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DEVELOPMENT OF EFFECTIVE CLAY ADSORBENTS FOR CLEANING FATTY ACIDS OBTAINED FROM COTTON

Abstract: This article shows the possibility of purification of fatty acids by local clay adsorbents. The physicochemical properties of local clays have been studied.

The carried out researches show that the sorbent obtained from the methods of sulfuric acid activation of Navbakhar alkaline bentonite, which mainly consists of montmorillonite mineral, is the most effective of the considered clay adsorbents. Its high sorption ability is provided by sulfuric acid activation, which develops internal pore volumes, especially with micro-sizes. It was found that the thermal activation of Angren kaolin does not give the desired degree of purification of fatty acids from the above impurities. The regularities of the processes of clarification and removal of residual metals from fatty acids on selected adsorbents have been established, and the optimal conditions for their implementation have been determined.

Keywords: fatty acids, adsorbent, calcinations, activation, clay minerals, bleaching, sulfuric acid.

At present, fatty acids and their individual fractions (stearin, palmitin, olein, etc.) are widely used in the production of rubber, medicines and detergents, surfactants, paints, etc.

At the same time, the quality requirements are increased taking into account the field of their application.

The known technologies for the separation and purification of raw fatty acids, depending on the type of feedstock (oils, salomas, etc.) do not completely satisfy the requirements of consumers. they contain a significant amount of impurities (residues of soap, coloring substances – gossypol, chlorophyll and their derivatives, surface-active substances – phospholipids, etc.)

One of the promising ways of upgrading fatty acids is the adsorption method for their purification using polyfunctional adsorbents, including clay ones [1]. The advantage of clay adsorbents is their availability, cheapness and simplicity of activation with the use of mineral acids, alkalis, etc.

In Uzbekistan there are large bentonite, palygorskite and kaolin clay deposits, which can be used in the production of adsorbents, etc. It should be noted that fatty acids obtained on the basis of cottonseed oil processing are more dark, contain more coloring pigments, phospholipid residues, catalyst metals

(Ni, Cu, etc.). Therefore, adsorption purification is considered to be a necessary technological stage of improving their quality.

The use of local minerals in the preparation of clay adsorbents allows several times to reduce the cost of production and use.

Taking this into account, we studied the mineralogical and chemical compositions of clays obtained from promising deposits in Uzbekistan. Analyzes of these samples were carried out according to the standardized methods described in [2; 3].

The results are shown in (Table 1).

Table 1. – Mineralogical and chemical compositions of selected local clays of Uzbekistan for obtaining polyfunctional adsorbents

Name clayey deposits	Main type of mineral's	Chemical composition of clay,%											
		SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	MgO	CaO	Na ₂ O	K ₂ O	SO ₃	H ₂ O	п.п.п
Navbakhar alkaline bentonite (Navaiya region)	Montmorillonite	57.91	0.35	13.69	5.1	–	1.84	0.48	1.53	1.75	0.75	0.2	16.17
Tul-Sokh carbonate palygorskite (Fergana region)	palygorskite	46.8	–	8.71	0.3	3.5	2.76	10.07	–	1.55		0.5	24.3
Angren kaolin (Tashkent region)	Kaolinite	65.3	0.45	25.28	1.5	0.1	0.35	0.30	0.4	0.94	0.16	0.2	5.12
Askan ascanite (Republic of Georgia) (control)	Ascanite-montmorillonite	54.14	0.38	18.74	4.98	0.22	4.64	2.41	2.82	0.64	0.07	0.2	10.94

From (Table 1) it can be seen that in the republic there are different types of clay minerals, of which minerals, from which it is possible to produce adsorbents for various purposes. To do this, it is necessary to develop optimal activation conditions taking into account their chemical composition.

It is known that montmorillonite (bentonite and palygorskite clays should be activated by chemical methods (acidic, alkaline or combined methods), and kaolinite by thermal calcination under optimal conditions [4].

The selected clays of Uzbekistan have poly-mineralogical compositions, so the method and conditions for their activation require a series of analyzes.

We carried out a differential-thermal analysis of the selected local clays in order to determine the optimum calcination temperatures. The experiments were carried out at the request of DTA on the Erba-Erba (Germany).

The results of the analyzes are presented in (Table 2).

Table 2. – Indicators of thermal “effects” of selected local clays

Name clayey deposits	Temperature «effects», °C		
	first	second	third
Navbahar alkaline bentonite (Navoi region)	200–235	550–700	800–900
Tul-Sokh carbonate palygorsk (Fergana region)	250–300	650–750	900–950
Angren kaolin (Tashkent region)	500–700	900–1000 ^{x)}	1200–1250 ^{xx)}
Askan Asconite (Republic of Georgia) (control)	200–250	500–700	850–900

Note: ^{x)} and ^{xx)} in these temperature ranges in kaolin, exothermic effects

From (Table 2) it can be seen that with a change in the type and chemical composition of the clay, the temperature values of the first, second and third thermal “effect” vary significantly. If, at the first “effect”, moisture and other volatile substances are removed from the surface of the clay, in the second, the removal of the above from their internal part occurs. With the third “effect”, the structure of clays is destroyed and their state is changed to a new state [5].

Therefore, taking into account and observing the given temperature values of the calcination allows us to correctly select the activation conditions for the selected clays.

The chemical composition of montmorillonites and hydromica shows the need for their acid (or alkaline) activation by leaching of unnecessary chemical components, and kaolinites – thermal activation under the conditions identified by their DTA.

In laboratory conditions, we carried out the acid activation of Navbakhar alkaline bentonite, Tulsokho carbonate palygorskite at 50 °C using an aqueous solution of 20 and 15% acid (H_2SO_4) for 6 hours, and thermal calcination of Angren kaolin in a muffle furnace at a temperature of 900–1000 °C for 1 hour cooled to room temperature, the adsorbents obtained were stored in glass beads prior to their use in the purification of fatty acids in a special installation [6].

Figure 1. Kinetics of the clarification of fatty acids, depending on the type of adsorbent: 1 – Navbakhar alkaline bentonite (NAB); 2 – Tulsokho carbonate palygorskite (TCP); 3 – Angren kaolin (AK); 4 – Askan Ascanite (AA) (control)

To determine the effective adsorbent, we conducted experiments on the sorption of coloring substances (gossypol, chlorophyll and their derivatives) from

fatty acids obtained from the products of processing cottonseed oil. Adsorption purification was carried out with vigorous stirring and 60–70 °C for 1 hour. At

the same time, the amount of adsorbent introduced was 2.0% of the weight of the fatty acids to be tested.

Figure 1 shows the kinetics of the clarification of fatty acids by the developed adsorbents.

Figure 1 it can be seen that when using adsorbents obtained from Navbakhar alkaline bentonite (curve 1), Tulsokh carbonate palygorskite (curve 2), and Angren kaolin (curve 3), the clarification of fatty acids proceeds smoothly according to the exponential law, and the Askan ascanite (curve 4) the initial stage of the process (for up to 20 minutes). At the same time, the greatest clarification of fatty acids is observed when using an adsorbent obtained from Navbakhar alkaline bentonite (curve 1) and vice versa, the smallest when using Angren kaolin (curve 3).

It is known that distilled fatty acids contain up to 95% of unsaturated fatty acids (linolenic, linoleic, oleic, etc.), which are oxidized by air oxygen during storage and thermal processing. This process is ac-

celerated by the presence of metal debris (Ni, Cu, etc.) in them. Therefore, before the purification of fatty acids, it is advisable to use adsorbents that sorb the metals (or their ions) as much as possible.

Taking this into account, we have studied the sorption of these metals in the purification of fatty acids on selected adsorbents. The experiments were performed under the conditions described above, and analyzes of the residual content of nickel and copper were carried out according to the procedures approved in [7]. Figure 2 shows the results of the analyzes

From (Fig. 2) that the greatest sorption of nickel is observed when Navbakhar alkaline bentonite is used and, on the contrary, the lowest – Askan ascanite (control), which in 20 minutes loses its sorption ability and further, practically does not change the residual nickel content in fatty acid. The same pattern is observed when copper is removed from fatty acids, which confirms the selective ability of adsorbents to adsorbate metal and nickel residues.

Figure 2. Change in the residual content of nickel (curves 1–4) and copper (curves 5–8), depending on the type of adsorbents and the cleaning time (τ , min): 1-Navbakhar alkaline bentonite (NAB); 2-Tulsokho carbonate palygorskite (TCP); 3-Angren kaolin (AK); 4-Askan ascanite (AA) (control)

On the basis of the studies carried out, the adsorbents chosen are arranged in the following sequence of a series of decreases; on clarifying ability:

Navbakhar alkaline bentonite > Askan ascanite (control) > Tulsokho carbonate palygorskite > Angren kaolin.

Removal of residual metals:

by sorption of nickel:

Navbakhar alkaline bentonite> Tulsokho carbonate palygorskite> Askan ascanite (control)> Angren kaolin.

on copper sorption:

Navbakhar alkaline bentonite> Askan ascanite (control)> Tulsokho carbonate palygorskite> Angren kaolin.

Thus, the conducted studies show that the sorbent obtained from the methods of sulfuric acid activation of Navbakhar alkaline bentonite, which

mainly consists of montmorillonite mineral, is the most effective of the considered clay adsorbents. Its high sorption ability is provided by sulfuric acid activation, which develops internal pore volumes, especially with micro-sizes. It was found that the thermal activation of Angren kaolin does not give the desired degree of purification of fatty acids from the above impurities. The regularities of the processes of clarification and removal of residual metals from fatty acids on selected adsorbents have been established, and the optimal conditions for their realization.

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