Proceedings of the World Congress on Mechanical, Chemical, and Material Engineering (MCM 2015)
Barcelona, Spain – July 20 - 21, 2015
Paper No. 355

Treatment of Old Pyrite Flotation Tailings for Recovery of Non-Ferrous and Precious Metals

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Extended Abstract

Mining and metallurgical treatment of sulfide ores is characterized by significant losses of non-ferrous and precious metals into the various wastes. Flotation of sulfide ores yields formation of sulfide flotation tailings. These wastes pose a problem not just because of their sheer volume, but some of them may affect local ecosystems. Nowadays, mining wastes can be considered as technogenic source of metals for biohydrometallurgy in particular. The solubilization of metals by acidophilic chemolithotrophic microorganisms is widely and successfully used in the industrial process of bioleaching or biomining to extract non-ferrous and precious metals. Acidophilic microorganisms that are able to oxidize sulfide minerals are phylogenetically heterogeneous and include representatives of several bacterial and archaeal phyla, such as mesophilic (*Acidithiobacillus ferrooxidans*, *Leptospirillum ferrooxidans*), thermotolerant (*Leptospirillum ferriphilum*, *Ferroplasma acidiphilum*, *Acidiferrobacter thiooxydans*), and moderately thermophilic species (*At. caldus*, *Sulfobacillus* spp., *Acidimicrobium* spp., and *Acidiplasma* spp.).

A sample of old pyrite flotation tailings from the concentrator contained 11.4% sulfidic iron, 14.5% sulfidic sulfur, 0.26% copper, 0.22% zinc, and 0.67 g/t gold. Pyrite was the main sulfide mineral (31%). The gold recovery from the unoxidized flotation tailings was 50%. Recently, it has been proposed to recover copper and zinc from this waste by the treatment with sulfuric acid solution (Bulaev et al., 2014). A biooxidation of the mining waste is proposed for the recovery of gold. The biooxidation of the waste was conducted in a few bioreactors that were connected in series under continuous conditions with periodic feeding and with effluent removal. Biooxidation was carried out in 2.0 L reactors that contained 1 L of pulp. A microbial consortium containing *Acidithiobacillus caldus* INMI-10, *Sulfobacillus thermosulfidooxidans* strains HT-4 and HT-1, *Leptospirillum* and *Acidithiobacillus* strains, and the indigenous culture obtained from the pyrite tailings was used as an inoculum for the biooxidation experiments. The pulp density was maintained at 20% (w/v).

The effects of temperature, pH, and duration of the biooxidation of old pyrite flotation tailings on the recovery of gold by carbon-in-pulp cyanidation were investigated. The best technological parameters of the biooxidation step for recovery of gold from the leach residue were the temperature of 35°C, pH 1.2–1.5, biooxidation for 12 days. Under these conditions, the sulfidic iron and sulfidic sulfur oxidation levels were 88.9% and 92.3%, respectively, and the gold recovery level was 92%. The extraction of copper into the liquid phase was 68.2%, and zinc extraction was 76.8%. Gold recovery after 6 days of biooxidation was 87% while copper and zinc extraction was 57.5% and 60.5%, respectively. Thus, it was shown that biooxidation of old pyrite flotation tailings with application of acidophilic chemolithotrophic microorganisms for recovery of copper, zinc, and gold could be a promising technique for the treatment of these wastes.

The study was supported by RFBR, research project no. 15-08-03763a and the Program no. 27 of the Presidium of the Russian Academy of Sciences.

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