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The Development of the Effective Way of Chromium-containing Wastewater Treatment by Means of Modified Sorbents

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The aim of the research is to develop an efficient method for purification of the chromium containing wastewater by the means of the modified natural sorbents with improved sorption and mechanical properties. The structural and sorption properties of the above-mentioned sorbents have been investigated. The proposed nanomaterial in the form of the paste-like modified sorbent based on the bentonite clay of Tagansk deposit of East Kazakhstan and basalt fibers allows to reduce the chromium content to maximum permissible concentration (MPC). It gives the opportunity to discharge and recycle the purified water in the production.

Keywords: Chromium-containing wastewater, Electroplating, Bentonite clay, Basalt fibers, Modified sorbents, Solid : liquid (S : L), Maximum permissible concentration (MPC).

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1. INTRODUCTION

The improving of the environment quality should include the creation and implementation of special integrated environmental and resource-saving methods, such as the use of local raw materials, which are specific for each region.

Recently, the natural sorbents of natural origin have been increasingly used for water purification such as bentonite clay and other argillaceous rocks, which have sufficiently high sorption capacity, cation-exchange properties, relatively low cost and availability [1].

East Kazakhstan is rich in minerals such as bentonite clay, deposits of which are located in sufficient proximity to the industrial enterprises, where it is supposed to use them. There is a Primanrak group of natural deposits of aluminosilicates, confined to the Upper Cretaceous and Paleogene sediments. Especially valuable clay is found in Tagansk field. The content of montmorillonite minerals in it exceeds 90 % [2].

2. EXPERIMENTAL DETAILS

Table 1 shows the results of wastewater treatment of reinforcing plant by the chromium ions with the application of granular thermally activated at 6000 °C bentonite clay of the 11 and 14 horizons of the Tagansk field and basalt fibers in the ratio of 2 : 1.

From the obtained data it can be concluded that the increasing ratio of the sorbent to wastewater (S: L) to reduce the consumption of the bentonite clay as the component of the modified sorbent based on the basalt fibers showed a decrease in the level of purity for all formulations.

Further examination of the modified sorbent was aimed at finding of its form and formulation, which give a high degree of purification at high ratio S:L and a low degree of sorption material consumption.

For mechanical activation of components the batch operation vibratory mill was used where the grinding of the material was conducted by the means of impacts and abrasions. The design of the used vibration mill in comparison with the rotary-type ball mills provided the intensification of the process in 5-10 times and allowed to implement the process of the wet grinding to give a pasty sorbent.

Table 1 – Shows the results of the wastewater treatment of reinforcing plant by the chromium ions at the initial concentration C_{oCr} = 0,028 mg/dm^3 with the application of the granular modified sorbents

Types of modified sorbents	SOLID : LIQUID RATIO							
	1 : 10		1 : 50		1 : 100		1 : 130	
	C_{Cr}^{common}, mg/dm^3	a, %	C_{Cr}^{common}, mg/dm^3	a, %	C_{Cr}^{common}, mg/dm^3	a, %	C_{Cr}^{common}, mg/dm^3	a, %
The 11 horizon bentonite clay and basalt fibers	0,0057	76,89	0,009	67,86	0,021	33,33	0,021	33,33
The 14 horizon bentonite clay and basalt fibers	0,004	86,24	0,008	71,43	0,009	57,86	0,009	57,86

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Table 2 – Shows the sorption purification results of wastewater from chromium ions with the application of the modified pasty sorbents based on bentonite clay and basalt fibers with initial concentration C_{oCr} = 0,034 mg/dm³

Types of modified sorbents	processing time in hours	SOLID: LIQUID RATIO					
		1 : 50		1 : 100		1 : 130	
		C_{Cr}^{common} mg/dm³	a, %	C_{Cr}^{common}, mg/dm³	a, %	C_{Cr}^{common}, mg/dm³	a, %
The 11 horizon bentonite clay and basalt fiber	3	0,0008	97,65	0,0007	97,94	0,001	97,06
	6	0,0032	85,45	0,004	81,81	0,0015	95,59
The 14 horizon bentonite clay and basalt fiber	3	0,0006	98,23	0,0011	96,76	0,0012	96,47
	6	0,0008	96,36	0,0045	79,54	0,005	85,29

The treatment results of the chromium-containing galvanic-manufactured wastewater of the reinforcing plant on the base of the bentonite clay and basalt fibers in the form of the pasty sorbent are shown in Table 2. The ratio of the bentonite clay and basalt fibers is equal to 2 : 1.

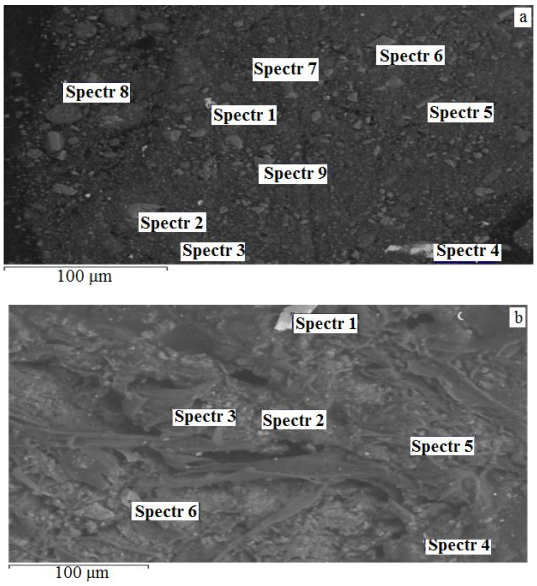

Fig. 1 – Electron micrograph of the modified pasty sorbents based on the 11 (a) and 14 (b) horizons bentonite clay and basalt fibers after the sorption purification

Our study has shown high efficiency of wastewater treatment by means of the pasty materials of all formulations obtained on the base of the bentonite clay and fibrous materials in all ratios of the sorbent to the chromium-containing wastewater.

Figure 1 shows electron micrographs of the modified pasty sorbents based on the 11 and 14 horizons bentonite clay and basalt fibers after the sorption purification.

Electron and microscopic analysis of the mentioned above modified pasty sorbents in spite of the chemical formulation has showed the presence of the asymmetric pores and open porous structure, which can be determined by the efficient adsorption of metal ions due to the internal surface. In all cases, the distribution of the bentonite clay over the entire surface of materials as a thin layer is homogeneous. The consumption of basalt fibers as a modifier improves the sorption properties of the sorbent.

3. CONCLUSIONS

Thus, in the result of the mechanically activated processing basalt fiber matrix with great specific surface area and highly developed structure of internal channels acquired properties of the sorbent and ion exchanger. Each fiber is coated with a thin layer of bentonite clay, creating a greater surface area.

The obtained modified sorbents can be referred to nanomaterials, because the length of montmorillonite clusters adsorbed on the surface of basalt fibers is 1.4 nm. Due to such dispersion the mineral has significant static exchange capacity – 1.2 – 3 mg·eq/g of dry mineral or more[4].

The study of the obtained sorption material efficiency showed that the intensive mechanical stress leads to the significant qualitative changes in its formulation.

Thus, the new modified natural pasty sorbents well combine filtration, adsorption and ion exchange properties and have significant advantages over granular sorbents in the technological process.

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