ISSN 0543-5846
METABK 59(4) 496-498 (2020)
UDC – UDK 669.052.26:66.014:622.785:479 =111

WAYS TO IMPROVE TEXTURE TECHNOLOGY REFLECTIVE CHROMITE ORE OF KAZAKHSTAN

Received – Primljeno: 2020-02-20
Accepted – Prihvaćeno: 2020-07-10
Preliminary Note – Prethodno priopćenje

The article presents the results of laboratory tests on the use of fluxing agents for improving the sintering technology of refractory chromite ore in Kazakhstan. It is shown that reduction to solve the most efficient thermal process level through the use of fluxing agents having a low melting temperature and low temperature promote the formation of compounds in interaction with components of the ore phase.

As an effective flux is proposed to use the calcined colemanite and basaltic rocks. The optimal cost fluxing agents, ensuring reduction of the thermal level the firing process at 100 °C.

Key words: chemical composition, chromite ores, pellet production, fluxes, Kazakhstan

INTRODUCTION

In terms of quality of lump raw material shortages for reliable source of raw materials ferroalloy plants, increasingly becomes important task involving the production of substandard size chromite ore fines, the amount of which is 50 % or more of the mined ore. However, issues fines agglomeration , chromite ore of Donskoi GOK to date remain valid.

Difficulty agglomeration Kazakhstan ores calcined methods due to their high melting point (1 500 °C and higher) due ref-racttoriness both ore phase (Cr-spinel) and the host rock, mainly represented by serpentine ($3MgO \cdot 2SiO_2 \cdot nH_2O$), passing on firing in forsterite $2MgO \cdot 2SiO_2$, having a melting point of ~ 1 900 °C. The chemical composition of the mineral constituents of chromite ore deposits "40 years of the Kazakh SSR", which now form the basis of ore base ferroalloy plants in Kazakhstan are presented in Table 1.

Sintering them to obtain durable agglomerates material occurs at temperatures above 1 400 - 1 500 °C. However, increasing the pellet sintering temperature or sintering in the layer by increasing the fuel flow leads to serious complications in the operation of firing equipment. For this reason, hitherto unsolved issues on an output at full capacity in a factory producing chromite pellets Don GOKa operated by Outokumpu Technology, with a firing temperature of 1 400 °C [1].

More effective is the reduction of the melting point of the charge, and accordingly, the process temperature and by introducing various fluxing agents having a low melting point and low temperature promote the formation of compounds in interaction with components of the ore phase. As the most widely used fluxes silicon- and aluminum-containing materials [2, 3]. Their choice is justified by the fact that these components are used in the smelting of ferrochrome slag for adjusting mode and eventually charge dilution at agglomeration of the main component is performed partially or wholly by reducing the amount of flux in the smelting.

They are tested as fluxes fusible Turkish colemanite (mp. ~ 1 004 °C) and basalt rock, are used mainly as raw materials for the silicate industry, and for the comparative analysis of quartzite screenings, which are successfully used in the agglomeration chromite fines [4]. The chemical composition of the mixture components is presented in Table 2

The reason for using basalt as binder materials are the results of the analysis of its mineral composition, which revealed that almost all varieties of basalt rocks in the system $CaO – MgO - Al_2O_3 - SiO_2$ sufficiently covers elementary tetrahedron anorthite ($CaO \cdot Al_2O_3 \cdot 2 SiO_2$) - diopside ($CaO \cdot MgO \cdot 2 SiO_2$) - enstatite ($MgO \cdot 2 SiO_2$) - SiO_2, where an extensive area of compositions having a melting temperature 1 200 - 1 300 °C[4]. It proposed as a siliceous flux basalt deposit "Dubersay" Aktobe region whose composition is shown in Table 2 has a melting point of ~ 1 450 °C. However, the ratio of components therein such that in the system $CaO – MgO - Al_2O_3 - SiO_2$ with increasing content of MgO and 10% of its composition falls in the range of low temperature eutectics (CaO - 13 - 20 %, SiO_2 - 55 - 60 %, Al_2O_3 - 15 - 20 %, MgO - 10 - 12 %) with a melting temperature 1 200 – 1 300 ^{0}C. The development of this process will facilitate the intimate contact of finely divided flux and chromite ore host rock which contains 36 – 38 % MgO, in the granulation process and, consequently, the early liquid phase formation during sintering. Another important factor is the proximity of depos-

A. Kim, A. Akberdin, Chemical-Metallurgical Institute, R. Sultangaziyev Karaganda State Technical University, Karaganda, Kazakhstan, email: sulrus83@mail.ru

Table 1 **Chemical composition of chromite ore mineral components**

Field	Name components chromite ore	Component Content / % wt.						
		Cr_2O_3	MgO	FeO	Al_2O_3	Fe_2O_3	SiO_2	MgO / Al_2O_3
"40 years Kazah SSR «	Chrome spi non-leeds	61,90 61,20 61,40 61,20	14,70 13,70 13,70 14,20	14,20 13,70 14,00 13,90	8,60 8,10 8,10 8,25	0,50 0,40 0,70 0,50	- - - -	1,71 1,69 1,69 1,72
	cementing-breeds	- - - -	36,00 37,80 36,10 38,50	4,30 5,30 3,80 4,60	2,20 0,50 - 1,80	- - - -	37,00 37,30 37,10 37,40	16,40 75,60 - 21,38

its of basalt from the consumer. For comparison, we also conducted experiments using quartzite screenings.

METHODS

Laboratory experiments to simulate the production process parameters and study the effect of different flux quality chromite pellets performed using chromite concentrate particle size of 0 - 3 mm, which was finished to size by output class -0,074 mm 79,5 %. Fluxes were ground to a particle size of output class – 0,074 mm 90,5 %. Chemical composition of experimental materials presented in Table 2.

Pelletizing was carried out in lab batches tumbling granulator 600 mm diameter, 200 mm in length. Drum speed was 27 r / min, which is equivalent to the rotation speed industrial drum of 2,8 m diameter equal to 12 rev / min.

Wet strength and dry pellet strength was determined on the meter type "IPG-1", dynamic strength - dropping green pellets onto a steel plate from a height of 300 mm. Pellets were fired in a monolayer in a laboratory tubular electric furnace with silicon carbide heaters. The firing pellets: heating rate 100 °C / min, cooling - 70 deg / min, the firing temperature – 1 300 °C, the holding time - 20 min. The compressive strength of the fired pellets was determined on a tensile testing machine Type P – 0,5. Tensile properties were determined as an average of measurements of 15 pellets of size 12 - 14 mm.

RESEARCH RESULTS AND THEIR ANALYSIS

In laboratory studies conducted experiments to pelletizing, burning, assessing the quality chromite pellets with various fluxing agents.

The results are summarized in Table 3. In experiments № № 1 and 2 present the experimental data base (№ 1) and industrial (№ 2) factory batch pelletization of the Don GOKa.

The selected firing temperature (1 300 °C) corresponds to the maximum firing temperature standard equipment used in industrial plants Kazakhstan. When the firing temperature 1 300 °C crushing strength with the addition of a base charge of 2,5 % coke fines grew from 115 to 132 kg / pel, while remaining below the requirements of the DUT (not less than 150 kg / s). Use as

Table 2 **Chemical composition of the mixture components**

Material	Content / %						
	Cr_2O_3	Fe	SiO_2	Al_2O_3	CaO	MgO	B_2O_3
chromite fines ore	51,60	9,60	7,15	7,75	0,03	18,72	-
basalt	-	9,03	54,81	14,56	12,33	5,40	-
screenings of quartzite	-	0,97	96,50	1,72	-	-	-
colemanite natural	-	0,06	5,50	0,40	27,60	3,00	40,20
colemanite calcined	-	0,07	6,80	0,50	34,50	3,25	50,25

an additive of natural colemanite led to negative results due to the pellet cracking during firing. This effect is caused by the explosive character of colemanite decomposition upon removal of hydrate moisture. This process proceeds in the temperature range 300 – 550 °C.

Addition of 0,5 and 1,0 % of natural colemanite strength chromite pellets at baseline. With increasing amounts of natural colemanite in the charge (up to 3 %, expe-rience № 5) strength of fired pellets had fallen to 36 kg / pel. Fracture in pellets in the basic experiment (experiment 1 № experience № 2) was absent, and with addition of 3 % of natural colemanite fracture was 100 %. Laboratory test results showed that the use of natural colemanite for improving the quality of the fired pellets and to reduce the thermal level of the firing process is impractical. To reduce the effect of cracking of the fired pellets colemanite was calcined in a muffle furnace at a temperature of 500 °C. The additive in the charge production chromite pellets 0,5 - 1,0 % calcined colemanite without loss of strength both wet and dry pellets, substantially increased the strength of the fired pellets. Already at the 0,5 % addition of colemanite calcined at 1 300 °C firing, which is 100 °C below the production, provided strength characteristics corresponding to factory specifications (strength not lower than 150 kg / pel) - 163 kg / pel. When the boron content is increase-ed to 1,0 % the flux strength of fired pellets increased to 222 kg / pel.

Positive results for improving the quality chromite pellets obtained by using as reinforcing fluxing agents basalt rocks. It is shown experimentally that the addition of 2,5 – 5,0 % to the charge instead of ben-tonite and basalt coke fines (experiment № 8, № 9) at a temperature of 1 300 °C firing and product is a fully sin-

Table 3 **Indicators of quality experienced chromite pellets**

number experi-ence	Name material	quantity	The green pellets			R_{dry}	R_{burnt} (1 300 °C)
			W / %	R, kg / pel	n, times	kg / pel	kg / pel.
1	Chromite conc. bentonite	99,4 0,6	9,74	0,98	7	3,51	115
2	Chromite conc. bentonite, coke fines	96,9 0,6 2,5	9,80	0,86	6	3,43	132
3	Chromite conc. natural colemanite.	99,5 0,5	9,60	0,85	4	3,20	110
4	Chromite conc. natural colemanite.	99,0 1,0	9,70	0,88	5	3,30	105
5	Chromite conc. natural colemanite.	97,0 3,0	9,80	0,95	6	3,40	36
6	Chromite conc. colemanite burned. (at 500 °C)	99,5 0,5	9,60	0,98	4	3,25	161
7	Chromite conc. colemanite burned.	99,0 1,0	9,40	1,12	5	3,40	222
8	Chromite conc. basalt	97,5 2,5	9,60	0,85	6	3,41	180
9	Chromite conc. basalt	95,0 5,0	9,50	0,90	6	3,31	175
10	Chromite conc. quartzite	90,0 10,0	9,60	0,78	6	3,31	130

tered material is streaked with the liquid phase throughout the volume and strength fired pellets was 175 - 182 kg / pel, which is substantially hi-gher specification.

As we tested hardening additive fines quartzite, which has been successfully used at present in the manufacture of chromite sinter at Aksu ferroalloy [4]. However, the effect of the oxidative roasting chromite pellets as agglomeration when unmet. Addition of 10 % quartzite strength of fired pellets at 1 300 °C was 130 kg / pel. This is evidently due to insufficient development of metabolic reactions to form low-temperature phase fayalite (2 Fe · SiO_2, T - 1 205 °C) due to diffusion of ferrous iron in the slag phase chrome spinels [5]. This process does not receive development due to the oxidative environment the firing process and, as a consequence, oxidation of divalent iron to trivalent.

CONCLUSION

Thus, laboratory tests the results obtained indicate that the calcined colemanite, basalt rocks are effective reinforcing additives. Entering into the batch production of chromite pellets calcined colemanite 0,5 – 1,0 % and 2,5 – 5,0 % bas-alt rocks raised indicators crushing strength to a level satisfying the technical conditions at 1 300 °C, which is below 100 °C produc-tion. Reducing the level of the thermal process will improve the resistance of the firing equipment, gas savings, improvement of productivity by lowering the height of the bed, for tape protection from exposure to high temperatures.

Acknowledgment

Paper was performed within grant No. AP05130325

REFERENSES

[1] Loginov N. M., Vykhodtsev V. M., Utemisov B. K. The plating of chrome raw materials is the solution to several problems of the Don Mining and Processing Complex and Kazchrome. // Materials of the 4th Int. scientific and practical conf. “Problems and ways of sustainable development of mining industries.” - Khromtau, (2007), 680-685.

[2] Zayakin O. V., Halperin A. P., Zhuchkov V. I. Possibilities of processing small chrome ores in modern conditions // Vestnik PAU. – (2003)5, 80-82

[3] Maksimov Yu. S., Fedorenko N. V., Parshina R. F. The method of agglomeration of fine chromite ore, Production of ferro-alloys. Novokuznetsk, (1986), 56-62.

[4] Kim A. S. Features of agglomeration of chromite ores // Transactions of the University, ed. KSTU, (2008) 3, 19-23.

[5] Gorokh A. V., Rusakov L. N. Petrographic analysis of processes in metallurgy. - Moscow: Metallurgy, (1973), 288.

Note: The responsible translator for English language is Nataliya Drag, Karaganda, Kazakhstan