



EFFECT OF TRACE ELEMENT COMPOSITION ON SOLUTION MINERALIZATION OF ELECTROCHEMICALLY ACTIVATED WATER IN ACIDIC MEDIUM

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Abstract: The article presents the results of research on the electrochemical activation of natural canal and tap water with low mineral content and the influence of the composition of microelements on the mineralization of the obtained solution.

Keywords: canal water, tap water, electrochemically activated water, electrolyzer, diaphragm, pH value, electrode, anolyte, catholyte, degree of mineralization of water, fresh water.

Currently, large-scale research is being carried out in various countries of the world to study the effects on chemical and biological processes of various physical factors on natural water that change its physical, chemical and biological properties. Especially in recent years, researches on the separation of products formed in electrolyzed water into anolyte and catholyte portions with the help of membranes, which took place as a shape change of the large-scale electrolysis process, have gained great scope in chemical technology. In this case, the electrolysis products divided into two parts are acidic (the liquid in the anode part of the anolyte membrane) and the other is alkaline (the liquid in the cathode part of the catholyte membrane), which differ not only in their hydrogen index, but also in their physical, chemical and biological Properties, differs from natural water (1,2,3,4,5).

In this context, we aim to develop a technology for using electrochemically activated water and its micronutrient compositions in pre-sowing treatment of seeds when growing polys crops in outdoor and greenhouse conditions. Because in this technology, ordinary canal or tap water is treated with electric current for a short time (15-20 minutes), and it can be used for treatment before planting seeds and is cost-effective.

The theoretical significance of the research results is that before sowing the seeds of polys plants, the solution of electrochemically activated water in an acidic medium (anolyte, pH=2.5-3.5) and its micronutrient composition (Cu) in a very low concentration (0.01%) is used and is refrigerated for 30 minutes and 24 hours. The implementation is carried out on the basis that the sowing is maintained in an acidic environment in an environment humidified with electrochemically activated water at a temperature of not less than 24 °C. In this way, it is possible to distribute the supplied micronutrients evenly over the field together with the seeds and to clean them of harmful microorganisms.

It is known from research that microfertilizers are used in the methods of application to the soil before planting, additional fertilization (spraying a 0.1-0.05% solution of microelements) and seed treatment before sowing (soaking the seeds with their 0.02-0.05% solution) are used), and the water used is mainly solvent-containing ordinary stream, canal and tap water. In the experiment, we used electrochemically activated water instead of ordinary water. Therefore, we considered it important to investigate the stability of the added trace element in the activated solution, especially its effect on the mineralization degree of the solution.

The sum of ions, molecules and various compounds in water provides information about its mineralization. The results of the analysis of long-term hydrogeological and hydrochemical regime indicators of Amudarya and Syr Darya show that the lower the degree of mineralization of river waters, the worse their quality. Under laboratory conditions, the mineralization of water bodies is represented by dry precipitation. Dry sediment is expressed in milligrams/liter, grams/liter or in brackish and nomopic waters, milligrams, grams.

Depending on the amount of dry sediment (mineralization), O. A. Alyokhin divided natural water bodies into five classes. In his opinion, the amount of dry residue in fresh water of the first class is 0-1 g/l (in some literature 1-1.5 g/l), which means that the degree of mineralization of the water is normal (6).

Based on the above information, we conducted studies on the electrochemical activation of natural canal and tap water with low mineral content, as well as the influence of the composition of microelements on the mineralization of the obtained solution.

The studies were carried out in the scientific research laboratory of the “Chemical Technology” Department of the Namangan Institute of Engineering and Construction in the Central Laboratory of the Namangan State Technical University “Suvokava” (Mutual Cooperation Agreement No. 2/2021). Electrochemical activation of the water used for the study was carried out using the ruthenium device MELESTA (TU 5156-002-32064510-2007, EAES No. RU D –RU.MN10.V.01343/20) manufactured in the Russian Federation (Figure 1).

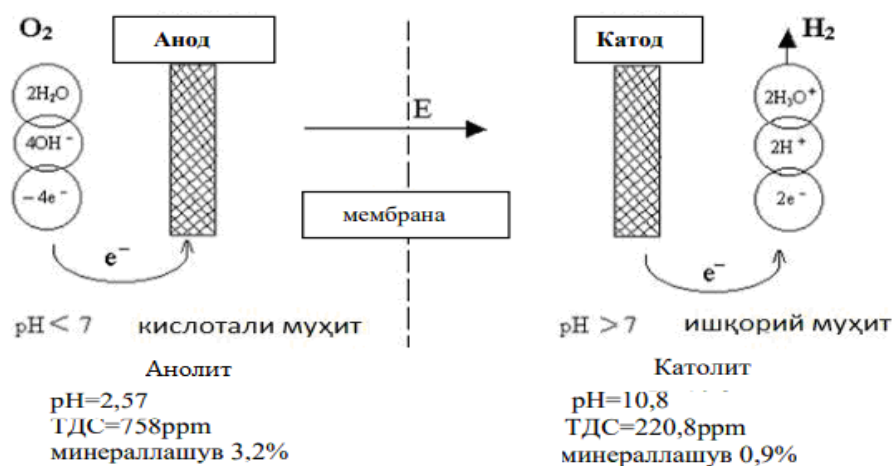


Figure 1. Melesta device.

The electrochemical activation device is divided into two parts by a membrane. When a constant electric current is applied, the positively charged cations in the water move toward the cathode and the negatively charged anions move toward the anode. Oxidation takes place at the cathode and reduction occurs at the anode. First, water, even in small amounts, is broken down into hydrogen cations and hydroxyl anions. In addition, salts found in natural canal and tap water are dissociated into cations and anions.

When an electrode is connected to a circuit, cations move to the negative electrode and anions move to the positive electrode. Hydroxyl ions OH^- give up their electrons at the anode, i.e. H^+ . the oxidation process takes place. Chlorine ions remain on the anode and bind hydrogen cations H^+ to themselves, creating an acidic environment

At the cathode, chlorine ions donate their electrons to the electrode and become free chlorine. This leaves Ca^{2+} ions around the cathode and binds hydroxyl anions to itself, creating an alkaline environment. As a result, the (+) part of the area in the solution containing the (-) electrode remains alkaline, and the active part near the anode remains an acidic environment (Scheme 1).



Scheme 1. Mechanism of electrochemical treatment of water

As can be seen in the diagram, the main chemical reactions at the cathode are, on the one hand, the formation of hydrogen and, on the other hand, the reduction of dissolved oxygen to hydroxyl ions, making the environment alkaline. Hydroxyl ions combine with metal ions to form hydroxides. Magnesium hydroxide precipitates in the solution because it is a poorly soluble base. After complete precipitation of magnesium hydroxide, calcium hydroxide is formed. When the solution reaches

$\text{pH}=11,5$, Ca^{2+} ions react with CO_3^{2-} ions, which are always present in the water, and form the next precipitate. This means that the hardness of alkaline water decreases. The separation of oxygen and chlorine takes place at the anode. Chlorine reacts with water to form hypochlorous acid (HClO), causing the environment to become acidic.

In year 3, experiments were carried out on the electrochemical activation of natural canal and tap water with a low mineral content, as well as on the influence of the composition of microelements in an acidic environment ($\text{pH}=2,5-3,5$) on the mineralization of the resulting solution in variants with 3 repetitions. The 1st option used water from the Northern Fergana Canal, the 2nd option used Namangan Canal water, and the 3rd option used tap water from the Namangan urban area. For the test, samples in a volume of 60 liters were taken from the relevant objects on November 1, 2023.

The solution environment of the samples taken in the study in the natural state (as a control variant), after electrochemical activation and with the addition of microelements to

the acidic environment of electrochemically activated water was determined in all variants using certified measuring devices according to international standards. In this case, the environment of the solutions (hydrogen indicator, pH) was analyzed under laboratory conditions with an EZ-9901/986 pH meter and the degree of mineralization with a "HANNA" HI 5321 conductometer (Figures 2 and 3).



Figure 1. Brand EZ-9901/986
pH-meter



Figure 2. "HANNA" HI 5321 brand
conductometer

In this case, option 1 is the water of the northern Fergana canal in natural water at a temperature of 18 C°, pH=7.8, the level of mineralization is 340.7mg.l. (340.7 ppm), the total concentration of mineral salts is 1.4%, option 2 natural Namangan canal water at a temperature of 17 C° has pH=7.7, the level of mineralization is 388.7mg.l. (388.7 ppm), the total concentration of mineral salts is 1.5%, and option 3 tap water taken from the territory of Namangan city at a temperature of 17C° has pH=6.6, the level of mineralization is 332.1mg.l. (332.1 ppm), the total concentration of mineral salts was 1.2%.

The obtained samples were activated for 20 minutes in the MELESTA device after the analysis of the control variants. Then, the degree of mineralization and environment of the electrochemically treated water in the resulting acidic and alkaline environments were measured.

In this case, variant 1 in acidic environment (anolyte) water of the northern Fergana channel at a temperature of 26 C°, pH =2.64, mineralization level is 730.8 mg.l. (730.8-ppm), the total concentration of mineral salts is 3.1%, option 2 Namangan canal water at a temperature of 29 C° has pH =2.5, the degree of mineralization is 1059.2mg.l. (1059.2-ppm), the total concentration of mineral salts is 4.1%, and option 3 tap water at a temperature of 29 C° has pH =2.6, the degree of mineralization is 758.0mg.l. (332.1- ppm), the total concentration of mineral salts was 3%.

Option 1 in the alkaline environment (catholyte) water of the northern Fergana canal at a temperature of 26.6 C°, pH=10.2, mineralization level 220.8mg.l. (220.8- ppm), the total concentration of mineral salts is 0.9% Option 2 Namangan canal water at a temperature of 27.8 C° has pH=10.7, the level of mineralization is 255.2mg.l. (255.2-ppm), the total concentration of mineral salts is 1%, and option 3 tap water at a temperature of 28.6 C° has pH=10.8, the degree of mineralization is 202.0 mg.l. (202.0-ppm), the total concentration of mineral salts was 0.8% (Table 2). In the device, a 0.01% solution of trace elements of copper (based on copper cuprate) was prepared in the part of the electrochemically activated water divided into two parts with an acidic environment, and the effect of the added salt on solution mineralization was studied.

In this case, the part of the northern Fergana canal water in the acidic environment (anolyte) of the electrochemically treated version 1 has a temperature of 25 C°, pH=2.4, and the level of mineralization is 960.1 mg.l. (960.1 ppm), the total concentration of mineral salts is 3.8%, option 2, the part of Namangan canal water in an acidic environment (anolyte) at a temperature of 26 C° has pH=2.3, the level of mineralization is 1236mg.l. (1236-ppm), the total concentration of mineral salts is 4.8%, and option 3 of tap water in an acidic environment (anolyte) at a temperature of 26.7 C° has pH=2.1, the level of mineralization is 958.9mg.l. (958.9-ppm), the total concentration of mineral salts was 3.6% (Table 1).

Table 1

Effect of micronutrient composition on solution mineralization on ECA water in acidic media

T.p.	Experience options	In control	Acidic in the environment	When the trace element Cu ²⁺ is composed
1.	North Fergana canal water	340,7	730,8	960,1
2.	Greater Namangan canal water	388,7	1059,2	1236,0
3.	Tap water	332,1	758,0	958,9

Compared to the control variants, it was observed that after the electrochemical treatment, pH changed in the average range of 2.5-2.6 in the acidic environment, and in the range of 10.2-10.8 in the alkaline environment. It was found that the degree of mineralization of the solution increased sharply in all variants, especially in an acidic environment, and decreased in an alkaline environment.

When copper salt was dissolved in electrochemically treated water in an acidic environment, it was observed that the degree of mineralization of the solution increased dramatically in all options (diagram 1).

diagram 1





Based on the conducted research, the following conclusions were made

- Analyzes of canal and aqueduct water in the natural environment showed an average pH value of 7.36 at 17.3 C°, the degree of mineralization is 353.8 mg.l. (353.8-ppm) and the total concentration of mineral salts was 1.4%;

- When the microelement copper is added to the anolyte part of the electrochemically activated water, its complete dissolution is observed and no precipitate is formed;

- Compared to the control options, pH after electrochemical treatment in the experimental options was observed to change in the average range of 2.5-2.6 in the acidic environment and in the range of 10.2-10.8 in the alkaline environment;

- It was found that the degree of mineralization of the solution increased sharply in an acidic environment for all options and decreased in an alkaline environment.

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