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Physico-Chemical Characteristics of Zinc Sulfate Produced from Zinc-Containing Concentrate of Khandiza Deposit

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ABSTRACT: The aim of the work is to obtain zinc sulfate from the zinc concentrate of the Khandiza deposit, which meets the requirements of the standard, the establishment of the chemical composition and the study of physical and chemical properties. It is shown that by means of sulfuric acid decomposition with concentrated acid at a given temperature it is possible to obtain zinc sulfate heptahydrate that meets the requirements of the standard. The main impurities of zinc sulfate are chlorine, fluorine, n.o., lead, cadmium, copper, nickel, iron and manganese.

I. INTRODUCTION

The Republic of Uzbekistan pays great attention to the development of the chemical industry, which makes a significant contribution to the development of the country's economy.

The republic needs many products of the chemical industry, among which zinc sulfate and a compound based on it occupy a special place. Despite the presence of a large deposit of pyrite-polymetallic ores, there is no production of zinc sulfate in the country. This is primarily due to the lack of an acceptable technology for the complex processing of polymetallic ores from the Khandiza deposit with the associated separation of other valuable ore components. The explored reserves of the deposit are about 1.5 million tons of zinc, 700 thousand tons of lead, 180 thousand tons of copper, 2.3 thousand silver. In addition, the ore contains selenium, indium, and cadmium along the way. Therefore, research aimed at developing topical. technologies for processing polymetallic ores from the Khandiza deposit with the production of zinc sulfate are relevant.

II. LITERATURE SURVEY

Zinc sulfate (zinc sulfate heptahydrate, $ZnSO_4 \cdot 7H_2O$, zinc sulfate) is used as a microfertilizer, as a mineral feed additive, in the production of mineral paints, as a paper bleach, in the production of various medicines, in dentistry, metallurgy, electroplating, yeast production, beer, leather goods, wood impregnation [1, 2, 3].

Zinc sulphate is produced in conjunction with other zinc product manufacturing processes. It is obtained by treating mineral ores, zinc ash, and secondary sources of raw materials containing metallic zinc or zinc oxide with sulfuric acid, followed by filtration, crystallization, and drying [4, 5].

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III. EXPERIMENTAL RESULTS

For research, zinc-containing concentrate from the Khandiza deposit of the following chemical composition (wt.%) was used: Zn - 45.15-45.45, Si - 12.90-13.30, Mn - 0.1, Fe - 1.57-1 .64, Mo - 0.031-0.033, Pb - 3.01-3.05 and technical sulfuric acid with a concentration of at least 92.5%.

In order to improve the technology for processing polymetallic raw materials and develop a strategy for complete, integrated processing, detailed studies of the mineralogical and chemical composition of both the ore of the Khandiza deposit and the resulting Sphalerite concentrates containing a number of valuable components were carried out.
Previously, studies were carried out on the production of zinc sulfate from zinc sulfide concentrates with sulfuric acid at a concentration of 200–300 g/l and a temperature of 80–90 °C [6]. Zinc sulfate from the zinc concentrate of the Khandiza deposit was carried out at the same process parameters.

The analyzes were carried out as follows. A mineralization device (MILESTONE Ethos Easy, Italy) was used to mineralize the sample. To do this, a test tube of the device was filled with 200 mg of a sample weighed on an analytical balance (FA220 4N), 6 ml of distilled purified nitric acid (HNO_3), obtained by distillation, was added. in an infrared acid purifier (Distillacid BSB-939-IR) and 2 ml of hydrogen peroxide (H_2O_2) as an oxidizing agent. The mineralization process was carried out for 40 minutes.

At the end of the mineralization process, the solution was transferred into a conical flask, diluted with distilled water (BIOSAN, Latvia) to reach 40 ml.

The solution from the flask was placed into special test tubes in the automatic sampling department and measurements were taken. The prepared sample was analyzed on an Avio200 ISP - OES Inductively-connected Plasma optical emission spectrometer (Perkin Elmer, USA). The accuracy of the device is high, which makes it possible to measure elements in solution with an accuracy of up to 10-9 g.

Table 1 shows the data of X-ray fluorescence optical emission analysis of zinc concentrate from the Khandiza deposit.

Table 1. Results of X-ray fluorescence optical emission analysis of the composition of zinc concentrate from the Khandiza deposit

№ sample	Chemical composition, wt. %											
	Zn	Si	K	Ca	Ti	Mn	Fe	Co	Cu	Mo	Cd	Pb
1	45,30	12,90	0,94	0,55	<0,01	<0,01	1,64	<0,01	0,81	0,032	0,40	3,03
2	45,45	13,10	0,94	0,58	<0,01	<0,01	1,61	<0,01	0,79	0,031	0,41	3,04
3	45,15	13,25	0,95	0,57	<0,01	<0,01	1,59	<0,01	0,77	0,033	0,39	3,01
4	45,35	13,30	0,95	0,56	<0,01	<0,01	1,57	<0,01	0,79	0,032	0,40	3,05

The table shows that the zinc-containing concentrate of the Khandiza deposit consists mainly of compounds of zinc, silicon, lead, iron, potassium, copper, calcium and other related elements and has a complex chemical composition.

X-ray fluorescence (ZetiumXRF), IR spectroscopic (Shimadzu, IRAffinity-1) methods of analysis were used to study the chemical composition and physicochemical properties of zinc sulfate obtained from the zinc-containing ore of the Khandiza deposit. For this zinc sulfate composition (wt %) was used: Zn_2SO_3-98.14; Cl-0.4; F-0.4; i.r.-0.05; Pb-0.007; CD-0.007; Cu-0.003; Ni-0.009; Fe-0.03; Mn-0.04.

The analysis of the chemical composition of zinc sulfate obtained from the concentrate meets the requirements of the standard for commercial zinc sulfate.

The spectra of the samples were taken using an IRAffinity-1 FT-IR spectrometer with high-performance, energy-dispersive X-ray fluorescence spectrometry - Japan, Rigaku NEX CG EDXRF Analyzer with Polarization. The IRAffinity-1 FT-IR spectrometer has the highest signal-to-noise ratio of 30,000:1 and a maximum resolution of 0.5 cm-1. The presence of a built-in automatic dryer significantly increases the accuracy of the installation, as well as the stable operation of the device when analyzing chemical elements with a high level of purity. The accuracy of setting the wave numbers when taking IR spectra is ensured by including a highly monochromatic radiation source (He-Ne laser) in the optical scheme of the device.

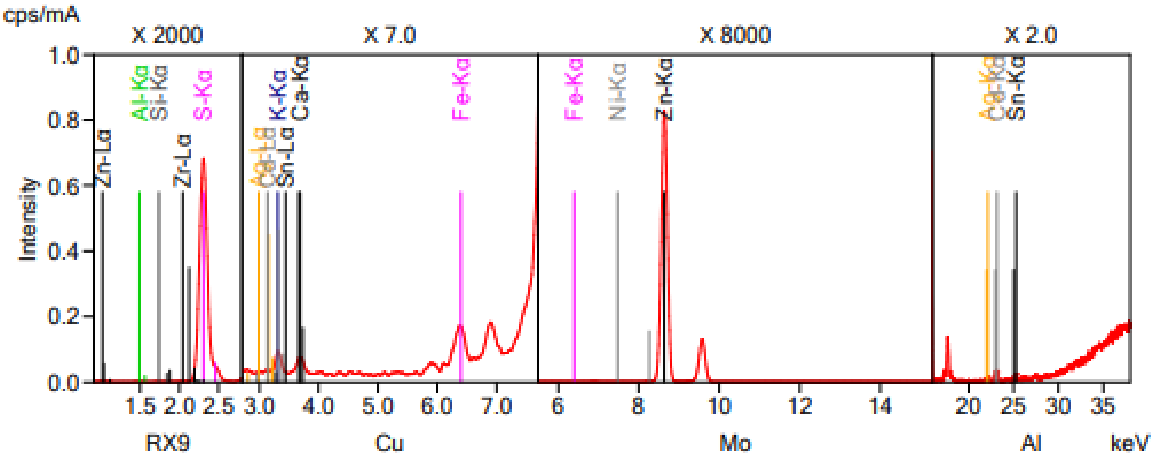

Fig. 1. X-ray fluorescence optical emission analysis spectra obtained for samples of zinc sulfate obtained from zinc concentrate from the Khandiza deposit. Intensity - the number of pulses.

Table 2 shows the data of X-ray fluorescence analysis of the finished product - zinc sulfate. The data on the content of oxides of aluminum and silicon are somewhat higher and amount to more than 0.362% for aluminum oxides and about 0.1% for silicon.

Table 2. The results of X-ray fluorescence analysis of the composition of zinc sulfate obtained from the concentrate of the Khandiza deposit

No	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Al_2O_3	0.362	mass%	0.0112	0.0241	0.0724
2	SiO_2	0.114	mass%	0.0043	0.0099	0.0296
3	SO_3	27.70	mass%	0.0164	0.0182	0.0545
4	K_2O	0.0386	mass%	0.0021	0.0034	0.0102
5	CaO	0.0258	mass%	0.0015	0.0025	0.0074
6	Fe_2O_3	0.0113	mass%	0.0012	0.0030	0.0091
7	NiO	0.0051	mass%	0.0006	0.0016	0.0048
8	ZnO	48.68	mass%	0.0427	0.0003	0.0009
9	ZrO_2	0.328	mass%	0.0037	0.0010	0.0030
10	Ag_2O	0.0025	mass%	0.0003	0.0004	0.0013
11	CdO	0.0090	mass%	0.0005	0.0005	0.0016
12	SnO_2	0.0046	mass%	0.0004	0.0007	0.0020

Figure 2 shows the IR spectrum of zinc sulfate obtained from the zinc concentrate of the Khandiza deposit.

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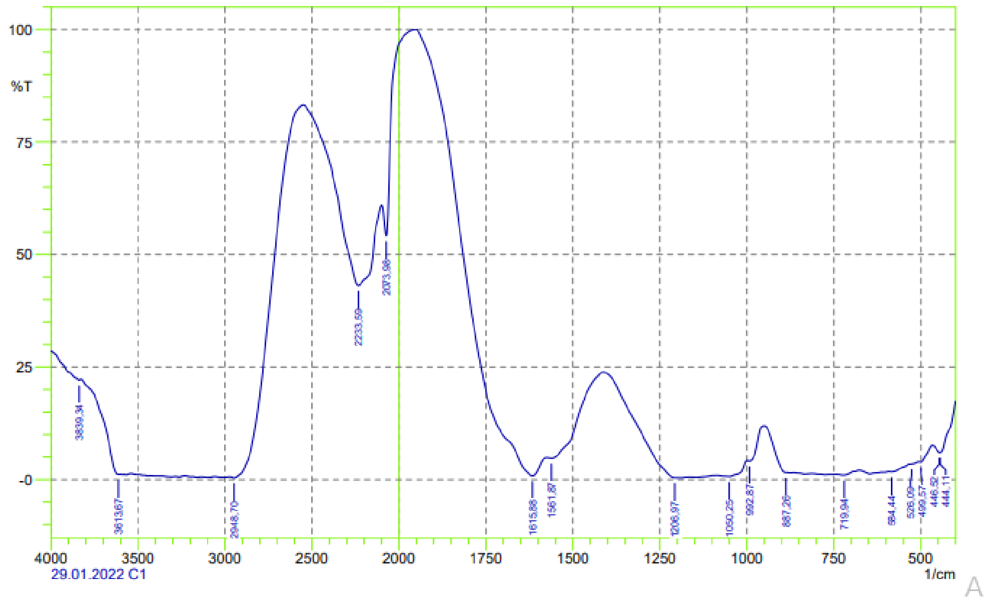

Fig. 2. IR spectrum of zinc sulfate obtained from zinc concentrate from the Khandiza deposit

The IR spectra have absorption bands 1050.25; 992.87; 887.26 cm-1 related to sulfate groups. The bands have a broadened structure due to intermolecular interactions in the crystal structure of the mineral object. This also confirms the obtained data of chemical and X-ray phase analyses.

The electronic spectra of zinc (II) complexes in many cases can provide important structural information (Fig. 3). Most of the six zinc coordination complexes have a high spin. Their base state is 4T1g and the spin-orbit effect is significant. Theoretically, there are three transitions in this group of complexes: 4T1g (F) → 4T2g, 4T1g (F) → 4A2g, and 4T1g (F) → 4T1g (R). The two-electron transition in 4T1g (F) → 4A2g is not observed. The transition at ~20,000 cm-1 corresponds to the 4T1g (F) → 4T1g (R) transition in octahedral complexes. The reason for the reflection is that the spin-orbit interaction at 4T1g(R) breaks the degeneracy. The second peak at 8350 cm-1 is characteristic of the 4T1g (F) → 4T2g transition.

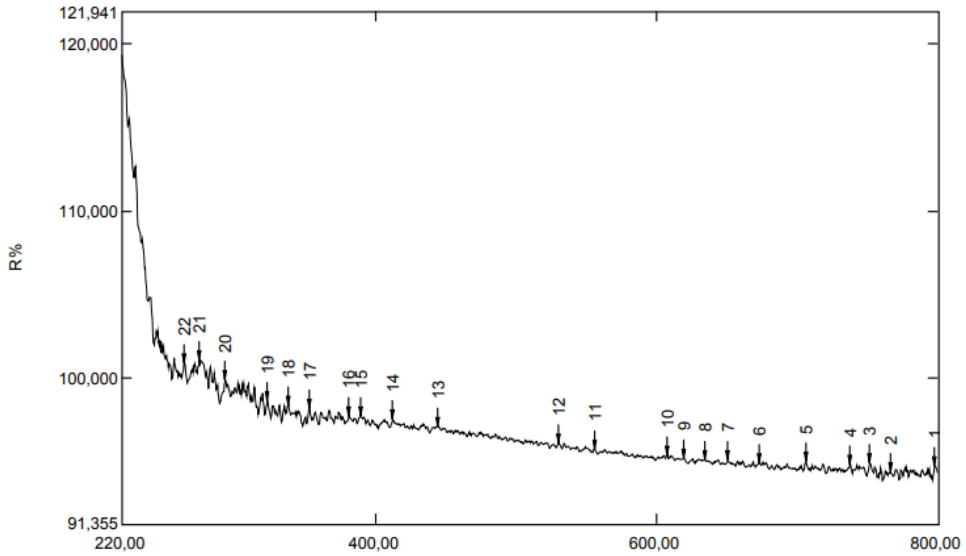

Fig. 3. ESDO spectra of zinc sulfate obtained from zinc concentrate from the Khandiza deposit

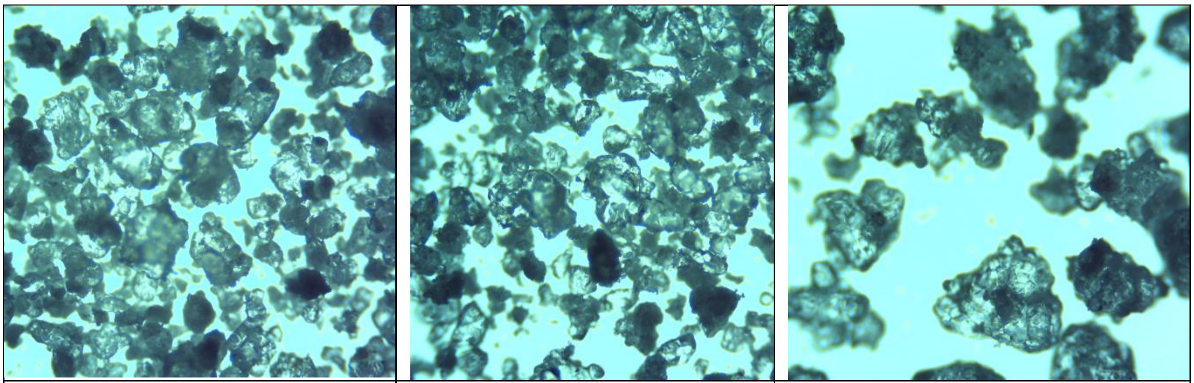

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Fig. 4. Micrographs of zinc sulfate obtained from the zinc concentrate of the Khandiza deposit

On fig. 4 are micrographs of zinc sulfate obtained from the Khandiza zinc concentrate, showing large folded spots that are due to zinc sulfate. This is another confirmation of the composition of the Khandiza zinc concentrate.

IV. CONCLUSION

Thus, the studies on the processing of zinc-containing concentrate from the Khandiza deposit for zinc sulfate, the study of the chemical composition and physico-chemical properties of the finished product prove the possibility of obtaining zinc sulfate that meets the requirements of the standard.

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