EFFICIENTLY FORMING THE PROFILE OF THE STOCKLINE AND THE STRUCTURE OF THE STOCK IN BLAST FURNACES AND EXPANDING THE POSSIBILITIES FOR CONTROLLING THE DISTRIBUTION OF THE CHARGE MATERIALS ARE IMPORTANT TO BLAST-FURNACE SMELTING, SINCE THESE MEASURES CAN HELP MINIMIZE COKE CONSUMPTION FOR A GIVEN LEVEL OF FURNACE PRODUCTIVITY OR HELP MAXIMIZE PRODUCTIVITY FOR A GIVEN LEVEL OF COKE CONSUMPTION.

The parameters of the charging regime determine the distribution of the materials in the top of the furnace, so they have a decisive effect on the radial distribution of the materials and the gas inside the furnace. It has been established that the charging parameters determine the profile of the layer of iron-ore-bearing charge materials in the top of the furnace, which in turn affects gas distribution throughout the furnace. However, the distributions of the charge and the gas flow across the furnace may vary for any given charging system and may be influenced by other factors as well (the amount of fines in the charge, the number of rounds used, the level of the stockline, etc.).

The West Siberian Metallurgical Combine is developing and introducing additional mechanical devices to regulate the distribution of the charge in order to efficiently structure the stock, thus making better use of the energy of the gas flow and improving the smelting indices.

In 1986, 3000-m³ blast furnace No. 3 at the combine was equipped with movable top slabs (MTSs) controlled by the furnace’s automatic control system (ACS). Introduction of the MTSs significantly changed the furnace operators’ approach to controlling the distribution of charge materials in the top of the furnace and the charging operation as a whole, and it made it necessary to devise new charging procedures and new methods of regulating the gas flow.

One important problem that was encountered in this attempt to make the smelting technology more efficient was reducing the amount of heat lost through the furnace wall per unit of time. One of the most effective measures found to solve this problem was decreasing the size of the peripheral gas flow by increasing the size of the axial flow. The size of the axial flow was controlled not by changing the ore burden, but by altering the granulometric composition of the charge materials introduced into the central region of the furnace. This made it possible to influence the temperature of the axial gas flow and the extent to which its chemical energy is used in the smelting operation. The new method was realized by controlling the granulometric composition of the stock over the radius of the top through the use of MTSs and a revolving charge distributor (RCD). This made it possible to charge coarse, fine, and intermediate fractions of the charge materials into the axial, peripheral, and intermediate regions of the top, respectively.

Charging of the fines toward the furnace wall decreased the size and temperature of the peripheral gas flow. That in turn increased the degree of use of the thermal and chemical energy of the gas, prolonged the life of the refractory lining, and significantly reduced heat losses through the wall. The regions in which the charge materials are in the plastic state – the intermediate zone and, especially, zones near the wall of the furnace – were shifted to lower levels. This shift
elevated the zone containing lump charge materials and increased the use of the energy of the gas flow. The developed axial gas flow resulted in more thorough heating of the coke cone in the hearth and reduced the probability of hearth becoming blocked.

The results obtained from commercial heats showed increases in the values of smelting rate based on smelted ore and total carbon, these quantities reaching 0.005–0.006 and 0.0010–0.0015 tons/m³·day, respectively. The gas flow – characterizing the temperature of the peripheral gases – became more stable. The scatter of peripheral-gas temperature at different points decreased by 90–120° and the degree of use of the gas flow increased 0.21–0.26%. The peripheral region was loaded earlier with charge materials and the central zone was opened up (Fig. 1). Unit coke consumption decreased 0.20–0.24% and furnace productivity increased 0.12–0.15%.

A charging apparatus with a revolving charge distributor was installed on 2000- and 3000-m³ blast furnaces in 1989, improving the possibilities for controlling the charge and gas-flow distributions and making it possible to lower pig-iron production costs while lengthening the furnace campaign.

With the use of a revolving charge distributor, the flows of charge materials are kept within the top of the furnace and form the turns of a spiral by undergoing multiple revolutions (1/5 of a revolution in the case of a five-vane distributor). This action further averages and evens out the charge directly on the surface of the stock. Up to 12 closed turns can be formed on top of the stock with the charging of one round of materials (2 skips). Here, the exact number of turns formed depends on the charging system that is used. A ring of charge materials formed in this manner might be composed of concentric or spiral five-part turns or combinations thereof.

The radial distribution of the charge materials is controlled by changing the direction and frequency of rotation of the revolving distributor. Its vanes are designed so as to minimize scatter of the trajectories of the materials and ensure the required distributions of the fine and coarse fractions over the radius of the top. The effects of the redistribution of the materials are also alleviated by the shallow trajectory followed by the materials as they leave the surface of the vanes and fall onto the surface of the stock.

The flow of charge materials at the level of the stockline envelops 2–3 annular regions. Most of the charge (roughly 0.5–0.7 of its volume) is distributed within the annular region that corresponds to the charge’s desired position. When the charge is directed into the annular region near the furnace wall, some of the material (0.15–0.2 of the volume) rebounds off the wall before it reaches the top of the stock. This results in an uncontrolled redistribution of the materials over the stock’s surface. The adverse effect of such a redistribution can be minimized by efficiently choosing the working trajectories of the charge materials and the charging programs. The revolving charge distributor makes it possible to place the charge materials in any prescribed annular region of the top based on the weight or composition of the materials while keeping the level of the stockline as high as possible.

Study results and results obtained from the operation of blast furnaces at the ZSMK have shown that the new charging apparatus efficiently distributes the charge materials over the radius of the top as a result of planned changes in the speed

![Fig. 1. Gas distribution in blast furnace No. 3 before and after it was regulated by changing the granulometric composition of the charge materials over the radius of the top.](image-url)