REFRACTORIES FOR THE CONSUMER

IMPROVING THE DESIGN OF THE LINING OF THE BANKS AND HEARTHS OF ELECTRIC-ARC STEEL-MELTING FURNACES

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Preparation of the bath lining of an electric-arc steel-melting furnace is one of the most critical operations. Despite the relatively low specific consumption of refractories (and consequently the low material costs for maintenance for the bath), in emergency situations which are the fault of the refractory lining there may be significant material losses. This occurs in penetration of molten metal through the refractory lining and loss of it from the bath. Most frequently such losses occur in the banks or at the point of the junction of the banks and the hearth (Fig. 1).

To reveal the reasons for emergency penetration of metal the lining of the banks was investigated in repair of them. The presence of joints twice as thick as the standard of the corresponding instructions was established. In some cases these joints were filled with metal (Fig. 2). Such a condition of the bank brick lining makes completely probable passage through it of molten metal if the layer of patching powder in the region of the thick joints is critically worn.

It is hardly possible to assume laying of a brick lining with such joints (up to 6 mm). Therefore the reason for formation of them must be sought for during service of the lining.

The standard technical instruction TTI-14-14-663-89 specifies lining of the hearth of parts laid on the bottom and almost abutting the walls of the shell. The banks are laid on the horizontally levelled peripheral lining of the hearth, and temperature joints remain between the shell and the hearth and between the shell and the bank.

During service both the rammed portion of the hearth and its lining are heated in the second half of the heat and cool during charging. Despite the fact that the rammed portion is heated to 1600-1700°C its expansion is compensated by compaction of the powder, and the pressure from expansion of the rammed layer is not transmitted to the lining of the banks. Heating of the lining of the hearth of parts to 300-400°C, taking into consideration its significant extent (about 6 m) and thermal expansion, predetermines movement of the lining under the banks in the direction of the shell by a distance of about 10 mm. In cooling, the joints between the parts in the hearth expand insignificantly, and they are filled with powder from the rammed layer and also with metal with a low melting point (primarily non-ferrous) accumulating on the hearth during melting (Fig. 3). Heating of the hearth lining during the next heat again predetermines movement of the lining in the direction of the banks and so on.

Practically no movements of the lining of the banks under the action of cyclic temperature changes are observed. Since the parts of the banks and the hearth are in contact, cyclic displacement of the hearth lining in relation to the banks loosens their lining, as a result of which the joints in it in the zone of contact become larger. With strong wear of the rammed layer of the banks and unsatisfactory patching of them flow of metal into this area is practically unavoidable. Figure 4 shows a characteristic region of the furnace in which passage of metal occurred during a failure.

In order to eliminate the possibility of loosening of the lining of the base of the banks and to increase the thickness of the joints in it it is necessary to eliminate the influence of thermal expansion of the hearth lining on the region of its contact with the banks. One of the solutions of this problem may be laying of the base of the banks on a "cushion" of rammed mixture separating the lining of the hearth and of the banks by a layer...
Fig. 1. Emergency loss of metal from an electric steel-melting furnace in the region of the joint of the hearth and the bank.

Fig. 2. Metal which had solidified in the joints of an electric furnace bank lining.

Fig. 3. Metal with a high copper content which had solidified in the joints of the hearth lining of an electric furnace.

of unformed material sufficient for absorbing the forces.* However, such a method (Fig. 5) does not exclude displacements of the bricks in the banks since the rammed mixtures are to some degree or another a compressible material. In connection with the fact that the thickness of the "cushion" and heating of it in service are nonuniform, the degree of shrinkage of the rammed mixture must be expected to be different in different portions, and therefore collapse of the banks, which by itself is undesirable, will be nonuniform and accompanied by opening up of the joints.

Transfer of the temperature joint from the shell in the direction of the center of the furnace in such a manner that the joint is located between the projection of the inner