The Study of the Characteristics of Zinc Cake and the Main Direction of Processing

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ABSTRACT: The paper studied the characteristics of zinc cake and the main directions of processing. The possibility of high-temperature sulfuric acid leaching of zinc cakes has been revealed.

KEY WORDS: zinc cake, chemical composition, preparation of raw materials, dissolution, process, metal extraction, solution, acid concentration, temperature.

I.INTRODUCTION

The problem of rational and integrated use of raw materials occupies an important place in the work of non-ferrous metallurgy enterprises. One of the main trends in the production of zinc at Almalyksky MMC JSC is to increase the complexity of the use of raw materials, determined by the presence of useful components in the raw materials and their degree of extraction into all types of marketable products [1].

One of the main trends in zinc production is to increase the complexity of the use of raw materials, determined by the presence of useful components in the raw materials and their degree of extraction in all types of marketable products. During the hydrometallurgical processing of zinc concentrates, a number of products are formed, the most important of which are cake from the leaching of concentrates and purification of the zinc sulfate solution from impurities [2].

Rational processing of intermediate products provides an increase in both the total extraction of zinc from raw materials and the integrated use of polymetallic concentrates. The middlings of the most interest from the standpoint of the complexity of the use of raw materials are zinc cakes obtained after leaching of calcined zinc concentrate. The yield of cakes is from 25 to 45% by weight of the cinder. This product is an additional source of zinc and a number of related valuable elements. Rational processing of zinc cakes determines the degree of total zinc extraction in production and the degree of complexity of the use of zinc concentrates [3].

Currently, about 95% of zinc is produced by the hydrometallurgical method. In this method, the calcine obtained after calcining zinc sulfide concentrates is finally to sulfuric acid leaching. In this case, leaching deposits are formed with a high content of zinc (18-24%) and copper (0,3-1,5%), called zinc cakes.Zinc and copper in cakes are in the form of sparingly soluble ferrites. The main method used for processing cakes is the Waelz process, which is based on reduction-distillation pyrometallurgical processing in a rotary tube furnace at temperatures of 1200–13000C. The result is sublimates (Waelz oxide) suitable for further leaching and electrolytic extraction of zinc, as well as a clinker used to extract copper at the enterprises of the copper industry. The Waelz process allows one to achieve high levels of zinc recovery (more than 90%), however, it is quite expensive due to the high consumption of coke breeze, reaching 50% with respect to cake.

The process of Weltzin zinc cakes has the following disadvantages:
-high consumption of expensive and scarce coke;
- high temperature process;
- Unresolved issue of the extraction of other valuable components - Au, Ag, Pb, Cu, Fe, etc., due to the lack of rational clinker processing technology;
- environmental pollution by processed products (hard-to-utilize clinker, sulfur-containing exhaust gases).

II. SIGNIFICANCE OF THE SYSTEM

For research, a sample of zinc cake was taken from the Zinc Plant of Almalyksky MMC JSC. The fractional composition, the results of the chemical and mineralogical composition of zinc cake using spectral, chemical and mineralogical methods of analysis are given in table.1-4. In addition to zinc, copper, lead, cadmium, iron, and others are of industrial interest for the extraction of metals. From the results of the analyzes of zinc cake it is seen that the composition of zinc cake is more than 20 % zinc and 2% copper. The main phases of zinc cake are sphalerite Zn1-xFexS, biancite ZnSO4·6H_2O, zinc-copper ferrite $Zn_{1-x}CuxFe_2O_4$, kenazite $Cu_{2,4}Zn_{2,6}(SO_4)_2{\cdot}(OH)_6{\cdot}6H_2O$, gypsum $CaSO_4{\cdot}2H_2O$ and anglezit $PbSO_4$.

Table 1 Fractional composition of zinc cake

№	Sizeclass, mm	Fraction output	
		g	%
1	+40	38,5	1,925
2	-40+20	227	11,35
3	-20+10	607	30,35
4	-10+5	645	32,25
5	-5+2	416	20,8
6	-2+1	14	0,7
7	-1+0,315	15	0,75
8	-0,315+0,140	10	0,5
9	-0,140	27,5	1,375
	Total:	**2000**	**100**

Table 2 The chemical composition of zinc cake, %

Productname									
	$Zn_{общ}$	$Zn_{в}$	$Zn_{к}$	C	$S_{общ}$	S_{so4}	Pb	Fe	SiO_2
Zinccake	21,42	5,59	13,26	0,14	7,69	6,86	6,48	15,21	9,39
	Al_2O_3	Cu	Cd	CaO	MnO	Mg	K	As	In
	1,43	2,32	0,21	2,67	0,85	0,49	0,28	0,35	0,006

Table 3 The mineralogical composition of zinc cake, %

Productname	Content, %					
	$Zn_{общ}$	$ZnSO_4$	ZnO	ZnO· SiO_2	ZnS	Zn Fe_2O_4
	21,42	7,97	3,05	3,44	1,07	6,11

Zinccake	$CuFe_2O_4$	$CuSO_4·5H_2O$	Cu_2S	CuO	CdO	$CaSO_4·2H_2O$
	5,25	1,45	0,16	0,03	0,02	7,16
	$PbSO_4$	FeS	Fe_2O_3	$CaCO_3$	MnS	MgO
	6,05	1,27	0,56	1,45	1,28	0,45

Table 4 The chemical composition of zinc cake in fractions

Class, mm	Classoutput, %	Content, %							
		Zn	Cu	Pb	Cd	Fe	Al_2O_3	SiO_2	S
+40	1,925	21,89	3,27	6,48	0,22	17,23	4,11	9,23	7,77
-40+20	11,35	21,60	3,38	6,57	0,22	17,34	4,13	9,18	7,75
-20+10	30,35	21,08	2,35	6,52	0,20	16,48	4,08	9,14	7,66
-10+5	32,25	21,62	2,34	6,49	0,21	16,50	4,15	9,36	7,69
-5+2	20,8	21,66	2,23	6,37	0,20	16,66	4,12	9,29	7,71
-2+1	0,7	21,63	3,33	6,25	0,29	14,60	4,07	9,17	7,74
-1+0,315	0,75	21,95	3,37	6,32	0,29	13,75	4,08	9,19	7,65
-0,315+0,140	0,5	22,45	2,29	6,32	0,28	12,09	4,17	9,14	7,68
-0,140	1,375	21,66	2,08	6,39	0,28	12,07	4,18	9,16	7,73

III. EXPERIMENTAL RESULTS

The main stages of determining the optimal parameters of high-temperature leaching of zinc cake are:

1. Preparation of raw materials. This operation promotes faster, more complete, selective leaching of the valuable component. Known mechanical methods (crushing, grinding) and physico-chemical associated with a change in the phase composition of the raw material.

2. High temperature leaching of zinc cake with sulfate solutions, iemetal transfer to the aqueous phase, followed by separation of the insoluble residue by settling methods, phase separation by filtration, centrifugation and washing of the residue.

3. Preparation of the solution - purification from impurities by physico-chemical methods and the extraction of metals from sulfate solutions:

- precipitation in the form of sparingly soluble compounds;
- carburizing;
- sorption separation;
- extraction separation.
- concentration of the solution by evaporation, sorption and extraction with the subsequent receipt of the aqueous phase during desorption and re-extraction.

4. Isolation from a solution of a valuable element in the form of a metal (electrolysis, autoclave gas deposition) or a compound (crystallization, chemical precipitation, distillation).

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When choosing a solvent for leaching the product, many factors were taken into account, of which the main ones are: the chemical and physical nature of the product;solvent cost;corrosive effect of the solvent on the equipment;the selectivity of the solvent in relation to the leached product;the possibility of regeneration of the solvent.Sulfuric acid is most suitable for leaching zinc cake.Sulfuric acid is a good solvent for oxidized zinc and copper minerals.And sulfuric acid has a low cost and has a relatively weak corrosive effect on hydrometallurgical equipment.

The previously established experimentally good solubility of oxides in sulfuric acid solutions served as the basis for studying the leaching of zinc cake depending on the duration, temperature, pulp density, and solvent concentration. In addition, taking into account the complex nature of the feedstock, it was important to study the behavior of the accompanying valuable components in sulfuric acid solutions in order to ensure complete separation of zinc into a separate product and selectivity for the extraction of zinc and other metals.

In the pulp there is always a certain amount of ferric sulfate, an oxidizer of sulfides, but the dissolution of sulfides proceeds more slowly than the reaction of dissolution of oxides. This makes possible the additional oxidation of zinc minerals.

It seemed interesting to study the kinetics of dissolution of zinc cake, i.e.in conditions of high temperature leaching. The necessary hydrodynamic regime to achieve a homogeneous pulp density is ensured by a mechanical mixing device. In the laboratory, studies have been conducted on the effect of temperature and acid concentration on the rate and completeness of the transition of zinc from cake to solution. The process was monitored by decreasing the concentration of sulfuric acid in the solution and the zinc content in it. The concentration of sulfuric acid and zinc in the solution was determined by titration according to standard methods. After the studies, calculations were made and graphs of the dependence of zinc extraction in solution on temperature and initial concentration of sulfuric acid were constructed.

From studies it was found that the dissolution of zinc from the ferritic form proceeds in the kinetic region and does not depend on hydrodynamic conditions and on the intensity of pulp mixing (diffusion). The extraction of zinc into the solution is significantly affected by the temperature and concentration of sulfuric acid in the solution (Fig. 1, 2).

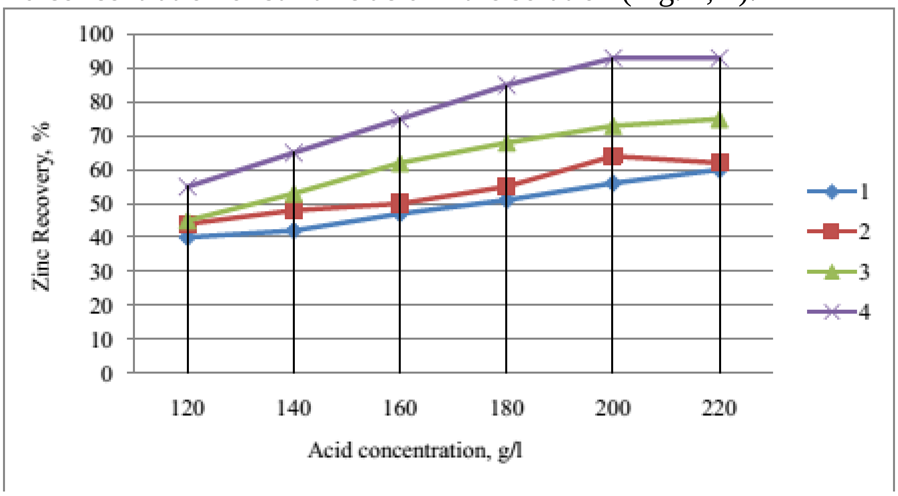

Fig. 1. Graph of zinc extracts in solution versus initial acid concentration at temperature., ^{0}C: 1-60; 2-70; 3-80

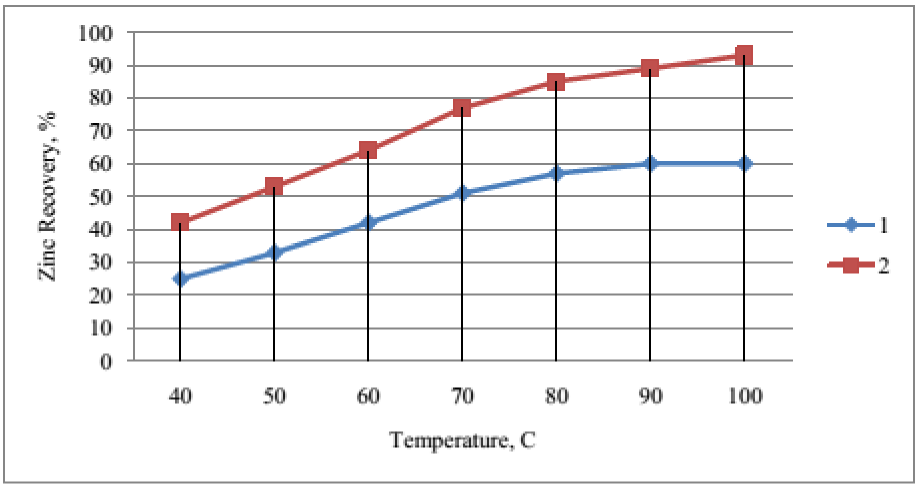

Fig.2. The graph of the dependence of the extraction of zinc in solution on temperature at a concentration of sulfuric acid in solution: 1-120 g/l; 2-200 g/l.

Surfactants - weakly anionic and nonionic flocculants - were used to improve the thickening and filtration of pulps. A study of the effect of the duration of the process on the leaching of zinc from cake by a sulfuric acid solution with a concentration of 100-200 g/l at various temperatures shows that in the initial period (up to 60-90 min), the transition of zinc into the solution proceeds very intensively, and after 3-4 hours a dynamic equilibrium leaching process. An increase in the duration of contact between the sulfuric acid solution and cake can lead to an increase in the content of impurities in the solution. When zinc cake is leached, sulfuric acid reacts primarily with oxidized minerals. Sulfide minerals interact with sulfuric acid slowly. Therefore, in order to achieve maximum zinc recovery with a minimum of impurities entering the solution, the leaching duration is 4 hours.

IV. CONCLUSION AND FUTURE WORK

The studies allow us to draw the following conclusions on the problem of hydrometallurgical processing of zinc cake:

1. The possibility of hydrometallurgical processing of zinc cakes by heat treatment has been identified. Hightemperature sulfuric acid leaching is well established in the processing of zinc cake, provides selectivity and complexity of processing.

2. The optimal leaching time is 4 hours with sulfuric acid concentrations of 180-190 g/l, and the leaching temperature of 90-950C.

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