INCREASED LIFE FOR OPEN-HEARTH FURNACE ROOF LINING

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Reasons are studied for the short life of sprung-suspended roofs of open-hearth furnaces and refractory objects are developed with reduced thermal conductivity and a special hook. During refractory laying a shrinkage-free high-temperature laying mortar is used. OAO Nizhnyi Tagil' Metallurgical Combine organizes industrial output of the refractories developed. Industrial testing is carried out in open-hearth furnace arched roofs of OAO Nizhnyi Tagil' Metallurgical Combine (NTMK) and ZAO Nizhnyi Sergi Metalware and Metallurgical Plant (NMMZ). According to test results the increase in roof life is 20 – 30%, and the economic effect for two open-hearth furnaces is 4,656 million rubles per year.

Keywords: refractory object spalling, sprung-suspended roof, special refractory object with reduced thermal conductivity, laying mortar, arched roof.

The life of an open-hearth furnace lining is governed by that of the roof lining, as the most rapidly worn area of a lining. For example, in the Nizhnyi Sergi Metalware and Metallurgical Plant (N. Sergi) the lining service life for two open-hearth furnaces is from 150 to 160 days, which leads to furnace downtime for thirty days in order to carry out expensive cold lining repair.

In the RF sprung-suspended roof structures of open-hearth furnaces are most widespread, combining suspension, preventing sagging, and restrictors preventing upwarping. Features of the structure are reinforcement with pins for all refractory objects of each roof ring, and reinforcement with metal plates (Fig. 1).

Abroad special attention is devoted to the quality of suspender plates. The chromium content within them is 20 – 25%, nickel 4 – 8%. In the RF there is no extensive experience of using heat-resistant plates. With an increase in open-hearth operating intensity, particularly with use of oxygen, cases are observed of rapid heating and breakage of suspender plates, which leads to premature stoppage of a furnace for repair with greater roof residual thickness.

Premature wear also occurs due to spalling of roof refractory objects. Spalling is a predominant form of wear, caused by thermal shock during roof cooling and warm-up, during charge loading, during hearth hot repair, and also during intermediate cold repair of a furnace hearth. Normally refractories wear rapidly in individual areas of a roof. Static stability is lost as a result of local wear of some roof arches. Less warm parts settle, and warmer parts lift. As a result of this a roof operating at the start of a campaign has a thrust roof and in the second half starts to serve as a suspended

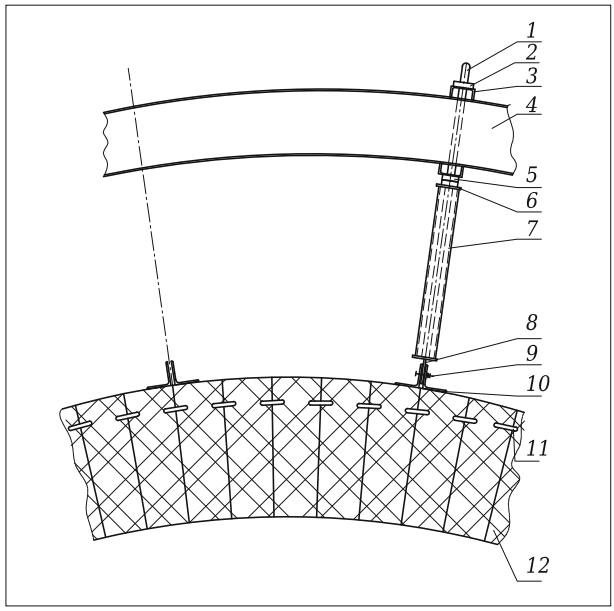

Fig. 1. Longitudinal section of roof suspender fastening: *1*) tie-rod; *2*) wedge; *3*) channel; *4*) supporting arch; *5*) packing; *6*) collar; *7*) tube; *8*) suspended plate; *9*) bolt; *10*) angle irons; *11*) pin; *12*) brick.

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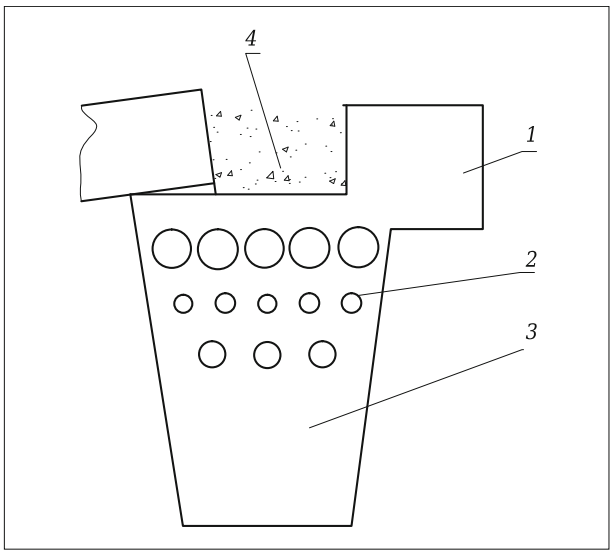

Fig. 2. Special refractory object: *1*) catch; *2*) artificial pores; *3*) refractory object working area; *4*) heat insulation filling of fiber material (kaolin wool, asbestos fiber, etc.).

roof. In order to prevent deformation it is normal to use supports of refractory objects or iron structures in areas of roof lift. Deposited dust also affects roof service life. It facilitates an increase in refractory surface temperature and rapid oxidation of plates and suspenders. Therefore often twice a day a roof is flushed with compressed air. Currently for lining open-hearth furnace roofs periclase-chromite or chromite-periclase composition objects are used (PKhS or KhP) with a length of 380 – 400 mm [1 – 3]. In addition, reasons for roof breakage are:

– occurrence of thermal stresses during warm-up before start-up of a roof lining, and its "growth". It has been revealed that with one-sided action of temperature on a refractory object the temperature gradient formed causes stresses, sometimes exceeding refractory mechanical strength. The area of greatest microcracking (breakdown of resistance) for roof refractory objects is at a distance from the working the working surface of 1/3 – 1/5 of its length [4]. Occurrence of cracks, parallel to a working surface, leads to spalling of objects from 40 to 80 mm (see Fig. 1);

– a greater length (380 – 460 mm) of objects, and as a consequence greater lining weight, which with an arched roof structure leads to additional stresses within a lining;

– high roof lining thermal conductivity for standard refractories (KhP, PKhS, PKhPP) which leads to heat loss, i.e., increased gas consumption, and as a consequence makes it necessary to use refractory objects of greater length (380 – 460 mm) [4];

– roof lining corrosive wear under action of high-temperature (up to 1800°C) and a corrosive gas atmosphere.

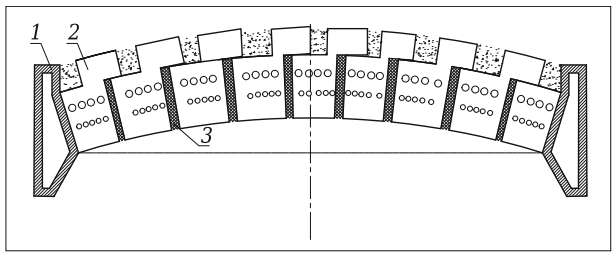

Fig. 3. Improved roof: *1*) support; *2*) special object; *3*) high-temperature refractory adhesive.

In order to improve open-hearth furnace roof life, taking account of results for studying reasons for refractory wear, the structure and substance composition have been developed for special refractory objects (Fig. 2), whose shape makes it possible to reduce thermal stresses in the roof lining worker area. Presence of a hook for an object almost excludes its descent during operation without roof wedging (Fig. 3). Artificial pores in the heat insulation zone of the developed object and heat insulation filling in gaps (kaolin wool, asbestos fiber) sharply reduces heat loss [5], (Fig. 2).

In view of quite considerable corrosive wear of a roof by melt reagents and a gas atmosphere special objects are prepared from a charge of periclase-chromite composition based on sintered or fuzed grains (PKhS, PKhPP). Objects are pressed and fired by traditional technology [5].

Special refractory objects are produced on an industrial scale in the refractory production of NTMK. These objects were tested in open-hearth furnace roofs of NTMK and NMMZ. Testing showed an increase in lining life by 20 – 30%. The saving effect obtained for two open-hearth furnaces was 4656 million rubles per year.

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