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## DEVELOPMENT AND PUTTING INTO PRACTICE THE NEW TECHNOLOGY OF CONCENTRATION OF COPPER-MOLYBDENUM ORES AT “ERDENET” WORKS



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Content of Cu in the copper concentrate	24.54
Extraction of Cu	85.09
Content of Mo in the molybdenum concentrate	48.13
Extraction of Mo	24.48

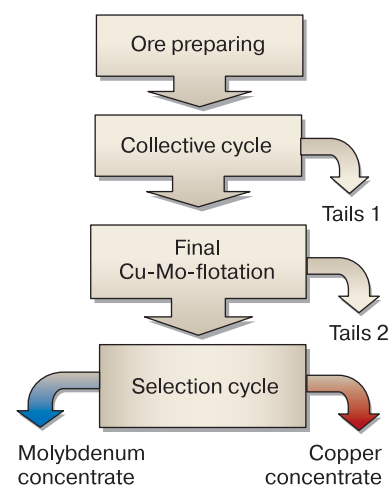
Change of the world price business conditions has predetermined the necessity of approving by administration of the corporation of the principal decisions for perfecting of technology of treatment of the Cu-Mo-ores and for modernization of the current fleet of flotation machines. The former technological strategies were aimed to increase of the volumes of the ore processing. But the newest stage of development is connected with increase of the depth (intensity) of the treatment and consequently with increase of the prices for the final products. Thus, the general conception of development of the works in 2005–2015 may be formulated as: *“maintenance and increase of production of the copper and molybdenum in the final concentrates in conditions of*

Deposit of the copper-porphyrific ores Erdenetyin Ovoo (the Republic of Mongolia) is the ore base of the biggest Asian enterprise of the same name. It is one of unique natural formation of the world importance. Its resources ensure operation of the enterprise with the constant increase of capacity for tens years.

One of the general problems of the raw mineral base of the enterprise is worsening of quality of the mined ore. It means decrease of absolute content of copper in the ore, change of mineralogical composition of the ore (in particular, with deepening of the mining works the share of primary copper minerals in the mined ore increases, texture-structural properties of the ore become complicated). As a result, through-extraction of the metal is decreased. Thus, extraction of molybdenum of the ore has decreased to 25–30%.

The technological scheme used at the concentration factory is

called “cleaner-scavenger” (fig. 1). The scheme is traditional for processing facilities for relatively low-grade Cu-Mo-ores. The scheme includes three flotation cycles: collective copper-molybdenum flotation of the ore comminuted to the coarseness 62–65% of the class –74 μm with obtain of the collective concentrate containing 13–15% of the copper and up to 0.3% of the molybdenum; final concentration cycle including the operations of the general, control and re-cleaning flotation and allowing to increase content of the copper in the foam product of re-cleaning up to 25%. It permits to obtain in the course of selection cycle the standard copper concentrate in the form of the tails of molybdenum flotation. Technological parameters (%) of operation of CP (concentration plant) “Erdenet” in 2005 are given below. It was the year preceded to reconstruction of flotation facility.



**Fig. 1. Current principal technological scheme of flotation facility**

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decrease of content of the metals in the ore".

NPO "RIVS" has cooperated with KOO "Erdenet" Works" earlier in modernization and supply with spares for flotation machines. Beginning from 2005 the corporation takes the active part in realization of the worked up conception.

In accordance with repeatedly used at the enterprises of non-ferrous metallurgy working scheme NPO "RIVS" jointly with the specialists of the combine have worked out in 2005–2006 the number of the measures. The last ones allow to work up the new technology of processing of the copper-molybdenum ores directly in the Central laboratory of KOO "Erdenet" Works" and to test the technology at the operating factory.

Analysis of technological products of CP has been carried out repeatedly. The analysis shows that the feeding material for flotation contains 95% of the non-metallic minerals. The rests are sulphides, including 3.1% of the most "problem" mineral – pyrites. Up to 90% of pyrites and to 95% of molybdenite are in free condition.

The total volume of the tails content 97% of the non-metallic minerals. About 90% of the last ones are in free condition. Predominant sulphides are the pyrites (~ 2.5%), presented mainly by the opened grits (85%). Content of the chalcopyrite

is about 0.1%, the free kind of the chalcopyrite is about 40% of above mentioned quantity. Almost all molybdenite presents in the opened form.

Thus, distribution of the minerals in accreted and in free form permits to establish as a preliminary that the general reserves of extraction of molybdenum lies in the reagent regime.

Large-scale laboratory study as applied to features of the ore of the current and perspective mining with usage of collectors of the firm "Cytex Ind" and technical water of KOO "Erdenet" Works" has shown possibility of increase (to 40% absolute) of extraction of the molybdenum in the collective cycle without decrease of extraction of the copper (see the table).

The new technology of concentration of Cu-Mo-ores has been formed in the course of the laboratory study. The technology was recommended for industrial testing of ability to concentration at the factory of the combine "Erdenet" in collective cycle at VI section of IFO.

It has been carried out some preliminary measures for preparation of the section.

*Modernization of equipment*

- the contact vats KCh-40 have been installed before the main industrial productive and re-cleaning flotation; it has permitted to stabilize feeding of

the both operations by the mineral and by granulometric composition;

- regular aeration blocks in flotation machines OK-50 and OK-30 installed at the major and control operations have been replaced by the blocks RIF 11 and RIF 9;

- it has been mounted the tech-sling constructions of NPO "RIVS" instead of reduction drives.

Immediately after VI section it has been carried out modernization of the equipment at V section: current flotation machines FPM-40 and FPM-16 have been replaced by flotation machines RIF 45 and RIF 16.

It has to be noted especially mounting of the special dosage apparatus for recommended reagents. Necessity of above mentioned apparatus was stipulated by the following circumstances:

- ♦ since the main recommended collector is water-insoluble, it was necessary to foresee loading of the collector directly to comminuting for better disperse;

- ♦ for decrease of the time lag of the response it has been offered to mount the dosing devices directly at the areas of comminuting;

- ♦ for perfecting of controllability of the reagent regime it has been offered to use the dosing devices combined with the control board.

*Technological measures*

- it has been optimized the value of pH of the medium in the collective cycle;

- it has been worked up the matrix of ratio of consumption of the recommended (Aero MX) and the factory-made (BK-901) collectors depending on the ratio of content of the primary and secondary copper minerals in the feeding ore;

- it has been excluded feeding of the diesel fuel and sulphureous sodium in the collective cycle;

**Comparative results (%) of the laboratory flotation tests**

Products	Output	Content			Extraction		
		Cu	Mo	Fe	Cu	Mo	Fe
<i>Factory technology</i>							
Collective concentrate	3.15	13.83	0.167	21.51	77.22	27.54	20.13
Dump tails	96.85	0.13	0.014	2.78	22.78	72.46	79.87
Ore	100	0.56	0.019	3.37	100	100	100
<i>Recommended technology</i>							
Collective concentrate	3.21	13.19	0.41	20.1	77.67	69.45	19.13
Dump tails	96.79	0.13	0.006	2.82	22.33	30.55	80.87
Ore	100	0.55	0.019	3.371	100	100	100

On completion of the preparatory works in 2006 it has been carried out industrial testing of the new technology of the collective cycle at the VI section. The synchronous tests have been carried out at the V section with unloaded products of the mills of self-comminuting as a feeding material. It was necessary for expansion of the information base.

Efficiency of technological regime, worked up at the stage of the laboratory study and preliminary technical measures, has been confirmed in the course of industrial tests in the April–October 2006 (see lower)

	Parameters, %	
	Planned to October 2006	Real in October 2006
Content of Cu in the Cu-concentrate	24	23.64
Extraction of Cu	85.5	85.5
Content of Mo in the Mo-concentrate	47	47.68
Extraction of Mo	30	40

- it has been optimized consumption of the foaming agent MIBK and specified the points of loading of the agent.

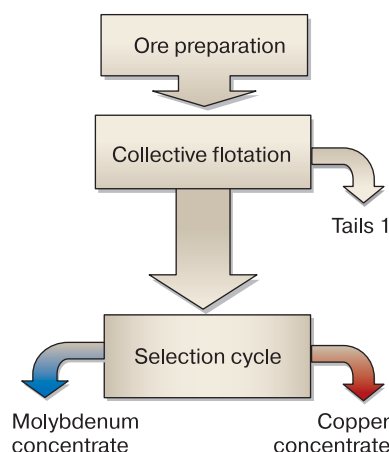
In accordance with results of the laboratory study and industrial testing it has been worked up the technology (scheme + reagent) of treatment of the copper-molybdenum ores. The technology foresees obtain in the collective cycle of the concentrate containing 14–16% of copper. After thickening and final concentration in the separate cycle the product is sent into the cycle of selection with obtain of molybdenum final product that is sent to re-cleaning. The chamber product is the copper concentrate. There is the version in the offered scheme (for the ore with the favorable composition) that foresees exclusion of the final concentration cycle. It is possible if the concentrate, containing more than 24% of copper, may be obtained in the collective cycle (fig. 2).

During the testing it has been revealed the necessity of:

- ♦ feeding of additional (water-soluble) collector in the control operation of the collective cycle for additional extraction of copper from the dump flotation tails;

- ♦ additional comminuting of the concentrate of the principal flotation before re-cleaning operation.

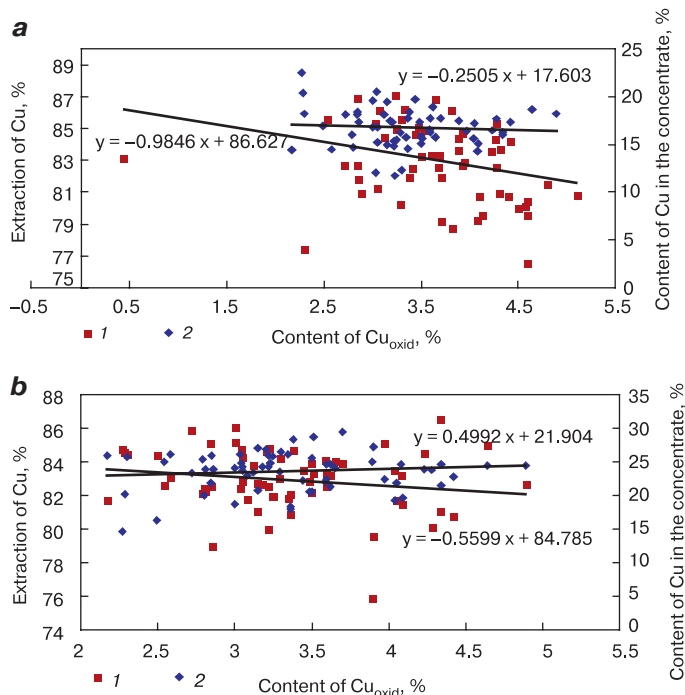
Usage of the water-insoluble collector Aero MX at the collective flotation and water-soluble Aerofloat — at the control operation is the important element of the offered reagent regime. It has been noted possibility to decrease the temperature of steam-curing of the collective concentrate



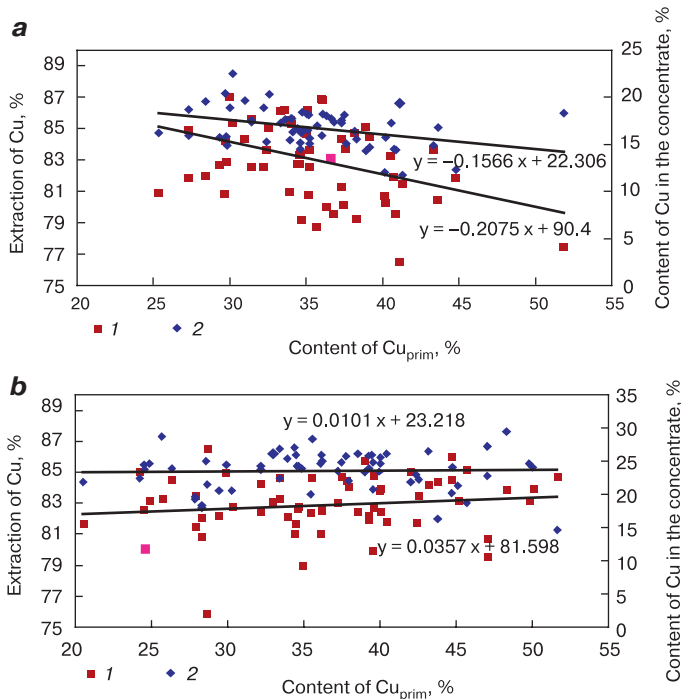
**Fig. 2. Recommended principal technological scheme of flotation facility for the ores with high content of the primary copper materials**

from 65 to 40–50°C in the course of operation at the recommended regime. It increases significantly stability of the bearing of the units.

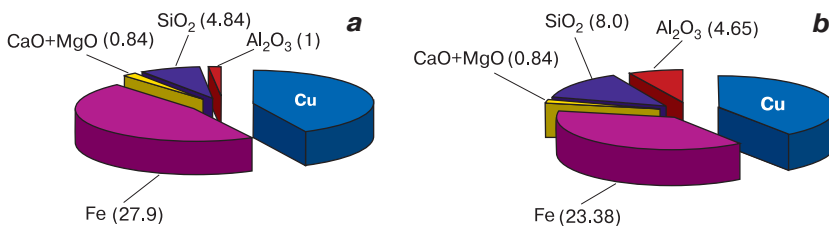
It has to be noted especially the results of statistical analysis of dependence of parameters of the collective flotation, carried out by means of the factory and recommended regimes, on the main technological properties



**Fig. 3. Dependence of extraction of copper (1) and content of copper in the concentrate (2) in the fabric (a) and recommended (b) regimes of flotation on the share of “oxidized” copper in the ore**



**Fig. 4. Dependence of extraction of copper (1) and content of copper in the concentrate (2) in the fabric (a) and recommended (b) regimes of flotation on the share of the "primary" copper in the ore**



**Fig. 5. Content (%) of the some slag-forming components in the copper concentrate, obtained in the fabric (a) and recommended (b) regimes of flotation**

of the ore: degree of oxidation of the copper minerals and content of the "primary" copper.

Content of the mud in the ore increases with increase of degree of oxidation, and flotability of the ore decreases\*. In the fabric reagent regime (fig. 3, a) increase of degree of oxidation leads to decrease quality of the collective concentrate and to decrease of extraction (every additional 1% of content of Cu<sub>oxid</sub> involves decrease of extraction of Cu by 0.98%). At the same time in

recommended regime extraction decreases by 0.56% only (fig. 3, b).


With deepening of the open-pit the share of the "primary" copper in processed ore and the size of dissemination of the copper minerals increase. In the fabric regime of flotation (fig. 4, a) every 1% of increase of content of the "primary" copper leads to decrease of extraction by 0.2% and to decrease of content of copper in the concentrate by 0.15%. In the recommended regime (fig. 4, b) increase of content of the "primary" copper in

the ore almost does not affect parameters of the process. Flotation process is stable enough in above mentioned conditions. First of all it concerns the V section, purposefully fed with the ore with increased "primarily" in the course of industrial testing. Increase of content of chalcopyrite from 30 to 70% does not adversely affect technological parameters.

It has to be noted that in the work with recommended technology it takes the place substitution of pyrites in the copper concentrate with the slag-forming components, containing Al<sub>2</sub>O<sub>3</sub> and SiO<sub>2</sub>. Favorable ratio Cu:Al<sub>2</sub>O<sub>3</sub>:SiO<sub>2</sub> in the final concentrates permits to decrease or to exclude completely at the metallurgical facility necessity in additional feeding of the silica (fig. 5).

Recommended technology has permitted to increase extraction of molybdenum into the final concentrate by 15% (absolute) in comparison with the ordinary regime. Besides, it allows to form the scheme of treatment of the ores with increased "primarily".

Obtained results have given to the enterprise the possibility to put into practice in the short period the recommended technology at the all facilities of the concentration factory and to begin modernization of the equipment with the regard for experience, accumulated during initial period of operation of the new technology.

Worked up by NPO "RIVS" conception of treatment of the copper-molybdenum ores is tested in industrial conditions at the different enterprises, processing the copper-molybdenum ores: Almalyksky GMK (Uzbekistan), Zangezursky MMK (Armenia). 

\* Баатархуу Ж. Влияние генетико-морфологических особенностей молибденита в технологии переработки ОФ «Эрдэнэт». // В сб.: «Эрдэнэт хөгжил.» — 2005. — № 5.