zone, and a working zone with a slag crust about 1 mm thick. The refractoriness of the least altered zone was 1650–1670°C, that of the transitional zone 1650°C, and that of the working zone 1500°C. The refractoriness of the initial mass was 1700°C.

The working zone (Fig. 1) consisted of fused and cracked quartz grains surrounded by jackets of glass with N = 1.503 ± 0.005 and brown glass with N = 1.553 ± 0.05. The mineral composition of the working zone was as follows (vol. %): quartz 85, glass 10, cristobalite 5.

The dark slag crust consisted of greenish brown crystals with weak pleochroism, oblique extinction, and N = 1.730 ± 0.003. It appears that they belong to hedenbergite CaFeSi2O6. These crystals are frequently surrounded by glass jackets containing magnetite inclusions. The content of the glass is about 10–12 vol. %.

Chemical analyses showed that during service the working zone of the rammed layer is enriched with ferrous oxide (up to 2%), calcium oxide (up to 5%), and manganic oxide (up to 0.3%).

The low refractoriness of the working zone indicates that during teeming the surface of the rammed layer on the ladle bottom is in a softened state.

The rammed layer on the ladle bottom experiences sudden heating during discharge of the metal into the ladle, and cooling after completion of teeming; as a consequence significant degeneration of quartzite to cristobalite is not observed. This is also promoted by the increase in the Al2O3 content of the rammed mass as a result of incorporation of the additional amount of clay. The retarding effect of aluminum oxide on degeneration of quartz is widely known [5].

This procedure for making a rammed lining of the bottoms of steel-teeming ladles in the form of a coating deposited with a sand slinger has been introduced into the converter shop of the Petrovskii Metallurgical Works; this has resulted in a saving of 6.39 kopecks per ton of steel.

LITERATURE CITED

MULLITE—CORUNDUM FILLED CHECKERWORK

T. S. Ignatova,* L. V. Uzberg, UDC 666.762.16;669.162.231.832
V. D. Koksharov, F. R. Shklyar,
and M. I. Agafonova

The increase in metallurgical production is making it necessary to build high-capacity furnaces in conjunction with large air-heaters giving high blast temperature. Thus, for blast furnaces with capacities of 3000–5000 m3 the height of the checker is 40–42 m, and the required blast temperature is 1400–1500°C, and this increases the capital costs of construction of the equipment and requires expansion of the production of high-quality refractories — which are expensive [1–5].

To reduce the dimensions of the air-heaters it is necessary to increase the specific heating surface area of the checkerwork and to improve the coefficient of heat transfer. This can be attained by using filled checkerwork, made of spheres or irregularly shaped bodies. If the porosity of the bed is 0.4, the specific heating surface area of a packing of spheres 20 mm in diameter is 180 m²/m³; if the spheres are 5 mm in diameter, the

*Deceased.

area is 720 m²/m³, much higher than the levels achieved in present-day blast-furnace stoves, i.e., 32.7 m²/m³ with a checker of six-sided blocks with holes 41 mm in diameter. There is little information on the operation of regenerators with filled checkerwork. In the USA [6] proposals have been made for a stove consisting of a cylindrical chamber 5.5 m long and 2.4 m in diameter, half-filled with crushed refractory with a grain size of 6-12 mm. In operation, such a stove heated 283 m³ of gas per minute to a temperature of 1540°C.

Work has also been done on an experimental stove with a packing of corundum spheres, 3 m deep, working at 1760-1815°C [7].

The High-Temperature Institute of the Academy of Sciences of the USSR has developed and tested an experimental two-chamber regenerator with a packing of corundum and zirconium spheres. The regenerator has now been in action in a U-02 plant for over 15,000 h, giving reliable continuous hot-air feed of up to 1.2 kg/sec. In a number of experiments lasting over 200 h, stable air heating to 1800-2000°C has been obtained [8, 9].

A drawback of packing with spheres is the high hydraulic resistance in comparison with that of checkers with straight channels. (This disadvantage can be to some extent avoided by changing the design of the stove.) Moreover, the use of large amounts of high-refractory materials in the form of spheres means the creation of new production lines [10].

We have investigated the use of checkers of loose material — classified mullite—corundum chamotte with 82-85 mass % of Al₂O₃, made at the Semiluki Refactories Works. The high density and strength of chamotte give grounds for assuming that a packing of this material will have a good heat storage capacity and sufficient strength at high temperature, and the costs of additional preparation of the chamotte in its classification will be very much less than the costs of organizing a new production technology for the spheres.

We investigated chamotte specimens from the 10-20 mm fraction and experimental specimens prepared from the raw mixture used to make the chamotte.

The mullite—corundum chamotte consists of partly rounded fragments from 5-7 to 30-35 mm in size, containing about 70% of the screened 10-20 mm fraction. In external appearance the chamotte can be divided into three varieties: gray (80-85%), white (8-5%), and gray-brown (10-12%). The appearance of the chamotte is shown in Fig. 1, and its characteristics are listed in Table 1.

<table>
<thead>
<tr>
<th>Chamotte</th>
<th>Mass percent</th>
<th>Phase composition, %</th>
<th>Apparent density, g/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al₂O₃</td>
<td>SiO₂</td>
<td>Fe₂O₃</td>
</tr>
<tr>
<td>Gray</td>
<td>84.75</td>
<td>12.22</td>
<td>0.36</td>
</tr>
<tr>
<td>White</td>
<td>87.75</td>
<td>12.25</td>
<td>0.34</td>
</tr>
<tr>
<td>Gray-brown</td>
<td>86.39</td>
<td>10.40</td>
<td>0.71</td>
</tr>
</tbody>
</table>

* Figures in brackets denote indices of experimental specimens of chamotte.
† Fe₂O₃ + TiO₂ + RO + R₂O₃.
‡ According to petrographic analysis data.