EPJ Web of Conferences **29**, 00006 (2012)
DOI: 10.1051/epjconf/20122900006

Recovery process of the mineral sphalerite of Chaabet El Hamra's deposit (Algeria)

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Abstract: The present study rests on the treatment's process optimization by flotation of the Chaabet El Hamra's zinc ore (Algeria), for the optimization parameters relating to the production. The choice of parameter to optimize for flotation, and the arrangements and the scheme's initial flotation, while considering the studies already undertaken, all this has enabled us to better focus our work, while minimizing the consumption of reagents in different tests, This has resulted in successful outcomes.
Keywords: Flotation, Sphalerite, Zinc, Amylxanthate,HAZEN, time.

1 Introduction

The area of the layer of Chaabet El Hamra forms part of the metallogenic zone of Hodna, which contains several lodgings and indexes of Pb-Zn-Ag-Ba. Amongst other things, the old Pb-Zn mine of Kharzet youssef is located at 10 km with the NW of the lodging of Chaabet El Hamra.

The zone of the Hodna is composed of several plicated structures breakable accidents which divide it into various tectonic blocks. The lodging of Chaabet El Hamra belongs to the block of Ain Melila.

This block includes three structures of rising having the shape of horst anticlines. The layer of Chaabet El Hamra, because of its direction NW-SE, is associated with the horst anticline of Rahbat**.**
The substratum of the area of Ain-Azel is composed of a sequence of carbonato-terrigenous sedimentary rocks characteristic of a medium of punt forms. The age of these rocks varies from cretaceous to tertiary sector. The rocks of Cretaceous age are subdivided from the base towards the top, in Valangien, Hauterivien, Barrémien, Aptien, Albien and Cénomanien. Zinc mineralisations of Chaabet El Hamra having economic interest are restricted with the lower part of Hauterivien.

Several lenses of surface of Fe (pyrite - marcassite) and of Zn (Sphalerite) are distributed in the sedimentary sequence of Chabet El Hamra. However, on the basis of their thickness and their Zn content, only two lenses show the necessary characteristics to support a mining. These two lenses of economic interest are distinguished, at the mine, as being bodies number 1 and 2 of the ore.
Zn is the only metal of economic interest for the ENOF contained in the mineralized bodies, the content of Pb (0.04 through 0.16%), Cd (0.001 through 0.005%) and the content of Ag (<5ppm). Lenses rich in Zinc of the bodies surrounded by a disseminated pyrite halation.

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The geological reserves of the layer of Chaabet El hamra are presented separately for the higher part above the hydrostatic level between profiles 0 and 10 and for the lower part drowned between profiles 10 and 15.

- the initial geological reserves (ratio ORGM 1992) are estimated for the two bodies I and II at a cut content of 3 %:

Flotation is a separation of particles based on their physico-chemical properties of surface. The separation is based on a hydrophobic mostly artificially extended to a family of particles by adsorption of molecules on the surface hydrophobic. Following the creation of gas bubbles in the pulp suspension, for example by injection of air, particulate matter (made) hydrophobic are collected by the gas phase. Accordingly, if the size of the bubble permits, lévitent particles collected in the pulp to be concentrated supernatant in a froth on the surface The foam can then be harvested either by scraping or simply overflow.

The operating parameters are:

- Packaging the pulp (duration);
- Reagents improving the selectivity of separation: active, depressing;
- The specific solid reagent to be recovered by flotation: collector;
- Structuring the reagent foam;
- Consumer these reagents is characterized in grams per tonne of material.

During this study, we carried out the treatment by flotation of a Polymetallic ore (Pb-Zn-Ag-Ba), the choice of the parameters to optimize for flotation, as well as the mode, and that by basing on the studies already undertaken.

2 Identification of the ore

2.1. Sampling

The sample placed at our disposal was taken from the carpet which carries the outgoing ore crushed fro the hopper towards the ball mill.

2.1.1. Physical property of the ore

- density: ρ=3.32%
- moisture: W=0.23%
- hardness : D=5-6 (échelle MOHS)
- porosity :P=3.78%

2.1.2. Mineralogical and petrographic study

The petrographic and mineralogical study on a polished section made it possible to distinguish:

- ***Sphalerite***: it is presented in the form of single-crystal aggregates, of dimension 10 mm or up of traditional crystals isolated from dimensions 0.09 through 0.28mm.
- ***pyrite*** : it appears in three forms:
  a. in aggregate (0 - 0.6mm)
  b. in grain ends xenomorphic 0.06mm
  c. In filonnets of 100 to 140 mm of length.
- **The marcassite**: it is presented in the form of crystalline aggregates flattened.
- ***The barytine***: is rare.
- ***Hematite***: very abundant.
- ***Crystal***: not very frequent.
- ***Dolomite***: it forms the wall-rocks.

1.1.3. Chemical analysis

The chemical analysis carried out gives the following results:

Pyrite (FeS)	Sphalerite (ZnS)	Crystal (PbS)
15.36 %	7.43 %	0.127 %

According to the chemical analysis we can say that the deposit of Chaabet El Hamra is a pyrite and sphalerite deposit.

1.2. Analysis granulometric of ore

The analysis was carried out on a series of AFNOR sieves going from 5mm to 0.074mm, for a sample of 1 kg.

After sifting by the dry way, we weigh then we analyze the refusal of each sieve. The results obtained are presented on the following figures:

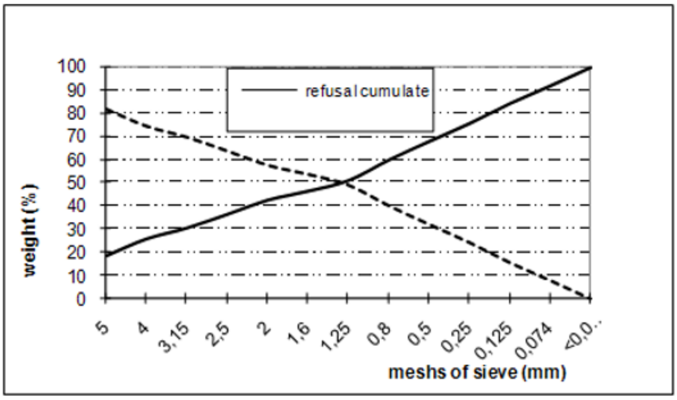

Fig. 1. Cuve1. Granulometric analysis of ore

1.3. Granulochimic analysis

It has the objective of specifying after classification the qualitative and quantitative aspect in metalliferrous elements on the level of each particle-size range. The results are presented on the following figure:

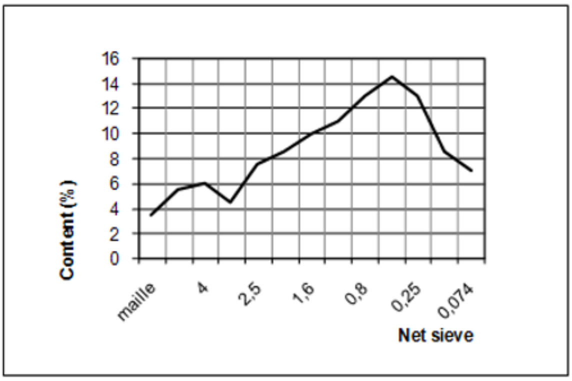

Fig. 2. Curve 2. Granulochimic analysis of ore

1.4. Interpretation of the results

The curve (1) of the cumulative passing presents a concavity upwards, this is because

- The coefficient of HAZEN (Cu = 24.44) is too high, this explains why the mechanical resistance of the various mineralogical components is very variable.
- The coefficient of curve (Cc=4.34) is higher than 1. That explains why mineralization is proportionally softer.

From this curve(1), we deduced the equation (1) which represents the correlation between passer cumulates and the diameter of the mesh sieve and the equation (2) which represents the correlation between refusal cumulate and the diameter of the mesh sieve

$$P_p = -0.1835\Phi^2 - 4.1339\ \Phi + 84,32 \qquad (1)$$

With $R^2 = 0.9979$

$$P_R = 0.1835\ \Phi^2 + 4,1339\ \Phi + 15,68 \qquad (2)$$

With $R^2 = 0.9979$

The curve (2) of the granulochemical results of the analysis indicate that zinc content is:

- Uniformly set out again in the higher particle-size ranges.
- Is more important in the lower particle-size ranges.

This explains why Zinc is finely disseminated in the gangue where a fine crushing is demanded for its release.

3 Tests of flotation

3.1. Study of the ability of crushing

This study consists of the determination of the time necessary to obtain a degree of 80% of the mineral grains lower than 74µm, thus allowing the release of useful minerals.

Crushing is carried out in a varying ball mill of various dimensions by the wet process for durations of 10 with 45min.

The results obtained are represented on the following figure:

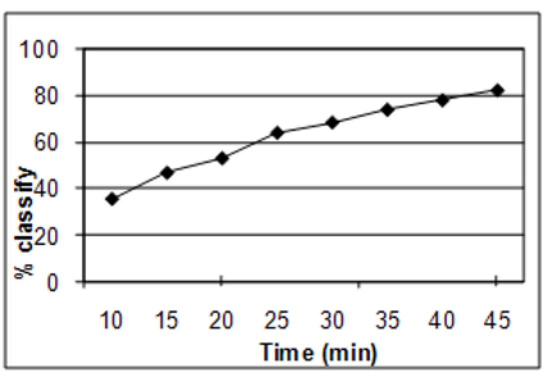

Fig. 3. Curve (3): Variation of class < 74µm according to time

3.2. The flotation of the Sphalerite (ZnS)

Flotation is carried out in a cell of type"Denver"

- condition of rotation is of 1200 rounds/min
- the report ratio liquid / solid is 3/2

- Preparation of the sample: a sample of 1Kg crushed with 1mm is mixed up with 1 liter of water.It is crushed during 42 min and 43 s in a ball mill to obtain a granulometry of 80% lower than 74µm. The product obtained is poured in a flotation cell.

3.2.1. Influence of the sphalerite (ZnS) collector quantity

Consumption in the circuit of Zinc varies in the following way:

Reagents	Quantity (g/t)			
Amylxanthate (KAX)	100	150	200	250

3.2.1. 1. Principal flotation

One addition in the cell:
- lime (CaO) to fix the pH between 10 and
- the activator (copper sulfate $CuSO_4$) 300g/T, the time of conditioning is of 5 min.
- Collecteur (Potassium Amylxanthate), the time of conditioning is of 5 min.
- foaming it oil 12.5g/t of pines), the time of conditioning is of 1min.
- we introduces air.
- the time of scrapingis of 5 min.

we recover the foam formed on the surface during 5 min, which represents le first concentrate.

3.2.1. 2. Flotation of control

We add
- 50g/T of Amylxanthate, the time of conditioning is of 3min.
- oil 12.5g/T of pine, the time of conditioning is of 1min
- We introduces air
- the time of scraping is of 5 min.

We recover the foam formed on the surface during 3 min, which represents the 2nd concentrate.
The results obtained are represented in the following figure:

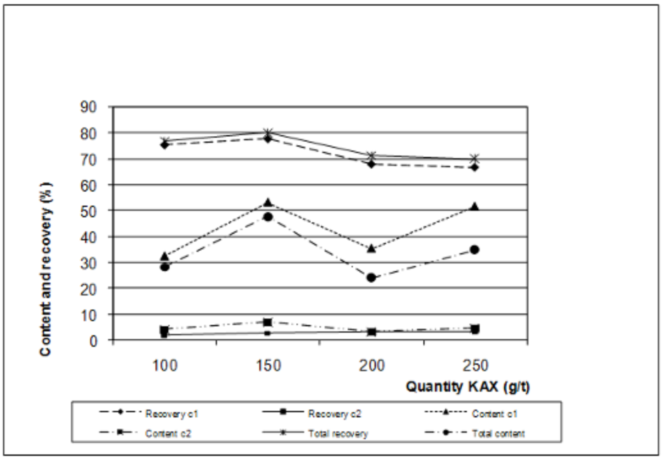

Fig. 4. Curve 4. Content and recovery of Zinc

3.2.2. Influence quantity of the activator ($CuSO_4$)) of the sphalerite (ZnS)

Consumption in the circuit of Zinc has been varied in the following way:

Activator	Quantities g/T			
$CuSO_4$	200	250	300	350

We add in the cell:

- lime (CaO) to fix the pH between 10 and 11
- the activator (copper sulfate $CuSO_4$), the time of conditioning is of 5min
- collecteur(Amylxanthate) the 150g/t, the time of conditioning is of 5 min
- Foaming 12.5g/t of pines oil), the time of conditioning is of 1 min
- We introduce air
- the time of scrapings of 5 min.

We recover the foam formed on the surface during 5 min, which represents the 1st concentrate.
The parameters of Flotattion of control remain constant. The results obtained are represented in the following figure:

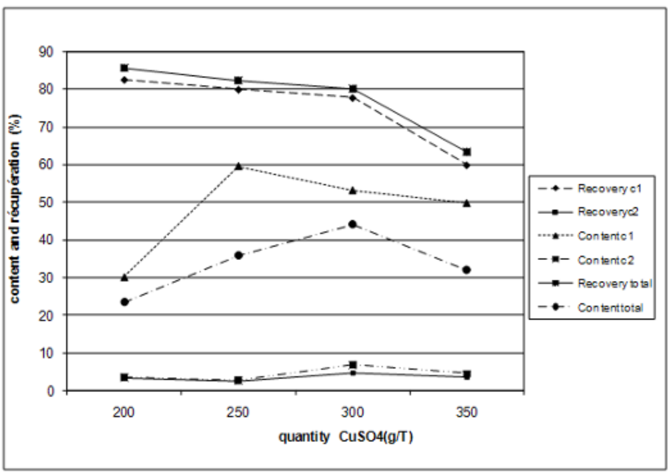

Fig. 5. Curve 5. Content and recovery of Zinc

3.2.3. Influence time of scraping:

The time of scraping varies in the following way:

Designation	Value in (min)			
Time of scraping	5	6	7	8

We add to the cell:

- lime (CaO) to fix the pH between 10 and 11
- the activator (copper sulfate $CuSO_4$) 200g/t, the time of conditioning is of 5min
- The collector (Amylxanthate) 150g/t, the time of conditioning is of 5 min
- foaming 12.5g/t of pines oil, the time of conditioning is 1min
- We introduce air
- The time of scraping is variable.

We recover the foam formed on the surface during 5 min, and this represents the 1st concentrate. The parameters of controlling the flotation remain constant. The results obtained are represented in the following figure:

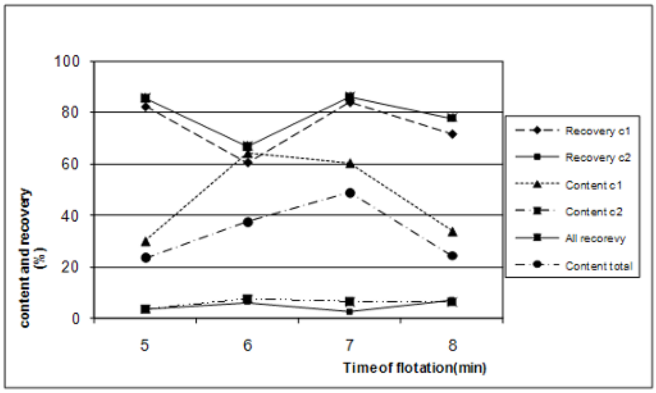

Fig. 6. Curve 6. Content and recovery of Zinc

3.3. Interpretation of the results

From curve (3), we deduced the equation (3) which represents the correlation between the Variation of class (<74µm) according to time

$$y = 34.762\ t^{0,4147} \tag{3}$$

With $R^2 = 0.9954$

The results indicate that the time of optimal release of minerals with a value of 42 minute and 43 second.

From this curve (4), we deduced the optimal quantity of the collector is of 150 g/T, corresponding to a Zinc content of 47.58 and one recovery of 80%.

From this curve (5), we deduced the optimal quantity of the Activator is of 200 g/T, corresponding to a Zinc content of 23.2 and a recovery of 85.70%

From curve (6), we deduced the time of flotation of Zinc was optimized with 7min, corresponding to a Zinc content of 49.13% and a recovery of 86.35%

4 Conclusion

During study, we carried out the treatment by flotation of a Polymetallic ore (Pb-Zn-Ag-Ba), the choice of the parameters to optimize for flotation, as well as the mode, and that by basing on the studies already undertaken

The study of Grindability allowed us to predict the optimal time to release minerals with a value of 45 min.

The optimum quantity of collector (AX) is 150 g / t, corresponding to a level of 47.58% and a recovery of 80 %.

The amount of activating is optimized at 200g / t for zinc flotation

We have achieved a level of 23.2% Zinc and a recovery of 85.70%

Time flotation of zinc has been optimized to 7 min, corresponding to a zinc content of 49.13% and a recovery of 86.35%

The addition of A.X to the shredder increases the recovery of Zinc.

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