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IMPROVEMENT OF EQUIPMENT AND TECHNOLOGY AT UCHALINSKAYA CONCENTRATING PLANT DURING 2000–2008

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Taking into account constant decrease of reserves of the high-grade ores, mining and concentrating works are obliged to increase the volumes of output. It is impossible without introducing of the new technique and technology. The most perspective direction in the mining branch is introducing of the new equipment and technologies at the facility of processing of the raw minerals.

Side by side with Gaysky GOK Uchalinsky GOK is one of the biggest copper processing works at the Urals. In total they produce more than 70% of the copper concentrates and about 90% of the zinc concentrates.

By-stage reconstruction of the facilities of the concentrating plant of "Uchalinsky GOK" JSC has been completed in 2007. Reconstruction has been started in 2000 with usage of the modern equipment and new technology.

Analysis of the volumes of processed ore at CP (concentrating plant) of "Uchalinsky GOK" in 1984–2007 has shown that output of the plant in period of reconstruction has not decreased. Quite the contrary productivity of the plant has increased by 24% up to 5 million tons of the ore every year (fig. 1).

The raw mineral base of Uchalinskaya concentrating plant includes:

- copper-zinc-pyrites ore of Uchalinskoe deposit;
- copper ore of Uzel'ginskoe deposit;
- two types of the copper-zinc ores of Uzel'ginskoe deposit: pyrites-containing and pyrrhotine-containing;
- copper-zinc ore of Molodezhnoe deposit.

Brought ores of Aleksandrovskoe, Nikolaevskoe, Saf'yanovskoe deposits indifferent periods formed the biggest share of processed ores.

The principal ore minerals of the ores processed at Uchalinskaya plant are pyrites, sphalerite and chalcopy-

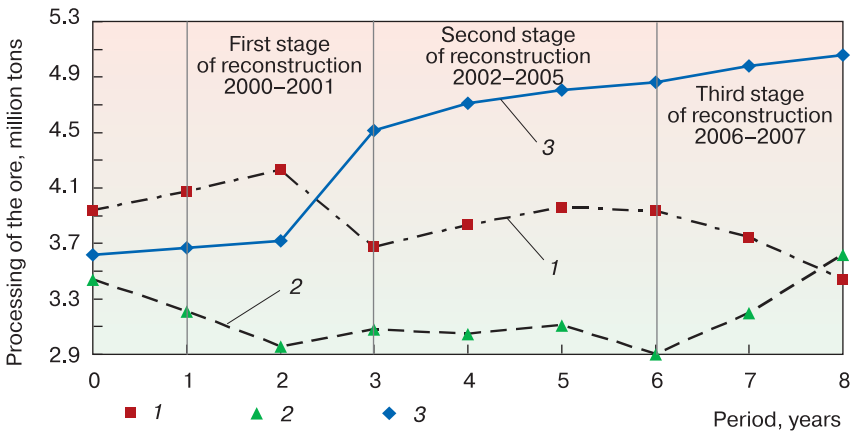

Fig. 1. Change of volume of processed ore at Uchalinskaya concentrating plant by the years:
1, 2 — before the reconstruction (1984–1991 and 1992–1999 correspondingly);
3 — after reconstruction (2000–2007)

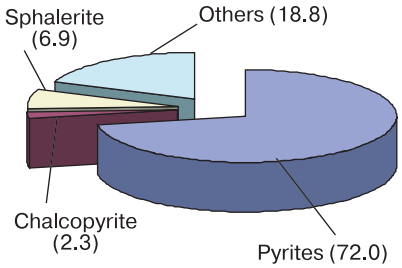

Fig. 2. Mineral composition (%) of the copper-zinc ore of Uchalinskoe deposit

rite (fig. 2). Mineral composition of the ore is rather simple, but it is characterized by complicated texture-structural features.

Analysis of work of the plant in 1984–2007 demonstrates steady decrease of copper and zinc content in the concentrated ores (fig. 3).

Unfavorable factors, defining concentration-ability of the ores, are:

- non-uniformity of distribution of the useful minerals in the ore, wide range of sizes of the mineral formations, that demands additional crushing;
- complex fine mutual accretion of sulfides, spreading of collomorphic varieties of the last ones disposed to over-crushing;
- presence of the varied forms of pyrites, fine inclusions of pyrites in chalcopyrite and sphalerite (fig. 4).

Simultaneously with beginning of reconstruction of the first section of the plant it was carried out the research works for perfecting of the scheme and regime of flotation. The results of the researches were used in the projected scheme of processing of the ore.

On the base of study of processed at the plant ores, carried out by the specialists of JV (Joint Venture) "IVS" JSC, it has been worked up the technological scheme of concentration, including the new technological solutions (fig. 5):

- separating of the inter-cycle copper-"head" and re-cleaning of the last one;

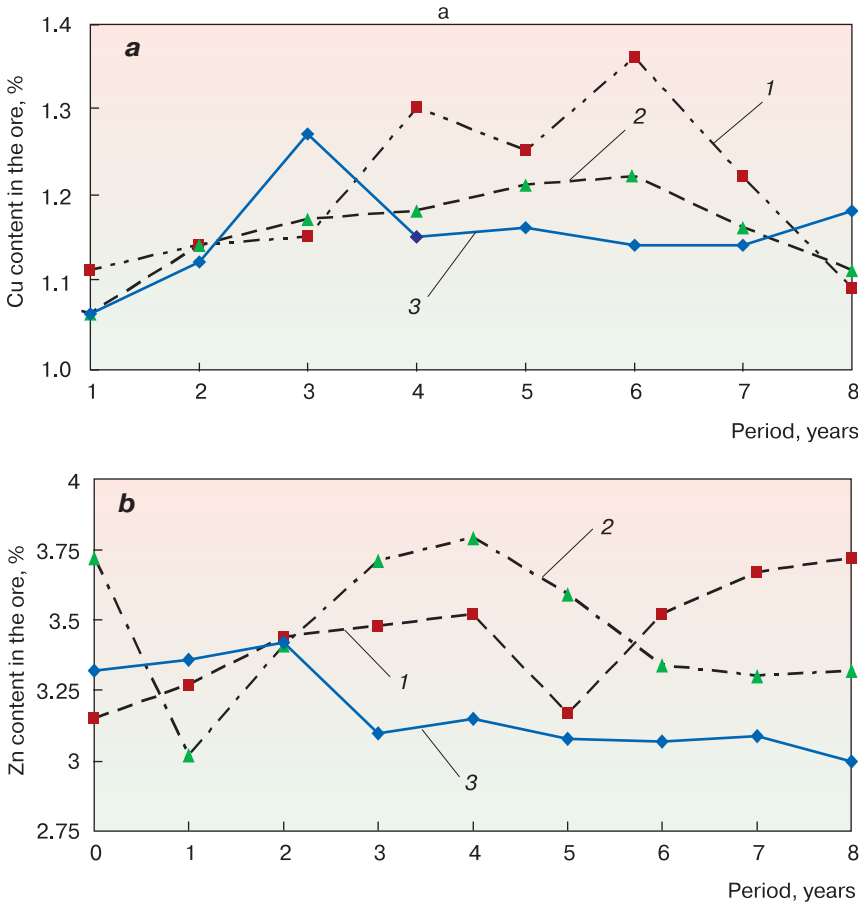

Fig. 3. Change of content of copper (*a*) and zinc (*b*) in processed ore by the years:
1–3 — the same positions as at the fig. 1

- obtain and separating of the high-grade (by copper content) collective concentrate with its subsequent additional crushing to coarseness 90–92% of the class –44 μm;
- introducing of the station of preparing of the pulp before separating of the first zinc-"head", including conditioning with the copperas and lime;
- additional flotation of sphalerite from the tails of the collective flotation;
- additional crushing and classification of the tails of the first re-cleaning of the zinc-"head" and the concentrate of additional flotation before send of the last ones to the thickener;
- heat and aeration conditioning of the pulp in the first zinc re-cleaning;
- removal of copper and ferrum out of the zinc concentrate with obtain of zinc with the chamber product and finishing of the copper-pyrites product in the separate cycle.

Worked up technological scheme was the basis for project of reconstruction of Uchalinskaya concentrating plant. By-stage introducing and perfecting of the scheme was carried out in the course of reconstruction.

Technical re-equipment of the plant has been begun from flotation and filtering-drying facilities since

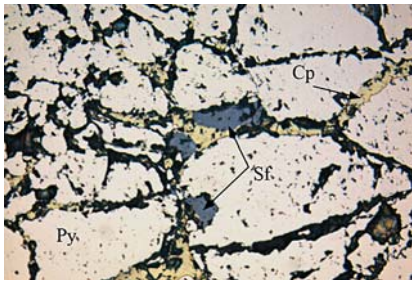

Fig.4. Spreading of chalcopyrite (Cp) and sphalerite (Sf) in the inter-grain space of pyrites grains (Py). Uchalinskaya copper-zinc ore

they are priority and give the biggest efficiency.

Before reconstruction the main building of the plant has been equipped with flotation machines of the two types: FPM-16 (on the base of flotation machine OK-16) and FM-6.3 including 412 chambers. Above mentioned equipment has worked about 20 years before beginning of the reconstruction. It was obsolete and depreciated. Great costs of repair of the equipment have increased the cost of the concentrate. It was not possible to improve parameters of concentrating.

The first stage of reconstruction (for annual volume of the ore processing 1.5 million tons) has been realized in the short time (nine months and twenty days) without decrease of the rate of output of the products owing to well coordinated and competent work of the specialists of the combine and JV "IVS" JSC. The first section of the operations of copper, collective and zinc flotation has been put into operation in February 2001.

On the base of results of testing of filtering of the copper and zinc concentrates the administration of "UGOK" JSC. has decided to buy the four press-filters of Italian firm "Diemme" as the most corresponding to conditions of Uchalinskaya concentrating plant. Four modern press-filters were installed in the filtering-drying section after dismantling of technological lines № 3 and 4.

Comparison of results of the work of the concentrating plant shows increase of extraction of copper by 7% and zinc — by 2.9% in period of reconstruction (fig. 6, *a*).

At the second stage it has been reconstructed the second and third sections in the cycles of the copper, collective flotation and additional flotation of zinc with increase of volumes of annual processing of the ore up to 3 million tons.

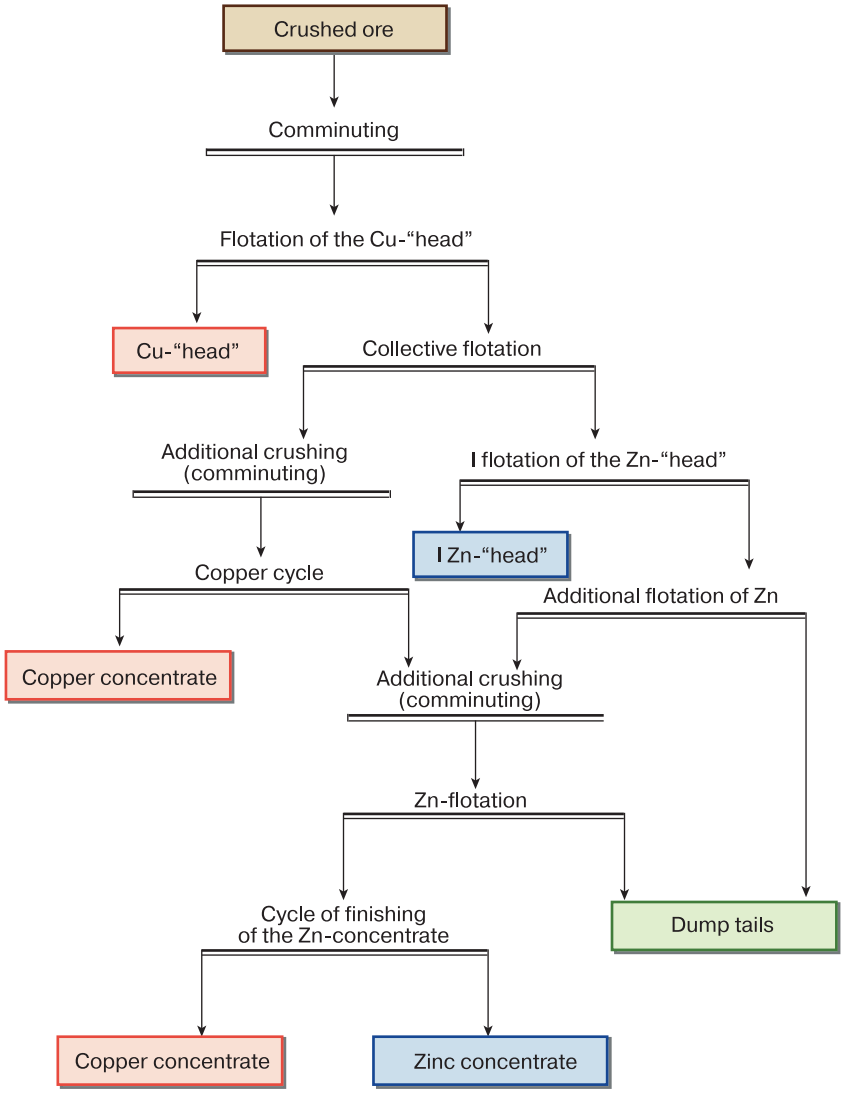

Fig. 5. Principal technological scheme of flotation at Uchalinskaya concentrating plant

In the course of reconstruction in 2002 the screens GIT-51 in the crushing facility of the concentrating plant has been replaced by the more efficient self-balancing screens GST-52UM produced by JV "IVS" JSC. Besides, it has been carried out stabilization of the assemblies of additional crushing at the first and second sections of the crushing facility of the main building of the concentrating plant.

The main attention in the course of the second stage of reconstruction has been paid to increase of extraction of zinc. It has been put into practice temperature treatment of the pulp in the lime medium before the operations of the main and first re-cleaning zinc flotation. Introducing of steaming has permitted to depress pyrites, to make more active and to stabilize flotation of sphalerite, to decrease the circulating loads. The biggest amount of the accretions of sphalerite with pyrites presented in the tails of the first zinc re-cleaning, in spite of additional comminuting of the products before the principal zinc flotation. So, it has been organized additional comminuting of the above mentioned tails and broadening three times of

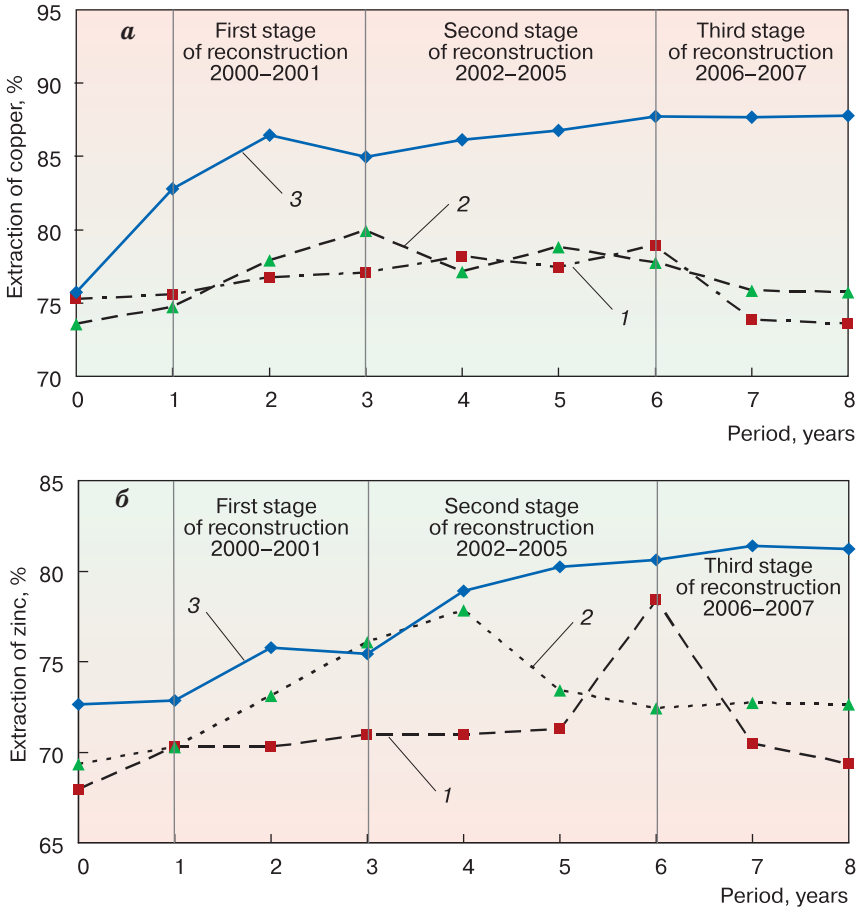

Fig. 6. Change of extraction of copper (a) and zinc (*b*) into the concentrates of the same name by the years:
1–3 — the same as at the fig. 1

the front of flotation of the second zinc-"head" with introducing of the heat conditioning. It has permitted to extract into the final product up to 70% of zinc (as against 50% earlier) and to increase the through extraction of zinc to 50%. Besides, the losses of copper and zinc in the tails and in the concentrates of the opposed names have decreases.

Fig. 6, *b* shows the change of extraction of zinc into the zinc concentrate in the course of reconstruction.

Comparison of results of the work of the concentrating plant on completion of the second stage of reconstruction shows increase of extraction of copper by 9.3%, of zinc — by 4.9% without decrease of quality of the zinc concentrate.

There is one serious problem at the Urals mining-metallurgical complex. The fact is that the ores are mined at the Southern Urals, but the main capacities for melting and refining are located at the Central Urals. Besides, efficiency of the mining-metallurgical complex is decreased because of comparatively low quality of the concentrates produced by the Urals factories. Thus, average copper content in the copper concentrate, produced by Uchalinskaya concentrating plant, was 15–16%. It is lower than the average world index (22–25%).

Owing to above-stated *the third stage of reconstruction* of the concentrating plant was directed to increase of quality of the copper and zinc concentrates.

Besides, modernization of equipment at the crushing facility of the concentrating plant has been continued at the third stage of reconstruction. It has been mounted the second screen GST-52UM and has been begun renewal of the crushers — the crusher KMD-2200 has been replaced by the more perfect KMD-2200T1DM produced by Uralmashzavod.

It has been stated in the course of study that increase of quality of the concentrates demands opening of the finest accretions of the sulfide minerals. In this connection in the August 2006 the industrial tests have stated expediency of usage of the cylindrical pebbles 25 mm diameter instead of the balls 40 mm diameter as the comminuting medium in the operations

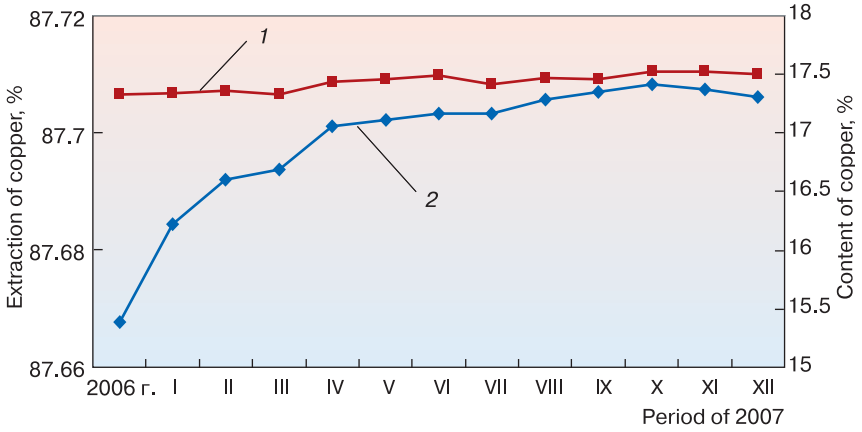

Fig. 7. Change of copper content in the copper concentrate (*1*) and extraction of copper (*2*) (I-XII months of 2007)

of additional comminuting. Analogous measure has been carried out in September 2007 in the mills of the third stage of comminuting: the steel balls 60 mm in diameter have been replaced by the cylindrical pebbles 32 mm diameter.

After putting into the practice of the new section of finishing of the rough zinc concentrate copper content in the common copper concentrate has increased up to 17.4% without decrease of extraction (fig. 7). The new section is destined for additional comminuting of the zinc concentrate with preliminary washing of the last one, for one principal cleaning and three re-cleaning of the copper-pyrites product. Content of zinc was 48%, extraction — 81.2%.

For further intensification of the process in the zinc cycle of the second section of the concentrating plant it has been carried out industrial testing of the rubbing complex OFK-15 RIF. The tests have been carried at the end of 2007 — at the beginning of 2008. They have permitted to increase content of zinc in the concentrate up to 50.2% without decrease of extraction.

The researches directed to increase of quality of the copper concentrate were carried out in the laboratory of JV "IVS" JSC in 2007. The principal element of the offered technology was application of the high selective reactants of the new generation. Recommended technology will permit to increase content of copper in the concentrate in the course of flotation of the copper ore of Uzel'ginskoe deposit up to 20%, of the copper-zinc ores — up to 18.5%.

Modern flotation facility of the concentrating plant is equipped with

Fig. 8. Section of finishing of the rough zinc concentrate at Uchalinskaya concentrating plant

Change of the principal technological parameters of the work of Uchalinskaya concentrating plant in the course of its reconstruction

Stages of reconstruction	Volume of processing of the ore, thousand tons	Extraction	
		Cu	Zn
Before reconstruction	3500	75.9	72.6
First stage	4499.8	82.9	77
Second stage	4847.9	85.1	78.9
Third stage	4384.5	87.7	81.2

flotation machines RIF-45 — 2 chambers, RIF-25 — 111 chambers, RIF-16 — 26 chambers, RIF-8.5 — 109 chambers. They are equipped with the systems of automatic stabilization of level of the pulp, consumption of the air ASSUP-RB (designer — JV "IVS" JSC).

Replacement of the obsolete flotation machines with the modern and less power-consuming ones RIF (fig. 8), equipped with the modernized impeller and original stator, has permitted to decrease the number of the chambers from 412 to 248 and to improve parameters of concentrating.

In the course of by-stage reconstruction with simultaneous introducing of the new technology at the concentrating plant it has been reached following technological results (see the table).

- volume of processed ore has increased from 3.5 to 5 million tons per year;
- total extraction of copper and zinc has increased to 168.65% and consequently it has increased output of the final products: copper — twice, zinc — by 32%;
- it has been ensured possibility of combined processing of the ores of different deposits with the single technological high efficient scheme, worked up by the common efforts of the specialists of the combine and JV "IVS" JSC, with usage of the flotation machines RIF.

The program of the works for 2008 foresees fulfillment in October-November of industrial testing of the new technique and technologies for further increase of quality of the copper concentrate obtained from pyrites copper-zinc ores. EM