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БИОГАЗ ТЕХНОЛОГИЯСЫ - КЫКТЫ КАЙРА ИШТЕТҮҮНҮН ЭФФЕКТИВДҮҮ ЫКМАСЫ

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Аннотациясы. *Биогаз технологиясы айыл чарба түзүмдөрү үчүн баалуу продукцияларды, биогазды жана биожерсемирткичти берген, кыкты кайра иштетүүчү эффективдүү ыкмалардын бири. Кыкты жеринде, азыркы айыл чарба түзүмдөрүнүн шартында кайра иштетүүнүн эффективдүүлүгү төмөнкү факторлор менен түшүндүрүлөт: айыл чарба түзүмдөрү үчүн кык өзүнөн чыккан сырье болуп эсептелет, анткени алар айыл чарба жаныбарларын жана канаттууларды багышат; кык жаңы кезинде кайра иштетилип, андагы өсүмдүктөргө азык болуучу заттар жана микроэлементер аз өлчөмдө жоготууга учурайт; автономдуу түрдө энергия менен жабдуу мүмкүнчүлүгү пайда болот, бул алыс жайгашкан керектөөчүлөргө өтө маанилүү жана энергияны үнөмдөөнүн азыркы талаптарына жооп берет; мал сарайларынын экологиягылык абалы жакшырат. Авторлор тарабынан кыктын түрлөрү, анын касиетери, структуралык-механикалык курамы изилденип, кичи айыл чарба түзүмдөрүнүн шартына ылайыкташкан биогаз орнотмосун иштер чыгууда, алгачкы материалдар катары колдонулду. Биогаз орнотмосунда кыкты кайра иштетүүнүн эффективдүүлүгү, ачытуунун температуралык режимин сыртты калыптанып туруучу энергия ресурсун колдонуп, жылуулук энергиясын алдын ала топтоо жолу менен жогоротулатылат.*

Өзөктүү сөздөр*: кык; биогаз; биожерсемиткич; айыл чарба түзүмү; энергия менен жабдуу; биогаз орнотмосу; айыл чарба жаныбарлары.*

БИОГАЗОВАЯ ТЕХНОЛОГИЯ - ЭФФЕКТИВНЫЙ СПОСОБ ПЕРЕРАБОТКИ НАВОЗА

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Аннотация*. Биогазовая технология это один из эффективных способов переработки навоза выдаёт ценные продукты для сельхозформирований в виде биогаза и биоудобрения. Эффективность переработки навоза на местах, в условиях существующих сельхозформирований объясняется следующими факторами : навоз является собственным* *сырьем в сельхозформированиях, так как они содержат сельскохозяйственные животные и птицы; навоз перерабатывается в свежем виде с минимальными потерями питательных веществ и микроэлементов для растений; существует возможность энергоснабжений автономно, что особенно важно для отдельных удаленных потребителей и это отвечает современным требованиям энергосбережения; улучшается экологическое состояние животноводческого помещения. Авторами исследованы виды навоза, его свойства, структурно-механический состав, которые послужили исходными материалами при разработке биогазовой установки в условиях малых сельхозформирований. Предлагаемой биогазовой установке эффективность переработки навоза повышается за счет соблюдения температурного режима сбраживания путём предварительного накопления тепловой энергии от внешних возобновляемых энергоресурсов.*

Ключевые слова: *Навоз; биогаз; биоудобрение; сельхозформирования; энергоснабжение; биогазовая установка; сельскохозяйственные животные.*

BIOGAS TECHNOLOGY IS AN EFFECTIVE WAY OF MANURE PROCESSING

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***Abstract**. Biogas technology is one of the most effective ways of processing manure and provides valuable products for agricultural enterprises in the form of biogas and biofertilizer. The efficiency of manure processing in the field, in the conditions of existing agricultural formations, is explained by the following factors: manure is its own raw material in agricultural formations, since they contain farm animals and birds; manure is processed fresh with minimal loss of nutrients and trace elements for plants; it is possible to supply energy autonomously, which is especially important for individual remote consumers and this meets modern energy saving requirements; the ecological condition of the livestock premises is improving. The authors investigated the types of manure, its properties, structural and mechanical composition, which served as starting materials for the development of a biogas plant in conditions of small agricultural formations. The proposed biogas plant increases the efficiency of manure processing due to compliance with the temperature regime of fermentation by preliminary accumulation of thermal energy from external renewable energy resources.*

***Keywords**: Manure; biogas; biofertilizer; agricultural formations; energy supply; biogas plant; farm animals.*

Introduction. Energy saving in the agricultural sector of the Kyrgyz Republic by actively involving renewable energy sources in the energy balance is relevant. Recently, many countries of the world have been paying special attention to the production of energy from alternative renewable resources - solar, wind, biomass, etc. The share of biomass (mainly manure) in the global energy balance is up to 15-18%, and in the EU countries – 40% [1,2].

Feed is converted into energy in the animal body, partially consumed for biological processes and partially released into the environment (excrement, respiration, etc.).

Taking into account the existing number of farm animals in Kyrgyzstan, the total mass of manure is about 5.5 million tons per year [3].

The potential use of this mass is estimated at about 110 million. m3 of biogas and 5.4 million tons of biofertilizer [4]. Manure and the technology of its processing with the help of a biogas plant are able to autonomously provide remote rural consumers with biogas and biofertilizer, since in such places there is available biomass-manure (as its own renewable raw materials).

However, the manure of farm animals differs in its physico-mechanical and chemical properties and they must be taken into account when processing by biogas technology. Therefore, the development of biogas plants in conditions of small agricultural formations, where the main types of biomass is manure, have their own characteristics [5].

Materials and methods. Manure and its properties, the yield of biogas and biofertilizer. Manure is a complex polydisperse structure including solid, liquid and gaseous substances. The density of liquid manure is: cattle and sheep 1010-1020 kg/m^3: horse 700-750 kg /m^3: pork 1050-1070 kg /m^3, chicken manure 700-1005 kg/m^3.. In cattle manure, fibrous particles with a length of more than 100 mm contain more than 30% of the total number of long particles. The deposition of large particles in manure amounts to 67%. The coefficients of friction of cattle manure on steel, concrete and wood are respectively equal to: 0.9; 1.4 and 1.2 [6].

The coefficient of stickiness of cattle manure at a humidity of 75-85% is about 6 kPa. The structural viscosity and limiting stress of different types of manure, depending on their humidity, varies widely, respectively: 0.3-7.8 Pa • S and 10-210 Pa [7].

This is explained by the fact that, for example, pig manure contains 5 times less colloids and its structure is 1.5 times weaker than the structure of cattle manure. Therefore, pig manure has significantly lower values of structural viscosity and ultimate stress.

The main characteristic of manure is its humidity (Table 1).

Table 1. Humidity of farm animal manure

Animals	Humidity, %	
	manure	Urine
Cattle	83-84	94,8-95
Sheep	67-69	94-95
Pigs	76-78	94-95
Horse	60-67	94-95

Under the influence of elevated temperature, the structure of manure is destroyed and large inclusions floating on the surface layer forms a crust of fibrous particles. This happens in the reactor of a biogas plant.

The noted structural and mechanical properties of manure largely depend on the proper feeding of animals. With proper feeding of cattle, it is possible to increase the methane-producing bacteria in their stomach. At the same time, cattle manure is the most suitable raw material for biogas plants of continuous fermentation. Sheep and goat manure contains more sand and soil, small stones, etc. therefore, before loading into the reactor of the installation, this type of manure must be cleaned and it is recommended to use it in installations operating in batch loading mode. Sheep manure emits more methane compared to other types of manure.

Chicken manure and pig manure contain high concentration ammonia, which prevents the reproduction of methane-producing bacteria. Therefore, when they are loaded into the reactor of a biogas plant, it is recommended to mix them with other types of manure. Table 2 shows the values of biogas output for different types of manure.

Table 2. Biogas output for different types of manure

Type of the manure	Biogas output (m^3 per kg of dry matter)
Cattle manure	0,25-0,34
Sheep manure	0,3-0,62
Chicken droppings	0,31-0,62
Horse manure	0,2-0,3
Pig manure	0,34-0,58

The yield of biofertilizer from processed manure is determined taking into account the volume mass of biogas, which is equal to 1.2 kg/m3 [8]. Calculations show that the mass of raw materials at the outlet of the rector decreases by 4-5%. Nutrients (nitrogen, phosphorus, potassium, magnesium, trace elements and vitamins) they are preserved in biofertilizer in the same content as in the feedstock. In addition, helminth eggs and weed seeds die in biofertilization, humus materials are formed that improve soil structures, humic acids, which increase the resistance of plants to various external adverse climatic conditions.

Materials on the structural, mechanical and chemical properties of manure and biofertilizer are used in the development of a biogas plant for small agricultural formations, which all types of manure have as their own raw materials.

In addition, when developing a biogas plant, the mixing mode of raw materials inside the reactor is taken into account, since the fermentation process is a symbiosis between different strains of bacteria. Bacteria of one species can feed another species [9]. Consequently, the unreasonable mode of mixing of raw materials, which provides only for the destruction of the crust, negatively affects the process of fermentation of manure inside the bioreactor.

Structurally, the technological scheme of the biogas plant is shown in Figure 1 [10].

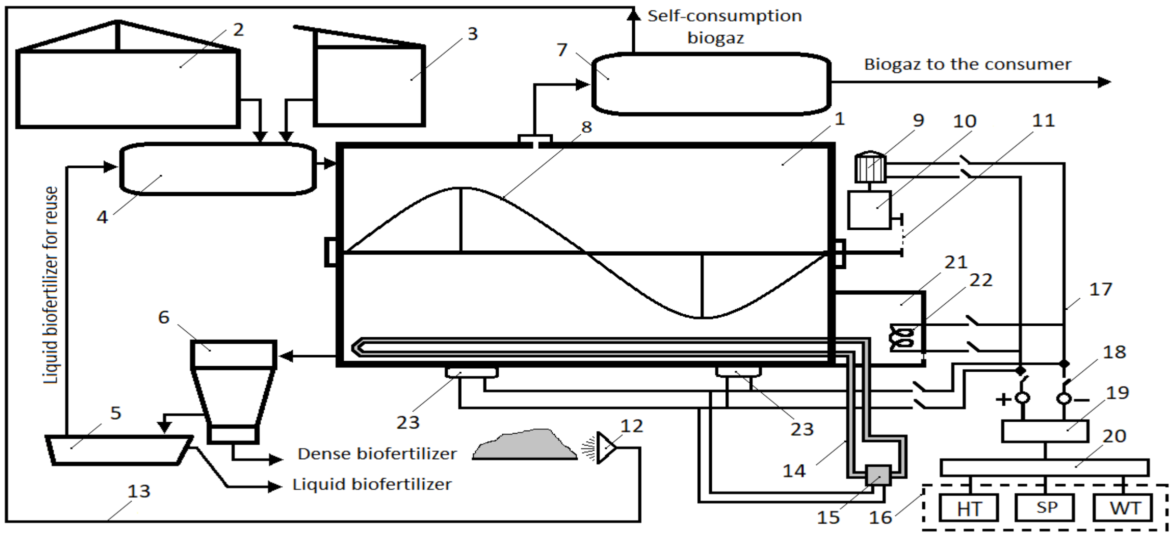

Fig. 1. *Structural and technological scheme of a biogas plant: 1-bioreactor; 2-livestock room; 3-container for raw materials and water; 4-mixer; 5-container for liquid biofertilizer; 6-centrifuge; 7-gas tank; 8-mixer blades; 9-electric motor; 10-reducer; 11-chain transmission; 12-burner; 13-gas pipeline; 14 pipeline; 15-pump; 16-renewable energy sources (HT-hydro turbine; SP-solar panel; WT-wind turbine); 17-electrical wiring; 18-switch; 19-battery; 20-multistage multiplier; 21-heat exchanger; 22-Heat and electric heaters – TEN; 23-electric stoves.*

The technological process of functioning of a biogas plant consists of the following sequentially performed operations: preparation of raw materials for loading into a bioreactor, which involves mixing different types of manure, as well as with water up to a humidity of 85-90%; loading of the substrate into a bioreactor; providing a temperature regime for a certain time, depending on the selected fermentation mode; accumulation of biogas and its supply to consumers; unloading of biofertilizer from the reactor and its separation into fractions.

The installation works as follows (Fig. 1).

Manure from the livestock room 2 is drained into the mixer 4, where sawdust from reed plants and water from the container for raw materials 3 are simultaneously loaded. After bringing the substrate to the required humidity (85-92%), the mixture is fed into the bioreactor 1 and occupies a certain volume. Electricity is connected from renewable energy sources 16, which can be: HT-hydro turbine; SP-solar panel and WEIGHT-wind turbine. The choice of a specific source of renewable energy sources is carried out depending on their availability and the location of the agricultural formation. Electric energy from renewable energy sources 16, accumulated in the battery 19 by means of a multi-stage multiplier 20, is transmitted through the electric wire 17 and the switch 18 to the electric motor 9, which in turn, through the gearbox 10 and chain transmission 11, begins to slowly rotate the mixer blades 8, thereby mixing the substrate in the bioreactor 1. If it is necessary to heat the substrate by means of thermoelectric heaters – heating elements 22, the liquid is heated in a heat exchanger 21, the heat of which will be transferred to the substrate by means of a pipeline 14 and a pump 15. Electric stoves 23 additionally heat the bottom of the bioreactor 1. As the substrate ferments, biogas accumulates inside the bioreactor 1, which is collected in the gas tank 7. The main part of the biogas goes to consumers, and a small part is sent through the gas pipeline 13 for blowing and drying with burners 12 of a thick mass of biofertilizer. At the end of the full cycle, the substrate from the biorector 1 is drained into the centrifuge 6, where it is divided into thick and liquid biofertilizer. Part of the liquid biofertilizer is reused as a starter for a new batch of the loaded substrate in biorector 1 and the cycle is repeated.

In this installation, the efficiency of manure processing is increased due to the preliminary accumulation of thermal energy from renewable energy resources. The autonomy of the installation more fully meets the requirements of remote agricultural consumers, especially in pasture conditions.

Conclusion. With the development of animal husbandry, the mass of manure increases as a renewable raw material for the production of biogas and biofertilizer. When developing biogas plants for small agricultural formations, it is necessary to take into account the chemical composition and structural and mechanical properties of different types of manure. The farmer usually keeps different types of farm animals and poultry and therefore has different types of manure. Before loading the bioreactor raw materials, it is necessary to perform preparatory work related to its humidity, mixing different types of manure and cleaning them from foreign inclusions.

The features and designs of biogas plants for small agricultural formations are related to overall dimensions, temperature regimes of fermentation, natural and climatic conditions of the area, the total mass of manure for a certain period and types of manure intended for processing. When developing the design and technological scheme of a biogas plant, these features are taken into account.

Biogas technology solves several issues, namely disinfection of manure in fresh form, energy supply to remote agricultural formations, improvement of soil fertility and reduction of methane emissions from animal husbandry.

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