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Electrochemical Recovery of Coagulants in the Processes of Wastewater Treatment of Textile Enterprises.

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ABSTRACT

Flotation technologies for wastewater treatment of textile enterprises have become very widespread. This raises the issue of wastewater treatment waste containing resistant organic compounds, such as synthetic dyes and surfactants. These substances account for the bulk of sewage pollution from textile factories. The purpose of the research was to study the electrochemical destruction of biologically stable organic substances in the liquid phase of the flotation sludge and to develop on this basis the technology for regenerating the coagulant solution to return to the wastewater treatment process. The research was carried out on the model solutions and samples of the flotation sludge of the operating flotation plants. It was found that the rate of oxidation of organic dyes is practically independent of the pH value. In the oxidation of surfactants, the maximum effect was observed at pH $\leq$ 4. The degree of electrochemical destruction of dyes exceeds 90%. At the same time, the electricity consumption is 10...12 Watt/h per 1g of the oxidized substances. The efficiency of electrochemical destruction of surfactants is not more than 55...65%, with specific electricity consumption of 12...15 Watt h/g. Further studies were aimed at intensifying the process of electrochemical oxidation of surfactants using the addition of chlorides and homogeneous catalysts. It was established that the degree of oxidation of the organic substances essentially depends on the dose of the catalyst. The effective dose of the catalyst - the ion Fe^{3+} is associated with the content of chlorides in the processed flotation sludge and is in the range of 60...100 mg/l. The degree of electrochemical destruction of surfactants in the presence of ferric iron salts is up to 96%. At the same time, the specific electricity consumption for the destruction of resistant organic substances by chemical oxygen demand (COD) is in the range of 5-12 kWh / (kg of COD). The method of electrochemical destruction makes it possible to regenerate the coagulant, reduce the mass of waste removed outside the enterprises, and significantly reduce the supply of resistant organic compounds to the environment.

Keywords: wastewater, flotation sludge, surfactants, electrochemical destruction, catalysts, regeneration of coagulant.

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INTRODUCTION

The peculiarity of textile production consists of a variety of types of the processed fibers, their processing methods, materials used, and also of the amount of water consumed. For general water consumption and sewage discharge, they are among the most water-intensive industries. Textile enterprises spend and dump into the environment up to 400 m3 of water per ton of products. This causes the features of waste waters of textile enterprises.

In the textile industry, the most water-intensive are the dyeing and finishing industries. The consumption of clean water and, accordingly, the formation of wastewater are related with the processes of boiling, whitening and dyeing on periodic and continuous devices. At the same time, the greatest amount of wastewater comes from the washing operations of fabric. However, the most polluted wastewater is the waste technological solutions. Wastewater of the textile industry enterprises have a complex mineral composition and contain a large number of the organic compounds, such as synthetic dyes, synthetic surfactants, textile auxiliary substances and other chemical reagents and preparations. A significant part of them refers to the resistant organic substances. As a rule, the content of dyes and surfactants in sewage many times exceed the permissible standards of these substances for the plants of biological treatment of effluents, and enter water bodies [1].

In the process of biological treatment, such wastewater cannot be completely discolored, as modern dyes are specially created resistant to the external factors. For example, in the air tanks the decrease in the intensity of coloring occurs by 30-50%, mainly due to the sorption of dyes on the active sludge. With further processing of the activated sludge, the dyes are returned to the water with the return flows. Unlike synthetic dyes, which are slowly mineralized in the environment, without causing its intense exposure, surfactants, even in small amounts, lead to a breach of the physics and chemical equilibria in soils, water bodies, biocenosis, and building structures. Surfactants also cannot be completely mineralized by biochemical methods to the concentrations allowing their discharge into water bodies [2, 3].

PROBLEM STATEMENT

Increasing efficiency of purification of industrial waste water by the treatment plants of enterprises leads to the transformation of the issue, as water purification processes create a problem of their waste. The proposed solution of the problem of minimizing the harmful impact of textile enterprises on the environment is the reduction of the mass of pollutants released from water during the process of its purification, in the form of concentrates and sludge using regenerative and destructive methods for their processing.

The most common sewage treatment processes for textile enterprises are based on the flotation methods for extracting pollutants. In wastewater treatment processes of water containing resistant organic compounds, such as surfactants and dyes, with the use of flocculating agents and flotation, the flotation sludge is formed in a quantity of 2-3% of the volume of the treated water. Surfactants and dyes in the liquid phase of the flotation sludge reaches 5000 and 2000 mg/l, respectively. The composition of the solids of the flotation sludge includes the extractable contaminants of wastewater, and the dispersed phase of the hydroxides of the added metal salts, the coagulants. Moreover, the mass fraction of hydroxides in the flotation sludge in relation to other substances varies from 1:1 to 3:1.

Methods of mechanical dewatering of the flotation sludge that are currently widely used do not fully provide a solution to the problem of wastewater treatment. This is due to the necessity of depositing the formed filter cake on the polygons and additional treatment of the filtrate [5].

The reduction of damage to the environment by the hydroxide containing sewage treatment waste and minimizing cost of purchasing coagulants can in principle be achieved by the regeneration. Technologically, the task of regenerating the coagulant from the flotation sludge is to separate the organic compounds from the solid phase of the metal hydroxides-coagulant and to obtain a reconstituted hydrolysate solution of the relevant coagulant salt.

RESEARCH QUESTIONS

In principle, there are several possible solutions of this problem on the basis of a combination of separating and destructive methods [5]. Since the extraction of the organic pollutants is easier to carry out from the aqueous solution, it was decided to expediently dissolve the flotation sludge hydroxides by lowering the value of pH. In addition to the main effect, a decrease in the pH value creates a number of concomitant conditions that facilitate the regeneration processes.

Studies conducted in Russia and abroad showed the possibility of effective application of electrochemical oxidation processes for the destruction of the organic contaminants. The feasibility of using this method for wastewater treatment of many types of pollutants is experimentally confirmed [6 - 9].

Given the high content of the organic contaminants in the flotation sludge, the known results did not allow directly using electrochemical oxidation for the regeneration of the metal-containing coagulant.

PURPOSE OF THE STUDY

The purpose of the research was to study the conditions for the electrochemical destruction of the organic part of the flotation sludge in the liquid phase, and to develop a technology for regenerating the coagulant solution to return to the wastewater treatment process. Basically, this process consists of dissolving the hydroxides of the coagulant metal in an acidic environment, electrochemical destruction of the organic pollutants and returning the acid solution of the recovered coagulant to the wastewater treatment process.

The research tasks included the selection of the anode material, the study of the specific features of the electrochemical destruction process of the biologically stable pollutants and methods of its intensification, and the determination of the efficiency of the electrochemical process, technological indicators and electric energy costs.

RESEARCH METHODS

The study of the conditions of the electrochemical destruction of the organic part of the flotation sludge and the possibility of regenerating coagulants included a number of basic steps.

Preliminary studies were conducted in order to select the optimum anode material. The anodes made of the platinized titanium and graphite were tested. The kinetics of electrochemical treatment of the model solutions was studied, as well as the dependence of the specific electric energy consumption on the concentration of salt, introduced for the intensification of the process. The experiments did not reveal significant technological advantages of the anodes from the platinized titanium in comparison with the graphite ones. Therefore, in the future only graphite anodes were used as the most accessible ones. As a cathode material, alloy steel or graphite was used.

At the first stage, the studies were carried out on the model solutions of direct, dispersed, acidic and active dyes, as well as surfactants of the anionic and nonionic types. The research tasks of this stage included determining the effect of the dose of the introduced chloride ions, and the pH and temperature values on the efficiency of electrochemical oxidation of the organic components of the flotation sludge. Studies to determine the effect of chlorides on the destruction were carried out on solutions containing 4-15 g/l of the chloride ions.

The effect of the active reaction of the medium on the oxidation of the organic components was studied in the pH range 2...10. The effectiveness of the electrochemical destruction of the organic contaminants in all experiments was determined by the formula:

$$\varepsilon = 100 \cdot \frac{(C_0 - C_n)}{C_0} \quad ,$$

Where: ε is the process efficiency, %;
C_0 и C_n is the content of the pollutant, respectively, at the beginning and at the end of the process, mg/l.

The second stage of the research was aimed at solving the problems of intensifying the electrochemical method of destructing pollutants using catalysts, and conducting search studies to develop a highly efficient technological process of the coagulant regeneration. According to some researchers, soluble iron salts are the most promising homogeneous catalysts in the processes of destruction of the organic substances, including sewage [10, 11]. Acceleration of the oxidation processes is explained by the formation of a Fenton reagent in the water with participation of iron ions possessing variable valency [12, 13]. The prospects for the use of iron salts, for example $FeCl_3$ and $Fe_2(SO_4)_3$, are conditioned by their use as coagulants in sewage treatment processes for textile enterprises.

Studies of the conditions for the regeneration of the coagulant were carried out on the flotation sludge obtained during the cleaning of the sewage of a textile factory at a compression flotation plant.

The optimal dose of iron-containing catalyst was determined by an analysis of the efficiency curves of the electrochemical destruction of surfactants in a solution of the flotation sludge with the electrolysis duration of up to 150 min.

Experiments on the electrochemical destruction of the flotation sludge were carried out on an experimental electrolyzer with a capacity of 0.015 m^3, equipped with the graphite anodes with an allowable current load of up to 100 A.

The third stage of the research consisted of studying the auxiliary operations of the technology of the coagulant regeneration. It included studies of mixing conditions, the effect of pH on the dissolution of hydroxides, as well as the dynamics of sedimentation of solid insoluble contaminants.

Selected sludge samples were treated with sulfuric acid with vigorous stirring to dissolve the hydroxides. The choice of sulfuric acid is conditioned by its use in the technological operations of dyeing and finishing industries that eliminates the need for an additional reagent farm. Visual control of this stage of the process is practically impossible due to the high intensity of color and the presence of a large number of dispersed impurities that do not dissolve during acidification. The acidification process was monitored by potentiometric titration with the use of a pH meter. The completeness of the hydroxide solution was fixed by the position of the isoelectric point on the titration curve.

Dissolution of metal hydroxides can occur both in the region of diffusion kinetics, where the dissolution rate depends on the intensity of mixing, and in the kinetic region, where it will depend on the duration of the reaction. The choice of the type of mixing devices depends on the region in which kinetics of the process lies. To determine the type of kinetics, experimental studies were carried out using a mechanical mixer with a speed varying in the interval of 20...120 min-1.

The experiments were carried out on the samples of the flotation sludge after adding a solution of sulfuric acid with a dose of 6 mg/l. The speed of the mixer and the period of complete dissolution of the hydroxides were fixed.

As a result of dissolution of hydroxides and the electrochemical oxidation of the organic components of the flotation sludge, dispersed contaminants remain in the treated solution. These contaminants include suspended substances separated from sewage during the flotation cleaning process, poorly soluble products of the destruction of dyes, the products of destruction of the anodic material (graphite) of the electrolyzer, and also a small part of the coagulant not dissolved in the acidic medium. The presence of these substances in the reconstituted coagulant solution leads to the accumulation of coarse-grained contaminants in the cycle of use of the coagulant, deterioration of the quality of wastewater treatment and processing of the flotation sludge. Taking into account the peculiarity of the composition of the suspended solids in the reconstituted coagulant solution, studies were carried out to simulate separation by sedimentation.

To carry out the research, the samples of the flotation sludge obtained from the flotation plant of a textile enterprise were used. Concentration of the suspended matters in the samples of the flotation sludge varied from 1360 to 4820 mg/l (the average value was 2240 mg/l), with a working dose of the coagulant injected into the flotator equal to 100...250 mg/l.

Preliminary experiments showed that the process of sedimentation of the suspended solids from the acidic solution of the flotation sludge proceeds quite effectively. To return to the water purification process, it is sufficient that the concentration of the suspended solids in the reconstituted coagulant solution does not exceed their concentration in the waste water entering the flotation. This corresponds to the suspended matters content of 100...140 mg/l.

To handle the results of the experimental studies of the dynamics of sedimentation of the dispersed impurities, the Kastalsky-Weitser method was used [14].

The final stage was to study the process of electrochemical regeneration of the coagulant using a pilot plant in the static and flowing modes. The pilot plant contained technological elements for the processing of flotation sludge with regeneration of the coagulant and worked together with the installation of a compression flotation of a textile factory. Schematic diagram of the pilot plant is shown on the Figure 1.

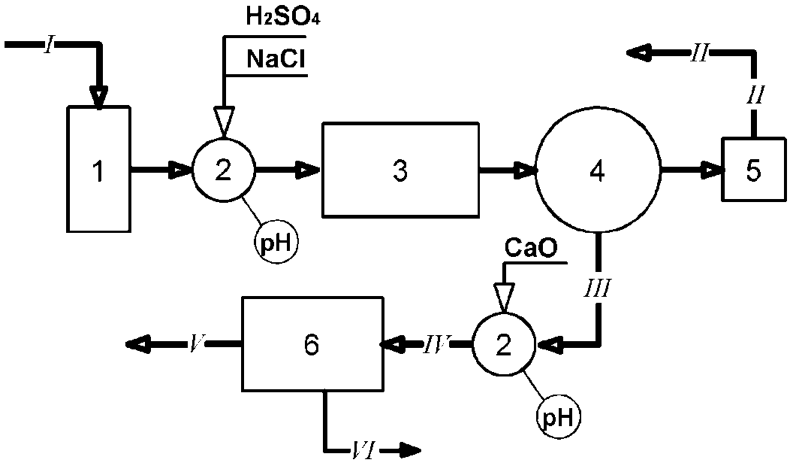

Fig. 1: Scheme of the pilot plant for processing flotation sludge with regeneration of the active part of the coagulant.

1 - receiving capacity of the foam product of the compression flotator; 2 - mixer; 3 - electrolyzer; 4 - sedimentation tank; 5 - intermediate tank; 6 - squeezing of the sediment;

I - flow of flotation sludge from the flotator; *II* - reconstituted coagulant solution; *III* - acid sediment; *IV* - neutral sediment; *V* - filtrate from squeezing of the sediment; *VI* - cake for removal.

The flotation sludge, separated in the process of wastewater treatment, enters the mixer (2) from the receiving capacity of the flotator (1). Solutions of sodium chloride and sulfuric acid are added to the mixer to lower the pH and dissolve the flotation sludge hydroxides. To ensure the most complete dissolution of hydroxides, pH control is constantly carried out. Then the mixture is put into the electrolyzer (3), where the electrochemical destruction of the organic components takes place. After the electrolyzer, the mixture enters the sedimentation tank (4) to separate the settling dispersed substances. The clarified solution containing the coagulant ions is discharged into the intermediate tank (5), from which it is pumped into the mixer of the reagents of a sewage treatment plant of a textile factory. The sediment deposited in the sediment tank enters a mixer where it is neutralized with dry lime. The sediment is then mechanically dehydrated (6). The separated filtrate is taken out to the total flow of the untreated sewage. The dehydrated part of the sediment (cake) is collected for subsequent deposition.

The study of the process of electrochemical regeneration of the coagulant under static conditions was carried out in the following sequence. The required volume of the flotation sludge was taken out from the receiving capacity of the foam product of a flotation treatment plant for sewage of the dyeing and finishing production of a textile factory. The flotation sludge was fed into the mixture, where sulfuric acid solutions to pH=2 and sodium chloride in an amount determined by the conditions of the experiments were added. The solution was mixed by a mechanical mixer for 5 minutes. After that, it was placed in the electrolyzer, where it was electrochemically destructed.

Further studies were carried out in the flowing mode of the electrolyzer. The processing time of the flotation sludge in the electrolyzer was chosen in such a way that the concentration of the surfactant in the solution at the outlet of electrolyzer did not exceed 100-150 mg/l. To determine the duration of the sludge treatment and the specific consumption of electricity for the oxidation of surfactants in the sludge, a series of experiments with the sludge containing from 1 to 5 g/l of surfactant was carried out.

FINDINGS

At the first stage of the research, it was experimentally established that direct dyes and non-ionic surfactants are most difficult to oxidize. In this connection, further experiments were focused on the oxidation of these components.

As a result of the research, it was established that the rate of oxidation of the organic dyes is practically independent of the pH value. In the oxidation of surfactant, the maximum effect was observed at pH $\leq$ 4 that corresponds to the highest content of hypochlorous acid (HOC1) in water, which has the highest oxidation-reduction potential in the series of chlorine-containing oxidants.

It should be noted that when the flotation sludge is acidified to pH <4, most of the aluminum hydroxides dissolve, and the molecules of dyes and surfactants they have sorbed earlier are transformed into the liquid phase.

During the experiments, a significant influence of the temperature on the dynamics of the electrolysis process was established. With increasing temperature, the electrochemical oxidation of the organic substances proceeds more intensively and with less energy consumption. This is explained by the fact that with increasing temperature, the electrical conductivity of water increases, and the rate of oxidation processes intensifies.

As a result of the conducted studies, it was established that the degree of electrochemical destruction of dyes exceeds 90%. At the same time, electricity consumption is 10...12 Watt h/g of the oxidized substances. The effectiveness of the destruction of surfactants is not more than 55...65%, with specific electricity consumption of 12...15 Watt h/g.

In general, the studies of the first stage confirmed the principle possibility of deep electrochemical oxidation of the organic components of the flotation sludge [15]. It was established that these are surfactants that limit the efficiency of electrochemical destruction. Therefore, in subsequent experiments, the evaluation of the results of the destruction of the organic impurities of wastewater was carried out by surfactants.

The solution of the tasks of the second stage of the research was aimed at selecting available and effective homogeneous catalysts for the electrochemical oxidation of synthetic dyes and surfactants. In the presence of Fe^{3+} ions, the electro-oxidation of surfactants occurs without addition of Cl^- ions into the solution being treated. The simultaneous presence of iron and chloride cations leads to a deep oxidation of the surfactant, as can be seen on the Figure 2.

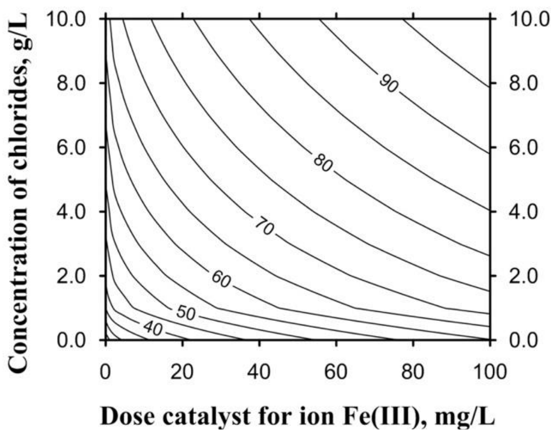

Fig. 2: The field of levels of equal efficiency of the electrochemical destruction of surfactants (initial surfactant content is 2800 mg/l), depending on the concentration of iron ions (3+) and chlorides.

DISCUSSION

It was found that the degree of oxidation is substantially dependent on the dose of the catalyst. The effective dose of Fe^{3+} ions depends on the content of chloride and is in the range of 60...100 mg/l. It should be noted that further increase in the dose of the catalyst does not lead to a significant change in the course of the process. This is significant in the processing of the flotation sludge obtained in wastewater treatment processes using ferric salts as a coagulant. In this case, the presence of iron compounds will be sufficient to ensure a catalytic effect on the oxidation processes. The results of the studies showed that the presence of a homogeneous catalyst significantly reduces the consumption of sodium chloride with an equally effective process of oxidation of the organic contaminants.

The obtained dependences of the efficiency of electrochemical destruction of surfactants show that the introduction of the catalyst makes it possible to increase the destruction efficiency of the organic contaminants by 1.4...1.7 times with the same chloride content, or reduce the concentration of chlorides by 6...8 times when the same oxidation depth of the organic components of the flotation sludge is achieved.

The results of studies carried out at the third stage of the experiments on the dissolution of hydroxides of coagulants revealed a significant effect of the speed of rotation of the mixer on the dissolution rate of the hydroxides. This influence is especially significant in the speed range of 20...60 min-1. It was experimentally established that the process of dissolution of aluminum and iron hydroxides proceeds according to the diffusion kinetics. It was identified that for the process of dissolving flotation sludge hydroxides in an acidic medium, it is necessary to use types of mixers with intensive mixing of mixtures.

The results of the experiments aimed at studying the relationship between the content of hydroxides of the metal of coagulants in the sludge with the pH value of their complete dissolution and the required amount of sulfuric acid are provided in the Table 1.

Table 1. Reagent consumption and indices of dissolution of metal hydroxides of the flotation sludge.

Coagulant	Dose of coagulant, mg/l	Amount of flotation sludge,%	Amount of hydroxides in the sludge, g/l	pH of total dissolution	Specific amount of acid, g/g
$Fe_2(SO_4)_3$	100	1.3…1.5 1.4	4.27…5.06 4.6	2.2…2.3	1.96
	150	1.5…1.8 1.7	4.45…5.58 5.2	2.1…2.2	1.98
	200	1.8…2.2 2.1	5.68…7.81 6.1	2.0…2.2	2.02
	250	2.3…2.7 2.5	9.09…7.15 6.5	2.0…2.2	2.05
$Al_2(SO_4)_3$	100	1.0…1.2 1.1	3.66…4.51 4.1	2.9…3.0	2.22
	150	1.2…1.5 1.4	4.42…5.50 4.8	2.8…3.0	2.24
	200	1.5…1.8 1.7	4.88…5.86 5.3	2.6…2.9	2.26
	250	1.7…2.0 1.8	5.5…6.41 6.3	2.5…2.8	2.30

Note: the numerator shows the change interval, the denominator indicates the average value.

The obtained data show that a sufficiently complete dissolution of iron hydroxide is observed in the pH range 2.0...2.3, and aluminum hydroxide - in the pH range 2.5...3.0. The dose of acid required for dissolution is directly proportional to the amount of metal hydroxides contained in the flotation sludge and can be roughly estimated by the formula:

$$Д_{кт} = 100\ К_{уд}\ С_{гидр} / (\gamma_{кт}\ a),$$

Where: $Д_{кт}$ is the dose of acid needed to lower pH and complete dissolution of hydroxides, dm^3/m^3;

$К_{уд}$ is the specific consumption of acid, that is 1.96...2.05 for iron hydroxide and 2.22...2.30 for aluminum hydroxide, kg/kg;

$С_{гидр}$ is the amount of hydroxide in the flotation sludge, kg/m^3;

$\gamma_{кт}$ is the density of acid solution, kg/dm^3;

a is the content of the active part of the acid, %.

As a result of processing experimental data on the dynamics of sedimentation of impurities of the flotation sludge insoluble in an acidic environment, it was established that in the process of sedimentation of particles, their coalescence is observed and the agglomeration index is not equal to 1. The values of indicators found for the 90% clarification efficiency are presented in the Table 2.

Table 2. Limit values of the sedimentation rates of the suspended solids from the flotation sludge by Kastalsky and Weitser [14].

Concentration of the suspended solids in sludge, kg/m^3	The agglomeration index (n)	Average hydraulic size (u_0), mm/s
1.50	0.35	0.20
4.50	0.33	0.28

During the experiments, it was found that the mass of the non-soluble dispersed part of the sediment does not exceed 30% of the mass of the coagulant hydroxides. The humidity of the sediment after two hours settling is 90...94%. The ash content of the sediment is 36...50%. The concentration of surfactants in the separated aqueous phase of the sediment is in the range of 100...150 mg/l.

The final stage of the research was carried out using the flotation sludge removed from the flotation plant of a sewage treatment plant of a textile enterprise. The average values and the interval of fluctuations of the indicators are as follows: surfactant - 2950 (2650...3260) mg/l, color by dilution - 1:1980 (1:1460...1:2200), COD - 4100 (2280...5820) mgO/l. The results of the research of the electrochemical destruction of the organic impurities of the flotation sludge under static conditions are presented in the Table 3.

According to the data provided in the Table 3, it is evident that as a result of the electrochemical oxidation, the organic components of the flotation sludge are deeply destructed. It should be noted that the discoloration of the solution occurs within the first 15...25 minutes, but the limiting stage of the process is the oxidation of the surfactant. The indicators characterizing the content of the organic contaminants in the treated flotation sludge do not exceed the average values of these indicators in the waste water entering the treatment facilities of the enterprise that corresponds to the conditions for organizing the process of regenerating the coagulant from the treated flotation sludge.

The results of the series of experiments performed in the flowing mode of operation (see Table 3) show that the processing time and energy consumption for oxidation of the organic components of the flotation sludge are 35-50% lower than when operating in the static conditions. This is due to the accumulation of some excess of active chlorine in the reactor, which immediately interacts with incoming organic substances. This is confirmed by the fact that in the flowing mode of operation, the bleaching of the sludge occurs almost instantaneously after it has entered the electrolyzer.

Studies of the flowing regime of the electrolyzer operation also confirmed that the limiting stage of the process is the oxidation of the surfactant.

It was experimentally established that the duration of processing of the flotation sludge and the consumption of electricity to a significant degree depend on the content of chlorides in it. The results of the experiments are shown in the Figures 3 and 4 for achieving the electrochemical destruction efficiency of surfactants up to 96%.

Table 3. Results of the electrochemical processing of the flotation sludge in the static and flowing conditions.

The processing period in the electrolyzer, min	Concentration of chlorides, g/l	Electricity consumption. energy, kWh/m³	Indicators of the flotation sludge and processing efficiency					
			Surfactant, mg/l	ε,%	Dyeing color	ε,%	COD, mgO/l	ε,%
Processing of the flotation sludge in the static conditions								
90	4	42	130	95,5	1:40	98	610	85.1
80	8	31	110	96	1:40	98	580	85.8
60	10	18	110	96	1:30	98,5	560	86.3
Processing of the flotation sludge in the flowing conditions								
80	4	31	120	96	1:40	98	600	85
60	8	22	110	96.3	1:30	98.5	570	86
45	10	12	100	96.6	1:24	98.8	560	86.3

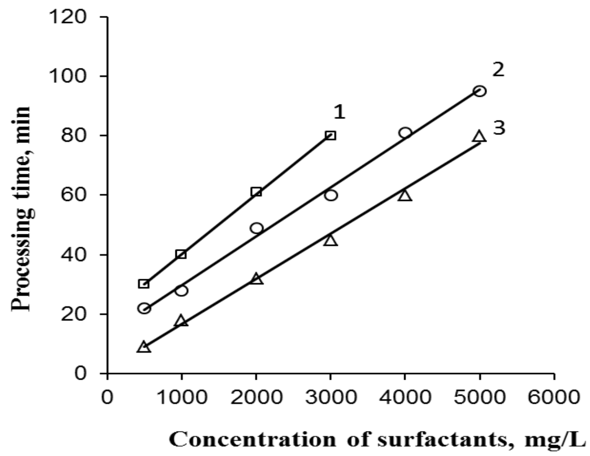

Fig. 3: Dependence of the duration of processing of the flotation sludge on the content of surfactants with the content of chlorides: 1-4 mg/l; 2-8 mg/l; 3-10 mg/l.

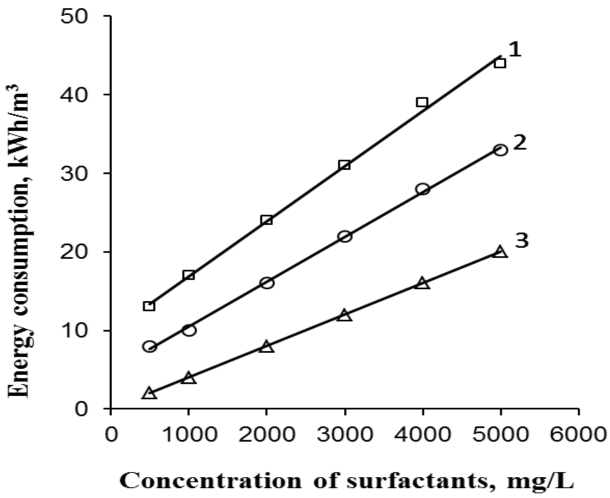

Fig. 4: Dependence of the energy consumption on the processing of the flotation sludge on the content of surfactants with the content of chlorides: 1-4 mg/l; 2-8 mg/l; 3-10 mg/l.

According to the presented dependences, it can be seen that the combination of a homogeneous catalyst in the form of Fe^{3+} with a sufficient supply of chlorides makes it possible to achieve the required depth of destruction of the organic part of the flotation sludge at a significantly lower specific electricity consumption from 5 to 12 kWh/(kgCOD), compared to the use of only chlorides in the electrolysis. The received results demonstrate the effectiveness of the application of electrochemical destruction to diminish the discharge of contaminants obtained from wastewater treatment with the use of coagulants into the environment [16].

The replacement of the reagent coagulation for the purification of textile wastewater by electrochemical one is seen as a promising development of this direction [17, 18]. The use of electrocoagulation with iron electrodes will ensure the adequacy of iron ions for the electrochemical destruction of the organic pollutants of the flotation sludge without the addition of iron salts, and will reduce the mineralization of the treated sewage. Electrochemical treatment of wastewater and sediments of textile enterprises creates favorable conditions for subsequent biological water purification [19, 20].

CONCLUSION

The carried out researches showed that in the process of electrochemical destruction with the use of a homogeneous catalyst, a deep oxidation of the organic components of the flotation sludge is achieved.

Studies demonstrated that trivalent iron (ferric) salts are an effective catalyst for the oxidation of surfactants. The minimum dose of the catalyst is 80-100 mg/l per iron ion. If iron salts are used as the coagulant in the wastewater treatment processes, the addition of a catalyst to the electrochemical process is not required.

The electrochemical destruction method allows effectively solving the problem of neutralization of the resistant organic compounds, such as surfactants and dyes, contained in the concentrated wastes of wastewater treatment of textile enterprises.

The results of studies of the electrochemical oxidation of the organic pollutants of the flotation sludge in the presence of a homogeneous catalyst are the basis for the development of new wastewater treatment technologies with the regeneration of the active part of coagulants. The use of such technologies allows reducing reagent consumption for water purification processes and diminishing the negative impact on the environment. This is conditioned by the exclusion of removal of waste containing persistent organic compounds and metal hydroxides outside the enterprises, and a significant reduction in the mass of the removed solids.

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