TEMPERATURE OF CRITICAL STRENGTH OF SSGOK
(THE SOKOLOVO-SARBAIISK ORE CONCENTRATION GROUP
OF ENTERPRISES) PELLETS IN BLAST-FURNACE SMELTING

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Owing to advances in the preparation of iron ore raw material to smelting, large quantities of synthetic iron ore materials, such as sinter and pellets, are used in ferrous metallurgy along with natural iron ores. On the one hand, the composition and properties of burden materials could be changed according to plan so that they could be used for specific metallurgical processes or plants. However, on the other hand, a new problem faced the metallurgists, i.e., to make synthetic iron ore materials stronger, which is necessary for their successful use in metallurgical plants, in particular, in blast furnaces.

The difficulties encountered in solving this problem can be divided into fundamental (decrease in strength during fluxing), technological (narrow sintering temperature ranges of pellets roasting, nonuniformity of sintering along the height of the layer, insufficient sintering time), and organizational (interruption of the process because of emergency stoppages, poor dehydration of the original concentrate, insufficient comminution of flux, etc.).

One of the main difficulties in the production of pellets is also the absence of clearly defined specific requirements on their quality, particularly, on their strength. Which property of the pellets is the decisive one for their successful use in the blast-furnace charge, and on which factor does this property depend? What should be the strength of the pellets?

To answer these questions, the behavior of pellets from the Sokolovo-Sarbaik Ore Concentration Group of Enterprises was studied in the A. A. Baikov Institute in conditions of heating and reduction. The pellets were sampled from the top of a layer in the sintering machines using three different operational methods: in August, 1967 (I method), in June, 1968 (II method), and in April, 1969 (III method). The scheduled temperature distribution over the length of the sintering machines for these three methods is shown on Fig. 1.

The strength of the pellets was measured in the following way. A pellet was put into a small Silit furnace at the bottom of a steel vessel, a punch was placed on top of it, and gas (35% of carbon monoxide and 65% of nitrogen) was fed through a hole in the bottom of the vessel to the pellet. Then the furnace was heated according to a S-shaped temperature-versus-time curve which is characteristic for the blast-furnace process. When the planned temperature was reached, the furnace was lifted by a hoist. During this operation, the bottom of the vessel pressed from below against the pellet which transmitted the pressure to the punch, to a lever, and to a dynamometer which was used to determine the load crushing the pellet at this temperature. Then the pellet was cooled in the furnace to 100°C in a stream of pure nitrogen.

Figure 2 shows the temperature dependence of the crushing strength (on reducing) for pellets from the Sokolovo-Sarbaik Group of Enterprises, using the mentioned three sintering methods, and for pellets cut from Cherepovets sinter lumps, for comparison.

The curves show that during the reduction, the strength of the pellets and that of the sinter decreases to 2-6 kg/pellet with an increase in temperature from 130-260°C. The structure of SSGOK pellets prepared by method I has three layers: the external layer is 1.5-2.0 mm thick and consists of intergrown, fine hematite crystals forming a very strong ore framework. The pellets have a hematite layer formed along the grains of magnetite which...
The character of softening of SSGOK pellets, described by curve I on Fig. 2, can be explained by the layered structure of the pellets which have been roasted using method I. However, it is not satisfactory from the point of view of use of these pellets in blast furnaces. By comparing curve I with curve IV for the strength of pellets cut from the sinter, it can be seen that the sinter loses most of its initial strength at 800°C, i.e., at a temperature which is 300°C higher than in the case of pellets obtained by method I. This indicates that the pellets may begin to break down at a considerably earlier stage than the sinter, i.e., in the upper section of the blast furnace stack. This will lead to a deterioration in the performance of the reducing gases in the burden column because of an increase in the amount of fines, to an increase in dust precipitation, and finally, to a decrease in the production-economics indices of the smelting process. This occurred in experimental blast-furnace processes using SSGOK pellets, manufactured in 1967, in the charge.

Many investigations of the behavior of materials show that almost all iron ore materials soften during reduction, i.e., lose their initial strength, and at temperatures of 800°C and above, have a crushing strength from 2-3 to 5-6 kg/pellet. Therefore, it is very important to know the temperature at which the iron ore burden material loses its initial strength during reduction. This temperature (or a comparatively small temperature range) at which the initial strength of the material considerably decreases by approximately one or two orders, the so-called temperature of critical strength, can also therefore be the criterion for determining the quality of the iron ore material as a blast-furnace raw material.

The blast furnace as a reducing unit itself softens all iron ore materials reducing their strength from the initial, at the blast furnace top, to zero strength on softening and smelting. For a successful utilization of these materials as basic ore constituents of the burden, it is also important that they should not be softened by the reducing gases before this is unavoidably done by the normally working furnace itself. In this case, there is an analogy with the smelting process of the ore constituent of the charge: if the iron ore material, having a melting point that is too low, will melt in the furnace earlier than at the required level, this will disturb the normal course of the blast furnace process and detrimentally affect the melting indices.

What should be the temperature of critical strength for blast-furnace iron ore materials? Since its level depends not only on the nature and quality of the tested material but also on the methods of determination (type of heating, composition of reducing gas, type of load applied to the material), its relative values can only be determined so far. Thus, for the conditions of our tests it can be said with certainty that \( t_{cr, str} \) of a material equal to 800°C and above can be reliably used in blast-furnace processes. This is confirmed by the temperature of critical strength of sinter from the Cherepovets Works.

The results of our investigations of a number of other materials, the smelting process of which in blast furnaces is very satisfactory, also confirm that 800°C is a good temperature, but it is not the minimum, and \( t_{cr, str} \), of burden