Comparison of $\sigma_{Fe}$ prior to and after averaging indicates that the procedure adopted for placement and borrowing ensures that its initial value will be diminished by a factor of 6.09-9.18. Averaging can be improved, if we eliminate the following drawbacks, which occur during the shaping and borrowing of a stockpile.

1. The delivery of raw material by a fleet of wagons, the number of which does not correspond to the discharge front.

2. The effect of the physical properties of individual materials on observance of the placement procedure. Thus, dry sinter screenings are dumped immediately after opening of the grab bucket, while the tailings, due to their high moisture content, discharge sluggishly.

3. The effect of segregation. It is established by the operating practice of the plant that the most significant variation in the chemical composition of the sinter is observed in the period of transition from one stockpile to another. This is explained by material segregation on the slopes of the pile; this alters the mix composition somewhat on the slopes as compared with the basic mass of the pile.

4. Inadequately effective mixing, which results in the fact that the excavator working on the loading removes a portion of the mixture without preliminary placement in a cone.

The variation in the iron content is also reduced in the technological chain of equipment operated at the sintering mill owing to supplementary agitation of the mixture during transportation, in the bins, and in the mixers. The efficiency of this stage is considerably lower, and the range in the degree of averaging amounts to 1.78-3.15. The total averaging of iron-ore materials reaches a higher value: For the stockpiles under consideration, it varies within the range from 13.48 to 21.21, and is 17.89 on the average.

Thus, the scheme adopted at the plant for averaging raw material, where it is carefully observed, ensures the production of sinter of satisfactory quality.

REGULATING HEARTH PROCESSES BY VARYING THE PARAMETERS OF THE AIR TUYERES

V. I. Loginov, G. Yu. Kryachko, and I. L. Kolesnik

It has been established from years of experience that the parameters of air tuyeres—cross section, shape, length, and the number of tuyeres around the periphery and throughout the depth of the hearth—have a significant effect on the heat and mass exchanges over the depth and through the section of the blast furnace, the movement of materials, the development of a gas flow, and the temperature distribution in the hearth of the furnace. Under steady conditions, the linear dimensions of the oxidizing zones do not always determine the processes that take place in the hearth and shaft of the furnace; however, the effect of these zones on the development and stabilization of conditions is significant.

The tendency to increase the discharge rate of the gas-air mixture from the tuyeres and the output of tuyere gas is observed with increasing blast-furnace volume and the extent to which they are forced; this causes the center of combustion to shift more toward the center. Under these conditions, the peripheral performance of the lower levels of the furnace deteriorates, the high-temperature zone shifts toward the axis of the furnace, and the useful capacity of the hearth is diminished owing to a thickening of slag hardened on the walls.

Proceeding from these considerations, the optimum number of tuyeres must be selected, taking the possible consequence of hearth performance into account. The operating experi-
ence gained from blast furnaces indicates that the rational positioning of oxidizing zones around the circumference of the furnace at an optimum distance from the periphery is a determining condition. The distance between zones should not be significant, while that between the zones and walls of the hearth should be excessive; otherwise, a large slightly active intertuyere zone with reduced temperature will form as a result of which the settlement of materials is disrupted, and the distribution of gas inhibited. In this case, the furnace performs poorly, and the frequency of tuyere burning increases.

Under conditions where the oxidizing zones come in contact and the distance between them and the periphery is uniform, the center-to-center spacing of the air tuyeres can be determined for furnaces with different hearth diameters from an empirical relationship (Fig. 1), which is determined by the equation

\[ l = 1 + \frac{25}{d_h^2}, \]

where \( d_h \) is the hearth diameter in m.

The required number of tuyeres as a function of hearth diameter and intertuyere spacing:

\[ n = \frac{\pi d_h^2}{d_h^2 + 25}. \]

The results of the computation are presented in Table 1, from which it follows that this equation readily reflects the modern tendency to change the number of tuyeres with increasing useful capacity of the furnaces. This is confirmed by computational data obtained by the State Union Institute for the Projection of Metallurgical Plants for heavy-duty 3000-, 5500-, and 7000-m³ blast furnaces in the USSR, and also by the operating experience gained with large-scale Japanese blast furnaces.

The operating experience of the Krivoi Rog plant has demonstrated that with an inadequate number of air tuyeres, the operating efficiency of a 2700-m³ blast furnace was well below its potential. This made it necessary to increase the number of tuyeres during an overhaul, after which the performance of the furnace was substantially improved.

**TABLE 1. Results of Computation of Number of Air Tuyeres**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Useful furnace volume, m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Hearth diameter, m</td>
<td>9.75</td>
</tr>
<tr>
<td>Number of tuyeres:</td>
<td></td>
</tr>
<tr>
<td>adopted*</td>
<td>20</td>
</tr>
<tr>
<td>computed</td>
<td>24</td>
</tr>
</tbody>
</table>

*Design data obtained by the State Union Institute for the Projection of Metallurgical Plants.