RESEARCHING OF THE PROCESSES OF PURIFICATION OF WASTEWATER IN TEXTILE PRODUCTION WITH BENTONITE ADSORBENTS

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Abstratct. *The article presents the main technological schemes for the formation of wastewater from textile production, and presents the results of experimental studies to establish the effectiveness of the use of bentonite clay in the treatment of wastewater from textile production. Based on the results of laboratory and semi-production experiments, it was established that modification of the alkaline earth form of bentonite clay with soda ash helps to increase the sorption and basic physical and technical properties of bentonite clay.*
Key words: *wastewater, treatment, sorption, sorbents, adsorbent, sorption capacity, water treatment, bentonite, regeneration, solution pH.*

Introduction. The volume of wastewater generated depends on the feedstock, the finishing technologies used, as well as the availability of repeated and recycled water supplies. In this regard, the specific parameters of wastewater generation are very average. Thus, during the production of acrylic fabrics, about 35 m^3 of wastewater is generated per 1 ton of fabrics, woolen fabrics - 70 m^3 per 1 ton of fabrics, cotton - 100 m^3 per 1 ton of fabrics. Technological processes at textile industry enterprises are very diverse, and therefore the concentrations of impurities contained in industrial wastewater and their qualitative composition can vary widely. Wastewater is generated during the processing of raw materials (wool, flax, cotton), bleaching and dyeing of fibers, their reinforcement with adhesives, chemical processing and finishing of fabrics, etc. Wastewater from textile industries contains fiber residues, dirt particles, reagents, surfactants, and dyes. The amount of pollutants in wastewater depends on the type of fabric produced (natural or synthetic), dyeing technology, and the solubility of reagents and dyes in water [1].

At the same time, in terms of the volume of process water consumption and wastewater disposal, one of the leading places in textile enterprises is occupied by dyeing and finishing shops. The specific water consumption and, accordingly, the consumption of SW in them ranges from approximately 70–400 m^3 per ton of product [2-3].

At the output of the textile production water disposal system, the key indicators that exceed the established maximum allowable concentration (MAC) are: - active reaction of aqueous solutions (pH) - the excess can be more than 30% of the established regulatory requirements; – total mineralization (dry residue) – peak excesses can be more than 100% in certain periods. At the same time, such excesses are not stationary (stable), but arise non-stationary and periodically during a work shift (day, week) depending on the range of products being produced, which creates objective prerequisites for smoothing out excesses of the MAC in terms of the "Total mineralization" indicator by installing a control tank disposal of wastewater into the city sewer system with an appropriate automatic control system.

In this way, stabilization of this quality indicator of aqueous solutions can be achieved [4].

Recently, the method of co-precipitation with hydroxides and clay adsorbents has begun to be widely used to isolate and concentrate traces of elements, for example, with iron hydroxides and magnesium bentonite in the analysis of natural, industrial and municipal wastewater.

It is known that bentonite or bentonite clay, the rock-forming mineral of which is the mineral montmorillonite, belongs to the group of aluminosilicates and has a layered structure. The clayey part of bentonite consists of at least 70% of smectite group minerals (montmorillonite, beidellite, nontronite, saponite, and hectorite), which have high binding capacity, thermal stability, as well as adsorption and catalytic activity. The crystal lattice of all smectites consists of layers. The unit cell includes three layers that form a package: the outermost upper and lower layers of the package consist of tetrahedra Al, SiO4 and are called tetrahedral. Between the tetrahedral layers there is a layer consisting of octahedra Al and Fe, called octahedral. Montmorillonite is formed mainly under exogenous conditions - in an alkaline environment rich in bases, especially Mg, in the absence of noticeable quantities, K-montmorillonite is distinguished by a variety of methods and conditions of formation - it is formed in sedimentary, volcanogenic, metamorphic rocks, in soils, in sediments near hot springs [5-10].

Co-precipitation of nickel, zinc, chromium (III, VI) from textile wastewater was carried out under the following conditions.

A carrier (200 mg of bentonite) was introduced into the analyzed sample and standard solutions with a volume of 1000 ml; the time of contact of the sediment with the solution varied from 15 to 30 minutes. The precipitation of these elements on bentonite occurs completely in the pH range of 5.5-9.5; the precipitate was separated by filtration.

The precipitate was calcined at a temperature of 400 ^{0}C, the calcined precipitate was mixed 1:1 by weight with spectrally pure coal and ground in an agate mortar, determined by the “three standards” spectrographic method.

Evaporation of standards and samples prepared for analysis is carried out from the crater of carbon electrodes. For this purpose, carbon rods with a diameter of 6 mm, grade S-Sh, are used. Using a special cutter placed on the axis of the electric motor, a hole 3 mm deep and 3 mm in diameter was drilled in its end.

Each reference sample and analyzed powder was introduced into the crater of three electrodes. The length of each electrode is 3.5-4 cm. A carbon rod sharpened on a truncated cone served as the electrode against it.

The spectra were excited by an alternating current arc discharge of 16 A and recorded with a medium-dispersion quartz spectrograph ISP-30 for 120 s, on type I “spectrographic” photo plates.

The target of the spectrograph, 0.02 mm wide, was illuminated with a standard three-lens condenser system with an intermediate diaphragm of 5 mm.

Photographic plates were developed with methol-hydroquinone developer for 3 minutes. Photometry was carried out on an MF-2 microphotometer.

The most intense lines of detected elements in the area were photometered 2800-3200$_{A}^{0}$. The analytical graph was built in the coordinate ΔS – C, %. It has been experimentally established that the content of nickel, zinc, chromium and cobalt dyes in the wastewater of the Locomotive Depot and Uztex Group JV LLC is less than the maximum permissible concentration (Table 1).

Table № 1

Results of experimental data on wastewater treatment at the Locomotive Depot and Uztex Group JV LLC using the sorption method

№	Element	mg/l MAC according to GOST	Entered mg/l	Found mg/l	Degree of purification, in%	MAC in solution
1	Chromium	0,5	3,0	0,1	96,7	MAC
2	Nickel	0,7	2,0	0,05	97,5	MAC
3	Zinc	0,13	1,0	0,01	99,0	MAC
4	Cobalt	0,6	1,5	0,012	99,2	MAC
5	Methyl violet	0,01	5,0	-	100	MAC
6	Methylene blue	0,01	4	-	100	MAC

Table № 2

Results of determination of microelements in wastewater "Locomotive depot"

№	Element	MAC mg/l	Found		Content relative to MAC
			in mg/l	in %	
1	Chromium	0,5	2,0±0,02	$(2,0\pm0,2)*10^{-5}$	MAC
2	Nichel	0,7	0,3±0,002	$(3,0\pm0,2)*10^{-5}$	MAC
3	Zink	0,13	1,0±0,001	$(1,0\pm0,1)*10^{-4}$	MAC
4	Cobalt	0,6	footprints	----	MAC
5	Methyl violet	0,01	footprints	----	MAC

In practice, various technological activation methods are used to obtain sorption-active clays. One of the reliable ways to increase sorption properties is to treat bentonite clays with mineral acids. During acid activation, a significant change in the composition and properties of clays is observed, which apparently occurs due to the transformation of the structures of clay minerals. Due to partial destruction of the mineral, leading to an increase in the pore radius to 40 – 70 A° and the number of active centers on the surface of the sorbent, its sorption capacity increases. As a result of the studies carried out during the activation process, it turned out that hydrochloric acid reacts most strongly with bentonite clays, and sulfuric acid reacts most strongly.

During hydrochloric acid treatment, optimal activation is achieved under the following conditions: temperature 95^{0}C, Process duration 50 minutes, hydrochloric acid concentration 20% at a dosage of 100%.

The preparation of activated bentonite clays was studied to elucidate the mechanism of wastewater softening. The object of the study was wastewater from a cement plant and a northern thermal power plant. The results of physicochemical analyzes of these waters are presented in Tables 3 and 4.

Table №.3

Results of physical and chemical analyzes of wastewater (cement plant)

№	Name indicators	Original	Original bentonite	Bentonite (activated)
1.	Transparency(cm)	4,0	18	св.30
2.	Active reaction (pH)	7,6	7,5	7,4
3.	Hardness (mg/l)	46,90	31,8	4,88
4.	Calcium (mg/l)	28,06	18,24	2,79
5.	Magnesium (mg/l)	18,84	12,25	1,87
6.	Amount (K+Na) mg/l	30,69	23,11	3,525
7.	Sulfates (mg/l)	43,88	25,56	3,63

Table № 4

Results of physical and chemical analyzes of wastewater (CHP)

№	Name indicators	Original	Original bentonite	Bentonite (activated)
1.	Transparency(cm)	св.30	св.30	св.30
2.	Active reaction (pH)	7,0	7,2	7,3
3.	Hardness (mg/l)	97,3	71,08	9,68
4.	Calcium (mg/l)	105,6	77,08	10,20
5.	Magnesium (mg/l)	9,37	6,84	0,67
6.	Amount (K+Na) mg/l	26,69	20,28	3,042

As can be seen from tables No. 3 and No. 4, the use of initial bentonite clays reduces water hardness slightly. This is explained by the properties of the original bentonite clay, characterized by a predominantly bentonite composition and a high content of oxides of alkaline earth elements, which was a weak sorbent.

The use of activated bentonite clays sharply reduces the hardness of water compared to the original by about 9-10 times and, apparently, this is the result of a sharp increase in the sorption capacity of activated bentonites. A study of the influence of various factors on hydrochloric acid activation of bentonites for wastewater softening showed that water consumption was a constant factor.

As can be seen in Fig. 1, when treating water with hydrochloric acid activated bentonite, with an increase in bentonite consumption from 2 to 8 grams, the degree of water softening increases from 31.5 to 90.4%, respectively.

A further increase in bentonite consumption has virtually no effect on the result.

The results of the study of the influence of wastewater flow on the degree of water softening are shown in Fig. 2.

As can be seen from the figure, with a water consumption of 25 to 50 ml. the degree of water softening increases from 64.8 to 89.8%, respectively.

With a further increase in water consumption, the degree of water softening gradually decreases from 89.8 to 80.3%; apparently, this result can be explained by the fact that the number of active centers on the surface of the sorbents is completely filled with calcium - magnesium ions, which helps to reduce the degree of softening

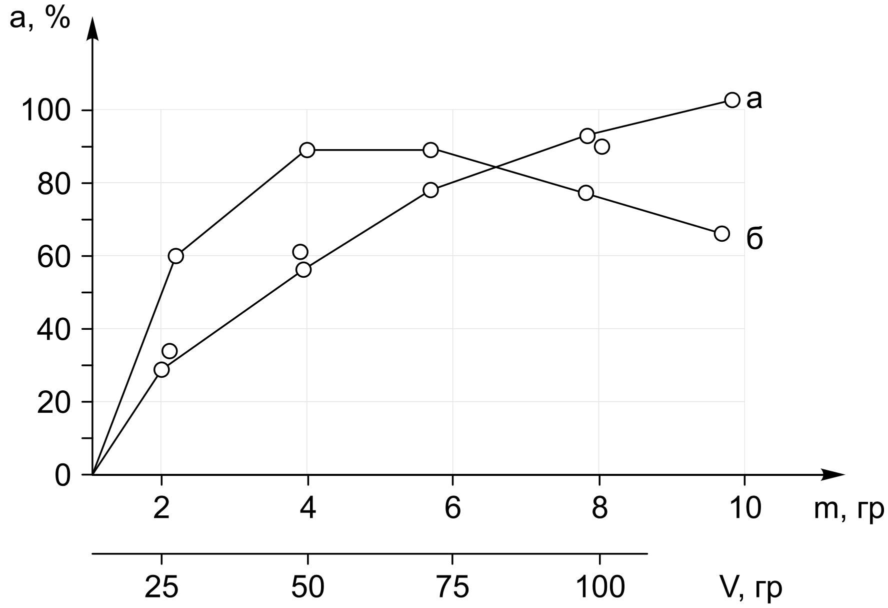

Fig.1. Dependence of the degree of wastewater softening with hydrochloric acid activated bentonites (a) and the volume of water (b)

It has been established that the optimal conditions for the process of water softening with hydrochloric acid activated bentonites are: bentonite consumption 8 g and water volume 50 ml. At the same time, the degree of water softening reaches 90.4%.

As can be seen in Fig. 1, the most favorable mode for carrying out the process is the consumption of 10 g of activated bentonite.

In this case, the degree of water softening reaches 86.5%, apparently, this result can be explained by the fact that the number of active centers on the surface of the sorbents is completely filled with calcium-magnesium ions, which helps to reduce the degree of softening.

It has been established that the optimal conditions for the process of water softening with hydrochloric acid activated bentonites are a bentonite consumption of 8 g and a water volume of 50 ml. At the same time, the degree of water softening reaches 90.4%.

The results of studying the influence of various factors for the second stage of sulfuric acid activated bentonite clays on water softening are shown in Fig. 2.

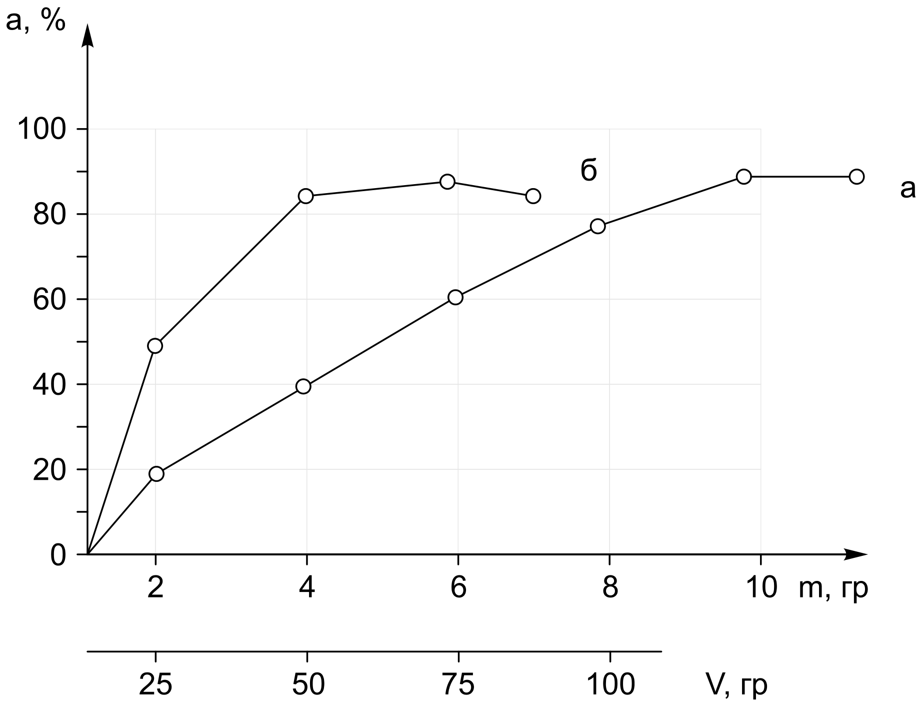

Fig.2. Dependence of the degree of wastewater softening with sulfuric acid activated bentonites (a) and the volume of water (b).

Based on the results obtained, we can conclude that the most favorable mode for carrying out the process is the consumption of 10 g of activated bentonite. In this case, the degree of water softening reaches 86.5%. In this case, the highest degree of softening is achieved with a water consumption of 50 ml. Subsequently, an increase in water volume consumption leads to a decrease in the degree of water softening due to complete filling ions Ca^{+2} и Mg^{+2} interlayer space of activated bentonites.

SUMMARY. The use of bentonite clays without treatment when softening natural waters reduces water hardness slightly, which is explained by the properties of the original bentonite clay, which is characterized by a predominantly calcium composition and a high content of oxides of alkaline earth elements, which is a weak sorbent. The use of activated bentonite clays (sodium form) sharply reduces water hardness compared to the original by about 9-10 times and, apparently, this is the result of a sharp increase in the sorption capacity of activated bentonites. A study of the influence of various factors on the hydrochloric acid activation of bentonites for wastewater softening showed a high degree of their application efficiency.

Based on the results obtained, we can conclude that the most favorable mode for carrying out the process is the consumption of 10 g of activated bentonite. In this case, the degree of water softening reaches 86.5%. In this case, the highest degree of softening is achieved with a water consumption of 50 ml. Subsequently, an increase in water volume consumption leads to a decrease in the degree of water softening due to complete filling with ions Ca^{+2} и Mg^{+2} interlayer space of activated bentonites.

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