TUNGSTEN RECOVERY FROM SULFIDE-CONTAINING W-TAILINGS: Beneficiation Tests and Bioleaching for Sulphide Removal

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Recovery of W-tailings

In the frame of the H2020 RAWMINA project (Grant Agreement nº 958252), recovery of critical raw materials such as tungsten (W) in mining waste is evaluated by various innovative (bio)hydrometallurgy techniques. First, the recovery of W from sulfidic mining waste is carried out by applying gravimetric separation techniques to concentrate W-bearing minerals (mainly sheelite). W can then be leached from the beneficiated tailings using alkaline leaching. However, arsenic-containing sulfides, such as arsenopyrite, can also be significantly deported in the W concentrate which can cause an increase of the reagents consumption in the alkaline leaching process (Suess and Planer-Friedrich, 2012). Moreover, the presence of As in the concentrate could negatively impact downstream processes and the final products. Bioleaching is known to be efficient in the removal of sulfidic material even at low sulfide content (Hubau et al., 2020). Therefore, after the beneficiation process, bioleaching is used to treat sulfide and reduce acidity, iron and arsenic concentrations in the beneficiated material.

Beneficiation of W-tailings by gravimetric methods

A representative sample (500 kg) was sampled on a mine site in Portugal and prepared at BRGM facilities to obtain homogenized sub-samples according to well-established procedures, i.e. drying, crushing, grinding and splitting. Beneficiation tests have been performed by gravimetric separation taking advantage of scheelite density ($CaWO_3$, 5.9-6.1 g/cm^3). This process can also concentrate the pyritic material (mainly constituted by arsenopyrite that have a similar density as scheelite). The first pre-treatment step was the classification in four size fractions (< 100 µm; 100 µm – 250 µm; 250 µm - 500 µm; 500 µm - 1 mm), since scheelite was observed at particle size up to 1 mm by UV shortwave radiation (blue spots of scheelite bright fluorescence). Then, a separation step was carried out using a gravimetric Wilfley shaking table for the coarser fractions (Figure 1). W content in the beneficiated product quantified by portable XRF technology was increased by 10 fold (from around 2000 ppm to 2-5 wt. %). Concentration using Mozley Multi Gravity Separator (MGS) is also planned to treat fine fraction (< 100 µm). In addition, iron and sulfur content in the beneficiated samples have been increased, indicating that arsenopyrite (main sulfide contained in the tailings) has also been concentrated.

Figure 1: Beneficiation tests of W-tailings using a gravimetric Wilfley shaking table

Bioleaching of the beneficiated W-tailings

Bioleaching tests are currently being performed in shake flasks to adapt a selected acidophilic microbial consortium to the bioleaching of the sulfide contained in the beneficiated W-tailings. The next steps include the inoculation of 2-L reactors with the adapted microbial consortium and a progressive increase of the solid concentration in stirred tank reactors to bioleach sulfides and produce sulfide-free samples. Preliminary bioleaching tests show that this substrate is particularly suitable for the growth and the activity of S-and Fe-oxidizing activity. The dissolution of sulfide minerals (mainly arsenopyrite) is almost complete and leads to the production of a solution of sulfuric acid and ferric iron.

Conclusion and perspectives

The beneficiation process applied to the W-tailings allowed concentrating not only scheelite but also arsenopyrite in the W-tailings. An optimal flowsheet of beneficiation and bioleaching processes will be established as a pretreatment of the tailings before alkaline leaching to dissolve tungsten. Downstream process considered in RAWMINA project include the W selective recovery using nanofibrous composite materials and electrowinning. Finally, the overall RAWMINA process would allow the reprocessing of the W-tailings, recovering the remaining W and reducing the environmental risks associated with sulfide- and arsenic-containing mining residues.

References

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