COMPARATIVE ANALYSIS OF TECHNOLOGIES FOR THICKENING GOLD-BEARING FLOTATION CONCENTRATES AND RECOVERING CLARIFIED PROCESS WATER

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Introduction

Efficient solid–liquid separation is one of the key technological stages in the beneficiation of gold-bearing ores and their subsequent hydrometallurgical processing. In particular, the thickening of flotation concentrates makes it possible not only to obtain a product with the solids concentration required for subsequent processing operations, but also to recover process water and return it to the production cycle.

The high proportion of fine dispersed particles in gold-bearing flotation concentrates, the complex rheological properties of the slurry, and the association of valuable components with fine particles considerably complicate the thickening process. Studies on refractory gold-processing materials have shown that the solids content of flotation concentrates can be increased from approximately 30% to 50%. At the same time, slurries containing a high proportion of ultrafine particles are characterized by slow conventional gravitational settling and difficulties in obtaining a sufficiently clarified liquid phase.

Therefore, the efficiency of thickening technologies should not be assessed solely on the basis of underflow solids concentration or settling velocity. A comprehensive evaluation should also include solids retention, overflow clarity, water recovery, flocculant consumption, slurry rheology, and the compatibility of the thickened product with subsequent technological operations.

Main Part

Conventional gravity thickeners and high-rate thickeners are widely used in industrial practice for the treatment of flotation concentrates. In high-rate thickening systems, the combined control of flocculation, slurry-flow hydrodynamics, and feedwell design makes it possible to increase the specific processing capacity of the equipment. However, high throughput alone does not necessarily indicate superior technological efficiency. If the loss of fine particles containing valuable components increases in the overflow, such an operating regime may become economically disadvantageous.

Optimization of flocculation conditions represents one of the main approaches to improving the thickening process. In addition to the type and dosage of flocculant, its dilution, point of addition to the slurry, and mixing intensity significantly affect the size and strength of the resulting flocs. Studies on improved feedwell designs have demonstrated that separating feed-

energy dissipation from the flocculation zone promotes the formation of larger aggregates and improves process stability.

Improving the drainage characteristics of the sediment bed is another promising approach for increasing the solids content of the thickened product. Studies conducted using deep-cone thickeners have shown that mechanical shear can modify the pore structure of the sediment bed and promote faster water removal. Under certain experimental conditions, an initial slurry containing 10 wt.% solids produced an underflow with a solids content of up to 58.5% when mechanical shear was applied. However, since these results were obtained for tailings, dedicated pilot-scale tests are required before their direct application to gold-bearing flotation concentrates.

Lamella settlers are also considered promising for the production of clarified process water. Inclined plates reduce the settling distance of particles and increase the effective settling area. This approach is particularly suitable for the additional removal of suspended solids from relatively dilute overflow streams discharged from the main thickener. At the same time, the application of lamella systems to highly concentrated flotation slurries requires careful consideration of solids loading, flow distribution, and sediment-removal conditions.

One of the innovative approaches to dewatering involves the use of superabsorbent polymers. Experimental studies on refractory gold flotation concentrates have shown that these polymers can absorb more than 94% of the water contained in dilute slurries within 30 minutes. After 60 minutes, water recovery was reported to be 45–76% higher than that achieved by gravity settling under the tested conditions. Nevertheless, industrial implementation of this technology requires additional evaluation of polymer separation, regeneration, water release, and repeated reuse.

The reuse of clarified water obtained during thickening contributes to the rational utilization of water resources and a reduction in overall process-water consumption. However, visually clear water should not automatically be considered suitable for direct recycling. Dissolved ions, residual reagents, and other chemical components may affect subsequent flotation or hydrometallurgical operations. Therefore, in addition to suspended solids and turbidity, the chemical composition of the water and its influence on downstream technological performance should also be evaluated.

The development of an optimal thickening flowsheet for gold-bearing flotation concentrates requires the integrated study of feed mineralogy, particle-size distribution, process-water chemistry, slurry rheology, and the distribution of gold between process streams. Moreover, comparative testing of different technological options using the same feed material and identical assessment criteria under continuous operating conditions is necessary for an objective evaluation of their performance.

Conclusion

The thickening of gold-bearing flotation concentrates should not be regarded solely as a process for removing water from slurry. It should be considered as an integrated technological operation involving the **maximum retention of valuable components, production of an underflow with the required solids concentration, and preparation of process water for reuse**.

Conventional and high-rate thickeners remain the principal industrial solutions. Optimization of feedwell hydrodynamics and flocculation conditions can improve the capture of fine particles, while enhanced sediment-bed drainage can increase the solids concentration of the underflow. Lamella settlers may be applied as an additional clarification stage downstream of the primary thickener, whereas superabsorbent polymers represent a promising alternative due to their high water-recovery potential.

At the same time, sufficient comparative data from continuous tests conducted on the same gold-bearing flotation concentrate are still lacking. Therefore, the selection of an optimal technological flowsheet should be based on laboratory and pilot-scale investigations, material-balance calculations, gold distribution between process streams, reagent consumption, water recovery, and an integrated assessment of economic efficiency.

Adabiyotlar, References, Литературы:

1. Joseph-Soly, S., Asamoah, R. K., Skinner, W., & Addai-Mensah, J. (2020). “Superabsorbent dewatering of refractory gold concentrate slurries”. Advanced Powder Technology, 31(8), 3168–3176. https://doi.org/10.1016/j.apt.2020.06.010.
2. Nguyen, T. V., Farrow, J. B., Smith, J., & Fawell, P. D. (2012). “Design and development of a novel thickener feedwell using computational fluid dynamics”. Journal of the Southern African Institute of Mining and Metallurgy, 112(11), 939–948.
3. Chen, X., Jin, X., Jiao, H., Yang, Y., & Liu, J. (2020). *Pore connectivity and dewatering mechanism of tailings bed in raking deep-cone thickener process*. Minerals, 10(4), 375. https://doi.org/10.3390/min10040375.
4. Liu, L., Perez, M. A., & Whitman, J. B. (2020). “Evaluation of lamella settlers for treating suspended sediment”. Water, 12(10), 2705. https://doi.org/10.3390/w12102705.
5. Björkqvist, A. (2017). *Water recycling in flotation*. Master’s thesis, Aalto University.
6. FLS. “Thickeners — Water Stewardship”. Manufacturer technical information.
7. Mirzavaliyev, D. B., Parmonov, S. T., & Ulugov, G. D. (2023). Processing of tungsten-containing waste and production of sodium tungstate solution. “Universum: Technical Sciences”, No. 10-2 (115).
8. Mizavaliyev, D., & Karshiboyev, S. (2023). The main problems of obtaining high-pure selenium in the industry and ways to solve them. “Innovations in Technology and Science Education”, 2(9), 106–113.