IMPROVED PERFORMANCE OF REGENERATORS IN OPEN-HEARTH FURNACES

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At the Nizhne-Tagil Metallurgical Group of Enterprises oxygen and compressed air are used as melting intensifiers in large-capacity open-hearth furnaces operated on the scrap-ore process with liquid pig iron additions. Recently, oxygen has also been used for direct oxidation of impurities in the bath. This lead to an increase in the temperature level not only in the working hearth, but also in the checkerwork, particularly during melting. At the same time, the oxidability of the furnaces increased and the entrainment of flue dust with the products of combustion became intensified.

As can be seen from investigations carried out at the Nizhne-Tagil Metallurgical Group of Enterprises, at the Zaporozhstal', Krivoi-Rog, M. S. Kirov Makeevka, Chelyabinsk, and other Metallurgical Works, the concentration of flue dust was largest during the molten pig iron addition and during melting, particularly 1.0-1.5 h after the molten pig iron had been added. With an oxygen consumption in the flame of 1500-2500 m³/h the content of dust in the flue gas of 380-600 t furnaces is 6-8 g/m³ of flue gas during the melting operation. When the oxygen consumption is increased to 3000-3300 m³/h, the content of dust is 35 g/m³. When the bath is blown with an oxygen supply intensity of 2200-2500 m³/h, the concentration of dust is 10-11 g/m³ of flue gas. With the increase in the oxygen supply intensity up to 4000-5000 m³/h, the entrainment of dust increases to 50-65 g/m³. A large quantity of dust is also entrained during the patching of the furnaces, particularly when fine magnesite powder is used (up to 50 g/m³).

To prolong the life of the furnaces, forsterite or forsterite-chromium bricks are used in the upper 10-15 rows of the air checkers, and in 5-10 rows of the gas checkers (and at some plants even to a larger extent). Such checkers make it possible to simplify the operation of the furnaces. However, in service, the basic refractories have a tendency to loosen, peel, and to become covered with flue dust which becomes sintered in the upper checker rows.

As can be seen from practice and special investigations, the slag pockets of modern open-hearth furnaces are very inefficient dust collectors, especially as approximately 50% of the quantity of the dust particles has sizes less than 500 μ. As a result, the checkers become heavily covered with dust and slag deposits. In such a case, the hydraulic resistance of the lower structure sharply increases and the conditions for heat-exchange and oxidation processes in the furnace deteriorate: the increase in the resistance in any section of the furnace is always accompanied by a change in the conditions of the gas flow in all other sections. As a result, the normal aerodynamics of the flame in the working hearth is disturbed. This is one of the most serious causes of the breakdown of open-hearth furnaces which is accompanied by a considerable decrease in the efficiency and by an increase in the specific fuel consumption during the run.

Fig. 1. Pipe with nozzle for high-pressure water jets for washing checkers: 1) nozzle for high-pressure hose 32 mm in diameter; 2) screw; 3) sleeve nut; 4) sleeve; 5) gasket; 6) gas pipe; 7) handle; 8) head of pipe; 9) nozzle; 10) ram.

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Fig. 2. Diagrammatic sketch of the plant for washing checkers and for dust removal from under the checkers and from the smoke flues in open-hearth furnaces.

Fig. 3. Construction of a 20-mm diameter Laval nozzle for blowing out dust from under the checker.

Usually, it became necessary to stop the furnaces prematurely for hot repairs and for the replacement of the forsterite checker section. Sometimes, it also became necessary to reset the checkers. If the checkers are not cleaned during the run, their resistance reaches 38-48 mm water column before the furnace is stopped for preventive hot repairs (180-220 heats).

To improve the thermal efficiency of regenerators, the NTMK and VNIIMT (Nizhne-Tagil Metallurgical Group of Enterprises and All-Union Scientific Research Institute of Metallurgical Heat Engineering) developed and introduced (into the industry) regular washing of the air checkers with water at a high pressure (8-10 abs atm). For this, two PNP-3M steam pumps of a capacity of 14 m³/h each at a pressure of 12 abs atm were installed in the shop. One of these pumps is used for five 400-t furnaces, the second for four; 83-mm diameter pipelines are mounted over the end faces of regenerators with standpipes leading to the end faces of the air regenerators. The checkers are washed by means of a special pipe, 30 mm in diameter and 7 m long, which has a head with a 10 mm diameter nozzle (Fig. 1) at the end. At the other end, this pipe has a nozzle for a high-pressure hose and a handle for turning or moving the pipe in the required direction.

The 10-12 upper rows of the air regenerators are at present lined with KhF-4 forsterite-chromium firebricks by using Cowper's method, and the upper fifth row is lined by using the Siemens method. The lower rows are lined with T-shaped PM-60 chamotte bricks by using the Siemens method. The dimensions of the cells are usually 155 × 155 mm. In some furnaces, as an experiment, the cells are increased to 190 × 190 mm, the height of the forsterite-chromium section of the air checkers is increased to 18 rows, and that of the gas checkers to 12 rows.

Two rows of holes are left in the end face walls of the regenerators for the introduction of the pipe during washing: the upper row over the checker, the lower at the fifth row of the checker (Fig. 2). The working sections of the roofs and the walls of the regenerators are lined with basic refractories.

The washing method consists of the following. At first, the upper holes 1 in the end face wall of the regenerator are opened. When the flue gases flow through the checkers, the pipe 2 is introduced through the hole 1 and at the same time water is admitted through the valve 3. The head of the pipe nozzle is directed downwards. On moving it gradually along the checkers (with a slight rotation around its axis), the dust deposits are washed off the work surface of the bricks. After washing off the upper rows, the holes in the end face are closed, apart from 2-3 for observation, and the lower holes 4 are opened. Then, the pipe is introduced into each hole in turn and the checkers are cleaned along the height. On advancing, the pipe nozzle is directed upwards, and on moving back, the pipe nozzle is directed downwards.