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INVESTIGATION OF PHYSICO-CHEMICAL CHARACTERISTICS OF IRON-CONTAINING TECHNOGENIC RAW MATERIALS IN THE CONDITIONS OF JSC “AMT”

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The results of experiments conducted to determine the efficiency of the use of man-made waste, including large-scale in volume among the waste of metallurgical production, melted films and sludge of the oxygen converter shop are presented. During the study of the sludge of the converter shop, the chemical, phase, granulometric composition and density of rolling scale and sludge of the oxygen converter shop were revealed.

Keywords: sludge, physio - chemical characteristics, rolling scale, granulometric composition, chemical composition.

INTRODUCTION

Currently, there are several types of metallization technologies for raw materials. The main processes of solid-phase metallization are Midrex, HyL, Danarex, Finmet, etc. [1 – 5], as well as the processes of reduction of basic liquid-phase iron Corex, Finex, Romelt, Ausmelt, HIsmelt, Technored, etc. [6]. Metallization of fine-grained and powdery iron oxide residues is an important area of metallurgy [7, 8]. The presence of low moisture and petroleum products makes it difficult to use burnt-out film in metallurgical processing as a charge.

The problem of utilization and recycling of converter sludge is very relevant, since in case of elimination of these problems it allows solving a number of important tasks: providing the enterprise with iron-containing raw materials, solving environmental problems of utilization of fine waste [9], contributes to saving natural raw materials and reducing the specific weight of the extracted steel [10]. In this regard, the use of efficient recycling technologies is one of the urgent tasks of modern metallurgy [11].

The purpose of this work is to study the physico-chemical characteristics, density of chemical, granulometric and phase compositions of trampled film and sludge of oxygen converter production, recommended for use for obtaining metallized products that are in great demand in steel production.

GENERAL CHARACTERISTICS OF MATERIALS AND METHODS OF THEIR RESEARCH

Rolling scale is formed as a result of secondary oxidation of the surface layer of the metal when heated. When 1 ton of steel is heated, about 25 – 30 kg of burnt scale is formed (2,5 – 3,0 %) [3]. Up to 50 million tons of scale are produced annually in the world, up to 1 million tons in Kazakhstan. Layered scale is widely used as an iron-containing component of sinter in sintering production.

Oxygen converter shop slurries are formed during the operation of the wet gas purification system of converter gases. Sludge is rich in iron (Fe_{prop} = 55 – 67 %) or relatively rich in iron (Fe_{prop} = 40 – 55 %). With wet gas cleaning, 10 - 30 kg of sludge (1 – 3 %) is formed per 1 ton of steel being smelted [4]. Consequently, about 14 – 38 million tons of sludge are formed in the world.

At the moment there are several stages of technological handling of rolling scale:

1 The first stage is primary settling tanks. After heating in the furnace or well, the ingot enters the receiving roller, which is equipped with a scale breaker. Scale is also removed by hydraulic fracturing, drilling and blasting, and scale breakers. All separated scale enters the substitutional tunnel and is transported by water to the primary scale settling tank located in the workshop and is a rectangular reinforced concrete well with two sleeves – inlet and outlet. The largest scale particles up to 2,5 mm in size with an average particle diameter of 0,5 – 0,7 mm are deposited in the sump. The scale particles have a lamellar shape. With a true density of 4,6 – 4,9 g/cm^3, the bulk density is 1,57 – 1,37 g/cm^3. With a large supply of lubricants to the settling tanks, petroleum products are found in the scale, which negatively affects its further disposal. This scale contains up to 1,74 – 3,8 % of oils. From the primary settling tank, the scale is shipped by a grab crane to the wagons.

2. The second stage is secondary settling tanks. After the primary settling tanks, water with fine scale particles (less than 0,1 mm) enters the intermediate pumping station, and from it is pressurized to the secondary

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settling tanks. As a rule, these are multi-section horizontal settling tanks. An oil removal system is provided on the sump. The scale of secondary settling tanks contains an increased amount of petroleum products and water, which makes it difficult to prepare and dispose of it. For this reason, this material is disposed of on average by only 75,1 %. The scale from the sump is taken away by a grab crane. Part of the larger scale is taken from the pockets of the sections and stored on a special platform for drying. As the wagons arrive, it is shipped to consumers. The content of petroleum products in this scale is 1,8 %. The other part of the smaller scale with a content of petroleum products up to 15 % is stored in a concrete bunker and periodically exported to the dump.

Currently, the following scheme of technological treatment of Oxygen converter shop sludge is standard. The sludge is formed as a result of spraying the process water flow from above onto converter gases containing highly dispersed dust fed into the scrubber from below. The sludge slurry is disposed of as follows: the sludge is transferred to a dewatering complex consisting of a radial sump, vacuum filters and a drying drum. In a radial sump, the slurry pulp thickens from 200 to 600 g / l, in a vacuum filter, the slurry suspension is filtered to a humidity of 32 – 36 %, in a drying drum, the slurry paste is dried at a temperature of 110 – 120 °C to a humidity of 8 – 10 %. The dewatered sludge is shipped to the consumer, and the clarified water is further purified at magnetic-water separation plants and returned to the gas treatment cycle.

The most widespread use of dehydrated sludge has been found in sintering production as an iron-containing component of sinter. The specific consumption of sludge can reach 200 kg/t of agglomerate. However, a significant disadvantage of this technology is the fact that the content of zinc and lead increases in the resulting agglomerate, which is unacceptable due to the significant influence of these impurities on the masonry of blast furnaces.

In this regard, a number of alternative technologies are proposed, such as a scheme with heat treatment of sludge in a drum rotary kiln, a scheme with treatment of sludge with nitric acid spent pickling solution at a neutralization station, as well as a combined two-stage scheme with solid-phase metallization and removal of zinc from the sludge and further liquid-phase recovery of partially metallized intermediates. But some metallurgical plants dump part of the sludge into sludge storage.

RESEARCH RESULTS AND DISCUSSION

The obtained results of determining the chemical composition of the rolling scale and converter sludge are shown in Table 1. The Table shows that the composition of the rolling scale contains more total iron (73,34 %) than in the sludge (42,2 %).

Based on the results obtained, it can be noted that rolling scale is less oxidized than sludge. Also not unimportant is the low content in the rolling scale (less than 3 %) of compounds that do not contain iron. In the sludge, on the contrary, the CaO content reaches 27,56 %. In addition, the content of sulfur and phosphorus in the rolling scale is an order of magnitude lower – 0,028 and 0,018 % versus 0,36 and 0,21 % in the sludge, respectively. However, sludge is a supplier of alloying elements such as manganese, chromium, vanadium, nickel in steel production. The sludge also contains up to 2,13 % total carbon, including up to 0,46 % solid carbon. Thus, both rolling scale and slurries are of interest as oxide-containing raw materials for the metallization process.

Table 1 **Chemical composition of rolling scale and sludge**

Chemical composition / %	Scale	Sludge
Fe_{com}	73,34	42,2
FeO	60,92	43,07
SiO_2	0,595	6,02
Al_2O_3	0,20	0,86
CaO	0,24	27,56
MgO	0,24	4,3
K_2O	Not determined	0,155
Na_2O	-	0,146
TiO_2	-	0,04
MnO	0,40	0,96
P	0,018	0,36
Cr_2O_3	Not determined	0,008
V_2O_5	-	0,028
S_{com}	0,028	0,21
BaO	Not determined	<0,01
Ni	-	0,01
Cu	-	0,021
Zn	-	>0,5 (1,21)
Pb	-	0,068
C_{com}	-	2,13
C_{solid}	-	0,46
Other	-	3,08

The granulometric composition of scale and sludge are given in Table 2. From the Table 2 it can be seen that the sludge is a more highly dispersed material than rolling scale.

Table 2 **Granulometric composition of rolling scale and sludge**

Content of the size class / mm	Scale / %	Sludge / %
> 2,5	14,7	7,16
1,6 – 2,5	8,5	3,7
1,0 – 1,6	12,9	3,84
0,63 – 1,0	2,75	4,56
0,4 – 0,63	8,43	7,32
0,315 – 0,4	10,8	3,2
0,16 – 0,315	24,17	6,14
0,10 – 0,16	14,55	4
0,063 – 0,10	1,8	4,8
0,05 – 0,063	1,2	1,9
0,032 – 0,05	0,2	6,3
0,016 – 0,032	–	24,6
0,008 – 0,016	–	10,7
< 0,008	–	11,78
Total	100	100

The predominant mineral of the sludge is magnetite. Also present are wustite, calcite, hematite, feldspar. The obtained data are in good agreement with the chemical analysis data. The true density of rolled scale ranged from 4,6 to 4,9 g/cm^3, converter sludge – from 3,5 to 5,0 g/cm^3. Thus, the density of rolling scale and Oxygen converter shop sludge is comparable.

The analysis of the properties of the specified iron-containing oxide raw materials allows us to conclude that it is advisable to use it in the metallization process. At the same time, the use of rolling scale is more preferable due to the higher content of total iron in it.

CONCLUSION

The chemical, phase, granulometric compositions and density of rolling scale and dehydrated sludge of gas purification of the oxygen converter shop of JSC "AMT" are investigated

The results obtained confirm the technological feasibility of using fine-grained scale and powdered sludge in metallization processes, including their preliminary briquetting in a mixture with a carbon reducing agent, for example, with the addition of carbon.

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