Environmental perspectives of the producing of biogas-bio humus complexes in Central Asia

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ABSTRACT

The article covers the environmental perspectives of the creation of biogas-biohumus complexes in the arid zones of Central Asia.

Keywords: biogas, mesophilic temperature regime, vetan digestion, methane tank, reactors, biomass, aerobic bacteria, anaerobic bacteria

Introduction

The technology of methane digestion of waste of the livestock, poultry, household and green mass is not new in world practice. Farms in the Netherlands, Denmark, Sweden, Germany, England, USA and other countries largely provide themselves with biohumus, thermal energy and fuel through the use of mini-factories for biological processing of waste [1].

One of the most important factors in the digestion process is maintaining the optimum temperature. Under natural conditions, the formation of biogas occurs at temperatures from 0°C to 97°C, but considering the optimization of the process of processing organic waste to produce biogas and biofertilizers, three temperature modes are distinguished:

- psychophilic temperature mode is determined by temperatures up to 20 -25°C,
- mesophilic temperature mode is determined by temperatures from 25°C to 40°C
- thermophilic temperature mode is determined by temperatures above 40°C [2].

Mesophilic, thermophilic, biological and combined methods are used. The most widely used method is mesophilic with biostimulators at a temperature of 15-20 °C.[1-3]

At that, technological processes are continuous, fully automated and computerized starting from waste collection to the sale of humus and biogas. Economically feasible and beneficial are the use of humus in liquid form, whilst for biogas as it is released in the gaseous state (without liquefaction). The use of a mesophilic digestion mode with biological stimulants is associated with the need for an additional biological laboratory for the cultivation and maintenance of microorganisms, which is quite difficult and expensive (in our conditions). Nevertheless, in comparison with the thermophilic mode, which requires additional consumption of thermal energy, with a shortage of fuel in general (in Europe) and a great need for environmentally friendly approvals, for technically (industrially) developed countries, the mesophilic mode becomes more rational and cheaper. In addition, for these countries, the quality of the water used in the process does not pose an additional problem.

The natural-climatic and water-soil features of the arid zone of the Central Asian region are such that for industrial solution of the problem of waste processing, no European technology and means of its support can be applied without significant modernization and additional support services for microbiological support and water treatment. These measures increase the cost of one complex by 6-3 times. The possibility of using solar energy in our region (8 months a year) for the thermophilic mode reduces the additional costs of thermal energy to a minimum, eliminating at the same time the need to create a microbiological base and water treatment.

Comparative (estimated) calculations show that the use of a mesophilic (low-temperature) mode, continuous methane digestion of waste using biological stimulants, with a European level of mechanization and automation of the technological process, can increase the estimated cost of creating a BGHC and its operation in our country by 8 times.

Therefore, when developing the technology of methane fermentation of dung, bird droppings and green mass and creating means for their provision, we adopted a thermophilic (high-temperature 50-55°C) mode and the principle of extreme simplicity of design and operation.

Methane digestion is the digestion of organic waste in a certain proportion with water, the content of this mass in a sealed environment, at a certain temperature, with periodic mixing at minimum speeds. Technology support facilities consist of fermentation chambers, heating systems (solar and conventional), filtration systems (wet and dry), biomass mixing system, gas pumping installation, control and measuring systems, and methane tank. For the industrial implementation of the technology, the following means are added: means for collecting, sorting and supplying waste to the pre-mixer in front of the reactors, a system for distributing feedstock to reactors, a system for draining and settling fermented biomass or systems for drying it (centrifugation), a system for drying, grading and packaging, a methane tank/tanks with an installation for methanol production.

The proposed project consists of 16 digestion reactors mounted on separate foundations, a filtration complex, a preparatory separation of systems, dehumidification and a storage area. The principle of operation of the BGHC is as follows:

- fresh dropping is loaded into fermentation reactors and diluted with water in 1:4 ratio (80% humidity, the reactors are sealed, if necessary, heating is connected to maintain the temperature no higher than 55 °C).

The biomass is periodically mixed, the temperature, the acidity of the medium, and the gas pressure are controlled. The process takes 15-18 days. The maximum gas pressure in digestion reactors is 0.15 atm. The resulting gas, due to the presence of sulfur-containing impurities, has a pungent odor. Purified gas has no specific odor.

The yield of biogas is 0.7-1.2 m^3 per 1 m^3 of digestion reactors when ordinary tap water is used.

Storing of droppings (dung). According to traditional technology, fresh waste is stored in collars for 1.5-2 years, during which (under natural conditions) the transformation of waste (droppings, dung) into fertilizer occurs. However, it loses 80% of organic nutrients, 50% nitrogen and 40% phosphorus.

When dung is stored in collars, the germination of weed seeds is not destroyed, which leads to additional costs of mineral fertilizers per 1 ha: nitrogen-140 kg, phosphorus-120 kg, potassium-130 kg.

The impact of livestock and poultry enterprises on the environment

Malignant pathogenic microorganisms, bacteria and helminths present in the dung during storage in collars retain their vital activity due to insufficient degree of processing. The main types of microorganisms are shown in Table 1.

Microorganisms Mushrooms	Poultry droppings
Aerobic bacteria	3.10 - 4.10
Anaerobic bacteria	8.10 - 2.10
Coliforms	10 - 3.10
Enterococci	2.10 - 7.10
Staphylococci	10 - 10
Lactobacilli	3.10 - 8.10
Aerobic spores	10 - 1.2.10
Clostridia	2.10 - 1.6.10
Salmonella	Occurs in most cases
Fungi	2.10 - 4.10

The insertion of litter-free dung causes intensive bacterial exchange of the soil. The minimum period of its self-purification from pathogenic bacteria of Escherichia coli is 4-5 months, and pathogens of polybacteriosis and salmonellosis remain viable in the soil for more than three months.

Fodder crops grown in fields fertilized without litter-free dung are seeded with pathogenic serotypes of Escherichia coli. In most cases, infection of livestock with pathogens of infectious and parasitic diseases is associated with feeding livestock with fodder harvested in these fields.

Helminth eggs can be moved by winds at a distance of 400-600 meters at a wind speed of 3-4 m/s. Consequently, the risk of infection by pathogens not only for animals, but also for people living near the complexes and farms, is very high.

In addition, livestock and poultry farms and their waste, in the absence of a processing system, adversely affect the quality of atmospheric air and groundwater. Atmospheric air in the farm area is polluted with microorganisms, ammonia, dust and organic substances, i.e., products of animal life and waste decay, which have mostly unpleasant odors. These include methanol, butanol, isobutanol, formaldehyde, mercaptan, etc.

The concentration of ammonia at a distance of up to 1 km from the KPC complexes and farms reaches 0.5 mg/m^3, within a radius of 2-3 km it decreases to 0.44 mg/m^3. The concentration of organic substances (biochemical oxygen demand) in the atmospheric air of the farm zone is 22.4 mg/m^3. The organoleptic specific smell is felt at a distance of 1-1.5 km from the farm as a strong constant, at a distance of 2-3 km as a weak constant.

According to traditional technology, fresh dung and bird droppings are stored in heaps for 1.5-2 years for further use as organic fertilizer. Under natural conditions, during this period, 60% of organic nutrients lost 50% of nitrogen, 40% of phosphorus in the waste.

When storing dung in heaps, the germination of weed seeds is not destroyed and therefore: firstly, fertilizer consumption increases; secondly, weeding losses and a decrease in yield of 4:5 centners per 1 ha are about 300:400 thousand UZS per 1 ha.

The impact of livestock and poultry enterprises on the ecological situation in the region is expressed in the following: malignant pathogenic microorganisms, bacteria and helminths present in dung, when stored in heaps for 1.5-2 years, due to insufficient degree of heat treatment, retain their vital activity.[3]

Application litter-free dung causes an intense bacterial effect on the soil. The minimum period of its self-purification from pathogenic bacteria of Escherichia coli is 4-5 months, and pathogens of bacteriosis and salmonellosis remain viable in the soil for more than 5 months.

Fodder crops when grown in the fields are fertilized with litter-free dung is replaced by pathogenic serotypes of Escherichia coli. In most cases, infection of livestock with pathogens of infectious and parasitic diseases is associated with livestock feed harvested in these fields.

Livestock farms and their waste, in the absence of processing systems, negatively affects the quality of atmospheric air and groundwater. Atmospheric air in the farm area is polluted with microorganisms, ammonia, dust and organic substances, i.e., products of animal life and waste decay, which have a large part of an unpleasant odor. These include methanol-butanol, isobutanol, formaldehyde, mercaptan, etc.

Concentration of ammonia at a distance of up to one km from the KPC complex and farms reaches 0.5 mg/m^3 within a radius of 2…2.5 km, it decreases to 0.44 mg/m^3. The concentration of organic substances (biochemical oxygen demand) in the atmospheric air in the area of the farm (complex) is 22.4 mg/m^3. Organic specific smell is felt at a distance of 1...1.5 km from the farm as a strong, constant, at a distance of 2.0 km as an impaired constant, and at a distance of 2...5 km as a weak constant.

Natural polluted waters usually contain a small amount of nutrients. In water, nitrogen is present in the composition of organic and mineral compounds (NH_3, NO_2, NO_3). Ammonium nitrogen prevails in summer. In winter, when surface water is replenished with groundwater, the nitrate ion predominates in the waters.

The results of the analyzes of water sources in the Bukhara region showed the following:

Source name	Physical-chemical composition		
	NH_3	NO_2	NO_3
Tap water	_	0.2	_
Irrigation ditch (aryk)	0.5	1.2	3.1
Collector	1.4	4.2	5.2

Data on the chemical composition of water in the areas where livestock farms are located indicate significant changes in the content of nitrogen, phosphorus, organic and other substances, the nitrogen content is 7-10 mg/l, and the value of biological oxygen demand (BOD) is 7-7.5 mg/O_2/l, mineral phosphorus is 5-6 mg/l.

When poorly treated livestock wastewater is discharged into the collector, its sanitary condition sharply deteriorates, the collector water acquires a putrefactive odor after discharge, the content of suspended solids in it increases to 140…150 mg/l, biochemical oxygen demand up to 70….80 mg/O2/l: a significant decrease, even the disappearance of some species in fish from the reservoirs of the region is a consequence of the above factors.

The causes of pollution of groundwater, and in some cases artesian waters, are nitrates, the level of nitrates in groundwater reaches 400-500 mg/l. The only way to stop pollution of ground (artesian) water is to keep livestock in paddocks, which allows collecting and treating wastewater while reducing nitrate levels to 57 mg/l and below (up to 20 mg/l).

The level and intensity of groundwater pollution in our region has its own characteristics: the permeability of sandy soils is very high, and the groundwater level ranges from two meters to 70 cm (in winter, when the soil is salted). Consequently, at a rate of water migration into the depth of the soil from 0.15 to 0.5 m per year, nitrates, phosphates, etc. reach groundwater in a year or two.

As we know, according to the regulatory requirements of agriculture, along with the application of unprocessed dung to the fields, mineral fertilizers (N, P, K,) are also applied by plants, from 30 to 70% of the applied mineral fertilizers are absorbed, the rest of it is lost in the soil in the form of various salt complexes. Due to the factors mentioned above, mineral fertilizers gradually pass from the soil into groundwater. Thus, the applied mineral fertilizers also lead to groundwater pollution, which has been confirmed especially in recent years.

World science has long known that during the decomposition of organic substances (compounds) of dung under natural conditions, the released methane and its chemical series, combining in nature with fluorine, give compounds in the form of gases that destroy the ozone layer of the earth.

In our opinion, the only highly effective, economically and socially justified way to preserve and improve the environmental situation in the locations of livestock and poultry farms, preserve underground drinking water reserves, and preserve the ozone layer from destruction is the anaerobic processing of waste as it accumulates locally into biohumus and the production of an alternative fuel, i.e., methanol biogas.

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