Coke-Battery Maintenance at OOO Mechel-Koks

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Abstract—The state of coke ovens at OOO Mechel-Koks is reviewed, and methods for their repair are described. Experience in identifying the source of lining defects at the heating-channel walls in coke batteries 1 and 3 is summarized. The factors responsible for the lining cracks in battery 7 are analyzed, and the state of coke batteries 2, 4, and 8 after repair is considered. A separate repair department at OOO Mechel-Koks has been created and charged with repair of the coke-battery lining. The coke ovens in batteries 8, 5, and 6 have been restored to service. The relining of the extreme heating channels at coke battery 1 is described. The expected life of the repaired coke ovens is more than 30 years.

Keywords: coke batteries, lining repair

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In the construction of the coke batteries at OOO Mechel-Koks (built to produce coke for Chelyabinsk Metallurgical Plant), during and after World War II, coke ovens of PK type were used for the first time.

In battery reconstruction in the 1980s, in view of the limited production space and the specialization of the plant’s metallurgical production, the coke batteries were confined to the existing area, using the existing foundations, buttresses, flues, and other systems. The heating system and some of the components were modified somewhat in the light of then-current environmental requirements.

Today, eight coke batteries are in operation at OOO Mechel-Koks; their characteristics are summarized in the table.

The condition of the coke-oven linings corresponds to their age.

At coke battery 3, 19 ovens were removed from operation between 2002 and 2012, on account of lining defects in the walls at heating channels 7–23, in rows 7–20 from the hearth. These defects took the form of scorch marks and spots of lining disintegration, as well as local deformation of the walls preventing coke discharge. A possible source of these defects is that a solution with elevated plasticizer (soda) was used for the lining of levels 5–10, with loss of the solution in the course of operation. In this period, the plant lacked equipment and materials for repair of the ceramic lining, and the repeated injection of fireclay dust was only a short-term remedy.

At coke batteries 1 and 3, which have not undergone major repair with relining of the extreme heating channels, constriction of some of the ovens on the coke side in the region of heating-channel overlap prevents complete coke discharge when they are fully loaded. In response, no more than 2.5 bunkers are emptied in loading those ovens.

At coke battery 7, operating with one gas collector and small columns with stationary tipping joints and hydraulic gates, cracking is observed earlier on the coke side in the lower zone of the wall lining, while blistering is seen in the region of heating-channel overlap under the gas-exhaust gate. During operation, the lining expands more at the level of the lower crossbeam than at the upper crossbeam, and there is increased flexure of the anchor columns on the coke side.

The condition of the unrepaired section of the walls and the repaired junctions in coke batteries 2 and 4 is satisfactory; the density of the cold section of the lining is basically good, with minimal inleakage. Experience in lining repair shows that, if the battery age is no more than 25 years, it is expedient to reline the extreme heating channels during battery shutdown. That extends their remaining life.

Since 2006, relining of walls over the complete length (in pairs) from row 8 of the conduit zone has been underway in coke battery 8. As a result, previously inactive coke ovens have been returned to service. The state of the lining in the chambers and the regenerators is satisfactory.

Before 2006, at Chelyabinsk Metallurgical Plant, there was no repair department responsible specifically for maintaining the battery linings in working order.

Repair groups (each of 15 workers) serve coke shops 1 and 2. In practice, these groups meet repair needs as they arise: guniting fireclay solution onto the phosphate binder, relining the charge holes, lining and
replacing the gas-exhaust columns, lining the coke-oven doors, etc. Major work was undertaken by outside contractors (such as Koksokhimremont and Kokoksokhimmontazh).

At the end of the 1990s and the beginning of this century, the condition of the coke-oven linings markedly declined, on account of their unstable operation, with rapid turnaround and periods of hot and cold conservation. There was an obvious need for a centralized repair department responsible for short- and long-term maintenance of the coke-battery linings.

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At that time, attention focused on restoration of the coke ovens at coke battery 8, since coking in individual chambers with open gas-exhaust columns had been introduced on account of problems with the hydraulic drives of the column lids. Gas-line operation was disrupted; sticking of the valves was observed; the battery tended to catch fire; and combustion of the conduit zone began. On account of the disruption of heating and constriction of the chambers on the coke and machine sides, many coke ovens were removed from service. No more than 38 coke ovens were in operation. After the institution of the coke-over repair shop in 2006, a repair schedule was drawn up, with the goal of returning all the coke ovens to operation.

In 2006, the extreme heating channels were repaired (2–5 on the machine and coke sides); repairs were undertaken at 26 walls. In parallel, coke batteries 5 and 6 were repaired.

Relining of the extreme heating channels did not permit complete restoration of coke-oven operation. Therefore, beginning in 2007, repair of all the coke-oven walls at coke battery 8 (from the floor or from the eighth row of the conduit zone, depending on its condition) began. Altogether, 13 walls were repaired in 2007; 12 in 2008; and the last eight walls in 2010. Since January 2011, all 65 coke ovens have been in operation. In recent years, 6–10 heating walls have been repaired during each repair season (October to May), depending on the capacity of the equipment.

To eliminate constriction of the coke ovens in coke battery 1 on the coke side, in the region of the horizontal channel and the collection rows, the 4–5 extreme heating channels in pairs of walls were repaired in the 2009–2010 season; in all, 14 walls were mended.

In the 2010–2011 season, eight walls were repaired; two were completely relined. These repairs shows that the depth that must be addressed for junc-

<table>
<thead>
<tr>
<th>Battery</th>
<th>Year of construction</th>
<th>Startup date after reconstruction</th>
<th>Type; number of coke ovens; volume</th>
<th>Heating</th>
<th>Year of shutdown for repair (relining of extreme channels over 4–7 vertical rows, with replacement of the anchorage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1944</td>
<td>December 1985</td>
<td>Pk-2k (PK-2); 61 chambers; $V = 20.0 \text{ m}^3$</td>
<td>Lateral supply; blast-furnace gas mixed with natural gas</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>1944</td>
<td>June 1981</td>
<td>As above</td>
<td>As above</td>
<td>2003</td>
</tr>
<tr>
<td>3</td>
<td>1948</td>
<td>September 1982</td>
<td>As above</td>
<td>As above</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>1951</td>
<td>November 1983</td>
<td>As above</td>
<td>As above</td>
<td>2008</td>
</tr>
<tr>
<td>5</td>
<td>1955</td>
<td>December 2011</td>
<td>PVR (dust-free discharge); broad regenerators; checkerboard combustion; 61 chambers; $V = 21.8 \text{ m}^3$</td>
<td>Lateral supply; coke-oven gas</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>1956</td>
<td>March 2011</td>
<td>As above</td>
<td>As above</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>1962</td>
<td>November 2006</td>
<td>PVR; narrow regenerators; combustion by row; 65 chambers; $V = 21.6 \text{ m}^3$ (gas collector only on the machine side)</td>
<td>Lateral supply; coke-oven gas</td>
<td>—</td>
</tr>
<tr>
<td>8</td>
<td>1963</td>
<td>April 1994</td>
<td>PVR; narrow regenerators; combustion by row; 65 chambers; $V = 21.6 \text{ m}^3$ (gas collectors on the machine and coke sides)</td>
<td>As above</td>
<td>—</td>
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</tbody>
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