analytical balance, two (2) graduated containers in centiliter, three (3) empty bottles of mayonnaise, valves, hoses, collars, liquid glue, teflon, pH indicator strips, a temperature sensor and a thermometer.

The cow dung sample (substrate) was collected at the Coléah abattoir in Matam Commune in Conakry. Conakry is a port city opened by a broad ledge on the Atlantic Ocean and which today has more than 2 million inhabitants. This makes it one of the most important African cities with an area of 308 km^2, a length of 34 km and a width of 1 to 6 km. Its climate is of sub-Guinean tropical type, characterized by the alternation of two (2) seasons, dry from October

to May and wet or rainy from June to September. The temperature varies between 25°C and 40°C [8]. The commune of Matam is one of five (5) communes of the city of Conakry, it extends over 8 km2, it is limited to the North by the commune of Dixinn, to the South by the Atlantic Ocean, to the West by the municipality of Kaloum, in the East by the municipality of Matoto (figure 1) [9].

Figure 1: Cow dung sampling site (substrate)

2.2 Methods

The three (3) plastic bottles of 4.5 liters volume each are interconnected by the hoses. The sealing was ensured by the collars, the liquid glue and the Teflon. The device is shown in figure 2. These three (3) bottles are used respectively as follows:

- The first is the fermenter or digester, it contains a mixture of the substrate (mixture of 2 kg dung with 2.5 liters of water);
- The second filled with water is the gasometer. The water contained in this bottle is emptied under the pressure of the biogas produced from the first (digester);
- The third recovers water from the second (gasometer), it is graduated in centiliter and liter using a graph paper to quantify the biogas produced.

During the digestion period: pH monitoring in the digester was performed using pH-indicator strips, the temperature in the digester and in the environment was followed by a temperature sensor and a temperature sensor. thermometer, the daily and cumulative biogas productions were determined by the water level in the third bottle. This bottle is emptied regularly once full (4.5 liters), while filling the second (gasometer) with water.

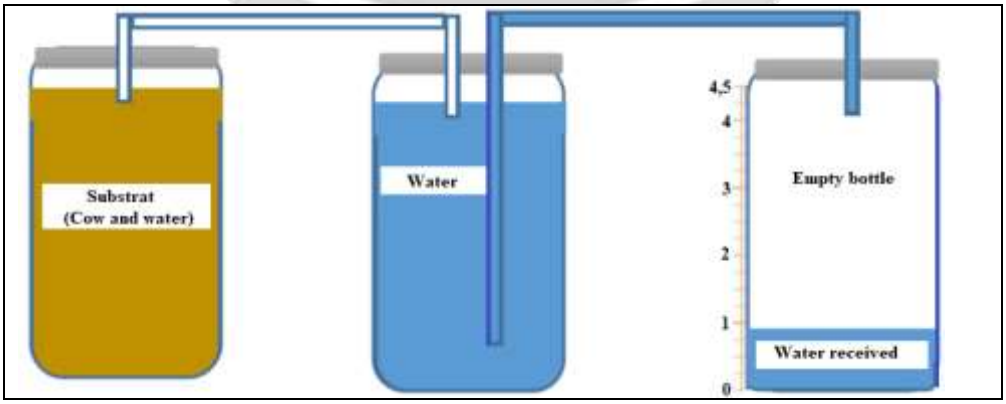

Figure 2: Experimental device

3. Results and discussions

The curves of figures 3, 4 and 5 showing the temperature variations in the ambient environment and in the digester, the pH, the daily and cumulative productions of biogas, allow a good presentation and discussions of the results obtained.

3.1 Temperatures in the environment and in the digester

The temperature variation curves in the environment and in the digester during the digestion time are given in fig 3.

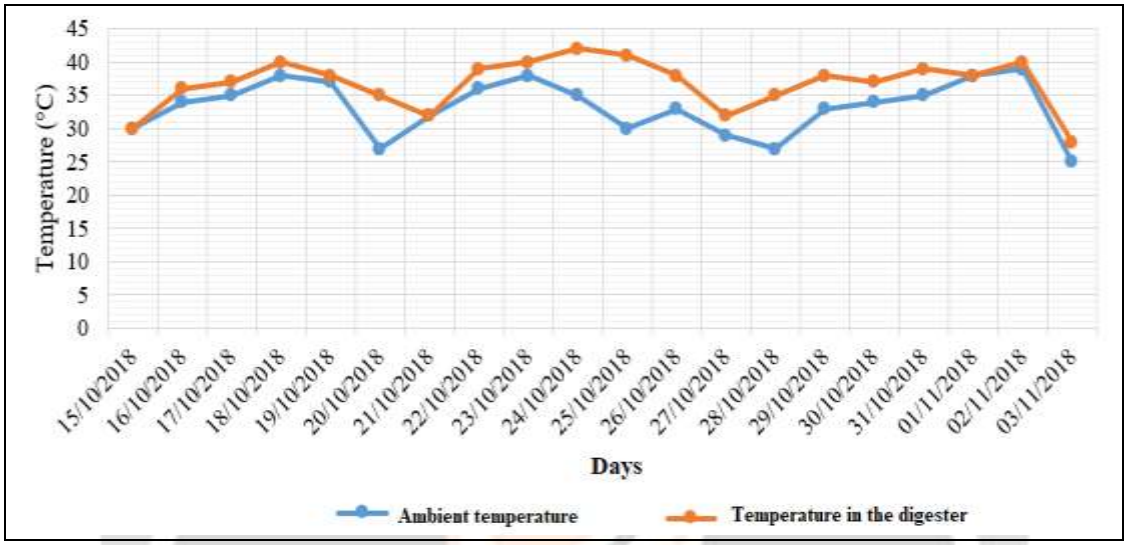

Figure 3: Variation of the temperature in the environment and in the digester

Figure 3 shows that the temperature curve in the digester is above that of the ambient, but these two temperature curves are similar and they have the same paces. The temperature in the digester ranged from 28 to 42°C, with an average of 36.75°C (mesophilic mode of digestion) [10], that of the environment ranged from 25°C to 39°C, with average 33.25 ° C.

3.2 pH change during digestion

The pH variation curve in the fermenter during production is given in figure 4.

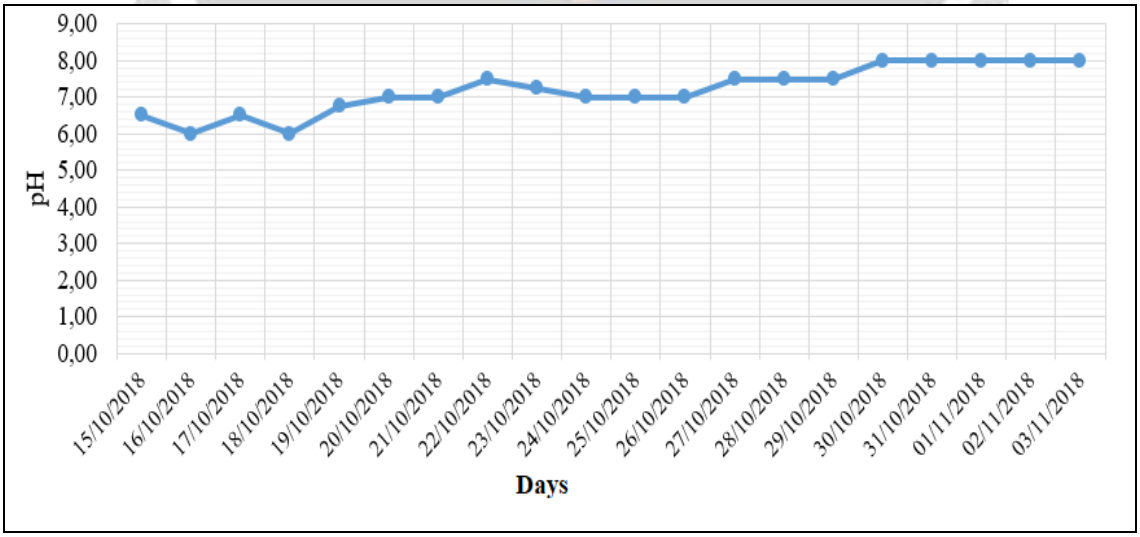

Figure 4: pH variation

Figure 4 shows that the pH varies from 6 to 8, with an average of 7.20. The pH values recorded are very favorable for the development of microorganisms in the context of the biogas. Three phases (acidification, alkanization and stabilization) are observed during the methanisation period [3].

3.3 Daily production of biogas

The kinetics of daily production is shown in figure 5.

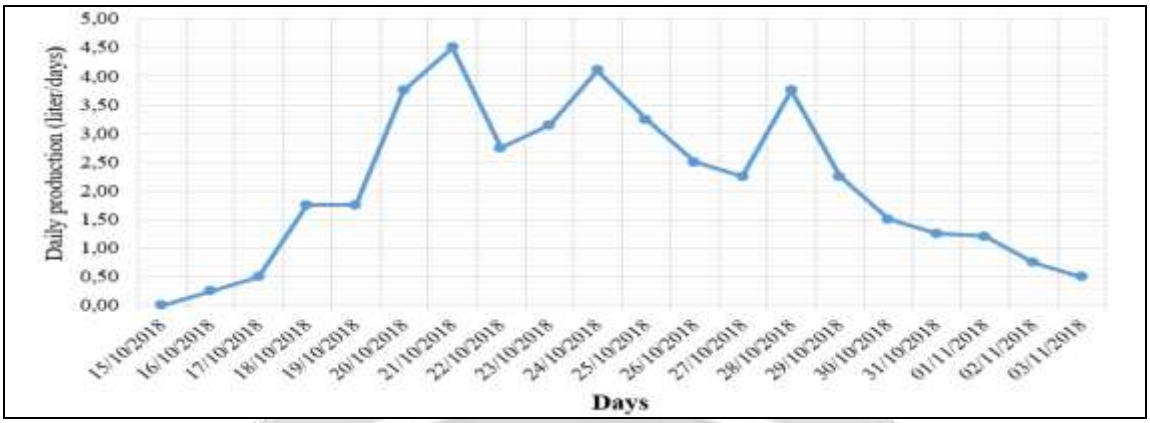

Figure 5: Daily production

Figure 5 shows that the production of biogas was recorded on the 2nd day of the fermentor load for a value of 0.25 liters. Between the 2nd and 7th day, there was a rapid increase in biogas production, for a maximum value of 4.50 liters, recorded on the 7th day (21/10/2018). Production fell the next day (day 8) to 2.75 liters. From the 8th to the 10th day, the production increased (4.10 liters), from the 10^{th} to the 13^{th} day, it decreased by 2.25 liters and between the 13th and the 14th day, there was an increase (3.75 liters) registered on 28/10/2018. In the end, from the 14th the production has gradually decreased until the 20th day, for a value of 0.5 liter, this results in the depletion of the substrate which causes a decrease in the population of microorganisms. This methanation process is consistent with other results [3, 5].

3.4 Cumulative production of biogas

The cumulative production kinetics of biogas is shown in figure 6.

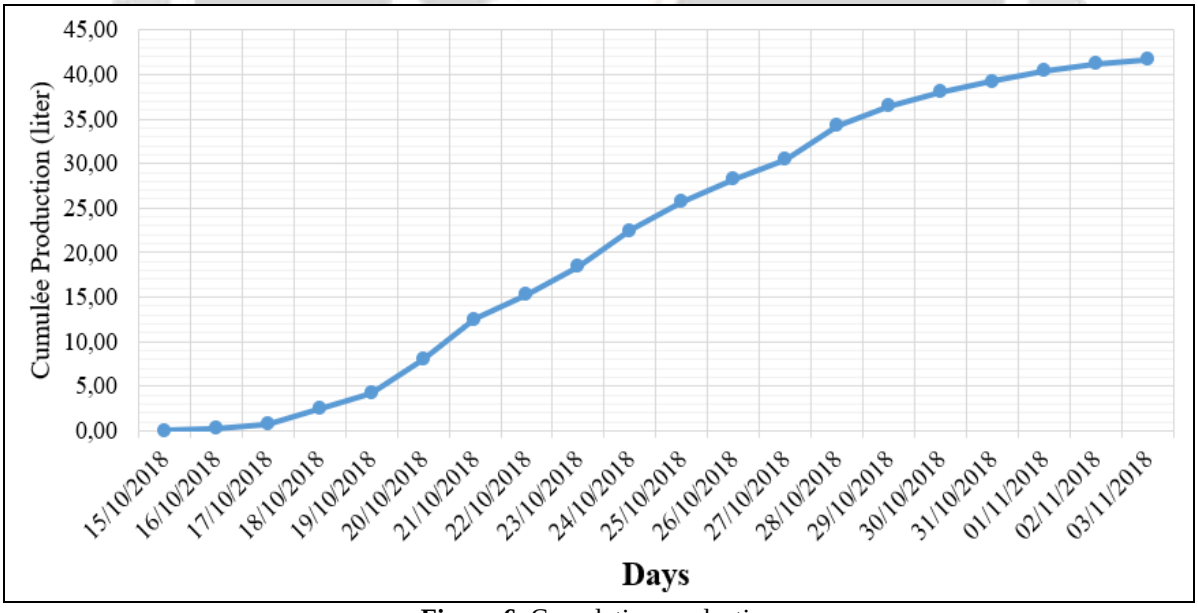

Figure 6: Cumulative production

The cumulative production curve of biogas (Figure 6), shows a low production during the first five (5) days of digestion. Then from the 6th to the 16th day, there is a rapid increase in production. In the end, from the 16th to the 20th day, there is a very small increase in production. This cumulative production kinetics has three (3) phases (latency, exponential and plateau), which correspond to the steps mentioned (2nd to 6th day, 6th to 16th day and 16th to 20th day). These results are consistent with those of other authors [11].

4. Conclusion

This research focused on assessing the amount of biogas produced from cow dung in an experimental digester. The following anaerobic digestion parameters (temperature, pH, kinetics of daily and cumulative production of biogas) were monitored during the twenty (20) days of digestion of 2 kg of cow dung, in an environment of average temperature of 33°C (mesophilic digestion mode). The average temperature in the experimental digester is 36.75°C, the average pH is 7.20 (basic medium), the average daily production is 2 liters and the cumulative production is 42 liters.

This research shows in general the importance of the biogas potential of animal dung, especially that of cow dung. Thus, the valorization of this biogas potential of Guinea's animal dung would make it possible to locally improve the energy problems and soil fertilization (heat, lighting, fertilizer, etc.) of the country's breeding sites.

5. References

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