

## HIGH-VOLTAGE PULSE DISCHARGE AS FACTOR OF THE METHANOGENESIS INITIATION

B. P. Chesnokov<sup>\*</sup>, F. K. Abdrazakov, E. V. Spiridonova, O. V. Naumova,  
D. S. Katkov

Federal State-Funded Educational Institution of the Higher Education "Saratov State Agricultural  
University of N. I. Vavilov" Russia, 410012, Saratov, Teatralnaya Square 1

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### ABSTRACT

Results of scientific research on influence of the high-voltage pulse discharge on process of bioorganic waste methane sludge fermentation in agricultural production are given in the article. Powerful infra- and ultrasonic fluctuations leading to emergence of shock waves exert strong impact on processes: disinfecting, cleanings and deflocculation of bioorganic mix, as well as on activity of various physical and chemical changes of synthesis products. Selecting the modes of high-voltage pulse processing, it is possible to provide highly productive anaerobic bacteria. At the same time "artificial selection" as a result of which weak microorganisms perish is observed, and the strong group remains. Viable species of microorganisms, having received at the order nutrient medium, as a result of destruction and death of weak microorganisms, begin to breed quickly, increasing growth of a biofilm responsible for a biogas exit. For the analysis of experimental data on development of technological process for anaerobic sludge fermentation the method of trans-resonant functional topography which provided informational content of the active environment concerning ions and free radicals arising in the course of modifying the organic substratum was used.

Author Correspondence, e-mail: [uunaumov@mail.ru](mailto:uunaumov@mail.ru)

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## INTRODUCTION

Transition of agro-industrial production to intensive technologies led to an aggravation of a huge bioorganic waste volume utilization problem of rural economic production including large poultry-farming complexes [1-4]. Becoming a source of environmental pollution, industrial poultry farming requires special attention for the solution of this problem. In this regard, bioconversion of agricultural waste gains crucial importance for receiving new products at high ecological process purity. One of the directions in the solution of an objective is use of anaerobic sludge fermentation process of a bird's droppings with simultaneous receiving organic fertilizers and commodity biogas.

The existing ways of anaerobic processing do not provide full disinfecting and deeper decomposition of agricultural production waste. Therefore development of new biogas units and technologies of processing liquid manure and guano in the conditions of an anaerobic sludge fermentation for receiving gaseous fuel and organic fertilizers at methane fermentation of agricultural production waste is an urgent task now.

The physical and chemical, microbiological properties and health requirements to organic fertilizers received as a result of an anaerobic sludge fermentation can be improved if to enter operation of the high-voltage pulse discharge into technological process. Application of the new perspective direction is based on use of electrohydraulic shock effect which appears in liquid environments under the influence of a digit impulse [5]. After processing organic raw materials, in the course of a sludge fermentation increase in depth of bioorganic waste decomposition on poultry-farming complexes, liquid activation, and decrease in time of decomposition and increase in an exit of biogas is observed. The unit [6] allowing processing the bioorganic waste by the high-voltage discharge (fig. 1) was developed for realization of the proposed technical solution.

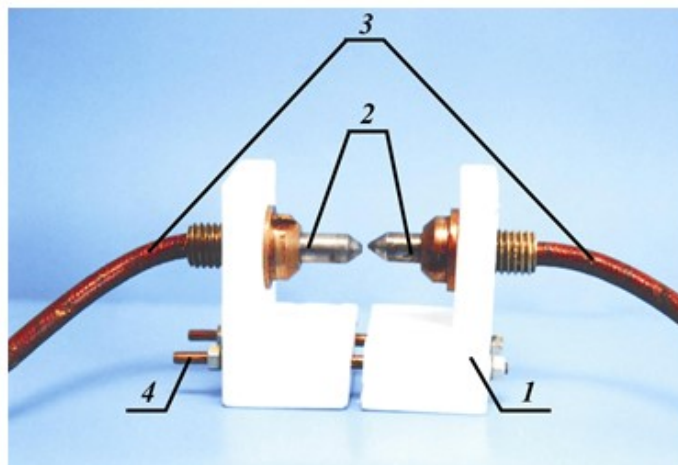


**Fig.1.** The device for high-voltage processing of bioorganic waste. 1 - air gap; 2 - voltage stabilizer; 3 - tension transformer; 4 - digit camera bioreactor; 5 - resistor block; 6 - high-voltage measuring instrument; 7 - condenser.

Advantage of the offered method consists in an opportunity to change thermodynamic characteristics: density, magnetic and electric susceptibility, pH and to provide anaerobic sludge fermentation process at lower temperatures.

### 1. Research Technique

Prerequisite for carrying out researches in this direction were earlier obtained data on change of water properties under the influence of a digit impulse. The technique of an experiment was planned taking into account a possibility of the high-voltage discharge use on kinetics of activation, decomposition and change of properties of water, solution and bioorganic chemistry at high ecology of conducting process. The universal digit knot (fig. 2) which is built in the camera of the bioreactor by means of which processing of water organic substratum was carried out was developed for initiation of anaerobic sludge fermentation process.



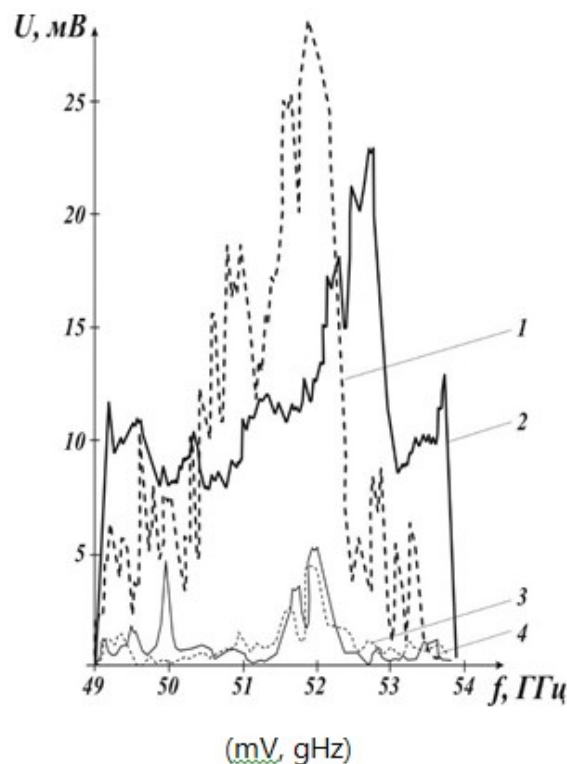
**Fig.2.** High-voltage digit knot: 1 - PTFE case; 2 - tungsten electrodes; 3 - high-voltage wires; 4 - adjusting device.

Processing of water or liquid organic substratum was exposed in the closed volume with a pulse voltage from 7 kV to 10 kV at the following quantity of impulses 3, 5, 7, 11. Production tests showed high technological efficiency of an air gap when processing a bird's droppings. In the course of production tests it was established that the offered way completely is implemented in a production cycle of anaerobic sludge fermentation. Application of this way shows high extent of decomposition of organic substance which makes 25-30% that above admissible values of the known technology of sludge fermentation. The method of high-voltage electric discharge for modifying water has a number of obvious advantages: simplicity of implementation, small processing time, a possibility of technological process regulation in the wide range of operating modes.

For studying the mechanism of modifying water and solutions as a result of activation of electro pulse processing the highly sensitive equipment allowing to register changes on a nano level and to issue data on a physical and structural condition of liquids on the basis of transmission and resonant EHF/UHF - radio spectroscopies was used. Control of change entropy was exercised on the trans-resonant functional topographer, developed by scientists of the Federation Council of IRE Russian Federation [7, 8]. High degree of resolution of the data-acquisition equipment ( $10^{-14}$  W / V), allows to reveal regularity of activation by change of a signal of entropy and own fluctuation of water and solutions depending on the mode of the electro spark pulse discharge.

## 2. Research Results

Water, being a source of super weak and weak variable electromagnetic radiation, very sensitively reacts to external influences increasing number of molecules with the free communications filling emptiness of tetrahedral structure. The effect causing "breakage" of complex structure of water causes change of density that is confirmed experimentally.



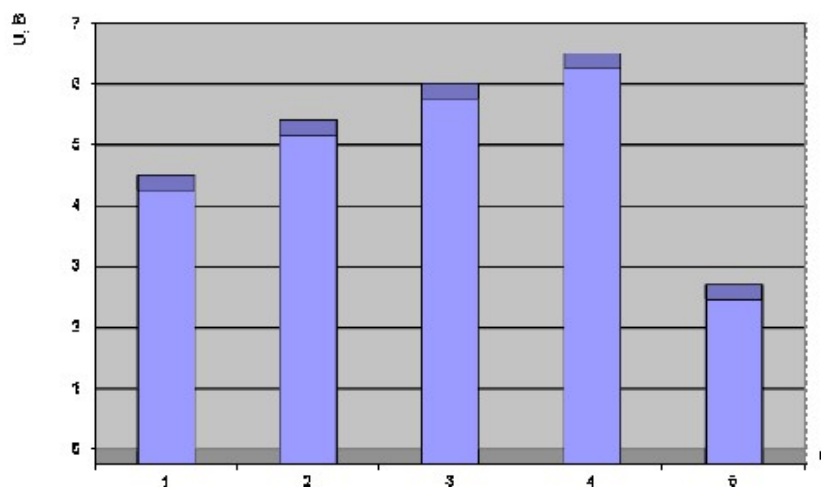
**Fig.3.** Spectral dependences of the water and distilled water

Ranges: tap water before processing (1) and after processing by the high-voltage discharge (2); the distilled water before processing (3) and after processing by the high-voltage discharge (4).

The original method of application of electric energy consisting in explosive impact on water allowed to establish that electric discharge leads to violation of the ordered orientation of its molecules and causes a rupture of molecular bindings; ranges 2 and 4 of which narrowing spectral lines is common. The last gives the chance to reveal the hidden local anisotropy and to track dynamics of a rupture of molecular bindings. At a frequency of 50 GHz the resonant peak which can be explained with formation of an intermediate product - hydrogen peroxides is observed. Using influence of highly sensitive radiometry when studying spectral water analysis

in processing by its high-voltage electric discharge, it was succeeded to track the nature of water structure change and to identify the stabilized intermediate products.

High-voltage processing of water leads to the fact that group of the molecules removed from each other on distances, the called "bifurcate bindings" which are in the excited and unstable state begin to have high radiating ability; increase in entropy (fig. 4) proves it.

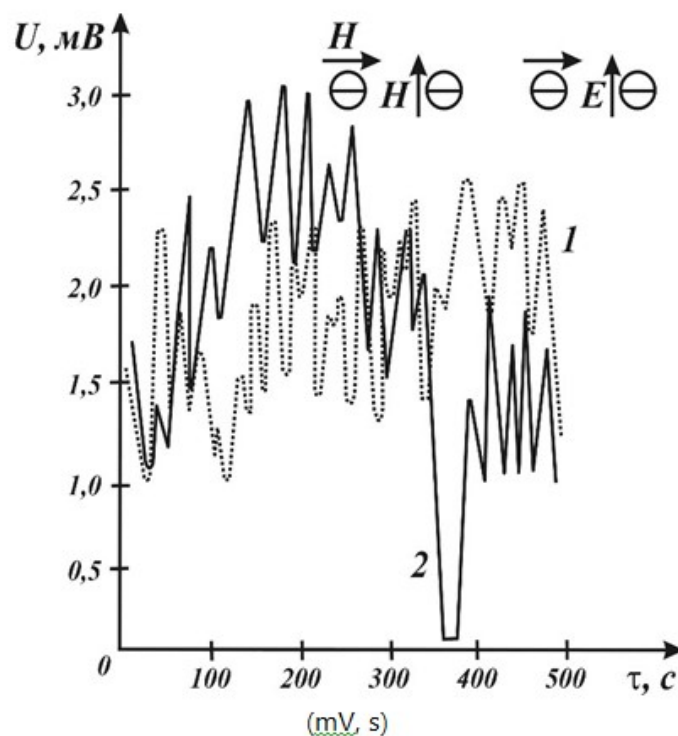


**Fig.4.** The nature of water entropy change before processing 1 - initial water; 2, 3, 4 - the water conditioned by electric discharges, respectively 3, 5 and 7 impulses; 5 - the structured water.

If to consider that the nature of change is caused by quantum and wave processes, then they define ways of distribution of electric influence which need to be explained on the basis of an elementary particles virtual couple energization in electron positron. Therefore, big entropy corresponds to the least structured water. The unstable electrochemical system cannot be durable and due to change of kinetic energy of intermolecular interaction of water molecule on which surfaces electric charges are distributed, leads to its structuring. This confirms the decrease in entropy of water in comparison with a reference value due to the ordered wave interactions since the system turns into steady state with stable properties.

The analysis of the existing problem showed that new ways of preparation of raw materials before a bookmark it in biogas units for an anaerobic sludge fermentation on the basis of high-voltage electric discharge use deserve close attention [9, 10]. The electro pulse discharge reconstructs structure of water solution of organic substances and creates the active centers changing a ratio of separate stages speeds of complex catalytic reaction of anaerobic sludge fermentation and strengthens exchange of charges between substratum components. Researches

allowed to state changes in structure of organic solution of the water environment after influence of the high-voltage discharge. Ranges show that frequencies of own molecular fluctuations of water and a substratum with bio environment microorganisms received on the known way and developed, have characteristic distinctive features (fig. 5).



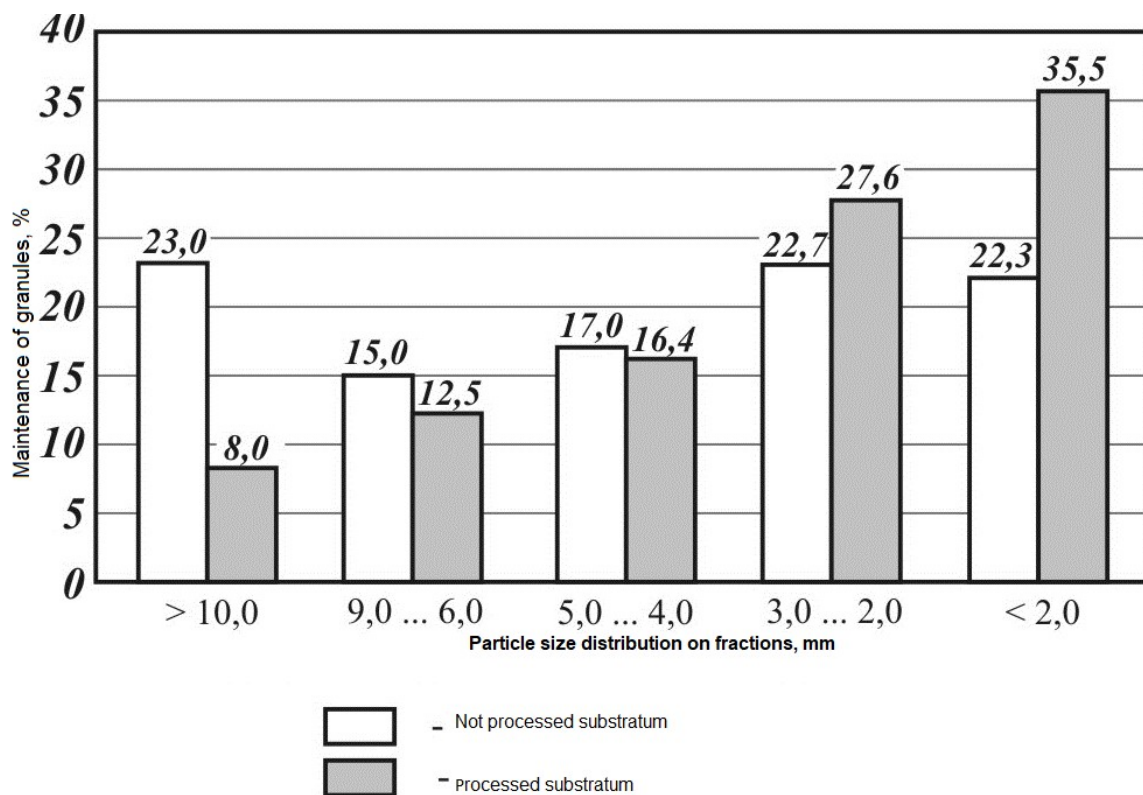
**Fig.5.** Ranges of own electromagnetic radiations of an organic substratum when imposing magnetic (N) and electric (E) fields: 1 - water + organic substratum of a bird's droppings raw; 2 - water mix with an organic substratum of a bird's droppings, subjected to impact of electric discharge

The electrohydraulic effect leads to violation of communications; researches of ranges of resonant frequencies confirm it. Samples placed in magnetic (tension 300 e) and electric (tension 30 V/cm) the field to which they are sensitive, and watching absorption or reflection of radio waves, judged degree of activity and structural changes in the studied objects.

Pulse processing, due to influence of the field of a high tension, creates the active centers changing speed ratio of separate stages of complex catalytic reaction and strengthens electronic exchange between substratum components, forming molecules of new substances. Researches showed that the electrohydraulic effect causes crushing of organic particles. The particles received as a result of influence of a high-voltage impulse favorably differ in the small size and a

large number at simultaneous increase in a specific surface. Emergence of the updated surfaces promotes increase in activity of a sludge fermentation of organic chemistry in the liquid environment.

Change of particles by the sizes testifies to the qualitative characteristic of the final product, and the proposed technical solution allows controlling process of reaction of a sludge fermentation and decomposition of firm components of a water organic substratum (fig. 6).



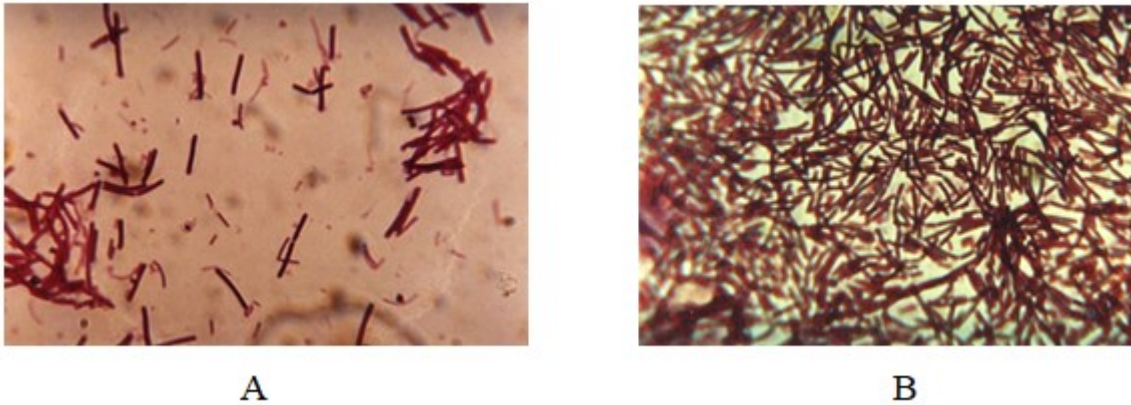
**Fig.6.** The chart of dependence of the particles sizes from a way of processing

Thus, impact of high-voltage pulse processing gives the chance not only to increase activity of the liquid environment, but also to provide cardinal reorganization of water solution structure with stable particle size distribution of organic substances. Besides, promotes receiving high-quality organic fertilizers in a digestible form and with the improved physical and chemical properties.

Biogas exit directly depends on quantity of microorganisms therefore a priority at a sludge fermentation of a substratum it is necessary to understand receiving the highly productive strains having valuable biosynthetic properties. The carried-out series of pilot studies demonstrates



changes of microbiological properties of a water organic substratum owing to the anaerobic sludge fermentation initiated by the high-voltage pulse discharge (7).



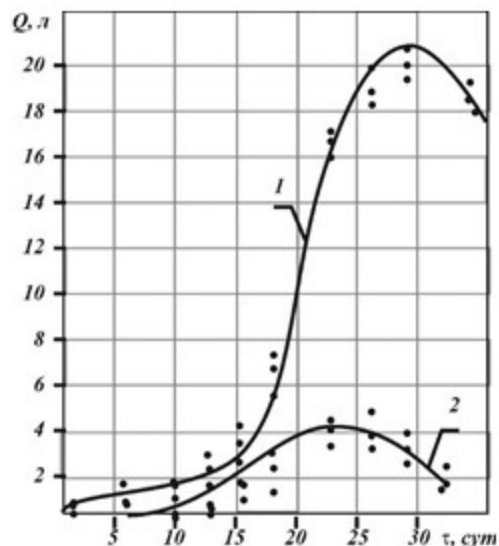
**Fig.7.** Dabs from the substrata received: on the industrial and offered technology.

Apparently from results of researches, the power information field defines origin and development of organisms, as well as bears information on how vital processes have to proceed. Therefore, increasing ability of a microorganism to produce metabolism of a cell, the possibility of increase in growth rate and increase in a surface of bacteria methanogenesis opens. Thus, manipulating energy and impulses of electric discharge in the course of impact on a cell microorganism according to in advance developed program, it is possible to influence significantly the hereditary device, designing thereby system of biofilms with new properties (fig. 8). The biofilm, bacteria methanogenesis, presented in the Figure 8, and, the carrying-out role of "the anaerobic filter", is characterized by a small specific surface and respectively a low exit of biogas.



**Fig.8.** Biofilms of the bacteria methanogenesis received by anaerobic sludge fermentation on the known and offered technologies.

The biofilm presented in fig. 8 (b) is a product of biologically active agent subjected to influence of a digit impulse and differs impressive (2,5 times higher) in surface area, and, therefore, in ability to produce a biogas exit for a short period. It is experimentally established that preliminary processing of bioorganic waste by the high-voltage pulse discharge promotes activation of biochemical processes and, as a result, to more intensive disintegration of organic substances and increase in an exit of biogas; results of researches (fig. 9) show it. The analysis of the obtained data shows that at the existing technological process (a curve 2), there is very slow process of decomposition of a substratum and a small exit of biogas is observed. Activation by a digit impulse of an organic substratum, allows to increase biogas exit by 5 times (a curve 1), in comparison with natural process.



**Fig.9.** Dependence of an exit of biogas from a water organic substratum from sludge fermentation time: 1 - after processing by the corona discharge, 2 - without processing.

Thus, investigating possibilities of a new microbiological way of receiving renewables (biogas) in the course of organic waste utilization it was established that, varying energy of the high-voltage discharge influencing the bioorganic mass of a substratum it is possible to increase intensity of a methane sludge fermentation and to provide effective and selective management of the reactions proceeding in the course of biogas production [11, 12].

### 3. DISCUSSION

The above-stated researches showed that high-voltage processing leads to changes in structure of a substratum due to which molecules gain ability to change the orientation. High activity of macromolecular fractions of bioorganic system is caused by emergence in initial mix of active particles under the influence of the electric field providing course of reactions at lower temperatures is 10-20 °C lower, than in usual conditions.

In view of the fact that in processing of a substratum the main role is played by structural changes in a liquid phase, using a micro location method, it is possible to track impact of the strong insurges caused by a digit impulse on structural changes of a water substratum. Activation is caused by products of a radiolysis OH, H and  $e_{\text{hydr}}$ , and, also the fact that gases, interfering with the proceeding reaction, work as acceptors of radicals. Thus, it turned out that the liquid organic substratum processed by the high-voltage discharge is capable to remote informing on the

properties through biofield electromagnetic radiation at a certain resonant frequency power in several electron/volt.

Studying the mechanism of energy migration at the molecular level shows that the crucial role in them is played by transport of electrons on a chain of oxidation-reduction reaction. An established fact of existence of bioelectric fields due to which transfer of electrons in fermentable systems and receipt in a cell of the nutrients influencing cellular metabolism is carried out.

All above the described processes confirm C. R. Darwin's theory according to which at first there are spontaneous fluctuations, in this case of organic substance, and then selection comes into force and irreversible biological evolution which leads to change and streamlining of structure of a biofilm responsible for a biogas exit begins.

#### 4. SUMMARY

High-voltage unit which allows carrying out multiple-factor physical and chemical influence is developed and underwent experimental testing for complex organic and biological structures, activation of water solutions of an organic substratum, to provide disinfecting and water purification, livestock drains, as well as to productively solve many problems in the agrarian sector of economy.

Improvement of advanced technologies on base of electro physical methods of influence by preparation for an anaerobic sludge fermentation of water organic raw materials for the purpose of the microorganisms' activation responsible for a biogas exit makes urgent use of the developed ways on an industrial basis and further improvement of process.

Use of the highly sensitive equipment based on a method of transmission and resonant EHF/UHF - radio spectroscopy, allowed to estimate changes of properties and structure of the studied environments, to reveal the nature of change of own fluctuations and entropy, as well as to define the optimum modes of processing: tension in  $UO_{\text{impulse}} = 7$  kV, quantity of impulses of  $n = 5$ .

Existence of electric potential in a water organic substratum which promotes increase in number of the microorganisms responsible for a biogas exit is experimentally established, gives the chance to operate technological process and to increase probability of high-quality change of the received final products properties.

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