

Zinc Manufacturing Waste - Clinker Recycling

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Annotation:

Re-creation and development of zinc production technology is required. This made it possible to expand zinc export to today's demand and worldwide.

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About 10 billion tons of minerals are mined annually in the world to meet the production needs of ferrous and non-ferrous metals. At the same time, the decrease of rich and easy-to-open ore deposits indicates the need to pay special attention to increasing the integrated use of secondary raw materials in the form of ore-mineral raw materials and iron ore wastes and man-made wastes of the mining and metallurgical industry.

One of the man-made wastes produced in zinc production is the clinker separated from the rolling of zinc cakes. Clinker is a polymetallic man-made waste with a complex composition, which contains dozens of non-ferrous metals as well as rare and chemical metals.

Based on the analysis of scientific works on clinker processing, it should be noted that complex studies (gravitational, electromagnetic, flotation enrichment processes, hydro- and pyrometallurgical processes) were conducted to extract metals from zinc production waste clinker, and various methods have been developed. In addition, processes of selective melting of metals from clinker in various solvents have been researched, but they have not yet been used on an industrial scale. It can be seen that the issues of complex extraction of metals in clinker and improvement of their processing technology have not been resolved yet. This is mainly due to the complexity of extracting valuable components from the clinker composition.

In one of the studies conducted on clinker processing, coke and heavy fraction were separated from clinker by enrichment methods (sedimentation, magnetic separation and flotation). The decrease in

the large fraction of the material led to a decrease in the concentration of copper in the magnetic fraction. About 70% of the copper went to the magnetic separation residue. However, due to the inhomogeneity of the clinker composition, magnetic separation did not give positive results.

The possibility of using the product of magnetic sorting as a precipitant was investigated. According to the Mostovich method, magnetic concentrate can be used as a cementing agent in beneficiation of copper ores. Using this method improved the precipitator crushing process and increased the copper recovery up to 84%. The research results show that good results are achieved with clinker up to 6 mm in size during precipitation and enrichment on concentration tables. Initial composition of copper

When it was 1.11%, a concentrate containing 1.31% copper was obtained, and the conversion to concentrate was 93.5%. Carbon was separated from the original 20.7% to 16.5%. Its amount in sediment residues was 84%. With the help of combined schemes (precipitation, magnetic enrichment or flotation), it is possible to obtain a concentrate rich in non-ferrous, rare and rare metals. The amount of non-ferrous metals can be increased by flotation, but the extraction of rare metals is correspondingly reduced.

In the work, 60-90% of the clinker was crushed to the class of particle size up to -0.074 mm and subjected to wet magnetic screening under standard conditions. The obtained magnetic fraction is selectively dissolved with sulfuric acid solution, spending 0.4 - 2.4 kg per 1 kg of iron in the clinker. After separation and washing of the residue, a copper concentrate was obtained. Crystalline iron sulfate was isolated from the filtrate containing Fe (II) sulfate.

Researches were conducted on clinker processing by magnetic sorting, selective melting of magnetic fraction and flotation of non-magnetic fraction. This method is patented as "Zinc production waste processing method" and includes the following: clinker crushed to 1-5 mm is subjected to magnetic screening. The magnetic fraction was selectively dissolved in the heap. The solution for selective dissolution consisted of 40 g/l H₂SO₄, 50 g/l active chlorine, and surfactant as a sorbent. After using the product solution 35 times in the process, useful components were extracted from them. The cake left over from the selective smelting was melted in a furnace to extract rare metals more fully.

In our opinion, the disadvantage of the method is that it is multi-step, that is, several methods are needed to implement it, and as a result, after selective melting in the pile, the remaining cakes are melted in the oven.

Clinker is processed by magnetic and flotation beneficiation methods at the Kazzintek factory. Three-stage magnetic separation is used. As a result of enrichment, three products were obtained: magnetic, non-magnetic and an intermediate product. The magnetic product can be used as a product concentrate based on its iron content. The yield of the intermediate product is 40-70% and is then crushed and enriched by flotation. A non-magnetic product contains coke.

In our opinion, the disadvantage of the method is that the process of copper flotation includes two main operations, control and cleaning, man-made effluents are released and they need to be processed again.

AIOkunev, LS Shugol, FI Nagirnyak, ES Gagarin and SE Friedman studied the method of direct electromagnetic enrichment of clinker. The authors found that the copper and iron in the clinker were mostly in the metallic state. The copper content of the starting clinker was 4.4% and crushing to minus 0.15 mm resulted in a magnetic concentrate (6.2% Cu), where copper extraction was 47%, and copper extraction from the residue (3.5% Cu) 53%; extraction of iron into magnetic concentrate was 82%. It should be noted that rare metals are distributed in approximately equal proportions between magnetic and non-magnetic fractions.

The researches of the employees of the "Mechanobr" institute showed that the best results of electromagnetic enrichment of clinker were achieved when the particle size was -2 mm. When the initial amount of copper in the clinker was (from 2.35 to 6.7%), a concentrate (magnetic fraction) with a copper content of 8 - 14.2% was obtained, and the extraction was 80 - 89%. As a result, man-made effluents with a copper content of 0.57 - 1.32% were obtained, and the extraction rate was 19.5 - 11%. When the amount of iron in the clinker was 28%, a 50.6% iron concentrate (separation 84%) was obtained for the magnetic product. As a result of magnetic screening of clinker containing 1.07% Cu, a copper concentrate with a copper content of 2.22% (separation 50.5%) and tailings with a copper content of 0.7% (separation 50.5 %) was obtained. Information about the behavior of rare metals and carbon is not given in the work, and it is not possible to draw conclusions about the rational use of enrichment products. The authors proposed the use of clinker and magnetic enrichment obtained as a result of beneficiation as a precipitating additive in slag fuming, in the beneficiation of oxidized ores, and as a precipitant for copper from mine waters.

Prohibition part. The chemical composition of zinc production waste clinker, which we conducted research, is presented in Table 1.

Table 1 Chemical composition of clinker, %

Element, compound name	Cu	Pb	Ms	Feumum	Sumum	C	CaO	Al ₂ O ₃	SiO ₂
Amount	2.2	0.51	2.1	19.53	8.39	29.55	6.06	4.08	16.42
Element, compound name	MgO	Cd	Ace	TiO ₂	H ₂ O	Mn ₂ O ₃	Ba	Aw	Ag
Amount	2.72	<0.01	0.155	0.21	0.6	0.47	2.3	3.2 g/t	260.27 g/t

According to the results of chemical analysis, zinc production clinker contains Cu (2.2%), Zn (2.1%), Pb (0.51%), 19.53 Fe, Ag (260.27 g/t), The presence of valuable components such as Au (3.2 g/t) and coke (29.55%) was found.

In addition, mineralogical (Fig. 1) and granulometric (Table 2) composition of clinker was studied. The mineral composition of clinker mainly consists of vitreous-fayalite (35.5%), coal (29.55%) and metallic iron (16.6%). Basically, clinker contains a lot of carbon and iron and prevents the extraction of valuable components.

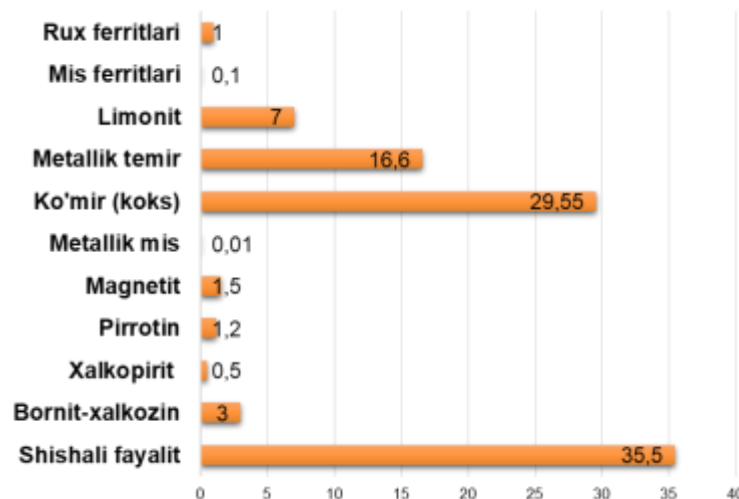


Figure 1. Mineralogical composition of clinker

Table 2 Granulometric composition of clinker

Nanuna number	Distribution of fractions									
	Size of the fraction g, mm	+20	-20+10	-10+6	-6+2	-2+1	-1			Total
1	Quantity, %	20.5	20.3	25.4	17.7	14.3	1.5			100
2	Size of the fraction g, mm	+20	-20+10	-10+6	-6+3	-3+2	-2+1	-1+0.5	-0.5	Total
	Quantity, %	22.5	21.6	25.2	11.3	2.5	13.5	1.9	1.5	100

According to the results of granulometric content analysis, large fractions make up 20-23%, medium class 11,317.7%, small class 2.5-14.3%, showing that clinker should be crushed before processing.

Thermodynamic analysis revealed that clinker components do not dissolve well in sulfuric acid solution, sulfides and metal ferrites do not dissolve in weak acid solutions. This leads to a decrease in the extraction of metals into the solution. A decrease in the concentration of sulfuric acid and an increase in the temperature of the selective melting process lead to the formation of silicic acid (H_2SiO_4) and other negative reactions, which complicate the further separation of phases.

When studying the behavior of clinker components in chlorinated solutions, it can be concluded that the valuable components of clinker, zinc, copper, lead, gold and silver, react with chlorine and its compounds and form water-soluble compounds. .

The content of iron in clinker is more than other components, and iron is an element with higher electronegativity, and it reacts with a large part of chlorine. This is considered undesirable because the electronegativity of other elements is lower. To avoid this, iron must be removed from the clinker as an iron concentrate before electrochlorination [8-9].

It is known that the size of particles in floto concentrates is 0.074 mm, naturally, cakes obtained from selective melting also have this size. However, as a result of rolling zinc cakes, the particles become larger as a result of sticking together up to 100 mm. In order to mechanically separate them from each other, it is necessary to grind them to a thickness of -1.0 mm. Studies on clinker grinding were carried out, and their results are presented in Table 3.

Table 3 Results of grinding clinker for 1.0 hours (1 kg clinker: 6 kg ball)

No	Class, mm	Output, %
1	-2+1	2.3
2	-1+0.5	87.5
3	-0.5-00	10.2

Studies were conducted on separating iron into a separate concentrate by enriching clinker. Dry magnetic separation was carried out to extract iron from the clinker composition. The dependence of the magnitudes of the current on the iron concentration and separation into the magnetic fraction was studied. The results are presented in Table 4.

Table 4 Results of magnetic enrichment of clinker

No	Current strength J, A	Resistance He, b	Concentrate output		Iron concentration, %	Separation of iron into a concentrate, %
			in grams	in %		
1	0.125	95	3.42	1.71	55.82	5.02
2	0.25	140	12.6	6.30	58.40	19.34
3	0.31	180	24.8	12.40	65.25	42.63
4	0.38	210	38.1	19.05	63.14	63.15
5	0.45	255	47.3	23.65	61.31	76.05
6	0.50	295	56.6	28.30	51.42	76.60

According to the results of the research, when the current strength was 0.31A, the iron concentration was 65.25%, and the iron extraction was 42.63%. Further increase in current does not increase iron extraction. The highest extraction was 76.6%, the current used in it was 0.5 A and the resistance was 295 V, but according to the results of the analysis, the iron concentration decreased to 51.42%. Analyzing the data obtained as a result of the experiment, it was found that the optimal current strength was 0.45A and the resistance was 295 V, the concentration of iron in these indicators was 61.31%, and the extraction was 76.05% (Fig. 2).

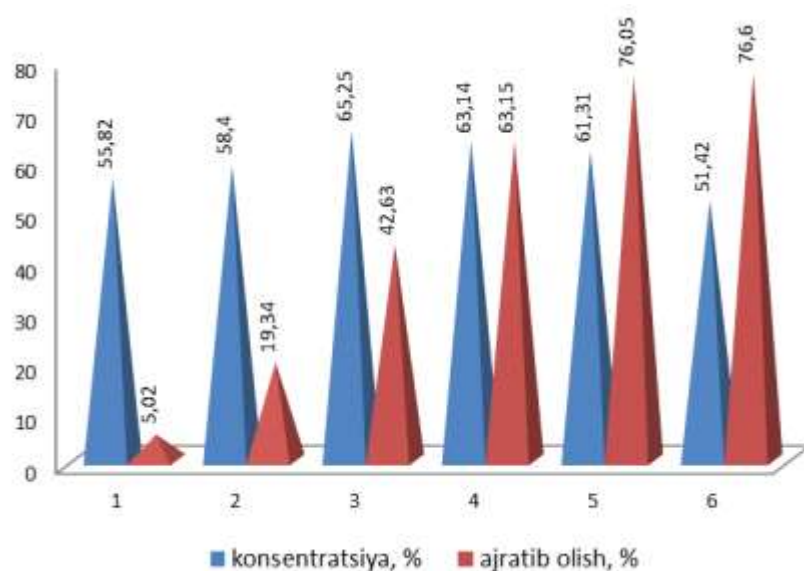


Figure 2. Dependence of extraction of iron from clinker by magnetic enrichment method on current strength

Summary. The results of the research showed that it is possible to extract iron from clinker by magnetic enrichment method and obtain a concentrate with an iron content of about 60%. By washing the magnetic fraction, it is possible to increase the amount of iron in the iron enrichment up to 66%. The obtained purified iron enrichment is suitable for further processing and can be sent to the consumer.

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