Selecting of the crusher type that can provide the charge with a narrow range of granule size composition

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Abstract
The article informs with the results of the crushers researching and developing that are able to provide crushed product distribution with a narrow range of a given size particles.
The necessity of such crushers creation is determined by the requirements for grading ore, fluxes, fuel and ligatures while downloading these types of materials directly into the steelmaking units or filling buckets. Part of the bulk materials, which then form slag (lime, limestone, fluorspar briquette), are served in the melt as the lump fractions (10...40 mm). Their preparation is produced in the shops of preproduction or directly on the Converter plants charge preparation sites.
Key words: cone vibratory crusher, crushing, granulometric composition, iron ore, fluxes, fuel, ligature, lime, limestone, one-act interaction of crushing elements with the lump

The problem and its connection with practical issues

On the contrary to the iron ore enrichment preparation technology, which should be provided with high dispersion material for its enrichment, the requirements for bulk materials when they are to prepare for their downloading directly to a Converter or a ladle are quite opposite to the previously reviewed ones as for the point of their effective use (acceleration of assimilation response and reduction of melting losses) [1].

We face a contradiction when we use such materials. It is due to the fact that relatively "large" pieces having applied in the metallurgical aggregates tend to slow the reaction of their assimilation; but the grain size decreasing under a certain limit leads to losses of valuable raw materials because of its "take-out" in the slag layer and into the air,and the last results not only in losses of valuable raw materials, but also in the atmosphere contamination [2].

In some cases raw materials are subjected to sieving before loading into the converters and filling buckets at the foreign enterprises to eliminate this contradiction. And the screening oversize product is introduced into melting, while the undersize is withdrawn from the process with its subsequent use in other technologies (for example, in the charge of sinter production). The materials mentioned are expensive, so misuse of some of them can be considered as a loss, and thus, this preparation scheme leads to the transport complication. Crushing of bulk, just to optimize their size distribution, leads to the "small" fraction additional formation (-10 mm).

In this situation, the forces actions optimization in the process of material crushing to reduce the fines content in the crushed product by the crusher type properly selecting is becoming extremely important.

The researches and publications analysis

To avoid the fines formation during crushing of metallurgical furnace charge parts fragmentation should takes place by means of the crushing elements and material pieces one-act interactions. Under such fragmentation the scheme of this piece destruction is following:
- initially the contact ground is formed in the interaction area of the crushing plates and a piece and the piece is compressed elastically. So in the contact zone the local destruction is observed with the formation of small particles of material and then the formation of one or two cracks. 95% of all energy consumed in crushing is used to achieve it; and this destruction pattern was reviewed by R. A. Rodin [3]. In [3] it is given the expression for the determination of fracture for a single act of exposure, including the number of empirical coefficients and hardly detectable characteristics of the material crushed (form coefficient in the contact zone, the limit voltage of the chip, etc.), which are not tabulated and require a significant amount of complex operations to define.

Having based on a scheme of destruction [3] we obtained the expression for the work determining required fracturing a piece for a single act of destruction

$$A = K_1 \frac{\sigma_{com.c.}}{tg\gamma (d_{p.beg.})^{0,5}}$$

Where K_1 is an empirical coefficient; $\sigma_{com.c.}$ – limit destructive (contact) compression stress; $tg\gamma$ – the coefficient of crushed material internal friction; $d_{p.beg.}$ – the size of the destroyed piece.

When we know the oscillations frequency values of the vibrating crusher working bodies ω, the number of pieces of crushed material, which are fed into the crushing chamber simultaneously n_x, we determine the useful power required for crushing.

$$N = K_N A n_K \omega$$

Where K_N is the coefficient that takes into account dissipative energy losses in the cell due to the friction between the pieces $(K_N > 1)$. The number of pieces n_K is determined from geometrical relations as [4]:

$$n_K = K_2 \pi \frac{D_{av.s.}}{d_{p.\max}}$$

Where $D_{av.s.}$ is the average length of the circumference of the annular loading slot crushers; K_2 is the coefficient of loading uniformity (0,6...0,9); $d_{p.max}$ is the piece maximum size the in loading.

95% of useful work is spent for the formation of a zone of all-round compression of the piece during the fragmentation and development of effective cracks until the destruction of the piece with all kinds of minerals and cakes, regardless of their strength [1, 3].

To fulfill such a destruction scheme one should use crushers with crushed pieces short staying in the crushing chamber, which ensure the evacuation of the crushed product from the crushing chamber without additional crushing efforts.

In Kryvyi Rih National University together with the National metallurgical Academy of Ukraine we developed a crusher that can provide the described destruction scheme (Fig.1) [5]. The cone vibrating crusher has a receiving hopper 1, 2 external and 3 internal cones, self-synchronizing vibrators 4, dampers with a high level of dissipation (energy absorption) 5 and the coil springs 6. External and internal cones crusher are made to be biconical with different taper angles in the upper and lower parts, and the ratio of the angles of the lower and upper parts of the outer and inner cone are selected depending on the external friction angle of the crushed material on the surface of the cones. The oscillation frequency of the cone 2 and the length of the generatrix of the cone 3 are selected so that interaction of the cone 2 during the movement of the crushed pieces by forming was only single.

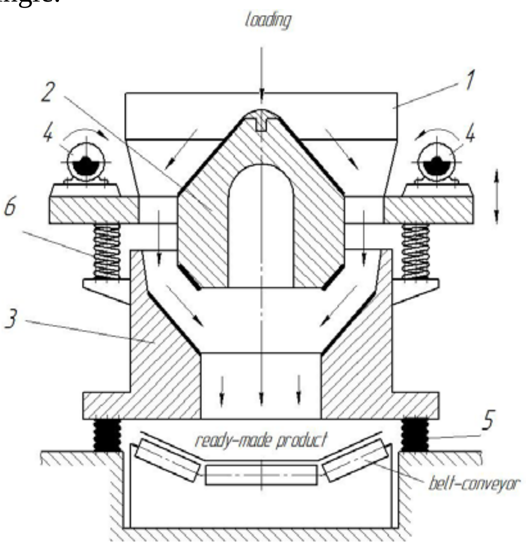

Figure 1. Vibrating cone crusher that provides one-act interaction of the piece crushing elements.

If some larger pieces come in the area of crushing or technological requirements on the crushed product size suggest lowering of the piece size the two-act destruction crusher is used (Fig. 2) in two consecutive chambers of "A" and "B".

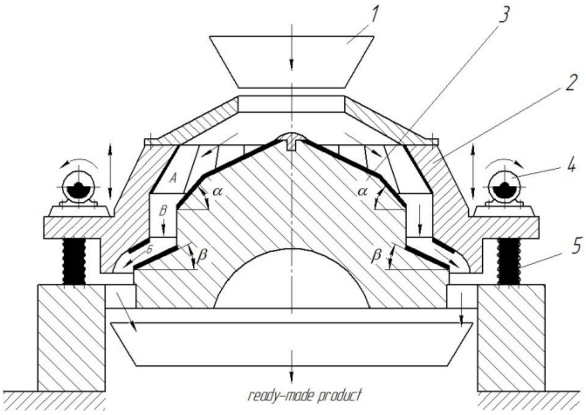

Figure 2. Vibrating cone crusher that provides two-act interaction

Such crushers have the first act of the crushing in the crushing chamber "A", and the second one in the chamber "B" in the zone "B" the materials crushing does not occur.

The crushers were tested for batch preparation to the melting units loading.

It is established that the yield of fraction reaches 94% by weight of the starting material for single-chamber and 87% for the two-chamber crushers.

Conclusions

1. In the preparation of ores and charges for filling in melting units, it is advisable to reduce losses of raw materials by use of a special vibrating cone crusher in order to minimize the output stuff when crushing and narrow the range of crushed material size.

2. For the preparation of ores and charge to download in converters and filling buckets with the dimensions of the original piece of 150 mm it is advisable to use the single-chamber vibratory crusher, providing one-act interaction of the crushing surfaces with the pieces of material fed to the crushing.

3. If the size of the original piece is more than 150 mm, crushing is done in two-chamber mills.

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