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From Agricultural Waste Moisture Control in Biogas Production through the Fermentation Process

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Abstract:

Various biomasses as raw materials used on the basis of biogas production technology, conducting research aimed at building high-efficiency measuring devices, controlling their moisture content, and analyzing the selection of the primary variable in the optimal control of the process.

Keywords: anaerobic, fermentation, biogas, biomass, measurement, control, measuring instrument, humidity, metrological classification.

INTRODUCTION and LITERATURE ANALYSIS

The agricultural sector produces a lot of waste from agricultural products, unfortunately, in most cases, it is observed that it remains in the field or is fed to livestock. One of the most promising technologies in most developed countries is the organic use of agricultural products, waste (cattle and pig manure, poultry manure) is processed anaerobically to obtain biogas and mineral fertilizers. [1, 2].

Anaerobic process mainly occurs in the absence of atmospheric air. In this process, a gaseous mixture of methane and carbon dioxide is produced from wet raw materials from dissolved, suspended or emulsified organic matter using methane. The fermentation process is carried out in methane tank reactors.

The moisture content of the raw material placed in the methane tank is of great importance in the fermentation of organic waste. Depending on the concentration of dry matter, the fermentation process is called wet if it is (less than 20%) or dry if it is around (about 30%) [3]. The raw material in the state of wet fermentation is the most useful and is productive . With that together , each one raw material type for maximum humidity get for suitable coming optimal humidity experimental respectively choose need and consequently flammable gas and high good quality it will be possible to get mineral fertilizers and medicines .

In this article, National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" scientific researches and their results are described in detail. It was found that there are several factors that negatively affect the amount of methane in biogas production and its composition. Among them, the most important thing was the humidity. The effect of moisture content on fermentation products and methane content of biogas during the anaerobic processing of agricultural products (livestock, sheep, poultry and organic plant waste) and the consumption of produced biogas it was found that its burning kilocalories are low and its burning properties are insufficient.

EXPERIMENTAL PART

A special laboratory device was developed for conducting research, which consists of a biogas device and control and measuring devices. The scheme of this laboratory device is presented in Figure 1.

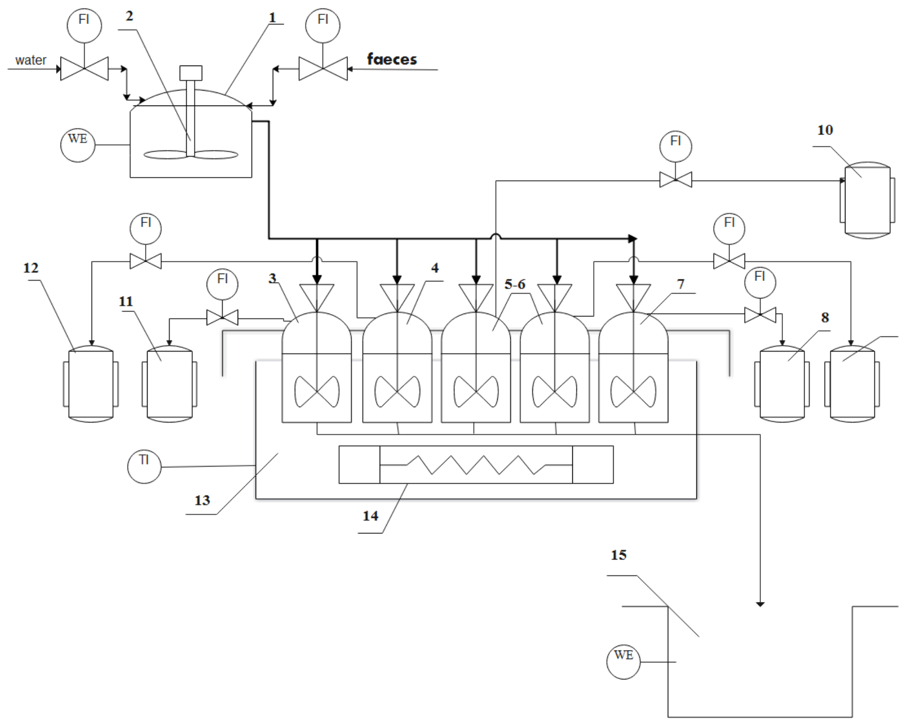


Figure 1 is a diagram of a laboratory device.

It is measured by the moisture content of the finished raw materials $WI$and distributed to the 3rd-7th bioreactors depending on the level of moisture content . FIThe measured gas is collected in gasholders 8-12 in order to provide heat inside the bioreactor. The water in the tank placed in the water tank 13 is heated by the heater 14. The temperature of the water in the tank $TI$is measured. and its humidity is also measured.

The laboratory device includes the following main elements:

- The device consists of a plastic container on the upper part of the device, which carries out a mixture of 5 kg of waste and transfers it to the methane tanks;
- To carry out anaerobic fermentation at different humidity levels (60%, 66%, 70%, 80%) - four methane tank-reactors, the volume of which is a plastic container of 2.5 liters, and the top of the reactor a gas outlet pipe is placed in the part, and the tank is filled with clean water directly where the reactor-methane tanks are located;

- In order to maintain the temperature of the methane tank reservoir and the substrates in it at a uniform temperature, the heating speed adjustment and the temperature of the heat-distributing water, a special water heater device LATR (0-220 V) is installed;
- A device that functions as a gas holder with a volume of 0.5 liters, consisting of four plastic containers that collect the amount of biogas that is ready. A gas tank is a plastic structure with a floating dome consisting of a stationary bottom and a movable upper part (dome). The dome floats in a special water pocket and rises or falls depending on the gas pressure inside it. The dome scale has divisions, which, in turn, allows you to quickly determine the volume of gas produced.
- After extracting biogas from the methane tank, a special 10-liter container is placed at the bottom of the mineral fertilizer substrate device.
- Each device is connected with adjustment valves for transfer and control of mutual substrates.
- Sensors are installed that monitor the amount of raw materials transferred to the anaerobic methane tank, the amount of moisture in the methane tank and its temperature, the amount of biogas in the collected gasholder, the mineral fertilizer substrate and its volume. The indicators are transferred to a special electronic display placed in the device.
- A special electronic display is located inside the control unit, and inside the unit, it consists of a controller, primary switches, an input/output interface and a display screen.
- In addition, the device is equipped with the following tools: a gas burner, which is necessary to determine the possibility of burning biogas of different composition; syringes with a volume of 150 ml and 20 ml for gas sampling;

The LHM-80 chromatograph designed to determine the biogas content (methane concentration) was used as the main control and measuring device in the laboratory stand.

RESULTS AND DISCUSSION

The experiment was carried out as follows. Cattle and agricultural waste with moisture content of 60, 66, 70, 80% were respectively loaded into the reactor-methane tank, which was hermetically sealed and placed in a water-filled container. The gas tanks are connected to the reactor tanks, from which air was previously sucked and brought to a vacuum state. The water around the reactors was heated once every day. Over time, primary gases began to appear in the gas tanks, which was determined by the rise of the domes. The amount and concentration of methane contained in the research vessel were determined twice in total every 10 days. The total fermentation period did not exceed 20 days.

The composition of the gas mixture taken from the device was determined by chromatographic method. An LHM-80 chromatograph of standard configuration was used for analysis.

The gas composition determination method "Dry gas. Component composition determination method" was determined in accordance with GOST 14920-79.

Determination of the material composition of the obtained gas was carried out using compounds suitable for qualitative analysis: CO_2, O_2, N_2 and a calibration mixture: 28% →CO_2; CH_4 →72% The shelf-life compatibility of each substance was determined by addition and comparison methods. The composition of the mixture was calculated by the method of internal normalization [6-7].

At the initial stage of fermentation (2-3 days), a strong release of gas was observed, and later it was noticed that the volume of released gas decreased. The reason for this is that it is indicative of a change in gas composition during fermentation. The dynamics of changes in biogas composition during fermentation is presented in Fig. 2.

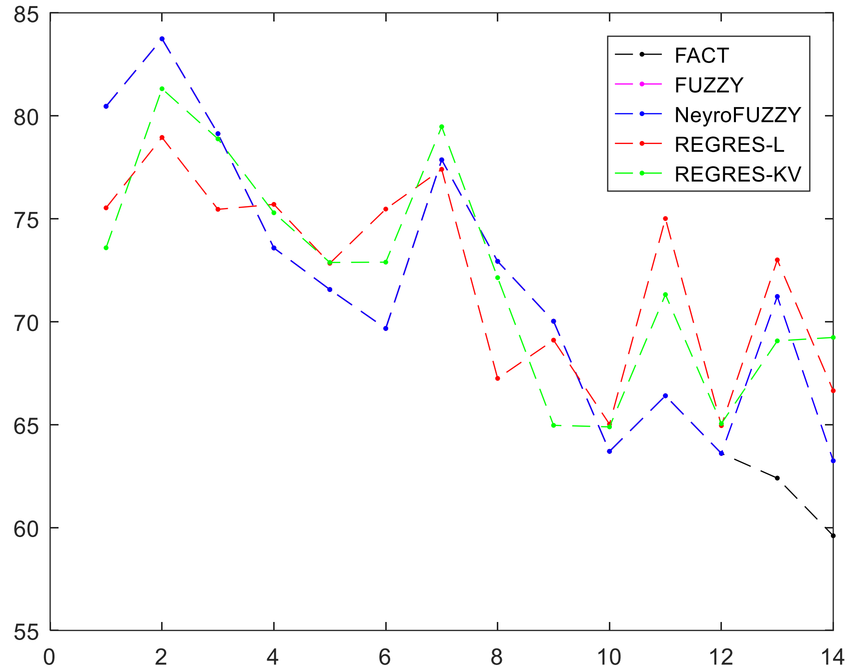


Figure 2. Dynamics of changes in biogas content during fermentation

Also, the observations showed that in the first 2 days, intensive development of anaerobic microflora and partial growth of anaerobic microorganisms (mainly acid-producing) were observed. From 2 to 4 days, anaerobic processes were minimized, acid-producing bacteria became active, as a result, the necessary amount of organic acids was accumulated in the biomass for the intensive development of methane-producing microorganisms [8].

Similar data were observed in the fermentation of waste with 80% moisture. However, in this case, an intensive change in the content of CO $_2$ and SN $_4$ biogas was observed within 6-10 days (it was stronger than at 70% humidity). The results of these observations were explained by the increase in moisture content of the biomass, which contributes to the development of microorganisms.

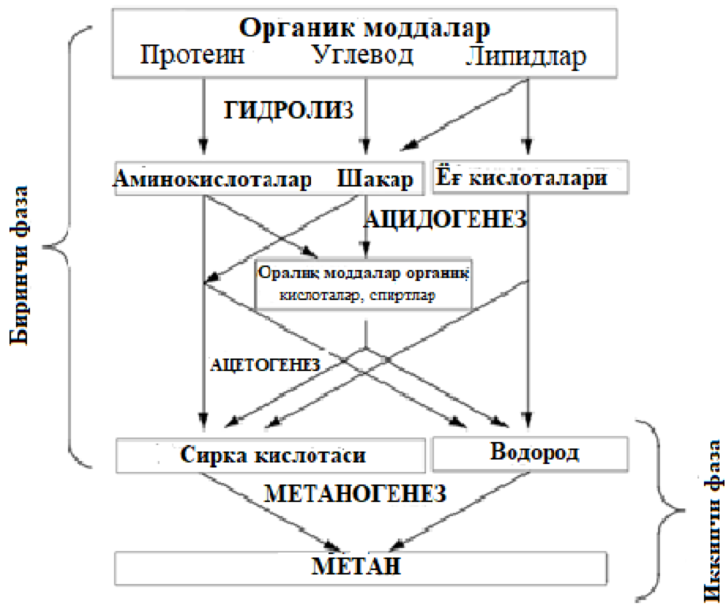
FACTORS AFFECTING METHANE EMISSIONS

One of the main factors affecting the intensity of biogas production is the amount of acid in the sediment (pN level). The main reaction of methane formation can be written as follows [1]

$CO_2 + 4H_2A \rightarrow CH_4 \uparrow$+4A+$2H_2O$ CO 4H A CH 4A 2H O. (1)

$CO_2 4H_2 \rightarrow CH_4 \uparrow +2H_2 0$ (2)

The process of methanization (stabilization) of raw sediment is divided into three, sometimes four stages. However, in one way or another, everything corresponds to the two-phase scheme of the fermentation process proposed by Barker (Figure 3.) [2] .



3 - Picture. Decomposition steps of an anaerobic converter

formula (1) with mature alcohol instead of N $_2$ A, the form of the reduction reaction takes the following form [1]

$CO_2 + 2CH_3CH_2OH \rightarrow 2\ CH_3COOH + CH_4 \uparrow (3)$

In addition to the main one, other methods of methane formation can also be formed. For example, by adding carbon monoxide reduction reactions in the presence of hydrogen [1]

$$CO + 3H_2 \rightarrow CH_4 + H_2O$$

also, as a result of the decomposition of acetic acid, the following is formed:

$$CH_3COOH \rightarrow CH_3 \uparrow + CO_2$$

The reactions of both stages of the fermentation process continue at the same time, and methane-forming bacteria have much higher requirements for their existence than for acid formation.

Therefore, they need a completely anaerobic environment and need more time to reproduce. This means that in order to create a balanced and efficient methane fermentation system, it is always necessary to take into account the entire layer and the specific conditions of its presence, rather than individual groups of bacteria [4, 5].

Methane- producing bacteria are well suited to exist in neutral or partially alkaline conditions. Since the metabolic activity and reproduction rate of methane bacteria is lower than the acid-forming level, excess volatile acids can appear with the increase in the amount of organic matter produced. reduces the activity of bacteria [5].

Usually, the rN value is maintained at a constant level due to the properties of the substrate with the formation of a non-uniform acid [9]. This is ensured by the formation of a higher amount of carbonates than the amount of CO_2 released during fermentation. But sometimes the pN level in the raw material drops below the minimum possible level. In such cases, the use of reagents is resorted to. Of the available reagents, lime is often used more due to its low cost.

CONCLUSION

To determine the amount of loading of waste substrates into the methane tank, it is necessary to take the total volume of the methane tank as 100%. The loading amount is the daily volume of the mass obtained for fermentation, expressed as a percentage of the volume of the methane tank, it depends on many parameters, the main of which is humidity, which is 8-12% for the mesophilic process and 15-23% for the thermophilic one was observed to vary between

Studies and their results show that, in terms of obtaining combustible biogas, when the moisture content of manure in the mixture of livestock and agricultural waste is 70-82%, the fermentation process and digestion are more efficient and the resulting methane content 65-78% combustible biogas can be obtained [10].

So, when obtaining biogas, and using agricultural waste as raw material in it, one of the factors affecting the amount of biogas and its contents, methane and carbon dioxide, is moisture. By adjusting this parameter and when the moisture content is 65-81%, methane concentration and its calorific value can be high.

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