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Raw material base and efficiency BIOGAS

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The basic technical and technological parameters of the biogas reactor and the process of biogas production. A technological stages biogas digesters using rotating. The economic efficiency of electricity from biogas.

Biomass digesters, biogas, mixing efficiency.

Formulation of the problem. Improving the energy efficiency of biogas plants is one of the main directions of improving the process of biogas production, and therefore justification methods for determining the specific power and energy parameters of operation of biogas plants requires constant improvement.

The operation of biogas plants showed that promote contact with anaerobic bacteria biomass substrate is provided by the mixing of the substrate, but with intensive mixing must be avoided, as this can lead to poor anaerobic digestion at the expense of symbiosis atsetohennyh and methanogenic bacteria. In practice, the compromise achieved by slow rotation agitators or work within a short time. [1] At the same time, operating experience biogas reactors showed that almost impossible to remove bundles of biomass in a reactor in mineral and organic sediment floating biomass, indicating weaknesses in the operation of the mixing [2, 3].

Analysis of recent research. As a result of research we have patented a number of technical solutions that largely eliminate the separation of biomass by providing mixing layers using biomass

embedded rotating biogas reactors. Defined as the level of immersion in the rotating liquid methane tanks and rate of filling, depending on the geometric parameters and density of the liquid, which is immersed rotating digesters in securing its location in a suspended state. [4]

The power it takes to overcome the moment of resistance in the bearings depends on the level of organic biomass into digesters, its weight and performance of biogas and biomass [5, 6]. Power consumed by mixing biomass depends on characteristics of biomass (density, dry matter content, particle size of dry matter) and structural-kinematic characteristics digesters (angular velocity, the inner radius, length, geometric dimensions and placement of blades, mixers and walls inside the digesters) .

The purpose of research. Set the main technical and technological parameters of rotating biogas reactor and process biogasas well asyznachyty economic efficiency of electricity from biogas.

Results. Production of biogas from digesters rotating invited to perform on technological stages that hover in Fig. 1.

Potential biogas production using plant biomass and using manure and litter can be determined by the following relationship:

$$Б = Б_P + Б_T = k_{БГР} k_{ВР} \sum_{i=1}^{n} S_i 100 У_i \left(k_{Bi} - k_{3i}\right) + k_{БГТ} k_{BT} \sum_{j=1}^{m} N_j T_j \left(m_{Ej} + m_{Bj}\right) k_{Гj}, \quad (1)$$

where: B - biogas potential in the fermented biomass and hnoyivky m3; BR - biogas yield in the fermented biomass, m3; BT - fermented in the biogas yield hnoyivky m3; kBHR, kBHT - Specific biogas yield during anaerobic fermentation of biomass and according hnoyivky m3 / kg; kVR, kVT - utilization according biomass and biogas installations in hnoyivky, ratio. ed .; n - number of crops in the rotation, used for the production of biomass; Si - growing area and th culture hectares; Ui - yield and th culture kg / ha; kVi - output ratio and biomass th culture, ratio. ed .; kZi - loss factor and biomass th culture in the collection, ratio. ed .; m - number of groups of animals and birds; NJ - cattle and poultry j-th type, Ch .; TJ - stall period cattle and poultry j-th species days; *mEj* - Weight excrement j-th species of animals and birds, kg / head. per day; mVj - the mass of water that enters the excrement j-th species of animals and birds, kg / head. kHj a day - The exit rate hnoyivky suitable for fermentation liquid phase, Rest. units.

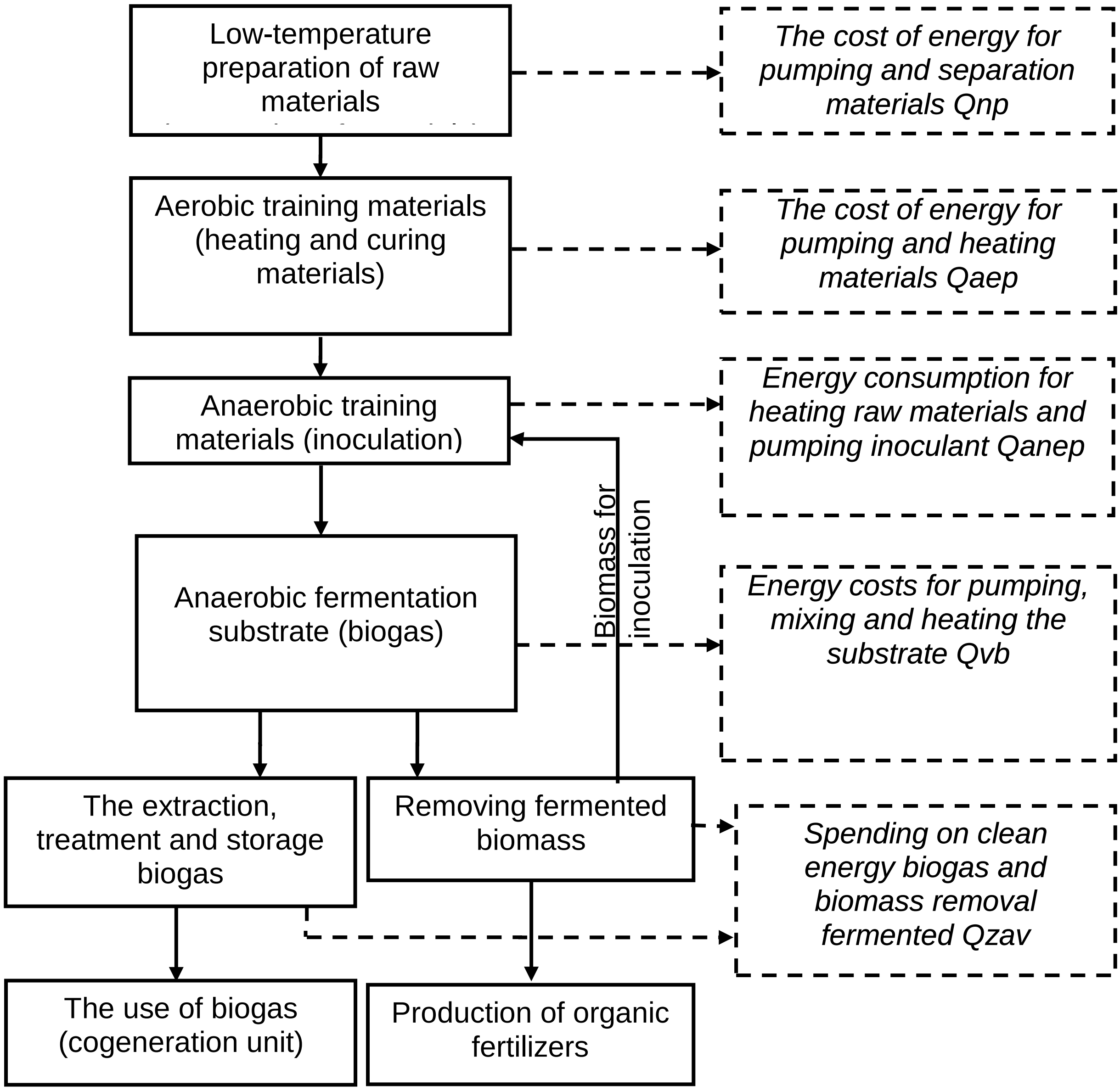

Fig. 1. Block diagram of the process stages biogas.

Utilization of biomass and biogas in hnoyivky plants, biomass and exit th culture and its losses during harvesting,hnoyivky output suitable for fermentation liquid phase, and the amount of crops in rotation used for biomass production, cultivation area and yield th and culture, the number of groups of animals and poultry, livestock and stall period the animals and birds j-th type, weight and excrement mass of water entering the excrement j-th species of animals and birds is established for each agricultural enterprise based on specific modelsfunctioning of agricultural ecosystems.

Based on the volume of biogas can set basic technical and technological parameters of a biogas reactor, in particular, and the whole process of biogas production in general.

Specific biogas yield per one kilogram of biomass with anaerobic digestion can raise up on the basis of studies [7, 8, 9, 10, 11, 12, 13] and knowing the basic parameters of substrates (Table. 1).

1. The main parameters of the substrate (mean) and limits the output values of specific biogas.

The base substrate	Density		The content of dry mass ksm	Particle size solids Rsr city	Dynamic viscosity ηB, Pa	Specific biogas yield, m3 / kg	
	ρB biomass, kg / m3	ρSRB dry biomass, kg / m3				mines	max
cattle Dung	1028	1140	0.20	0.01	0.03	.0314	.0570
swine Manure	1046	1200	0.23	0.01	0.05	.0405	.0900
Bird droppings	1006	1020	0.32	0.01	0.02	.0473	.1152
Corn residues (silage)	1027	1100	0.27	0.03	0.03	.0765	.2328
Sugar beet	1069	1300	0.23	0.05	0.06	.1656	.1879
Fodder beet	1036	1300	0.12	0.05	0.04	.0465	.0867
Beet tops	1024	1150	0.16	0.03	0.03	.0578	.0768
Green grass (silage)	1038	1100	0.38	0.02	0.04	.0963	.2356
Grain bard	1004	1050	0.07	0.01	0.01	.0214	.0493
Potato bard	1004	1050	0.07	0.01	0.01	.0204	.0466
fruit bard	1001	1030	0.03	0.01	0.01	.0054	.0185
Pressed pulp	1048	1200	0.24	0.02	0.05	.0495	.0865
Molasses	1043	1050	0.85	0.01	0.05	.2448	.3969

Based on the values of the specific release of biogas and biomethane can determine the density of the resulting biogas for a wide range biosyrovyny (tab. 2).

Based on the basic parameters of the substrate and biogas are given in Table. 1 and Table. 2 [11] and the relevant calculations [4, 6] to set the rotary digesters that provide energy to minimize the mixing of biomass and biogas for the necessary performance.

2. Estimated values of density biogas.

The base substrate	Specific output biomethane (*CH4)* m3 / kg		The content of CO2, m3 / kg		The density of biogas			
					in a bioreactor, kg / m3		under normal conditions, kg / m3	
	mines	max	mines	max	max	mines	max	mines
cattle Dung	.0182	.0342	.0132	.0228	1,251	1,226	1.236	1,211
swine	.0235	.0540	.0170	.0360	1,251	1,226	1.236	1,211

Manure Bird droppings	.0269	.0691	.0203	.0461	1.263	1,226	1,248	1,211
Corn residues (silage)	.0383	.1280	.0383	.1047	1.352	1.289	1.335	1.273
Sugar beet	.0878	.1015	.0778	.0864	1.314	1,301	1.298	1.286
Fodder beet	.0246	.0468	.0219	.0399	1.314	1,301	1.298	1.286
Beet tops	.0306	.0415	.0271	.0353	1.314	1,301	1.298	1.286
Green grass (silage)	.0510	.1272	.0452	.1084	1.314	1,301	1.298	1.286
Grain bard	.0124	.0320	.0090	.0172	1,251	1,163	1.236	1.149
Potato bard	.0118	.0303	.0086	.0163	1,251	1,163	1.236	1.149
fruit bard	.0031	.0120	.0023	.0065	1,251	1,163	1.236	1.149
Pressed pulp	.0347	.0648	.0149	.0216	1,100	1,037	1,087	1,024
Molasses	.1714	.2977	.0734	.0992	1,100	1,037	1,087	1,024

At the recommended settings biomass, biogas and biogas selected structural parameters of the rotating reactor [11], we can estimate the effect fill factor on energy consumption and determine its optimal value.

set to rotating biogas Rector (Table. 3) at the optimum ratio of filling to ensure its swimming [5, 6].

Using the parameters listed in Table. 3. The design allows the rotating rotary biogas reactors with minimal specific energy consumption for mixing biomass.

The analysis can be argued that filled the magnitude of 94 to 95% of a rotating reactor with a volume Vb biomass load of 3 to 103 m3 (working diameter D is in the range of 1 to 4.3 m) require minimum power to drive Nkr from 299 watts to 10.4 kW at his immersion into liquid by the amount of 95 to 97%. This drive mechanism power density per volume of biomass in the reactor lie in the range of 99.85 to 101.23 W / m3.

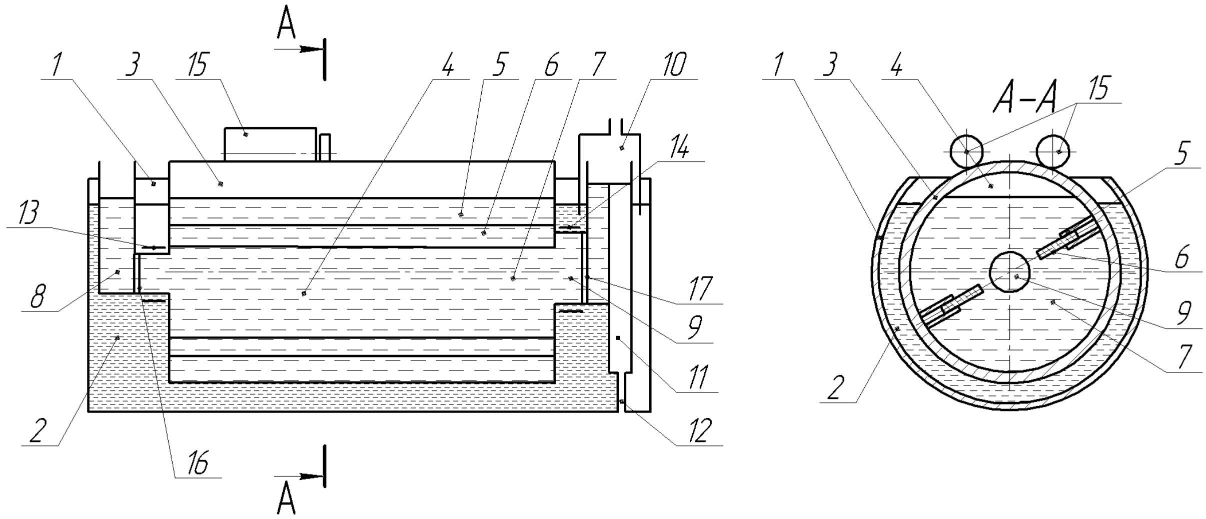

Fig. 2. Scheme rotating biogas reactor module type 1 - horizontal outer casing; 2 - liquid; 3 - cylindrical reactor; 4 - cell fermentation; 5 - bulkhead; 6 - moving plate; 7 - organic matter; 8, 9, 12 - pipes; 11 - discharge chamber; 13 14 - bearing assemblies; 15 - external drive; 16, 17 - block seals.

3. Rational structural parameters of rotating biogas reactors.

Operating the reactor diameter, D, m	Wall thickness reactor s, m	The diameter of the outer shell Dz city	Working length L, m	Mr reactor Weight kg	Fill factor KZ biomass	Volume loaded biomass (maximum) Vb, m3	Power to Nkr rotation, W
1	0,003	1.2	4	200	0.94	3.0	299
2	0,005	2.4	4	424	0.94	11.8	1197
3	0,005	3.6	4	895	0.94	26.6	2661
4	0,005	4.8	6	1979	0.95	71.3	7114
4.3	0,005	5.2	7.5	2797	0.95	103.0	10408

Given that the heating of the substrate can be direct biomass energy crop, and for mixing and pumping the substrate of the share of electricity generation due to the use of biogas, biomethane production cost will be:

$$C_{БМ} = \frac{\rho_{ПБ}}{k_{БМ}\tau_{ЗБ}} Ц_{БМ}\left(1-k_{Д}\right)+\left(1+k_{ЗВ}+k_{ЗГ}\right)\left(ТОР_{БМ}+ЕЛ_{БМ}+ЗП_{БМ}\right), \quad (2)$$

Where: SBM - biomethane production cost, € / m3; ρ_{PB} - density processed in biogas reactors biomass t / m3; kBM - out of biomethane per day per unit volume of biogas reactor, m3 / m3 day; τ_{BZ} - Hold

biomass in the reactor during the fermentation, days; TSBM - cost biomass, which comes to processing in the biogas plant, UAH / t; kD - factor increasing the cost of organic fertilizers after anaerobic digestion of biomass, ratio. ed .;
kZV -factor that takes into account overhead costs, relative. ed .; kZH - factor that takes into account the general running costs, relative. ed .; TORBM - payments for maintenance and repair biogas plant to the production of biomethane, € / m3; ELBM - the cost of electrical energy consumed in the production of biomethane, € / m3; ZPBM - payroll taxes from the production of biomethane, € / m3.

The cost of electricity from biomethane can be determined based on the expression:

$$C_{ЕЛ} = \frac{3{,}6\rho_{ПБ}}{k_{БМ} q_{БМ} \eta_{Г} \tau_{ЗБ}} Ц_{БМ}\left(1 - k_{Д}\right) + \left(1 + k_{ЗВ} + k_{ЗГ}\right)\left(ТОР_{ЕЛ} + ЕЛ_{ЕЛ} + ЗП_{ЕЛ}\right), \quad (3)$$

where: pos - the production cost of electricity, € / kWh .; qBM - biomethane calorific value, MJ / m3; η_G - efficiency of the diesel generator in the electricity, ratio. ed .; 3.6 - conversion factor, MJ / kWh; Torel - payments for maintenance and repair biogas plant with the electricity, € / kWh .; ELEL - the cost of electrical energy consumed in the production of electricity from biomethane, € / kWh; ZPEL - payroll taxes from the production of electricity from biomethane, € / kWh.

Apparently from the resulted expression,out of biomethane per day per unit volume of biogas reactor (Fig. 3) is a value that defines the technical and economic performance of biogas plants.Calculations showed that with the increase of arable land Specific biogas yield increases slightly, due to an increase in efficiency of biogas digesters with increasing volume.

The cost of electricity from biomethane with reference to the area of crop rotation shestypilnoyu shown in Fig. 4.

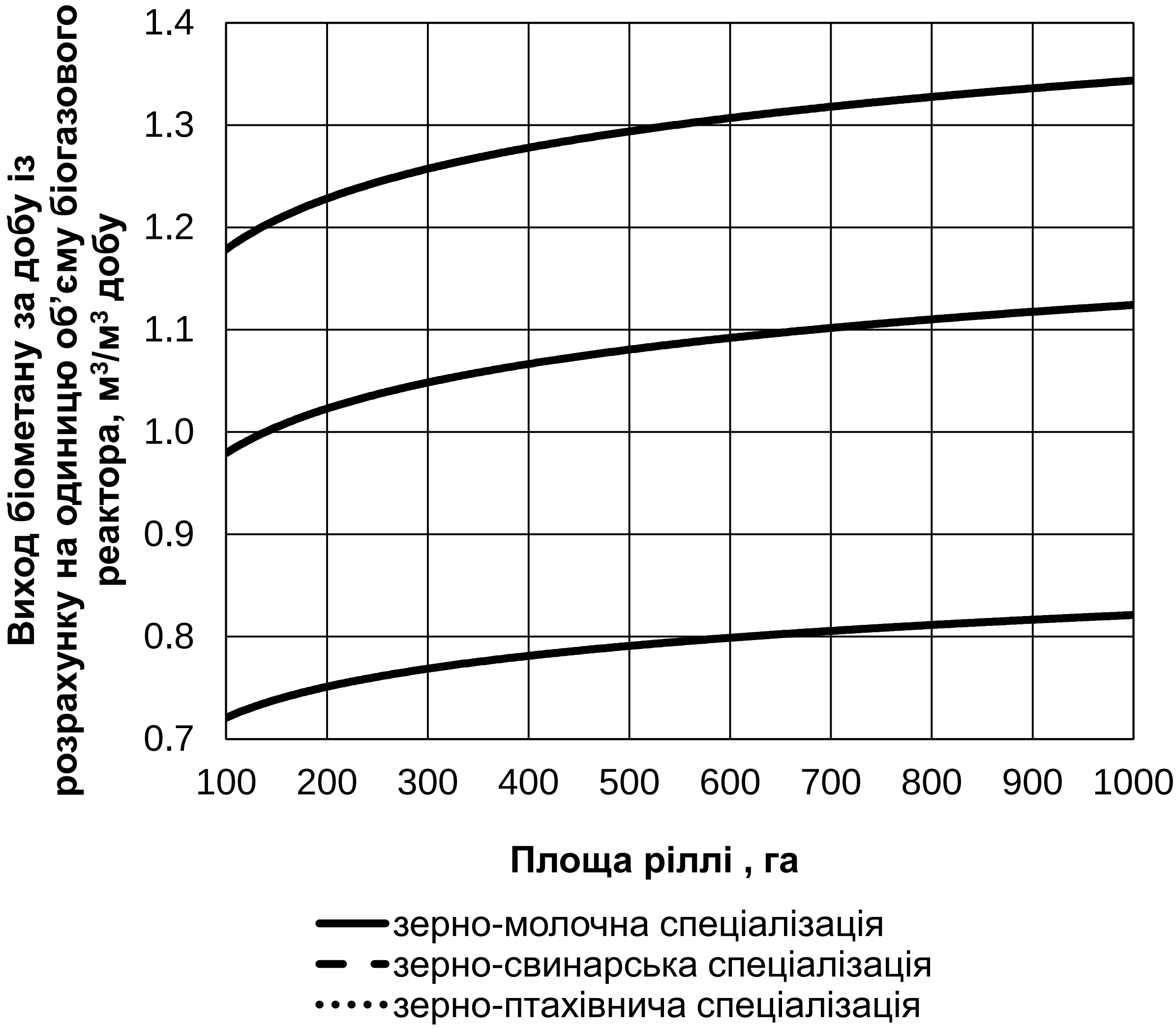

Fig. 3. Out of biomethane per day per unit volume of biogas reactor depending on model farms arable land.

Thus, with increasing area of arable land of over 1,000 hectares of the cost of electricity from biogas stabilizes at a level of 0.30 to 0.44 USD / kWh.

Conclusion. Output per day of biomethane per unit volume of biogas reactor for companies with a major grain-milk ranging from 0.72 m3 / day m3 to 0.81 m3 / m3 dayAnd the production cost of electricity based on using biogas reactors rotating type is between 0.44 USD / kWh. to 0.85 USD / kWh. for companies with seed-pig specialization respectivelyfrom 0.98 m3 / day m3 to 1.12 m3 / m3 day andfrom 0.38 USD / kWh. to 0.85 USD / kWh. and for enterprises of grain and poultry specialization - from 1.18 m3 / day m3 to 1.34 m3 / m3 day andfrom 0.30 USD / kWh. to 0.72 USD / kWh. At lower values and higher output biomethane mentioned the cost of electricity will take place in the area of 100 hectares of arable land, and the relatively larger output value biomethane and lower values of the cost of electricity - with 1,000 hectares of arable land.

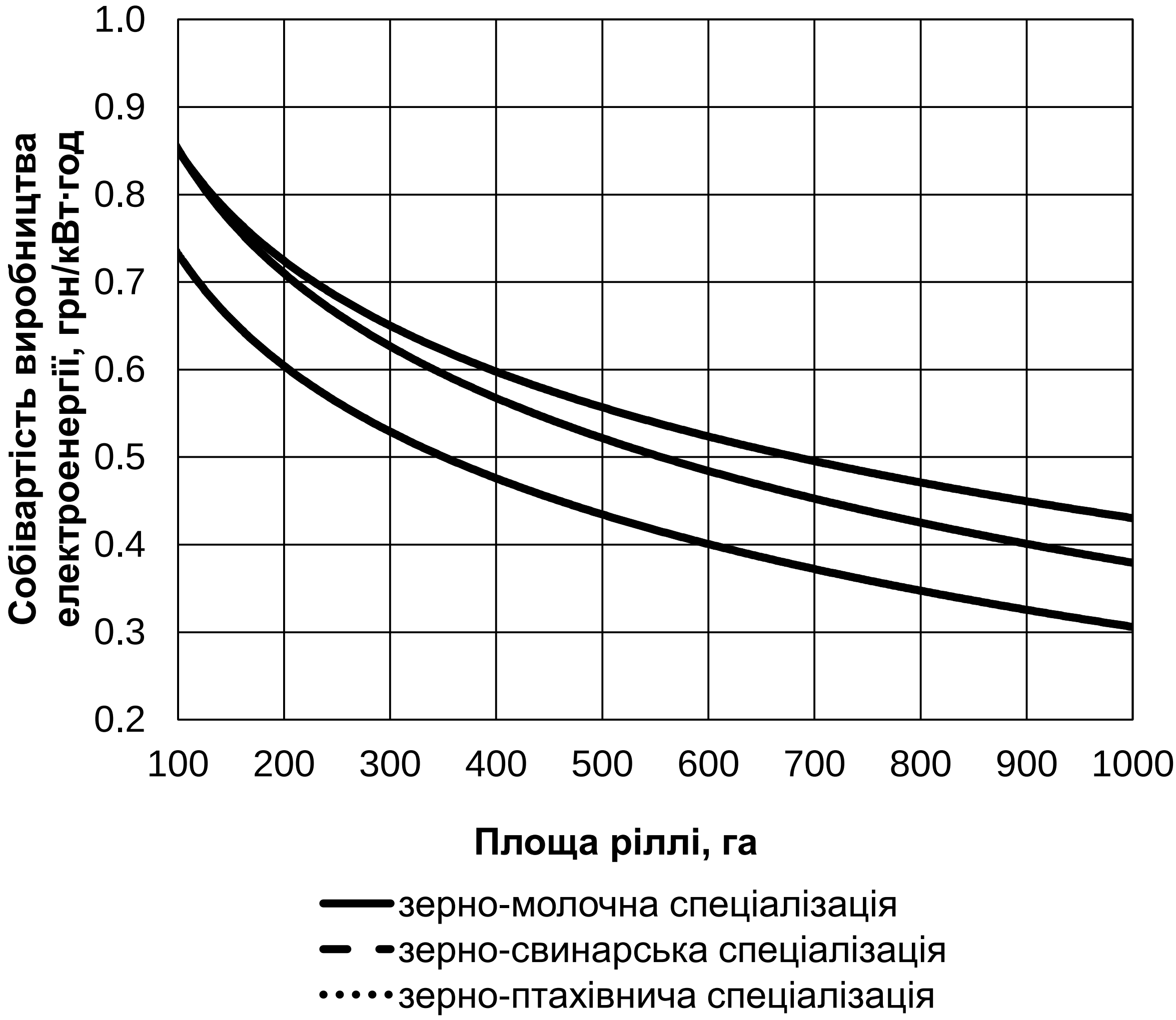

Fig. 4. Changes in the cost of electricity produced from biomethane depending on model farms arable land.

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Ustanovlenы Basic technical and Technological Options byohazovoho reactor and biogas production process. Predlozhenы Technological эtapы obtaining biogas digester with primeneniem vraschayuschyhsya. Opredelena Economic Efficiency electricity production based on biogas.

Byomassa, digesters, biogas, peremeshyvanye, effectiveness.

Was established the basic technical and technological parameters of biogas reactor and process of biogas production and proposed technological stages of biogas digesters using rotating methane tanks and determined the economic efficiency of electricity generation with biogas.

Biomass, methane tanks, biogas, mixing, efficiency.