DECONTAMINATION OF KHERZET YOUCEF MINE TAILINGS

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Abstract - Mining industry has been an important economic activity for many decades. Although this industry brings significant socio-economic benefits, many negative impacts on the environment result. In the short term, the destruction of the natural landscape, the fragmentation of ecological environments are major negative impacts while in the long term, it can cause significant damage by acidification of the environment called acid mine drainage (AMD). The objective of this work is to conduct a remediation study of the Kherzet Youcef mine tailings and to remove the maximum of sulphides from these residues so that they are no longer acid generators by applying the non-selective flotation technique. As in any treatment study, physical, chemical and mineralogical characterization tests are carried out, in order to allow the identification of the discharges coming from the Kherzet Youcef mine complex dike. For the desulfurization process, we studied the different parameters affecting the non-selective flotation method. To do this, we varied the concentrations of the chemical reagents used (collector and activator), as well as the pH and the particle size, in order to determine the optimal conditions allowing to obtain the best results, and to elaborate a flow sheet of tailings processing of Kherzet Youcef mine. The case of the Kherzet Youcef mining complex where research conducted by Belkhiri, 2011 and Aitouchak, 2006, on groundwater, soils and sediments of the wadis of the plain of Ain Azel, confirmed the pollution of the region. We therefore proposed to undertake, as part of this project, to carry out a study to decontaminate these residues.

Index Terms - Decontamination, Desulfurization process, Kherzet Youcef mine, Mine tailings.

I. INTRODUCTION

The goal of desulfurization is to remove enough sulphides so that the final residue is no longer an acid generator [1]. This is one of the techniques used to prevent this acid production and is a process that produces residues classified as non-acidogenic and which, consequently, makes their management less restrictive. The most effective way to avoid acid effluents is obviously to remove the sulphides present. The desulphurization can be operated by flotation or by bioleaching process, it is possible either to recover the sulphides by flotation, or recover their content of metals by bioleaching [2] [3].



Fig.1 Location of the study area

Environmental desulphurization by non-selective flotation of sulphides is a tailings management method, technically feasible and environmentally effective. Flotation technique aims to recover sulphides at the surface by using a collector that is added to the pulp, thus greatly reducing the acid generation potential of residues.

Kherzet Youcef mine is located in the east of Algeria, 5km north-west of the town of Ain Azel, about 50 km southeast of the town of Setif. Beside the Kherzet Youcef mine are located laundry and a tailings dam (Fig.1).
This dam occupies an area of 07 ha [4], collecting since 1979, Kherzet Youcef mineral processing residues and since 1994, the residues of Chaabet El Hamra ore [5].

On a regional scale, the study area is represented by a set of links, some of which culminate at more than 1500m, such as Jebel Boutaleb (1886m), which take turns to form a topographic and climatic barrier between northern Algeria. and the Saharan domain [6].
According to the processed data collected at the National Office of Meteorology (ONM) and within the National Water Resources Agency (ANRH) of Algiers, the region of Ain Azel is characterized by a semi-climatic mediterranean climate.
The rainfall pattern of the study area is characterized by a dry period (May to October) and a rainy period (November to April). Intense rainfall that characterize the wet period leads to high erosion which reflects the

horizontal (runoff) and / or vertical (seepage) transport of the water loaded with metals in the soil.

II. METHODOLOGY

A. Sampling and sample preparation

The samples we worked on were taken from the Kherzet Youcef tailings dam, using a conventional sampling method of dividing the dam surface into six zones and taking a representative sample from each area at a depth of up to 1.5m.

It should also be noted that this sampling step was carried out in 2 campaigns, the first one was in December 2011 and the second in April 2012. The purpose of the sampling is to have representative samples since the tests in the laboratory are carried out on a very small quantity of product and therefore when the initial quantity is important the composition can vary from one place to another.

The first step of this preparation was an open-air drying operation for a week, after which we performed a manual homogenization of our sample, and finally we divided it into quarter-sided sub-samples (Fig.2). We then used a rotating sample divider to divide our sample into eight representative parts (Fig.3); each part being collected in a separate vial, repeating this operation, the residue resulting from the soils is thus prepared for the analysis.

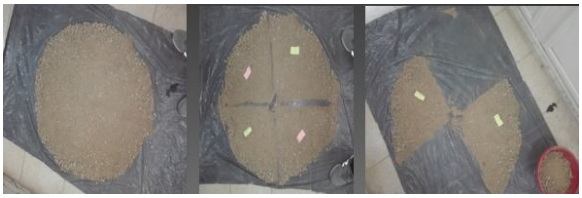


Fig.2 Sampling operation (quartering)



Fig.3 Sample Divider

B. Physico-chemical and mineralogical analysis

A sieve analysis was carried out to determine the distribution of the different particles of a sample according to their size and to provide particle size fractions for the following steps. The knowledge of particles size is essential because it affects many soil characteristics. The pH value was measured using a standard pH meter (Jeneway) in the flotation pulp.

Mineralogical characterization was performed using thin sections observed under a polarizing optical microscope in reflected light and a scanning electron microscope. It was supplemented by X-ray diffraction spectrometry which mainly identified the gangue minerals.

C. Flotation tests

Preparation and Stabilization of the pulp

The flotation cell we used is a DENVER type cell with a capacity of 2.5 liters. For all of our tests we took 750g of residue in a 30% solid/liquid ratio. This preparation step begins with the introduction of the 750g of solid into the conditioning tank, then water is added to the volume of 2.5 liters. it is always necessary to make sure that the material does not have any agglomeration and this by applying a continuous stirring during a period of 20 minutes [7], during this step, we took the measurement of pH (10 and 20 min).

Conditioning of pH

Indeed, the pH value is one of the parameters that we studied, so we had to condition several times its value, to do this we used two pH regulators, namely the lime (CaO) and the sulfuric acid (H_2SO_4) [8]. This step lasts approximately 10 minutes

Adding reagents

The addition and conditioning of reagents is a step that takes us between 10 and 15 minutes depending on the parameters studied [9]. Generally, it starts with the addition of activator copper sulphates and stirring for 5 minutes after the addition of Xanthates (collector) and stirring for 10 minutes, and lastly the foaming pine oil is added with a stirring of one minute. The different reagents and their dosages are represented in the following table.1:

Tab.1 Reagents of flotation process

Reagent	type	Concentrations
Ethyl-xanthat	Collector	100g/t 200g/t 300g/t 400g/t
Copper sulfate ($CuSO_4$)	activator	100g/t 200g/t 300g/t 400g/t
Lime (CaO)	pH regulator	/
Sulfuric acid	pH Regulator / Activator	/
Pine oil	foaming	One Drop

Flotation begins with an injection of air into the pulp and then collects the resulting bubbles into plastic

tubs. The flotation time being 15 minutes divided into five (3 '6' 9 '12' and 15') the concentrate corresponding to each period is collected separately in a tank.

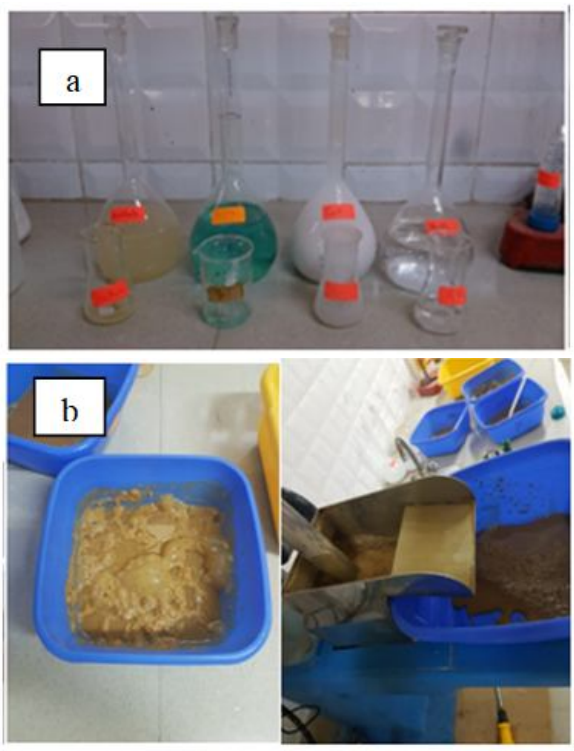


Fig. 4 (a) Reagents used during the tests (b) Flotation process

Filtration and drying

This is the last step of the process, its purpose is to separate the water from the solid concentrate. Tthis step is composed of two main parts, the first is to filter a maximum amount of water using a pump and filter paper (Fig.5), and then we dry the concentrate in an oven set at 105°C for a period of 24 hours.



Fig.5 Filtration of samples

III. RESULTS

We followed the pH value during the flotation test, from the pulp conditioning stage which lasted 20 minutes, the different phases of pH regulation and addition of the reagents, until to the recovery of concentrates. The graph (Fig.6) shows that the initial pH of the pulp is 11.7, and is substantially stable throughout the stabilization step.

After pH conditioning, using H_2SO_4 and lime, the pH value is slightly influenced by the presence of the activator and the collector.

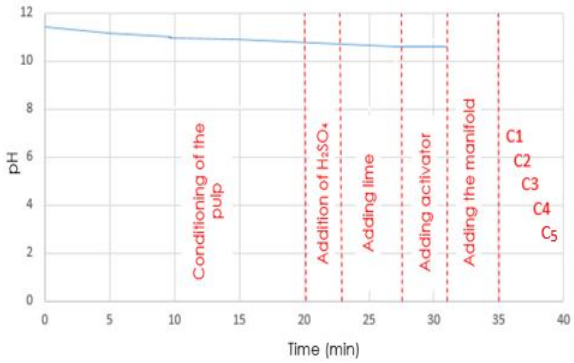


Fig. 6 pH change depending on the time of flotation

The recovery of pyrite during the flotation time and with: an initial pH of 11.7 and 100 g/t of collector is shown in figure 7. We note that about 98% of pyrite was recovered during the first six minutes. While the sulfur content decreases rapidly during the first two minutes.

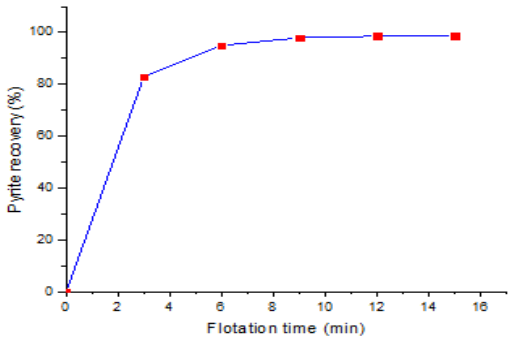


Fig.7 recovery of pyrite as a function of flotation time

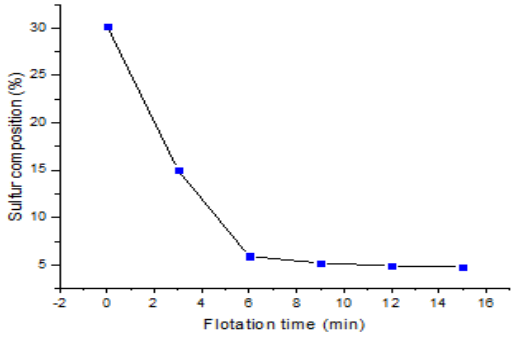


Fig.8 Sulfur composition depending on the time of flotation

We studied the influence of several parameters on the non-selective flotation process of sulphides present in Kherzet Youcef mine tailings [10] [11]. We began by varying the collector and activator reagents, in order to determine the concentrations to achieve the best results as well as the variation of grain size (-125 + 100µm), (-100 + 80 µm) and (-80 + 63 µm). The final scheme proposed for flotation is as follows:

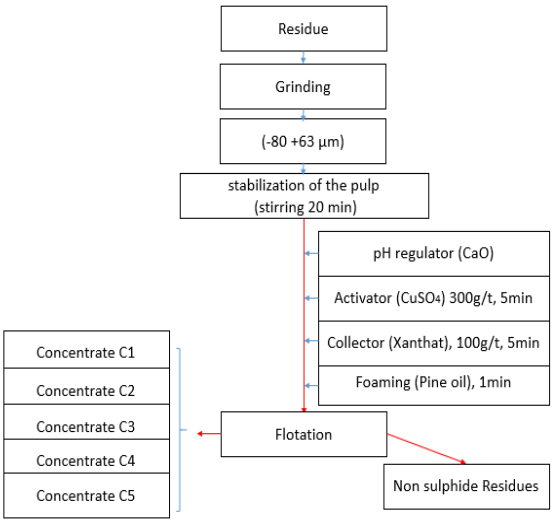


Fig.9 Flow sheet proposed of decontamination of Kherzet Youcef mine tailings

CONCLUSION

The experimental part of our work mainly on the flotation method allowed us to determine the optimal values of the parameters affecting the desulphurisation of Kherzet Youcef mine tailings. Indeed, we found that the flotation requires a concentration of 100 g/t of collector with activation of particles with sulfuric acid and an activator at a concentration of 300 g/t. A pH of 9 and a particle size range between 63µm and 80µm are also recommended for the flotation of residues from the Kherzet Youcef mine. The choice of different reagents was made in relation to previous work, therefore we opted for ethyl xanthate as a collector, copper sulphates for activation, acid sulfuric and lime for regulation pH value and finally pine oil.

It should be noted that the use of non-selective flotation for the desulphurisation of the tailings residues is an effective method of treatment and decontamination of the sulphured tailings of the kherzet youcef mine.

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