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RESEARCH OF FEATURES AND COMPOSITIONS OF VERMICULITE FOR USE AS SUSPENSION FIRE RETARDANT FOR TEXTILE MATERIALS

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Abstract. *This article presents studies of fire resistance in the treatment of expanded vermiculite, which depends on the size of the dispersed particles and the orientation of the granules, their moisture and temperature. It has been studied that one of the interesting and important in practice properties of vermiculite is its ability to swell and turn into a lightweight effective material for imparting fire resistance. The properties and compositions of vermiculite from the Tebinbulak deposit are studied, from which a flame-retardant suspension is prepared for processing textile materials based on vermiculite dissolved in orthophosphoric acid and alkali in an aqueous medium. When modifying materials with developed flame-retardant suspensions, it is possible to obtain fire-resistant textile materials that meet the requirements of GOST for fire resistance, smoke generation and other physical and mechanical properties*

Key words: *feature, composition, spectroscopy, vermiculite, fire protection, suspension, fire retardant, material.*

Fire protection is the most important element of the fire safety system. It should increase the fire resistance of materials (iron, wood, textiles, etc.) to the required level, reduce their fire hazard and prevent the development and spread of flames. The execution of these criteria reduces the likelihood of death of people and the material damage of explosion. One of the most efficient and economical methods to provide fire resistance to products of a different nature is to add a protective coating to them. Obtaining these flame-retardant products for the Uzbek industry is an urgent problem. Fires cause significant material damage to the Uzbek sector. The greatest damage caused by fires is caused not only by fires, but also by gasses emitted on the basis of those fires. In specific, the fire hazard of textile products is defined by the following fire-related characteristics: flammability, flammability, surface flame distribution, smoke-forming capability and toxicity.

The main purpose of different fire protection systems of all products is to reduce the intensity of heating on the surface while preserving its resistance characteristics for a specific period of time. At the same time, having a large potential raw material base, it is quite possible to produce these products in a quality that is not inferior to the imported counterparts.

For this reason, we have researched minerals dependent on vermiculite and phosphorus-containing compounds to generate flame retardants for the production of cellulose-containing materials. Vermiculite is a versatile natural resource belonging to the hydro microbial category of minerals. Under natural conditions, vermiculite is produced in a weathering crust as a consequence of hydration of magnesia-ferrous mica-biotic or phlogopite-under the control of certain hydrothermal processes and, as a rule, at a shallow depth. In its initial state, it contains 8 to 20 per cent of the crystallization water, which is removed when heated to a temperature of 300-5000C, so that the mineral particles expand 9-16 times perpendicular to the mica layers. Vermiculite in the swollen state after removal of hydrate water has a density of 80 to 150 kg / m3 and can provide an excellent basis for the production of materials with different properties. A wide range of

refractory thermal insulating products focused on swollen vermiculite with different types of binders is widely used in domestic and foreign use.

Vermiculite in the extended state following elimination of hydrated water has a density of 80 to 150 kg / m3 and can provide an outstanding base for the manufacturing of products with different properties. At present, a fairly wide variety of refractory heat-insulating products based on extended vermiculite with different types of binders is used in domestic and foreign use. One of the interesting and important in practice properties of vermiculite is its ability to swell and turn into a light effective heat-insulating material. Therefore, the study of the causes of expansion of vermiculite has always been of interest to both scientists and industrialists. The degree of expansion of vermiculite is significantly affected by the phase composition and structure of hydromica, humidity and the method of crushing of the initial product, the heating rate of particles, the duration of their holding at maximum temperature, and the cooling rate. The nature of hydromica bloating is determined by the number of vermiculite layers and their distribution between the layers of the original mica. The distribution of phlogopite (biotite) and vermiculite layers in mica largely determines the nature of the expansion of vermiculite or hydromica and affects the properties of the resulting product. When studying hydromica of new deposits, this factor should be given special attention.

Research has shown that fire resistance to swelled vermiculite processing also depends on the size and orientation of the granules, their humidity and temperature. There is a significant increase in heat conductivity with increasing granule size under the condition of the same material density. The angle of inclination of the straight line, which reflects this dependence, increases with increasing temperature as the convective heat exchange in coarse-grained material is larger than in fine grained material.

In order to impart flame retardant properties to textile materials, we studied the structural characteristics of mica minerals in the Tebinbulak deposit vermiculite series, and IR spectroscopy was performed on selected vermiculite minerals. This is due to the fact that when removing infrared spectra of individual minerals - biotitic, hydrobiotite and vermiculite they are identical in appearance, and hydrobiotite is the main part of vermiculite concentrate. Fig. 1 shows infrared absorption spectra of vermiculite mineral of Tebinbulak deposit.

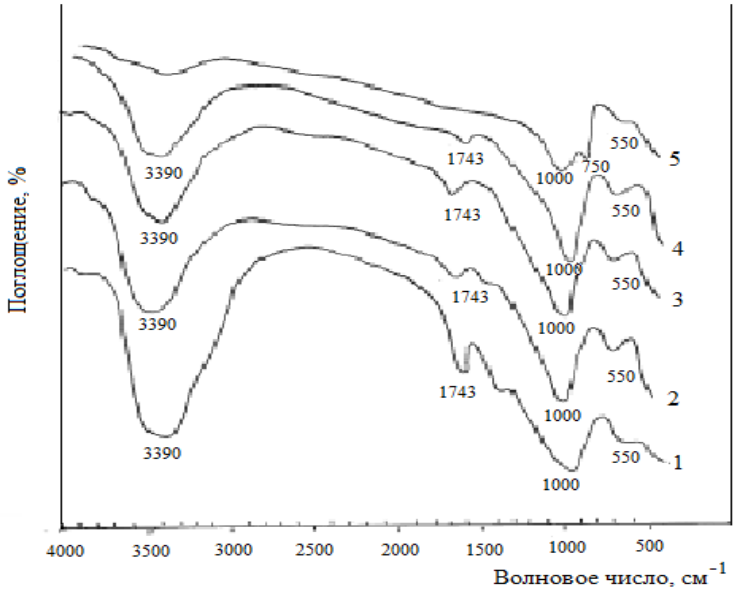

Fig.1. IR absorption spectra of mica minerals of vermiculite ore. 1- Source ore; roasted ore at: 2-200; 3-400; 4-600; 5-950.

Table 1

Chemical composition of samples of vermiculite minerals on the basis of local raw materials, extracted in laboratory conditions

Mineral	Content of oxides of mass. %						
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	MnO	
Vermiculite	34,83	0,09	13,52	8,96	16,71	сл	сумма
	CaO	Na_2O	K_2O	P_2O_5	SO_3	H_2O (общ.)	100,01
	8,43	2,52	0,6	0,02	сл	14,33	

On the IR spectrum of the source mineral Fig. 1 one can see an intensive absorption band in the region of 3390 cm^{-1}, which is typical for the fluctuations of the hydroxyl group OH in the trioctahedral region of the hydrobiotite crystal and confirms the presence of zeolite water, this absorption band is shifted to the low-frequency region. Comparing the data of chemical and radiographic analyses (Table 1), we can see that the content of aluminum oxide in the mineral of hydrobiotite of the Tebinbulak deposit is 16.66%, iron oxide - 9.64%, magnesium oxide - 16.78%, calcium oxide - 1.82%, alkali metal oxides of sodium and potassium - 5.54 and 1.72% respectively. It means that the crystal lattice of hydrobiotite contains Mg^{+2}, Ca^{+2}, Na^{+} cations, which replace each other isomorphously.

Vermiculite rocks based on local raw materials are mainly loose fine-grained rocks, sometimes cemented into conglomerates up to 10-15 cm in size. Vermiculite mica with hard rocky pyroxenite rocks is often found. The main fraction of vermiculite mica itself are particles smaller than 10 mm (crosswise), their total share is 70-80%. The rest of vermiculite particles reach the size of 30-40 mm (in the form of separate sites in the nests of hydrobiotite species of the formed vermiculite). In terms of appearance, micaceous minerals of vermiculite ore at different sites can be divided into two types: part of them is represented as large terminations of micaceous particles of black color with characteristic mica gloss (hydro biotic variety), the other part is represented by small leaves with brownish tint.

The average bulk density of vermiculite ore at humidity not exceeding 2% is 2200-2300 kg/m^3. The average chemical composition of vermiculite rock is given in Tables 2, 3.

Table 2

Average granulometric composition of vermiculite

№	The average particle size distribution, masses.	%
1	fraction less than 1.0 mm	24,6 - 34,8
2	fraction less than 5.0 mm	54,8 - 68,8
3	fraction from 5.0 to 10.0 mm	4,4 - 6,1
4	fraction above 10.0 mm	4,3 - 2,2

Table 3

Average mineralogical composition of vermiculite

№	The average mineralogical composition of ore, masses.	%

1	micaceous minerals of vermiculite	7,5 - 15,6
2	Pyroxene	50 - 80
3	Peridotite	to 10
4	Scroll	to 7
5	Titanomagnetite	to 8

Vermiculite concentrate separated from vermiculite rock by wet deposition methods on the laboratory concentration table was used for research. Vermiculite concentrate is represented by scales of black, dark grey and brown color, fraction 5-10 mm; bulk density is 2045-2020 kg/m^3. The appearance of coarse vermiculite, not swollen, is shown in Fig. 2 a.

a b

Fig.2. Vermiculite rock based on local raw materials: a) vermiculite concentrate; b) swollen vermiculite.

Swollen vermiculite, obtained by roasting in laboratory conditions in a muffle kiln at a temperature of 950^{0}C vermiculite concentrate, golden color, shown in Fig. 2 b. The density of bloated vermiculite depends on its fraction: a fraction of more than 10 mm has a bulk density of 60-100 kg/m^3; a fraction of 5-10 mm has a bulk density of 80-120 kg/m^3; a fraction of 1.0-5.0 mm - 120-180 kg/m^3; a fraction less than 1.0 mm - 200-270 kg/m^3;

To study the material composition of mica minerals of vermiculite rock on the basis of local raw materials, technological samples were taken from various sites in the amount of 20 kg. Vermiculite concentrate contains scales of single crystals of micaceous minerals of different colors from black to dark brown. The samples were visually separated by color. Three varieties of mica minerals were obtained - black, dark grey with a black tint and dark brown.

Vermiculite on appearance is presented by scales of dark-brown color, with characteristic shine: bulk density (fraction 2,5-5мм) - 1870 kg/m^3; true density - 2700 kg/m^3; hardness on Mohs scale - 1,5; melting temperature – 121^0 C.

In natural fires and techno genic accidents the greatest danger for objects of different physical-chemical and biological nature is radiation-convective heating. At its influence on combustible materials their ignition and formation of new centers of fire can occur. The greatest danger for a person is the impact of radiation-convective heating on open and protected areas of human skin. Investigation of ignition and combustion patterns of clothing materials is of great practical importance for creation of fireproof materials based on their modification with combustion retarders. Giving non-combustibility to textile materials is a necessary but not sufficient condition in the problem of human thermal protection in emergency situations.

Comparative assessment of flammability and thermal protection properties of materials is carried out mainly on the basis of normalized indicators. The practical importance of standard methods consists in obtaining initial information for the development of new approaches and means to improve the fire resistance properties of textile materials. In the system of occupational safety standards, the fire safety of materials is determined by indicators, the choice of which depends on the conditions of their application.

In the given work those nomenclature indexes which characterize fire hazard to textile materials are chosen, it is combustibility, smoke formation, emission of toxic gases and oxygen index. The use of uniform normative indices on fire safety of textile materials allows comparing and evaluating reliably the fire-resistant properties of textile materials obtained in research laboratories.

Thus, an average sample of ordinary vermiculite ore was separated from field samples of the rock taken on the basis of local raw materials for technological research. By means of enrichment the vermiculite concentrate in amount of 20 kg was obtained. It's chemical, mineralogical and particle size distribution compositions have been established. On the basis of vermiculite, phosphorus containing compounds in aqueous solution was added trehatomic alcohol to improve the physical and mechanical properties of textile materials, while the obtained suspension fire retardant gives fire resistance to textile materials.

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