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Synthesis of Sulphoaluminate-Belite Clinkers

Egamberdiev M.S.
Professor of the department "Hydrology and ecology"

Annotation: By firing at a temperature of 1523…1673 K, sulfoaluminate-belite clinkers were obtained containing 10…60% calcium sulfoaluminate, 40…90% dicalcium silicate and 10…30% excess calcium sulfate. The analysis of these clinkers and their electron microscopic examination testify to the formation of these minerals during the firing process.

Key words: sulfoaluminate-belite clinkers, calcium carbonate, aluminum oxide, silicic acid, calcium sulfate, clinker former, calcium sulfoalminate, clinker microstructure.

For the synthesis of sulfoaluminate-belite clinkers, chemical reagents were used: calcium carbonate, aluminum oxide, silicic acid and calcium sulfate, which were taken in amounts necessary to form various ratios of calcium sulfoaluminate (10 ... 60%) and dicalcium silicate (40 ... 90%) . In order to study the effect of calcium sulfate on the properties of sulfoaluminate-belite clinkers, clinker with an excess content of anhydrite was also synthesized - in the amount of 10, 20, 30%.

After pre-treatment of the reagents, the calculated mixtures were compiled and beams 10,0*3,0*1,8 cm in size were molded. The beams were fired in a laboratory silite furnace by the high-speed method, maintaining the specified temperature for an hour. The firing was carried out at temperatures of 1523, 1573, 1623, 1673 K with a sharp air cooling. Clinkers not containing excess calcium sulfate self-disintegrated upon cooling. Moreover, at a temperature of 1523, 1573K they split into pieces, and at 1623 and 1673K they turned into a fine powder, which facilitated their grinding. The synthesized clinkers are distinguished by their porosity and easy grindability. With an increase in the proportion of excess calcium sulfate, the clinker samples become more caked, their volume decreases.

In order to reveal the reactivity of raw mixtures, the kinetics of lime binding during synthesis was studied. In clinkers containing an excess of calcium sulfate, no free lime was found, which indicates a favorable passage of clinker formation reactions. In the absence of excess calcium sulfate, the amounts of unbound lime were significant. These clinkers were fired again under the same conditions. Repeated firing contributed to a more active assimilation of lime. So, with an increase in the firing temperature, the assimilation of lime improves, and two-time firing at 1673K leads to its absence in the synthesized clinkers.

At the same time, with an increase in the firing temperature, the decomposition of calcium sulfate increases, and this reaction occurs in clinkers containing an excess of calcium sulfate, so its amount only slightly decreases, without affecting calcium sulfoaluminate.

During firing of mixtures, the degree of decomposition of calcium sulfate is insignificant in the absence of its excess.

The synthesized sulfoaluminate-belite clinkers were subjected to electron microscopic analysis in order to study their microstructure. On fig. Figure 3 shows micrographs of clinker chips synthesized at temperatures of 1573 and 1623 K.

The surface of the cleavage of clinker containing 10% calcium sulfoalminate and 90% dicalcium silicate, as well as 20% excess calcium sulfate, is a separate densely packed grains of indefinite shape with a smooth surface of β-dicalcium silicate, against which you can see small intergrown grains of rounded calcium sulfoaluminate , as well as tabular, prismatic crystals of calcium sulfate.

A micrograph of a clinker chip containing 20% calcium sulfoaluminate and 80% β-dicalcium silicate, as well as a 10% excess of calcium sulfate, is characterized by a high uniformity of the structure due to the fact that the grains of β-dicalcium silicate are smaller, the grains of calcium sulfoaluminate are somewhat enlarged.

The surface of the cleavage of clinker containing 30% calcium sulfoaluminate and 70% dicalcium silicate, as well as 20% excess calcium sulfate, is covered with large melted blocks, against which there are oval calcium sulfoaluminate grains. The micrograph also shows tabular, prismatic crystals of calcium sulfate.

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The microstructure of the clinker containing 40% calcium sulfoaluminate and 60% dicalcium silicate in the presence of 10% excess calcium sulfate is represented by melted oval blocks, the surface of which has depressions and bulges. The phases of β-dicalcium silicate, calcium sulfoaluminate and calcium sulfate are not presented separately, but have the form of a single-phase monomineral substance. The blocks are interconnected by grains of calcium sulfoaluminate.

The surface of the cleavage of clinker containing 40% calcium sulfoaluminate with a 20% excess of calcium sulfate is characterized by melted blocks of dicalcium silicate, on which oval grains of calcium sulfoaluminate are located, due to which the blocks have bulges. The melted appearance of the blocks is given by calcium sulfate.

The microstructure of the clinker containing 50% calcium sulfoaluminate, as well as 20% excess calcium sulfate, is composed of blocks on which small oval grains and tabular, prismatic crystals are located.

The microstructure of clinker containing 40% calcium sulfoaluminate and 60% dicalcium silicate, as well as 10% excess calcium sulfate, synthesized at 1623K, is characterized by a melted form of large blocks, the surface of which is covered with small oval and plate-like crystals.

It should be noted that the microstructure of the synthesized sulfoaluminate-belite clinkers with an increase in the content of calcium sulfoaluminate changes as follows: blocks of β-dicalcium silicate become coarser, taking on a melted form, convex oval grains of calcium sulfoaluminate are located on their surface. With an increase in the content of excess calcium sulfate, the surface becomes covered with small crystals of a tabular, prismatic shape.

Thus, firing at a temperature of 1523…1673K produced sulfoaluminate-belite clinkers containing 10…60% calcium sulfoaluminate, 40…90% dicalcium silicate and 10…30% excess calcium sulfate. The analysis of these clinkers and their electron microscopic examination testify to the formation of these minerals during the firing process.

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