manganese corrosive steels. The production of such nozzles is being introduced at the Kras-
noarmeisk factory (TU 14-8-476-84).

Body compositions 4-6 and 62-a were used to make a trial batch of baddeleyite inserts
which were fixed into mullite-corundum bases, impregnated with pitch, and tested in the ladles
for casting steel into ingot molds, and with continuous casting.

Tests confirmed that the inserts with the higher thermal-shock resistance (6 and 62a)
during casting of manganese steels from 170-ton ladles at the Donets factory had lower wear.
The wear of the edges due to the movement of the gate valve equals 3-5 mm (for 4 and 5 the
edge wear reached 7 mm). This means we can recommend these inserts for industrial testing
in steel casting.

Trial batches of the composite plates containing baddeleyite inserts impregnated with
bakelite, in contrast to impregnation with pitch, after completion of the casting and cooling
processes, were stuck together due to the slag, forming at the end of the casting cycle and
wetting the insert, which led to a rupture in the working surface of the inserts and meant
they could not be used again. To avoid sticking of the slabs after completion of casting,
and thus to ensure repeated use, it is possible to cut off the slag in filling the ladle
with metal, and impregnate the article with pitch, containing up to 45% carbon and reducing
the wetting of the plate by the slag.

LITERATURE CITED
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REFRACTORIES BASED ON FUSED MULLITE

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Mullite forms the main stable structural mineral in the fused mullite refractories.
However, the resistance of the refractories to the action of different factors depends not
just on the weight content of mullite. It is necessary to consider the morphology of the
mineral and the formation of new complex systems due to the participation of other minerals
and the additives. A material containing the maximum quantity of the large-size (long)
acicular crystals of mullite is a promising refractory for the units working under the con-
ditions of high temperatures and loads.

Experimental studies showed that during the formation of mullite from the melt, its
cooling regime is important. Rapid cooling of the melt leads to the crystallization of fine-
grained mullite along with the glass phase [1]. In view of this, we used the classic
method of obtaining mullite from the stoichiometric mixtures corresponding to the mullite
composition. The melt obtained using an arc furnace was poured into high-tonnage (large)
molds in which slow cooling occurred over a period of several days. During the growth of
mullite crystals, the metastability of the glass with respect to the crystals forms the driv-
ing force during the devitrification process of the glasses. Devitrification of the glass
and crystallization of mullite occur only when the equilibrium is disturbed as a result of
cooling and this process continues up to the complete disappearance of the liquid phase.

The material obtained from the slowly cooled melt consists of 95-96% mullite and 4-5%
glassy cryptocrystalline substance.

In order to obtain the refractories, large blocks of fused mullite were crushed and
milled and the 3-0.5 mm and the minus 0.06 mm fractions were prepared. In order to estab-
lish the optimum parameters for the production of refractories, we carried out studies on
the effect of different factors on the variation of the properties of the products. Products

Ukrainian Scientific-Research Institute of Refractories. Translated from Ogneupory,
Fig. 1. Dependence of the apparent density $\rho_{\text{app}}$, the volumetric shrinkage $\Delta V$, the ultimate compressive strength $\sigma_{\text{cm}}$, the gas permeability $G$, and the open porosity $P_{\text{open}}$ of the fused mullite based products (Nos. 1-3 charges, see Table 1) on the compaction pressure: --- dried unfinished products; ---- fired products.

Table 1. Characteristics of the Fused Mullite Products Compacted at a Pressure of 120 N/mm$^2$

<table>
<thead>
<tr>
<th>Parameters*</th>
<th>Charge number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cont. of the minus 0.06 mm fraction in the charge, %</td>
<td>5</td>
</tr>
<tr>
<td>Weight content, %:</td>
<td></td>
</tr>
<tr>
<td>SiO$_2$</td>
<td>25.48</td>
</tr>
<tr>
<td>Al$_2$O$_3$</td>
<td>73.94</td>
</tr>
<tr>
<td>Fe$_2$O$_3$</td>
<td>0.20</td>
</tr>
<tr>
<td>others</td>
<td>0.38</td>
</tr>
<tr>
<td>Phase composition, %:</td>
<td></td>
</tr>
<tr>
<td>mullite</td>
<td>93.24</td>
</tr>
<tr>
<td>glass</td>
<td>6.76</td>
</tr>
<tr>
<td>Open porosity, %</td>
<td>17.5</td>
</tr>
<tr>
<td>Apparent density, g/cm$^3$</td>
<td>2.54</td>
</tr>
<tr>
<td>Thermal shock resistance† (1300°C-water), thermal cycles</td>
<td>3-11</td>
</tr>
<tr>
<td>Temperature corresponding to the beginning of softening at a stress of 0.5 N/mm$^2$, °C</td>
<td>&gt;1750</td>
</tr>
<tr>
<td>Additional volumetric shrinkage at 1800°C after a 2-h dwell, %</td>
<td>0.37</td>
</tr>
</tbody>
</table>

*The refractoriness of the products 1860°C; softening temperature at a stress of 0.2 N/mm$^2$ >1750°C; the additional shrinkage at 1700°C after a 2 h dwell is equal to zero.

†Numerator - limiting values; denominator - average value.

The products compacted at a pressure of 120 N/mm$^2$ exhibit high levels of properties (Table 1) and their mullite content amounts to 92.74-93.48 %. Increasing the content of the finely milled (minus 0.06 mm) constituent in the charge composition improves the ultimate bend strength at 20, 1260, and 1405°C (Fig. 2). The creep strain increases with increasing content of the fine fractions of mullite in the body composition (Fig. 3). The steady-state creep of the specimens containing 5% finely milled constituent in the charge is less than that of the specimens containing 20 and 40% fine fractions (0.0056%/h as compared to 0.0131%/h). At a temperature of 1500°C and a stress of 0.5 N/mm$^2$, the strain of the fused mullite specimens containing 5-40% binder can attain a value of 0.1% within 24 h; and at 1600°C and 0.2 N/mm$^2$, it amounts to 0.2-0.3%. Under the given conditions, the limiting temperature at which mullite refractories can be used amounts to 1600°C.