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TECHNOLOGICAL IMPROVEMENT OF ORE FLOTATION AT THE CONCENTRATING PLANT OF UCHALYNSKY MINING AND CONCENTRATING WORKS

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Deposits of the copper-zinc-pyrites formation of the Southern Urals are presented by the three mineral types: sphalerite-chalcopyrite-pyrites; chalcopyrite-magnetite-pyrrotine-pyrites and pyrites. The *first* type is presented by the main ore bodies of Uchalynsky and Molodezhnoe deposits and upper ore bodies of Sybaiskoe and Uzel'ginskoe deposits. The *second* type corresponds to the lower bodies of the many-tier ore fields of Sybaiskoe and Uzel'ginskoe deposits. Pyrites ore body of Gayskoe deposit belongs to the *third* type and is accompanied by pyrophillite metasomes.

Increase of demand of quality of the copper concentrate (without decrease of achieved extraction) in the course of treatment of the copper and copper-zinc ores at the concentrating factory of "Uchalynsky GOK" JSC was the foundation for fulfillment of the special technologic researches by the specialists of JV (Joint Venture) "IVS" JSC. The goal of the research was the more accurate definition of technological scheme and reactant regime of flotation in the copper cycle. The scheme and regime have to ensure obtain of the copper concentrate containing not less than 17% of copper by means of application of the high selective reactants of the new generation.

Copper and copper-zinc ores of Uchalynsky and Molodezhnoe deposits are the ore base of the Uchalynsky concentrating plant. Some part of the copper-zinc ores of Talganskoe deposit is sent to the plant too.

The ores of Uzel'ginskoe deposit are the main volume of the raw material processed at the factory today and in future. Follow mentioned minerals are presented in the ores:

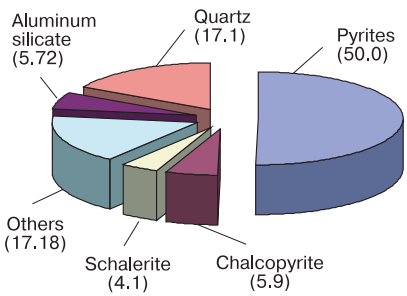

Fig. 1. Mineralogical composition (%) of the copper-zinc ores of Uzel'ginskoe deposit

- principal — pyrites, pirrotine, melnikovite, markazite, sphalerite, chalcopyrite and tetrahedrite;
- secondary — arsenopyrite, magnetite, haematite, galena;
- rare — bornite, chalcocite, altaite, hessite, silvinite tellurium-bismuth and so on;
- non-metallic minerals — quartz, schistose silicates (mainly sericites), potassium hydro-mica, peach, seldom — carbonate.

In spite of the simple mineralogical composition (fig. 1) the samples of the ore are characterized by significant diversity of the texture-structural features. Massive texture is the most typical (fig. 2).

Study of comminuting of processed at the factory ores has shown:

- massive-disseminated ores (Molodezhnoe deposit) are comminuted much worse than the compact ores (Uchalynsky and Uzel'ginskoe deposits);
- pyrites is opened in the greatest degree in the ores of all kinds of the sulfide minerals in the class –0.074 mm;

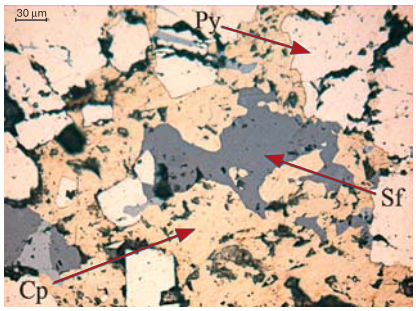

Fig. 2. Chalcopyrite (Cp) accreted with schalerite (Sf) and pyrites (Py) (magnification 20)

• in the compact ores of the sulfide minerals in the class –0.044 mm the most opened mineral is chalcopyrite, in the disseminated ores (Molodezhnoe deposit) — sphalerite.

Fig. 3 shows dependence of degree of opening of the general sulfides on coarseness of comminuted copper-zinc ore of Uzel'ginskoe deposit.

Results of study of substantial composition of examined ores permit to conclude:

• expediency of separation of the copper-"head" at beginning of technological scheme owing to opening of the copper minerals of the ore comminuted to coarseness 65% of the class –0.074 mm;

• necessity of additional comminuting of the tails of flotation of the copper-"head" for opening of the fine accretions;

• expediency of the collective flotation of the sulfides with subsequent obtain of the final concentrates.

Fig. 4 shows current technological scheme of flotation of the copper and copper-zinc ores at CP (concentrating plant) "Uchalynsky GOK" JSC. The scheme has been worked up and put into practice by the specialists of "Uchalynsky GOK" JSC jointly with the specialists of JV "IVS" JSC in the course of reconstruction in 2000–2007. The worked up scheme involves the following flotation cycles: separation of the copper-"head" containing 17–18% of copper (at the copper ore — to 20%); I and II collective copper-zinc flotation; selecting cycle including the main and the three re-cleaning operations, allowing to increase the copper content in the foam product of re-cleaning up to 14–15%.

The product of the cycle of copper removing from the coarse zinc concentrate (9–12% of copper) is the component of the final copper concentrate.

It has to be noted that complication of obtain of the high-grade copper concentrate is connected with present in the ore of the fine easily processed by flotation pyrites (50–70% of the total quality of pyrites). So, it is necessary to maintain the high residual concentration of the lime — from 300 to 500 mg/l for depression of pyrites. It leads to higher losses of the zinc with the copper concentrate. Flotation under the low concentration of the lime (56–140 mg/l) is the obliged measure for prevention of the losses of zinc. Besides, usage of the non-selective reactants complicates the situation. The reactants are butyl xanthagenate and foam generator KSF (kaprolactam of the spirituous fraction).

The laboratory studies of the methods of increase of quality of the copper concentrate have specified:

• technological scheme of flotation;

• necessary coarseness of the comminuted ore and additionally comminuted final products;

• condition of flotation in the copper cycle, including usage of the high-selective collectors and modifiers of the new generation.

The aim of the new technology is obtain of the high quality copper-"head", containing 22–24% of the copper and not less than 16% of the copper concentrate after third re-cleaning.

It has been carried out testing of the copper flotation in the open cycle for choice of the most selective reactant-collector in combination

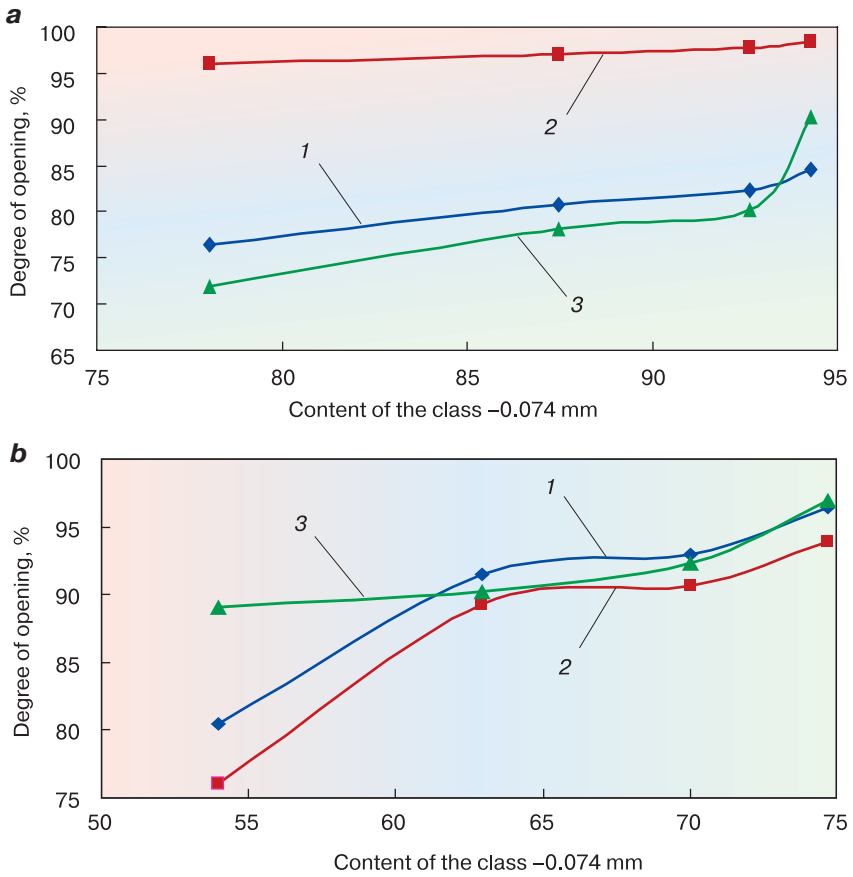

Fig. 3. Dependence of content of the free mineral grains on coarseness of comminuted ore (*a* — in the class –0.074 mm, *b* — in the class –0.044 mm)
1 — chalcopyrite; *2* — pyrites; *3* — sphalerite

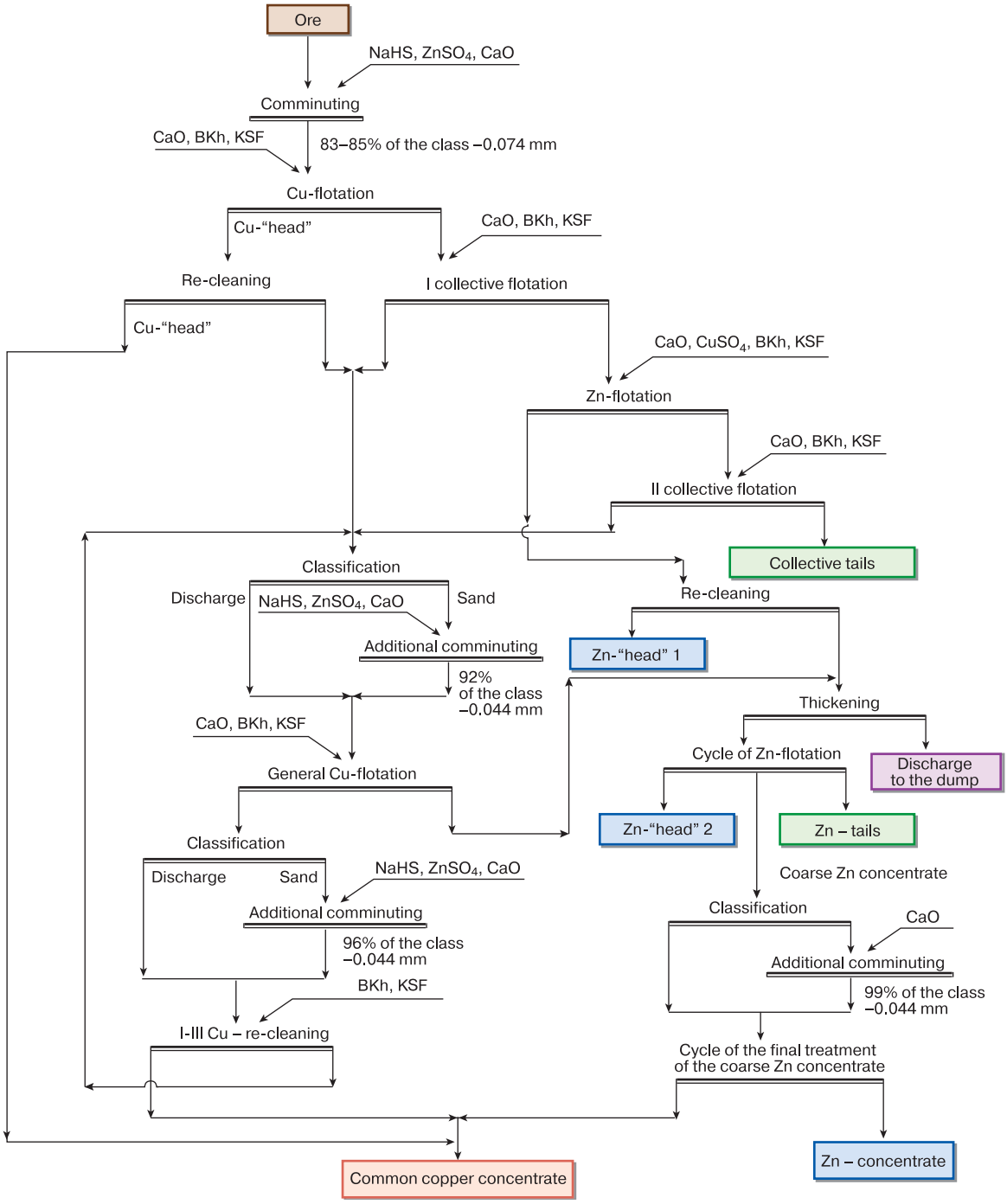

Fig. 4. Current scheme of flotation at Uchalynsky factory with application of the standard reactant regime

with the foam-generator OrePrepX-133. The following reactants of the firm Cytec (USA) have been tested: Aerophine 3418A; Aerophine 6931; Aero 9863; Aero 7048 (fig. 5). Butyl xanthagenate in combination with the foam-generator KSF were used as the standard collector.

It is obvious that the highest quality of the copper-"head" — 23.8% of copper (extraction — 33.7%) is reached in the case of application of Aero 9863 (the summary extraction into the total collective concentrate is 88.3%).

Usage of the more selective reactants has permitted to optimize separation of the copper, zinc minerals and pyrites, and to increase residual concentration of the lime to 300–500 mg/l for deeper depression of pyrites. It has permitted to decrease the losses of zinc in the copper concentrate.

Usage of the reactant S-7261A of the firm Cytec as the depressant of the pyrrotine and pyrites favors increase of selectivity of flotation (losses of zinc

Technological parameters of flotation

Type of the ore	Content in the ore, %		Cu content in the Cu-concentrate, %	Extraction of Cu into Cu-concentrate, %
	Cu	Zn		
Copper ore of Uzel'ginskoe deposit	1.8/1.82	0.54/0.5	17.65/20.03	90.4/90.9
Copper-zinc ore of Uzel'ginskoe deposit	1.15/1.19	2.91/3.29	17.44/19.09	85.8/84.4
Copper-zinc ore of Uchalynsky deposit	0.97/0.93	4.03/4.22	14.86/18.57	82.9/82.2
Copper-zinc ore of Molodezhnoe deposit	1.29/1.27	2.52/2.48	14.82/19.56	81.4/78.6
Working mixture of the copper-zinc ores of Uzel'ginskoe and Uchalynsky deposits	1.11/1.09	3.98/3.98	14.81/18.57	85/83.9

Numerator – standard flotation scheme and reactant regime, denominator – recommended ones.

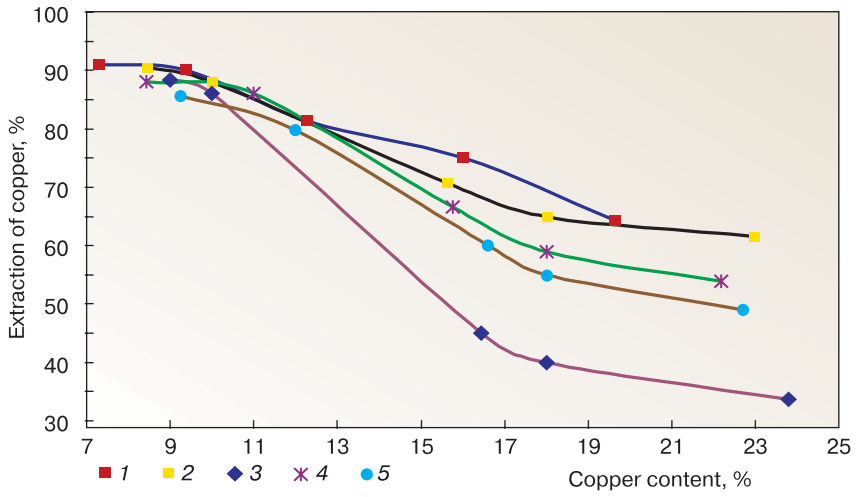

Fig. 5. Technological parameters of the copper flotation with application of the different collectors

1 — Butyl xanthagenate; *2* — Aerophine 3418A; *3* — Aero 9863; *4* — Aerophine 6931; *5* — Aero 7048

decrease by 3.3% in comparison with the standard regime, extraction of copper increases by 2.7%).

It has been determined that the best opening of the useful minerals of the studied ores takes place in the case of comminuting to coarseness 88–90% of the class –0.074 mm. Meanwhile achieved to now coarseness is: for copper ore of Usel'ginskoe deposit — 74% of the class –0.074 mm; for copper-zinc ores — 83–85% of the same class. So, it is recommended to use the more effective collector (butyl xanthagenate) in the collective cycle for additional extraction of chalcopyrite and sphalerite.

Thus, recommended technological scheme and reactant regime include:

- separation of the inter-cycle copper-"head" by means of two re-cleaning (for copper ore — one re-cleaning);
- directing of the final products of re-cleaning to the cycle of selection of the copper concentrate;
- recommendation for coarseness of the feeding material of the inter-cycle flotation: 55% of the class –0.074 mm for copper ores and 65% of the same class for copper-zinc ores;
- usage of combination of the collector Aerophine 3418A and foam-generator OrePrepX-133 in the cycle of selection and in flotation of the copper-"head";
- use of additional depressant of sphalerite and pyrites — reactant S-7261A — in flotation of the copper-"head";
- usage of the butyl xanthagenate in the cycle of the collective flotation.

Results of the laboratory closed tests in accordance with the standard and offered flotation schemes and reactant regimes (without copper removing from the coarse Zn concentrate) are given in the table.

It is obvious that recommended scheme and reactant regime of flotation permit to increase copper content in the concentrates of the different ore by 2–5%. It is going to carry out this year industrial testing of the recommended technology for Uzel'ginskoe copper ore and for working mixture of the copper-zinc ores of Uchalynsky, Uzel'ginskoe and Molodezhnoe deposits. EM