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About The Possibility of Extraction of Metals from Mother Solutions Processing of Copper

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ABSTRACT: to article the possibility of extraction of ions of metals from uterine solutions of the vitriol plant is considered. The technique of carrying out experiments is defined. Process of ionic flotation is the cornerstone of the studied process. In work the dependence of extent of plating on pH value of solution, concentration of the collector and duration of flotation is established.

KEY WORDS:solution, copper, nickel, flotation, concentrate, reagent, sulfuric acid, metal recovery.

I. INTRODUCTION

The main objectives of the development of the joint-stock company Almalyk Mining and Metallurgical Combine (Almalyk MMC) in the production of metallurgical products for the short term are defined by Resolution of the President of the Republic of Uzbekistan #RP-2533 of May 20, 2016 "On measures to increase the production of finished export-oriented productsbased on deep processing of non-ferrous and rare metals for 2016-2020"[1].

At present, the design capacity of JSC Almalyk MMC, which is one of the largest enterprises in Uzbekistan, amounts to 31 million t for copper-containing ore and 0.5 million t for lead-zinc ore per year. The reserves of non-ferrous metal ores are mainly concentrated in the Almalyk ore field. The unique deposit is Kalmakyr, which is considerably superior to foreign analogues in the production of copper-molybdenum ores. In addition, prospective Yoshlik I and Yoshlik copper deposits have been explored with large reserves of copper, molybdenum, gold, silver, rhenium, tellurium, selenium and sulfur. It is advisable to build a new concentrator at the Yoshlik deposit, with the participation of foreign capital in copper mining and extraction of associated metals. At the same time, the security of the factory with ore raw materials is calculated for 200 years. The copper smelter is the final link in the copper chain of Almalyk MMC. In the process of processing waste electrolytes of the copper electrolysis plant (CEP) and the bleaching solutions of the gold and silver refining plant (CACiP) of the CSP, mother solute solutions with a high content of impurities are formed in the vitriol plant. The results of analyzes showed that the content of nickel and copper in the mother solution reaches 10-60 g/l, therefore, the nickel present in the mother solution of the vitriol plant is irretrievably lost. In addition, part of the nickel goes into the composition of copper sulfate, with the result that the resulting finished product sometimes does not meet the requirements of GS (grade VS).

II. SIGNIFICANCEOFTHESYSTEM

Currently, more and more attention is paid to the technology that allows you to effectively extract metal ions from metal-containing solutions and wastewater. Thus, it is possible to prevent the harmful effects of solutions and wastewater on the environment and to ensure financial returns. In this regard, research on the processing of solutions for copper production and extraction of metals is an urgent scientific and practical problem.

The task of this work is to search for affordable solutions that are implemented at minimal cost, allowing for effective cleaning of copper production solutions from metal ions with the extraction of valuable metal.

III. LITERATURE SURVEY

The well-known methods for extracting metals from solutions (reagent method, extraction, ion exchange, cementation, sorption) [2-5] have a number of significant drawbacks, since they use expensive reagents or energy-intensive equipment, environmental pollution occurs with secondary pollutants.

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The basis of the studied process is the process of ion flotation. The work established the dependence of the degree of deposition of metals on the pH of the solution, the concentration of the collector and the duration of flotation. The selection of a column-type apparatus for the ion flotation process is substantiated.

For the extraction of metals from waste solutions with low contents, it is permissible to use the process of ion flotation based on the following advantages:
1) the possession of high productivity (flotation time is a few minutes);
2) efficiency at low concentrations of metal in solution (from fractions of a milligram to hundreds of milligrams per liter);
3) low loss of organic reagent when properly selected reagent mode (does not exceed a few milligrams per liter);
4) the difference in low investment.

In most cases, for the flotation of metal ions, gas is needed only as an inert phase for the formation of an interfacial surface of liquid - gas. Therefore, in laboratory studies, nitrogen or air is most often used, which give almost equivalent results. On an industrial scale it is necessary to focus on air, although, if necessary, it is possible, apparently, to organize the regeneration and circulation of gas. In our case air is used. One of the main factors affecting the efficiency of ion flotation is the pH environment, which can affect as follows:
- impact on the solubility of sublate (product extracted into the foam);
- impact on the charge of the extracted ion;
- a change in the ratio of ion-gatherer;
- impact on stability of foam.

IV. METHODOLOGY

For research were selected uterine solutions of vitriol plant. The volume of runoff is 20-30 m^3/day. The content of sulfuric acid is – 4÷7 g/dm^3.
The results of chemical and phase analysis are shown in Table 1 and Table 2.

Table 1. Chemical analysis results

Analyzed product	**Chemical composition,** g/dm							
	H_2SO_4	**Cu**	**Zn**	**Fe**	**Ni**	**Sb**	**Mo**	**As**
The mother solution of vitriol plant CSP	7	62,5	0,21	0,052	12,5	0,35	0,002	0,14

Table 2. Phase analysis results

I. COMPOUNDS	**$CuSO_4$**	**$NiSO_4$**	**$FeSO_4$**	**$ZnSO_4$**	**$HSbO_2$**	**$HAsO_2$**	**H_2SO_4**
II. CONSIST, G/DM	156,9	32,94	0,14	0,518	0,445	0,2	7

From table 1 it can be seen that nickel, copper, zinc, and iron are of industrial interest for the extraction of metals. The complexity of the processing solution is associated with a high content of acid.

The method of ion flotation. The flotation of metals from solutions was carried out in an ion flotation unit. The flotation chamber is made of organic glass, and the impeller and pipe for air leaks from ordinary glass (Figure 1). Changing the pH of the solution was carried out by adding reagents. To control the concentration of hydrogen ions, a laboratory universal pH meter of mark pH- 211 with a silver chloride electrode was used. Air supply and adjustment of air flow was carried out through a gas disperser. Extraction of metals into the foam (foam is a product of ion flotation, consisting of the chemical compound of the collector with metal ions and from a certain amount that did not react with the metal ions) was determined by its residual concentration in the solution after flotation.

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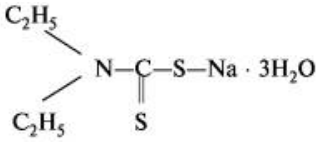
V. EXPERIMENTAL RESULTS

Sodium diethyl dithiocarbamate 3-aqueous 3-aqueous N, N-diethyldithiocarbamate reagent was used for research. It is a white or white crystalline powder soluble in water and alcohol that is white or white with a yellowish or grayish tint. Sodium 3-aqueous diethyldithiocarbamate formula:

Structural 

empirical $C_5H_{10}NS_2Na\ 3H_2O$.
Molecular mass (by international atomic mass)- 225,31.
According to chemical indicators, sodium 3-aqueous N, N-diethyldithiocarbamate must comply with the requirements and standards specified in Table 3.

To date, the theory of the successive decomposition reactions of sodium DEDTP in acidic media has received experimental confirmation. In the first stage, anion hydrolysis occurs $(C_2H_5)_2NC(S)S^- + H^+ = = (C_2H_5)_2NC(S)SH$. On the second one, which proceeds much more slowly, the decomposition of monobasic diethyldithiocarbamic acid occurs with the formation of the corresponding secondary amine and carbon disulfide $(C_2H_5)_2NC(S)SH^- + H^+ = (C_2H_5)_2NH_2 + CS_2$.

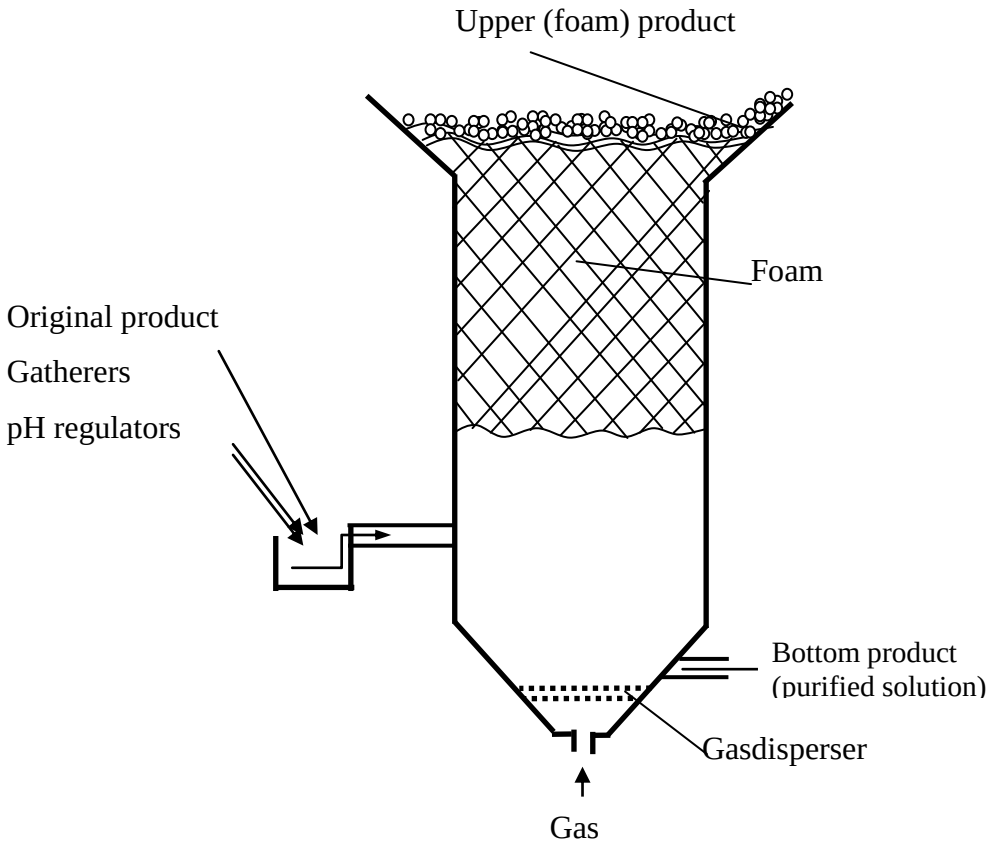


Fig. 1.Installation diagram for ion flotation

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Table 3.Requirements and standards provided for sodium 3-aqueous diethyldithiocarbamate

.	NAMEOFTHEINDICATOR	**NORM**
		PURE (P) OKP 26 3515 0721 08
1.	MASS FRACTION OF 3-AQUEOUS SODIUM N, N-DIETHYLDITHIOCARBAMATE($C_5H_{10}NS_2NA \times 3H_2O$), %, NOT LESS	98
2.	MASS FRACTION OF FREE ALKALI IN TERMS OF NAOH,%, NOT MORE THAN	0,4
3.	WATERSOLUBILITY	NOT STANDARDIZED
4.	CU^{2+}IONSENSITIVITY	NOT STANDARDIZED

The ability to use sodium EDTTA to bind metal ions in acidic aqueous solutions is determined by the tendency of this metal to form strong compounds with this reagent, and not by the rate of reagent decomposition. The interaction of metals with sodium DEDTK proceeds as a result of the following reaction:

$$Ni^{+2} + 2(C_2H_5)_2NC(S)SNa = [(C_2H_5)_2NC(S)S]_2\ Ni^{+2} + 2Na^+$$
$$Cu^{+2} + 2(C_2H_5)_2NC(S)SNa = [(C_2H_5)_2NC(S)S]_2Cu + 2Na^+$$
$$Zn^{+2} + 2(C_2H_5)_2NC(S)SNa = [(C_2H_5)_2NC(S)S]_2Zn + 2Na^+$$
$$Fe^{+2} + 2(C_2H_5)_2NC(S)SNa = [(C_2H_5)_2NC(S)S]_2Fe + 2Na^+$$

The competition of water molecules and collector ions depends on their affinity for the extracted ion. Most simple non-hydrolyzed cations readily hydrate $Me^{x+}(OH_2)_y$. Therefore, at low pH, when hydrolysis is minimal, the hydrated form of the ion is more stable than the product of interaction with the collector. This is especially true for low-charge ions, which are less prone to hydrolysis. In these cases, low pH values are not satisfactory for ion flotation.

To determine the optimal acidity of the solution, experiments were performed at various pH values. For pH adjustment, NaOH solution was used. Sodium DHTTP was used as a collector, and T-80 transformer oil was used as a frother. Conducted laboratory experiments to determine the optimal duration of the flotation time at 2, 4, 6, 8, 10 min.The research results are shown in Figure 2 and Table 4.

To determine the optimal flow rate of the collector, experiments were conducted at various costs of the collector of the stoichiometric amount (Table 5).

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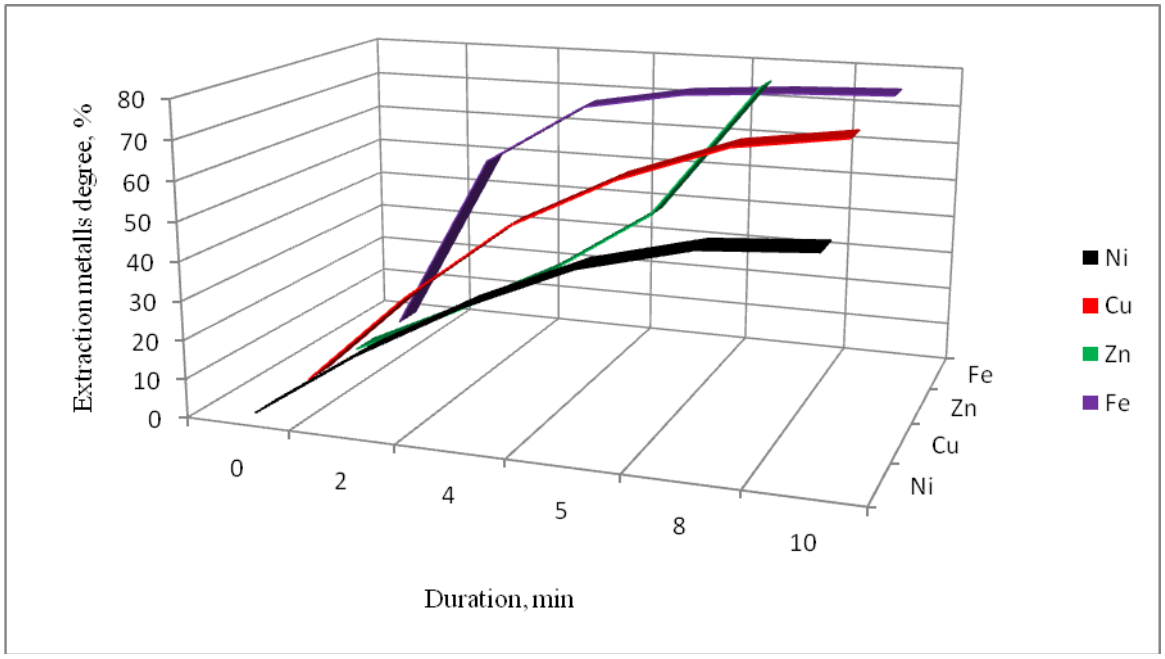

Figure 2.Dependence of the degree of extraction of metal ions on the duration of flotation. Experimental conditions: pH-5, collector consumption 100% of stoichiometry, consumption T-80 - 3,0 g/m^3.

Table 4. Collector consumption from stoichiometric amount

pHofthe solution	The content in the solution after ion flotation, g/dm^3			The output of the foam product, g/dm^3	The degree of extraction in the foam product, %		
	Ni	Cu	Fe^{+2}		Ni	Cu	Fe^{+2}
1	12,5	62,5	0,052	56	10	12	10
2	11,25	55	0,047	58	12	18	16
3	9,9	45,1	0,04	60	15	25	35
4	8,4	33,8	0,025	64	22	42	48
6	6,5	19,6	0,01	69	54	74	75

Table 5.pH values at which almost 100% recovery of metals into the sediment of the corresponding complexes with DEDTK is achieved

Collector consumption	Nickel	Copper	Zinc	Iron (II)
100% of stoichiometric amount	6	4	5,5	7
150 % of stoichiometric amount	4	2	2,5	5

It is revealed that with increasing concentration of the collector, an increase in the degree of metal extraction at low pH values is observed. Studies have shown that the method is effective for metals with an initial concentration of DEDTC sodium 50 g/dm^3 in a wide range of pH values.

Experiments on the effective separation of nickel from copper from solutions show that the use of sodium DEDTA did not give positive results due to the ability of complex formation of sodium EDTTA from both copper and nickel, this is evidenced by a qualitative analysis of the obtained ion flotation products. For the analysis of the sample, the "Spectrometer X-ray energy dispersive BRA-135F" certificate No. 05.9163-2015 dated 05/07/2015 was used. The X-ray energy dispersive spectrometer BRA-135F is a stationary instrument designed to perform X-ray spectral analysis of chemical elements of solid, liquid and powder samples in the range from fluorine (Z = 9) to uranium (Z = 92) (Figure 3-4).

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The results of the experiments show that the maximum metal recovery is observed at pH = 6. The degree of purification of metals is 55-75 %.

The efficiency of the process largely depends on the pH of the treated solution. Over the entire pH range of the solution, precipitation of metals occurs in the form of solid particles . The most complete deposition takes place in close environments, corresponding to the presence of metals in the form of hydroxides. The resulting foam product can be processed by the method of solvent extraction to obtain selective copper, nickel, iron concentrates.

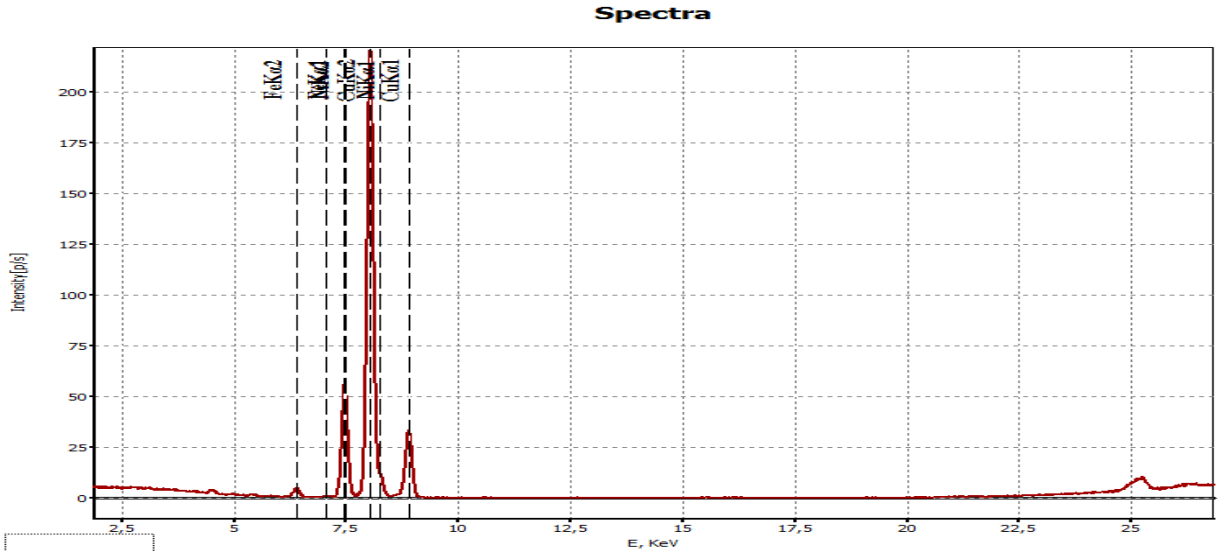

Figure 3. Spectra of a qualitative analysis of the solution after ion flotation using sodium EDTA on the BRA-135F X-ray analyzer

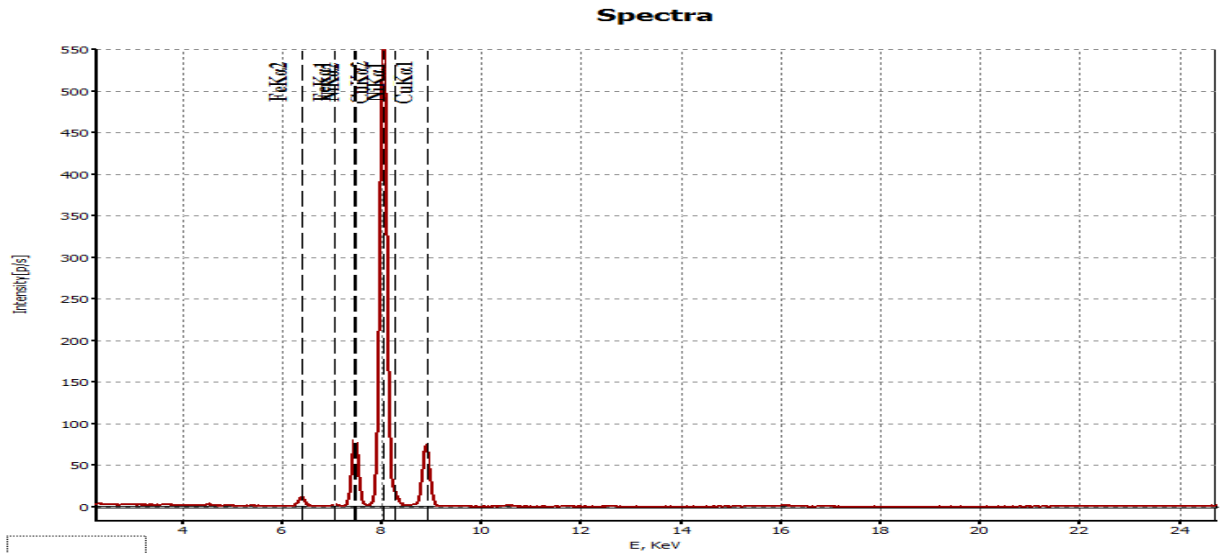

Figure 4. Spectra of the concentrate (foam product) of ionic flotation of mother liquors using sodium DEDTA on an X-ray fluorescent analyzer BRA-135F

VI. CONCLUSION AND FUTURE WORK

The main conclusions and recommendations from the research are as follows:

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Conclusions are as follows:
- justified the possibility of extracting metals from solutions by ion flotation;
- The results of the analysis showed that industrial interest for the extraction of metals from solutions are: nickel, copper, which are contained in solutions in the form of sulfates;
- the method of ion flotation was determined, the necessary reagents were selected.
Found technological solutions can be applied in other industries related to the processing of metal-containing products.

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