Increase in productivity of sintering machine and sinter quality by improvement of ore preparation for sintering

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Abstract

In the paper, economic and technology factors proving need of use of sintering ore as a ferriferous component of sintering furnace charge are considered. On the basis of analysis of material structure of ferriferous, fuel and flux components of sintering furnace charge, it is shown that the easiest way of improvement of composition of furnace charge is improvement of particle size distribution of sintering ore, which content in furnace charge reaches 20%.

On the basis of influence of the analysis of granulometric characteristic of sintering ore fed to furnace charge composition for sinter production on sintering machine operation and indicators of sinter use, the technology of sintering ore preparation is suggested. This technology is based on truncation of the initial granulometric characteristic of sintering ore "from below" (i.e. removal of a part of fine fractions from initial composition) and "from above" (i.e. removal of "coarse" part from initial composition with subsequent recrushing and return of crushed product to furnace charge).

Key words: FURNACE CHARGE, SINTERING ORE, GRANULOMETRIC CHARACTERISTIC, SINTER

Problem statement

Along with a concentrate, sintering ore is ferriferous component of sintering furnace charge; its use in sintering charge is connected with the following economic and technology factors:

- one ton of iron in the composition of sinter of ore is cheaper than the same mass of iron fed by a concentrate approximately for 13-14%, it is connected with the fact that the average cost of one ton of sintering ore is significantly lower than concentrate cost (for 20-22%);

- in the sinter made from a concentrate without sintering ore, content of unconditioned (-5 mm) and aero-active (-0.5 mm) fractions is higher than at the sinter made with the use of sintering ore (it is connected with the fact that efficiency of sintering charge granulation before sintering is higher with the assistance of the firm centers of pelletizing (ore - 2-5(6) mm) than in case of the drop centers of pelletizing);

- stocks of the iron ores of underground production used as sintering ore are not exhausted, and infrastructure of the mining enterprises is rather perfect, is actively functioning and developing; its complete preservation is impossible due to inflow of underground waters and necessity of preserving surface under the mining horizons.

There are other also significant factors (including social) allowing us to claim that the use of sintering ore in a production process of sinter will continue in the near future in spite of the fact that increase in sintering ore content in furnace charge causes decrease in content of iron in sinter; and the content of iron in sintering ore tends to reduction.

Purpose

Preparation of sintering ore and the sinter production economization connected with this process remain important economically reasonable task.

Furnace charge for production of sinter on the large metallurgical wide-profile enterprises includes a concentrate with size of particles (-0.074 mm), fluxes (-3 mm), sintering ore (-16 mm), fuel (-3 mm), metallurgical sludge containing iron oxides and flux component (-1.0 mm) and other disperse waste of metallurgical production (oily scale, spills, etc.). Concentrate is mixed with slimes before passing in collecting bins in stock at some enterprises; sometimes, it undergoes preliminary mixing with a concentrate of oily scale, spills, etc., and another mentioned furnace charge ingredients pass to the collecting conveyor forming polylayer structure on it. In this case, all furnace charge is mixed in the conveyor by linear rotor mixer forming homogeneous mixture.

Before sintering, furnace charge is pelletized in pelletizing drum, where the concentrate and other high-disperse components of furnace charge are rolled to the pelletizing centers – return of sinter (-5 mm) and sintering ore (-16 mm) [1, 2]. At present time, the sintering ore is fed into sintering charge, as a rule, without preliminary preparation. The particles of size bigger than 5-6 mm in sintering burden lead to the situation that these particles are not melted in the course of sintering and form the concentration of mechanical tension in sinter body at the boundary of their surface with sintered material that is conductive to increase in offgrade fractions (-5 mm) in sinter. In this paper, the problem of expediency of preliminary preparation of sintering ore in sintering factor by its screening and recrushing to 5-6 mm is considered. The initial sintering ore which particle size distribution, as a rule, is in the limits (0-16 mm) supports fraction (-2.0 mm), which along with the low content of iron (less than 52%) contains sulfur and, in some cases, the phosphorus which negatively influence quality of produced pig iron and steels. A conclusion about possibility of sintering charge conditioning by removal of fraction (-2.0 mm) from it is obvious. Use of sintering ore of fraction (-2.0 mm) removed from composition depends on content in the initial ore, and also on availability of sulfur and phosphorus in it. If the content of fraction (-2.0 mm) is low (F_{-2} < 2-3 %) and it contains sulfur and phosphorus, it is certainly removed from composition of sintering ore and it can be used as a filling agent of concrete or be a part of crushed stone for road surface; if F_{-2} > 3 %, and it does not contain harmful components, it is expedient to return it to a cycle of benefication for obtaining additional concentrate (Fig.1).

Fraction of sintering ore (2-5 mm), as it was already mentioned, provides high efficiency of granulation of furnace charge before sintering, and the fraction (5-16 mm) is subject to recrushing, which purpose is increase of fraction (2-5 mm) as a part of furnace charge.

Influence of particle size distribution of sintering ore on productivity of sintering machine and quality of sinter is illustrated in Table 1.

Table 1. Influence of particle size distribution of sintering ore on productivity of sintering machine and quality of sinter

No	Fractional composition, mm	Fractions content in an initial sintering ore, % F_{in}	Content of iron as a part of fractions, % F_{Fe}	Content of harmful impurity, % $F_{h.im.}$	Influence of fraction on efficiency of granulation	Influence of content of certain sintering ore fractions on quality of sinter: Content in sinter	
						Fe	F_{-5} mm
1	2	3	4	5	6	7	8
	-0.5	23	53.6	0.14	+ +	- -	-

	0.5-2.0 (3)	16	54.9	0.04	+ +	+	-
	2 (3)-5	26	55.6	0.01	+ +	+ +	+
	5-8	21	55.6	0	+ +	+ +	+
	8-10	8	55.9	0	-	+ +	-
	10-16	6	55.9	0	- -	+ +	- -
	0-16	100	54.61	0.4			

Note: in the analysis of influence of narrow fraction of sintering ore (column 2) on granulation efficiency (column 6), the sign "+" means "positive influence"; the sign "+ +" means “considerable positive influence”; in the analysis of influence of narrow fraction of sintering ore on the content of iron in the sinter, the sign "-" means decrease in content of iron in the sinter (column 7) and increase in content of off-analysis fraction (-5 mm) in sinter (column 8); the sign "-" means very considerable decrease in the content of iron (column 7) and significant increase in content of fraction (-5 mm) in sinter (column 8)

In case of increase in efficiency of furnace charge granulation, gas permeability of a layer of furnace charge on sintering belt increases that allows increasing of sintering machine productivity without change of speed of sintering belt movement due to increase in height of a layer of furnace charge on sintering belt, in case of ensuring the pressure losses in a layer, which do not exceed the size of the corresponding discharge of an exhauster. Productivity of sintering machine:

$$Q_{SB} \equiv K \cdot B_{SB} \cdot V_{SB} \cdot H_l \text{, m}^3\text{/s}$$

K – constant coefficient;

B_{SB} – width of sintering belt, m;

V_{SB} – speed of sintering belt movement, m/s;

H_l – the furnace charge layer height on sintering belt; it is selected from conditions of equality of pressure losses in a layer to the discharge created by an exhauster, m.

Granulating of furnace charge before sintering is operation determining quality of sinter and sintering machine productivity.

Technique of researches, statement of the main material

The general requirement to a furnace charge layer in case of its sintering is high gas permeability of the layer formed from it depending on the granulometric characteristic of the granulated furnace charge and height of a layer [1, 2]. The negative impact on intensity of sintering process and quality of the obtained sinter have those fractions of the granulated furnace charge, which size is more than 10 mm and less (-0.5 mm).

According to the data provided in Table 1, for conditioning (improvement of quality) of sintering ore, it is necessary to execute two consecutive operations:

- to remove fraction (-0.5 mm) from its composition;
- to remove fraction (+ 5 mm) and perform its recrushing to fraction (2(3) - 5 mm) and to put crushing product into an initial sintering ore.

For removal of fractions (0.5 mm) and (+5 mm) from composition of sintering ore, the double-deck (three-product) screen with the corresponding sizes of holes and vibration crusher, which crushes oversize fraction of top screen deck, should be introduced into the scheme of chains and devices of sintering factory [3, 4].

The effective recrushing of sintering ore (+5 mm) with minimization of dust-like fractions in the crushed product can be produced by the vibration conical crusher [3, 4] providing productivity from 8 to 12 m^3/h with content of fraction (-2.0 mm) no more than 12% in a crushed product (the rest is 2-5 mm). Such small-sized crushers can be established in each channel of supply of furnace charge to pelletizing.

After carrying out operations on preparation of sintering ore, which granulometric characteristic is shown in Table 1, the granulometric characteristic of the conditioned ore is created. In this ore, the content of class (-0.5 mm) is lower more than by 2 times, than in case of the absence of recrushing operation, and the content of iron is higher than at an initial sintering ore by 0.6 … 3% abs.

The use of ore in agglomerative furnace charge with the conditioned granulometric characteristic and the content of iron increased allows, in turn, increasing iron content in sinter at least by 0.6% that, according to [5], will cut a coke consumption in blast furnace by 0.8% and will increase performance of the furnace by 1.5%.

Conclusions

Comparative assessment of indicators of sintering ore before truncation of its granulometric characteristic has shown that operation of preparation has led to increase in content of iron in the prepared sintering ore, and to decrease in content of fraction (-0.5 mm), at the same time, harmful impurities are removed from sintering ore completely.

Further improvement of sintering ore quality without use of transactions of magnetic separation can be achieved due to increase in efficiency of its screening in the course of preparation up to 65-70%.

Improvement of quality of sinter allows cutting consumption of coke and increasing efficiency of the blast furnace by 0.8% and 1.5% respectively.

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