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NEW SORBENTS FOR ADSORPTION CLEANING PHENOL-CONTAINING WASTE WATER REFINERY

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Abstract: The article discusses some issues of creating new adsorbents based on local raw materials and waste for the purification of phenol-containing wastewater from refineries. Studied some sorption properties of new sorbents.

Key words: microwave processing, natural clay, adsorption, raw materials, waste, purification of phenol-containing wastewater, refineries.

НОВЫЕ СОРБЕНТЫ ДЛЯ АДСОРБЦИОННОЙ ОЧИСТКИ ФЕНОЛСОДЕРЖАЩИХ СТОЧНЫХ ВОД НПЗ

Аннотация: В статье рассмотрены некоторые вопросы создания новых адсорбентов на основе местных сырьевых ресурсов и отходов для очистки фенолсодержащих сточных вод нефтеперерабатывающих предприятий. Изучены некоторые сорбционные свойства новых сорбентов.

Ключевые слова: СВЧ-обработка, природная глина, адсорбция, сырьевые ресурсы, отходы, очистка фенолсодержащих сточных вод, нефтеперерабатывающие предприятия.

Introduction. Currently, the problem of wastewater treatment of oil refineries is relevant. At the same time, more and more common, both in the purification of wastewater and in water treatment, is obtained in a simple hardware design, but an extremely effective adsorption method.

The kinetics of the sorption of organic substances from aqueous solutions has been the subject of many studies [1–3], which is connected, in particular, with the need to create a mathematical model that makes it possible to evaluate the sorption properties of sorbents without conducting expensive and lengthy experiments. However, at present, the creation of such a unified model of adsorption is complicated by the lack of theoretical ideas about the mechanisms of adsorption of molecules from solutions, which are usually based on studying the possibility of applying different theories of the adsorption of gases on solid surfaces. From a practical point of view, two established patterns are of great importance.

Formulation of the problem. The first determines the dependence of the efficiency of sorption of compounds of one homologous series on their molecular weight at the initial stage. With increasing length of the hydrocarbon chain adsorbate, the efficiency of sorption first increases (which is explained by an increase in the adsorption equilibrium constant), and when the adsorbate molecular weight reaches a certain critical value, the resulting reduction in sorption efficiency with increasing molecular weight is observed.

The second pattern, determining the structure of the surface layer, creates a theoretical basis for the targeted choice of the adsorbent in specific cases, i.e. the process of adsorption goes towards alignment of the polarity of the phases of the adsorbent and the solution being purified, the more effective the larger the initial difference of polarities. It also follows that the adsorption of compounds less polar than water will occur more efficiently on the surface of the non-polar adsorbent (coal, vermiculite, etc.), and, the more intense, the lower the solubility or hydrophilicity of the substance.

Sorbability, as well as hydrophilicity, depends on the structure of the compounds (its functional groups). In this case, synthetic sorbents, as a rule, with a significantly higher efficiency than AU (activated carbon), remove only certain organic pollutants. In addition, natural sorbents known to date, as well as synthetic ones, have a greater sorption capacity than AU only for certain organic water pollution. When modifying natural sorbents, the sorption capacity can be increased by several orders of magnitude; an increase in the number of pores (mainly micro- and mesopores) also allows an increase in the sorption capacity.

Due to the fact that universal sorbents based on AU have a high cost, and a great problem of their regeneration, therefore, the search and creation of new cheap and effective sorbents for purification of wastewater from oil refineries from phenols is very relevant today.

We as such a sorbent are invited to use microwave modified clay containing phosphogypsum - waste of «Maham-Ammofos» OJSC.

The resulting sorbent is a fine powder with a number of valuable properties that determine its scope: a high degree of dispersion; high chemical resistance in different environments; well developed active specific surface; ecological purity and safety of use.

We have conducted experimental studies on the use of microwave-modified clays containing phosphogypsum, as a sorbent for the purification of concentrated phenol-containing wastewater refineries.

The study of the properties of the modified clay and the processes of adsorption and desorption showed that with the microwave processing of natural clay its specific surface increases, while the sorption platform decreases (although it significantly exceeds the size of the adsorbed molecules themselves) (table 1). In accordance with the size of the adsorption site, we can conclude that as a result of the adsorption of phenols, a monolayer is formed on the surface of clay sorbents, consisting of adsorbed molecules, the series is very small and due only to dissociation functional groups - SiOH – AlOH and SiOH – ROH formed on the faces of the crystals. Consequently, minerals of type 2 are of greater importance: 1. A large negative charge is concentrated mainly on the basal surface of elementary packets and neutralized by exchange cations of alkali and alkaline earth metals, which are located mainly in the interpacket spaces and in the form of aquacomplexes that communicate between the packets. Clay minerals are highly dispersed, have a developed surface and are good sorbents.

Table 1

Parameters of the adsorption layers of phenol and resorcinol during adsorption on various clays

Sorbent	Specificsurfacem² / g	Adsorbate			
		Phenol		Resorcinol	
		G_{max}, g/g	A,nm²/ mol	G_{max},g / g	A,nm²/ mol
Montmorillonite clay + 3% phosphogypsum (№ 1)	1103,5	0,02941	5,85685	0,03082	6,54021
the same 10 min microwave	1310,6	0,06494	3,15025	0,06691	3,57792
the same 20 min microwave	1337,2	0,06671	3,12891	0,07058	3,46072
Montmorillonite clay + 5% phosphogypsum (№ 1)	970,0	0,02607	5,80788	0,03484	5,08564
the same 10 min microwave	1183,1	0,06014	3,07075	0,06526	3,31151
the same 20 min microwave	1178,5	0,06149	2,99166	0,06601	3,26116

For clay minerals, as well as for zeolites, physical and molecular sorption are characteristic, along with ion exchange. Physical sorption is due to the presence of some excess negative charge on the faces of the crystals and surface hydroxide groups of an acidic and basic nature, capable of ionization.

The presence of phosphate and OH groups also causes a slight anion exchange capacity observed in layered minerals.

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In molecular sorption, the substances to be sorbet are located between the planes of the packages, destroying the original aquacomplexes, but without changing the structure of the layers themselves. At the same time, the distance between the layers increases, since the clay mineral swells inside the laminar layer, which distinguishes it from the zeolite, which is not capable of swelling.

Conclusions. Due to this, clay minerals have a high selectivity for organic ions and molecules, in relation to which their sorption capacity is even higher than for inorganic ions. This allows you to use them for the treatment of wastewater from organic compounds.

We consider the increase in the sorption capacity during the processing of natural clays by microwave radiation, primarily due to the fact that there is a partial destruction of aquacomplexes that communicate between the packets, which contributes to a better penetration of the sorbed substances to the negative charge concentration centers.

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