UDC 622.7

V.P. KRAVCHENKO, PhD
(Ukraine, Mariupol, "Era plus"),
V.F. GANKEVICH, PhD, A.A. PASHCHENKO, PhD
(Ukraine, Dnipropetrovs'k, National Mining University)

INFLUENCE OF PHYSIC-MECHANICAL PROPERTIES ON A CHOICE OF METALLURGICAL SLAGS PROCESSING TECHNOLOGY

The way of their primary processing has the main impact on a choice of technology of processing of metallurgical slags in products. Primary processing in this case is meant as cleaning of slags from slag units and all subsequent operations of thermal and mechanical impact on fusion of slag at its cooling and hardening.

Known ways of primary processing do not guarantee obtaining the most effective properties of slags, but have impact on their manifestation. In [1, 2] most perspective direction the furnace slag processing (granulation) with correction of fusion properties and the subsequent stabilization of necessary slags quality due to management of crystallization process is considered. Now the level of primary slag processing is defined by a type of metallurgical production and physic-mechanical properties of slag fusions.

The majority of slag fusions by blast furnace production have the "extended" period of increase of viscosity in the range of temperatures 1450 – 800 ^{0}C. It promotes creation of conditions for impact on the mode of crystallization and receiving various slag productions (granulated slag, crushed stone, slag wool, etc.).

Unlike blast furnace, steel-smelting slags are characterized by intensive increase in viscosity and a narrow interval of cooling.

At such increase in viscosity possibility of fusions processing is at a loss.

Recently started applying to preprocessing of steel-smelting slags widely a thermoshock way of crushing which consists in intensive cooling of slag fusion after its pouring in tank on the prepared surface. The intensification of cooling is carried out by watering of fusion or compulsory cooling of receiving tank, a platform. Critical tension at sharp temperature difference for rather short period is artificially created.

It is experimentally established that isotropic, and also partially crystalized, rather fragile materials to which it is possible to carry also the hardening slags, certainly, in that case when in any of the directions in them some is reached the critical stretching tension. The deformations arising thus are a consequence of a rupture of interatomic communications.

Practical application of thermal shock when processing metallurgical slags does not exclude operation of crushing, classification, crushing for production of commodity slag production (crushed stone, sand, dust, etc.).

At a choice of the equipment for mechanical processing of solid metallurgical slags it is important to consider their physic-mechanical properties different from properties of minerals.

Metallurgical slags in the course of cooling and long storage are subject various look in the open air to structural transformations which are followed by change of volume, forms, weight and other physical properties. At silicate disintegration depending on a chemical composition to 85-90% of a slag monolith can turn into dust. Limy and ferriferous disintegrations lead to emergence both micro and macro cracks and to destruction of separate grains of slag. Intensity of disintegration processes is various. Depending on temperature, a state of environment and a way of primary processing disintegration can proceed from several hours to several years.

The analysis of particle size distribution of slags of old dumps and tendency of releases confirms this situation (the tab.1 and fig. 1).

Distinctive feature of metallurgical slags is existence in them of metal inclusions in the form of shapeless pieces, joints of metal and slag. The slag reinforced by metal possesses qualitatively new properties in comparison with its components. It is possible to speak about slag as about composite material. Availability of metal in slag increases its volume weight, changes the mechanical durability, resistance to disintegration, etc.

Introduction in technology of primary processing of slags of a way of thermocrushing leads to stabilization in slags hydraulically of active phases. Together with it in blankets of slag there is a stabilization of a vitreous and fine-crystalline phase which possesses the high primary hardness and abrasivity.

Table 1

Average particle size distribution of dump and current slags

Type of slag	The full remains on sets with sizes of openings (mm), %					
	300	120	70	40	20	10
Dump (mix blast furnace and steel-smelting)	3	4	5	10	32	46
The current martin	10	28	53	62	77	85
Current converter after crushing	10	47	55	67	78	88

Noted factors along with other mining technological properties define a choice of the equipment and technology of processing of metallurgical slags.

The main operation when processing of the breaking-up metallurgical slags (disintegration> of 70%) their separation into silicate and metal components is. It is for this purpose used gravitational and inertial or gravitational and centrifugal qualifiers, and also air-through and air-closed separators. In these units under the influence of centrifugal and gravitational forces and the directed streams of air separation of material according to fineness and density is made.

Thin, easy fractions are brought out of devices, on system of pneumotransport move in silage warehouses and are shipped to the consumer. Large and heavy particles are exposed to crushing and fractionation with passing metal extraction.

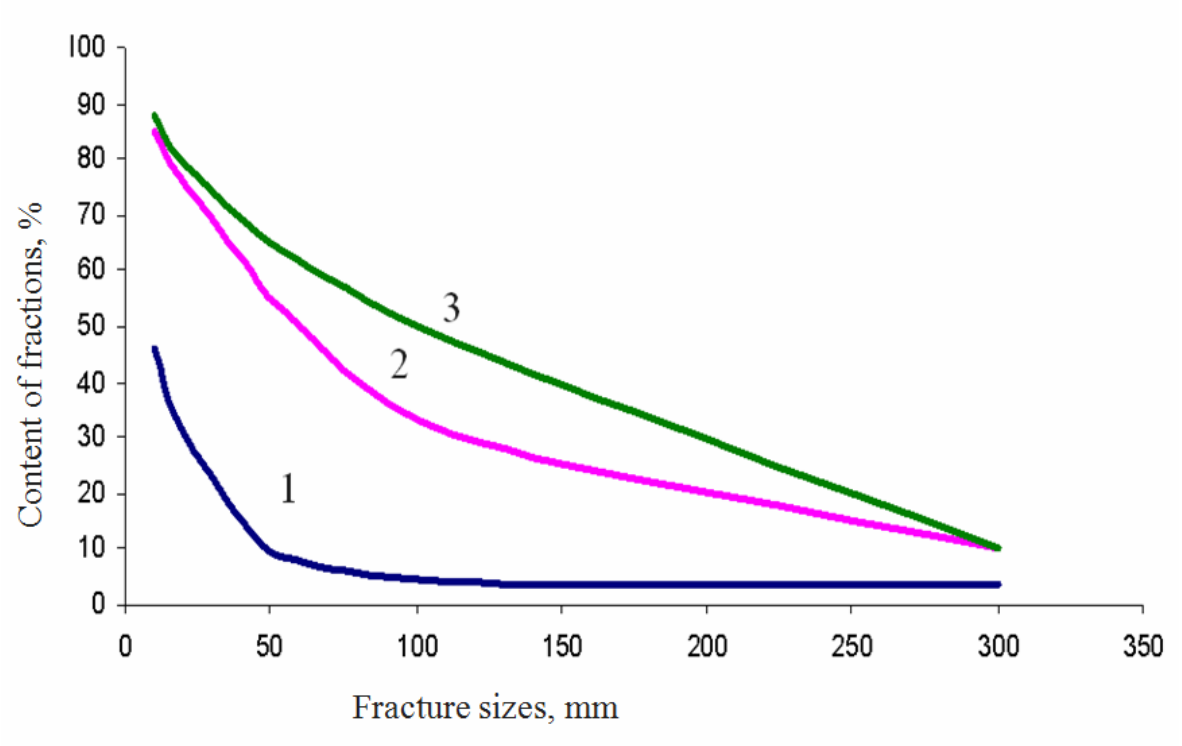

Fig. 1. Change of particle size distribution of dump slags rather current:
1 – dump slag; 2 – current martin; 3 – current converter

Depending on magnetic properties of metal inclusions in slags electromagnetic separators and iron separator with strong and weak magnetic fields are applied.

In technological schemes of processing of the breaking-up slags air qualifiers for extraction of not magnetic and low-magnetic metal inclusions found application.

The choice of the crushing equipment is made from calculation of fineness of slag, necessary productivity, and quality of products and existence of metal inclusions. The amount of metal inclusions in the current slag practically does not give in to exact definition. Therefore at a choice of head crushers apply additional measures to decrease in probability of metal hit and it's jamming in a crusher. For this purpose in a crusher obviously increase the size of an output crack.

Characteristics of grain composition of dump slags (see the tab.1) show that the sifting and extraction of metal have to be the main operations for their processing. One more distinctive feature of dump slags is smaller values of abrasivity in comparison with slags of the current exit. Indicators of abrasivity of dump slags are 1,5-2 times lower, than at slags of the current exit. Therefore when processing dump slags it is expedient to apply the domestic mobile crushing equipment on the basis of jaw and rotor crushers. The last differ in high extent of crushing and provide the admission of not split up metal inclusions.

Operation of extraction of metal inclusions from slags is used as accompanying processes of crushing and a sifting now.

In a source [3] it is provided the description of a way of processing of dump

metallurgical slags which includes two stages of crushing, sifting and the subsequent dry magnetic separation after which large, average and small magnetic fractions arrive on a warehouse, and averages and large not magnetic fractions are also transferred to a warehouse for the subsequent use them as construction materials. The small not magnetic fraction is crushed to a fine state in a jet mill and divided into fraction with a specific surface 0,5 – 0,8 m^2g/g which is besieged in a cyclone and fraction with a specific surface 0,8 – 2,0 m^2g/g which is besieged in the filter. The first fraction is used as the independent knitting material and as an additive to cement, and the second is used as microfiller for receiving high-strength and dense concrete (fig. 2).

In the technological scheme (fig. 2) on the basis of results of research [4] fine jet crushing of slags is used at a final stage of processing. This new direction in technology of processing of metallurgical slags also has advantages in economic and ecological aspects in comparison with the existing technologies. According to this technological scheme it is possible to recycle also slags of the current exit.

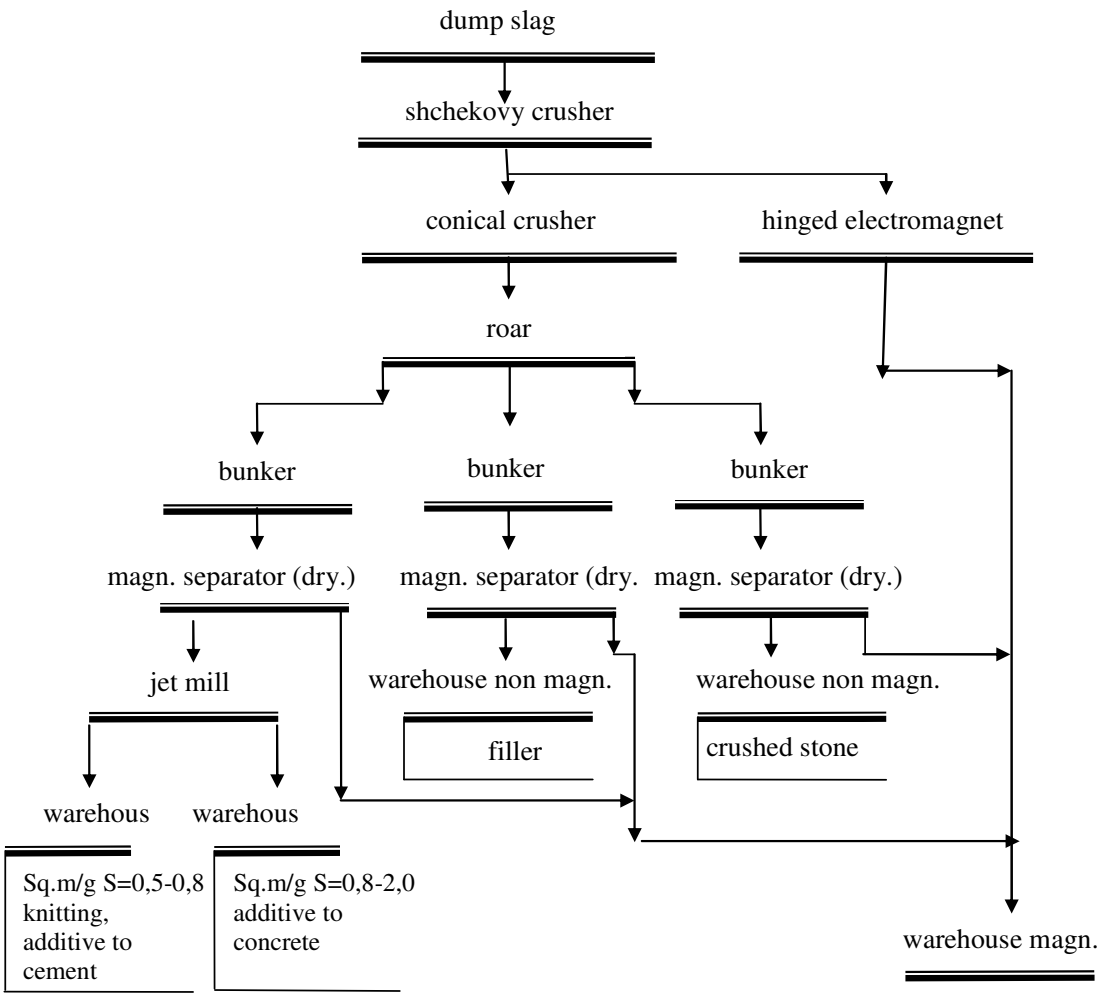

Fig. 2. Technological scheme of processing of dump metallurgical slags

Disintegration of slags of the current exit, their high abrasivity and drying of a surface of pieces of slag after operation of thermocrushing leads to formation of a large amount of dust in the course of processing. Known ways of aspiration do not provide the demanded sanitary conditions in the main technological bridles of slag processing installations. Therefore in new slag processing complexes it is necessary to provide dust removal of initial slag in the reception bunker at delivery it to the technological line, at transportation and in pour point, applying for this purpose intensive having blown in pieces of slag and use of such means for collecting dust, as pneumotransport, dust precipitators, cyclones, pneumoqualifiers, and. properties of dust-like fractions, their sizes, availability of metal, soaring speeds, other taking into account density.

Literature list

1. Панфилов М.И., Коломиец В.А., Орининский Н.В. Пути перевода доменных цехов предприятий ВПО "Союзметаллургпром" на работу без шлаковых отвалов // Сб. УралНИИЧМ. – Свердловск, 1982. – С. 5-12.

2. Панфилов М.И. Металлургический завод без шлаковых отвалов. –М.: Металлургия, 1978.

3. Пат. 18107, Украина, В 03С 1/00. Способ переработки отвальных металлургических шлаков / В.П. Кравченко, И.Н. Фектисов, В.А. Струтинский, А.В. Черкасов; заявитель и патентообладатель ПАО "ММК им. Иллича". – № 200605806; заявл. 26.05.2006; опубл. 16.10.2006, Бюл. № 10, 2006.

4. Кравченко В.П., Струтинский В.А. Гидравлическаяактивность доменных шлаков. – М.: Сталь, 2007. – № 1. – С. 94-95

Надійшла до редколегії 20.08.2015 р.
Рекомендовано до публікації д.т.н. К.С. Заболотним