CORUNDUM REFRACTORIES FROM COMMERCIAL GRADE ALUMINA

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In 1971 the Snigirev Division of the Vnukovo Refractories Plant brought on stream a section for producing refractories from synthetic corundum which would meet the requirements of Ferrous Metallurgy Technical Specifications 8-68-69. The apparent density of the product should not exceed 30% and the Al₂O₃ should be at least 96% [1, 2].

After the introduction of certain technical measures and a minor modification in the production process [1] the plant started producing corundum refractories including certain types based on synthetic corundum. The Al₂O₃ of these products is about 96% and the thermal strength three reversals from 1300°C into water.

For certain applications the Al₂O₃ content must be 98% (giving less impurities in the form of SiO₂ and Fe₂O₃) and the thermal shock resistance must be greater. These requirements can be met by producing the refractory from commercial alumina and corundum chamotte [3-5]. The process was adopted by the Snigirev Division in 1972. The alumina used were commercial grades GA85 and GK. Their chemical composition is given in Table 1.

Prior to briquetting the GA85 grade alumina was dried to a residual moisture content of 0.6% or less, then ground for 6-8 h in a M-200 vibro-mill to a preponderant grain size of 6-9 μ (measured in a microscope). The weight ratio of the balls and alumina in the grinding process was 740/80 = 9.25/1. The grinding elements were steel balls varying in diameter and in the following quantities: 240 kg 8 mm in diam. and 100 kg 14-16 mm in diam.

### TABLE 1. Chemical Composition of the Alumina, %

<table>
<thead>
<tr>
<th>Grade</th>
<th>Al₂O₃</th>
<th>SiO₂</th>
<th>TiO₂</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>Na₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA85</td>
<td>&gt;99.56</td>
<td>0.03</td>
<td>&lt;0.01</td>
<td>0.03</td>
<td>0.03</td>
<td>&lt;0.004</td>
<td>0.36</td>
</tr>
<tr>
<td>GK</td>
<td>&gt;99.43</td>
<td>0.02</td>
<td>&lt;0.01</td>
<td>0.05</td>
<td>0.02</td>
<td>&lt;0.01</td>
<td>0.46</td>
</tr>
</tbody>
</table>

### TABLE 2. Properties of the Corundum Refractories

<table>
<thead>
<tr>
<th>Molding press strength, kg/cm²</th>
<th>Porosity, %</th>
<th>Apparent density, g/cm³</th>
<th>Cold-crushing strength, kg/cm²</th>
<th>Thermal strength after 10 minutes, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>15.0</td>
<td>3.26</td>
<td>1230</td>
<td>10</td>
</tr>
<tr>
<td>1200</td>
<td>14.1</td>
<td>3.36</td>
<td>1140</td>
<td>Not determined</td>
</tr>
</tbody>
</table>

*Tests with whole bricks.

Ukrainian Scientific-Research Institute of Refractories. Vnukovo Refractories Plant. Translated from Ogneupory, No. 11, pp. 3-6, November, 1974.
The molding mixture was prepared by mixing the fine-ground alumina with sulfite-liquor waste (15% of the dry weight) in an IA-11 type intermittent edge-runner mill. The batch weighed 200 kg and its moisture content was 16 ± 0.3%. The mixture was rubbed through a 5 mm mesh screen and briquetted in a DA-2238 hydraulic press at a pressure of 300 kg/cm². The briquettes were dried in drying chambers to a residual moisture content of 1-4%. The dried bricks measured 230 x 115 x 65 mm and were fired in a tunnel kiln in a close-set charge in five tiers with the briquettes standing on edge at 1640 and 1700°C in accordance with a procedure described elsewhere [2].

The water absorption of briquettes fired at 1640°C varied 2-7%, that of briquettes fired at 1700°C 0.7-2%. The fired briquettes were crushed on an SM-165 A type jaw-roller crusher and screened through a GZhD-1 double-screen to fractions of 2-0.5 and finer than 0.5 mm. Each fraction was passed through an MS-2 separator to remove ferrous grindings.

The molding batch consists of 45% corundum chamotte of grain size 2-0.5 mm, 10% corundum chamotte finer than 0.5 mm, and 45% fine-ground binder component which consisted of unfired GK alumina and GA-85 alumina fired at 1500°C ground together in a vibro-mill.

The batch components were mixed in an edge-runner mill after which the batch was wetted with sulfite-liquor waste (2% of the dry substance) to a moisture content of 2.7%. The grain size distribution of the batch was as follows: 4.6% coarser than 2 mm, 20.1% 2-1 mm, 9.3% 1-0.5 mm, 14.2% 0.5-0.06 mm, and 51.8% smaller than 0.06 mm. The amount of the fractions smaller than 0.06 mm was shown to be higher than the standard due to the corundum and chamotte in the runner mill.

The green brick was molded to 237 x 116.5 x 67 mm in a 630-ton hydraulic press in three stages mainly at pressures of 1000 and 1200 kg/cm², then dried in a drying chamber for 4.5 days to a residual moisture content of 0.8-1%, and fired in a small tunnel kiln at 1700°C with holding time of 8 h.

The property indices of the finished refractory were good (Table 2) but the end faces of the bricks contained over-pressure cracks as a consequence of the high proportion of fine fraction in the batch. To eliminate the causes of cracking the fine fraction in the batch was reduced (Table 3), and the bricks were molded to 237 x 116 x 67 and 252 x 124 x 67 mm at a pressure of 1000 kg/cm² in addition to which bricks measuring 252 x 124 x 67 mm were experimentally molded at various other pressures. The green products were dried to a residual moisture content of 1-1.3%. The bricks measuring 252 x 124 x 67 mm were fired in a tunnel kiln at 1680°C with 5 h holding and at 1690°C with 3 h holding. The properties of bricks molded at temperatures ranging from 700 to 1200 kg/cm² were very similar (Table 4).

To determine the influence of the firing temperature on the density of the product standard and wedge-shaped bricks molded at pressures ranging from 800 to 1000 kg/cm² were fired at 1700°C with 8 h holding in a tunnel kiln at the Snigirev Division and another batch at 1750°C with 6 h holding in an intermittent