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Development of technology for reuse of collector trench waters

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Abstract. It is known that water in nature has the property of self-purification. But by our century, the level of water pollution exceeded the norm. As a result, water could not completely eliminate the contaminants contained in its composition. This also defines the problem of solving on self-purification of water. There are various ways to control the quality of water, from which it is possible to list the following: reduce the number of dissolved salts contained in the water or dilute the water, reduce the hardness of the water, reduce the amount of iron contained in it, reduce the number of floating substances hanging in the water, etc. Therefore, in this proposed method, salt underground water sources are used, and the problems of water for use in rural areas, farms, and similar enterprises have been solved. The degree of desalination depends on the content of water. Magnesium cation water is sufficient to separate the gypsum compounds, which are found to be unfavorable for this method. This requires a method and technology that will distinguish only these salts from water. In this article, the process of adding irrigation water to groundwater, treating it, and reusing it for irrigation has been implemented. An experiment was conducted using Faraday's law. The experiment was mainly to remove unwanted salt content from the water through plates and check the quality of the water. As a result, the excess amount of salt in the water was removed, and it was reused and used for irrigation.

1 Introduction

Now we live in one of the periods of development of a new field of science. To date, if we take the water resources of our homeland as 100%, then 11% of it is formed in the territory of the Republic of Uzbekistan; the remaining 89% flows from the army countries, that is, from the cross-border countries. Unfortunately, in all seasons of the year, water is distributed unevenly; in some climatic conditions, there is a shortage of water when the need for it increases, and there is even a need to reuse collector-trench water. This, in turn,

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leads to a further increase in the level of salinity of the land, and as a result, the harvest of crops and the growth process slows down for a while, and it is observed that the expected harvest is not collected [1,2]. To solve these problems, it is necessary to develop environmentally and economically acceptable technologies to reuse collector trench waters in water-deficient areas by reducing water mineralization using new innovative technologies [3, 4]. Thanks to the technology of reuse of the currently proposed collector-trench waters, these problems can be avoided [5].

At present, some small projects are being used in our country to prevent the complete disappearance of the Aral Sea water in Uzbekistan, the longest collector on the territory of the Republic of Karakalpakstan, even in the world, as the only example to tell them. The Akchadarya collector is the longest in the world [6,7]. The length of the collector is 193 km and holds 30-35 cubic meters of water per second. The World Bank built this collector based on the "Uzbekistan drainage project" from 2004-2013. Based on the project, reconstruction, and repair of 241.93 km main and 1903.4 km inter-farm collectors systems were carried out [8, 9]. The construction of the Akchadarya collector, which drains an average of 800 million m3 of the evil (zakh) waters of the southern regions of the Republic of Karakalpakstan (Turtkul, Ellikkala, Beruni) with a total of 100 thousand hectares of irrigated areas per year, was completed in 2013 and the collector waters through the old channel of the Zhanadarya River (Zhanadarya - an old tributary of the Amu Darya) were brought to the drained place of the Aral Sea (The Big Island). Only in one district of our republic 800 million m^3 of water is unintentionally discharged [10]. We must create the possibility of reusing these waters by reducing water salinity based on innovative technologies. The technology we are developing offers a device for reuse by cleaning highly mineralized water with mechanical, chemical, and physical methods [11, 12].

To successfully explore the new land and provide all irrigated areas with water, it is necessary to look for new water reserves. One of the solutions to this problem is the use of a mineralized collector trench and underground water.

Groundwater came from the use of water for irrigation purposes. So far, groundwater use for agricultural needs on the surface of the Earth has been developed in many countries. 66% of the irrigation reserves are groundwater and trench waters. Groundwater in Saudi Arabia and Lebanon is the only source of irrigation water. In Spain, more than 10 000 hectares of land are also irrigated by groundwater [13, 14]. In some nearby sea districts, research has been carried out on irrigation of some crops, for example, vineyards with salt sea water. If the water was too salty, it was used by mixing with clean water with fewer reserves. As can be seen from the results of such research, the amount of salt in the soil did not increase. During irrigation, the main part of the salts (up to 83%) that fall into the soil is washed with irrigation water [15, 16].

In the Eastern States of the United States, especially on the shores of the Atlantic ocean, rivers, lakes, and other water sources mixed with ocean waters are used to irrigate carrots and other agricultural crops. The degree of mineralization mixed with the waters on the rise of the ocean water varies. The concentration of salts in the cultivated soil layer is excessive. Then during precipitation and irrigation, the salts are washed off, and the salinity of the soil decreases [17].

Research on the use of low-saline waters in irrigation of various crops in the Mediterranean countries, the USA, Australia, India, Pakistan, and other countries shows that vegetable and melons crops, alfalfa, rice, wheat, and other crops up to 5,72 g/l, watered with much more grown waters can obtain a good harvest [18].

In Tunisia, the effect of irrigation of saline low lands with salt water on the reclamation state of the lands is established. Such sand soils were irrigated with mineralized water up to 5 g/l, and in heavy soils with mineralized water up to 2-2.5 g/l for several years in irrigation lands to be used in good trench conditions. This indicates that the state of soil salinity remains good [19, 20].

Previous experience in the Khorezm and the Bukhara regions, agricultural experience in the Fergana region, and other experience-in melioration on the use of mineral waters in reclamation and cultivation conditions of production show the possibility of using mineralized collector-trench waters [12, 13, 20]. At the Khorezm experimental sites, 3.5-4.6 g/l, at 0.86-1.14 g/l level of chlorine-ion, mineralized trench water was used for irrigation in cotton cultivation [14]. The productivity of cotton varied from 18 c/ha to 42 c/ha.

In the Bukhara experiment (1983 y), the irrigation field was watered with mineralized water up to 2-2.6 g/l, 4-5.2 g/l, 8-10.4 g/l, and was harvested at 25, 20.8, 19, and 19.8 c/ha, respectively. Cotton fields were irrigated with mineralized trench water in an increased volume of up to 6 g/l and approved to obtain a higher yield on relatively light rural lands [16].

2 Methods and materials

Faraday's laws of electrolysis. The reverse process of liquid dissociation is called recombination or molization. In weak solutions, the phenomenon of dissociation is stronger than molization, so even in such solutions, there are always ions.

In the absence of an external electric field in the electrolyte, Ions formed due to dissociation are in chaotic (irregular) motion. Suppose the K — cathode and A — anode, which are lowered into the electrolyte, are connected to a constant source of current (Figure 1), at the field effect. In that case, the ions begin to move in order, and an electric current is formed in the electrolyte. Since ions with a positive charge move towards the negative electrode — cathode (K), they are called cations, and ions with a negative charge move towards the positive electrode — anode (A), they are called anions [17,18].

After the ions go to the corresponding electrode, it either gives it an extra electron or turns into a neutral atom or molecule, taking what it didn't have.

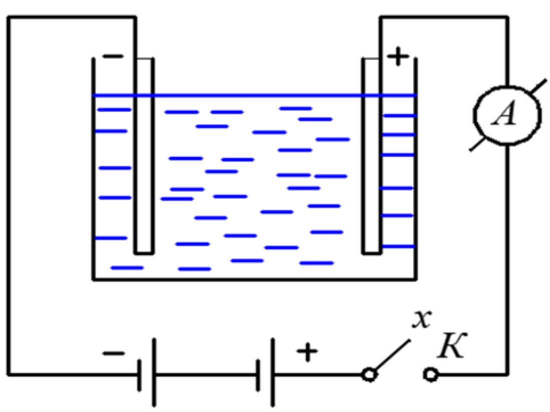

Fig 1. The process of electrolysis

The process of decomposing substances in the electrolyte under an electric current is called electrolysis. For example, we look at the process that occurs when an electric current passes through a copper chloride (CиC12) salt solution. The copper chloride molecule in the solution is dissociated into two positively charged copper atoms ion Cu^{++} and two negatively charged chlorine ions *2Cl*:

$$CuCl \Leftrightarrow Cu^{++} + 2Cl^{-} \qquad (1)$$

At that time, it is possible to determine using a free electron and write the following-looking reactions for ions that meet in the cathode and the anode:

$$Cu^{++} + 2e = Cu \qquad (2)$$

$$2Cl^{-} 2e = 2Cl \qquad (3)$$

So, the copper ion Cu^{++} takes two electrons from the cathode and turns them into a neutral copper atom *Cu*, while the chlorine ion *Cl* gives one electron to the anode and the neutral chlorine atom turns into *C1*.

Thus, the direct result of the electrolysis process is the accumulation of products of the chemical decomposition of electrolytes in the electrodes.

M. Faradei discovered two laws of electrolysis based on experiments called the Faradei laws. The first electrolysis law of Faradei is described as follows:

At the time of electrolysis, the mass of the divorced substance in the electrodes is proportional to the amount of charge passing through the electrolyte:

$$m = kq \qquad (4)$$

where: m is the mass of the substance decomposed in the electrode, q is the amount of charge passing through the electrolyte, k is the proportional coefficient, it is different for different substances, regardless of both the shape of the electrode and the strength of the current, both the temperature and the pressure, it is called the electrochemical equivalent of the substance [29, 30].

Based on the laws of Faradei, it is possible to find the mass of the dissociating substance in electrodes during electrolysis from the following equation:

$$m = \frac{1}{F} \cdot \frac{A}{z} It \qquad (5)$$

This is a mathematical expression of Faraday's combined law, which is described as follows:

The mass of the substance released in the electrodes during electrolysis is proportional to the chemical equivalent, current strength, and passage time.
Faraday number equals an increase of elementary electric charge *e* to Avogadro number N_A:

$$F = e \times N_A \qquad (6)$$

It follows from this that the charge of the electron is equal to:

$$e = \frac{F}{N_A} = \frac{96485309 Kl \cdot kmol^{-1}}{6.0221367 \cdot 10^{26} kmol^{-1}} = 1.60217733 \cdot 10^{-19} Kl \qquad (7)$$

The value of the electron charge found by this method corresponds to the value found in modern. This method is currently used in various fields.

Thus, it is possible to develop several spheres with the help of electrolysis. Based on the Faraday theory, we also conducted studies in natural field conditions in several collector trench water located in the Syrdarya region to reduce the mineralization of collector-trench waters.

The volume of collector-trench water collected in one year by the Republic is 12-15 billion m^3. These waters can not be supported in direct irrigation because water is highly mineralized and contains a variety of poisonous substances; there are chlorides, sulfates, magnesium, sodium, and other element compounds. But despite this, we can see cases in the practice of direct use of collector-trench.

The mineralized level of collector-trench waters is 3-16 g/l. They consist mainly of various sulfates. The suitability for irrigation of saline waters can be determined by various methods used in irrigation. In the Stebler method, the suitability of saline waters is estimated by the amount of Na+ ва Cl ions.

$$K = \frac{298}{n(Na + Cl)} \qquad (8)$$

where: K is irrigation coefficient; $n(Na + Cl)$ is the number of ions in pairs; K is the larger the quantity, the better the water consumption.

The goodness of water in the method of Sabolch and Darab indicates an excess of magnesium cation in the percent:

$$\%Mg = \frac{Mg^{2+}}{Ca^{2+} + Mg^{2+}} \cdot 100\% \qquad (9)$$

Results of determination of suitability for irrigation of waters treated by electrolysis based on the above methods are presented in Table 1.

Table 1. Assessment of the suitability of collector-trench waters for irrigation.

№	Stebler method		Sabolch method	
1	K=2.75	K=5.9	62	1.45
2	K=2.83	K=4.26	65.5	0
3	K=2.09	K=3.68	62	0
4	K=2.18	K=2.89	59	2.6
5	K=2.93	K=6.05	64	1.2

Based on the data obtained by the Sabolch and Darob method, the previous waters in the processing (initial state) were suitable for irrigation (mg>50%); after unipolar processing, water can be used in irrigation (up to 0-15.4%). When evaluating with the Stebler method, the amount of irrigation coefficient also increases after the electricity is produced (from 2.09 – up to 6.05). This means that after processing, the quality of the collector-trench waters increases. Most pure liquids, including absolutely pure water, kerosene, mineral oils, etc., are poorly conductors of electric current. But solutions of salts, acids, and alkalis in water and some other liquids-electrolytes conduct electric current well.

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For example, suppose you throw a little food salt (NaC1) into distilled water or drop a few drops into sulfuric acid. In that case, the water will become a good conductor because when many acids, alkalis, and salts dissolve, their neutral molecules decompose into ions with a positive and negative charge.

3 Results and Discussion

Samples were taken from the collectors of Saykhunabad district of the Sirdarya region for several chemical inspections. The results obtained from the Saykhunabad district of the Sirdarya region were brought to the practical laboratory and analyzed. In research in the laboratory process, we first determine the mineralization of collector water through the waterproof family device (Figure 2).

Fig 2. The process of preparing collector trench water for the sample

In the laboratory, several devices were used to create the water electrolysis process. The working process was organized through the Later device, accumulator (20W-35W), copper plate, and developed model.

As a result of the research, the own model was developed (Figure 3). In the developed model, water from the collectors is transported to the mechanical treatment plant, which is cleaned from a certain amount of various wastes. In this Part, 2 copper plates are installed. We must ensure that one of the 2 copper plates works in the anode and the other in the cathode system. An electric current is connected to the copper plate. Through it, the current will be transmitted in an unchanged state. In the process of electric current, the process of electrolysis occurs. Then the chemical compounds in the water are separated into two poles; that is, the process of division into anion and cation appears (Figure 3).

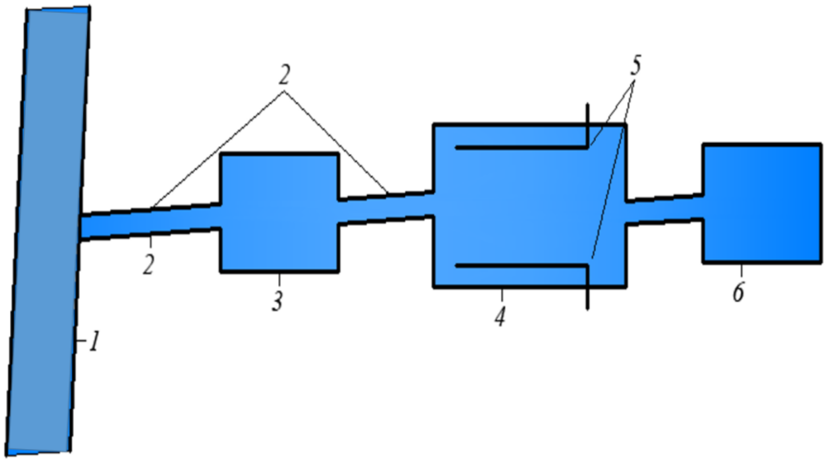

Fig 3. Developed model: 1 is collector, 2 is water intake channel, 3 is water sedative, 4 is water electrolysis unit, 5 is electrolysis, 6 is purified water storage department.

The main purpose of the conducted research is to reduce the mineralization of the collector-trench waters to a certain amount. When conducting such analysis, it is necessary to calculate the exact anions and cations of the collector's water (table 1) and electrolysis water to its suitability.

Table 2. The chemical composition of collector-trench water

№	Collector-trench water							
	Chemical components	Display form of analysis			Chemical components	Display form of analysis		
		mg/l	mg-eqv/l	mg-eqv-l		mg/l	mg-eqv-l	mg-eqv-l
1	HCO_3	326	6.52	30.56	Ca	56	1.12	6.26
2	Cl	95	2.85	13.36	Mg	119	4.76	26.6
3	SO_4	598	11.96	56.07	Na+K	182	12.012	67.14
4	Anion sum	1019	21.33	100	Cation sum	357	17.89	100

In chemical analysis, it was found that the dry residue was – 3376 mg/l, free CO_2 – 13.0 mg/l, PH – 7.02, total hardness 7.0 mg-ekv/l. To check the correctness of the analysis, the following expression was used:

$$K = \frac{\sum a - \sum K}{\sum a + \sum K} 100\% \quad (10)$$

$$K = \frac{\sum a - \sum K}{\sum a + \sum K} 100\% \quad (11)$$

Dry residue of water (Vernadsky E.P.) and the degree of hardness (o.A.Alekin) by methods determined. A dry residue of the collector-trench water – saline water, the degree of hardness – turned out to be solid water.

We determine water's acidity or alkalinity according to the aluminum classification.

$$HCO_3 > Ca + Mg \quad \underline{\textit{Alkaline waters}} \qquad (12)$$

The results obtained were verified using the device, according to which the salinity of water during the electrolysis process for 20 minutes; we continued the experiment with a current power of 20 V. At the same time, the salinity in the water taken for the chemical composition in the collector trench was 3.376 mg/l. After the experiments, the salinity of the water decreased from 3.376 mg/l to 2.293 mg/l.

4 Conclusions

- The main measure to protect against pollution of natural water sources is to prevent the release of collector-trench water into open water bodies by extensively using these waters to irrigate agricultural crops.
- After analyzing the existing theoretical developments and experimental data, the technology of reuse of collector-trench waters was developed.
- A model has been developed in the TIIAME laboratory to reuse collector-trench waters. Experiments were conducted on the model.
- At the same time: water –10 (liters), voltage – 20 V, plate surface – (12x20 (S)), duration of the experiment – (1200 sec), the result of the experiment – salt content decreased to 0.90 (mg/l).
- The possibility of reducing the salinity of collector-trench waters to irrigation water was created.

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