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Management and Control of Variables for the Generation of Biogas from Pig Zungo

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Abstract

This research focuses on determining the potential of biogas generation for combustion from the Zungo pig manure (manure mixture of the three sizes of the pig in a proportion of 33.33% for each size) located in the department of the Atlantic-Colombia. The properties of the biogas obtained were evaluated with a gas analyzer and a chromatograph, demonstrating that, under controlled temperature conditions, after the bio digestion of Zungo pig manure there is a methane content greater than 50%, which is acceptable demonstrating that this biogas is flammable. It was also established that there is a correlation between pH and methane content in biogas, so it is required to control it in the process.

Keywords: Biogas, Biomass, Manure, Pig, Combustion

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1. Introduction

The business world is driven by the demand for products and services that customers require. However, the patterns of demand considerably vary from one period to another [1] Currently, emphasis has been placed on the use of renewable energy and the use of biomass for the reduction of global warming due to the non-use of fossil energy [2]; [3]; [4]; [5]; [6]; [7]. However, the use of renewable energy focuses on hydraulic energy and solar energy [3]; [8]. Another alternative lies in the use of biomass as an energy element [8].

Research using this process for the generation of biogas from pig manure shows a good yield of methane production, (CH4) [9]; [10]. Of the known processes to mitigate the environmental effects of pig manure and produce both energy, anaerobic digestion stands out [11].

In specialized literature, Biogas is considered the future substitute for natural gas of fossil origin [11]; [3]. In Europe, a real potential for generating biogas of 30 billion m3 (22.7 billion m3 CH4) from manure from farm animals has been identified [12]. Of this potential, 13% is generated from pig manure [12].

In Colombia, pig manure is rarely used for energy purposes, however, it is the second biomass with the greatest energy potential, with approximately 2114 TJ / year [2]; [13]. In particular, the department of Atlántico occupies the 11th position in pig manure production nationwide [2]. In this, a special type of pig predominates, known as zungo-Creole pig [14]; [2]. Usually, this manure is used for fertilization or its final disposition is made according to the special requirements established by the state [15] .However, it is not used in the generation of biogas for energy purposes because, the department does not know its characteristics and composition in methane [2]. Therefore, this study focuses on determining the composition of CH4 of the biogas generated by the manure of the zungo pig in the Atlantic department at controlled atmospheric conditions and whether it is capable of developing an acceptable burning time according to the amount of biogas.

2. Materials and Methods

The materials and methods are shown below:

2.1.- Materials

The raw material is shown below.

2.1.1.- Raw Material

The raw material for this research is limited to the dung of the zungo pig in its different stages of growth: piglet, middle-aged pig, and adult pig in the municipalities of the department of Atlántico in Colombia.

The zungo pig is a mammalian-omnivorous animal with black skin, sparse hair, black drop, and straight snout [16]; [14]. Its weight ranges between 70 kg and 90 kg [14]. In Colombia, this type of pig is found in the department of Atlántico [14]; [17]. There are three types of zungo pig [14]; [18]; [17]:

- The Chonco: it is a small, round body animal with short legs with high fat content.
- Medium: Its body tends to have a rectangular shape, has long legs and phalanges.
- Chuzo: It is medium in size, its body tends to have a rectangular shape, long thin legs and has a long, straight knife-shaped snout.

2.1.2.- Equipment and supplies used

For the development of the experiment, an upper dome bio digester was used (Fig. 1), with a volumetric capacity of 35 L, water and calcium oxide (CaO), the measuring instruments used were: a pH meter EcoSence 100 A, a sensor temperature, a level sensor and a gas analyzer for the percentage composition of biogas.

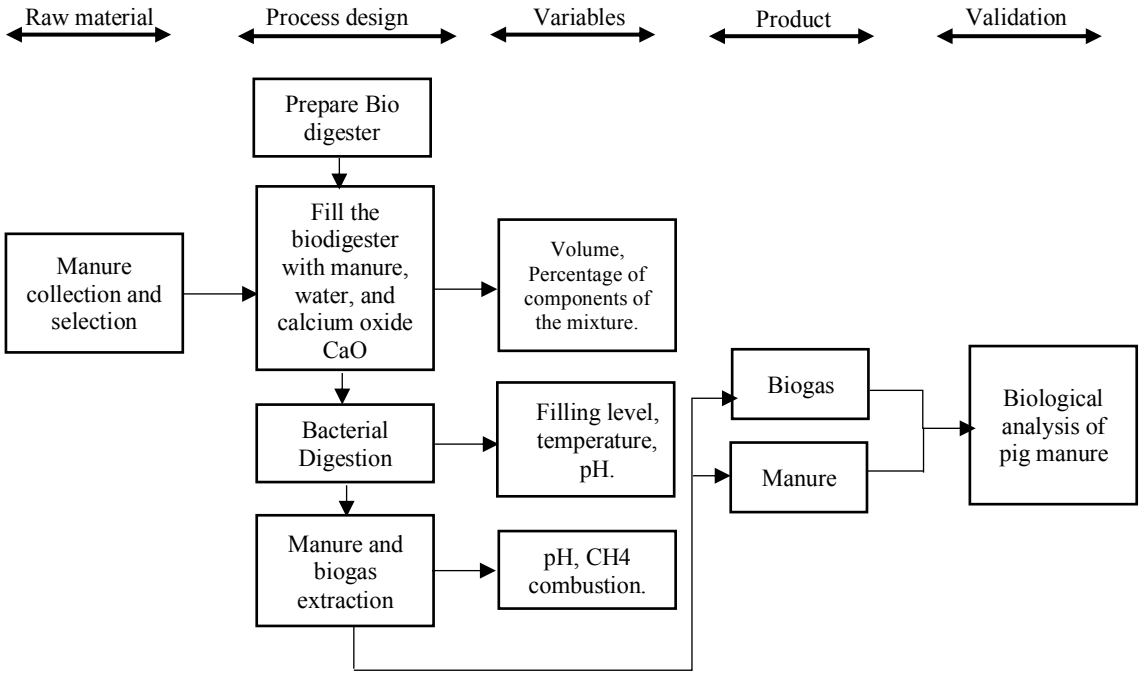

Fig 1. Experimental layout of biogas development

2.2. Methods

A mixture of pig manure (75%), CaO (5%), and water (5%) was prepared to fill 85% of the volume of the digester. The composition of manure was given at a rate of 33.3% for each size of the pig (piglet, medium, choncho).

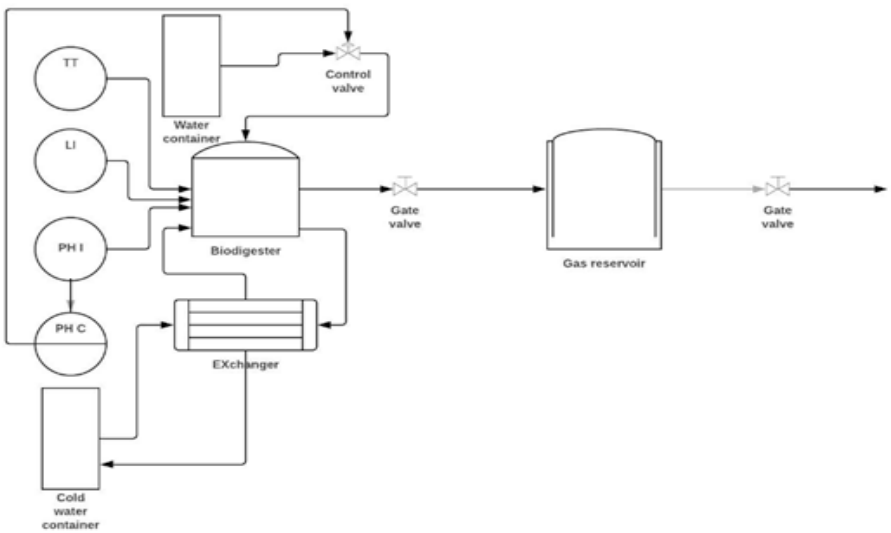

Fig 2. Diagram of the digester and other components

The bio digester reservoir changes its volume depending on the pressure of the biogas because its material is elastic. The temperature of the bio digester was maintained at 34 ° C, the state of the water with the manure was controlled

so that the pH was neutral with a relative humidity of 30%. The process used for the generation of biogas was anaerobic digestion. The components necessary for anaerobic digestion are included in the bio digester, therefore, they are not shown in Fig. 2.

For the identification of the microorganisms generated from pig manure, the sample was sent to a specialized laboratory. The retention period and / or generation of biogas was 15 days. The number of samples was 15 for every 24 hours after retention time (15 days). After 15 days, the generated biogas was burned, and the combustion verified for the retention period. The Table 1 shows the characteristics of the pig studied in the Department of the Atlantic for the experiment.

Table 1. Characteristics of the pig studied in the Department of the Atlantic for the experiment.

Type of pig	Amount of pigs that generated manure	Average live weight (kg)
Zungo-Criollo (Chonco, Mediano y Chuzo)	30	80

3. Results and Discussions

The Table 2 show the results of the samples that were made to the manure deposited in the Bio digester after the retention time or season. The existence of psychrophilic and mesophilic microorganisms is highlighted due to the previous tests of the specialized laboratory.

Table 2. Result of the samples with the pH meter, physical characteristics of the manure, type of bacteria and weight of the manure used

Average pH	Present microorganisms	Dimensions of microorganisms	Manure color	Weight of the amount of manure used (kg)
7,47	Cocos -Methanosarcina barkeri, micrococcus, mesofilos	2-3 µm the package	Light brown	27,49

The Fig. 3 and table 3 show the percentage composition of biogas (%) obtained from the gas chromatography study and the gas analyzer. In it, it is concluded that the percentage of methane is above 50% which indicates that in said retention time and the type of biogas can be burned and used energy thanks to its potential in the combustion process. However, these results were only obtained under carefully controlled atmospheric conditions. Fig. 5, shows that the value of the pH in the digester affects the composition of the biogas that is produced. Because methanogens are considered the limiting stage of the process, it is necessary to keep the pH of the system close to neutrality.

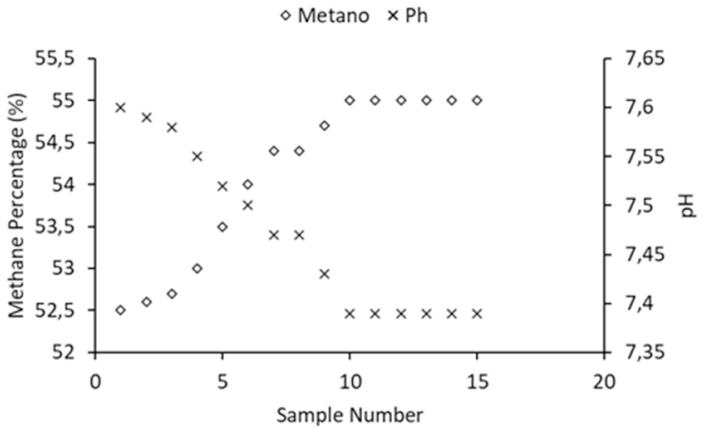

Fig 3. Composition of biogas (% methane) and pH according to the samples

The pH value is controlled because the generation of CH4 can be affected. A pH less than 6 and greater than 8 produces a biogas with poor CH4 content. The Table 3 shows the average composition of the samples taken. This indicates a good quality of biogas, however, a high amount of pigs for manure generation stands out.

Table 3. Average biogas composition.

Average composition of the samples	Percentage (%)
Methane	54,1
Carbon dioxide	40
Sulfhydryl Acid	2,5
Hydrogen	2,5

4. Acknowledgment

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5. Conclusions

With this study the potential of biogas production from the manure of the Zungo pig in the sizes was evaluated; piglet, medium and Chongo in the municipalities of the department of Atlántico in Colombia. The results obtained allowed verifying that there is potential to produce biogas, finding that, under controlled conditions, the average composition of methane in the samples taken was approximately 54%.

It was found that there is a correlation between CH4 and the biogas pH, with the appropriate ranges of the latter variable being between 6 and 8, which indicates the need to control this variable in the bio digester.

The combustion time and the size of the flame were acceptable considering the amount of manure and the diameter of the outlet pipe of the reservoir. The average sulfide acid content of the samples was 2,5%, likewise, the bacteria with greater predominance in this type of manure were coconuts-Methanosarcina barkeri, Micrococcus and mesophiles.

For the development of future research, an analysis of the variation of the atmospheric conditions in non-stationary and biogas burning conditions, the quantification of the calorific value of the biogas and a more detailed analysis of the other components thereof are proposed, due to These can affect your energy efficiency such as high CO2 content.

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