Refractory properties of siliceous bodies for ramming the linings of acid arc steel furnaces

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In recent years several factories have started to use rammed linings for the walls of acid arc steel furnaces. Replacing the brick linings by rammed linings greatly increases their resistance (from several dozen to several thousand heats), appreciably improving the production organization in steel casting workshops, reducing the furnace downtime, reducing the labor content of repair work, releasing production space previously occupied with the storage of refractories, reducing handling work, and also reducing the consumption of silica brick (dinas).

However, rammed linings for walls in such steel furnaces have not yet been introduced into the majority of factories. One of the basic reasons for this is the essential fettling of the walls of the furnace with refractory body after each heat with this method of lining, which is due to the inadequate refractoriness of the bodies employed, and as a consequence the fusion of the lining in the wall. Hot fettling of the walls of furnaces is a manual operation which the steel melter carries out from platforms welded to the housing of the furnace, exposed to very high temperatures.

Wide introduction of the ramming method for lining walls may follow from the development of suitable compositions for siliceous bodies conferring a high resistance to the rammed lining, without hot fettling during every heat when the steel is being heated for casting at high tapping temperatures (1700-1730°C).

These bodies should have a high refractoriness (apparently not less than 1740°C) which is determined by their chemical composition [1, 2], and by the quantity, composition, and rate of formation of the melt at high temperatures [3, 4].

This article gives some results of a study into the effect of the chemical composition of siliceous bodies on the refractoriness, on the basis of which the Kharkov Elektrotyazhmash Factory put into production...
a ramming lining body for acid arc steel furnaces with a capacity of 5 and 0.5 ton without fettling the walls after every heat.

Previous experiments [5] showed that to ensure a high strength in the rammed lining and the necessary technical properties in the refractory body based on quartz sand, it should contain water glass, fireclay, and caustic soda. The need for adding these constituents requires careful study of the refractory body in conditions involving the combined action of oxides incorporated by additives, since the composition of the bodies is very different from those dinas materials that have already been investigated.

In laboratory conditions bodies were prepared with differing compositions containing from 0 to 10% water glass, and fireclay in the same limits. All the bodies containing water glass also contained a 12%-solution of caustic soda. In all 14 versions of the bodies, eight weighings were prepared, from each of which samples were selected for determining the refractoriness and chemical composition. The refractoriness was determined by the standard method as specified by GOST 4069-48.

The chemical composition of the bodies was: 91.4–98.4% SiO2, 0.04–3.6% Al2O3, trace–0.25% TiO2, 0.06–2.3% CaO, trace–1.3% MgO, 0.08–1.73 Na2O, 0.04–1.2% Fe2O3.

Figure 1 shows the relationship between the refractoriness of the bodies and the concentration of SiO2 and Na2O, without taking into account the quantities of residual oxides. The reduction in the refractoriness of the body as a result of diluting the silica with additives agrees well with the well-known statements on the formation in this case of fusible silicates, which during the tests of the refractoriness, at relatively low temperatures, flow from the cone, and thus reduce the stability of the pyroscope. Accordingly, an increase in the concentration of sodium oxides and calcium oxide* also causes a marked reduction in the refractoriness of the bodies (see Fig. 1). However, the affect of the oxides of the alkaline metals is more strong, which is due to the nature of the phase diagram for the system Na2O–SiO2, and is confirmed by earlier investigations [1, 6, 7].

The experimental data on the effect of the body composition was processed by the least squares method [8] in the form of linear equations of the type

$$f_{pry} = A + B \times (\% R_{o_{m}}).$$

*Here and subsequently by the term "Na2O content" we understand the total oxides of soda and potassium which are not separable in chemical analysis.