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Study of polymetallic Zhezkazgan deposit ore's flotation using phosphorus collectors

Sorption of collectors — dibuthyldithiophosphate of ammonium and sodium on samples of polymetallic ores was investigated. Values adsorption equilibrium was determined. The sorption curve of selective collector (dibuthyldithiophosphate sodium) was obtained. Also in the paper the comparative analysis of the flotation properties of dibuthyldithiophosphate ammonium and sodium respect to polymetallic ore of deposit «Nurkazgan» is given. A high selectivity of dibuthyldithiophosphate solution was established that enabled the development of flotation circuit.

Key words: flotation, collectors, dibuthyldithiophosphate ammonium and sodium, polymetallic ore, metals, sorption, sorption capacity, selectivity.

It is known that problem of deep processing of mining products is currently acquired special urgency. It is included in the list of priority directions of science of the Republic of Kazakhstan. Nowadays analysis of the literature showed that researches of flotation ability of different collectors for ores in development selective flotation mode. Amine collectors were used for flotation extraction of scheelite from other calcareous minerals [1].

It is shown that dodecyltrimethylammonium acetate showed relatively high flotation properties towards scheelite. According to IR-spectrophotometry and adsorption tests revealed that for the salts of alkyl amines characterized by physical adsorption on the surface of minerals. In particularly dodecylacetate is secured firmly on the surface of scheelite than calcite [2, 3]. Also the kinetics of the adsorption of two surface compounds was investigated.

The relative amount of copper xanthate and dixantogen depends on the presence of copper atoms on the surface, therefore, the mobility of atoms in the interface region, which is different for each of the minerals. The amount obtained dixantogen increases for the slow diffusion of copper. Three selective flotations of minerals can be improved on the basis of differences in adsorption amyl xanthate (selective changes in the mineral hydrophobicity) under optimal conditions [4].

In the case of sulfide ore the flotation occurs at the exchange mechanism, followed by chemisorption of collectors. Various collectors compared to selective flotation of copper-zinc ore. Isopropylethylthionocarbonate (Z-200), buthylxanthogenate, dibuthylammonium, ammonium dithiophosphate and mercaptobenzothiazole (MBT) were used as collectors. The latter collector has the effective selectivity at the flotation of chalcopyrite and marmatite [5].

Thereby the study of flotation properties of phosphorus collectors is relevant, because enrichment of disseminated ores is quite challenging, requiring an integrated approach with both technological and physical-chemical point of view. Purpose of research is study of the flotation properties of phosphorus-containing collectors with respect to polymetallic ore.

Experimental part

Flotation of polymetallic ore samples was carried out by the procedure described in work [6].

The calculation of basic indicators flotation was carried out using the formula [6].

Yield of product (concentrate) E (%) is calculated to:

$$E = \frac{m_k}{m} \cdot 100\,\%\,. \qquad (1)$$

The degree of extraction (%) is calculated to:

$$x = \frac{C_k m_k}{C_m} \cdot 100\,\%\,, \qquad (2)$$

where C_k, C_m — mineral amount in the concentrate and ore, mas. fraction.

Degree of concentration (enrichment) K is calculated to:

$$K = \frac{C_k}{C}. \quad (3)$$

The atomic-absorbing analysis was made on the AA240 brand device.

Adsorption of phosphorus-containing collectors respect to polymetallic ore was carried out by the technique described in work [7].

Adsorption equilibrium constants were calculated by the formula:

$$C_L = C_M \frac{V_M}{V_L}, \quad (4)$$

where C_L, C_M is the concentration of the ligand and metal; V_L, V_M — its volume.

Adsorption value is calculated from the obtained values from equation:

$$\frac{x}{m} = \frac{(C_0 - C_p)V}{m}, \quad (5)$$

where C_0, C_p — initial and equilibrium concentration of solution, mole·L^{-1}; V is the volume of solution in which the adsorption process, ml; m — amount of adsorbent, g.

Materials and reagents. As the main object was used polymetallic ore of Zhezkazgan deposit. Dibuthyldithiophosphate sodium and ammonium were used as the collectors. Diisoocthyldithiophosphate ammonium is used as the foaming agent. Calx was used for environment control.

Results and Discussion

Analysis of sorbent properties of collectors with respect to polymetallic ore particles was carried out. The studies were conducted on samples of Zhezkazgan deposit ore using the collectors based on derivatives dithiophosphoric acids. According to the results of atomic-absorption analysis the investigated ore is chalcopyrite. Consequently, the main ions in the crystal lattice of the composition are iron and copper ions.

It is known that the destruction of the solid state when disconnection occurs between the molecules, atoms and ions, unsaturated bonds appear on the surface. In this case, these are due Cu–S, Fe–S, so the interaction energy between the solid surface and the molecules gatherers determined by the strength and nature of the bond formed in the adjacent layer. Copper sulfide ores to mineralogical composition can be attributed to the low and average power dense [8].

I.e. key issue is to choose the most selective collector with energy of the same order. As previously mentioned fixing of the collector takes place closest to the surface layer which is monomolecular. This data confirms the lower equilibrium concentration in the collector solution (Tables 1 and 2).

T a b l e 1

The results of potentiometric determination of adsorption equilibrium at the interface «copper – dibuthyldithiophosphate sodium» (T=298 K)

№ solution	$C_0 \cdot 10^5$, mole·L^{-1}	$C_p \cdot 10^5$, mole·L^{-1}	$x/m \cdot 10^4$	lg C_p	lg (x/m)
1	2.00	1.00	5.00	–5	–3.30
2	2.00	1.00	3.00	–4.92	–3.52
3	1.00	1.00	1.00	–4.00	–4.92

T a b l e 2

The results of potentiometric determination of adsorption equilibrium at the interface «copper ore – dibuthyldithiophosphate ammonium» (T =298 K)

№ solution	$C_0 \cdot 10^5$, mole·L^{-1}	$C_p \cdot 10^5$, mole·L^{-1}	$x/m \cdot 10^4$	lg C_p	lg (x/m)
1	1.00	0.80	1.00	–5.097	–4
2	1.00	1.00	0	–5	–
3	1.00	1.00	–1.00	–4.921	–

As can be seen from the data in Table 2, low levels of sorption values for ammonium dibuthyldithiophosphate indicate physical adsorption based on the Van-der-Waals interactions. In the case of sodium dibuthyldithiophosphate the formation of strong covalent bonds with ions of copper or iron was observed.

This process is possible only in case of an exchange or hydroxyl groups, or sulfate and thiosulfate ions formed during the oxidation of the surface ore oxygen. In this connection, sorption isotherm has been built.

Analysis of the adsorption is showed that an increase in the equilibrium concentration of the collector the amount adsorbed on the surface of polymetallic ore is reduced. Therefore, the main process is the potential which determines the adsorption of copper ions or their complexes with the inner collector electrode electric double layer [8].

These compounds are crucial in securing an air bubble on the surface of the ore and the formation of water layer in the flotation. This water shell has a charge by the presence of a minor amount of counter ions, which, in this case, the ions are sodium or ammonium. E.Fervey and Ya.Overbek showed that presence of a double layer leads to repulsion between the particles and thereby to stabilize the system [9].

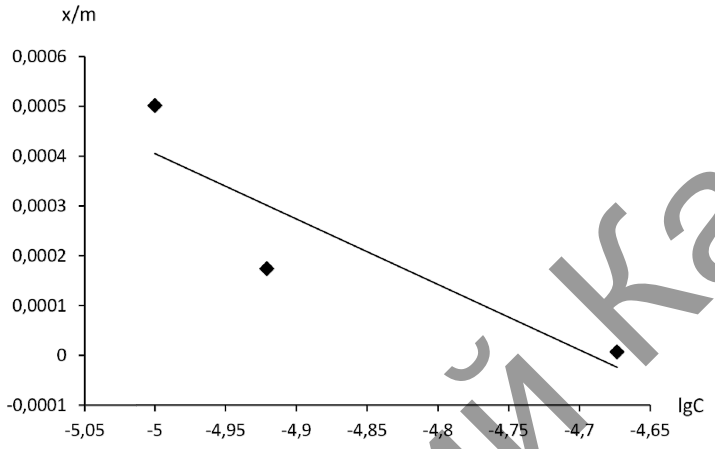

Figure 1. The adsorption isotherm of sodium molecules of dibuthyldithiophosphate at the interface «copper ore – solution»

In this regard, collectors on reducing the adsorption capacity can be arranged in the following line: $(C_4N_9O)_2PS_2Na>>(C_4N_9O)_2PS_2NH_4$ likewise changes and hydration energy of the cations in the aqueous solution for a similar ions. Based on the fore going dibuthyldithiophosphate sodium was selected as the base agent and the ammonium dibuthyldithiophosphate can used as auxiliary flotation reagents.

Figure 2 shows a diagram of the laboratory tests for individual collectors with diisoocthyldithiophosphate ammonium as a foaming agent.

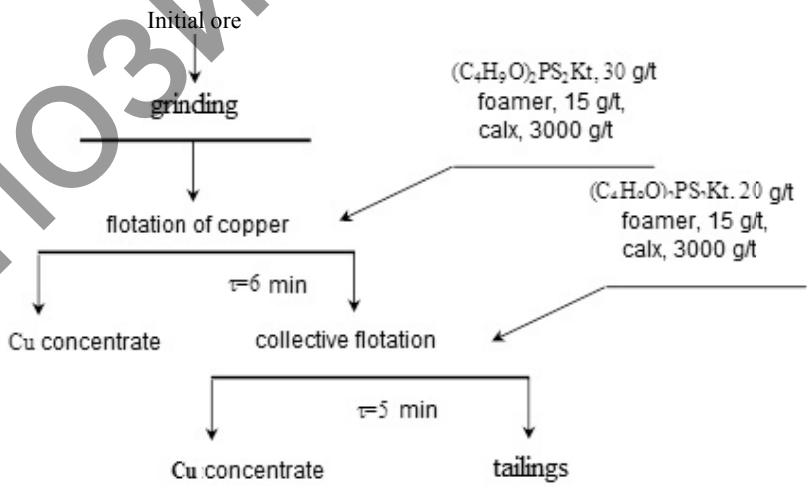

Figure 2. Schematic diagram of laboratory flotation in open loop for individual phosphorus collectors: Kt — Na^+, NH_4^+

Table 3 shows the results obtained according to the scheme of collective flotation separation of copper concentrate for reservoir phosphorus.

T a b l e 3

Results of experiments using circuit phosphorus-hydril collectors on pulp of current processing

Product	Yield		Extraction, %		The degree of enrichment, %	
	g	%	Cu	Fe	Cu	Fe
Dibuthyldithiophosphateammonium50g/t, diisobuthyldithiophosphateammonium15 g/t						
concentrate	0.23	2.31	54.08	58.02	7.08	7.59
tailings	9.77	97.69	45.92	41.98	49.72	45.45
intotal	10	100	100		56.80	53.04
Dibuthyldithiophosphateammonium50g/t, diisobuthyldithiophosphateammonium15 g/t						
concentrate	0.20	2.04	47.12	41.76	23.07	20.43
tailings	9.78	97.96	52.88	58.24	53.99	59.45
intotal	10	100	100		77.06	79.88

According to the results of circuit flotation experiments revealed that sodium dibuthyldithiophosphate exhibits high flotation ability with respect to polymetallic ore. The degree of extraction of ore and copper and iron concentrate shows it. Application dibuthyldithiophosphate sodium improves the recovery of metal in the concentrate as compared to ammonium dibuthyldithiophosphate.

This fact is due to the different wettability, surface hydrophobicity, and consequently, on the other hand, ammonium ions constituting the outer shell of the electric double layer on the particle surface when attaching the air bubble, inhibit its degradation, which leads to reduction in the strength of Van-der-Waals bonds between the bubble and particle.

Conclusion

Thus, the behaviors of flotoreagents at the interface «solid–solution» were identified as a result of researches of flotation capacity of phosphorus collectors. It is shown, that sodium dibuthyldithiophosphate is characterized by high extraction degree of copper in concentrate, as this is due to the strength of the adsorption complex and hydrophobic complex «bubble-particle». The physical adsorption occurs in the case of ammonium dibuthydithiophosphate, which degrades the ore flotation. Thereby the development of selective flotation reagent regime of polymetallic Zhezkazgan deposit ore by using dibuthyldithiophosphate sodium as collector was carried out.

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Фосфорқұрамды коллекторлар қолданылған Жезқазған кен орнындағы полиметалды кендерінің флотациялануын зерттеу

Мыс кендері үлгілеріндегі натрий және аммоний дибутилдитиофосфат коллекторларының сорбциясы зерттелген. Адсорбциялық тепе-теңдігінің мәндері анықталған. Натрий дибутилдитиофосфаты болып анықталған селективті коллекторының сорбция қисығы алынған болатын. Кеннің беткі қабаты мен коллектор арасындағы әрекетінің сипаттамасы анықталған. Сонымен қатар «Нұрқазған» кен орнына қатысты натрий және аммоний дибутилдитиофосфаттарының флотациялық қасиеттерінің салыстырмалы талдауы жүргізілген болатын. Флотация схемасын дайындауға себеп болған натрий дибутилдитиофосфаттың жоғары селективтілігі айқындалған.

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Исследование флотируемости полиметаллической руды Жезказганского месторождения с использованием фосфорсодержащих коллекторов

Изучена сорбция коллекторов дибутилдитиофосфата аммония и натрия на образцах полиметаллической руды. Были определены величины адсорбционного равновесия. Получена кривая сорбции селективного коллектора, которым служил дибутилдитиофосфат натрия. Выявлен характер взаимодействия коллектора с поверхностью руды. Также в статье был проведен сравнительный анализ флотационных свойств дибутилдитиофосфата аммония и дибутилдитиофосфата натрия по отношению к полиметаллической руде месторождения «Нурказган». Установлена высокая селективность дибутилдитиофосфат натрия, что позволило провести разработку схемы флотации.

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