Various factors affecting the stability of lining elements of the working zone of open-hearth furnaces were analyzed at the Azovstal' Works. The damage affected not only the weld bead and the fettling layer, but even the brickwork. Certain segments of the weld bead were transformed into finely dispersed powder, which became especially evident after stopping the furnace for cold repair.

Due to a marked deterioration of the bottoms the furnaces had to be stopped ahead of schedule for bottom repairs and even for cold repairs. This increased the consumption of magnesite powder used for bottom repairs and fettling the working zone; the labor input, duration, and amount of current cold repairs of the open-hearth furnaces grew.

In the course of study it was discovered that the main reasons for intense destruction of the open-hearth furnace bottoms in operation is the elevated content of CaO and SiO$_2$ in magnesite powder supplied from Satkinskoe deposit and the absence in the slag of a sufficient amount of P$_2$O$_5$, which prevents conversion of 2CaO·SiO$_2$ into the γ-modification in cooling of the furnace. Previously, P$_2$O$_5$ had been introduced with the pig iron obtained from the high-phosphorus ore of the Kamysh-Burunskoe deposit. The destruction of the bottom weld bead after the furnaces are stopped for cold repair occurs because of saturation of the bottom material with slag and formation of bicalcium silicate upon its crystallization.

In order to eliminate the reasons for the destruction of the lining elements of the working zone of the open-hearth furnaces we selected chemical, mineral, and grain compositions of magnesite powder that would prevent formation of bicalcium silicate in service. As a result it was suggested that magnesite powder from Slovakia be used for maintenance and cold repair as well as for fettling the open-hearth furnaces.

Slovakian magnesite powders differ in their physicochemical parameters from Satkinskoe deposit powders:

a) in a low SiO$_2$ content (from 0.6 to 1.2%). With an average CaO content in the powder of 3.0 – 4.5% this provides a molecular ratio CaO : SiO$_2$ > 3.75 which, in turn, determines the type of binding under sintering. At CaO : SiO$_2$ > 2 the binder is magnesiowustite MgO·FeO, magnesioferrite
MgO·Fe₂O₃, and tricalcium silicate 3CaO·SiO₂. In the magnesite powder from Satkinskoe deposit CaO∶SiO₂< 2, which results in formation under sintering of bicalcium silicate 2CaO·SiO₂ (up to 10%), mervinite 3CaO·MgO·SiO₂, and magnesioferrite MgO·Fe₂O₃;

b) in a high ferrous oxide content, which provides filling of voids between the grains of the heated powder. The rate of dissolution of periclase in a ferrous solution is less than the rate of filling the voids in the working layer of the bottom. This creates advantageous conditions for cementing highly refractory periclase grains with liquid-mobile ferrous smelt during repairs without a dangerous reduction in their refractoriness;

c) in grain composition, which provides compact packing of the grains with a minimum loss of the fine fraction.

In 1994—1995 at the open-hearth plant of the Azovstal’ Works a technology for fettling the open-hearth furnace bottoms with Slovakian magnesite powders was developed and implemented. The average durability of weld beads made with Slovakian magnesite powder is 30.1 days against 18.2 days when using powders from Satkinskoe deposit [1].

Moreover, the plant needed to increase the service stability of the fettling layer of the working zone of the open-hearth furnaces the low stability of which was caused by the same factors. Moreover, from the economic point of view it was necessary to replace fired dolomite with magnesite powders since the price of dolomite exceeded significantly that of magnesite powder.

According to the technology currently used at the Works for fettling the working zone of the open-hearth furnaces fired dolomite of grades DOM-1 and DOM-2 is used, alternating with magnesite powder of grades PPK-78, PPIM-78, PPK-85, PPIM-85. For a fettling, about 30 tons of dolomite and 10—12 tons of magnesite powder are consumed (the approximate ratio is 3∶1). For the bottom weld beads magnesite powders of grades PPMP-86, PPP-85, PPM-85 produced by Magnezit Company are used.

Under increased wear of the lining elements of the furnace working zone the “restoration” of the brickwork as a rule was done by increased fettling with magnesite powder. This increased the consumption of magnesite powder for fettling the working zone and the labor input, duration, and amount of current cold repairs of the open-hearth furnaces.

To elucidate the influence of the quality of the magnesite powder and the fired dolomite on the stability of fettling the lining elements of the furnace working zone the chemical and granular compositions of the magnesite powder coming into the Works were analyzed. The presence in the fired dolomite of a significant amount of SiO₂, which in combination with the periclase brickwork and the weld bead forms fusible eutectics, and its grain composition, preventing optimum compactness in the packing of the grains, reduce the effectiveness of this material for working-zone fettling. Therefore the poor

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Powder grade</th>
<th>Mass fraction, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MgO₂ above</td>
<td>CaO below</td>
</tr>
</tbody>
</table>

TABLE 2. Grain Composition of Samples of Magnesite Powder and Fired Dolomite before Service, %

<table>
<thead>
<tr>
<th>Sample number (see Table 1)</th>
<th>Passed through sieve No.</th>
<th>Retained on sieve No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

TABLE 3. Service Qualities of the Fired Dolomite Have to be Compensated with its Quantity.

The chemical parameters of magnesite powders produced by Magnezit Works and fired dolomite are given in Tables 1 and 2.

Petrographic analysis of the powders before application and material samples taken after the furnace was stopped for cold repair is of great interest in elucidating the reasons for destruction of the fettling layer and brickwork. The investigations were performed on immersion specimens in transmitted and reflected light using an Amlival microscope. Optical properties of the materials were determined by the immersion method.

The following results of analyzing the powders before service were obtained. Sample No. 1 was taken from magnesite powder PPK-78, and sample No. 2 from magnesite powder PPK-85. The samples are of light-brown color and consist of periclase grains, and the brown crystals are saturated with ferrous oxides. The silicate phase is represented by a vitreous phase. Occasionally crystals of 2CaO·SiO₂ are encountered.

Along with the tests described above, samples of the fettling layer material and brickwork were taken from different sites of the open-hearth furnace pools and their chemical and mineral compositions were determined. The chemical composition of magnesite powder samples after service is given in Table 3.