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RATIONALE FOR ENERGY EFFICIENT WAY POWER SYSTEMS ELECTROTECHNOLOGY CLEAN WATER SOLUTIONS

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One of the most affordable water purification methods are electrochemical because due course of electrochemical processes, it is possible not only to remove pollutants from the water, but its disinfection.

The defining element of the cost of this method of water treatment is the cost of electricity, which depend on the parameters of the system power supply electrolysis. In this regard, to achieve effective use of electrochemical methods of water purification advisable to explore similar system power electrolysis to improve them in the direction of optimization parameters and select appropriate modes of supply.

It is known that most affects power in the process of electrolysis of water - pulse current (pulsed electrolysis), self-adjusting modulation which is a promising area of energy efficiency water treatment processes. The use of self-regulating pulse-current regimes for water electrolysis is now little known measure of electro-technological adaptation to unmanaged natural and industrial factors that determine the properties of uncontrolled water inlet system cleaning.

There electrotechnological system power electrode electrochemical production include power supplies that use established by the operator (pulsed) modes feed supply current of electrolysis with the ability to change operator parameters and forms of supply current. Such designs electro-technological systems designed for specific end product in stable conditions. This explains its existing wide range of design solutions electrotechnological water purification systems, features of types and kinds of appointments.

Given the conditions of use of the above systems when abnormal changes in natural and industrial factors leading to frequent abnormal deviations technical and technological conditions of operation defined unpredictable pollutants from incoming water need clean water to carry out such other systems with non-standard methods of providing the power. Mathematical modeling of these processes is difficult. There are theoretical solution of similar problems may not be the correct application for multifactorial and multi nonlinear processes incoming water changes during the year. Implementing them into practice requires finding universal technical solutions that will take into account the specified parameters obtained theoretically incorrect.

As we know from theoretical electrochemistry electrolysis parameters depend on the hydrodynamic regime of water in the interelectrode space and the content of pollutants in raw water. The concentrations of the constituents in the water determine its resistance in the interelectrode space, which in turn determines the power consumption. Of the known parameters of the power supply system of electro-technological water treatment systems to consider eight factors choose: temperature, water quality content, the distance between the electrodes, the area of the electrodes, current, voltage, waveform voltage and current pH.

The maximum energy possible while ensuring a constant interelectrode space defined parameters, and as a key determinant - the current density, which varies according to the parameters of the incoming water, pH, etc. The paper A. M. Ozerov The influence of pulse current and changing pH electrode space, indicating the interplay pulse mode for pH. So, let's possible reverse effect of pH on the current density, discharge and mass transfer mechanism using pulsed current, especially when changing waveform as the most effective indicator for the process of self-regulation. Given the advanced water purification system, which control system based on pH, it is reasonable to assume the importance of better understanding of the relationship of pH to the work of the power supply system.

To study the possible links of this theory and efficiency of water use experiments to obtain the most promising disinfecting solution - sodium hypochlorite.

The purpose of research - the experimental search for energy efficiency parameters of pulsed current with the influence of the main technological parameters.

Materials and methods research. The basic object of study - electrosynthesis process perspective disinfecting agent - sodium hypochlorite.

Sodium hypochlorite treated by electrolysis of sodium chloride concentration of 100 g / l (1.7 M). The electrolyte was prepared by dissolving salt NaCl brand h.ch. in distilled water. The scheme of the experimental setup is shown in Fig. 1. The study was carried out in a cylindrical glass cell without separating the cathode and anode spaces with a working volume of 100 cm3 electrolyte and plane-parallel rectangular electrodes of equal area. As anode oxidation of chloride ions used Horta protyelektrodom - cathode - was stainless steel. The distance between the electrodes was 0.7 cm, the working surface area of the anode and cathode - 0.194 dm2.

Experiments were carried out to obtain sodium hypochlorite in a constant or pulsed current density of 5 A / dm2 using a power source ATH-1535 or pulse potentiostate PI-50. Relevant labor power was 0.97 A.

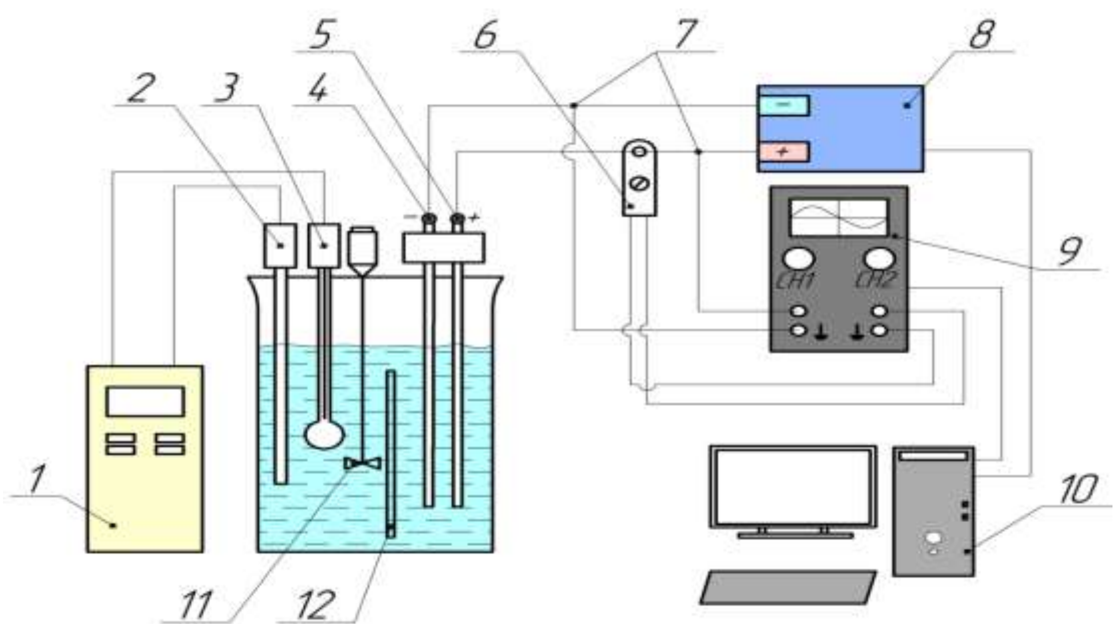

Fig.1. Scheme of laboratory setup for electrolysis:

1 - pH meter (pH 150m); 2 - sensor pH meter; 3 - combined glass electrode pH meter; 4 - a cathode made of stainless steel; 5 - anode of Orta; 6 - overcurrent adapter ATA-2504 to measure current; 7 - sensors measure the voltage on the electrodes; 8 - source current (or power source ATH-1535, or potentiostate PI-50-1.1 connected by dvoelektrodnoyu scheme); 9 - PC; 10 - channel digital oscilloscope RIGOL DS5062M; 11 - a device for mixing; 12 - dielectric wall

Switching modes electrolysis asked so that the average current density IC deposition was similar in all experiments and consistent deposition current density in the steady state (5 A / dm2). We used pulses of rectangular and triangular shapes.

Triangular-pulse modes modeled so that the peak current and (max) pulse 2 times higher than the average current density, then one pulse amount of electricity consumed, as well as during the same time period fixed electrodeposition.

Results. It is known that the maximum efficiency possible while ensuring appropriate form and frequency pulsed current, which are subject to the parameters of the input solution. In the course of electrochemical reactions greatest impact frequency pulse current to 10 Hz, and the waveform to 5Hz.

Basic, qualitative parameter working solution is pH. After all, it is mainly the pH affects the mechanism of electrochemical current primary and secondary chemical reactions and may determine the effective yield.

So, let's possible impact, namely, pH energy pulsed mode with some form of electrolysis current pulse.

To study possible links energy efficiency of water treatment systems with the basic technological parameters of the process carried out experimental research to obtain one of the most promising disinfecting agents - sodium hypochlorite.

At the anode oxidation occur parallel to water or hydroxyl ions with oxygen and chloride ions. At the anode overpotential of oxygen evolution Horta is greater than the oxidation of chloride ions. Therefore, it is the most preferred process.

The higher the pH of the electrolyte, the higher the degree of dissociation of hypochlorous acid. At pH 8.5 - 9 dissociation occurs almost completely. It is known that hypochlorous acid exists in solution within pH 4 - 6.5, but it is unstable and gradually decomposes even in dilute solutions. Hypochlorous acid is a strong oxidizer as salts, including sodium hypochlorite, calcium and magnesium.

From the published data we know that the main products of the electrolysis of sodium chloride is molecular chlorine, hypochlorite and sodium chlorate (NaClO and NaClO3). In the process of electrolysis formed in the anode space compounds are able to recover back to the cathode, anode and cathode if space is not separated by a membrane.

In order to study the impact on the shape of the pulse rate of formation of sodium hypochlorite proposed three basic forms of pulse easiest implemented (Figure 2): rectangular, triangular front with increasing direct current, with declining reverse triangular front. The speed increase or decrease the pulse was 3.88 A / s.

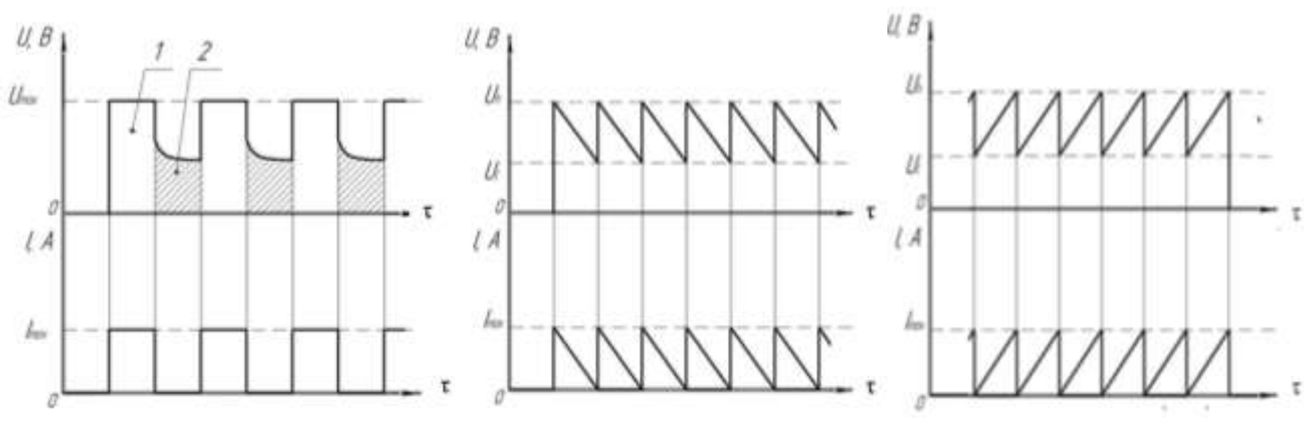

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Fig.2. Schematic representation of the pulse electrolysis modes:

a - of rectangular pulses and pauses tpauzy timpulsu = (1 - pulse 2 - pause); - with triangular shaped pulses with reverse current decay front without interruption; 3 - triangular shape of the pulses of direct current rise front without a pause

In order to select the frequency of the pulse electrolysis for the synthesis of NaClO conducted a series of experiments at initial pH 7 solution. Electrolysis is carried out in a stationary mode at a constant current density of 5 A / dm2 and mode - pryamokutnyy pulse-pause, with the same average density current in steady state. Preliminary experiments showed that changing the duration ti / TP has little effect on the process.

Fastest growing concentration of hypochlorite is pulsed at a frequency of 1.5 Hz electrolysis.

A comparison of the number actually received hypochlorite with theoretical data (temperature of the electrolyte at the end of the experiment was approximately 35 ° C) confirms the assumption that the main mechanism of its formation is the dissolution of molecular chlorine. Additional reasons somewhat lower concentration compared to the calculations is to restore hypochlorite at the cathode, and further oxidation to his chlorate at the anode. In the bulk solution as possible hypochlorite decomposition such as disproportionation.

However, continuous flow solution in molecular chlorine concentration of hypochlorite closer to the theoretical value.

In neutral solution was also tested triangular-pulse mode pulsed electrolysis.

From these experiments, it became clear that the greatest intensification process electrosynthesis NaClO achieved by using triangular pulse mode with direct current growth front without interruption. As a first approximation, the result can be explained most intense pidluzhuvannyam solution during electrolysis, in which case the pH increases from 7 to 12. At the same time using other modes of electrolysis pH increase is only 10 - 11.

Addition was done comparing the effectiveness of pulsed mode with a triangular shape and momentum of the rising edge of current for the frequency range 1 - 2 Hz. The best results were obtained at a frequency of 1.5 Hz. This optimal frequency will be used for further studies of the effect of pH on the effectiveness of the solutions of sodium hypochlorite electrosynthesis.

Thus, as shown by experimental studies using pulsed electrolysis mode allows a certain degree intensify the process of electrosynthesis of sodium hypochlorite for reducing power consumption. In addition, the shape of the current pulse selectively affect the performance of the process at a certain initial pH of the solution.

Analyzing the experimental data electrotechnological use water purification systems, we can conclude that their further improvement appropriate to the principles of the methodology of preventive and prophylactic adaptation.

Conclusions

1. The directions of technical improvement of power electrolysis process water and reasonably basic parameter pH self-regulatory regime to ensure its supply.
2. The effect of frequency pulsed current for a rectangular pulse mode to process electrosynthesis of sodium hypochlorite. It is shown that the greatest intensification process is achieved by frequency of 1.5 Hz.
3. Revealed a selective effect on the pH of the solution process performance electrosynthesis of sodium hypochlorite in some form of current pulse.
4. It is shown that the greatest intensification process (pH = 7) is achieved using current pulses with a triangular shape with straight front current rise.
5. Given the preliminary results of experiments perspective of improving energy efficiency electro-technological systems supply water purification systems, consider their development methodology based on preventive and prophylactic adaptation processes automatically optimize settings selection pulse-current electrolysis mode via the main factor - the shape of the pulse current, which uses for determining parameter pH.

6. Further promising line of research is to determine the influence of parameters of pulsed electrolysis mode at specific power consumption and learning process intensification electrosynthesis of sodium hypochlorite in terms of deviation from the initial pH neutral values.

The problem of energy efficient power systems electro-cleaning water solutions at the example of the production of sodium hypochlorite to disinfect water. Established shortcomings of traditional power systems electro systems for water treatment and suggested ways to improve their performance on the basis of optimizing the choice of parameters of pulsed-current electrolysis regimes with regard to pH. Experimental study of energy-efficient way of cleaning power of water solutions.

Power system, water treatment, pH, electrolysis, pulsed current, pulse shape, pulse mode efficiency.