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STUDIES OF CHANGES IN THE STRUCTURE OF VERMICULITE AS A FILLER OF BUILDING MATERIALS BY THE METHOD OF ELECTRON MICROSCOPY

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In this article, construction materials are considered, which are used as a lightweight aggregate for concretes and mortars as well as for thermal insulation designs. Particular attention is paid to materials based on expanded vermiculite. The methods of using vermiculite in construction are analyzed. The study is carried out by electron microscopy of vermiculite crystals burnt traditionally and treated with chemical solutions (fired at 400 ° C). Based on the above study, the developed method for baking vermiculite can be considered the most suitable for technological parameters and operational requirements for use in the construction industry.
Keywords: *Vermiculite, thermal insulation, baking, electron microscopy, building materials.*

The complex energy situation in the building complex of Ukraine requires the use of low energy technologies for both the construction materials themselves and products based on them. In modern construction, a number of light materials are used from natural mineral raw materials, such as expanded clay, agloporite, expanded perlite, glass and mineral wool, and the like. All listed materials are widely used as a light aggregate for concrete and mortars, and as insulation materials. However, all these materials are related to roasting types and they are obtained by laborious and energy-intensive technologies.

One of the effective types of thermal insulation designs are materials based on expanded vermiculite on a cement or gypsum binder. [1] They are classified as environmentally friendly, non-combustible materials and provide high thermal insulation. The production of such materials can be quickly established, including at existing enterprises for the production of concrete and reinforced concrete products with their minor modernization.

Vermiculite in construction is applied:

- brickwork in half a brick of vermiculite blocks for thermal insulation is equivalent to 1.5 m brickwork;
- facing the buildings with a layer of plaster based on vermiculite (replacing the thermal conductivity of the masonry, the thickness of one brick, while eliminating the 80% loss of heat through the “frosty bridges”);
- the use of expanded vermiculite in lightweight concretes makes it possible to significantly reduce the weight of (common) building structures, significantly reduce heat loss;
- plates, based on expanded vermiculite, and internal plaster rendered the room virtually soundproof and eliminate heat loss;
- high melting point (about 1400 C) causes almost 100% fire safety of housing;
- as a filler in lightweight concretes based on cement and gypsum binders;
- filler of heat-insulating and waterproof masses on the basis of bituminous binders;
- filler of warm concrete on the device of self-leveling floors;
- aggregate in raw materials for the production of piece wall materials;
- filler of dry building mixtures for light external and internal plasters and fire retardants;
- manufacture of plates for fire retardant enclosures.

The pricing of the production of these products presupposes not only the costs of extraction of raw material, but also the direct reduction in the cost of production technology. In the technology for the production of expanded vermiculite, the most energy-consuming step is the baking step, which takes place at a temperature of 800-1000° C [2-4]. Solving the problem of lowering the vermiculite swelling temperature and modernizing the baking technology will make it possible to reduce the cost of producing the expanded vermiculite and make it a competitive building material. Therefore, the implementation of this task is urgent.

The mineral precursors of vermiculite include biotite, phlogopite and hydrobiotite, as well as minerals of possible weathering of vermiculite-kaolinite and talc with a chemical composition that can be described by the following formulas:

- phlogopite - $KMg_3 [AlSi_3O_{10}] (F, OH)_2$;
- biotite - $K (Mg, Fe)_3 [AlSi_3O_{10}] (OH, F)_2$.

The process of weathering was artificially modeled by the treatment of vermiculite with chemical solutions. For the preliminary study, the electron microscopy method was used.

To study the method of electron microscopy, crystals of raw vermiculite with a size of 3-15 mkm were taken. As seen from the photomicrograph, they have a dense micaceous structure.

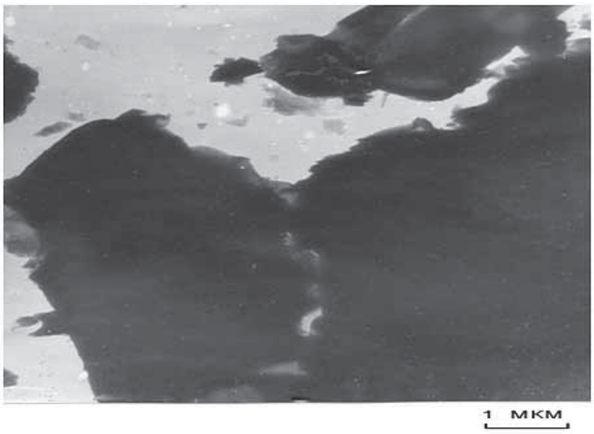

Fig. 1. Electron micrograph of raw raw vermiculite.

Fig. 2. Electron micrograph of raw vermiculite, firing at T = 400° C.

After firing at T = 400° C untreated vermiculite, many crystals are stratified, forming numerous scales. But the lamination on the plate does not occur throughout the crystal, but mainly in its surface layers, the peeling flakes have both sharp sharp boundaries and diffuse outlines. The latter particles form cloudy clusters around partially destroyed grains of vermiculite, some grains remain without visible changes.

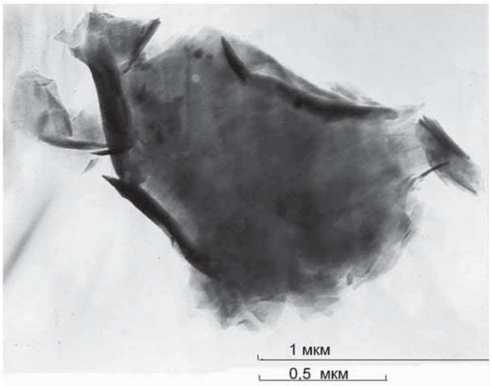

Fig. 3. Electron micrograph of a sample treated with a chemical solution and calcined at 400° C.

After baking vermiculite treated with a chemical solution and fired at T = 400° C, a photograph (Figure 3) shows the appearance of fibrous particles with a size of 0.07-0.6 μm, initially on the surface of very shallow layered crystals, and then in the volume of small thin crystals.

Fig. 4. Electron micrograph of a sample of traditionally baked vermiculite.

Based on Fig. 4, after calcination of untreated vermiculite at T = 900-1000° C, it is possible to observe the appearance of large elongated particles in sizes up to 0.25-4 μm along the whole surface of the vermiculite grain.

After baking vermiculite treated with distilled water for 24 hours and fired at T = 400° C, a similar pattern is observed as in untreated vermiculite calcined at T = 900° C, namely, an increase to 0.25-3.5 μm and an elongation throughout Surface of the grain of vermiculite (almost to the complete removal of all water).

Fig. 5. Electron micrograph of a sample of untreated vermiculite of fired T = 400° C.

As shown by electron microscopic studies of untreated vermiculite calcined at T = 400° C, its full swelling is not observed. And when processing with reagents (the most successful samples were chosen after physico-chemical studies), the similarity of the samples obtained is evident, namely, the unprocessed samples burned at 900° C have the same form as those treated at 400° C with reagents.

Proceeding from the studies of electron microscopy, we see that samples of raw vermiculite burned traditionally and samples treated with chemical solutions (baked at 400° C) have a similar structure.

On the basis of the application of physical and chemical analysis methods it is necessary to conclude that the most effective is the treatment of vermiculite with chemical solutions and **baking** at 400° C. Similar features of vermiculite, peculiar to phlogopite, allow to consider a sample, preliminarily held in a chemical solution and fired to 400 C, which is the most acceptable for technological parameters and operational requirements for use in the construction industry.

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THE STRESS-STRAIN STATE OF THE FLAT ROPE OF HOISTING ENGINE WITH CONSIDERING THEIR TECHNICAL STATE

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Obtained an analytical dependence for determining the tensile forces acting in cables of the flat rubberized rope. It takes into account the design of the hoisting engine – the deviations of generating line of the drum from a straight and of the possible break of the cable in rope. A comprehensive account of the impact of various factors on the stress-strain state of the rope allows determining the loss of tractive capacity in operation on the hoisting engine. The results should be taken into account in the design and operation of hoisting and transporting machines with flat traction bodies.

Keywords: *hoisting engine drum, geometrical parameters, flat rubberized rope, breaks of tractive elements, complete the impact of various factors, stress-strain state, and analytical dependences.*

Introduction. Flat rubberized ropes are widely used as traction units of lifting and transporting machines. The design, technical condition of the machine and the conditions of operation affect the stress-strain state of their tractive elements, including the ruptures of the cables. In the process of the rope motion with a damaged cable, the field of stress caused by various factors may superpose and affect the actual ultimate strength of the rope.

State of question and formulation of the problem study. Methods for studying the influence of a complex of factors on the stress-strain state of the rubberized rope are absent. A development for this method is a ***topical scientific and technical task***. Its