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THE EFFECT OF CARBONATE FILLERS ON THE PROPERTIES OF ANHYDRITE BINDER AND GYPSUM STONE

Abstract. Technology of contact hardening composite materials based on substandard raw materials is presented. Production of anhydrite binder having relatively high strength in comparison with other types of gypsum binders is shown. The scope of application of anhydrite binder: plaster and masonry mortars, floor screeds, solutions for filling mine workings, decorative facing plates, architectural details, small-piece wall stones, dry mixes.

Keywords: anhydrite binder, mineral fillers, carbonate fillers of various chemical and mineral composition.

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Introduction. The creation and study of contact hardening composite materials using substandard raw materials is a step in creating fundamentally new materials and solving problems of materials science.

The advantages of anhydrite binder, in comparison with other types of gypsum binders, are relatively high strength, delayed setting time, lack of volumetric expansion during hardening. The scope of application of anhydrite binder is the manufacture of plaster and masonry mortars, floor screeds, solutions for filling mine workings, decorative facing plates, architectural details, small-piece wall stones, dry mixes [1-3].

Good operational and economic indicators of gypsum materials and products, a large labor and energy-saving effect in their production and application, relatively low capital intensity of the final product serve as the basis for the development of technology of binders and products made of phosphogypsum.

Currently, about 8 million tons of phosphogypsum have accumulated in the dumps of the mineral fertilizers plant of Kazphosphate LLP, the amount of which continues to increase annually by 0.4-0.5 million tons. One of the most effective ways of processing phosphogypsum is to obtain binders based on it.

In this regard, a promising direction is the development of technology for a number of composite binders and wall materials replacing more expensive similar materials such as natural stone, ceramics, and other artificial materials.

According to the research results, taking into account the highest degree of filling of anhydrite binder, while increasing or maintaining its strength indicators,

carbonate fillers-calcite (limestone) and dolomite with a specific surface area of 300 m^2/kg are more effective compared to gypsum and quartz fillers.

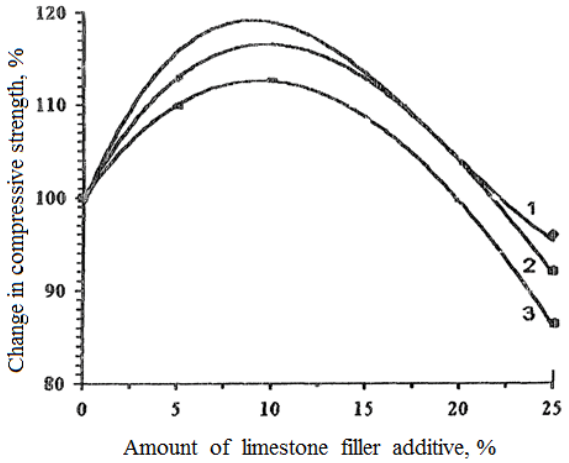
Research methods and conditions. To determine the possible limits of the introduction of carbonate fillers of various chemical and mineral composition, studies of their effect on the basic physical and technical properties of anhydrite binder and gypsum stone based on it were carried out.

During the research, samples of limestones and dolomites of some Karatau deposits of the Republic of Kazakhstan were used.

Mineral fillers, ground to a specific surface area of 300 m^2/kg, were introduced into the composition of anhydrite binder together with the addition of lime, C-3 and expanded clay dust taken in optimal quantities, mixing was carried out in a laboratory ball mill.

According to research data, when introducing limestone or dolomite fillers with a CaO content of more than 28.6%, an insoluble residue of up to 11.7% in an amount of 10% of the binder weight, the strength of gypsum stone samples increases by 20-13% and 15-5%, respectively, depending on the chemical composition of the additive. The water demand and softening coefficient of gypsum stone based on it remain at the level of control samples without the introduction of filler, amounting to 27% and 0.71%, respectively. The timing of the beginning of setting of the binder is reduced from 1 h. 20 min. to 1 h. 10 min., the timing of the end of setting from 3 h. 15 min., to 3 h.

Research results and discussion. Analysis of the research results shows that with the introduction of carbonate rocks with approximately equal content of insoluble residue (samples 1,3,4) or approximately equal content of CaO (samples 1,2 or samples 5,6,8), the effectiveness of the use of additives increases with increasing their crystal chemical proximity to the hydration product of anhydrite II-gypsum (increasing the content of CaO), as well as reducing the content of insoluble the remainder- dispersed impurities, in the composition of which, according to X-ray analysis, the clay component predominates, and quartz, mica, feldspar are also present.

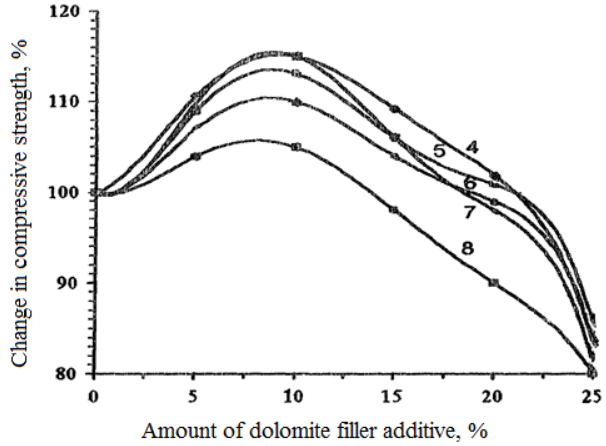


1– content CaO – 49,1 %; MgO – 0.9% ; n.o – 3,2%;
2– content CaO – 50,6 %; MgO – 2.4% ; n.o– 5,4%;
3– content CaO – 41,2 %; MgO – 9.3% ; n.o– 3,1%.

Figure 1. Dependences of changes in compressive strength of samples based on anhydrite binder at the age of 28 days on the amount of limestone filler introduced

Clay impurities, according to known concepts [1-3], reduce the adhesion of the binder and filler. Quartz, as shown above, is less effective as a crystallization center substrate for gypsum compared to carbonate fillers.

With the introduction of limestone or dolomite fillers with a CaO content of more than 28.6% of the insoluble residue up to 7.3% (samples 1-7) in an amount of 20% of the binder weight, the strength of gypsum stone samples is maintained at the level of the sample made of unfilled binder. Dolomite filler with a CaO content of 29.1% of the insoluble residue of 11.8% (sample 8) does not reduce the strength of the anhydrite binder when administered in an amount of up to 15% by weight of the binder. The water demand and softening coefficient of gypsum stone based on it are maintained at the level of the sample made of unfilled binder. The water demand and softening coefficient of gypsum stone based on it are maintained at the level of control samples without the introduction of filler. The timing of the beginning of setting of the binder is reduced from 1 h. 20 min., to 1 h. 10 min., the timing of the end of setting from 3 h. 15 min. to 3 h. 00min. A further increase in the content of limestone or dolomite fillers, regardless of their chemical or mineral composition, leads to a decrease in the strength of the anhydrite binder and the softening coefficient of gypsum stone based on it.



4 – content CaO – 33,7%; MgO – 16.7% ; n.o– 3,2%;
5 – content CaO – 30,1 %; MgO – 21.9% ; n.o– 0,40%;
6 – content CaO – 29,3 %; MgO – 21.3% ; n.o– 1,3%;
7 – content CaO – 28,6 %; MgO – 15.8% ; n.o– 7,3%;
8 – content CaO – 29,1 %; MgO – 14.6% ; n.o– 11,8%.

Figure 2. Dependences of changes in compressive strength of samples based on anhydrite binder at the age of 28 days on the amount of dolomite filler introduced

Discussion of scientific results. Thus, based on the conducted studies, it was found that when limestone or dolomite fillers with a CaO content of more than 28.6% of the insoluble residue up to 11.7% in the amount of 1% of the binder weight are introduced into the composition of anhydrite binder, the strength of gypsum stone samples increases by 20-13 and 15-5%, respectively, without reducing the strength compared to the original unfilled binder, it is permissible to introduce limestone or dolomite filler with a CaO content of more than 28.63% of the insoluble residue of 7.35% in an amount of 20% of the binder weight.

Conclusion. The creation of production of materials based on phosphogypsum and other industrial waste reduces the costs not only for the construction of the plant, but also for the transportation of raw materials and finished products, makes them less dependent on energy sources and allows solving not only economic and environmental problems of the region, but also social problems associated with the opening of jobs and infrastructure improvements.

The economic effect will be about 15 million tenge, the payback period of the mini-plant is 1 year.

References

1. Volzhensky, A.V. Mineral'nye vyazhushchie veshchestva [Mineral binders] – M.: Stroyizdat, 1986. – 464 p. [in Russian]
2. Lyashkevich, I.M. Effektivnye stroitel'nye materialy na osnove gipsa i fosfogipsa [Effective building materials based on gypsum and phosphogypsum] – Minsk: Higher School, 1989. – 160 p. [in Russian]
3. Gontar, Yu.V. Suhie gipsovye smesi dlya otdelochnyh rabot [Dry gypsum mixtures for finishing works] // Stroitel'nye materialy [Building materials], 1997. No. 7. P. 10-11. [in Russian]

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КАРБОНАТТЫ ТОЛТЫРҒЫШТАРДЫҢ АНГИДРИТ ТҰТҚЫР ЖӘНЕ ГИПС ТАСЫНЫҢ ҚАСИЕТТЕРІНЕ ӘСЕРІ

Аңдатпа. Кондициялық емес шикізат негізінде контактілі қатаю композициялық материалдарының технологиясы қарастырылған. Гипс байланыстырғыштардың басқа түрлерімен салыстырғанда салыстырмалы түрде жоғары беріктігі бар ангидрит тұтқыр алу мүмкіндігі көрсетілген. Ангидритті тұтқыр затты сылақ және қалау ерітінділері, еденге арналған стяжкалар, тау-кен қазбаларын толтыруға арналған ерітінділер, сәндік-қаптау плиталары, архитектуралық бөлшектер, ұсақ дана қабырға тастары, құрғақ қоспалар және т.с.с. бұйымдар жасауда қолдануға болады.

Тірек сөздер: ангидрит тұтқыр, минералды толтырғыштар, әртүрлі химиялық және минералды құрамдағы карбонатты толтырғыштар.

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ВЛИЯНИЕ КАРБОНАТНЫХ НАПОЛНИТЕЛЕЙ НА СВОЙСТВА АНГИДРИТОВОГО ВЯЖУЩЕГО И ГИПСОВОГО КАМНЯ

Аннотация. Рассмотрена технология композиционных материалов контактного твердения на основе некондиционного сырья. Показана возможность получения ангидритового вяжущего, обладающего относительно высокой прочностью в сравнении с другими видами гипсовых вяжущих. Область применения ангидритового вяжущего: штукатурные и кладочные растворы, стяжки под полы, растворы для заполнения горных выработок, декоративно-облицовочные плиты, архитектурные детали, мелкоштучные стеновые камни, сухие смеси.

Ключевые слова: ангидритовое вяжущее, минеральные наполнители, карбонатных наполнителей различного химического и минерального состава.