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RESEARCH ARTICLE

The Study of the Chemical composition of Sorption Substances

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ABSTRACT:
The article presents a study of the chemical composition of sorption substances. The chemical composition is established, the main prevailing elements and impurities are revealed. The crystal-chemical structure of sorption substances is proposed. A comparative analysis of the chemical composition and the classification of sorption substances, depending on the origin. A basic type of chemical sorption capacity is proposed. Elemental analysis showed the predominance of cations in montmorillonite clay, which indicates its higher potential for selective and ion-exchange sorption. Montmorillonite clay requires further study as a promising domestic substance for obtaining drug delivery and release systems.

KEYWORDS: Sorbent, Chemical composition, Energy dispersive spectrum.

INTRODUCTION:
One of the main problems of modern pharmacotherapy is the problem of drug transport [1]. The study of transport and modification of drug release coexist in parallel with the search and synthesis of new substances and are aimed at the same requests of clinical practice [1, 2]. By controlling the process of delivery and release of drugs, you can control the therapeutic effect, avoid overdose or lack of effectiveness, increase the duration of the effect and increase compliance pharmacotherapy [3-6].

The following methods of release modification are distinguished:
1. Physical (use of auxiliary substances that alter solubility, absorption, distribution, elimination; the use of physical processes - diffusion, osmosis, physical sorption);
2. Chemical (formation of salts, complexes with a carrier, the addition or replacement of functional chemical groups in the molecule of the drug, chemical sorption, selective ionic sorption and ion exchange) [7-10];
3. Technological (creation of reservoirs, microparticles, liposomes, films, patches, microgranules, microcapsules, immobilization through adsorption on carriers).

Currently, sorption substances are widely used in medicine and pharmacy to create transport drug systems, in which the main mechanism of binding, transport and release of the drug molecule is sorption. The sorption substance in this case acts as a carrier of the drug molecule, followed by its delivery to the destination through desorption. The use of sorption substances in pharmaceutical technology requires the study of their chemical composition. Medical clays are promising sorption substances, they have unique sorption characteristics and are currently widely used in medical practice. The purpose of the work is the study of the chemical composition of sorption substances.

MATERIALS AND METHODS:
Objectives of the study:
1. Study of the chemical composition of objects;
2. Study of chemical sorption properties of objects.

Objects and methods of research:
The study used the following materials: Active Coal (clarifying wood powder OU-A, GOST 4453-74, Russia), Silicon Dioxide (P N001140/01, Russia), Povidone (low molecular weight medical polyvinylpyrrolidone with molecular weight 12,600±2,700, N LS-001913, Russia), Smectite Dioctahedral (RU PN 015155/01, France), Kaolin Clay (GOST 19608-84, Russia), Montmorillonite Clay (TU 9296-001-62646221-2012, Russia).

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An EDAX energy dispersive spectrometer equipped with FEI Quanta 600 and FEG Quanta 200 3D microscopes was used to study the chemical composition. The spectrometer allows us to study the elemental composition of matter from different areas of the sample and to plot the distribution of elements. The signal processing system divides X-ray photons by energy and, thus, the full spectrum of the elemental composition of the samples is obtained. The study of the chemical composition of sorption substances was carried out on the basis of the Center for collective use of "Technology and Materials of Belgorod State University".

RESULTS AND DISCUSSION:

Fig. 1 shows the spectrum corresponding to the elemental composition of Active Coal. In Fig. 1 shows the structural formula of Active Coal.

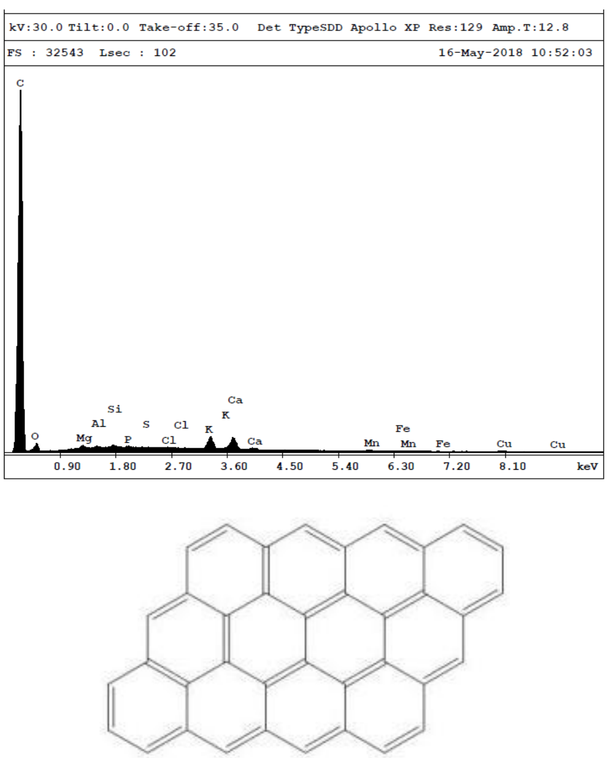


Fig. 1. Energy dispersive spectrum of Active Coal [Center for collective use of "Technology and Materials of BSU"]

As follows from Fig. 1, the main structural elements of Active Coal are carbon (87.9%) and oxygen (7.3%). In addition, the analysis allowed to detect impurities of potassium (1.5%), calcium (1.6%), magnesium, copper, silicon, manganese with a fraction of less than one percent in the sample.

As follows from Fig. 1, the chemical sorption properties of active coal is carbon atom. At its external energy level there are 4 electrons, therefore, to complete the level, carbon can give them away or attach them to form covalent bonds. Most often carbon attaches oxygen, which is the main active chemical sorption center of Active Coal.

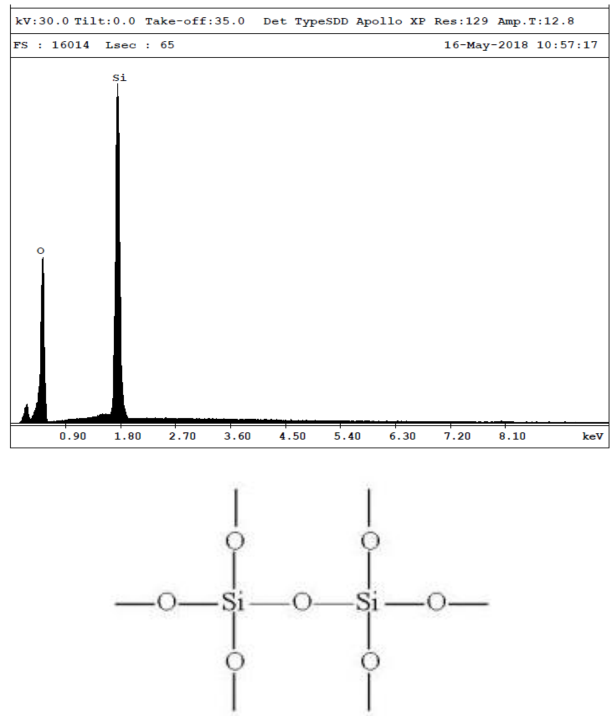


Fig. 2 shows the energy dispersion spectrum of Silicon Dioxide. In Fig. 2 shows the structural formula of silicon dioxide.

As follows from Fig. 2, the main structural elements of Silicon Dioxide are oxygen (57.5%) and silicon (42.5%). Impurities are missing. As can be seen from Fig. 2, oxygen is the chemical sorption center.

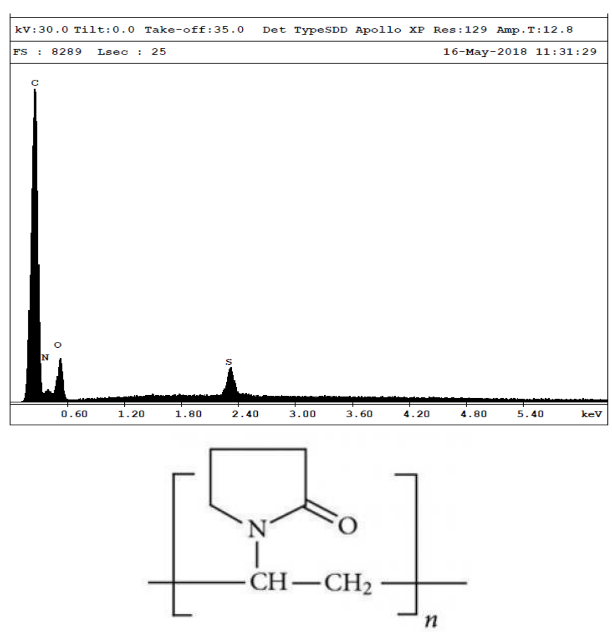
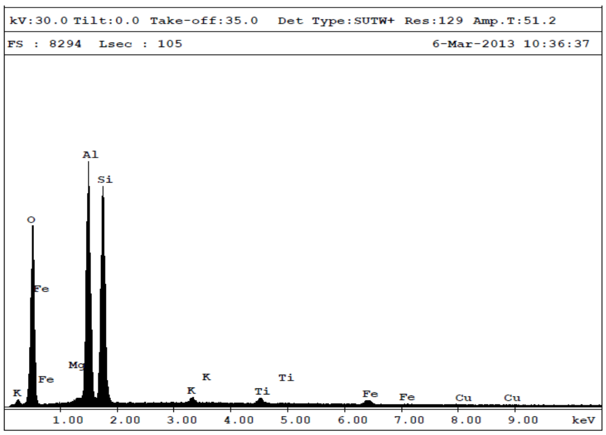


Fig. 3 shows the energy dispersion spectrum of Povidone. In Fig. 3shows the structural formula of Povidone.

As follows from Fig. 3, the main structural elements of Povidone are carbon (63.1%), oxygen (21.0%) and nitrogen (14.2%). The analysis carried out revealed sulfur impurities (1.7%) in the sample. Povidone (Fig.3) is a polymer consisting of N-vinylpyrrolidone monomers. The presence of a lactam cycle polymer in the macromolecule provides for the solubility of Povidone in water and the chemical sorption capacity through complexation.



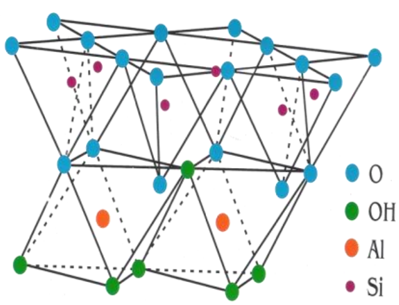
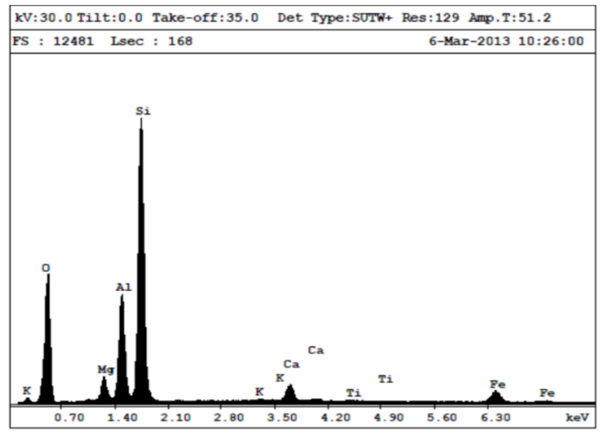


Fig. 4 shows the energy dispersion spectrum of Kaolin Clay. In Fig. 4 shows the kaolinite crystal structure.

As follows from Fig. 4, the main structural elements of Kaolin Clay are oxygen (50.3%), silicon (25.9%), aluminum (20.9%). The analysis made it possible to detect in the sample impurities of iron, titanium, potassium, and magnesium with a fraction of less than one percent. The presented chemical composition corresponds to kaolin clays with the predominant mineral kaolinite. The structural unit of kaolinite (Fig. 4) is a package consisting of one aluminohydroxide octahedral and one silicon-oxygen tetrahedral layer, there is no interpacket space between them. The layers of kaolinite are firmly connected to each other through hydrogen bonds. The chemical sorption capacity of kaolinite is manifested only in the surface layer of the packets by means of an ion exchange mechanism.

The resulting energy dispersive spectrum of a Smectite Dioctahedral is presented in Fig. 5. In Fig. 5 shows the crystal structure of montmorillonite.



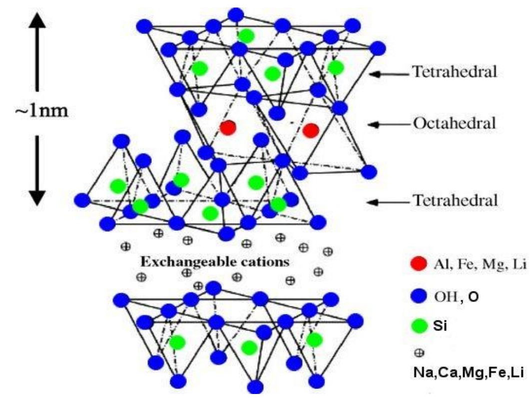


Fig. 5. Energy dispersive spectrum of Smectite Dioctahedral [Center for collective use of "Technology and Materials of BSU"]

As follows from Fig. 9, the main structural elements of Smectite Dioctahedral are oxygen (46.9%), silicon (33.4%), aluminum (11.4%). The analysis performed revealed magnesium impurities (3.2%), iron (2.6%), calcium (2.0%), potassium and titanium with a fraction of less than one percent. The presented chemical composition corresponds to montmorillonite clays with the predominant mineral montmorillonite. The structural unit of montmorillonite (Fig. 10) is a package consisting of one aluminum hydroxide octahedral and two silicon-oxygen tetrahedral layers with the presence of ions of alkaline earth metals calcium and magnesium in the interpacket positions. These ions indicate a weak sorption of water in the interpacket space and the absence of an increase in the volume of the structural package of montmorillonite. Thus, chemical sorption of a dioctahedral smectite will be observed in the surface layer of the packet and in the interpacket space by means of the ion exchange mechanism.

The elemental composition of Montmorillonite Clay in the elements of silicon and aluminum is 3:1. In comparison with the Smectite Dioctahedral, a smaller amount of magnesium is presumably in the octahedral structure of the clay mineral Montmorillonite Clay is compensated by iron. Chemical sorption of montmorillonite will be observed in the surface layer of the package and in the interpacket space by means of an ion exchange mechanism.

Based on the energy dispersive spectra of the samples under study, a comparative analysis of the chemical composition of sorption substances was carried out and the classification characteristic of sorption substances was proposed. The results are presented in Table 1.

Table 1. Chemical composition, mass. %

№	**Name**	**C^{4+}**	**O^{2-}**	**Si^{4+}**	**Al^{3+}**	**Ca^{2+}**	**Fe^{3+}**	**K^{+}**	**Mg^{2+}**	**N^{4+}**	**S^{4+}**	**Na^{+}**	**Impurities**	**Total**
Group 1 - Organic Sorbents														
1	**Active Coal**	87.9	7.3	-	-	1.6	-	1.5	-	-	-	-	1.7	100
Group 2 - Synthetic Sorbents														
2	**Povidone**	63.1	21.0	-	-	-	-	-	-	14.2	1.7	-	-	100
3	**Silicon Dioxide**	-	57.5	42.5	-	-	-	-	-	-	-	-	-	100
Group 3 - Mineral Sorbents														
4	**Kaolin Clay**	-	50.3	25.7	20.9	-	-	-	-	-	-	-	3.1	100
5	**Dioctahed-ral Smectite**	-	46.9	33.4	11.4	2.0	2.6	-	3.2	-	-	-	0.5	100
6	**Montmoril-lonite Clay**	-	44.7	31.7	9.5	3.7	5.5	2.2	1.7	-	-	0.1	0.9	100

As follows from Table 1, depending on the origin, the studied sorbents are represented by three groups:

1. Organic Sorbents–Active Coal. The predominant element is carbon. Chemical sorption of active coal is carried out through oxygen centers.
2. Synthetic Sorbents – Silicon Dioxide and Povidone. The predominant element of Silicon Dioxide is oxygen, and Povidone is carbon. The chemical sorption capacity of Silicon Dioxide is manifested through the oxygen active sorption sites, and Povidone, through complexation. Synthetic Sorbents are the most standardized sorption substances in which there are no impurities.
3. Mineral Sorbents–Kaolin Clay, Dioctahedral Smectite and Montmorillonite Clay. The predominant element of mineral sorbents is silicon. The chemical sorption capacity of kaolinite is manifested only in the surface layer of the packets by means of an ion exchange mechanism. The chemical sorption capacity of montmorillonite will be observed in the surface layer of the packet and in the interpacket space by means of an ion exchange mechanism.

CONCLUSION:

1. The chemical composition of sorption substances was studied. The chemical composition is established, the main prevailing elements and impurities are revealed. The crystal-chemical structure of sorption substances is proposed.
2. Analysis and comparison of the chemical composition of sorption substances was carried out and classification was developed. The basic type of chemical sorption capacity is proposed. Elemental analysis showed the predominance of cations in Montmorillonite Clay, which indicates its higher potential for selective and ion-exchange sorption. Montmorillonite Clay requires further study as a promising domestic substance for obtaining drug delivery and release systems.

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