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PHYSICO-CHEMICAL PROPERTIES OF ACTIVATED ADSORBENTS BASED ON LOGAN BENTONITE

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Abstract:

Objective. The article clarifies the physicochemical properties of adsorbents activated from Logon bentonite under various thermal and chemical conditions. It has been established that the desorption lines in the LBK and LBI intersect with the adsorption lines at a relative pressure R/Rs = 0.1–0.2, forming an adsorption hysteresis surface.

Results. Nowadays, modified bentonites, especially organobentonites (concrete), are increasingly used in various sectors of the economy [3]. In particular, in the treatment of industrial waste water by adding bentonite to polymeric substances obtained on the basis of various industrial wastes, as a stabilizer in increasing the thermal stability of silicone rubbers, in improving the rheological properties of drilling fluids, as a binding and hardening additive for coal briquettes.

Methods. The adsorption of non-polar benzene vapors on the obtained modified bentonites was studied. Samples modified on the basis of logan bentonite (LB) were thermally and chemically treated before being used in adsorption. Adsorbents obtained under such conditions: chemically activated; LBK, LBI and thermal treatment were designated as LB-1, LB-2, LB-3

Conclusions. According to the results of industrial experiments, it was found that these adsorbents can be used as adsorbents in the treatment of organic and inorganic waste substances in the waste water of various industries.

Keywords: bentonite, benzene, adsorbent, absorbate, adsorption, desorption, isothermal monolayer capacity, specific surface.

Introduction. The rapid development of industrial sectors, the use of various technologies in technological processes leads to an increase in the demand for effective adsorbents used in this field. Preparation of such adsorbents on the basis of local raw materials, including Logan bentonite clay, is of particular importance. Considerable scientific research has been conducted in our country to study the properties of mineral adsorbents such as adsorption properties, surface area, nature and strength of active centers [1]. Modified adsorbents based on Navbahor alkaline bentonite and various organic compounds were obtained and their adsorption properties and thermodynamic characteristics of phase state changes in adsorbed substances were studied [2].

Results. Nowadays, modified bentonites, especially organobentonites (concrete), are increasingly used in various sectors of the economy [3]. In particular, in the treatment of industrial waste water by adding bentonite to polymeric substances obtained on the basis of various industrial wastes, as a stabilizer in increasing the thermal stability of silicone rubbers, in improving the rheological properties of drilling fluids, as a binding and hardening additive for coal briquettes. It is used as an adsorbent that absorbs various microorganisms, in the treatment of water contaminated with heavy metals and oil products, in the retention of dyes from the wastewater of finishing factories, in the production of purified sulfur from technical sulfur, in the production of various antibacterial adsorbents [4]..

Methods. The adsorption of non-polar benzene vapors on the obtained modified bentonites was studied. Samples modified on the basis of logan bentonite (LB) were thermally and chemically treated before being used in adsorption. Adsorbents obtained under such conditions: chemically activated; LBK, LBI and thermal treatment were designated as LB-1, LB-2, LB-3 [5].

The quantitative and qualitative composition of the functional groups in the obtained adsorbents was determined by IR-spectroscopy (Shimadzu IRTracer100, Japan). The high sensitivity of the spectra (60,000:1 signal/noise ratio) leads to the continuous analysis of the amount of impurities in different samples, despite the low intensity of the lines of interest in the spectrum. The IRTracer-100's spectral resolution of 0.25 cm^{-1} provides high resolution for quantification of spectral identification, especially in the case of gaseous compounds. Interferometer performance optimization system together with internal self-diagnosis ensures stable operation of the device. IR-spectra of activated adsorbent in acidic and alkaline environment are presented in Fig. 1.

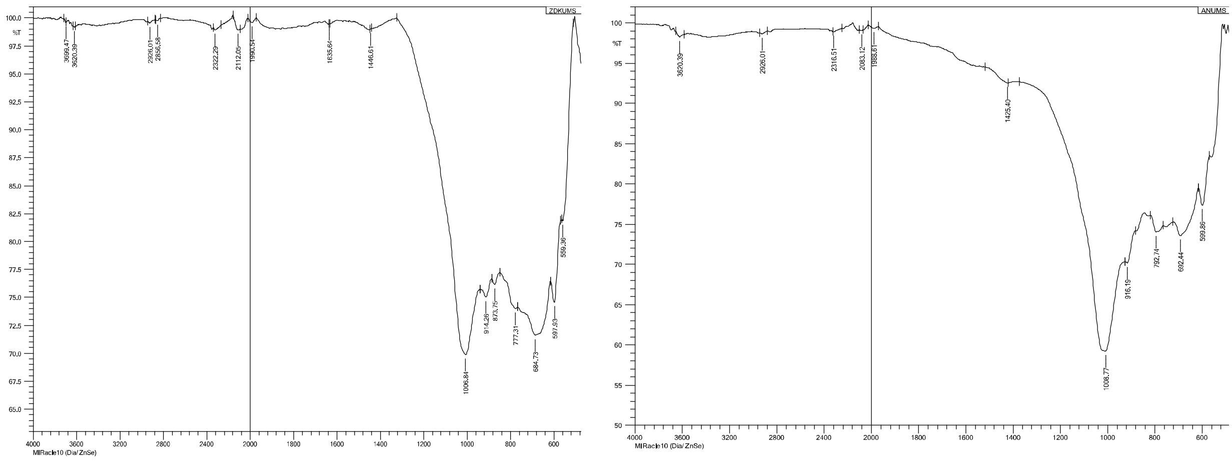

Figure 1. IR-spectra of activated adsorbent in acidic and alkaline media

From the analysis of the literature and the results of IR-spectra of obtained adsorbents, LBI adsorbent contains organo-metal (400-900 sm^{-1}), Al-O-Si or Si-O-Si (914-1007 sm^{-1}), Al=O (1447-1636 sm^{-1}), Al≡Si (2112-2322 sm^{-1}), Si-H (2856-2926 sm^{-1}), -OH (3600±50 sm^{-1}) groups can be seen. LBK adsorbent contains organo-metallic (400-900 sm^{-1}), Si-O-Si (1009 sm^{-1}), Si≡Si (2033-2166 sm^{-1}), -OH (3600± sm^{-1}) functional groups was determined. It is possible to see the high intensity of the peaks characteristic of the orgo-metal bond in these samples. Moreover, in the formation of these adsorbents, we can say that the interaction between metal and silicon in bentonite is strong. As a result of the modification, the formation of a new group of Si-O-Me atoms as a result of the interaction of the Si-O- group of atoms in bentonite with metal atoms. The high intensity of the IR spectrum peaks at 914-1007 sm^{-1}confirms the conclusions. . As a result of the interaction of acid with oxygenated functional groups on the surface of bentonite, additional pores are formed in the adsorbents, as a result, the size of the pores decreases, that is, the amount of mesopores decreases, and micropores amount increases.

In order to increase the reliability of the above data, X-ray analyzes were taken at the UzRFA Institute of Biorganic

Chemistry. The chemical composition of activated adsorbents was analyzed.

Table 1

X-ray image and chemical composition of Log'on bentonite (LB)

Mineral		LB (%)	LBK (%)
SiO_2		10,17	10,17
Feldspar		8,05	7,10
clinoptilolite		5,71	4,51
Muscovite-KAl2(Si3Al) O10(OH,F)2		5,83	8,83
Illite (K,H3O)(Al,Mg,Fe)2(Si,Al)4O10[(OH)2,(H2O)]		10,84	7,84
Diopside-CaMgSi2O6		1,58	1,58
Montmorillonite (Na,Ca)0,3(Al,Mg)2Si4O10(OH)2•n(H2O)		57,82	59,97
	Total:	**100**	**100**

It can be seen from Table 1 that Log'on bentonite contains SiO2 10.17%, feldspar 8.05%, clinoptilolite 5.71%, muscovite 5.83%, illite 10.84%, diopside 1.58% and mondmorillonite 57.82%, as a result of activation of Log'on bentonite with acid it contains feldspar from 8.05% to 7.1%, clinoptilolite 5.71%, muscovite 5.83%, illite 10.84%, diopside 1.58% and mondmorillonite 57.82%. From this, it can be concluded that when Log'on bentonite is activated with acid, the amount of montmorillonite in its content increases by 2.15%. It is known from the literature that an increase in the amount of montmorillonite in bentonite has a positive effect on its sorption properties.

Benzene adsorption in LBK and LBI (activated in acid and alkaline conditions) adsorbents is very low compared to LB-1, LB-2, LB-3, adsorption in the initial states of adsorption. This is related to the electronic nature and interactions of cations (Na+ and [Al13O(OH)24(H2O)12]7+) and benzene molecules located between the adsorbent layers. It can be seen from the adsorption isotherms that at high specific relative pressures (R/Rs □ 0.3) the amount of adsorption in LBK and LBI increases sharply (Fig. 2).

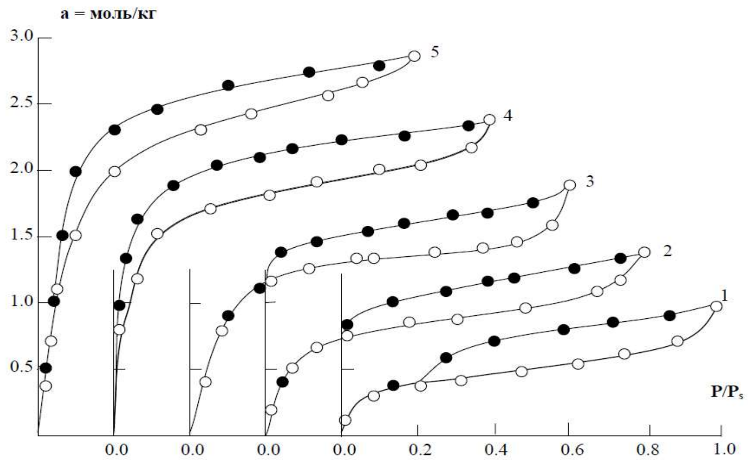

Figure 2. Adsorption isotherms of benzene vapors on activated bentonites LB-1 (1), LB-2 (2), LB-3 (3), LBI (4), LBK (5)

In most cases, adsorption processes in chemically activated bentonites proceed with capillary condensation, in such cases adsorption hysteresis is observed. The desorption lines in LB-1, LB-2, and LB-3 intersect with the adsorption lines at relative pressure R/Rs = 0.2, forming an adsorption hysteresis surface. Formation of adsorption hysteresis surfaces in adsorbents occurs due to adsorption of adsorbate molecules in different pores formed in mineral layers.

The relative relative pressure (P/Ps) of the hysteresis loops in the adsorption isotherm in LBI and LBK approaches to zero value due to the interaction of benzene molecules with the central atom in the adsorbent.

The surface area (S) of the adsorbents was determined from the structural adsorption parameters using the equation of the Brunauer, Emmet, Teller (BET) theory. If the ordinate is P/Ps/a(1 - P/Ps) and the values of P/Ps are placed on the abscissa axis, straight line coordinates are obtained.

Based on the isotherms of benzene vapor adsorption on modified adsorbents, the monolayer capacity am, saturation volume Vs (or adsorption as), and their relative surfaces S were calculated from the important parameters of adsorbents (see Table 2).

Table 2

Structure and sorption indicators of benzene vapor adsorption of modified bentonites thermally treated at different temperatures

Adsorbents	Single floor capacity, a_m, mol/kg	Comparison surface,S · 10^{-3}, m^2/kg	Saturation adsorption a_s, mol/kg
LB-1	0,19	45	1,14
LB-2	0,53	149	1,40
LB-3	0,68	164	1,87
LBI	0,76	175	2,47
LBK	0,83	198	3,10

Specific surface area (S) for all adsorbents from the table: 45 103 m^2/kg for LB-1, 149 103 m^2/kg for LB-2, 164 103 m^2/kg for LB-3, 175 103 m^2/kg for LBI and 200 103 for LBI m^2/kg and saturation adsorption (as): 1.14 mol/kg in LB-1, 1.40 mol/kg in LB-2, 1.87 mol/kg in LB-3, 2.47 mol/kg in LBI, 3.10 in LBK mol/kg was found to be equal. So, as a result of chemical activation, comparing the adsorption of benzene vapor compared to Logon bentonite (LB-1), it can be seen that it leads to an increase in adsorption to 1.14-2.47 in LBI and 1.14-3.10 in LBK.

When activated in such conditions, due to the release of physically adsorbed water molecules and additional salts in the samples, modified clays are associated with the formation of additional spaces (porosity) between the layers.

Thus, in the work, the adsorption of benzene vapors on clay adsorbents activated by thermal and chemical methods was studied under different conditions. According to the results of benzene vapor adsorption of adsorbents, the adsorption capacity of activated adsorbents was ranked according to the saturation adsorption volume (Vs) in the following order:

LBK > LBI > LB-3 > LB-2 > LB-1

The arrangement of activated adsorbents in terms of their ability to absorb benzene molecules in this order is the removal of additives contained in bentonite as a result of chemical activation, on the other hand, the specificity of the interaction of non-polar benzene molecules with activated adsorbents, that is, hydrophilic and lyophilic adsorbents is related to the change of nature. In LBK, the amount of benzene vapor adsorption is higher than other adsorbents, the adsorbent is cleaned from the substances released in acidic conditions between the adsorbent layers, and the adsorbent's lyophilicity and porosity increase.

Wastewater treatment using modified adsorbents.

A large amount of water is used in the field of oil production, and a large part of this water is being cleaned using various methods in open water reservoirs. A large amount of acidic and alkaline water is produced during the refining of oils and fats in oil industry enterprises. Such wastewater has an unpleasant smell.

In most cases, soda ash is used as a reagent to neutralize acidic waters, but its high cost makes it less practical and less effective.

Therefore, it is an urgent task to replace expensive imported reactants with adsorbents produced on the basis of cheaper local raw materials. For this purpose, cheap wastewater obtained on the basis of Logon bentonite was used in the treatment of acidic wastewater with a pH of 1.2-1.7 with adsorbents capable of comprehensive treatment.

Waste water of oil-oil production plants is contaminated with organic compounds in the form of fatty products (vegetable oils, animal fats, fatty acids, phosphatides, soaps, etc.) in emulsion state. To date, "Yog-gar" JSC wastewater is cleaned by collecting oily substances in a clarifier, then acidic water is neutralized with sodium carbonate and discharged through sewage pipes. Oily substances in wastewater are not cleaned by adsorption method. In laboratory conditions, experimental test works were carried out on industrial waste water purification using adsorbents modified by activation of inorganic and organic substances.

From the results of the experiment, it was found that the pH value of adsorbents obtained by the method of thermal activation: 5.3 in LB-2, 3.1 in LB-3, adsorbents obtained by the method of chemical activation: 4.6 in LBK, 5.4 in LBI. It was found that with the help of adsorbents activated in an alkaline environment, logan bentonite can remove 80% of acid anions, 97% of organic substances, and increase the pH value from 1.7 to 5.2 (Table 2).

Table 2

Results of "Yog-gar" JSC wastewater treatment by adsorption method

Adsorbents	Wastewater indicators, mg/l							
	pH	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	OQ^*
Amount of ions in wastewater	1,7	21	92	61,2	640	903	11	520
LBI	5,3	19,81	23,33	44,21	301,22	324,2	2.21	12,21
LBK	3,1	23,02	70,41	54,12	614,31	825,3	8,52	191,2
LB-2	4,6	20,82	22,62	44,34	308,42	343,2	-	16,42
LB-1	4,4	22,12	85,21	56,13	604,41	792,6	3,41	52,63

Conclusions. According to the results of industrial experiments, it was found that these adsorbents can be used as adsorbents in the treatment of organic and inorganic waste substances in the waste water of various industries. The use of these adsorbents as adsorbents in various industries makes it possible to eliminate the demand for adsorbents in our Republic in a certain sense. Firstly, the lack of adsorption capacity of imported adsorbents is economically effective by saving foreign currency based on the use of local adsorbents instead, and secondly, it is ecologically effective due to the characteristics of industrial wastewater treatment.

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SIMULATION OF HEAT TRANSFER PROCESS IN ABSORBER CHANNELS

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Abstract:

Objective. At present, the issues of systematization of the energy balance, the development of thermal and mathematical models, as well as the generalization of methods and computer programs for calculating photovoltaic thermal modules are relevant.

Methods. The program “Comsol Multiphysics 5.6.” was used to simulate the process occurring inside the absorber. To describe the laminar motion of a liquid (water), a non-stationary system based on the Navier-Stokes equation and the [1] heat distribution equation was used.

Results. This article describes a mathematical model of heat transfer in absorber channels developed using the «Comsol Multiphysics 5.6. program». The results are presented for determining the longitudinal flow velocity at various sections of the flow channel, heat distribution over time, as well as the heat distribution isoline and isotherm.

Conclusion. Developed on the basis of the program «Comsol Multiphysics 5.6.» a simulation model of heat transfer from a photovoltaic battery to a heat absorber can be used to calculate heat and power supply systems. The use of a simulation model in the design of a heat and power supply system makes it possible to reduce the consumption of heat and electricity.

Keywords: absorber, flow, temperature, hydrostatic pressure, viscosity coefficient, flow channel.

Introduction. Design of solar power plants, allowing to generate electrical and thermal power on an energetically tangible scale without negative impact on the environment; experimental research and practical application of solar power plants

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