

CONCERNING THE PROSPECT OF USING ELECTROCHEMICAL ACTIVATION IN THE PRODUCTION OF ALCOHOLIC PRODUCTS

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INTRODUCTION

The problem of improving the quality of alcohol products (AP) remains relevant for any liquor, wine-brandy company. Compliance with the requirements of the national standards in force in Ukraine on the main components of AP – technological water (TW), ethyl alcohol rectified (EAR), and ready-made AP do not always lead to market success. Therefore, the growing demand and competition in the AP market make the problems of improving the processing of TW, EAR, water-alcohol mixture (WAM) and finding optimal conditions for the processes of production of AP.

To date, there are no scientifically substantiated conclusions and knowledge that are related to the adaptation of the technology of creating the AP to the specific production conditions, taking into account the large variety of characteristics of the main and auxiliary components. Given these characteristics, the enterprise intuitively selected: the scheme of water treatment; optimal proportions of TW; conditions for the creation of the WAM; methods of processing semi-finished products and others, which would ensure the stable quality of finished products. Since drinking water used in production has a non-permanent composition, therefore there are no single recommendations for achieving the optimal composition of the TW.

In this regard, the work of such leading scientists as Burachevsky Y.¹, Fedorenko V.², Bobin N.³ acquire special significance, which are devoted to a comprehensive study of the characteristics of the main components of AP – TW and EAR, their impact on the quality of the AP, both separately and in the complex.

¹ Бурачевский И.И., Федоренко В.И. Подготовка технологической воды и её влияние на качество водок. *Ликероводочное производство и виноделие*. 2003. № 44. С. 20-23.

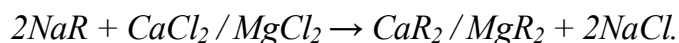
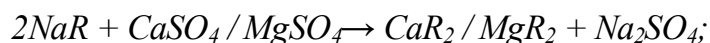
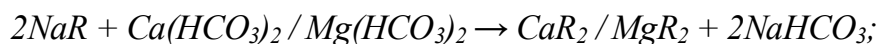
² Федоренко В.И. Современные системы водоподготовки для пищевых производств. *Ликероводочное производство и виноделие*. 2000. № 5. С. 1-6.

³ Бобин Н.Н., Дерусов А.А., Федоренко В.И. Многофункциональная система водоподготовки. *Ликероводочное производство и виноделие*. 2001. № 20. С. 4-6.

In the production of AP there are three types of TW, depending on the purpose of use: filtered and deodorized; softened due to Na-cationization; demineralized due to reverse osmosis. The TW must meet the requirements of normative documentation for water, with compliance with the technological regulations, technological instructions, sanitary norms and rules for each type of AP.

The technology for receiving filtered and deodorized process water includes the following elements: a filter for deferrization – oxidation of Fe^{2+} to Fe^{3+} with oxygen followed by removal; multilayer filter – filtration of microflora, Fe^{3+} , silicon, etc.; impurities filter for removal of colloidal organic contaminants through a layer of ion exchange resin in the *H*-form; carbon filter – reduces the concentration of free chlorine and organic compounds, by means of sorption on activated carbon; *UF*-sterilizer – neutralizes bacteria.

The technology of obtaining softened water to reduce the content of hardness salts is due to *Na*-cation exchange between Na^+ ions in cation exchangers and Ca^{2+} and Mg^{2+} ions in water. Due to the difference in the concentrations of these ions, cation exchanger is absorbed from Ca^{2+} and Mg^{2+} water and gives an equivalent amount of Na^+ to water⁴. Unlike calcium and magnesium, sodium does not form a precipitate, but it has well-soluble compounds in water⁵:



where NaR – cationite in *Na*-form;

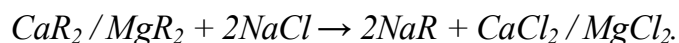
R – is a macromolecular moiety (radical), in the pores of which there are functional groups with mobile cations *Na*.

The cation exchanger is reduced by a 6...10 % aqueous solution of *NaCl*. Due to the high concentration of Na^+ ions in the regeneration solution there is a replacement

⁴ Федоренко В.И. Современные системы водоподготовки для пищевых производств. *Ликероводочное производство и виноделие*. 2000. № 5. С. 1-6.

⁵ Бобин Н.Н., Дерусов А.А., Федоренко В.И. Многофункциональная система водоподготовки. *Ликероводочное производство и виноделие*. 2001. № 20. С. 4-6.

of previously absorbed Ca^{2+} and Mg^{2+} cations under the reactions:



Upon receipt of demineralized water at the expense of reverse osmosis, the distribution of the solution occurs through preferential penetration of the solvent through the membrane under the influence of external pressure, which is much greater than the difference in the osmotic pressure of the solutions on both sides of the membrane. The membrane is a solid selective penetrable partition separating the mass transfer apparatus into two working zones, in which different vices are supported and various compositions of mixtures are formed (permeate, concentrate).

Alternative methods of preparing TW for the production of AP are^{6, 7, 8, 9, 10, 11}: chlorination; ozonization; silver processing; magnetic processing; electrochemical activation (ECA)^{9, 10}; heat treatment; defending, filtration; coagulation; deodorization; demaganation; lighting and discoloration; defluoridation de-oiling; decarbonization; fluoridation; elimination of sulfates; eliminating gases. From existing practical methods of disinfection of water: reagents (with the help of oxidants, metal ions – copper, silver, etc.)⁷; reagent (thermal, ultrasound, UV radiation, radioactive radiation), the most widely used oxidative disinfection⁸. Oxidants use chlorine, chlorine dioxide, sodium hypochlorite and calcium, as well as ozone, less hydrogen peroxide, potassium permanganate, and others¹¹.

1. Electrochemical activation of preparing technological water for the production of alcohol products

⁶ Бурачевский И.И., Федоренко В.И. Подготовка технологической воды и её влияние на качество водок. *Ликероводочное производство и виноделие*. 2003. № 44. С. 20-23.

⁷ Бахир В.М. *Современные технические электрохимические системы для обеззараживания, очистки и активирования воды*. М.: ВНИИИМТ, 1999. 84 с.

⁸ Алехин С.А., Байбеков И.М., Гариб Ф.Ю. и др. *«Живая» вода – мифы и реальность*. М.: МИС-РТ, 1998. 120 с.

⁹ Куртов В.Д. *Об удивительных свойствах электроактивированной воды*. К.: НПФ «ЭкоВод», 2010. 236 с.

¹⁰ Прилуцкий В.И., Бахир В.М. *Электрохимически активированная вода: аномальные свойства, механизм биологического действия*. М.: ВНИИИМТ, 1997. 228 с.

¹¹ Старикова Т.А., Лебедева С.А., Кольцов С.В. К вопросу о воде и водоподготовке. *Ликероводочное производство и виноделие*. 2005. № 62. С. 7-9.

According to our studies^{12, 13, 14, 15, 16, 17}, we can conclude that today there is no universal water treatment system for the production of AP that would satisfy all production needs in water, so each enterprise individually identifies the necessary combinations, both in equipment and in the definition of rational conditions production. Therefore, the purpose of the work was to study all sorts of information regarding the expansion of TW characteristics due to the use of ECA aqueous solutions in the creation of AP.

One possible step is to analyze existing technologies and alternative information about the ECA. Today it is known that the ECA appeared as a result of the works begun by Bahir V.M. in 1972, with further development^{18, 19, 20, 21, 22}, resulting in the emergence of the latest direction of applied electrochemicals – ECA.

In simplified form, «ECA» means «activation»¹⁸ with «electrolysis»¹⁹ through a «partition»²⁰ in the double electric layer of the anode/cathode with abnormal physicochemical and catalytic activity²² – during the period of «relaxation»²¹. A detailed review of all these issues needs some clarification^{18, 19, 20, 21, 22}.

– activation – the sum of the phenomena (effects, properties) that arise in the application of technical techniques for controlling the reactivity of substances without changing their elemental chemical composition occurring over a certain period of time – from the beginning to the end of the relaxation process;

¹² Kuzmin O., Suikov S., Niemirich O., Ditrich I., Sylka I. Effects of the water desalting by reverse osmosis on the process of formation of water-alcohol mixtures. ¹H NMR spectroscopy studies. *Ukrainian Food Journal*. 2017. 6 (2). pp. 239-257.

¹³ Kuzmin O., Suikov S., Koretska I., Matiyashchuk O., Poliovyk V. Identification of equilibrium state of hydroxyl protons in vodkas by ¹H NMR spectroscopy. *Ukrainian Food Journal*. 2017. 6 (2). pp. 314-336.

¹⁴ Kuzmin O., Topol'nik V., Myronchuk V. Eduction of equilibrium state in vodkas by means of ¹H NMR spectroscopy. *Ukrainian journal of food science*. 2014. 2 (2). pp. 220-228.

¹⁵ Kuzmin O. Determination of systems with a steady equilibrium in vodkas, depending on transformation of hydroxyl protons. *Ukrainian journal of food science*. 2015. 3 (1). pp. 33-41.

¹⁶ Kuzmin O. Mechanism of transformation of protons in the process of creating aqueous-alcoholic mixtures. *Ukrainian Journal of Food Science*. 2017. 6 (4). pp. 686-697.

¹⁷ Кузьмін О.В. Вплив електрохімічної активації води на рівноважний стан водно-спиртових сумішей. *Міжнародний науковий журнал «Інтернаука»*. 2018. Т.1, №6 (46). С. 26-32.

¹⁸ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

¹⁹ Бахир В.М. *Электрохимическая активация*. М.: ВНИИИМТ, 1992. 2 ч. 657 с.

²⁰ Бахир В.М. *Медико-технические системы и технологии для синтеза электрохимически активированных растворов*. М.: ВНИИИМТ. 1998. 66 с.

²¹ Леонов Б.И., Прилуцкий В.И., Бахир В.М. *Физико-химические аспекты биологического действия электрохимически активированной воды*: [монография]. М.: ВНИИИМТ. 1999. 244 с.

²² Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

– electrolysis – the decomposition of water by electric current with the physico-chemical modification of its composition, with the appearance in it of ions H^+ , OH^- , hydrates, metal oxides, acids, peroxide compounds and radicals, free chlorine, hydrogen peroxide, etc.;

– partition – diaphragm or membrane separating electrodes (cathode from the anode) and forms, when separated, working chambers (cathode, anode) that allows penetration of ions to transfer current through an electrolyte and prevents electrolysis products from penetrating into the starting material;

– relaxation – a gradual transition of the system from a nonequilibrium state, under external action, to a state of thermodynamic equilibrium.

According to Bahir V.M.²³, the relaxation is determined not only by pressure and temperature, but also by the interaction between particles, consisting of two stages: equilibrium in individual microobjects; at slow processes of relaxation (viscosity, diffusion, thermal conductivity, conductivity, *ORP*, *pH*, surface tension, etc.) – to stationary values of parameters.

It can be argued that relaxation is determined by the time at which changes are made in relation to the initial state, and an increase in relaxation leads to an increase in the degree of activation. In this case, the *pH* and *ORP* values for catholyte and anolyte are not only beyond the limits of the chemical regulation area, but beyond the limits of thermodynamic water resistance²³.

Physical description of the ECA process: during the time (τ), an electric current (flux of electrons – e) of high density (j) with high overvoltage (η) passes through the water), with the formation of a catholyte (*Red*) in the cathode and anolyte (*Ox*) in the anode^{23, 24, 25}.

Mechanism of action of ECA: in interelectrode space, all molecular structures break down into ions, water is saturated with high-level substances: reducing agents

²³ Бахир В.М. *Современные технические электрохимические системы для обеззараживания, очистки и активирования воды*. М.: ВНИИИМТ, 1999. 84 с.

²⁴ Старикова Т.А., Лебедева С.А., Кольцов С.В. К вопросу о воде и водоподготовке. *Ликероводочное производство и виноделие*. 2005. № 62. С. 7-9.

²⁵ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

(atomic hydrogen is converted into molecular molecules on the cathode); oxidants (at the anode formed atomic oxygen, which is connected to the molecule); radicals with a small time of life; as a result of which there is a change in the acid-base, oxidation-reducing and catalytic properties that lead to changes in the *pH*, *ORP*, etc. parameters^{26, 27, 28, 29, 30, 31, 32, 33}.

Classification of ECA systems²⁶:

– by appointment: generators of active chlorine, for decomposition of *NaCl* solutions, seawater (sodium hypochlorite, chlorine); installations for obtaining ECA-water as an agent for sterilization and disinfection; ECA-water for treatment and prophylaxis of diseases; ECA-water as catalysts of chemical and biochemical processes; installations for the electrochemical purification of drinking water;

– according to the principle scheme: porous (diaphragmatic) – the transfer of ions occurs by their migration through the pores, filled with an electrolyte (Fig. 1, a); ion exchange (membrane) – the transfer of ions is a relay transfer between dissociation functional groups and are part of the polymer of the membrane (Fig. 1, b); without diaphragm with mercury cathode (Fig. 1, c).

The ECA process of drinking water in the diaphragm flow reactor^{26, 29}: through the water there is a constant electric current and the introduction of electrons into water near the cathode and the removal of electrons from water near the anode, which is accompanied by a series of ECA reactions both on the surfaces of the cathode and the anode, and in the volume of water (table 1), which changes the system of intermolecular interactions, forms new substances, etc.

²⁶ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

²⁷ Алехин С.А., Байбеков И.М., Гариб Ф.Ю. и др. «Живая» вода – мифы и реальность. М.: МИС-РТ. 1998. 120 с.

²⁸ Старикова Т.А., Лебедева С.А., Кольцов С.В. К вопросу о воде и водоподготовке. *Ликероводочное производство и виноделие*. 2005. № 62. С. 7-9.

²⁹ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

³⁰ Бахир В.М. *Электрохимическая активация*. М.: ВНИИИМТ, 1992. 2 ч. 657 с.

³¹ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

³² Леонов Б.И., Прилуцкий В.И., Бахир В.М. Физико-химические аспекты биологического действия электрохимически активированной воды : [монография]. М.: ВНИИИМТ. 1999. 244 с.

³³ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

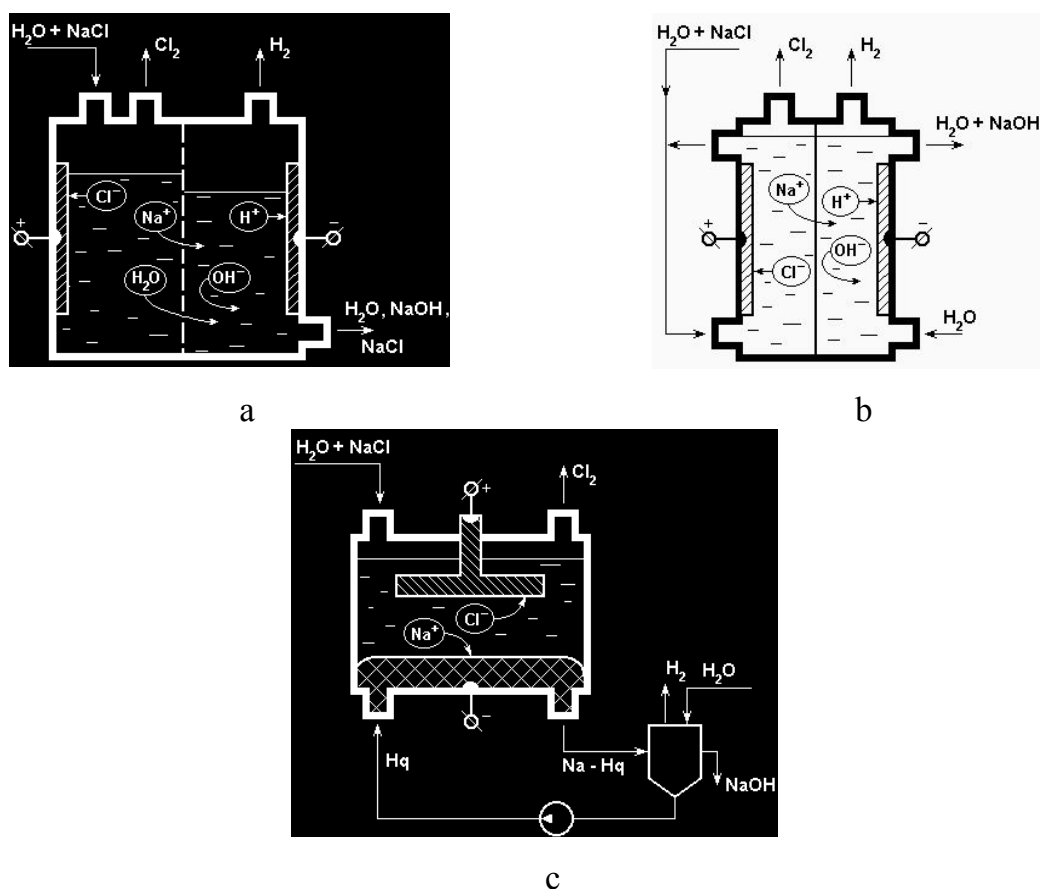


Fig. 1. Principal diagrams of electrolyzers³⁴: a – with an aperture; b – with an ion exchange membrane; c – with a mercury cathode

2. Structural and energy changes of water in the process of electrochemical activation

In the simplified form the anode takes place^{34, 35, 36, 37}: water oxidation ($2H_2O - 4e \rightarrow 4H^+ + O_2$), formation of gaseous chlorine ($2Cl^- - 2e \rightarrow Cl_2$), formation of high-level oxidants (Cl_2O , ClO_2^- , ClO^- , $HClO$, Cl^\bullet , O_2^- , O_3 , HO_2^\bullet , OH^\bullet , H_2O_2). At the cathode occurs: the recovery of water ($2H_2O + 2e \rightarrow H_2 + 2OH^-$) and the formation of highly reactive (OH^- , $H_3^-O_2^-$, H_2 , HO_2^\bullet , HO_2^- , O_2^-). These processes require a more detailed refinement.

³⁴ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

³⁵ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

³⁶ Леонов Б.И., Прилуцкий В.И., Бахир В.М. Физико-химические аспекты биологического действия электрохимически активированной воды : монография. М.: ВНИИИМТ. 1999. 244 с.

³⁷ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

Table 1

Chemical reactions occurring in ECA^{38, 41, 44}

Reactions on an anode	Reactions on the cathode
$2H_2O - 4e \rightarrow 4H^+ + O_2$	$2H_2O + 2e \rightarrow H_2 + 2OH^-$
$2H_2O - 2e \rightarrow 2H^+ + H_2O_2$	$O_2 + e \rightarrow O_2^-$
$O_2 + H_2O - 2e \rightarrow O_3 + 2H^+$	$O_2 + H_2O + 2e \rightarrow HO_2^- + OH^-$
$OH^- - e \rightarrow OH^\cdot$	$HO_2^- + H_2O + e \rightarrow HO^\cdot + 2OH^-$
$3H_2O - 6e \rightarrow O_3 + 6H^+$	$O_2 + 2H^+ + 2e \rightarrow H_2O_2$
$O_2 + 2OH^- - 3e \rightarrow O_3 + H_2O$	$e_{cathode} + H_2O \rightarrow e_{aq}$
$H_2O - e \rightarrow HO^\cdot + H^+$	$H^+ + e_{aq} \rightarrow H^\cdot$
$H_2O_2 - e \rightarrow HO_2^\cdot + H^+$	$H_2O + e_{aq} \rightarrow H^\cdot + OH^-$
$3OH^- - 2e \rightarrow HO_2^- + H_2O$	$CO_3^{2-} + 6H^+ + 4e \rightarrow HCHO + H_2O$
$H_2O - 2e \rightarrow 2H^+ + O^\cdot$	$CO_3^{2-} + 8H^+ + 6e \rightarrow CH_3OH + 2H_2O$
$H_2O - e \rightarrow H^+ + OH^\cdot$	$2CO_3^{2-} + 4H^+ + 2e \rightarrow C_2O_4^{2-} + 2H_2O$
$3OH^- - 2e \rightarrow HO_2^- + H_2O$	$2CO_2 + 2H^+ + 2e \rightarrow H_2C_2O_4$
$2Cl^- - 2e \rightarrow Cl_2$	$CO_2 + 2H^+ + 2e \rightarrow HCOOH$
$Cl^- + H_2O - 2e \rightarrow HClO + H^+$	$CO_3^{2-} + 2H_2O + 2e \rightarrow HCO_2^- + 3OH^-$
$Cl^- + 2H_2O - 5e \rightarrow ClO_2 + 4H^+$	$2SO_4^{2-} + 5H_2O + 8e \rightarrow S_2O_3^{2-} + 10OH^-$
$HCl + 2H_2O - 5e \rightarrow ClO_2 + 5H^+$	$2SO_4^{2-} + 4H^+ + 2e \rightarrow S_2O_6^{2-} + 2H_2O$
$Cl^- + 4OH^- - 4e \rightarrow ClO_2^- + 2H_2O$	$SO_4^{2-} + 4H_2O + 2e \rightarrow SO_3^{2-} + 2OH^-$
$Cl^- + 4OH^- - 5e \rightarrow ClO_2 + 2H_2O$	$SO_4^{2-} + 4H^+ + 2e \rightarrow H_2SO_3 + H_2O$
$Cl^- + 2OH^- - 2e \rightarrow ClO^- + H_2O$	$NO_3^- + 5H_2O + 6e \rightarrow NH_2OH + 7OH^-$
$Cl^- + 2H_2O - 4e \rightarrow HClO_2 + 3H^+$	$2NO_3^- + 2H_2O + 4e \rightarrow N_2O_4^{2-} + 4OH^-$
$2SO_4^{2-} - 2e \rightarrow S_2O_8^{2-}$	$N_2 + 5H^+ + 4e \rightarrow N_2H_5^+$
$2H_2CO_3^{2-} - 2e \rightarrow C_2O_6^{2-} + 4H^+$	$Fe^{3+} + 3e \rightarrow Fe$
$HCl + NaOH \rightarrow NaCl + H_2$	$Fe^{2+} + 2e \rightarrow Fe$
$HO_2 - e \rightarrow HO_2^\cdot$	$2H_2O + 2Na^+ + 2e \rightarrow 2NaOH + H_2$
$ClO^- + H_2O_2 \rightarrow {}^1O_2 + Cl^\cdot + H_2O$	
$Cl_2 + H_2O \leftrightarrow HClO + HCl$	

1. Anode Treatment (AT) assumes^{38, 39, 40, 41, 42, 43, 44, 45.}

³⁸ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

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⁴⁰ Старикова Т.А., Лебедева С.А., Кольцов С.В. К вопросу о воде и водоподготовке. *Ликероводочное производство и виноделие*. 2005. № 62. С. 7-9.

⁴¹ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

⁴² Бахир В.М. *Электрохимическая активация*. М.: ВНИИИМТ, 1992. 2 ч. 657 с.

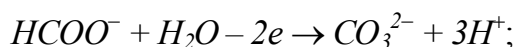
⁴³ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

⁴⁴ Леонов Б.И., Прилуцкий В.И., Бахир В.М. Физико-химические аспекты биологического действия электрохимически активированной воды: монография. М.: ВНИИИМТ. 1999. 244 с.

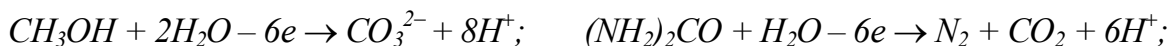
⁴⁵ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

- change of water structure;
- reduction of *pH* level of water with further increase of acidity;
- increase of ORP to the extreme positive (oxidative) values due to the formation of acids (sulfuric, hydrochloric, chloric, superoxide), hydrogen peroxide, peroxosulfates, peroxocarbonates, oxygen-containing compounds of chlorine, etc. intermediate connections;

- reduction of surface tension;
- increase of electrical conductivity;
- increase in the content of dissolved chlorine and oxygen;
- reduction of concentration of hydrogen and nitrogen;
- oxidative destruction of organic compounds of bacterial, viral, fungal etiology;
- decomposition of intermediate products to non-toxic compounds:



- destruction of ammonia (NH_3), nitrite (NO_2^-), hydrogen sulfide (H_2S), formaldehyde ($HCHO$), methyl alcohol (CH_3OH), urea ($(NH_2)_2CO$); phenols:



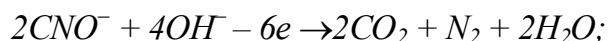
- conversion of bivalent iron:



- decomposition of cyanide ions (CN^-) or complex ions of cyanides ($[Cu(CN)_3]^{2-}$, $[Zn(CN)_4]^{2-}$, $[Cd(CN)_4]^{2-}$ and others) when present in water to cyanate ions:



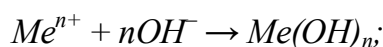
with further oxidation and the formation of safe products:



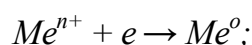
During the transition of electrons from organic compounds to the anode, the number (or multiplicity) of oxygen-containing bonds ($C-O$, $N-O$, $S-O$, etc.) usually increases, or the number of hydrogen bonds ($C-H$, $N-H$, $S-H$, etc.) decreases).

2. Cathode Treatment (CT) provides^{46, 47, 48, 49, 50, 51, 52, 53}:

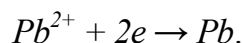
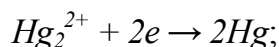
- increase of *pH* level with further increase of alkalinity;
- reduction of *ORP* to extreme negative (restorative) values;
- reduction of surface tension;
- decrease in the content of dissolved oxygen, nitrogen;
- increased concentration of hydrogen, free hydroxyl groups;
- reduction of electrical conductivity;
- saturation of water with high-level reducing agents: OH^- , H_2O_2 , HO_2^- , O_2^- , e_{aq} ;
- formation of insoluble hydroxides of heavy metals:



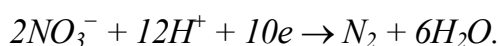
– electrolytic restoration (on the surface of the electrode), as well as electro-catalytic reduction (in volume of water) of multi-charge cations of heavy metals, due to their conversion into inactive form:



example,



– reduction of nitrate ions to nitrogen:



– a change in the structure of not only shells of hydrates of ions, but also of free water volume.

3. Ion Transport (IT) – electromigration transfer of ions (mixed)^{46, 49, 51, 53}, $IT_{a \rightarrow c}$ – electromigration transfer of ions from an anode chamber to a cathode; $IT_{c \rightarrow a}$ – electromigration transfer of ions from a cathode chamber to the anode) implies:

⁴⁶ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

⁴⁷ Алехин С.А., Байбеков И.М., Гариб Ф.Ю. и др. «Живая» вода – мифы и реальность. М.: МИС-РТ. 1998. 120 с.

⁴⁸ Старикова Т.А., Лебедева С.А., Кольцов С.В. К вопросу о воде и водоподготовке. *Ликероводочное производство и виноделие*. 2005. № 62. С. 7-9.

⁴⁹ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

⁵⁰ Бахир В.М. *Электрохимическая активация*. М.: ВНИИИМТ, 1992. 2 ч. 657 с.

⁵¹ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

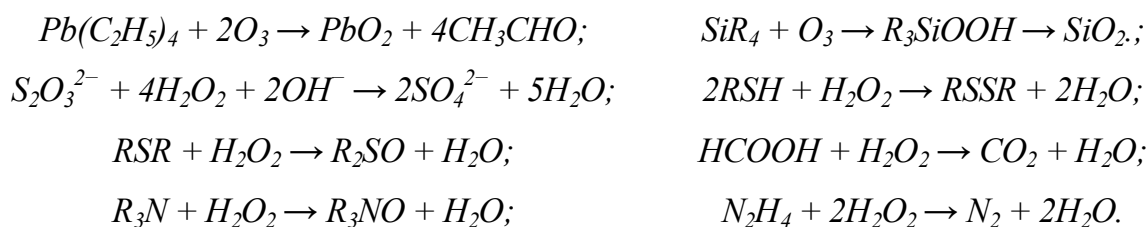
⁵² Леонов Б.И., Прилуцкий В.И., Бахир В.М. Физико-химические аспекты биологического действия электрохимически активированной воды: монография. М.: ВНИИИМТ. 1999. 244 с.

⁵³ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

removal through the aperture of the ECA-reactor is an excessive amount of ions, due to changes in the electric current density, pressure drop across the diaphragm and optimal physical and chemical characteristics.

4. Flotation Treatment (FT) implies^{54, 55, 56, 57}: the flotation of the coagulated colloidal particles and the pre-liquid phase catalytic oxidation of organic substances as a result of the oxidative action of ozone, atomic oxygen, peroxide radicals, chlorine, chlorine dioxide, allowing them to stick to pop-up bubbles and drain away. The electrical activity of the bubbles is due to the fact that at the interface between the phases «gas-liquid», the ECA is concentrated in unstable products of cathode reactions, at the same time, insoluble metal hydroxides and other colloidal particles are concentrated.

Reactions in the process of electroflotation:



5. Electro-Kinetics Treatment (EKT) implies^{54, 55, 56, 57}: extraction from the water by an electric field of a negatively charged surface of quartz crystals of microparticles of hydroxides of heavy metals that lose the shells hydrates and retained by physical sorption. Regeneration of quartz loading is carried out by removing the charge from the surface of quartz particles under the influence of a weak acid solution, followed by washing with water and removal.

6. Heterophase catalytic destruction of Heterophase Catalytic Destruction (HCD) assumes^{54, 55, 56, 57}: destruction of active chlorine compounds ($HClO$, ClO_2^\bullet , $HClO^\bullet$, ClO^\bullet) with formation Highly active short-lived particles: O^\bullet , O , Cl^\bullet , OH^\bullet , carried out

⁵⁴ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

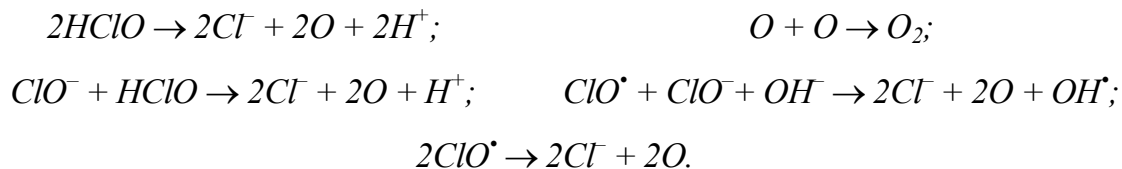
⁵⁵ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

⁵⁶ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

⁵⁷ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

in the dechlorination catalytic reactor – on the surface of carbon pellets and does not require the replacement and regeneration of the catalyst.

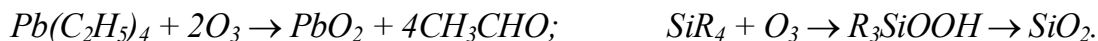
Reactions of catalytic decomposition of compounds of active chlorine:



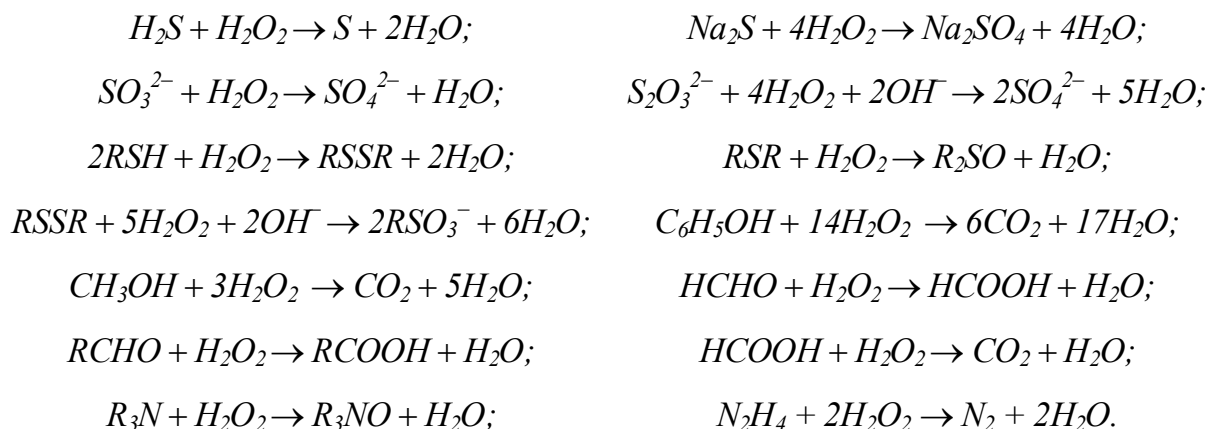
Active particles formed during the catalytic decomposition of active chlorine compounds provide destructive oxidation of a wide range of organic substances, including phenols, chlorophenols, dioxin:



7. Liquidphase Catalytic Oxidation (LCO) provides^{58, 59, 60, 61}: oxidation of organic substances with electron acceptors synthesized in the anode or donor of electrons generated at the cathode ECA reactions. So, destroyed ozone-element compounds formed during anodic reactions:



Hydrogen peroxide, which is formed during anodic and cathode reactions, participates in the reactions of destruction of harmful substances:



The end products of these reactions are absolutely non-toxic, harmless and safe for

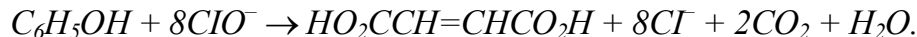
⁵⁸ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

⁵⁹ Бахир В.М. Электрохимическая активация 2012: новые разработки и перспективы. *Водоснабжение и канализация*. 2012. № 5-6. С. 65-74.

⁶⁰ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

⁶¹ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

human connections. In the reactions of the destruction of phenols in water after the anode processing also take part hypochlorite ions:



ECA processes, depending on the sequence of technological stages, are presented in Fig. 2-3 in the form of principle hydraulic circuits^{62, 63, 64}.

Symbols for flows and equipment: RPE is a flow-through electrochemical reactor in the form of diaphragm flowing electrolytic modular elements; *D* – drainage; *R* – hydraulic resistance; *M* – mixer; *S* – separator for separating gas from liquid; *F* – flotation reactor for separating solids from liquid particles; *C* – catalytic reactor; *E_τ* – an intermediate capacity for aging in the reaction medium before the completion of chemical reactions; *E_k* – electrokinetic reactor for separation of hydroxides of heavy metals, iron and colloidal suspensions; *W* – drinking water is initial; *PW* – water purified.

In fig. 4 representations of FEM with coaxial arrangement of external tubular and internal rod electrodes with tubular ceramic diaphragm, which is ultrafiltration and allows to effectively implement the basic conditions of ECA water.

The main instrument that provides the vital functions of any organism and regulates the ratio of energy to support homeostasis (relative dynamic constancy of the composition and properties of the internal environment and the stability of the basic physiological functions of the body) and is spent on the regeneration of the cells of the body, is the change in the rate of ORR. This rate depends on the concentrations and the ratio of oxidized and recovered forms of substances in the body, therefore, one of the most important factors for regulating the parameters of the ORR is the *ORP*, which characterizes the biological activity of the liquid medium that affects biological systems and allows estimating the energy of these processes⁶².

At redoximetry of the *ORP* internal environment of an organism of a healthy person has a value less than zero (–100 ... –200 mV). At the same time, the *ORP* of drinking

⁶² Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

⁶³ Бахир В.М. Медико-технические системы и технологии для синтеза электрохимически активированных растворов. М.: ВНИИИМТ. 1998. 66 с.

⁶⁴ Бахир В.М., Задорожний Ю.Г., Леонов Б.И. и др. *Электрохимическая активация: история, состояние, перспективы*. М.: ВНИИИМТ. 1999. 256 с.

water from the network of urban water supply, depending on the location of the water supply, during the year, the water treatment system (except for the ECA), is always greater than zero (+ 100 ... + 400 mV).

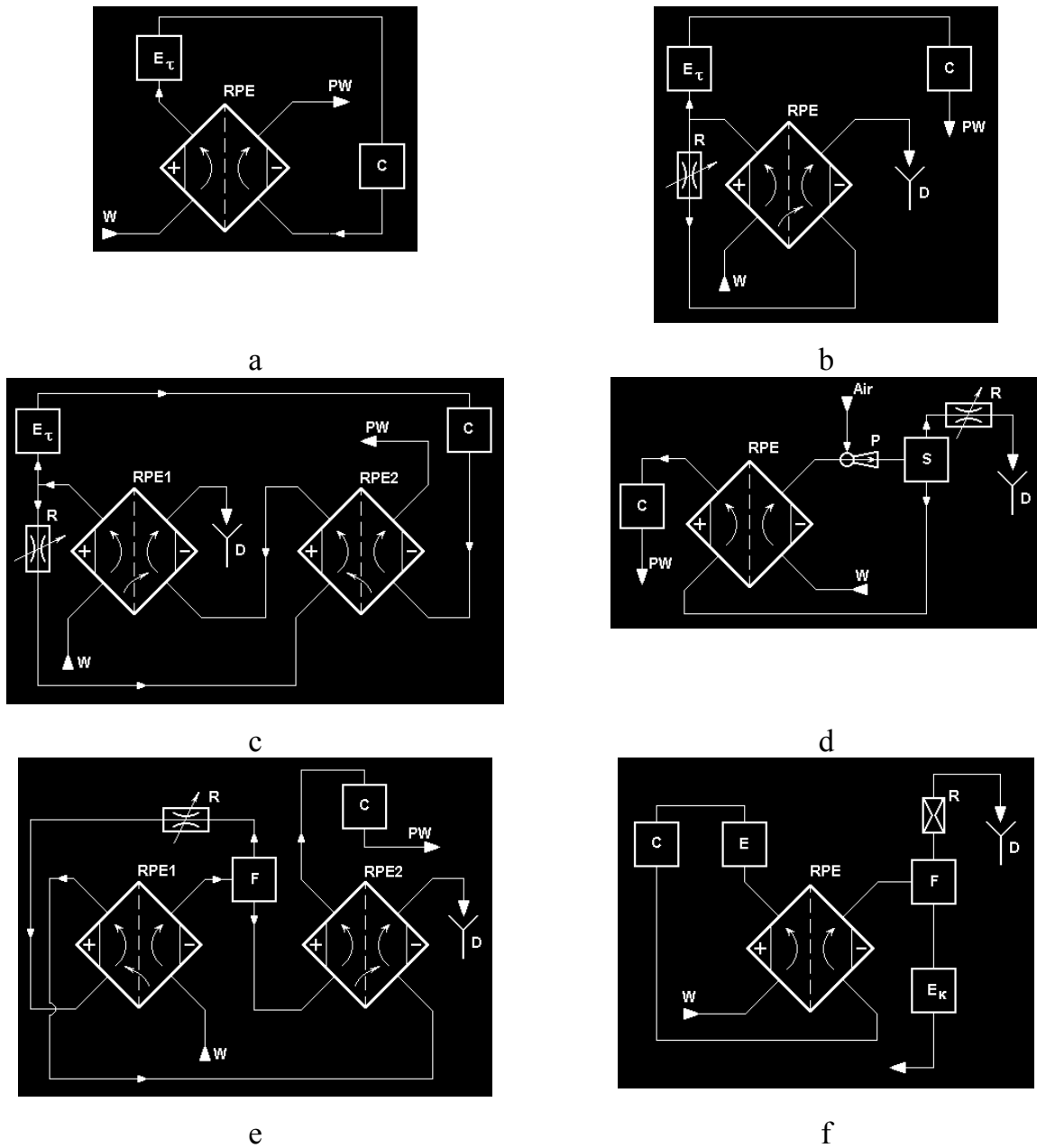
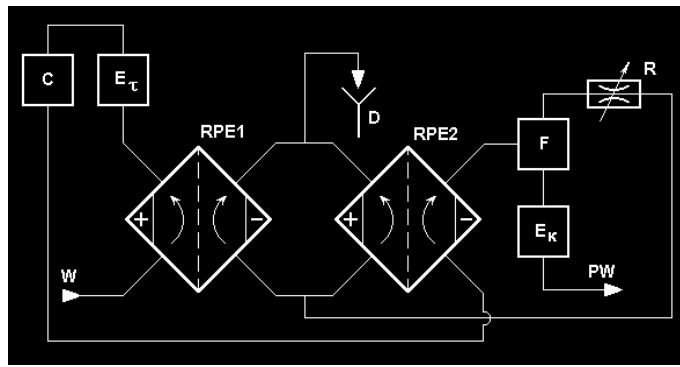
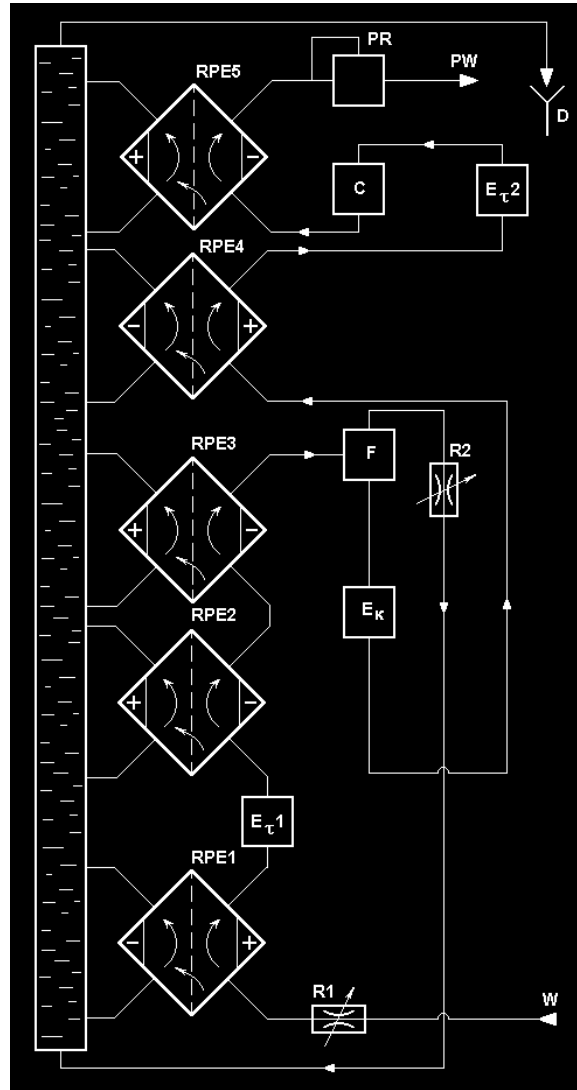


Fig. 2. Principal water purification schemes: a – Type «ID»: $AT \rightarrow LCO \rightarrow HCD \rightarrow CT$; b – типу «SR»: $AT + IT_{a \rightarrow c} \rightarrow LCO \rightarrow HCD$; c – «CL»: $AT(1) + IT_{a \rightarrow c}(1) \rightarrow LCO \rightarrow HCD \rightarrow CT(2) + IT_{c \rightarrow a}(2)$; d – «MF»: $CT \rightarrow FT + EFT \rightarrow AT \rightarrow HCD$; e – «CF»: $CT(1) + IT_{c \rightarrow a}(1) \rightarrow FT + EFT \rightarrow AT(2) + IT_{a \rightarrow c}(2) \rightarrow HCD$; f – «AT»: $AT \rightarrow LCO \rightarrow HCD \rightarrow CT \rightarrow EFT \rightarrow EKT$



a



b

Fig. 3. Principal scheme of water purification: a – type «TZ»: $AT(1) + IT_{a \rightarrow c}(1) \rightarrow LCO \rightarrow HCD \rightarrow CT(2) + IT_{c \rightarrow a}(2) \rightarrow EFT \rightarrow EKT$; b – «AM»: $AT(1) + IT_{a \rightarrow c}(1) \rightarrow LCO(1) \rightarrow CT(2) + IT_{c \rightarrow a}(2) \rightarrow CT(3) + IT_{c \rightarrow a}(3) \rightarrow EFT \rightarrow EKT \rightarrow AT(4) + IT_{a \rightarrow c}(4) \rightarrow LCO(2) \rightarrow HCD \rightarrow CT(5) + IT_{c \rightarrow a}(5)$

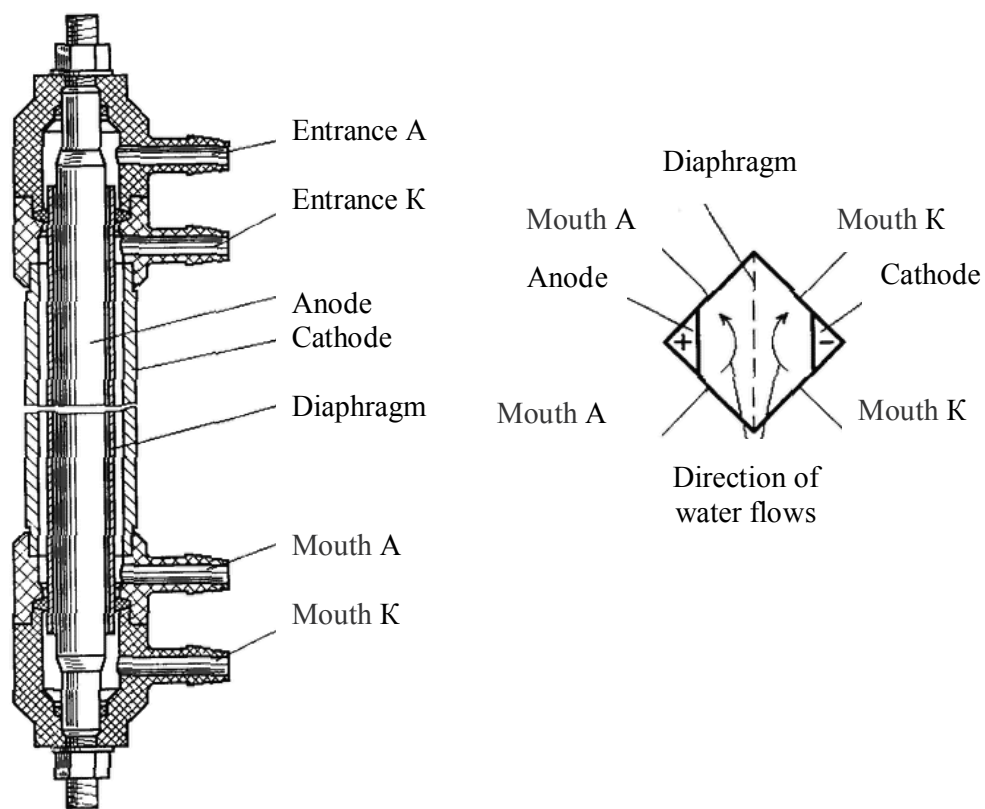


Fig. 4. Device and symbol of flowing electrochemical modular element^{65, 66}

The indicated differences in the *ORP* of the internal environment of the human body and drinking water mean that the activity of electrons in the internal environment of the organism is much higher than the activity of electrons in drinking water. At the same time in the body there is a necessary change in the *ORP* of drinking water due to the expenditure of electrical energy of cell membranes, that is, the energy of the highest level of energy, which in fact is the final product of the biochemical chain of transformation of nutrients⁶⁵.

The amount of energy consumed by the body to achieve the biocompatibility of water is proportional to its amount and the difference in the *ORP* of water and the internal environment of the organism. In addition to drinking water, people consume water and WAM, food products, *ORP* of which has a positive value. When such products enter the tissues of the body there is subtraction of electrons from cells and tissues, which are 80-

⁶⁵ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

⁶⁶ Леонов Б.И., Прилуцкий В.И., Бахир В.М. Физико-химические аспекты биологического действия электрохимически активированной воды : монография. М.: ВНИИИМТ. 1999. 244 с.

90% consist of water. As a result, the biological structure of the organism (cell membranes, organoids of cells, nucleic acids, etc.) are oxidative destruction, the body is worn out, aging, vital organs lose their function⁶⁷.

When aqueous solutions with negative *ORP* close to the values of *ORP* of the internal environment of a human organism enter the body, the electrical energy of cell membranes is not spent on correction of the activity of electrons of aqueous solutions, therefore products are immediately assimilated because they have biological compatibility under this parameter.

If the aqueous solutions have *ORP* more negative than the *ORP* of the internal environment of the organism, they feed it with this energy used by the cells as an energy reserve of antioxidant protection of the organism from the adverse effects of the external environment.

CONCLUSIONS

A literary review has been conducted that allows us to determine the promising use of ECA when creating TW as an alternative method or additional to existing processes in the production of AP: mitigation by means of Na-cation exchange; demineralization due to reverse osmosis. In this case, the ECA-technology allows, without the use of chemical reagents, to shift within very broad limits the acid-base, oxidation-reduction and catalytic properties of dilute aqueous solutions and water itself and use such liquids instead of traditional solutions of chemical reagents in various technological processes in order to save labor costs, time and materials.

ECA provides: the destruction of all types and forms of microorganisms and the complete disinfection of water under the influence of electric current, as well as high-level oxidants and reducing agents; effective removal of toxic elements and compounds; removal of excess salt concentrations and solid precipitate components; management of the level of mineralization of water; aimed at changing the *ORP* and increasing the biological value of water while maintaining the neutral acid-alkaline characteristics;

⁶⁷ Бахир В.М. Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 1999. 84 с.

preservation of the amount of biologically useful micro- and ultra micronutrients necessary for an organism.

Taking into account the above analysis of current trends in the technology of production of AP and scientific ideas about the processes of forming its qualitative characteristics, further development of scientific research should be aimed at finding the optimal conditions for the implementation of basic processes in order to improve the quality of domestic products in a wide range of indicators and its stabilization. This will enable the production and supply of competitive products to the market and meet the demand for high-quality AP.

SUMMARY

The problem of improving the quality of AP remains relevant for any liquor, wine-brandy company and involves the production of the same amount of raw materials and materials products that more fully meet the public needs. To date, there are no scientifically substantiated conclusions and knowledge that are related to the adaptation of the technology of creating the AP to the specific production conditions, taking into account the large variety of characteristics of the main and auxiliary components. We can conclude that today there is no universal water treatment system for the production of AP that would satisfy all production needs in water, so each enterprise individually identifies the necessary combinations, both in equipment and in the definition of rational conditions production. Therefore, the purpose of the work was to study all sorts of information regarding the expansion of TW characteristics due to the use of ECA aqueous solutions in the creation of AP.

A literary review has been conducted that allows us to determine the promising use of ECA when creating TW as an alternative method or additional to existing processes in the production of AP: mitigation by means of Na-cation exchange; demineralization due to reverse osmosis. In this case, the ECA-technology allows, without the use of chemical reagents, to shift within very broad limits the acid-base, oxidation-reduction and catalytic properties of dilute aqueous solutions and water itself and use such liquids instead of traditional solutions of chemical reagents in various technological processes in

order to save labor costs, time and materials.

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