Research of New Methods of Production Of Wollastonite Material In Uzbekistan

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Abstract: The article analyzes the possibility of obtaining artificial wollastonite from associated raw materials in the conditions of the Navoi mining and metallurgical production. The formation of wollastonite as a result of solid-phase transformations during heat treatment of a mixture of chalk rocks and quartz sands has been experimentally confirmed. A complex of technological operations for the production of synthetic wollastonite is proposed.

Keywords: Wollastonite mineral, ultrabasic, skars, artificial, molar mass, USA, United Kingdom, generators, voltage, emissions, hydroelectric power stations, synthetic silicate of calcium, alternates.

Introduction

In world practice, wollastonite is most widely used in the production of plastics and various ceramics for both household and industrial purposes, significantly reducing the yield of rejects, increasing the quality and consumer properties of products. It can be used in

such high-tech industries as the production of ultra-high-resistance ceramic materials, high-frequency ceramics, bio ceramics used in dentistry, orthopedics and other fields of medicine, for the production of glass-crystalline compositions, the manufacture of exhaust nozzles, turbine blades and nose cones for spacecraft, etc. The addition of wollastonite lowers the ceramics firing temperature, increases its strength, reduces shrinkage during drying and firing, and also reduces the temperature of formation of the glass phase [1, 2].

Wollastonite is a promising environmentally friendly material for multipurpose purposes, which is used in the manufacture of refractory and insulating materials for industrial and domestic use, welding electrodes, porcelain and earthenware, special radio ceramics, insulators with low dielectric losses, facing bricks, special cements, paints, and abrasives [3].

Synthetic wollastonite, which differs from natural wollastonite in a high degree of controlled dispersion, uniformity in composition and low content of impurities, is more widely used:

• As a mineral filler and reinforcing additive in the production of paper, vinyl polyesters and epoxy resins, heat-resistant pigments, ceramic internal combustion engines, ceramics and similar materials, heat-resistant oil paints, plastics and finishing materials, cosmetics, building materials, in medical prosthetics (artificial joints, fillings);

• As a substitute for asbestos, talc, kaolin, chalk, titanium dioxide;

• As a highly effective sorbent for high-molecular organic substances, dyes, oil, oil products, heavy metal ions from aqueous media.

Since the reserves of natural wollastonite in the world are limited, its synthetic analogue has been produced in European countries for quite a long time [4]. According to its properties, artificial wollastonite is practically identical to natural, and in some respects even surpasses it; while the price of synthetic is 2-3 times cheaper than natural.

The purpose of this work was to develop a technology for synthetic wollastonite from natural calcium- and silicon-containing compounds.

To achieve this goal, it was necessary to solve the following tasks:

1. To comprehensively investigate the initial components: carbonate rocks (calcite, micro calcite), silica-containing raw materials (flask, tripoli, diatomite, quartz) and the resulting products.

2. Select the optimal conditions for preparing raw materials for solid-phase synthesis (grinding, mechanical activation, chemical activation).

3. To develop an algorithm for the technology of synthetic wollastonite, taking into account the ratios of raw materials, firing temperature and the duration of the solid-phase sintering process.

4. To reveal the kinetic laws of the interaction of calcium carbonates with silicon-containing compounds.

5. To develop a basic technological scheme for obtaining synthetic wollastonite from natural calcium and silicon-containing compounds.

6. To study the effect of wollastonite on the physical and mechanical characteristics of ceramic materials and binders.

Materials and methods

Scientifically substantiated and experimentally carried out the choice of the most optimal options for the preparation of the raw charge and the selection of the conditions for the solid-phase synthesis of calcium met silicates, which have a fibrous habit of particles, which determines their useful technological properties. A program of stepwise sample preparation of natural raw materials is proposed, by means of which a given disperse composition is achieved. In accordance with the principles of formal kinetics, a system of differential equations is obtained that adequately describes the experimental data.

It was found that the yield of a useful product ((3-wollastonite-calcium met silicate) depends on the crystal-chemical and textural features of natural raw materials: the degree of perfection of the crystal structure, dispersion, shape of primary particles and their aggregates. The degree of defectiveness of the crystal structure of the newly formed wollastonite phase is also determined the above factors.

The thermal modes of firing the prepared mixture were determined in order to obtain [3-wollastonite, which has an acicular structure.

Special techniques are proposed to accelerate the synthesis of wollastonite: pressing the raw material mixture; adding natural wollastonite particles to the reaction mixture; increasing the reactivity of charge components by mechanical and chemical activation methods; introduction of special additives (liquid glass and its crystalline derivatives).

It was found that the useful properties of the obtained product are due to the additive effect of structural and crystal chemical features of all newly formed phases of calcium silicates (wollastonite, larnite, gelignite).

It was established for the first time that the uniformity (in the range 30-700 ° C) and multistage (3 main stages) of the dehydration process of the silicon-containing component leads to an increase in the yield of P-wollastonite.

According to the data of thermo kinetic analysis, several main stages of solid-phase synthesis have been established (3-wollastonite: the first is a heterogeneous reaction with autocatalysis proceeding at the interphase boundaries, the second is bulk and surface self-diffusion. The limiting stage of solid-phase interaction is the formation of growth and phase transformation of calcium orthosilicate to calcium met silicate. In the coming years, industrial enterprises plan to extract synthetic calcium silicate (wollastonite) minerals from these deposits. Fig.1.

Fig.1. Wollastonite mineral (synthetic silicate of calcium)

Especially using to the wall and roof panels, in colored mineral wool (as a thermal insulator). Used in the manufacture of sanitary porcelain and tiles, electrical insulation porcelain. As filler it is added to papers, paints, rubbers. The use of wollastonite vollaconium in rubbers increases the strength of elastic rubber. The use of wollastonite mineral in waxed ceramics protects against deformations and cracks in cold weather.

Result and discussion

We used wollastonite (Vl) grade M325 (USA) with an average particle size of 12 μm, bulk density 0.75 g / cm3 and true density 1.3 g / cm3 determined that when the content of Vl in the mass is more than 45%, the strength begins to increase sharply. Samples, containing 48% of such filler, have strength of about 40 MP, but at the same time density of samples − 0.78 g / cm3, and λ = 0.16 W / m • K. Such material should be classified as light structural materials with enhanced thermal insulation properties. When with a VL content of less than 15-20%, the strength is too low. The greatest influence on strength is exerted by the proportion of Vl in the mass (Fig. 11) and the coefficient foaming, the first factor works to increase this property, and the second

reduces this index. LM modulus and density in the investigated range in this porous system are not essential for strength, although for structural materials on the basis of such a binder, the mechanical properties of the material are largely determined.

The apparent density of the material with a decrease in the proportion of Vl and an increase in the proportion foamed binder in all cases decreases almost linearly (Fig. 12). In addition, the density is strongly influenced by Kw (especially at high wollastonite) and foaming technology. The slope changes depending on these conditions direct. Mathematical analysis of the results of this experiment revealed the fact that the density of the samples depends mainly on the content of Vl. The concentrations of PB-Lux and K_v, values have little effect, and mixing time is not significant factor. With an increase in Kw from 4 to 5 at a high content of Bl in the system, the apparent the density of the material increases. This fact is explained by the fact that it decreases "Bearing capacity" of the foam. For a sufficiently heavy filler, which is Vl, at its small content, this ability is enough so that the mass does not "sit down", but with its content above 35%, needle crystals of the filler destroy the foam of the binder, which leads to an increase in the apparent density of the material. For lighter aggregates this effect is less pronounced.
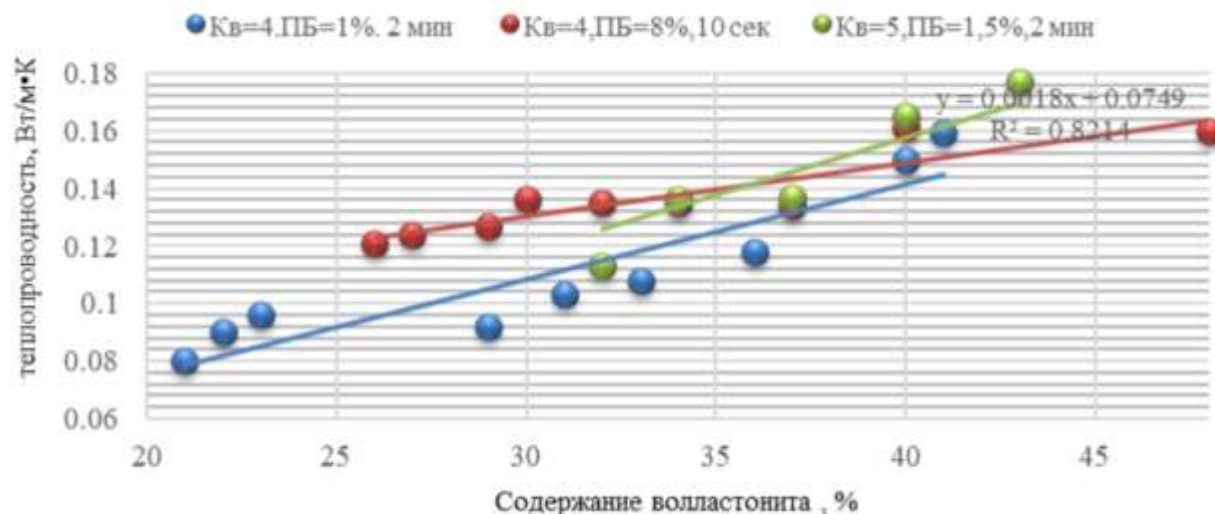

Fig.1. Addiction coefficient thermal conductivity material based on Z_hS

(M = 2.62 and ρ 1.335 g / cm3) from content wollastonite (w_t %) at different coefficients

foaming (Kw) and duration foaming. In order to reduce the value of λ, the next experiment provided for a decrease the proportion of wollastonite in the composition of the molding mass. At the same time, molding mixes of four series (Table 4), in which the ratio between mass fraction of WL (M = 2.93) and filler in the following proportions: "WL: wollastonite = 83%: 17%; 80%: 20% and 77%: 23%. The compositions are shown in table. 4.

The apparent density is closely related to the total porosity, and its value and nature porosity largely determines the thermo physical properties of the material. With magnification the proportion of LH, the total porosity increases due to the growth of exclusively closed porosity, which is presented precisely in a foamed binder.

Conclusion

On the basis of the experimental data of the complexes of methods, the composition and properties of natural silicon and calcium-containing components used to obtain synthetic wollastonite are characterized. Changes in their structural, textural and morphological characteristics were revealed upon thermal exposure, chemical and mechanical activation.

The technology of synthetic wollastonite by the method of solid-phase synthesis has been developed and the optimal technological conditions have been determined: raw components - calcite and diatomite in the ratio CaO: SiO_2 = 0.7; firing temperature - $1050°$ C, holding time at the final temperature. It has been established that the highest yield of wollastonite when used as a silicon-containing component of diatomite is due to its structural state (amorphous silica modification SiO_2-NH_2O-opal A in an amount of 72% by weight) and the gradual uniform nature of the diatomite dehydration process.

It was found that an increase in the reactivity of the charge components by means of mechanical and chemical activation leads to an increase in the yield of the useful component (wollastonite) by an average of 20%. The use of calcite activated in the energy-intensive mode (n = 450 rpm; t = 35 min) leads not only to an overall increase in the yield of calcium silicates (larnite, helenite and wollastonite 78.1 - 80% in total), but also to the absence of an unwanted impurity - portlandite ... An increase in the yield of a useful product - wollastonite upon chemical activation of diatomite (acid activation: ZN HC1, impregnation method, 1 = 20 ° C, t = 72 hours; alkaline activation: 5% NaOH, impregnation method, t = 20 ° C, t = 60 hours) is due to the total energy contribution of structural defects, both in the diatomite itself and in the impurity clay phase.

Wollastonite synthesis is a heterogeneous process and develops in the space of the reaction zone. The first stage begins with areas of the active surface of diatomite and is described by the equation of a heterogeneous reaction with Prout-Tompkins autocatalysis, proceeding along the interphase boundaries: $d_a / c_{1m} = 1 < (1 - a)* 1'72$. The second stage of the reaction is associated with the thermal decomposition of calcite, the diffusion of the formed carbon dioxide molecules and their subsequent desorption from the surface of the solid phase.

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