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TECHNOLOGICAL LINE ON PRODUCTION OF BIOGAS AND BIOLOGICAL ORGANIC FERTILIZERS FOR GROWING ECOLOGICALLY CLEAN AGRICULTURAL PRODUCTS

The problem of production of biological organic fertilizers with the certain content of phosphorus, nitrogen, potassium and calcium for the given agricultural crop is examined in the article.

Key words: *biological organic fertilizers, biogas, reactor, technological line.*

Introduction. In the world practice two technological lines on the processing of biomass into biogas as well as biological fertilizers are used. Technological line in which biogas transformed in the coherent unit into the heat and electricity and produced in the result of fermentation is used in Germany, Denmark and other European countries. The produced heat is applied for warming biomass in the reactor, and the electricity is transferred to the electrical grid. Technological line on production of biogas and biological fertilizers is used in China and other Asian countries. Biogas is used in the internal combustion engines. In China about 43 billion m^3 of biogas is produced. Biological fertilizers are used for soil fertilization.

The aim of the investigation. To determine the changes in the composition of biological organic fertilizers after the dissolution of minerals in the animal waste. Impact of the obtained fertilizers on the yield capacity of corn.

Materials and methods of the investigation. The investigation was carried out in laboratory conditions on the animal farm.

Investigation results. We presented investigations showing that if the line on production of biogas and organic biological fertilizers has two reactors, and in one of them in the alkaline environment minerals will be dissolved, then it is possible to produce highly qualitative biological organic fertilizers with the certain content of phosphorus, nitrogen, potassium and calcium for the given agricultural crop directly on the farm.

Table 1

Testing results of biological fertilizers made of manure

(for 2013)

№	Name of indicator	Testing results	
		content in the dry matter	content in the raw natter
1	Mass fraction of moisture, %	90,91	
2	Acidity pH	8,9	
3	Mass fraction of organic matter, %	71,1	6,52
4	Mass fraction of ash, %	28,3	2,6
5	Mass fraction of ammonia nitrogen, %	1,93	0,175
6	Mass fraction of total nitrogen, %	3,38	0,31
7	Mass fraction of total phosphorus (P_2O_5), %	0,84	0,08
8	Mass fraction of total potassium (K_2O), %	5,69	0,52
9	Mass fraction of calcium, %	2,21	0,38
10	C:N	10,5	

Data in tables 1 and 2 demonstrate that by dissolution of ground shell limestone in the alkaline environment of animal waste, calcium content has increased from 2,21% to 13,72% 6 fold, and the ratio of carbon to nitrogen (C:N) increased from 10,5 to 18,2.

In production of mineral fertilizers high temperatures are applied so soil bio organisms don’t accept such fertilizers. In our variant minerals are dissolved in the alkaline environment, and bio fertilizers have been produced in the acidity reactor in acid environment at a temperature of 35-37 °C. This has created favourable conditions for the life of bio organisms and for the application of fertilizers.

Some minerals with the phosphorus, nitrogen, potassium and calcium content were dissolved by us.

Table 2

Testing results of biological fertilizers made of manure in which the ground shell limestone is dissolved (for 2013)

№	Name of indicator	Testing results	
		content in the dry matter	content in the raw matter
1	Mass fraction of moisture, %	81,53	
2	Acidity pH	8,8	
3	Mass fraction of organic matter, %	52,51	9,71
4	Mass fraction of ash, %	47,9	8,79
5	Mass fraction of ammonia nitrogen, %	0,83	0,154
6	Mass fraction of total nitrogen, %	1,44	0,27
7	Mass fraction of total phosphorus (P_2O_5), %	0,66	0,12
8	Mass fraction of total potassium (K_2O), %	2,20	0,41
9	Mass fraction of calcium, %	13,72	2,54
10	C:N	18,2	

This investigation demonstrates that we should produce highly qualitative biological fertilizers directly on the place of their application. Such fertilizers will cost about 300 hrn.

For ensuring the highly effective process on transformation of biomass into biogas and biological organic fertilizers, the following technologic line is suggested (Picture 1). It gives the overview of the sequence of some stages and work operations of the organic bio fertilizers and biogas production process with its further usage as raw material for the cogeneration unit on the production of electricity and heat. It comprises the whole operation cycle – from receiving the raw material to obtaining the manufactured goods.

Biomass received on the cattle farm with humidity 80-95% is delivered to the complex by auto transport for grinding long-fibre inclusions and is pumped into the oxidation fermenter 2, where the process of biomass heating, oxidation, mixing as well as dissolution of mineral supplement in the biomass takes place. This process lasts for 5-7 days.

Our investigations demonstrate that the dissolution of carbonates increases the amount of potassium by 4-7 times. In parallel with the loading process 30% of corn

silage is added into the oxidation reactor. The corn is delivered from the storehouse by the tractor and is also loaded into the receiving tank, then going through the grinder 3 to the particles of 1-3 mm. The loaded substrate is heated with the help of heat exchanger 4 to the temperature 25 °C and may be oxidized up to 5 days depending on the need in loading of the biomass fermentation reactor 6.

The process of heating mixing of the substrate due to operation of a mixer 5 takes place. Liquid biomass is delivered into the reactor 2 through the faeces pump 1.

Reactor 6 is a completely air-tight tank made of acid-resistant concrete, in which heat is isolated by the layer of insulation.

The period during which raw material is in the fermenter can be 20-40 days with the fixed for microorganisms temperature 34-37 °C.

Biomass mixing within the reactor is conducted by the sloping mixers 8 made of stainless steel, and the heating occurs in the result of hot water cycling in the heat exchanger 9. The temperature of water coming into the reactor is 60 °C, while after passing through the reactor it is about 40 °C.

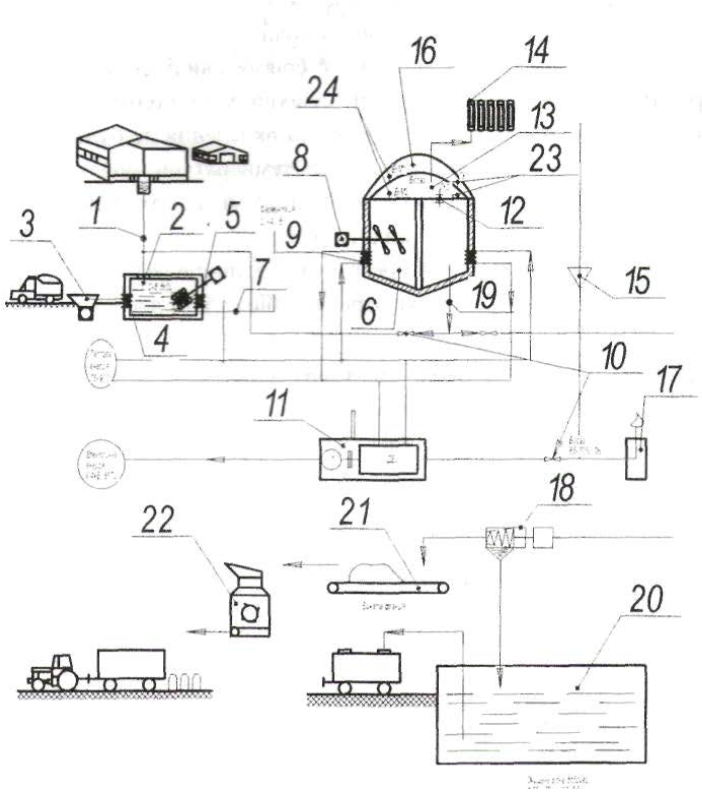
Biogas unit is equipped with the cogeneration unit 11 in which water from the ICE cooling is used for the reactor heating. Water temperature after generator is 90 °C. Heat and electricity consumption by the unit itself is from 5 to 15 % of all energy, produced by the biogas complex.

Cogeneration units are the equipment for combined production of electricity and heat, in which gas-piston internal combustion engines adapted to work on the low-caloric gases are applied. Cogeneration thermal power station can produce 2-4 kW of electric and 2-8 kW of heat power out of $1m^3$ of biogas. Biogas is burned immediately without enrichment. The fermented mass is delivered from the reactor 6 onto the separator 18 which is auger millet, by the pump 19.

The removed liquid fraction is kept in the lagoon 20, but it is also delivered for mixing with the fresh substrate during the phase of biomass oxidation and is used as liquid biological organic fertilizer of high quality.

Pressed solid component is delivered by the transporter 21 to granulator 22, from which dry matter – highly qualitative biological organic fertilizer, is obtained.

Production of dry granule fertilizer practically excludes loss of nutrients during long storage, gives the opportunity to put these fertilizers within the most favourable calendar terms with the application of standard mechanisms.



Picture 1 The scheme of production line of biomass into gas and biological organic fertilizers

1 – faeces pump; 2 – oxidation reactor; 3 – grinder; 4, 9 – heat exchanger; 5, 8 – mixer; 6 – reactor; 7, 19 – pump-dosimeter; 10 – locking control unit; 11 – cogeneration unit; 12 – valve; 13 – ; 14 – purifying column; 15 – compressor; 16 – tent covering; 17 – flare; 18 – separator; 20 – lagoon; 21 – belt; 22 – granulator; 23 – safety valve; 24 – electronic-contact manometer

The mass is pumped from the tank for keeping liquid fertilisers into the tanks and is removed on the fields or on sale. Dutch firms are working on the problem of the extraction of food supplement out of the liquid fraction.

Investigations on the influence of biological organic fertilizers on the yield capacity of corn, tomatoes and cucumbers were carried out. Table 4 demonstrates the

results of field experiments on the influence of biological fertilizers on the yield capacity of corn.

Table 3

Influence of fertilizers on the yield capacity of corn, t/ha

(for 2013)

Name of corn hybrid	Yield capacity, t/ha		
	control	manure application	Application of biological fertilizers
DCS 3571	13,7	15	15,6
DCS 2971	8	8,6	11,5
DC 315	9,9	11,6	12
DCS 3472	11,3	12,3	15,2

Data in table 3 demonstrate that the yield capacity of corn in the result of application of biological organic fertilizers has increased by 35−40%. Testing of biological organic fertilizers when growing tomatoes and cucumbers, has led to the increase in their yield capacity by 40 i 90% accordingly.

The conducted investigations demonstrate the possibility for Ukraine with its large reserves of biomass as well as minerals containing calcium and phosphorus to produce biological organic fertilizers on the place of the usage and growing of ecologically clean products. The given technology has one more advantage – preparation of fertilizers for the given crop, changing our attitude to the rotation.

Conclusions.

1. For Ukraine with its large reserves of biomass as well as minerals containing calcium and phosphorus it is advisable to use biological fertilizers of the certain content for the given crop with growing ecologically clean products.

2. Application of biological fertilizers acting in the soil up to 10 years, increases yield capacity of agricultural crops by 40-90 %.

3. For further development of agriculture our state must develop animal husbandry, and therefore transfer work of internal combustion engines on biogas.

4. Refusal of agrarian sector from mineral fertilizers and diesel will make it economically independent and more efficient.

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Анотація

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Технологічна лінія по виробництву біогазу та біологічних органічних добрив для вирощування екологічно чистої сільськогосподарської продукції.

В статті розглянуто питання виробництва біологічних органічних добрив заданого вмісту фосфору, азоту, калію і кальцію під задану сільськогосподарську культуру.

Ключові слова: *біологічні органічні добрива, біогаз, реактор, технологічна лінія.*

Аннотация

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Технологическая линия по изготовлению биогаза и биологических органических удобрений для выращивания экологически чистой сельськохозяйственной продукции.

В статье рассмотрены вопросы производства биологических органических удобрений заданного содержания фосфора, азота, калия и кальция под заданную сельськохозяйственную культуру.

Ключевые слова: *биологические органические удобрения, биогаз, реактор, технологическая линия.*