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TECHNOLOGICAL ANALYSIS OF THE PROCESS OF METALS RECOVERY OF LARGE DUST FROM THE CONVERTER USING METALLURGICAL METHODS

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Abstract— *In the converter shop, the main sources of environmental pollution are dust and gas emissions into the atmosphere. These high-temperature emissions are subdivided into organized ones, which include exhaust gases captured when leaving the converter neck, and unorganized, which are usually not captured and enter the workshop atmosphere. Unorganized emissions occur periodically - when pouring cast iron, loading scrap, draining metal and slag, rolling the converter, when knocking out gases through the gap between the neck and the entrance to the gas outlet tract; these emissions contain dust, heat and a number of harmful gases (in various cases, these are CO, oxides of nitrogen and sulfur, fluorides).Even greater pollution of the environment can be caused by gases leaving the converter due to their large amount and high dust content. These gases are products of carbon oxidation and, when blown from the top, contain 83–89% CO, 9–11% CO_2, 2, 2; their temperature in the course of blowing increases from 1350 to 1700 °C. The gases contain fine dust - mainly iron oxides, which appear as a result of iron evaporation in the high-temperature under-tuyere zone and subsequent vapor oxidation; the amount of dust is 80-250 g/m3 of gas, in connection with which all converters are equipped with gas cleaning systems to reduce the dust content to acceptable sanitary standards (less than 0.1 g/m3)In this regard, all oxygen converters are equipped with an exhaust gas removal and purification system, which significantly complicates and increases the cost (by 10-20%) of the construction of a converter shop.The complexity and high cost of cleaning is associated with high temperature, a large amount of exhaust gases that changes during the purge. The approximate amount of exhaust gases can be determined taking into account the fact that they consist mainly of CO and when carbon is oxidized to CO, two molecules of CO are formed per molecule of oxygen. Therefore, the maximum amount of exhaust gases will be approximately equal to twice the oxygen consumption. The rate of oxygen supply is 2.5–5 m^3/(t*min); therefore, the yield rate of converter gases will be 5–10 m3/(t*min) in the middle of the purge. At the beginning and end of the purge, when less carbon is oxidized than in its middle, the amount of exhaust gases decreases.*

Keywords— metallurgy, chalcopyrite, oxidation, reduction, copper, processing, zinc , electrolysis, thermodynamic changes.

Introduction

The conversion process is one of the most important sections of copper production technology. The obtained intermediate product (stein) is loaded into the converter machine, regardless of which smelting furnace copper ore is processed. Typically, stein obtained from smelting furnaces contains 24-40% Cu, 24-26% S and 35-45% Fe. The purpose of the Stein converter process is to remove iron and sulfur. During the process, a number of harmful substances, gases and dust are also released. The dust emitted from the ovens is captured in two stages: first the large ones, and then the fine ones. The size of captured dust can be from 0.0001 mm to 0.1 mm [1].

To supply air to Stein's liquid bath, the converter has holes, each hole is made of steel pipe. Air is supplied from it with an excess pressure of 1.0-1.2*10 Pa. A 40-t converter has 28 units, and a 75-t unit has 43-50 units. The diameter of the large converter hole is 52 mm. The cover and the lower part of the converter are protected by 350-460 mm refractory bricks. The width of the lining is increased to 475 mm in the fur belt [2].

Gases are partially cooled by a vacuum cleaner and dust is captured. Vacuum cleaners are air or water cooled when they are made of cast iron or steel plates.

Gases are sent from vacuum cleaners to the collector to get sulfuric acid. During the conversion of copper stein, all the iron in the stein separates into rock. Sulfur, in the form of SO_2 and SO_3, separates from the solution and passes into a gaseous state. During conversion, raw copper containing 96-98% copper is formed by combining metals such as gold, silver, selenium, tellurium, cadmium, and nickel with properties close to each other. Large dusts are released from the conversion process due to pressurized air spraying of copper steins. Dusts larger than 10 μm are technically called large dusts . The large dust created by the conversion process also contains precious metals such as Cu, Zn, Pb, Pt, which are necessary for us. This shows that it is necessary to study the chemical composition of the large dust coming out of the converter, especially the material composition, and pay attention to dust processing.

The result of spectrometric analysis showed that the amount of precious metals in the large dust coming out of the converter is much higher than their amount in the ore. The chemical composition of the large dust fraction from the converter is presented in Table 1 and the diagram below [3].

As can be seen from this chemical composition, heavy non-ferrous metals (Cu+Zn+Pb) make up the main part of the dust mass (60.08%). But choosing an effective technology for processing dispersed nanoparticles with such a composition requires knowledge of their material composition.

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Determining the material content is quite difficult and for this it is necessary to conduct many qualitative and quantitative analyses.

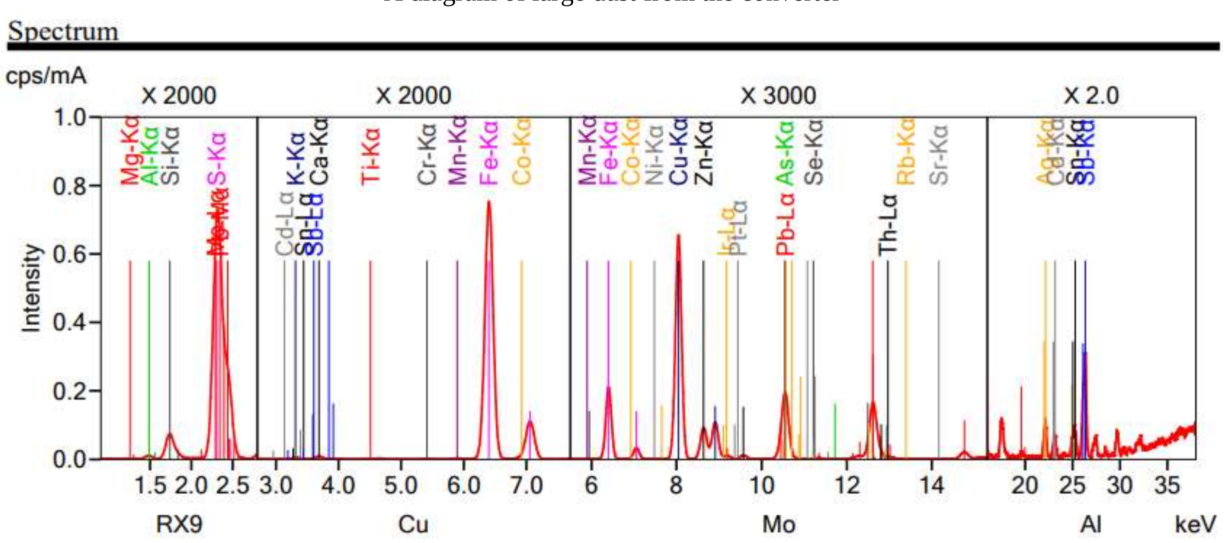
In order to conduct a material analysis, it was taken as a task to conduct several studies: a) magnetic separation; b) ruchthermia; c) electrolysis and analysis of events.

Table 1. Chemical composition of the large dust fraction leaving the converter

Analyzed result(FP method)

No.	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Mg	0.498	mass%	0.0220	0.0516	0.155
2	Al	1.62	mass%	0.0132	0.0139	0.0418
3	Si	6.01	mass%	0.0150	0.0057	0.0171
4	S	10.1	mass%	0.0114	0.0189	0.0568
5	K	1.22	mass%	0.0134	0.0125	0.0374
6	Ca	1.19	mass%	0.0106	0.0110	0.0330
7	Ti	0.0998	mass%	0.0023	0.0041	0.0124
8	Cr	0.0148	mass%	0.0007	0.0018	0.0053
9	Mn	0.0422	mass%	0.0033	0.0077	0.0232
10	Fe	17.1	mass%	0.0315	0.0075	0.0225
11	Co	(0.0327)	mass%	0.0054	0.0160	0.0479
12	Ni	(0.0089)	mass%	0.0020	0.0055	0.0165
13	Cu	39.3	mass%	0.0320	0.0033	0.0099
14	Zn	4.38	mass%	0.0112	0.0053	0.0158
15	As	0.380	mass%	0.0152	0.0429	0.129
16	Se	ND	mass%	0.0017	0.0049	0.0148
17	Rb	(0.0065)	mass%	0.0009	0.0026	0.0077
18	Sr	(0.0047)	mass%	0.0007	0.0020	0.0060
19	Zr	0.390	mass%	0.0066	0.0039	0.0116
20	Mo	0.0679	mass%	0.0076	0.0112	0.0335
21	Ag	0.0694	mass%	0.0024	0.0020	0.0059
22	Cd	0.0470	mass%	0.0021	0.0022	0.0067
23	Sn	0.0642	mass%	0.0025	0.0027	0.0081
24	Sb	0.255	mass%	0.0047	0.0027	0.0082
25	Ir	0.577	mass%	0.0133	0.0365	0.110
26	Pt	0.113	mass%	0.0084	0.0224	0.0672
27	Pb	16.4	mass%	0.0329	0.0207	0.0620
28	Th	0.105	mass%	0.0056	0.0156	0.0468

A diagram of large dust from the converter

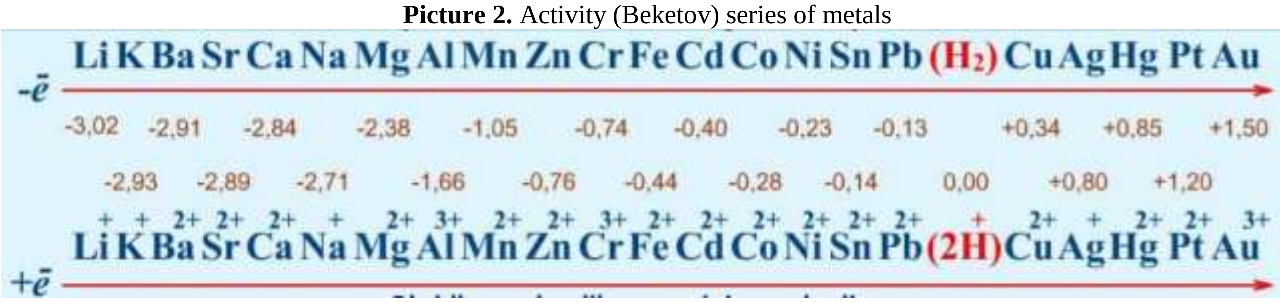


Initially, the converter magnetically separates the large fraction of dust and attracts the compound containing iron metal [4]. As a result, large amounts of heavy non-ferrous metals (Cu+Zn+Pb) remain in large dust fractions.

Picture 1. A large sample of dust from the converter

We analyzed the physical-chemical properties and thermodynamic laws of the remaining heavy non-ferrous metals (Cu+Zn+Pb). As a result of research, the properties of zinc metal (Zn) are more active than other metals. We can learn this from the activity (Beketov) series of metals [5].

Picture 2. Activity (Beketov) series of metals



We use ruchthermy to extract heavy non-ferrous metals (Cu+Zn+Pb) from large powder phases [6]. Beketov restored the pure metal from the compounds of the metals that were next to him, i.e. after zinc metal. In this case, zinc powder is sprinkled into the solution. In order for the process to proceed, it is necessary to give the initial substances activation energy. The chemical reaction equations in the system:

$$CuO + Zn = Cu + ZnO$$

$$PbO + Zn = Pb + ZnO$$

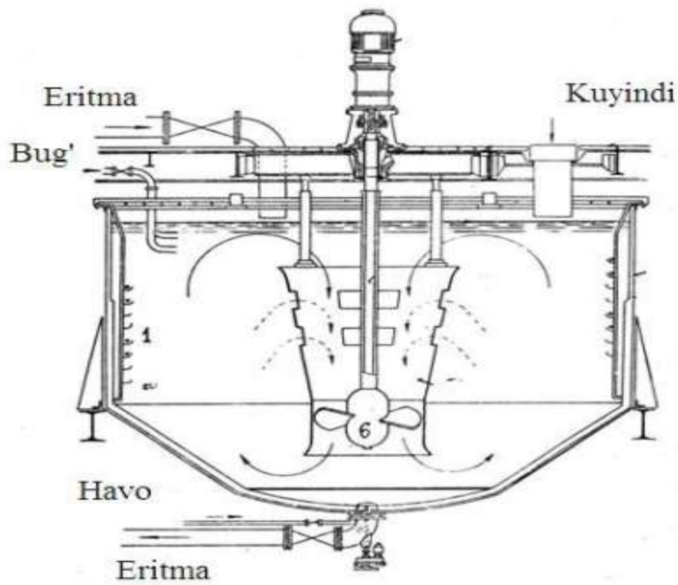
ZnO

During the process, phases of zinc oxide (ZnO) and heavy non-ferrous metals (Cu+Pb) are formed. The phases are distinguished from each other by their density [7]. Heavy non-ferrous metals (Cu+Pb) are poured into special molds. The obtained zinc oxide (ZnO) is given to the selective melting process. The process goes like this:

Selective dissolution process: the resulting carbon black is selectively dissolved in H_2SO_4. The selective melting process is carried out in two stages: 1st stage: neutral selective melting (to get rid of silicates). In this case, the environment of the solution is weakly acidic (pH = 4-6); 2nd stage: sour (acidic) selective dissolution. In this case, the environment of the solution is strongly acidic (pH = 1–2). Chemical reaction of the process (chemistry):

$$ZnO + H_2SO_4 = ZnSO_4 + H_2O$$

Picture 3. Zinc soot selective melting reactor (agitator)



Cleaning the solution from unnecessary additives:

1. For cleaning from SiO_2, a neutral environment with pH=7 is created. In this case, all silicates will precipitate.
2. Zn powder is sprinkled to remove Fe^{2+}, Cu^{2+}, Cd^{2+}, Ni^{2+}, i.e. cementation:

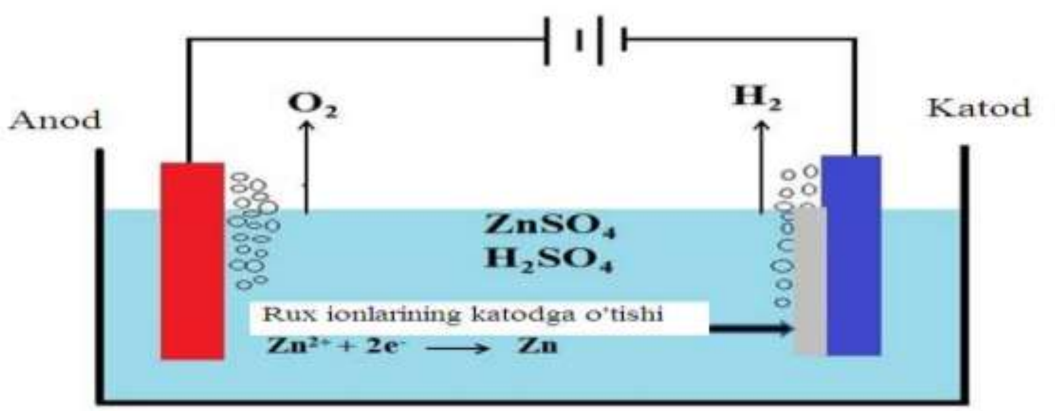
$$FeSO_4 + Zn = Fe\downarrow + ZnSO_4$$

$$CuSO_4 + Zn = Cu\downarrow + ZnSO_4$$

From the purified $ZnSO_4$ solution, zinc is sent to electrolytic recovery.

Electrolysis process. In this case, 3.5-3.6 volt electric current is supplied. Then, zinc and partial hydrogen are released at the cathode, and oxygen is released at the anode. The cathode plate is made of aluminum, and the anode is made of an insoluble lead and silver alloy (1% silver).

Picture 4. Schematic view of the process of electrolysis of zinc sulfate solution



Heavy ferrous and non-ferrous metals obtained as a result of the research are applied to the production process. As a result of processing the large dust of the converter, the impact of damage to the environment is reduced and it is economically effective. This, along with increasing the productivity, creates a basis for saving the consumption of mineral reserves.

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