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Д.В. Сокольский атындағы
«Жанармай, катализ және электрохимия институты» АҚ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
АО «Институт топлива, катализа и
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NAS RK is pleased to announce that News of NAS RK. Series of chemistry and technologies scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Химия және технология сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия химии и технологий» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество в глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

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PREPARATION AND PHYSICO-CHEMICAL CHARACTERIZATION OF ORGANIC
MODIFIED CLAYS WITH GRAFTED ORGANOALKOXIDES

Abstract. Natural clays are inexpensive and easily accessible materials. If properly modified their characteristics can be changed to make them cheap and available industrial adsorbents. In this work natural clays from the Shymkent deposit of Kazakhstan were used and modified to obtain organo-clays to improve the adsorption properties, by introducing organic compounds into the natural clays.

A new hybrid organoclay material (denoted DMSO-K) was obtained by feeding dimethyl sulfoxide (DMSO) into the interlayer space of kaolinite (K) using the kaolinite/DMSO compound as an intermediate product. Various analyses were used to describe the obtained adsorbents, such as infrared spectroscopy (IR), X-ray diffraction (X-ray diffraction), differential thermal analysis (DTA) and elemental analysis, among others. The organic molecules located in the interlayer space caused significant changes in the morphology of pure kaolinite.

The results of studies of adsorption characteristics of the initial and of the modified natural clays are presented revealing the suitability of the developed materials.

Key words: Kaolinite, thermal analysis, intercalated grafting, dimethylsulfoxide-DMSO, natural clay, modified clay, organoclay.

Introduction. The kaolin group includes minerals: kaolinite, halloysite, dickite, and nacrite from which the first two are of industrial importance [1]. White or near white kaolinite powder is mainly used for paper coating, paper filling, and traditionally in ceramics [1]. Halloysite deposits are rare and unique, however where possible the mineral is used as an additive in the production of high quality ceramics. On the other hand another area of the use of kaolin minerals that is growing continuously in the last decade is the preparation of kaolin group-based materials which are used as sorbents, catalysts, molecular sieves and fillers in the synthesis of polymer nanocomposites [2-6]. Structure of kaolin group minerals is built from differentially stacked 1:1 layers. In contrast to 2:1 layered minerals e.g. montmorillonite, the kaolinite layer composed of octahedral (Al) and tetrahedral (Si) sheets is asymmetrical. It was shown that the inner surface hydroxyls of the octahedral sheet may react with selected organic molecules to form grafted complexes through formation of Al-O-C type bond [7,8]. Thus, the kaolinite layer may play the role of a building block for the materials with new properties. Current studies showed the possibility of grafting reactions with e.g. alcohols [7], diols [9], organic acids [8], ligands [10], and aminoalcohols [11]. The advantage of the grafted materials over classical intercalates is their high thermal stability and resistance to washing with water [7,11]. Recently the grafting reaction of triethanolamine followed by methylation reaction with iodomethane in the interlayer space of the mineral was reported [12,13]. This induced a positive charge connected with the formed ammonia nitrogen balanced by iodide ions. Previous studies confirmed the availability of the charge for Cr (VI) anions which penetrated the interlayer space [12]. The anions were ion-exchanged for iodide ions and such modified kaolin group minerals showed improved anion sorption properties in contrast to raw minerals with low affinity to anionic species. Apart from possible application for waste water treatment its use for coating of the electrodes in analytical chemistry for the anions detection was reported [14].

Functional organic species can be immobilized and stabilized in natural clays, obtained what is known

as organoclays. Organoclays represent a universal field of research, which is due, in particular, to the wide availability of natural clay minerals and their ability to include a wide variety of functional molecules, including polymers [15-21]. Due to the strong interactions between tetrahedral and octahedral sheets through H-bonds and dipole interactions, direct intercalation of bulky compounds into the kaolinite interlayer space has not yet been recorded. However, compounds obtained as a result of intercalation of small dipole compounds, such as dimethyl sulfoxide (DMSO), N-methyl formamide (NMF) or urea, can be used as precursors for further intercalation of other organic molecules or polymers. The interaction between organic guests, as dimethyl sulfoxide organic compounds, and kaolinite is mainly due to weak Van der Waals interactions. These materials do not resist water treatment. When treated with water, the guest is displaced from the interlayer spaces, leading to the formation of kaolinite hydrates [22]. In the case of organic fragments grafted into the natural clay, they are covalently bound to octahedral layers after reaction with aluminol groups. These compounds strongly resist hydrolysis by water. In this article, the data of thermal analysis (TG and DTA) in combination with X-ray diffraction (XRD) data, elemental analysis and spectroscopic analysis of ICS are used for qualitative and quantitative characteristics of various natural clays and modified clays obtained from the use of organic compounds.

Experimental. Material and Solid Synthesis. Natural clays from the Shymkent deposit of Kazakhstan, C_2H_6OS - dimethyl sulfoxide (DMSO), distilled water (H_2O), $C_4H_4O_2$ - dioxin, C_3H_8O - isopropanol were obtained from the Shymkent deposit from Kazakhstan are presented.

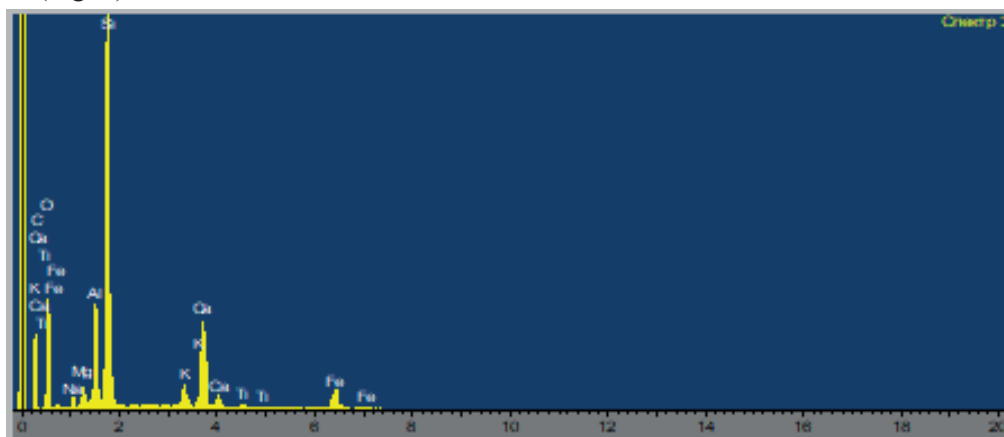
Method for obtaining organo-clays. The natural clay from Shymkent deposit was crushed into powder in a mill and sorted through a sieve No. 0.063. 6 g of the kaolinite clay was washed with 6 L of water and 30 mL of DMSO and 2.5 mL of water were further added to the mixture. The suspension was kept under magnetic stirring for 5 days at a temperature of 80 °C. Then, the mixture was left for 2.5 days at room temperature. The resulting material was recovered after two series of washing-centrifugation using first dioxane (2 x 25 mL), then isopropanol (2 x 25 mL). The product was finally dried at a temperature of 50 °C.

Materials Characterization and Analytical Methods. Table 1 and Figure 1 shows the contents of elements in the starting natural clay. As it is noted in Table 1, the Shymkent clay is rich in silicon (25.38%), calcium (10.69%) and aluminum (6.53%).

Table 1. Elemental composition of the natural clay from the Shymkent deposit

Natural clay from Shymkent	Weight of the element (%)										
	O	Na	Mg	Al	Si	Cl	K	Ca	Ti	Fe	Result
	48,01	1,14	1,91	6,53	25,38	-	2,10	10,47	0,34	4,12	100,00
	Results in connections %.										
	Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	SO ₃	Cl	K ₂ O	CaO	TiO ₂	FeO	Result
	1,59	3,32	12,97	57,45	-	-	2,70	15,74	0,60	5,62	100,00

The results of the elemental composition of the natural clay and of the modified clay were obtained using EMP analysis (Fig. 1).



Full scale 2735mm, Cursor 0.000

keV

Figure 1. Elemental composition of the natural clay from Shymkent

To determine the quantitative ratio of the crystalline phases of alumina in the natural clay from Shymkent, the samples were subjected to X-ray diffractometric analysis. The results are shown in Figure 2.

Diffractograms of a sample of natural clay are carried out on an automated diffractometer DRON-3 with SiKa radiation, a β – filter. Conditions carinf.com It is not responsible for diffractograms: U=35 kV; I=20 mA; shooting θ -2 θ ; detector 2 cities/min (Fig. 2.).

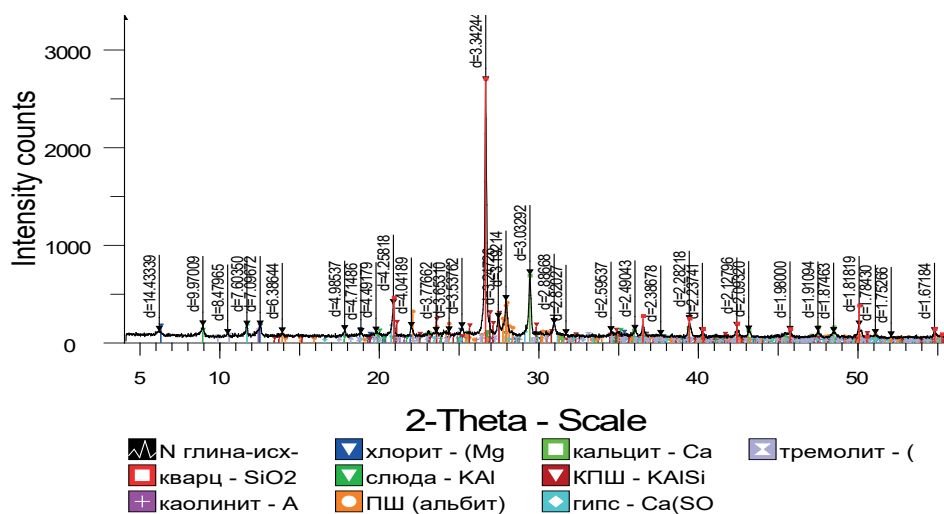


Figure 2. Diffractogram of the natural clay form Shymkent

X-ray phase analysis on a semi-quantitative basis was performed using diffractograms of powder samples using the method of equal attachments and artificial mixtures. The quantitative ratios of the crystal phases were determined. The interpretation of diffractograms was carried out using data from the ICDD card file: PDF2 powder diffraction data base (Powder Diffraction File) and diffractograms of minerals free of impurities. Shooting conditions: Diffractometer DRONE-3.0; accelerating voltage-35 kV; anode current-20 mA

The analyses were performed on a derivatograph of the company “MOM” - Budapest (Hungary). The method used is based on the registration by the device of changes in the thermochemical and physical parameters of a substance that can be caused when it is heated. The thermochemical state of the sample is described by the curves: T (temperature), DTA (differential thermoanalytic), TG (thermogravimetric) and DTG (differential thermogravimetric), the latter curve is a derivative of the TG function. DTA-DTG - TG-

The analysis was carried out in an air environment, in the temperature range from 20 to 1000°C The heating mode of the furnace is linear ($dT/dt = 10$ degrees/minute), the reference substance is calcined Al_2O_3 . For clarity, the shooting conditions of the sample sample was strictly 200 mg, with the sensitivity of the scales-100 mg. The analysis was taken within the following limits of the measuring systems of the device: DTA = 250 μ V, DTG = 500 μ V, TG= 500 μ V, T = 500 μ V.

The sample and the reference substance for analysis were placed in ceramic crucibles.

Results and Discussion. The results of semi-quantitative X-ray phase analysis are gathered in Table 2.

Table 2. Results of semi-quantitative X-ray phase analysis of Shymkent

Mineral	Formula	Concentration, %
quartz	SiO ₂	54.2
kaolinite	Al ₂ (Si ₂ O ₅)(OH) ₄	10.6
chlorite	(Mg,Fe) ₅ Al(Si ₃ Al)O ₁₀ (OH) ₈	3.6
mica	KAl ₂ (AlSi ₃ O ₁₀)(OH) ₂	2.5
PS (albite)	Na(AlSi ₃ O ₈)	4.8
calcite	Ca(CO ₃)	13.3
KPS	KAlSi ₃ O ₈	4.0
gypsum	Ca(SO ₄)(H ₂ O) ₂	3.1
tremolite	(Ca, Na, Fe) ₂ Mg ₅ Si ₈ O ₂₂ (OH) ₂	3.8

The result of the analysis established that the sample of the studied Shymkent clay belongs to the group of layered silicates-kaolinite $\text{Al}_2(\text{Si}_2\text{O}_5)(\text{OH})_4$, with a low amount of chlorite $(\text{Mg,Fe})_5\text{Al}(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_8$, admixtures of muscovite $\text{KAl}_2(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$, $\text{Na}[\text{AlSi}_3\text{O}_8]$ (albita) $\text{Na}(\text{AlSi}_3\text{O}_8)$, $\text{Ca}(\text{SO}_4)(\text{H}_2\text{O})_2$, KAlSi_3O_8 (orthoclase) KAlSi_3O_8 and thermolite $(\text{Ca, Na, -Fe})_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$. Possible impurities with a low content and unambiguous identification may be present due to the existence of only 1-2 diffraction reflexes, the absence or poor crystallization of chemical composition data.

The natural clays of the Shymkent deposit and the modified clays were also subjected to a comprehensive study by FTIR spectroscopy. FTIR spectra of all compounds were recorded in solid form in KBr tablets. The decoding of the spectra is carried out by a database that includes the characteristic oscillation frequencies of the reference publications of the program. The obtained results are given in Figure 3.

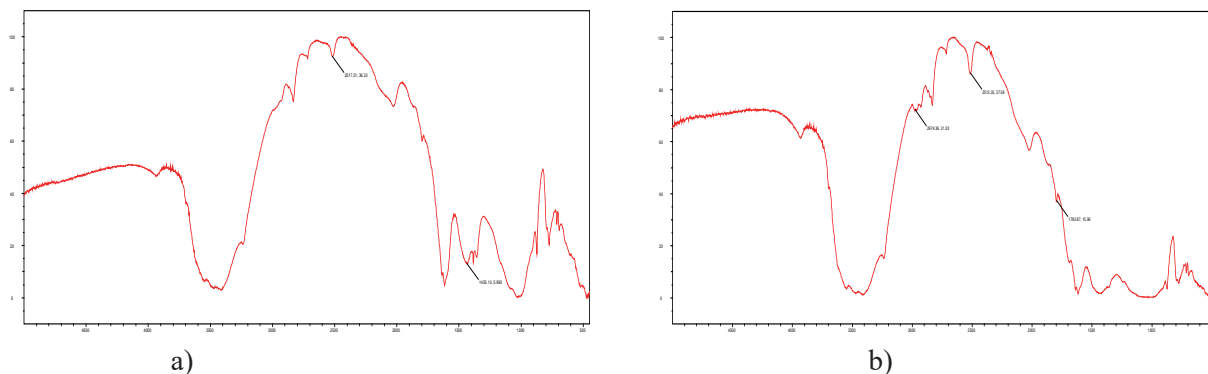


Figure 3. FTIR spectrum of a) natural clay from Shymkent, b) modified clay DMSO/Shymkent

The analysis of the FTIR spectra shows that the main bands in the natural clays belong to the valence bonds of silicon with oxygen and of hydrogen with oxygen. The OH stretching, Si-O stretching fluctuations, and bending peaks of crude kaolinite in the ranges 3700-3200, 1650-1000 and 950-450 cm^{-1} , respectively, are shown in Fig. 3a. The mineral kaolinite has four FTIR-active hydroxyl stretching bands centered at 3550, 3500, 3450, and 3220 cm^{-1} , originated from different hydroxyl groups [23]. The three peaks of the higher frequency oscillations belong to the regions of hydroxyl groups on the inner surface, the intensity and position of these bands usually depend on the intercalation and grafting of the guest molecule, while the peak at a lower frequency (3220 cm^{-1}) corresponds to internal hydroxyl groups and, as a rule, does not depend on intercalation and grafting of the guest molecule [24]. In addition, the kaolinite band at 880 cm^{-1} is attributed to fluctuations of the hydroxyl groups of the inner surface during flat bending and is also sensitive to intercalation and grafting processes, since the band at 750 cm^{-1} is attributed to bending fluctuations of internal hydroxyls and is usually not affected by intercalation and grafting of guest molecules [25, 26]. Direct intercalation of DMSO into the interlayer space of kaolinite led to a significant decrease in the intensity of the hydroxyl band of the inner surface by 3580 cm^{-1} and the appearance of a new peak at 3200 cm^{-1} (Fig. 3b). But this process did not affect the peak of stretching of internal hydroxyl groups at 2974 cm^{-1} . The peak at 2513 cm^{-1} occurs as a result of the formation of an H-bond between DMSO and the hydroxyl groups of kaolinite on the inner surface. The peak of stretching C=O of liquid DMSO at 1793 cm^{-1} shifted to 1591 cm^{-1} for the K-DMSO complex, which indicates that the DMSO molecule forms an H-bond with the hydroxyls of the inner surface through carbonyl oxygen. In addition, the peak of CN stretching of liquid DMSO at 1298 cm^{-1} is observed at 1356 cm^{-1} for the K-DMSO complex. In addition, the peak of deformation of N-H liquid DMSO at 1246 cm^{-1} is observed with a lower frequency at 1591 cm^{-1} , and the peaks of stretching of C-H liquid DMSO at 2922, 2895 and 2716 cm^{-1} are shifted to 2716, 2679 and 2511 cm^{-1} , respectively, while the peaks of deformation of C-H liquid DMSO at 1880 and 1973 cm^{-1} are located at 1541 and 1591 cm^{-1} , respectively, as a result of intercalation of DMSO species. In addition, the loss of the intensity of the peak bending of the hydroxyl of the inner surface of kaolinite at 972 cm^{-1} confirms that the DMSO molecule forms H-bonds with the hydroxyl of the inner surface of kaolinite [27, 28].

The results of thermal analysis (DTA and TGA) of the clay from Shymkent and of the modified DMSO/Shymkent clay are given in Figure 4.

As a result of dynamic heating of these samples, the curves DTA, DTG and TG noted the manifestations caused by the occurrence of various types of reactions in the system. Among them are the processes associated with the release of H_2O and hydroxyls into the atmosphere during the decomposition of clay minerals, reactions with CO_2 emissions, as a result of the combustion of organic matter, as well as during the destruction of calcite. During the thermal decomposition of its mineral components, were recorded two pronounced effects associated

with the decomposition of plaster (in the range of 20-200°C) and with the dissociation of calcium carbonate (in the range of 400-725°C), as observed in Figure 4a. According to the thermogravimetric curve, in the first case, gypsum is dehydrated (in two stages) with a weight loss equal to $\Delta m_1 - 0.3\% = 1.7\%$, which corresponds to the presence of 8.1% gypsum in the sample.

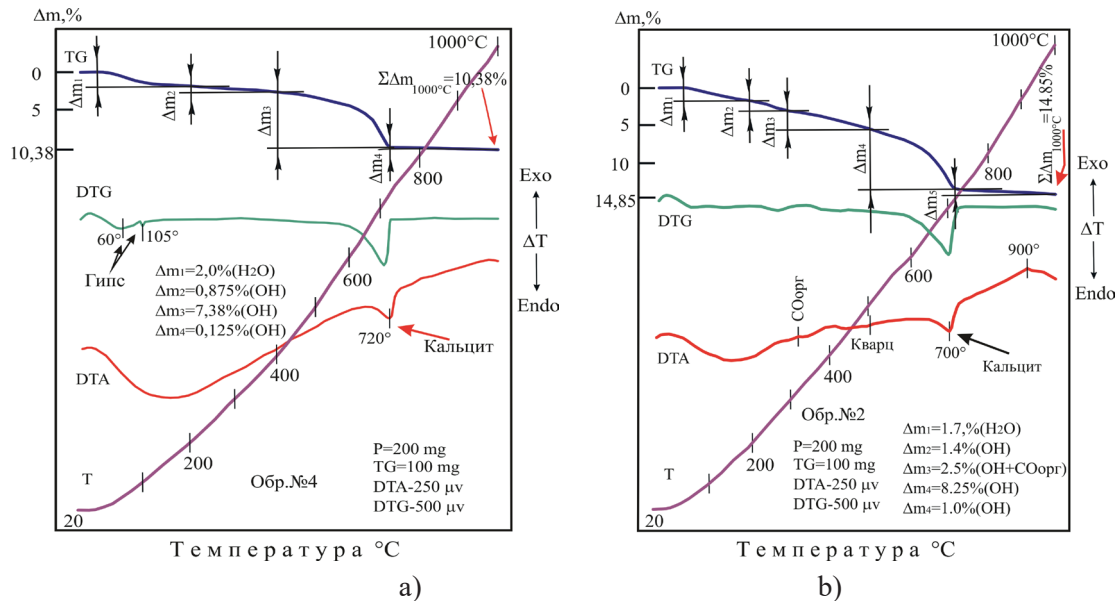


Figure 4. Derivatogram of a) natural clay from Shymkent and b) modified clay DMSO/Shymkent

The modified Shymkent clay, when heated, noted on its curves a number of thermal effects of mainly endothermic orientation, Fig.4b . The reactions that caused these manifestations occurred accompanied by emissions from the molecular water system [Δm_1 (1.7%)], hydroxyls [Δm_2 (1.4%), Δm_5 (1.0%)], carbon dioxide from the decomposition of calcite, as well as as a result of joint losses [Δm_3 (2.5%) = OH (2.2%) + CO₂ (0.3%) at destruction of kaolinite and combustion of S, respectively, Table 3.

Table 3. Thermo gravimetric readings of the natural and modified Shymkent clays in the range of 20-1000°C

Thermogravimetric readings	Weight Loss Sequence	The amount of weight loss, in %	Volatile components of the heated sample	Temperature range of the decomposition stage, °C
Natural clay Shymkent	Δm_1 Δm_2 Δm_3 Δm_4 $\sum \Delta m_{1000^\circ C}$	2 0,875 7,38 0,125 10,38	H ₂ O OH CO ₂ OH H ₂ O, OH, CO ₂	20-200 200-400 400-725 725-1000 20-1000
Modified Shymkent clay	Δm_1 Δm_2 Δm_3 Δm_4 Δm_5 $\sum \Delta m_{1000^\circ C}$	1,7 1,4 2,1(OH)+0,4(CO ₂) 8,25 1,0 14,85	H ₂ O OH COopr OH OH H ₂ O, OH	20-200 200-300 300-~500 500-720 720-1000 20-1000

When heated, kaolinite leaves on the DTA curve a weakly expressed endothermic manifestation in the range of 300-500°C and an equally weak exothermic peak in the region of 900°C. Thermal dissociation of this mineral occurs together with the combustion of organic matter (OM). At the same time, kaolinite forms a weight loss of the sample by 2.2% (OH↑), and OM - by 0.3% (CO₂↑). Thus, the content of this clay mineral (according to its stoichiometric formula given above) corresponds to 8.3%, and the amount of organic matter in the sample, in accordance with the emissions from the CO₂ system, is 0.3% of the mass of the sample.

Calcite showed itself most clearly during heating, leaving clearly defined peaks on the DTA and DTG curves in the region of 700°C due to carbon dioxide emissions into the atmosphere. At the same time, the weight loss of the sample was 8.25%, which corresponds to 18.8% of calcium carbonate in the composition of the test sample.

Table 4. The composition of the natural and modified Shymkent clays obtained by DTA and DTG

№	Composition of Shymkent clay according to DTA and DTG data	natural .Shymkent clay is obtained according to the data of DTA and DTG definitions in %	Modified Shymkent clay according to DTA and DTG data
1	Quartz	~40	~40
2	Calcite	16	18,8
3	Hydrosluda	7,3	8,8
4	Kaolinite	-	8,3
5	Chlorite	>1	8,3
6	PlasterofParis	8,1	8,1
7	SOorg	-	0,3
8	Thermally inert formations, some of which are degraded (dehydrated kaolinite), thermolite, etc.	<30	~7,0

According to the thermogravimetric readings of the thermal installation and the control data of X-ray analysis, gypsum – 8.1%, hydroslude – 8.8% and chlorite-8.35% were also determined. At the same time, the weakly developed peak of polymorphic transformation of silicon dioxide, in the region of 500 °C, revealed the presence of quartz - ~40%. According to the residual principle, the presence of a thermally inert substance ~7% in the sample was revealed, Table 4. The mineral and material composition of the modified clay of Shymkent, performed by thermal analysis is shown in Table 4.

The results obtained are close to the indications of the prepared sample of natural Shymkent clay. Some discrepancies in the mineral content of the Shymkent clay, apparently, are related to the process of preparing the sample.

Conclusions. Based on the results of the thermal analysis of a number of natural kaolinite characteristics and taking into account the dehydroxylation temperature of the primordial clay (usually 510°C), it is possible to predict the nature of the organoclays obtained by modification of kaolinite. In particular, a clear distinction can be made between materials obtained by intercalation of organic molecules in the interlayer spaces of kaolinite and materials obtained by their intercalation with subsequent covalent grafting on the inner surfaces of kaolinite.

The characteristic vibrational characteristics of the organoclays were confirmed by the data of thermal analysis and X-ray diffraction pattern. The thermal analysis data showed that the grafted thermal gravimetric (TG) species were thermally more stable than the intercalated molecules in the kaolinite interlayer space. The formation of a covalent bond (Al–O–C) between the OH group of the TG molecule and the hydroxyls of the inner surface of kaolinite is the main reason for increasing the thermal stability of the hybrid material. The morphology and surface area of pure kaolinite are affected by intercalation and grafting of molecules within the distance between the galleries. The results obtained in this study can provide further insight that K–DMSO materials can be used for the development of new clay-based organoclays with a relatively higher temperature resistance.

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ОРГАНОАЛОКСИДТЕРМЕН ЕГІЛГЕН ОРГАНИКАЛЫҚ ТҮРЛЕНДІРІЛГЕН САЗДАРДЫ АЛУ, ФИЗИКАЛЫҚ-ХИМИЯЛЫҚ СИПАТТАМАЛАРЫ

Аннотация. Бұл мақала ағынды сулардан ауыр металдарды алу мәселелеріне арналған. Табиғи балшықтарды пайдалану ағынды суларды ауыр металдардан тазарту дәрежесін арттырады, бұл әдіс арзан және қол жетімді болғандықтан оны өнеркәсіптік сорбент ретінде ұсынады. Табиғи саздар арзан және оңай қол жетімді материалдар болып табылады. Химия өнеркәсібінде жоғары сорбциялық қабілеті бар саздар да қолданылады. Модификацияланған саздарды алу үшін табиғи саз қолданылды.

Сорбциялық қасиеттерді жақсарту үшін табиғи сазды органоқлейге ауыстыруға болады. Органикалық желім – органикалық қосылыстарға табиғи сазға енгізу арқылы алатын нәрсе.

Каолинит/ДМСО қосындысын аралық өнім ретінде пайдалана отырып, каолиниттің аралық кеңістігіне ДМСО себу арқылы ДМСО-К жаңа гибридті органоглиндік материал алынды. Адсорбенттерді сипаттау үшін инфрақызыл спектроскопия (x), рентгенодифрактометриялық талдау (X-ray diffraction), дифференциалды термиялық талдау (ДТА), элементтік талдау және т.б. сияқты түрлі талдаулар қолданылды.

Аралық кеңістікте орналасқан органикалық молекулалар таза каолинит морфологиясында айтарлықтай өзгерістер тудырды. Қазақстанның Шымкент қаласында кен орнының бастапқы және түрлендірілген табиғи сазының сорбциялық сипаттамаларын зерттеу нәтижелері ұсынылды.

Түйінді сөздер: каолинит, термиялық талдау, интеркалирленген егу, диметилсульфооксд - ДМСО, табиғи саз, түрлендірілген саз, органоқлей.

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ПОЛУЧЕНИЯ И ФИЗИКО-ХИМИЧЕСКИЕ ХАРАКТЕРИСТИКИ ОРГАНИЧЕСКИХ МОДИФИЦИРОВАННЫХ ГЛИН С ПРИВИТЫМИ ОРГАНОАЛОКСИДАМИ

Аннотация. Данная статья посвящена проблемам извлечения тяжелых металлов из сточных вод. Использование природных глин позволит увеличить степень очистки сточных вод от тяжелых металлов и предложить ее в качестве промышленного сорбента за счет дешевизны и доступности. Природные глины являются недорогими и легкодоступными материалами. В химической промышленности также используются глины с высокой сорбционной способностью. Для получения модифицированных глин использовалась природная глина. Природную глину меняем на органоқлей для улучшения сорбционных свойств. Органический клей-это то, что мы получаем, вводя органические соединения в природную глину.

Получен новый гибридный органоглиновый материал ДМСО-К путем посева ДМСО в промежуточное пространство каолинита с использованием соединения каолинит/ДМСО в качестве промежуточного продукта. Для описания адсорбентов использовались различные анализы, такие как инфракрасная спектроскопия (ИКС), рентгенодифрактометрический анализ (X-ray diffraction), дифференциальный термический анализ (ДТА), элементный анализ и др. Органические молекулы, расположенные в промежуточном пространстве, вызвали значительные изменения в морфологии чистого каолинита. Представлены результаты исследований сорбционных характеристик исходных и модифицированных природная глина из Казахстана месторождения г.Шымкент.

Ключевые слова: каолинит, термический анализ, интеркалированная прививка, диметилсульфооксд-ДМСО, природная глина, модифицированная глина, органоқлей.

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90-летие академика Национальной академии наук Республики Казахстан Е.А.БЕКТУРОВА



Исполнилось 90 лет со дня рождения и 65 лет научно-педагогической и общественной деятельности известного ученого в области физической химии высокомолекулярных соединений, академика НАН РК, лауреата Государственной премии Казахстана, заслуженного деятеля науки и техники Республики Казахстан, доктора химических наук, профессора Есена Абикеновича Бектурова.

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в Институте химических наук АН КазССР, где прошел путь от младшего научного сотрудника до заведующего лабораторией. С 2010 по 2021 годы Е.А. Бектуров работал профессором Казахского Национального педагогического университета. В 1983 г. Е.А. Бектуров избран в члены-корреспонденты, а в 2003 г. – в академики Национальной Академии наук Республики Казахстан.

Основное научное направление Е.А. Бектурова связано с фундаментальными исследованиями в области физической химии полимеров: водорастворимые полимеры, полиэлектролиты, полиамфолиты, комплексы полимеров, полимерные катализаторы, ионопроводящие комплексы, гидрогели, наночастицы металлов, стабилизированные полимерами. По результатам исследований в изданиях Казахстана, ближнего и дальнего зарубежья опубликовано более 800 работ, среди них 18 изобретений, 8 обзорных статей в журналах США, СССР, Энциклопедии полимерных материалов (США). Издано 32 монографии, 6 из них в ФРГ, Японии, Польше, России и 4 учебных пособия. Цикл работ Е.А. Бектурова с сотрудниками «Водорастворимые полимеры и их комплексы» в 1987 г. был удостоен Государственной премии Казахской ССР.

Исследования Е.А. Бектурова получили широкое признание в нашей стране и за рубежом. Публикации регулярно цитируются в монографиях и статьях ученых ближнего и дальнего зарубежья. Министерством науки и технической политики России Е.А. Бектуров был включён в базу данных «Лидеры науки СССР» в числе 6-ти наиболее цитируемых казахстанских ученых за период 1986-1991 гг. На монографии Е.А. Бектурова опубликовано 47 рецензий известных ученых в журналах СССР, США, ФРГ, Чехии, Румынии. Результаты исследований Е.А. Бектурова включены в ряд отечественных и зарубежных монографий, справочников и учебных пособий, а также стимулировали работы в некоторых лабораториях в нашей стране и за рубежом.

Е.А. Бектуровым внесен крупный вклад в развитие физической химии полимеров, создана широко известная в мире научная школа. Большое внимание Е.А. Бектуров уделяет подготовке высококвалифицированных кадров. Под его руководством защищено 35 кандидатских и 9 докторских диссертаций, в течение ряда лет прочитаны курсы лекций в Казахском и Вильнюсском университетах, Казахском химико-технологическом институте. Е.А. Бектуров – был членом специализированных Советов по защите докторских диссертаций, членом научно-консультативного совета журнала «Химия и технология воды» (Украина) и международного исследовательского совета Американского биографического Института (США).

Е.А. Бектуров неоднократно представлял казахстанскую науку за рубежом, выезжая для участия в качестве докладчика или члена оргкомитета в международных конференциях и симпозиумах, для чтения лекций и проведения совместных работ в ведущих научных центрах Японии, ФРГ, Чехии, Турции, Ирана, Голландии, Швейцарии, Италии, Канады.

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Е.А. Бектуров награжден медалями «За доблестный труд», «Ветеран Труда», «10 лет Конституции Республики Казахстан», «65, 70 и 75 лет Победы в Великой отечественной войне», а также грамотами Президиума АН КазССР.

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