A batch of solid electrolytes of the aforementioned composition was produced at the pilot plant of VostIO and is undergoing tests in electrochemical devices.

LITERATURE CITED


DEVELOPMENT OF THE TECHNOLOGY OF FUSED-CAST REFRACTORIES OF THE Al₂O₃-Cr₂O₃-CaO SYSTEM

E. F. Kolometiseva and O. N. Popov

Our earlier studies [1] established the promising features of the fused-cast refractories of the Al₂O₃-Cr₂O₃-CaO system under the service conditions involving contact of the refractories with molten glasses and basic slags. These refractories are distinguished by the absence of low-melting glassy phases that act as thermal shock absorbers (stress dampers) during crystallization (solidification) and annealing of large-size products but, at the same time, decrease their corrosion resistance and adversely affect the thermomechanical properties in a number of cases.

Thusfar, no studies have been carried out on the technological aspects of the fused-cast refractories of the Al₂O₃-Cr₂O₃-CaO system taking the phase transformations and the structural changes occurring during the crystallization process into account.

In this investigation, we used commercial-grade aluminum and chromium oxides and calcium carbonate as raw materials. The total content of the impurities in the charge did not exceed 1.5%.

A melt of the desired composition was obtained by melting the charge in a three-phase arc furnace available at GIS maintaining a voltage of 100-160 V across the electrodes and a current up to 3 kA. The extent of superheating of the melt was controlled by varying the duration of melting the charge at the predetermined power; it amounts to 90-270°C when melting the charges having the optimum range of compositions [1].

The melt was poured into graphite and cast iron molds measuring 300 × 200 × 200 mm using a feeder head (hot top) having a volume amounting to 0.05-0.2 times the volume of the mold. The graphite molds were insulated using particulate alumina and the products were annealed along with the mold. The products obtained by pouring the melt into the cast iron molds were removed from the molds and were annealed separately using a protective layer of alumina.

In order to obtain defect-free castings having optimum service properties, the main technological parameters were established taking the phase composition and the structural features of the products of crystallization of the Al₂O₃-Cr₂O₃-CaO system into account.

It was established that the defectiveness (cracks, chip formation) of the products obtained after crystallization in the graphite molds can be correlated with the phase composition, the structure, and the velocity of sound in the specimens drawn from the dense portion of the ingot. The dependence of the velocity of sound in the specimens on their composition is nonmonotonic (extremal) in nature (Fig. 1). The maximum velocity of sound in the specimens corresponds to the minimum defectiveness of the products containing 5-10% CaO. The products containing 15% CaO have the same defectiveness (defect density) independent of the velocity of sound. The minimum velocity of sound corresponds to the systems whose structure shows large crystals of the solid solution of (Al, Cr)₂O₃, cracklike pores, and microcracks.

*Here and elsewhere, weight contents are given.

The defectiveness of the products obtained by casting in the graphite molds is significantly affected by the ratio of the weights of the mold ($M_m$) and the casting ($M_0$) and the cooling rate of the casting. It was experimentally established that the ratio $M_m:M_0$ must be equal to 1:(2-4) in order to obtain castings having minimum levels of defectiveness.

The effect of the cooling rate of the surface and the temperature gradient between the central region and the cooled surface of the products on their defectiveness was evaluated theoretically and experimentally. We measured the temperature (calibrated VP 5/20 thermocouples having leads measuring 0.35 mm in diameter were used) and the temperature gradient between the central portion and the cooled surface of the products having different compositions (Figs. 2 and 3).

The critical cooling rate of the surface of the products ($\frac{\partial T}{\partial t}$)$_{cr}$ was calculated according to the well-known equation [2] in the temperature range below the temperature at which the material of the refractory transforms into the elastic state from the elastoplastic state. The measured and calculated cooling rates of the surface of the products are presented in Table 1.