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RECYCLING TECHNOLOGY FOR GOLD-CONTAINING TAILINGS WITH THE USE OF A COMPOSITE REAGENT MICROEMULSION

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Preliminary Note – Prethodno priopćenje

The paper contains the laboratory study results for the flotation processing of gold-containing tailings with the use of the composite reagent (CF). The CF flotation reagent is a microemulsion from a composition of sodium butyl xanthate and reaflot. A gold-containing concentrate was obtained with a gold content of 6,7 g/t with a recovery of 59,71 % in the basic mode. The use of the CF composite flotation reagent increases the gold extraction into the gold-containing concentrate by 3,77 %, as compared with the main collector - sodium butyl xanthate. The consumption of CF flotation reagent is reduced by 20 %.

Keywords: technogenic raw materials, flotation, composite reagent, extraction, X-ray research

INTRODUCTION

For many operation years of the mining complex enterprises, billions of tons of waste from mining and ore dressing have been accumulated in dumps and tailing dumps. The maintenance of these facilities requires significant capital and material costs, and the stored crushed beneficiation waste pollutes the soil and the atmosphere due to water and wind erosion. It is possible to solve the issue of environmental safety improvement both through the creation of technologies intended to process stored beneficiation wastes and through the maximum extraction of all useful components.

Thus, the use of modern approaches, new flotation reagents, and modernized equipment for the beneficiation of mineral and technogenic raw materials is a priority in the creation of innovative technologies [1-3].

The need to increase the processing amount of poor man-made mineral reserves requires the development of new technological solutions for the gold extraction with a low production cost [4-6]. For example, the stale tailings of a gold recovery plant operating under a gravity-flotation diagram have been studied. A combined gravity-flotation beneficiation diagram has been developed enabling us to obtain gravity and flotation concentrates with content of ~ 60 g/t of gold with a total metal recovery of ~ 63,6 % [7]. Technogenic raw materials are distinguished by the presence of oxidized minerals, a significant amount of intergrowths, and slime particles. Therefore, the existing reagent schemes and recycling technologies for industrial wastes become less and less effective [8].

With the purpose to solve the problem of recycling waste from concentrating enterprises, it is proposed to use a combination of various reagents in the form of a microemulsion that promotes deep beneficiation of industrial waste [9-10].

The combination of various collectors, dispersion, and optimization of the composition of such reagents (an increase or decrease in the length of the hydrocarbon radical and its branching, the introduction of an additional component) results in an improvement in the foaming, collecting, and other properties of the used flotation reagents.

MATERIALS AND METHODS

Analytical equipment was used in the studies, i.e. atomic emission spectrometer Optima 2000 DV (USA); X-ray diffractometer D8 ADVANCE; FTIR spectrometer Thermo Nicolet Avatar 370 FTIR Spectrometer; X-ray fluorescence spectrometer Venus 200 PANalyical B.V. (Holland); electron probe microanalyzer JXA-8230 made by JEOL.

The study subjects were the technogenic gold-containing tailings of the Kazakhstani deposit and the CF composite flotation reagent. The composition of sodium butyl xanthate and higher aeroflot (reaflot) was used as a CF in the flotation of gold-containing tailings.

For studies, the original tailings were reground in a laboratory ball mill 40ML-000PS (Russia) up to 95 % of the class -0,074 mm. Sedimentation analysis of the tailings was performed with the use of an FSKh-6K photometric sedimentometer (Russia). Flotation experiments were performed with the use of laboratory flotation machines with a chamber capacity of 1,5; 0,75; 0,5 liters. The experiments were performed in a closed cy-

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cle. The flotation diagram included regrinding, main flotation, control, and two cleaning operations for gold concentrate. 8 weighed portions of tailings, 0,5 kg each, were used in the experiment. Soda was put in the regrinding process to create a pH of the medium equal to 8,0-8,5. The flotation operation time was as follows - the main flotation - 15 minutes, the control flotation - 10 minutes, the first cleaning - 8 minutes, the second cleaning - 6 minutes. Such reagents as sodium butyl xanthate and CF composite flotation reagent were used as a collector; T-92 – as a foaming agent. The CF flotation reagent was used in the form of an emulsion obtained in a T18 digital ULTRA-TURRAX disperser (Russia). The particle sizes of the CF flotation reagent microemulsion were measured with the use of a Photocor Compact particle size analyzer (Russia) and a Winner 2000E laser particle analyzer (China).

The ratio of solid to liquid in flotation was 1: 3. After regrinding, the flotation pulp was mixed with a collector (2 min.) and a foaming agent (1,5 min.) without air supply at a rotor speed of 1 300 rpm. After supplying atmospheric air, the pulp was flotation treated under the applied beneficiation diagram.

RESULTS AND DISCUSSION

The material composition has been studied, and the reagent mode of flotation for gold-containing tailings with the use of main and composite flotation reagents has been worked out.

The main part of the initial sample of flotation tailings, under the results of X-ray phase analysis, is represented by rock-forming minerals, such as quartz (41,2 %), clinochlore (20,1 %), microcline (14,3 %), tremolite (13,1 %), albite (5,2 %), calcite (3,5 %), muscovite (2,6 %). Chemical analysis showed that the studied tailings sample contains 0,59 g/t of gold. According to the X-ray fluorescence analysis results in the original sample of the tailings, silicon has the main mass, i.e. 24,573 %, oxygen – 43,701 %, aluminum – 6,734 %, iron – 3,256 %, calcium – 3,115 %.

Electron probe microanalysis of the original tailings sample (Figure 1) confirms that the main mass of the tailings consists of quartz and aluminosilicates.

Based on rational analysis results, 33,50 % of gold is in hard-to-recover form with quartz; 28,87 % in the form of finely dispersed gold; 37,63 % in intergrowths with sulfides and rock.

The dispersion analysis of the original tailings was performed with the use of an FSKh-6K photometric sedimentometer designed to measure the particle size distribution of powders and suspensions with a particle size of less than 300 μm. The device operation principle is based on the Stokes sedimentation law and the law of radiation attenuation in turbid Lambert-Barr media. The sedimentation process is performed in a uniformly mixed diluted suspension of the solid phase (ore) in a dispersion liquid (water) and is recorded by the change

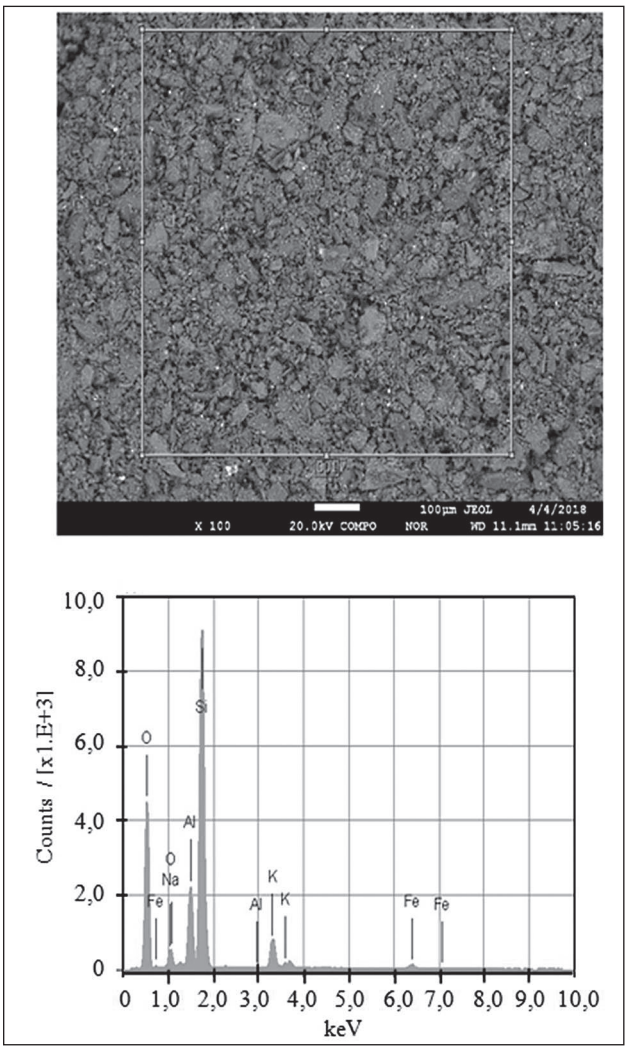

Figure 1 - Electron probe microanalysis of the original tailings sample

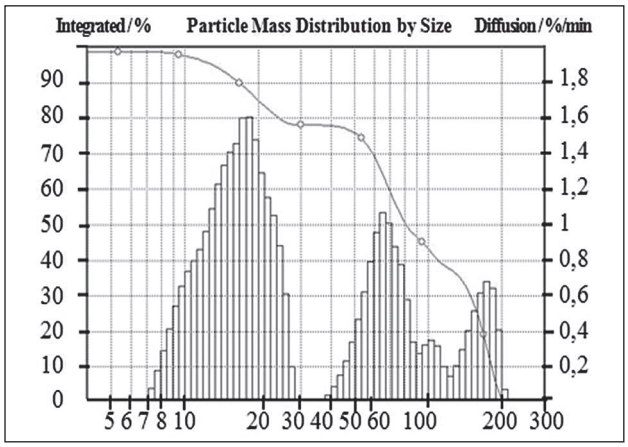

Figure 2 - Results of dispersion analysis for initial tailings with FSKh-6K

in the intensity of light passing through the suspension where the particles are deposited (sedimented). The device determines the Stokes diameters of the particles. Stokes diameter is the diameter of a spherical particle with the sedimentation rate equal to the sedimentation rate of the studied optional spherical particles. The device measures the optical density of a suspension at the

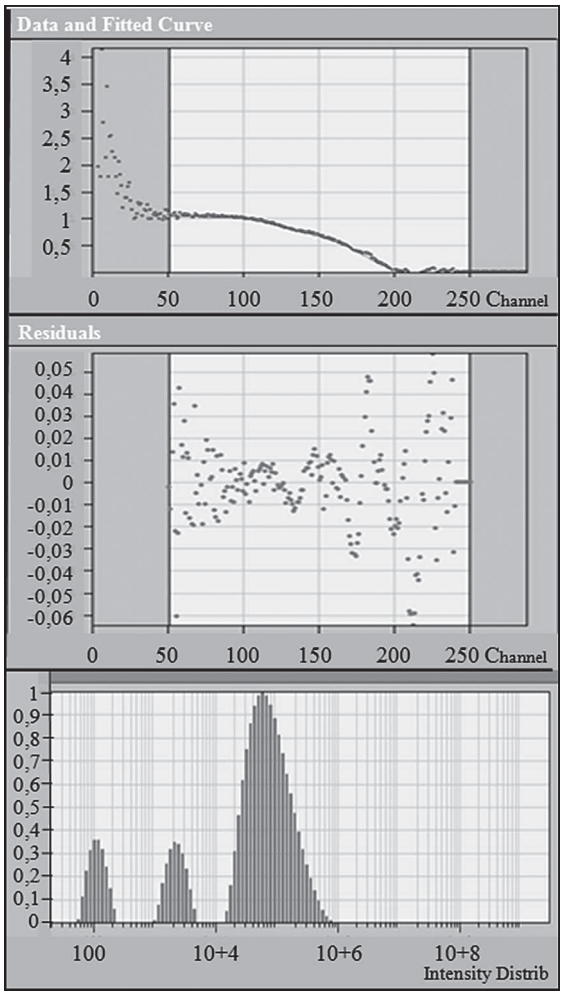

Figure 3 - Particle distribution in the emulsion of the CF composite reagent

Table 1 - Results of flotation of gold tailings

Name of the sample	Yield/ %	Content Au/g/t	Extraction Au/%
Basic Mode			
Au conc-t	5,24	6,70	59,71
Tailings	94,76	0,25	40,29
Initial tailings	100,00	0,59	100,00
Using the CF reagent			
Au conc-t	5033	7,10	63,48
Tailings	94,67	0,23	36,52
Initial tailings	100,00	0,59	100,00

level of the optical slits at pre-calculated times under Stokes› law, corresponding to the sedimentation of particles of a given size. The dispersion analysis results for the initial flotation tailings are shown in Figure 2.

A composition of sodium butyl xanthate and reaflot was used as a CF composite flotation reagent to improve additional gold recovery from flotation tailings. The CF flotation reagent to obtain an emulsion before flotation was processed with the use of a T18 digital ULTRA-TURRAX disperser for 15 seconds. Figure 3 shows the results of the particle size of the CF reagent emulsion after treatment with a disperser.

The number of particles of the emulsion mixture with a particle size of 104 nm is 82,4 %, 41,6 nm – 10,4 % with an optimal dispersion time of 15 sec.

Laboratory studies on the flotation processing of gold-containing tailings have been performed with the use of the CF composite reagent microemulsion.

The flotation results are presented in Table 1. As you can be seen from the data presented, the use of the CF composite flotation reagent pretreated on a disperser increases the gold recovery into the gold-containing concentrate by 3,77 % compared to the main collector - sodium butyl xanthate. The CF flotation reagent consumption is reduced by 20 %.

Thus, the results of flotation experiments show that the use of the CF composite flotation reagent is promising in the processing of gold-containing technogenic raw materials.

CONCLUSION

The material composition of gold-containing tailings has been studied in one of the Kazakhstani deposits. The studied tailings sample contains 0,39 g/t of gold under the chemical analysis results. The main part of the original tailings sample is represented by rock-forming minerals, such as quartz, clinochlore, microcline, tremolite, albite, calcite, and muscovite. 33,50 % of gold is in hard-to-recover form with quartz; 28,87 % in the form of finely dispersed gold; 37,63 % in intergrowths with sulfides and rock based on rational analysis.

The reagent mode of flotation of gold-containing tailings has been worked out with the use of main and composite flotation reagents. A composition of sodium butyl xanthate and reaflot was used as a CF composite flotation reagent to improve additional gold recovery from flotation tailings.

A gold-containing concentrate was obtained with a gold content of 6,7 g/t with a recovery of 59,71 % in the optimal baseline mode. The use of the CF composite flotation reagent pretreated with a disperser, increases the gold recovery into the gold-containing concentrate by 3,77 % compared to the main collector - sodium butyl xanthate. The consumption of CF flotation reagent is reduced by 20 %.

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Note: The person responsible for the translation into the English language is Kurash A. A., Almaty, Kazakhstan