PRODUCTION AND SERVICE OF HIGH-ALUMINA CERAMIC CASTABLES.
1. RAMMING MIXTURES BASED ON MODIFIED BAUXITE HCBS

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The prospects of using bauxite-base HCBS in the production of high-quality ramming mixtures for lining blast furnace spouts are considered. A system of Chinese bauxite (filler) and bauxite HCBS (binder) is shown to give a ramming mixture with a porosity of 18–22% and a strength of 120 MPa. The effect of some process factors on the properties of the new refractory material is considered. The life of the mixture in the main hearth spout is shown to be 70–90 thousand tons cast iron before the first repair at a consumption of 0.53–0.63 kg mixture per one ton cast iron. The processes that occur in the interaction between the material and blast furnace slags of various chemical compositions is considered. The characteristics of the developed mixture are compared with those of the standard ones.

Initial materials and binding system. The binder was a HCBS obtained by wet milling of bauxite with an additive of highly dispersed quartz glass.

The HCBS was prepared from heat-treated Chinese bauxite (delivered from Shanksi Province) that contained 85% Al2O3, 7% SiO2, 3% TiO2 [3]. The bauxite was milled, screened, and subjected to magnetic separation. The milling bodies were made of uralite with an apparent density of 3.10–3.15 g/cm3. The effective density of the milling bodies in the final milling stage did not exceed 0.40 g/cm3. The total milling time was 16–19 h.

The charge placed into the mill was enriched with highly dispersed quartz glass in the form of the waste of centrifugally shaped quartz refractories [4]. The additive corrected substantially the grain composition of the HCBS with respect to the content of the colloidal component [4], the presence and the concentration of which is a decisive factor for providing the requisite rheological properties of the HCBS. The density of the ready suspension was 2.72 g/cm3, the volume concentration of the solid phase Cs was 0.70, and the moisture content was 12%. The plasticizing additive was clay of the Nizhne-Uvelskoe deposit of grade NU2 (30% Al2O3, 60% SiO2, 3.5% Fe2O3).

The grain compositions of the suspensions and the mixes are presented in Fig. 1. Comparing the integral curves of the...
distribution of the solid-phase grains, we can see a substantial difference in the dispersity and polydispersity of the clays, the waste, and the modified bauxite suspensions.

The rheological properties of the suspension were studied with the help of a Rheotest-2 rotation viscometer. The initial suspensions were characterized by principally different flow patterns (Fig. 2). The bauxite suspension had a well manifested thixotropic-dilatant flow (the coefficient of dilatancy at $\dot{\varepsilon} = 10 - 100$ sec$^{-1}$ was equal to 1.9), whereas the waste had a virtually Newtonian flow pattern. The bauxite suspension with the waste was characterized by a lower dilatancy; the optimum amount of the additive was 10 – 15%. The viscosity of the suspensions decreased as in mixed suspensions of mullite and waste [4].

The specimens for determining the properties of the binder were shaped by slip casting into gypsum molds to obtain beams 70 x 10 x 10 mm and cubes with an edge of 40 mm. After the formation of the structure the castings were withdrawn from the molds, “dry cured” in air, and dried to a constant mass at 110°C. Then they were heat treated at various temperatures with a hold of 1 h. The dependence of the strength and the porosity of the castings on the treatment temperature is presented in Fig. 3. At a high temperature the mechanical strength is somewhat diminished. This effect is explainable by the polymorphic transformations of the quartz glass into cristobalite and the corresponding volume changes.

Ramming mixtures were prepared with a filler of the mentioned bauxite and silicon carbide (with at most 92% SiC). The integral curves of the grain distribution in the mixes are presented in Fig. 1. The composition with HCBS of heat treated bauxite (30 – 40% dry substance) and a polyfractional filler (60 – 70%) was chosen as a base variant. The grain composition of the filler is presented in Fig. 1.

Preparation of the mix under industrial conditions was performed in a roll mixer with a volume of 1.5 m$^3$. At first the fillers were mixed in a dry state and then with clay additives and the HCBS. The prepared mix was placed into 1-ton soft containers.

The composition of the mix was chosen so that the open porosity $P_{op}$ upon ramming of the mix was at least 20%.

The properties of the mixes were studied for beam specimens 230 x 55 x 65 mm in size fabricated by the method of pneumoramming. The ramming was performed using a laboratory Frolich + Klupfel compactor with an impact frequency of 800 strikes per minute in three layers with loosening the surface of each layer to a depth of 5 – 7 mm.

The porosity and the strength of ceramic castables is affected substantially by the mass fraction of the binder $m_b$ in the initial molding sand system (Fig. 4). When $m_b$ is increased from 15 to 35% the porosity decreases by a factor of 1.9. The respective values of $\sigma_c$ of the heat treated specimens