and on the rate at which the water is eliminated from the material. This assumption was verified by drying experimental specimens (diameter 35 mm and weight 250 g) of the notch material inside a pipe placed into a laboratory furnace heated to 1000°C. After the evaporation of the water the temperature of the material rose sharply and after 6-12 min reached 500-600°C, i.e., the level of the temperature in the notch prior to tapping (Fig. 2).

The use of silicon carbide and coke slurries accelerated the drying of the notch material and reduced the oxidation of its carbon components.

The improvement in the quality of the notch material made it possible to use longer notches in the 2700-m³ blast furnace of the Cherepovets Metallurgical Plant (Fig. 3) and to reduce their erosion; the durability of the notch material on the other blast furnaces of the Plant also increased; the blast-pressure drop during tapping was almost entirely eliminated.

CONCLUSIONS

The operating conditions of the blast furnace, more particularly the iron and slag tapping cycle, must be taken into account when modifying the composition of the material for the iron notch. The period before the notch is ready for the next tapping depends on the thermal conductivity and the rate of drying of the material of the notch. The addition of silicon carbide to the notch compound accelerates the drying process and reduces the oxidation of the carbon constituents.

LITERATURE CITED


DURABILITY OF THE LINING OF MIXER-TYPE TRANSFER LADLES


At the West Siberian Metallurgical Plant the cast iron is transferred from the blast furnaces to large converters in 420-ton mixer-type ladles.

There are no stationary mixers in the converter section so that the continuity of operation of the converters and of the steelmaking process depends on the durability of the lining of the transfer ladles, which depends in turn on the material and quality of the masonry of the active layer.

The lining of the mixer-type ladles consists of several layers. An insulation layer of asbestos sheet lies next to the shell, then comes a reinforcing layer of two tiers of class B chamotte brick, and finally the active layer which consists of class A chamotte bricks, viz., grades D-1-D-6 (GOST 1598-53) and Sh-19, Sh-20, and Sh-26 (GOST 8691-73). The masonry of the active layer is laid with ShT-1 mortar, which contains at least 38% Al₂O₃ + TiO₂ and has a refractoriness of 1730°C. In the tapered and cylindrical parts and in the end walls of the ladle the thickness of the active layer is 345 mm, at the point of impact of the melt jet it is 575 mm.

Such a lining in the mixer ladles withstands only 316 melt transfers on average. Industrial-scale experiments* were therefore carried out at the Plant with the aim of increasing the durability of the ladle lining, viz., by impregnating the chamotte brick with coal tar. The characteristics of the latter were: viscosity 3.1E

* A. A. Antonov, Yu. A. Marakulin, and N. A. Pupkov participated in the work.

At the West Siberian Metallurgical Plant. Translated from Ogneupory, Vol. 18, No. 8, pp. 29-31, August, 1977.
at 80°C, density 1.177 g/cm³, water content 5.3%, ash content 0.1%, naphthalene content 10.35%, and phenol content 1.02%.

A steam coil for heating the tar was installed in a freshly lined mixer ladle after drying the lining and cooling it to 40°C. The temperature of the tar was controlled with two Chromel–Copel thermocouples installed in the conical part of the ladle. The ladle was then filled with tar and steam was admitted into the coil. The impregnation process was continued for 68 h. The mean temperature of the tar in the ladle was 82°C during the first day, 105°C during the second, and 101°C on the third. During some periods the tar was heated to 115°C.

To determine the depth to which the active layer was impregnated in relation to the process time, three steel boxes were filled with refractory bricks of grade D-4 after which chamotte mortar was poured over them in such a manner that only the end faces of the bricks were covered with it. The boxes were placed into the ladle with tar for periods of 24, 48, and 65 h. When they were removed from the ladle the brick was dried with a gas burner in the same conditions as the tar-impregnated lining of the ladle after which the depth of impregnation was measured (Fig. 1). The properties of nonimpregnated and tar-impregnated chamotte bricks before and after service are given in Table 1. The open porosity was lower and the cold-crushing strength higher in the case of the tar-impregnated brick.

To investigate the effect of the tar impregnation on the properties of the material of the masonry joints in the active layer, a box containing four bricks laid with mortar was placed into the ladle with tar and removed at the end of the impregnation process for the ladle lining. On inspection, the joints appeared to be solid. A chemical analysis showed that the joint material contained up to 2.5% carbon.

When the tar-impregnated lining was dry the ladle was taken into service. During its campaign of 400 transfers the lining was patched twice, viz., the first time after 300 transfers (i.e., after the transfer of 95,297 tons of cast iron) when the active layer around the throat was renewed. An inspection during the patching operation showed that erosion occurred mainly at the joints but to a lesser degree than in ladles with a non-impregnated lining. The erosion of the active layer was at maximum at the point of impact of the jet of liquid.

**TABLE 1. Properties of the Experimental D-4 Chamotte Brick before and after Service**

<table>
<thead>
<tr>
<th>Tar-impregnation time, h</th>
<th>Cold-crushing strength, kgf/cm²</th>
<th>Open porosity, %</th>
<th>Apparent density, g/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not impregn.</td>
<td>403</td>
<td>15.20</td>
<td>2.15</td>
</tr>
<tr>
<td>24</td>
<td>407</td>
<td>13.50</td>
<td>2.15</td>
</tr>
<tr>
<td>48</td>
<td>404</td>
<td>11.70</td>
<td>2.26</td>
</tr>
<tr>
<td>65</td>
<td>420</td>
<td>11.30</td>
<td>2.21</td>
</tr>
<tr>
<td>After service*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not impregn.</td>
<td>532</td>
<td>15.70</td>
<td>2.28</td>
</tr>
<tr>
<td>68</td>
<td>559</td>
<td>14.43</td>
<td>2.23</td>
</tr>
</tbody>
</table>

*Averaged values.