FLOTATION BENEFICIATION OF COPPER ORE

PURPOSE

The objective of this task is to perform the flotation beneficiation of finely ground copper ore and, after the beneficiation process, determine the copper contents of the feed, concentrate, and tailings.

THEORY

Copper content in solution (copper-ion concentration) can be determined with UV-VIS spectrophotometer when a reference solution of known concentration is used. A copper-containing solution can be prepared, for example, from crystalline copper sulphate ($CuSO_4 \cdot 5\ H_2O$). An aqueous solution of copper sulphate is relatively colourless, but the situation changes when sufficient amount of ammonia (NH_3) is added to it. Copper ion and ammonium ion form a dark blue complex according to the following reaction equation:

$$CuSO_4 \bullet 5\ H_2O + 4\ NH_4OH \rightarrow Cu(NH_3)_4SO_4 \bullet H_2O + 8\ H_2O$$

$$Cu^{2+} + 4\ NH_3 \rightarrow [Cu(NH_3)_4]^{2+}$$

PROCEDURE

Sieve the crushed and ground copper ore (passing a 0,125 mm sieve) until 500 g of feed material has been collected. From the well-mixed ore powder, take a 1 g sample (Note: weigh the sample using an analytical balance).

The flotation test is carried out in a 2 L flotation cell. Add 2 L of water and 500 g of feed to the cell, start the flotation machine, and set the impeller speed to 1100 rpm. Adjust the slurry pH to 11 using calcium hydroxide and monitor the pH throughout the flotation process.

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Prepare a 1% aqueous solution of sodium isobutyl xanthate (toxic) and add the required amount so that the collector dosage is 100 g per tonne of ore. After the reagents have been added, allow conditioning to proceed for approximately 15 minutes.

Add a few drops of SylvaPine frother (or another suitable frother, such as tall oil) to the slurry, and shortly thereafter open the air valve of the flotation unit. Once froth begins to form, skim it off from the surface of the flotation cell. Continue removing the froth as long as it remains dark in color, exhibits a distinct metallic sheen, or until, when rubbed between the fingers, no noticeable particles can be felt.

Next, filter the tailings remaining in the flotation cell and the concentrate collected as the froth product. Place the samples in a drying oven to evaporate the water.Weigh the dried tailings and concentrate to determine the recovery percentage. Note: Retain both the concentrate and tailings samples until the laboratory report has been submitted.

SAMPLE PREPARATION FOR ANALYSIS

1. Weight accurately approximately 1 g of samples into 400 ml beakers.
2. Add approximately 25 mL of concentrated hydrochloric acid (HCl) to the samples and boil nearly to dryness.
3. Add carefully approximately 20 mL of concentrated nitric acid (HNO_3) and boil until the sample has dissolved.
    - If the sample does not dissolve, small amounts of hydrochloric acid and nitric acid may be added alternately while boiling. The objective is to dissolve the entire sample.
4. Remove the beakers from the hot plate and carefully add approximately 50 mL of deionized water.
5. Boil until only approximately 25 mL of solution remains.

6. Add 30 mL of 25 % aqueous ammonia solution initially, and add more, if necessary, until the pH is above 9.
7. Filter the solution into 100 mL volumetric flasks using a funnel and filter paper. Rinse with a small amount of water.
8. Before filling to the mark, check that the pH is above 9 and, if necessary, add more ammonia solution.

Preparation of reference solutions (standards)

1. Add approximately 100 mL of deionized water into a 400 mL beaker.
2. Prepare the stock solution (1 g/L) by accurately weighing 785,855 mg of copper (II) sulphate pentahydrate ($CuSO_4 \cdot 5\ H_2O$). Add it to the beaker and stir until the powder has dissolved.
3. Measure 10 mL of concentrated ammonia solution and 10 mL of deionized water into a graduated cylinder.
4. Slowly pour the solution from the graduated cylinder into the beaker while stirring intermittently (the colour changes to a dark blue).
5. Rinse the graduated cylinder with 2 x 10 mL of deionized water and add the rinsing water to the beaker.
6. Stir the mixture and transfer it into a 200 mL volumetric flask using a funnel. Rinse the beaker with a small amount of deionized water. Finally, fill the volumetric flask to the mark.
7. Prepare additional standards from the stock solution (1 g/L) with concentrations of 0,5 g/L and 0,25 g/L.

Spectrophotometric analysis

Measure the reference solutions and samples using a UV-VIS spectrometer at a wavelength 607,30 nm, using deionized water as the blank sample.

RESULTS PROCESSING

1. Calculate the amount of copper contained in the feed, concentrate, and tailings.
2. Calculate the concentration ratio and recovery of the flotation test.

Laboratory Report

Prepare a laboratory report (using a word processor) describing the experimental procedure, calculations, results, and an evaluation of the work, including a self-assessment.

Concentration ratio (K)

$$K = \frac{F}{C} = \frac{c-t}{f-t}$$

F = mass of ore feed

C = mass of the concentrate

c = copper concent of the concentrate, %

f = copper concent of the feed, %

t = copper concent of the tailings, %

Recovery percentage

Recovery (**R**) is the fraction of the valuable mineral or metal that is recovered into the concentrate.

$$R = 100 \cdot \frac{c \cdot C}{f \cdot F} \%$$

Recovery (**R**) can be expressed based on analytical values as follows:

$$R = 100 \frac{c\,(f\text{-}t)}{f\,(c\text{-}t)} \%$$

Handling of waste

Pour the solutions down the drain and place the dried flotation tailings and concentrate into their designated containers. Dispose of the filter papers in energy waste.

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