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DETERMINATION OF HUMIDITY CONTROL PARAMETERS IN THE BIOGAS PRODUCTION PROCESS USING DIGITAL TECHNOLOGIES

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Abstract: The article describes the production of biogas as a result of the processing of organic waste. The problems of obtaining biogas as a result of heating the bio-waste with a mixture of water at certain degrees in the bio-waste digestion reactor have been developed. Based on the technology of obtaining biogas from waste, a product aimed at the construction of high-efficiency measurement and control of various biomasses, their moisture content, was produced.
The main focus of the research was on the selection of optimal control methods of the technological biogas extraction process and on the basis of the control devices, the primary variable control and its measuring device were provided, the secondary control device that measures and records the product measurement signals received from the sensor. synthesized.
Synthesized moisture measuring tools are mainly aimed at correcting and optimizing the moisture content of the waste in the biogas production process, obtaining the amount of methane in the biogas.

Key words: anaerobic, fermentation, biogas, biomass, organic, reactor, bacteria, microflora, experiment, gasholder.

Introduction. The most promising technology for the utilization of agricultural organic waste (cattle and pig manure, poultry litter) is their anaerobic digestion for the production of biogas and biofertilizers [1, 2].
Anaerobic digestion occurs when air is unavailable. In this process, a mixture of methane and carbon dioxide gas is produced from organic matter dissolved, suspended, or emulsified in water by methanogenic bacteria in the feed.
The fermentation process is carried out in digestion reactors.
The moisture content of the feedstock is of great importance in the fermentation of organic waste. Depending on the concentration of dry matter, the fermentation process is called wet (less than 20%) or dry (about 30%) [3]. Wet fermentation is considered the most profitable. At the same time, for each type of raw material, it is necessary to experimentally select the optimal moisture content corresponding to the maximum amount of combustible gas and high-quality biofertilizers. The proposed work studies the effect of raw material moisture on the yield and properties of products from anaerobic processing of waste from poultry farms specializing in turkey breeding.
The experiment was conducted to determine the distribution of moisture throughout the biomass. For these purposes, the dielectric method of humidity measurement is more consistent. The principle of operation of humidity control devices is based on the existence of a relationship between the dielectric constant of the controlled material and its humidity. The study of capacitive primary converters has been devoted to a large number of works [2-4], but in the field of humidity measurement, materials such as biomass have not been practically used, although many studies of this method have been analyzed. The development of humidity control devices

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based on them allows us to formulate requirements for converter designs [5]: Ensuring the stability of the conversion function over time, i.e., mechanical and temperature stability of its power; small dimensions and weight; corrosion resistance; mechanical strength; manufacturability.

In preparation for the study of this method, a number of literatures, sources [6, 7, 8, 9, 10] were studied and analyzed, as well as studies aimed at measuring the moisture content of various materials. However, the publications and research results did not find the moisture biomass in the search sources. On the one hand, the lack of a complete theoretical basis for this method makes it difficult for us to conduct research, on the other hand, the volume of biomass is the most difficult value to measure. Large biomass flow under the circumstances his/her size humidity with fast and clear assessment is required. The article , this under the circumstances biomass measurement for thermogravimetric and indirectly from methods use , humidity control to do device working exit and synthesis to do relevance theoretical and experimental accordingly based on As a result , this research results new.

It is known that methane harvest doer bacteria vital activity only biogas device in the reactor oxygen unless possible will be ; that for the purpose we are experimental installation strength we provided , that is the reactor to work from dropping before pressure under pressure held and work during biogas oxygen amount measured.

Experience part

A laboratory stand consisting of a biogas plant and control and measuring instruments was created to conduct the research.

The laboratory device includes the following main elements:

- six digestion reactors for anaerobic digestion of raw materials at different moisture contents. The digestion reactor is a plastic container with a volume of 1.5 liters. It has a gas outlet at the top;
- six gas holders for biogas collection - this gas holder is a floating dome plastic structure, consisting of a fixed base and a movable part.

upper part (dome). The dome floats in a special water pocket and rises or falls depending on the gas pressure inside. The dome has divisions, which allow you to quickly determine the volume of gas formed. A 10% NaCl solution is placed in the water pocket to prevent water bloom;

- gas system;
- water bath - a 20-liter container. Clean water is poured into the container, directly into the cooling water where the methane tank reactors are located;
- a heating element to maintain the required temperature of the coolant. It is used to regulate the heating rate and temperature of the coolant

LATR (0-220 V). To prevent burning and melting of the material of methane tank reactors due to high temperatures, the heating element is surrounded by a piece of aluminum. The section is perforated, so it does not allow uniform heating of water throughout the volume;

As additional equipment, the stand is equipped with: a gas burner necessary for determining the combustion and combustion probability of biogas with different compositions; rubber gas lamps for collecting and storing gas samples. The LKhM-80 chromatograph, designed to determine the composition of biogas, was used as the main control and measuring instrument on the laboratory bench. The fermentation process was adjusted depending on the composition of biogas. The stand also includes a LATR, which is necessary to regulate the voltage supplied to the heating element. A thermocouple equipped with an electronic sensor was used to measure the temperature of the heat carrier. The approximate temperature inside the outlet reactor is determined by the calculation method, taking into account that the heat capacity of manure is 4.06 kJ / (kg · oC). The experiment was carried out as follows. Six digestion reactors were loaded with poultry waste with moisture contents of 60, 62, 65, 68, 70 and 82%, which were hermetically sealed and placed in an empty water bath filled with refrigerant. A heating element was installed. The gas tanks were connected to the methane tank reactors, which had previously been evacuated. The reactor tanks were heated daily. Over time, gas appeared in the gas holder, as evidenced by the rise of its dome. The resulting gas was collected daily and sent for analysis. The fermentation of the raw material was carried out for 20 days. The limitation of the digestion time was associated with energy conservation. After the end of the fermentation, the contents of the digesters were sent for analysis and the installation was loaded again to conduct 2 experiments.

Determination of the material composition of the resulting gas - qualitative analysis - was carried out using reference compounds SO2, O2, N2 and a calibration mixture of 28% SO2, 72% SN4. The determination of the compliance of each substance with the storage time was determined by the addition and comparison methods. The composition of the mixture was calculated by the internal normalization method.

RESULTS AND DISCUSSION

At the initial stage of fermentation (2-3 days), a strong evolution of gas was observed, and then the volume of evolved gas decreased. The reason is the change in gas composition during the fermentation process. The dynamics of changes in the composition of biogas during fermentation is shown in Fig. 3.

Study of the effect of raw material moisture content and composition of products from anaerobic processing of poultry factory waste.

A decrease in the oxygen and nitrogen mixture in biogas was observed in all digesters, which indicates that the organic matter of the biomass was oxidized with oxygen in the sealed digester. For the same reason, an increase in the amount of carbon dioxide, which is an oxidation product, was observed in the first days. During anaerobic fermentation of raw materials with a moisture content of 80%, strong oxidation was observed on the first day, which led to an increase in the carbon dioxide concentration to 82%. On the 6th day, the content of CO_2, O_2, N_2 in biogas changed insignificantly. The methane concentration varied without correlation throughout the experiment. The above indicates the instability of anaerobic processes occurring during digestion. In the 2nd digester, with an increase in the CO_2 content to 80% in the first 2 days, organic matter was intensively oxidized and simultaneously appeared in biogas.

The maximum amount of carbon dioxide was observed on days 3-4, after which its concentration decreased to 60.5% (6% per day) for 10 days, after which its composition changed less intensively (0.7% per day). In this regard, for days 4-14, the methane content in the gas increased from 8.4 to 70.2% (6.2% per day), after which the intensity of education decreased to 0.8% per day. This phenomenon can be explained by the presence of aerobic, acid- and methane-forming bacteria. At the first stage, organic matter is oxidized by atmospheric oxygen with the participation of aerobic microorganisms. At the same time, atmospheric oxygen is consumed and carbon dioxide is formed, as a result of which, with the density of the digester, conditions are created for the development of anaerobic bacteria, which, in turn, break down acid-forming

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(complex substances). into simple acids and releasing CO_2) and methane-producing (consuming the acids formed by CH_4 and CO_2). Thus, in the case under consideration, in the first 2 days, there was a rapid development of aerobic microflora and insignificant growth of anaerobic microorganisms (mainly acid-producing).

From 2 to 4 days, aerobic processes were reduced to a minimum, acid-forming bacteria were activated, as a result

The biomass accumulated the necessary amount of organic acids for the intensive development of methane-producing microorganisms. Similar data were obtained when fermenting turkey waste with a moisture content of 80%. At the same time, in this case, a strong change in the composition of CO_2 and CH_4 was observed on days 6-10 (humidity is stronger than at 80%). This fact is explained by the increase in the moisture content of the biomass, which contributes to the development of microorganisms. Anaerobic processing of raw materials with a moisture content of 78-82% differs significantly from the dependencies considered above. As can be seen, in the first days the content of O_2 and N_2 in the biogas decreased significantly - on average to 55%, after which aerobic processes slowed down. The release of methane from the biomass continued without visible acceleration. The content of carbon dioxide in the biogas decreased slightly in the 4th digester after 4 days, in the 5th - it remained practically at the same level, and in the 6th it increased at all. These disturbances in the anaerobic process are the result of sedimentation. Thus, in digesters 4-5, intensive sedimentation of solid particles of biomass to the bottom of the digester and its compaction during the day were observed. Sedimentation, on the one hand, improves the anaerobic processes occurring in the mass, but on the other hand, compaction of the mass prevents the development of microorganisms, one of the conditions for which is sufficient water shear. In this regard, additional mixing or agitation devices are required when designing digesters, which leads to an increase in installation costs. Table 1 summarizes data on the profitability of gaseous products.

Table 1. Changes in the rate of bacteriological methane production with increasing temperature.

The defectors types and size (kg)	X1 humidity (%)	X_2 pressure (MPa)	X_3 temperature (˚C)	Volume of biogas produced m3/kg	Biogas in the content methane amount (concentration) %
Cattle manure	60	0.1134	40	0.29	62
			45	0.95	63
			50	0.3	63
			55	0.3	63.5
	66	0.1134	40	0.32	64
			45	0.33	65
			50	0.34	68
			55	0.35	70
	70	0.1253	40	0.3	65
			50	0.32	65

			45	0.33	65.5
			55	0.335	66
	80	0.126	40	0.28	63
			45	0.29	64
			50	0.3	65
			55	0.32	67

As experience has shown, in terms of obtaining combustible gas, it is more effective to ferment turkey droppings with a moisture content of 60-80%, since in this case it is possible to obtain combustible gas with a methane content of up to 75%.

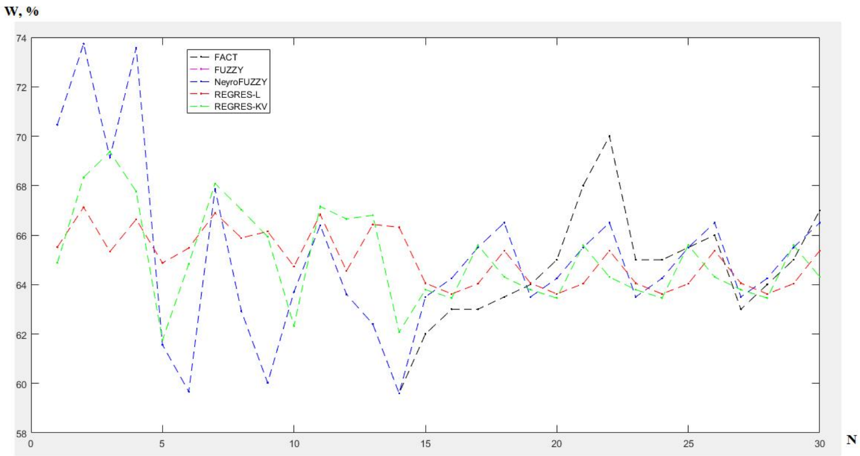

Figure 1. From waste outgoing biogas graphic appearance

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