Finishing of gold-bearing concentrated products

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Abstract. The research data on the finishing centrifugal flotation of the pre-concentrated gold-antimony ore product are reported on a series of laboratory tests at a centrifugal flotation machine with peripheral discharge of the concentrate (CFM) and a mechanical flotation machine (FM). The selectivity of mineral particle detachment from the mineralized flotation froth moving along an inclined plane after flotation process running at different modes with/without a collector. It is demonstrated that the use of a collector makes it possible to control intensity and selectivity of material detachment from the froth layer. It is found that flotation finishing in the centrifugal flotation machine actually enables to improve the final concentrate characteristics.

1. Introduction
The problem on separation of minerals with close processing properties is usually solved by improving the selectivity of mineral separation. The improvement is gained by using the directed-action agents, selective modification of mineral processing properties by applying different energy effects [1, 2]. One of the ways to affect the flotation performance is to apply additional centrifugal forces to rotate a pulp. The process is known as centrifugal flotation [3].

In flotation process the sulfide minerals as well as rock-forming minerals used to move to a concentrate in the form of slime particles. The further removal of rocks from concentrates is realized by the combined recleaning processes, involving additional classification of the material into sand and slime fractions, and dump tailings in slime fraction [4]. The sulfide mineral content in the flotation concentrate is reduced by depressing some of sulfides at a recleaning stage. When processing run-of-mine gold-bearing ores containing such sulfide minerals as pyrite and arsenopyrite, the selective flotation is intended to separate these particular minerals [5].

The present research is aimed at improving the performance of the final recleaning of flotation concentrates, containing fine and very fine gold by applying the new type of centrifugal flotation machines.

2. Centrifugal flotation machine with the peripheric concentrate discharge
According to the new flotation process, developed at IGDS SB RAS, the separation of mineral particles is realized in regard to hydrophobicity in a fine layer at the surface of rotating water stream (pulp) [6–9]. The research was conducted on the pre-concentrated gold-antimony ore products. Sentachan gold-antimony ore deposit is reported as a rich deposit of the ore grade: 20.85 % Sb and 31.4 g/t Au [10].

The investigation into selectivity of the mineral particle detachment from the mineralized flotation froth moving along an inclined plane after flotation at different operation modes...
with/without a collector enabled to state that the collector allowed the control of intensity and selectivity of the material detachment from the froth layer. Inhomogeneity of a water stream under the froth (comparative research results with partitions) has insufficient influence on selectivity of the particle detachment in the case when a collector is used, but its effect can be much more negative in the mineral separation process at a “hungry” mode [6].

The studies were conducted on finely ground ores of -0.071+0 mm in size from Sentachan gold-antimony deposit. The material composition of the study ore specimens was assayed beforehand. Sulfide minerals are pyrite-arsenopyrite-antimonite, other sulfides, antimony is represented by antimonite, and arsenic as arsenopyrite. The conventional procedures for determination of granulometric mineral composition and physical properties of minerals were employed to sample, to process, and to assay ore specimens.

The analysis of the material composition of the separated products involve the application of the assay tests for gold, chemical tests for antimony and arsenic, spectral analysis of element composition at SRS-3400sequential X-ray Fluorescent spectrometer, Bruker Co.

The flotation agent is butyl xanthate as the main collector to float sulfide minerals; it is used as 2–10% solution at consumption rate 20–100 g/t [5].

The test flotation is carried out at a centrifugal flotation machine with peripheric concentrate discharges designed at IGDS SB RAS (protected by RF Patent) [8]. The specifications of the flotation machine are reported in Table 1.

| Specifications                      | Measurement units | Operation parameters |
|-------------------------------------|-------------------|----------------------|
| Additional water consumption        | l/min             | 2–3                  |
| Air consumption                     | m³/min            | 0.05                 |
| Number of body rotations, max       | rpm               | 400                  |
| Electrodrive power                  | kW                | No more than 1.0     |
| Overall dimensions:                 |                   |                      |
| diameter                            | mm                | 230                  |
| height                              | mm                | 180                  |

Figure 1. Recovery of gold, arsenic, and antimony into the concentrate at centrifugal flotation machine (CFM) and at a laboratory mechanical flotation machine (FM).
It is obvious in Figure 2 that arsenic content in CFM concentrate is lower as compared to that of FM concentrate, thereto, antimony content is much higher.

![Figure 2. Content of arsenic and antimony in CFM and FM concentrates.](image)

3. Conclusions
The research on development of the finishing flotation process for the pre-concentrated gold-antimony ore products justified the feasibility to improve the final product grade at a centrifugal flotation machine with the peripheric concentrate discharge (CFM), therewith gold is co-currently recovered in flotation of antimony into the concentrate, and arsenic content in CFM concentrate is lower alternatively to that of FM concentrate.

References
[1] Chanturia VA, Lavrinenko AA and Krasnov GD 2006 Flotation efficiency rise on the base of usage of power effects *Gorny Zhurnal* No 10 pp 48–52
[2] Lavrinenko AA and Krasnov GD 2007 Up-to-date state and main directions of creation of flotation equipment *Gorny Journal* No 2 pp 108–117
[3] Rubinstein Yu.B Perelman EY and Spivakovskiy IN 1988 *Review. Inform TsNIITEEItyazhmash, Mining Equipment*. Ser.2 (in Russian)
[4] Gorbunova TG and Frolov YuI 1985 *Technology for Beneficiation of Ore Deposits and Placers: Collected Papers VNIINeft* Magadan pp 3–9 (in Russian)
[5] Lodeishchikov VV 2005 Features of technology of gold recovery from refractory ores *Col. Metals* No 4 pp 51–55
[6] Matveev AI and Salomatova SI 2008 *Flotation of Gold on the Surface of a Rotating Fluid* Yakutsk: IGDS SO RAN (in Russian)
[7] Matveev AI, Salomatova SI, Yakovlev VB, Monastyrev AM, Eremeeva NG and Sleptsova ES 2002 Pat 2183998 Russian Federation *Inventions Utility models* No 18 (in Russian)
[8] Matveev AI, Salomatova SI, Chikidov AI, Monastyrev AM and Yakovlev VB 2005 Pat 2248849 RF B 03 D1 / 24. Method of flotation and centrifugal flotation machine *Inventions. Utility models* No 9 (in Russian)
[9] Salomatova SI 2017 Application of centrifugal flotation for enrichment of gold products *Gorn. Inform-Analit. Byull. No 11(24) pp 240–246
[10] Boltukhaev GI and Solozhenkin PM 2009 Processing of large-size samples of gold-antimony ores of the Sentachansky deposit *Col. Metals* No 4 pp 41–44