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BIOGAS PRODUCTION UNDER UTILIZATION OF AGRICULTURAL PRODUCTION WASTE PRODUCTS

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The basic directions of the technological process of biogas and organic fertilizers obtaining from waste products are generalized. The recommendations for the creation and use of optimal designs of biogas plants are given.

Key words: biogas, biogas reactor, organic fertilizers.

Introduction. During the energy crisis in many regions of the country the use of renewable energy sources, was reduced significantly, even those that had some distribution in the past (small hydroelectric stations, wind plants, wood, etc.). In many localities fuel stocks, especially wood were eliminated. Significantly reduced supply use of small hydro electric stations and wind plants, caused additional problems of energy supply and the need to replace them. In recent years the interest in the process of biogas-production has greatly increased, it is evident not only in the growing number of planned and constructed biogas plants, but also in the interest of a growing number of farmers, utilities, enterprises, politicians and private households which watch attentively the development of this sector. The energy sector also with the care concerns to decentralization of production through the biogas plants construction. Biogas arises during the decomposition of organic substances (hereinafter abbreviated -organics) by bacteria. Different groups of bacteria decompose organic substrates that consist mainly of water, protein, fat, carbohydrates and minerals into their primary components - carbon dioxide, minerals and water, as a product of metabolism, with a mixture of gases, called biogas. Combustible methane (CH_4) makes 50 to 85% and is the main component of biogas and therefore energy containing main component. The process of biogas and fertilizer production from raw materials called fermentation or digestion. [1-6].

Problem. For example it can be an important opportunity to the farm to withdraw its wastewater into biogas plant instead of costly sewer connection [6,7,8]. From an environmental point of view the ability to recycle nitrogen by fermentation into suitable for storage substance, has the great interest for environmental enterprise. The argument in favor of biogas plant building may be also creating jobs for the future farm owner. For the food industry, gastronomy, great restaurants, catering companies and food waste processing enterprise biogas technology provides the chance of cheap utilization of organic wastes and residues of food in biogas plants for the benefit of Agriculture. It can also be wastes of industry (sugar, alcohol, dairy, breweries), as well as municipal wastewater purification plants. Another possibility is to use the natural processes of anaerobic digestion that takes place in solid domestic waste (SDW) landfills and graveyard.

Analysis of recent researches and publications. Biogas plant can be interesting and appropriate under the following conditions: • Production of high-caloric

energy; • Production of high quality fertilizers; • Reducing the intensity of odors; • Reduction of aggressive corrosive action; • Improvements in yield; • Reducing ammonia and methane air pollution; • Loss of nutrients prevention; • Reduction of nitrate leaching; • Better adaptability to plants consumption; • Improved plant health; • Hygienisation of manure; • Weed seeds germination ability reduction; • Organic wastes recycling; • Savings on the cost of sewage system connection [1-6].

The purpose of research: to summarize the main directions of the technological process of biogas and organic fertilizer obtaining from waste, to give recommendations on the establishment and use of optimal designs of biogas plants.

Results of researches. Biogas plants usually is a tightly closed container, in which at a certain temperature fermentation of organic waste matter, wastewater, etc. occurs with biogas production. The principle of biogas plants operation is the same: after the collection and preparation of raw materials, that is brought to the desired humidity in special containers, they are fed into the reactor, where the conditions to optimize the processing of raw materials are created. The basis of each biogas plant is the reactor [6,7,8,9,10]. The reactor is hermetic thermos, in which a given constant temperature is maintained. To maintain the temperature heating system and thermal insulation system of the reactor are used.

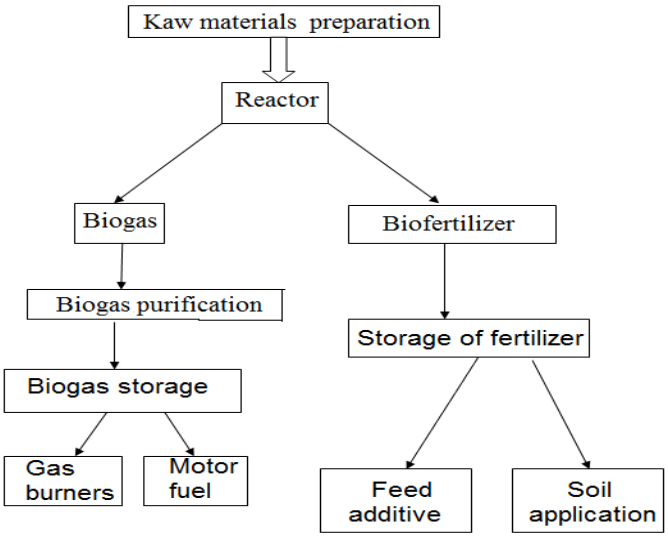

Fig.1. The scheme of organic waste processing in biogas plants.

All these is controlled by automation unit. Also, for the normal reaction the system of raw materials mixing, is used which is also controlled by automation unit [6,7,8,9,10]. To supply the reactor with feedstock the raw material preparation system is used. For buffering the produced gas and stabilizing its pressure gasholder is used. The gas system is used for dehydration of gas produced, gas pressure control, systems of emergency gas reduction and preventing reverse movement. To drain the waste material (prepared biofertilizers), drain a system is used. The conditions necessary for the processing of organic waste inside the reactor of biogas plant, in addition to the oxygen-free regime include: temperature control; availability of nutrients for bacteria; choosing the right fermentation time and timely loading and unloading of raw materials; acid-base balance adherence; compliance of carbon and nitrogen ratio; correct proportion of particulate matter in

the raw material and mixing; absence of process inhibitors [6,7,8,9,10]. The extraction of biogas occurs in the pipeline, which is equipped with automatic condensate and safety devices that protect the gasholder from exceeding allowable pressure. The device works on indicator of limit values. Automated system can also work in manual mode. From the gasholder continuous supply of biogas to cogeneration system or to gas purification system is performed. Cogeneration is a process of combined production of electricity and heat in a single thermodynamic cycle using one type of fuel. The produced energy can be used for both heating and cooling. In the process of operation, most of the power plants heat is evolved into the atmosphere through cooling cycles or by flue gases. Most of this energy can be returned and used rationally. Thus, we can increase the efficiency of power plants by 30-50%, and the efficiency of cogeneration to 80-90%. Cogeneration equipment has much more benefits: - energy of the most effective fuel; - emissions reduction; -significant reduction of production costs, which increases the competitiveness of enterprises; - the possibility to offer the cheapest energy to customers; - the minimal loss of energy in the decentralized system; - competition in the branch of energy production; - relatively short payback period. The obtained energy can be used: - to heat water for heating and hot water for use; - in steam production; - in cold generation; - in manufacturing processes, using heat of exhausted gases.

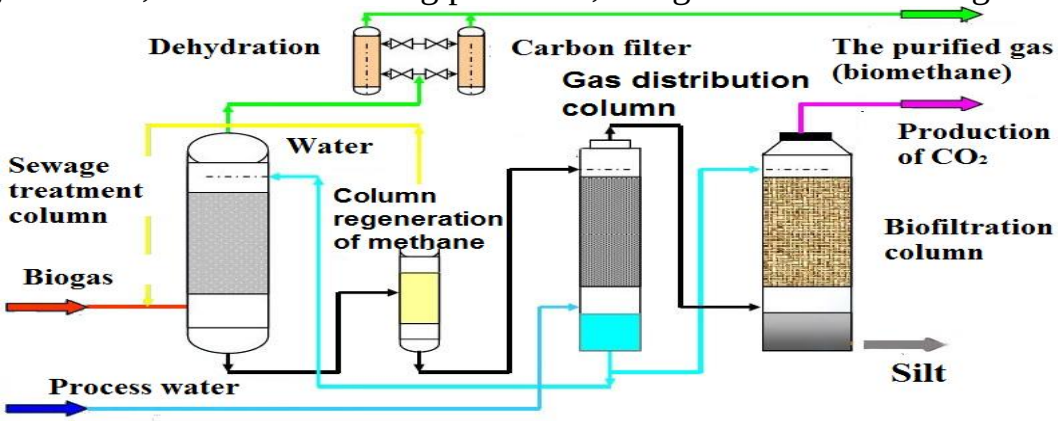

Fig.2. The scheme of organic wastes processing in biogas plants.

The resulting energy can be used: - for own production process; - to be sold to the licensed enterprises engaged in the distribution and transmission of electricity [6,7,8,9,10]. Trigeneration is combined production of electricity, heat and cold. Trigeneration has advantages of efficient use of heat energy not only in winter – for heating, but in summer - air conditioning in hotels, shopping malls, hospitals and others. Trigeneration is also used in various industrial sectors where cold water is required (temperature from 8 to 14 ºC), for example, the milk processing plants and breweries. Production of such water in summer is a very laborious process. The process of carbon dioxide evolving from biogas is a desorberi, CO_2 - (carbon dioxide) is colorless gas with a slightly sour smell, not toxic. It is used in greenhouses, storages, food industry (as preservation agent for soda water and lemonade), in freezing units and fire extinguishers. Processed substrate from the plant is fed into the separator. The system of mechanical separation works in program-time mode and shares remains after fermentation in bioreactor for solid and liquid fertilizers. Biogas technology allows to obtain rapidly using anaerobic

digestion Natural biofertilizer contains biologically active substances and minerals. Here are the main advantages of bio fertilizer after biogas plant compared to common manure and fertilizers: - maximum preservation and accumulation of nitrogen; - lack of weed seeds; absence of pathogenic organisms; lack of storage period; - resistance to leaching of soil nutrients; - the environmental impact on the soil [6,7,8,9,10]. Biogas plants are active cleaning systems, any other treatment system consumes energy, but does not produce. Products of any cleaning system still need to be sold but the product of biogas plant is required to an enterprise. As the process occurs without air (anaerobic bioreactors are completely sealed), then the processing odours do not spread. Biogas plant allows to remove the bulk of polluting organic substances, that is why after plant wastes have no disgusting odor. After common purifying systems wastes just remain wastes. After the biogas plant it is a high-quality fertilizer. Average yield of biogas from the bioreactor of 1 cubic meter capacity is 2.0 cubic meters. One cubic meter of biogas is equivalent to 0.6 cubic meters calorific energy of natural gas, to fuel oil 0.7 liters, to 0.4 liters of kerosene and 3.5 kg of wood and is 5.5 - 6.5 thous kcal / cbm. Biogas plants are simultaneous solution of problems not only in agricultural chemistry and energetics, but also improvement of the overall ecological environment and social conditions of the villagers. The raw material potential for biotechnology includes vegetation capacity, agricultural and domestic wastes. This calculation is limited by the definition of raw material potential on manure of cattle, pigs and poultry litter as a predominant share of the total raw material potential and easier to recycle on site. [6,7,8,9,10].

Table 1.**Biogas plants power capacity ratio between reactors volumes and the presence of cattle in farms.**

The reactor volume, cubic meters	Number of animals and birds		
	Cattle, heads	Pigs, heads	Hens, 100 heads
5	10	40	16
10	25	100	34
25	60	250	90
50	125	500	170
100	250	1000	340
200	550	2200	700

Table 2.**Biogas plant economic efficiency.**

Indicators	Plant volume, cubic meters					
	5	10	25	50	100	200
Annual economic efficiency thousand. UAH.	17,1	32,76	85,13	181,82	367,36	774,32
The term of payback, years (counting operation period 10 years)	2,95	3,05	2,58	2,25	2,1	1,81

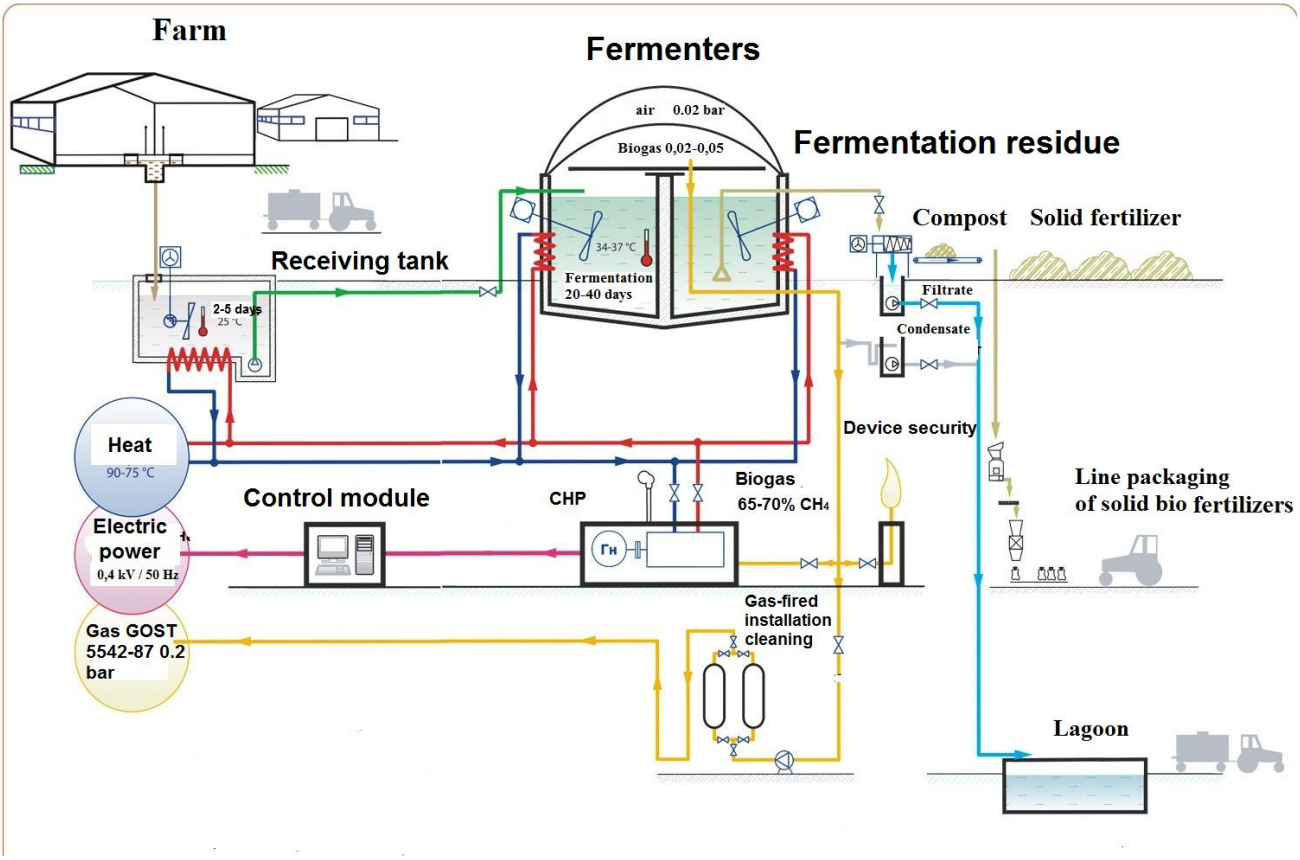

Fig. 3. The scheme of waste processing in biogas plant for manure effluent. [10]

Table 3. **Specifications of biogas plant for manure effluent (humidity 92-94%) [10]**

Specifications		The dimension	Value						
1	Productive efficiency of raw materials processing	t / day	30	60	90	120	150	300	450
2	Biogas evolving	m^3/day*	1200	2400	3600	4800	6000	1200	18000
3	Necessary electric power	kW	10	15	20	25	30	50	70
4	Need thermal capacity ($T = 20^0C$)	kW	35	70	105	140	175	350	500
5	Staff	the person	1	1	1	1	1	1	1
6	Footprint	hectare	0,20	0,25	0,30	0,45	0,50	0,65	0,75
7	Output of solid biofertilizers	t / day	3	6	9	12	15	30	45
8	Output of liquid biofertilizers	m^3 /day	25	50	75	100	125	250	375

***** - biogas yield from fresh manure

Conclusions. The raw materials potential of biotechnology includes vegetation capacity, agricultural and domestic wastes. Biogas plants for animal manure are the

simplest and widespread throughout the world. For processing large quantities of waste of vegetable and animal origin produced in farms and private courtyards people need to use biogas plants, in which processing takes from 7 to 20 days. Biogas technology allows to obtain rapidly using anaerobic digestion natural bio fertilizers containing biologically active substances and minerals.

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ПРОИЗВОДСТВО БИОГАЗА ПРИ УТИЛИЗАЦИИ ОТХОДОВ АГРО ПРОИЗВОДСТВА

Уминский С. М., Житков С.С.,

Ключевые слова: биогаз, биогазовый реактор, органические удобрения.

Резюме

Обобщены основные направления технологического процесса получения биогаза и органических удобрений из отходов производства, даны рекомендации по созданию и использованию оптимальных конструкций биогазовых установок.

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Summary

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