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Tails Recycling Technology Gold-Uranium Ores

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Abstract: In this article, we have studied stale tailings of gold recovery factories. The technology of complex processing of this raw material, including the flotation of gold-bearing pyrite, roasting of pyrite concentrate, leaching of gold and uranium, has become widespread; the gases from roasting are used to produce sulfuric acid, which is returned to the uranium leaching process. Thus, a practically waste-free technology for processing gold-uranium raw materials has been created.

Keywords: solution, gold, silver, flotation, carried, gravity, reagent, hydrocyclone, concentrate, product.

For many years, the processing of enrichment tailings in the gold mines of South Africa was carried out mainly with the aim of additional extraction of uranium. However, in recent years, due to rising prices, more and more attention has been paid to the additional extraction of gold from this raw material.

The technology of complex processing of this raw material, including the flotation of gold-bearing pyrite, roasting of pyrite concentrate, leaching of gold and uranium, has become widespread; the gases from roasting are used to produce sulfuric acid, which is returned to the uranium leaching process. Thus, a practically waste-free technology for processing gold-uranium raw materials has been created.

At many factories, flotation enrichment of tail products is carried out after preliminary activation of pyrite in a slightly acidic medium at pH 3–4. Solutions of sulfuric acid or copper sulfate are used as an activator. This operation improves the recovery of gold and improves the quality of the resulting concentrate.

In the flotation cycle, amines, mercaptobenzothiazole and dithiophosphate are used as collectors. The use of these collectors is determined by the presence of residual concentrations of cyanide in the processed products. It has been established that at pH below 5 these collectors do not reduce their flotation activity, despite the presence of cyanide ions, which favorably distinguishes them from xanthate.

The extraction of gold is carried out, as a rule, from the residues of uranium production according to the scheme of a complete sludge process, or in the process of sorption leaching using activated carbon. Gold recovery ranges from 25-55%.The main commercial products of the factories are gold, uranium trioxide, and sulfuric acid.

Currently, there are six factories in South Africa for processing stale tailing gold dumps with a gold content of 0.4 - 0.6 g / t and sulfur 0.5 - 1.4% and six factories for processing flotation tailings of the current processing with a gold content of 0 .25 - 0.5 g / t and sulfur 0.7 - 1.7%.

Since 1978, complex processing of gold ore tailing dumps of concentrators in the West Rand region (South Africa) has been carried out at the ERGO plant. The plant includes a mining

workshop that develops tailing dumps with hydraulic monitors and transports the pulp to the flotation plant; uranium shop, sulfuric acid plant, gold recovery shop for processing pyrite cinders to extract gold from them. The productivity of the processing plant is 19.34 million tons/year.

According to the project, the plant is to develop and clean the areas of 19 tailing dumps located at a distance of up to 14 km from the processing plant within 20 years. The development of tailing dumps is carried out with a separate storage of the vegetation layer and its further use for the reclamation of cleared areas. Three tailing dumps are being developed simultaneously.

Tailings with a size of 70% of the class - 74 microns are supplied for enrichment with an average gold content of 0.54 g / t, uranium trioxide 0.044 kg / t and sulfur 1.07%. Before entering the flotation, the starting material was activated with sulfuric acid at pH 3.5. The main flotation and recleaning is carried out in Denver machines with a chamber volume of 14 and 8.5 m3. The total number of chambers in the main flotation is 108 pcs.

From slimes containing 0.79 g/t of gold, 0.058 kg/t of uranium and 0.96% sulfur, a pyrite concentrate is obtained containing 28–30% of sulfide sulfur, 11–14 g/t of gold and 0.55–0. 65 kg/t uranium trioxide. Flotation tailings are neutralized with lime, thickened to 50% solids and pumped to a new tailing dump.

The pyrite concentrate of the main flotation is sent to the uranium shop, where uranium is leached in pneumatic agitators. After filtering, the cake goes to the sulfuric acid plant, where, after thickening to 70% solid, it is fired in a fluidized bed furnace with a diameter of 10.45 m and a capacity of 24.4 t/h for the fired material. The resulting sulfur dioxide is captured to produce sulfuric acid.To extract gold, the burnt material after grinding in ball mills (2.7x3.05 m) is sent for cyanidation. Branch about equipped with vats with a capacity of 654 m and drum filters (5.49x6.1 m) with a capacity of 4.7 t/m/day. Gold from the filtrate is precipitated by zinc dust. Zinc sludge after washing with acid is melted in an electric furnace with a power of 242 kVA. The consumption of reagents is: cyanide - 1.6 kg/t, zinc - 0.4 kg/t. Cyanidation and flotation tailings are also combined after neutralization with lime (lime consumption is 6 thousand tons).tons/year) are stored in a new tailing dump. The tailing basin discharge is returned to the technological cycle. According to design data, gold recovery at the plant should reach 54%, uranium - 20%, sulfur 86%. However, in 1993 gold recovery was only at the level of 45%. Studies have shown that the fine particles of free gold contained in the tailings are flattened during the grinding process and are not amenable to flotation. In this regard, the company in 1980-1982. conducted detailed semi-industrial tests on the hydrometallurgical processing of pyrite flotation tailings, which proved the feasibility of building an appropriate workshop with a capacity of 1.6 million tons / month. Flotation tailings will be treated with weak cyanide solutions followed by gold recovery by sorption on activated carbon. The use of two-stage technology will increase the gold recovery from 45 to 70%. In 1981, Rand Mine Property (South Africa) started construction of a new facility with a capacity of 4.4 million tons/year to process 14 old tailing dumps containing 50 million tons of sand and 22 million tons of slurry fraction. The average gold content in tailings is 0.67 g/t. The project provides for the development of sludge dams with hydraulic monitors, and tailing dumps - with two excavators Visuchy 7IB with a capacity of 1 thousand tons / h. Sand after coarse screening is transported to the factory by a belt conveyor. The processing plant provides for two processing cycles: sand and sludge.The sand fraction after desliming in hydrocyclones (sludge content 22%) undergoes flotation. The resulting pyrite concentrate containing 5-7 g/t of gold, after regrinding to 90% - 75 microns, is sent for cyanidation, followed by precipitation of gold on activated carbon. Cyanidation tailings are again

subjected to flotation to obtain a conditioned alcohol concentrate. The latter is supplied to sulfuric acid plants. The tailings of the sand concentrate processing cycle are returned to sand flotation. Sand flotation tailings are dehydrated on screens, crushed and, together with dam sludge and sludge released on hydrocyclones during sand classification, are sent to the cyanidation cycle with subsequent sorption of gold onto coal. Tailings from the sludge cycle are stored in a new tailings facility. About 40% of the water from the tailings is returned to the factory for reuse. Gold recovery is expected to be 70%. The factory will produce 5,000 tons of pyrite and 200-250 kg of gold every month, while the costs will be 7,000 tons of lime and 220 tons of cyanide. According to economists' estimates, the enterprise will be profitable if the price of gold is about $9 per 1 year. The operating costs of the project are 3.5 - 4.0 rand per 1 gram of gold. The Rand Mines company also considered the possibility of processing the tailing dumps of the old City Dean and Consolidated Mine Reef mines, the reserves of which are estimated at 65 million tons with a gold content of 0.76 g/t [12-15].

In 1977, the Amuran metallurgical complex was put into operation for the processing of tailing dumps in the Velkom region (South Africa). The Amuran complex is designed to process tailings accumulated at six mines and tailings from current processing. It is estimated that this volume will be enough for 15 years of operation of the enterprise.

The Amuran complex includes three flotation processing plants built at the President Brand, President Stein and Geduld mines; a uranium shop at the President Brand mine, which extracts uranium from pyrite concentrate; plant for leaching gold from the residues of sulfuric acid production.

The planned capacity of flotation plants is 140 thousand tons/month. tails; production of sulfuric acid 360 thousand tons/year, of which 24 thousand tons/month. used to leach uranium.

Products containing 0.7 - 1.0% pyrite are enriched at flotation plants, with the production of a concentrate containing 33% sulfur with its extraction of 80 - 85%.

Before flotation, a preliminary

tailings conditioning with weak solutions of sulfuric acid for 5-6 hours.

Pyrite flotation is carried out at pH 4, mercaptobenzothiazole is used as a reagent - a collector, TE reagent is a blowing agent. When processing individual batches of tailings, copper sulfate and dextrin are used (to suppress pyrophyllite and shale flotation). The time of the main and control flotation is 20 min.After flotation, the tailings are thickened, neutralized and stored in a new tailings facility. The tailing dump is returned to the factory.

At the sulfuric acid plant, pyrite concentrate is roasted in fluidized bed furnaces. The resulting cinders after water cooling and regrinding are pumped to the gold leaching plant. Gold from the filtrates is precipitated by zinc dust. Gold-free solutions are used in the pyrite flotation cycle.

When studying the prospects of extracting gold from stale tailings dumps in Zimbabwe, it was noted that the most rational technological process for processing tailings dumps, which are mainly represented by quartz and bedrock, is percolation leaching.

Currently, a large number of plants are operating in Zimbabwe that process tailing products with an average gold grade of 0.4 g/t [16].

The technological scheme adopted at the plants includes a leaching tank, a filtration tank, tanks for gold precipitation from zinc solutions with zinc shavings, return of the gold-free solution for percolation. The transfer of solutions from the percolation tank to the filtration

tank and to gold precipitation is carried out by gravity. This prevents cyanide solutions from additional saturation with oxygen. The overflow of the solution occurs through plastic pipes equipped with cast iron valves to regulate the flow rate. The leaching vats are usually made of fired bricks with a wall thickness of 230 mm. The permeable bottom of the vats is made of bricks set with teeth, covered with two layers of burlap and a 50 mm layer of sand.

The vat has a diameter of 5 m and a height of 1.3 m, the volume of material loaded for washing is approximately 40 tons. An installation of eight of these vats allows washing tailings at a capacity of 1000 tons per month.

The filtration vat is similar in structure to the leaching vat. Its diameter is 3 m, sand is used as a filtering layer, the layer thickness of which is about 150 mm. The gold precipitation vat has 5 compartments 0.5x0.5x0.7 m each. The first three compartments filled with zinc shavings are in working condition. The resulting gold-free solution is collected in an intermediate tanker, where it is reinforced with cyanide and again sent for percolation.

Studying the prospects of using the technology of processing products of tailings and dumps by the method of percolation, foreign experts carried out technical and economic calculations of the performance of the plant using this technology.

The calculations show that the capital costs for organizing a plant with a capacity of 1000 tons/month of tailings by the percolation method are relatively low and amount to 20.3 thousand dollars.

The percolation process is cost-effective for quartz ores and allows you to get a significant income depending on the gold content in the original product and the value of the metal.

So, at a price of 12.86 dollars per 1 g of gold, processing of tailing dumps with a volume of 12 thousand tons.t is profitable with an average gold content of 0.54 g/t. An increase in the volume of processed products up to 48 thousand tons makes it possible to make a profit even with a decrease in the gold content to 0.44 g/t.

An analysis of the main costs affecting factory operating costs showed that they are due to the costs of reagents and transportation, due to the large (50 km) distance of the storage facilities from the plant.

The low level of employment and cheap labor in African countries allows tailings to be processed with low operating costs.

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