An analysis of the methods and technologies for creation of lamellar refractories makes it possible to conclude that all of them are quite complex and laborious. The parts are actually formed and fired several times.

One of the basic problems in production of double-layer systems intended for service at high temperatures and especially with alternating heating and cooling is reliable joining of layers of different density. In our opinion, for this it is necessary, first, to create an irregular surface of contact of the layers and, second, to have a transition layer "levelling" the temperature stresses occurring between the layers of different density.

Based on this assumption we have designated three basic starting possibilities of obtaining a double-layer refractory:

- compaction and joining of the layers through a transition layer in a single production operation;
- elimination of equipment for forced compaction (ramming, vibration, guniting, etc.);
- use of free-flowing mixtures making it possible to simplify laying of the mixture in molds without mechanical action on them.

Obviously, constructional and thermal insulation refractories may be produced according to such principles by different methods. We made our selection of the method based on the capabilities of self-compacting mixtures. It includes addition to the molding mixture of the burning-off addition (fine fractions of polystyrene), which froths during drying, and heat treatment of such mixtures in closed perforated molds.

However, the investigations showed that heat treatment of lamellar refractory-polystyrene mixtures with hot air causes a strong nonuniformity of the temperature field in them, especially at the start of heating. The temperature differentials in the thickness of the unfired part occurring in connection with this create a nonuniform internal pressure. In this case intense dehydration of the surface layers, which become difficulty permeable for exit of the water remaining in the mixture, occurs. The moisture is entrapped within the unfired part. This makes it necessary to heat up the self-compacting system slowly, which significantly lengthens heat treatment.

In order to eliminate long heat treatment of the mixture with hot gases we used forced heating with an electric current. In electric heating, the mixture in the mold is connected in a circuit and a line-frequency ac is passed directly through the mixture. As a result of resistance of the medium the electrical energy is converted into thermal and the mixture is heated according to the specified method, which may be controlled by changing the parameters of the current.

The method was developed on corundum parts, a material in very short supply, the demand for which for various branches of technology is very high as a result of its valuable properties.

In the work the following original materials were used: type GK commercial-grade alumina with not less than 35 wt.% finer than 1 μm fraction and not more than 1 wt.% coarser than 63 μm fraction; electrofused corundum of the finer than 60 μm fraction; foaming bead polystyrene of the finer than 0.5 mm fraction; an aqueous solution of sulfite-yeast mash with a density of 1.02 g/cm³.

The previous articles of the series "Lightweight Refractories of Self-Compacting Mixtures" were published in Nos. 7-8 and 9-10 of 1992.
The weight ratio of electrocorundum and alumina in the mixtures was (60-55):(40-45) for the dense layer and (58-55):(42-45) for the porous. To the mixture for the porous layer was added 4-7% above 100% polystyrene.

First the mixture for the dense layer with a moisture content of 35-40%, which was poured into a mold with perforated bottom, was prepared in a paddle mixer. Then the mixture for the thermal insulation layer was prepared. For it the foam polystyrene was loaded into the mixer, the aqueous solution of sulfite-yeast mash was poured in, after this the dry refractory components were loaded, and after this all of it was mixed for 5-6 min. The finished mixture with a moisture content of 40-45% was placed on the dense layer and the mold was covered with a lid, creating a closed volume. The mixture was heated with a line-frequency (50 Hz) electric current through electrodes located on the upper and lower faces of the mold.

Under the action of the ac the mixtures were heated to 90-100°C, and the polystyrene, displaying its activity, uniformly foamed in the whole volume of the thermal insulation layer.

As a result of the internal forces developed, which reached 0.2-0.4 MPa, compaction of the solid phase, displacement from the mold through the perforations of a portion of the mixing water (up to 70%), and molding of the porous thermal-insulation layer to the dense layer occurred.

The thicknesses of the dense and thermal insulation layers were specified based on thermal engineering calculations and also design requirements.

After completion of mechanical displacement of moisture from the mixture and opening of the mold the unfired part had a temperature of 70-80°C and therefore drying was forced at 120-130°C for 2 h. In this way the combination of electric heating with convective drying made it possible to remove moisture from the unfired part in 3 h.

The parts were fired at 1550-1600°C with a 4 h hold at the maximum temperature. Cutting and grinding of them were not required (Fig. 1).