Fig. 8.25 Industrial production of chromium-based brex at Aktobe Ferroalloy Plant

Aktobe Ferro Alloys Plant Report on BREX Smelting

At the Aktobe Ferroalloy Plant, the accumulation of the dust from bag filters of ore-smelting furnaces (material 1) takes place. This type of dust differs significantly in its chemical composition, since it is formed as a result of metallurgical processing, and dust from aspiration technological units (material 2) is captured in aspiration systems located above conveyor belt conveyors and drying drums. It has the same chemical composition as the original chromium ore. Adding them to the charge for the extrusion process satisfactorily affects the quality characteristics of the extrusion briquettes. In connection with the ban on the placement and storage of metallurgical redistribution products in the territory of the slag dump, the management of the enterprise made a decision to introduce materials 1 and 2 into the extrusion charge.

Table 8.15 Dust of the aspiration systems of the Aktobe Ferroalloy Plant

| Dust source | Dust formation, t / year | Content of chemical elements,% (wt.) | | | |
|---|---|---|---|---|---|
| | | $Cr_2O_3$ | C | S | P |
| Raw material unloading station | 787.3 | 23.5 | 16.27 | 0.25 | 0.018 |

| | | | | | |
|---|---|---|---|---|---|
| Raw material drying department | 2737.3 | 15.5 | 66.85 | 0.32 | 0.019 |
| Dry raw materials warehouse | 4499.9 | 16.0 | 47.80 | 0.27 | 0.018 |
| Storage compartment for prepared batch and its dosage of furnaces No. 41, 42 | 5753.6 | 36.5 | 15.20 | 0.18 | 0.017 |
| Department of storage of prepared charge and its dosage of furnaces No. 43, 44 | 3828.8 | 30.5 | 11.00 | 0.11 | 0.016 |
| Bag filter dust | 23332.3 | 20.0 | 5.10 | 0.68 | 0.018 |

Table 8.15 shows the values of annual dust formation, as well as average values for the content of chromium oxide, carbon, sulfur and phosphorus in them.

The study of the composition of polydisperse dust, as well as the selection of binders were carried out in laboratory conditions [9-10].

The cost of processing 1 ton of material is 11-14 US dollars; electricity consumption is 33 kWh [11].

Moistening of dry mass was carried out according to the consistency of the mixture. As a result, the optimal ratio of the charge components was determined experimentally:

- 75% material 2;
- 25% material 1;
- + 6% (by weight of the dust mixture) bentonite;
- +3% (by weight of the dust mixture) polymer binder.

The finished extrusion briquettes were unloaded into the body of a dump truck by means of a belt conveyor, after which they were taken out to an open area, where they were dried in natural conditions. Every day, for 6 days, samples of extrusion briquettes were taken for moisture to determine the dynamics of drying at an average daily atmospheric temperature of 25 ° C, as well as to determine the quality characteristics (in the winter period of time, extrusion briquettes are not dried, since the moisture present in the composition of extrusion briquettes, accelerates freezing of the charge, which is a favorable factor for transportation).

During the tests, a pilot batch of extrusion briquettes weighing 600 tons was produced for remelting in an ore-thermal furnace. Comparative data on the mechanical characteristics of the obtained brex with the required strength values of extrusion briquettes at Aktobe Ferroalloys Plant are presented in Table 8.16.

Table 8.16 Strength indicators under basic and experimental conditions

| Option | Binder, % | | Mechanical strength of dry briquettes,% | | | | |
|---|---|---|---|---|---|---|---|
| | Bentonite | Polymeric | CCS, MPa | 2 m drop test | | Impact | Abrasion |
| | | | | +5 mm | -5 mm | +5 mm | -0,5 mm |
| Experimental | 6 | 3 | 10 | 97.3 | 2.7 | 67.7 | 19.1 |
| Base | 6 | - | 4.7 | 88.1 | 11.9 | 30.0 | 40.0 |
| Requirements | - | - | 9 | 85.0 | 15.0 | 60.0 | 30.0 |

According to the results of measurements of the strength of experimental extrusion briquettes, it can be seen that, in terms of mechanical properties, extrusion briquettes with the addition of polymer binders showed generally higher values in comparison not only with the current production, but also with the required strength values that were not achieved.

The metal smelting test using experimental extrusion briquettes was carried out in an AC ore-smelting furnace RKO-22.5 MVA. A batch of extrusion briquettes dried on a special site was sent to the charge warehouse of chromium ore materials. When stored in bins, spontaneous destruction was not observed within up to three weeks. Before starting work, the thermodynamic and material-heat balance were calculated [12].

The main raw material for smelting high-carbon ferrochrome was rich chromium ore with a content of at least 48% $Cr_2O_3$. The number of extrusion briquettes fed into the furnace was increased in several stages. In the base period, only bentonite was used as a binder; then, in combination with a polymer binder, three stages were distinguished depending on the proportion in the sample. At the first stage of experimental smelting, the share of extrusion briquettes in the ore charge was 10%, at the second stage it was increased to 12.8%, at the third stage - up to 18.3%.

The dosing was carried out through the receiving hoppers of the dosing department of the workshop together with the main part of the ore material and the reducing agent. The top temperature was 1000 ° C. As the charge descended along the height of the furnace, new portions of material were poured onto the top.

Table 8.17 shows the generalized indicators of the furnace operation during the test period. Average composition of metal during testing, %: 69.05 $Cr_{met}$; 0.75 Si; 8.54 C; 0.026 S; 0.027 P.

Table 8.17 Indicators of operation of the furnace No. 12 in the baseline and experimental periods

| Work period | The share of brex in the ore sample, % | $Cr_2O_3$ content in ore sample, % | Ore materials supply to the furnace, t / day | Chromium production in ingots, t / day (including downtime) | Daily consumption of | Average $Cr_2O_3$ content in slag,% |
|---|---|---|---|---|---|---|

| | | | | | electricity, MWh | |
|---|---|---|---|---|---|---|
| Base | 11,1 | 49,71 | 292,51 | 64,66 | 414,86 | 3,9 |
| In general, during the tests | | 46,5 | 242,67 | 49,32 | 327,81 | 3,67 |
| Stage 1 | 10 | 47,12 | 305,56 | 60,78 | 406,2 | 3,89 |
| Stage 2 | 12,8 | 46,63 | 163,6 | 28,63 | 225 | 4,08 |
| Stage 3* | 18,3 | 45,96 | 233,01 | 49,93 | 317,38 | 3,37 |
| Stage 3 in the absence of stoppages of the furnace | 18,3 | 47,17 | 284,51 | 62,78 | 390,75 | 3,72 |
| * During stage 3 of the test, the furnace stopped for several hours due to technical reasons. | | | | | | |

Average slag composition,%: 2.2-5.5 $Cr_2O_3$; 45-47 MgO; 27-31 $SiO_2$; 0.7-1.1 CaO; 16-17 $Al_2O_3$; 0.5-0.8 FeO.

The performance of the furnace during the experimental period is close to the baseline. At the most stable experimental stage, the specific power consumption for the smelting of 1 ton of chromium is 3.1% lower than the baseline values. The obtained average extraction of chromium for the period of experimental heats is 1.7% higher than the base period.

The improvement in the performance of the furnace was due to a decrease in the content of fine fractions and moisture content in the charge. Earlier, when extrusion briquettes prepared according to the basic recipe were fed into the furnace, a decrease in lumpy chrome ore and the presence of a large amount of fines in the charge were repeatedly observed, which was the main reason for limiting their share in the sample when smelting high-carbon ferrochrome.

The results of industrial tests showed that the obtained high-carbon ferrochrome meets the requirements of GOST 4757 (ISO 5448-81) [13] and has an average chemical composition, which allows shipping products to consumers in accordance with contracts. Analysis of slag with Cr2O3 content in the range of 2.2-5.5% shows the maximum possible recovery of chromium-containing raw materials in industrial conditions.

In the process of manufacturing extrusion briquettes, the addition of a polymer binder led to an increase in their strength, while technological difficulties were not noted.

During the operation of the ore-thermal furnace, deviations in the operation of the furnace were not recorded. The resulting high-carbon ferrochrome met the chemical composition requirements. A small positive effect was observed due to increased strength of extrusion briquettes and improved gas permeability of the charge layer in the furnace. The percentage of the use of chrome raw materials has significantly increased - up to 5% for the whole plant.

The ecological problem was solved by using the generated dust in a closed technological cycle.