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# Granulometric Analysis in Comminution Circuits of Sustainable Processing Plant, Case Study Telma Mine Ecuador

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## *Abstract*

*The purpose of this paper is to carry out a short analysis of the comminution circuit carried out in the beneficiation plant that processes the minerals from the Telma mine, exclusively with water without additional reagents. For this, an analysis of the current comminution process in the beneficiation plant is carried out, generating the FlowSheet of the system with the help of the illustration program called Adobe Illustrator CS6 in order to understand the process of the comminution circuit. Then, a review of the operational parameters of the crushers, vibrating sieves and mills, together with the evaluation of the distribution of their particles in the meshes, both in crushing and grinding, were carried out. The granulometric analyzes are carried out both in the beneficiation plant and in the Mining Laboratory of the ´Escuela Superior Politécnica del Chimborazo´ ESPOCH, to superimpose data; in the first stage of mineral reduction, the reduction results were 90% of the ore; on the other hand, the analysis of granulometry distribution carried out in the discharge of the cyanidation tank, was executed in the ESPOCH mining laboratory showing that only 57.66% of the mineral has a 120 mesh particle size. Therefore, the mineral delivered by the size reduction circuit carried out in the beneficiation plant that processes the minerals from the shaft mine does not correspond to the ideal particle size, according to the required feed percentage F80 for the fines hopper. Finally, as the main recommendation, 120 mesh separators should be implemented to separate coarse particles.*

**Keywords:** *Comminution, Reduction Circuit, Sieves, Flowsheet, Particle Size, Granulometric Analysis.*

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## Introduction

Parisaca et. al (2015), names that the mining industry faces an urgent need to improve and increase the efficiency of its operations in various sectors, since the activity occupies a high place in energy costs, manufacturing costs and maintenance of its machinery. and the other activities it represents. In this context, the grinding process plays an important role, both in terms of total operating costs and in the overall efficiency of the process, so a great effort has been made to try to optimize it technically and economically of this important single operation, taking into account the general operation of industrial grinding equipment such as crushers and mills, and their respective classifiers or sieves (Magne & Titichoca, 2005).

In the different stages of grinding and concentration of the mineral, the size of the particles is one of the most relevant variables for the activity, since a greater or lesser release of ore depends on it. The mineral activity along the crushing/sieving, grinding/sorting steps depends largely on the size of the particles to be treated at each of these process stages. Therefore, it is necessary to properly identify and quantify this variable (Casapalca, 2013).

The comminution process is where the operation consumes the most energy and where most of the process costs are concentrated. The biggest factor that the company represents is in its comminution circuits (crushing, sieving and grinding). Therefore, its problems are analyzed in the comminution stage, specifically in the processing plant that processes minerals from the Telma mine operated by the company "OROCONCENT S.A.", located in the Portovelo canton (Samaniego, 2022).

The first stage of crushing is undoubtedly the main stage of the process and the most important, so sometimes the mineral arrives with the presence of moisture, which causes the material to generate sticks due to its clayey agents and that causes the material to get stuck in its discharge from the hopper both fine and thick and when performing its meshing they do not manage to cross through the openings of these. Another of the problems presented by the company's beneficiation plant presents energy fluctuations, where it causes its comminution circuits to stop and this creates problems both in losses of processed ore (processing time), and energy loss, since the start of industrial machinery creates excessive consumption in its energy (ARMAS & POMA, 2013).

In mining operations, the main technique used is the use of meshes or sieves. The distribution of the particle size in the different stages of the mineral grinding process, which tends to release valuable species of the extracted material, depends on the grain size obtained, in order to achieve a metallurgical characterization of the mineral in each individual operation, so that data collection at each sampling point is essential to achieve an interpretation of the particle size distribution or the granulometry of the material (CISA, 2020).

Therefore, the present research emphasizes analyzing the comminution circuit from primary and

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secondary crushing as well as grinding, significantly optimizing the granulometry of the treated ore, thus reducing production costs (GUPTA & YANG, 2006).

## Methodology

For the development of this research, which includes 3 phases: field work, laboratory of both the company and the University, cabinet; the use of the following materials is required (Table 1).

**Table 1:** Materials needed for the execution of the research.

| Field Phase | Laboratory Phase | Cabinet phase |
|---|---|---|
| **- Protective helmet.** | - Jaw crushers | - Computer |
| **- Reflective vest.** | - Ball mill 6' x 12' | |
| **-Gloves.** | - Sieve set. | |
| **-Balance.** | - Camera | |
| **-Shovel.** | - Balance | |
| **- Plastic bags.** | - Stove | |
| **-Notebook.** | - Containers | |
| **-Pencil.** | - Vibro sieve | |
| **-Marker.** | - Spatula | |
| **-Camera** | - Heat gloves | |
| **- Hand tools.** | - Plastic covers | |

### *Elaboration of the current crushing and grinding circuit.*

### *Plant visit*

It consists of carrying out the visit and analysis to the processing plant and thus achieving a survey of the pertinent information, both of its equipment and its operational parameters of the same, to carry out an effective survey we proceed to know everything about the process carried out in the plant and obtain relevant information that helps us understand needs and strengths in each operational section.

### *Circuit design*

After having the relevant information of each of the teams in charge of their comminution circuit, the achievement of the comminution process (FlowSheet) is designed in a Slider of the Abobe Illustrator CS6 program, defining each of the parts of the operational phases of the comminution system.

### Evaluation of the distribution of the meshes in the crushing and grinding circuits. Processing Plant, and ESPOCH Mining Laboratory.

### Processing Plant Procedure

### *Grinding*

We proceed to make the meshes that we will occupy in the crushing circuit, which we will occupy meshes of 8, 4, 2 and 1 inch and have a granulometric distribution.

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The respective discharge of the thick hopper to its feeding to the primary crusher is made, which consists of collecting periodically in a period of 3 hours, which is the crushing time of the Telma material.

Samples are collected in a voucher with the help of a quarterer so that the sample is homogeneous, which takes samples of 25 to 30 lb.

To analyze both its loading and unloading of the ore in the first phase of comminution is carried out the taking of 188 lb and pass them through the different types of meshes or sieves, this was done at the different sampling points of the crushing circuit.

## Mining Laboratory Procedure - ESPOCH

Initially samples are collected at strategic points, where a mesh analysis was carried out with the help of the Mercy balance, later it was taken to the metallurgical chemical laboratory of the company OROCONCENT S.A. to proceed with the drying of the material, in which an industrial kitchen was used to eliminate all moisture and then be stored to be transferred to the Mines laboratory of the ESPOCH, in the city of Macas (Fig. 1 and 2).

**Figure 1:** Preparation of the sample for laboratory analysis.

The specific procedure carried out in the mining laboratory is as follows:

Once the samples are collected at the sampling points of the milling circuit, they are transported to the city of Macas to be analyzed in the ESPOCH Mining Laboratory.

The use of a vibro sieve of Endecotts brand is carried out, where mesh sieves were used, 4,7,10,12,18,20,30,40,80,100,120,140,200,270,325,400.

We proceed to make a composite, of the samples to be analyzed, discharge from the mill.

Then already obtained and weighed with a weight less than 500 grams of each sample, we proceed to place in the containers of the sieves and to be able to analyze their granulometric distribution.

The vibration is performed for a time of 5 minutes with a frequency of M1 and M2, which is the force and time of vibration, analyzing that with this characteristic an effective particle size distribution is obtained.

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Then we proceed to weigh each mass retained in the sieves.

Using a unique balance to obtain the exact masses in each measurement.

With the data obtained, an excel table is created to find the percentages of: retention, accumulated and passing, and they create graphs of granulometric curves.


**Figure 2:** Granulometric analysis in the Mining Laboratory – ESPOCH.

## Results

### *Diagram of the circuit comminution process*

In the following figure (Fig. 3), the final diagram of the comminution circuit #1 is observed, which is responsible for crushing and grinding the ore from the Telma Mine. visualizing each of the equipment and / or machinery of the process that is carried plant such as: Thick hoppers, jaw crusher, sieve 1, conveyor belt, fine hopper, Mill 6x12, hydrocyclone, 5x10 remoliend, water pump, pipes and cyanidation tank. It should be noted that the diagram only corresponds to the circuit that is responsible for reducing the size of the ore from the Telma Mine, which is located in the Rio Amarillo sector in the parish of Portovelo.

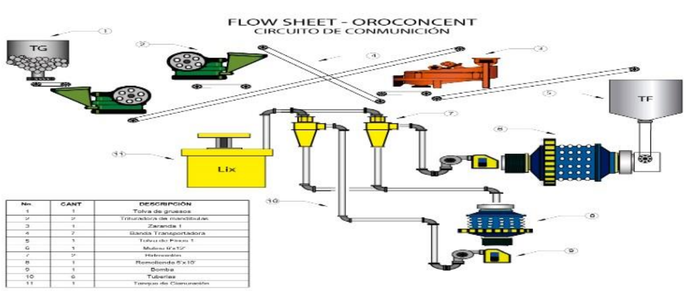


**Figure 3:** *Flow Sheet* of the comminution circuit.

### *Analysis of particle size distribution in crushing and grinding.*

The ore arrived at the beneficiation plant is fragmented to a size suitable for its release of valuable particles, which includes a primary and secondary crushing stage, which consists of a jaw crusher for both primary and secondary. This operation is the first part of the mineral comminution

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process, which reduces the particle size of rocks exploited in the Telma mine, which arrives with an approximate size of 8 "and this when passing through the primary and secondary crushing circuit, fragments it until reaching the mesh size of -2" an approximate size of 50 mm. This section has two series of circuits which is crushing circuit #1 and crushing circuit #2. Where the analysis was carried out only in the crushing circuit #1, since it is only in this circuit where they process the ore from the Telma mine, owned by the company.

***Primary crusher***

*Feed Primary Crusher - C1*

As can be seen in table 2, the percentage of mass that was retained in each mesh size is found, analyzing that a small part of the samples taken, are in a range greater than 8 "which is the optimal size so that it can be reduced, with only 5.3% of rocks greater than 8", With this it is understood that the material delivered from the mine is feasible to be processed by the primary crusher.

**Table 2:** Particle size distribution of feed to primary crusher - C1

| Sieve N° | Aperture (µm) | Sample weight | % Retained | % Accumulated | % Intern |
|---|---|---|---|---|---|
| **8"** | 203200 | 4.535,92 | 5,3 | 5,3 | 94,7 |
| **4"** | 101600 | 1133,98 | 1,3 | 6,7 | 93,3 |
| **2"** | 50800 | 29.483,5 | 34,7 | 41,3 | 58,7 |
| **1"** | 25400 | 31.751,5 | 37,3 | 78,7 | 21,3 |
| **Intern** | | 18.144 | 21,3 | 100,0 | - |
| **Total** | | 85.048,55 | 100,00 | | |

The following figure indicates how its particle size distribution is, taking into account its 3 axes that are % retained, % accumulated and its % through, and thus be able to have a detailed particle size curve according to the percentage of sample taken in the feed of its primary jaw crusher.

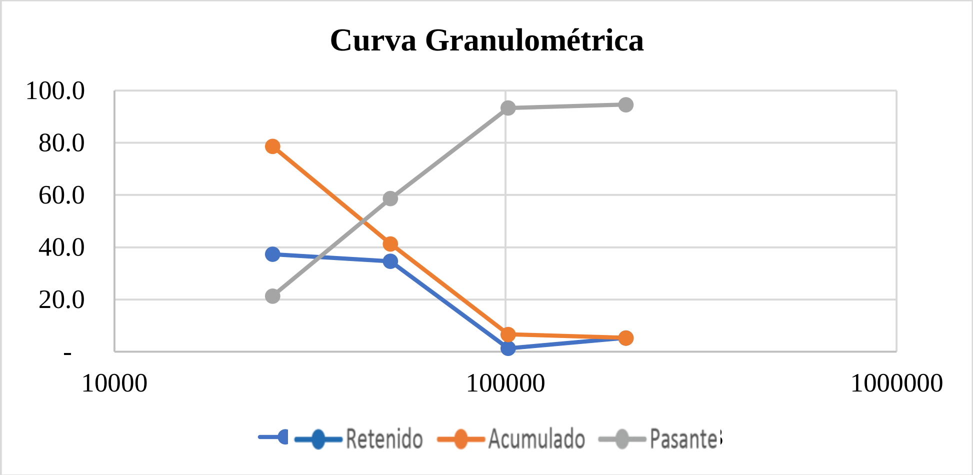


**Figure 1:** Feed particle size curve

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Reviewing graph 1 of the granulometric curve with respect to the percentage of passing material, it is observed that the behavior of the graph describes an unsuitable form of the granulometric distribution so it is very linear, although in its last part an idealized shape is already appreciated, showing us that the particles are not well distributed. This happens, because the data taken were not made with standardized meshes with which a more complete distribution would be taken, but used the handmade ones made *in-situ*.

**Table 3:** F80 Calculation

| **F80** | |
|---|---|
| **101600** | 93,3 |
| **82061,53** | 80,00 |
| **50800** | 58,7 |

As indicated in Table 3, the F80, which corresponds to 80% feed to the primary crusher (80% incoming material) are optimal particles to enter the primary crusher that are in a particle size of 82061.53 [µm].

The calculation of the particle size in which 80% of the mineral passes was made from Table 2, using the Lagrange interpolation method.

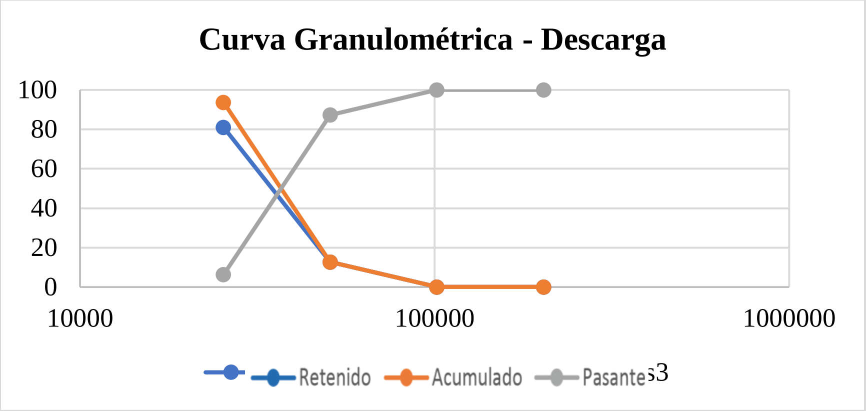
*Crusher Discharge - C1*

As can be seen in table 4, the percentage of mass that was retained in each mesh size is observed, resulting in only 12.70% of the crushed ore being above the 2" mesh is the ore that will be sent to the secondary jaw crusher, while 87.3% of the ore product of the primary crusher is already in an optimal granulometry.

**Table 4:** Particle size distribution of primary crusher discharge - C1

| **Sieve N°** | **Aperture (µm)** | **Sample weight** | **% Retained** | **% Accumulated** | **% Intern** |
|---|---|---|---|---|---|
| **8"** | 203200 | 0 | 0 | 0 | 100 |
| **4"** | 101600 | 0 | 0 | 0 | 100 |
| **2"** | 50800 | 9171,85 | 12,70 | 12,70 | 87,30 |
| **1"** | 25400 | 58555,35 | 81,03 | 93,72 | 6,27 |
| **Intern** | | 4535,92 | 6,28 | 100 | 0 |
| **Total** | | 72263,12 | 100 | | |

The figure presented illustrates the particle size distribution of the sample, utilizing three axes: % retained, % accumulated, and % through. This comprehensive representation allows for a detailed particle size curve, providing valuable insights into the proportion of particles at various sizes in the discharge of the primary jaw crusher. By analyzing the % retained axis, we can determine the percentage of particles of different sizes that remain in the crusher's discharge. The % accumulated axis demonstrates the cumulative percentage of particles accumulated at or below a specific size, offering a holistic view of the particle distribution process. Furthermore, the % through axis reveals the percentage of particles passing through a certain size, aiding in understanding the efficiency and effectiveness of the primary jaw crusher in reducing the sample to desired particle sizes. The utilization of these three axes in the figure enables researchers and operators to make informed decisions regarding the crusher's performance and optimize its operation to achieve the desired particle size distribution for further processing or analysis.




**Graph 2:** Granulometry curve discharge from the primary crusher**.**

Reviewing graph 2, of the particle size curve with respect to the percentage of passing material, it is observed that the behavior of the graph describes a more ideal behavior, indicating that the particles are more distributed, showing a more adequate distribution of the particles. This happens, because the data taken were not made with standardized meshes with which a more complete distribution would be taken, but used the handmade ones made *in-situ*.

**Table 5:** Calculation of the P80.

| **Q80** | |
|---|---|
| **50800** | 87,3 |
| **48509,31** | 80 |
| **25400** | 6,3 |

As indicated in table 5, the P80 that corresponds to 80% of discharge from the primary crusher (80% of through material) are optimal particles in which they are stored in their fine hopper and that only 12.70% of the ore that is classified by means of its vibratory sieve returns to a secondary jaw crusher. (The calculation of the particle size in which 80% of the mineral passes was made from Table 4 using the Lagrange interpolation method.)

*Reduction ratio for primary crusher C1*

F80= Particle size 80% feed ore.

P80 = Particle size 80% of product ore (outgoing).

$$Rr=\frac{\text{Tamaño de Alimento}}{\text{Tamaño del Producto}}=\frac{F80}{P80}$$

$$R80=\frac{82061{,}53}{48509{,}31}$$

R80= 1.69

Where it is obtained that the reduction ratio is 1.69, reducing the mineral almost to half of its initial size.

***Secondary crusher***

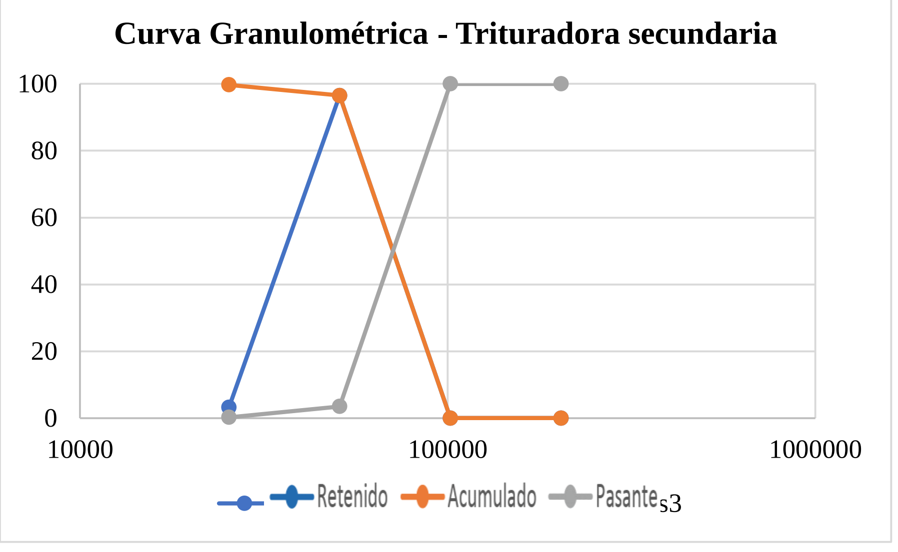
*Feeding Jaw Crusher 2 - C1*

According to the above data, it was found that only 12.7% of the circulating load is sent to its secondary crusher, verifying in its following table that this is fulfilled (Table 6).

**Table 6:** Jaw crusher feed 2 - C1

| Sieve N° | Aperture (µm) | Sample weight | % Retained | % Accumulated | % Intern |
|---|---|---|---|---|---|
| **8"** | 203200 | 0 | 0 | 0 | 100 |
| **4"** | 101600 | 0 | 0 | 0 | 100 |
| **2"** | 50800 | 45058 | 97 | 97 | 3 |
| **1"** | 25400 | 1502 | 3 | 100 | 0 |
| **Intern** | | 125 | 0 | 100 | 0 |
| **Total** | | 46.685,00 | 100 | | |

The following graph (graph 3) indicates how the particle size distribution is, taking into account its 3 axes that are % retained, % accumulated and its % through, and thus be able to have a detailed particle size curve according to the percentage of sample taken in the feed of the secondary jaw crusher.




**Graph 3:** Secondary feed particle size curve.

Reviewing graph 3 of the granulometric curve with respect to the percentage of passing material, it is observed that the behavior of the graph describes an unsuitable behavior, obtaining an initial behavior with a very low distribution, and then a linear behavior is obtained in its subsequent phases. This happens, because the data taken were not made with standardized meshes with which a more complete distribution would be taken, but used the handmade ones made *in-situ.*

**Table 7:** Calculation of F80.

| **F80** | |
|---|---|
| **101600** | 100 |
| **60273,1324** | 80 |
| **50800** | 3 |

As Table 7 indicates, the F80 corresponding to 80% feed to the secondary crusher (80% incoming material) corresponds to a particle size of 60273.13 [µm]. Indicating that the ore that is fed to the secondary crusher is in a size greater than 2". (The calculation of the particle size in which 80% of the mineral passes was made from Table 6, using the Lagrange interpolation method).

### *Jaw Crusher Discharge 2 - C1*

As can be seen in table 8, the percentage of mass that was retained in each mesh size is analyzed, the mineral retained even in a mesh equal to or greater than 2", is 4.8% a small fraction that will return to its secondary crusher, until it can be found in a mesh less than 2".

**Table 8:** Particle size distribution of discharge.

| Sieve N° | Aperture (µm) | Sample weight | % Retained | % Accumulated | % Intern |
|---|---|---|---|---|---|
| **8"** | 203200 | 0,0 | 0,0 | 0,0 | 100,0 |
| **4"** | 101600 | 0,0 | 0,0 | 0,0 | 100,0 |
| **2"** | 50800 | 2548,0 | 4,8 | 4,8 | 95,2 |
| **1"** | 25400 | 48051,0 | 90,4 | 95,2 | 4,8 |
| **Intern** | | 2548,0 | 4,8 | 100,0 | 0,0 |
| **Total** | | 53147,0 | 100,0 | | |

The granulometric distribution graph, as shown in Figure 4, provides valuable insights into the particle size distribution of the sample obtained from the discharge of the secondary jaw crusher. It employs three axes: % retained, % accumulated, and % through, allowing for a comprehensive and detailed granulometric curve. By analyzing the % retained axis, we can determine the percentage of particles of various sizes that remain in the discharge after passing through the secondary jaw crusher. The % accumulated axis showcases the cumulative percentage of particles accumulated at or below specific sizes, offering a comprehensive view of the particle distribution process. Furthermore, the % through axis illustrates the percentage of particles that successfully pass through a given size, providing essential information about the crusher's efficiency in reducing the sample to desired particle sizes. The use of these three axes in the granulometric

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distribution graph empowers researchers and operators to assess the crusher's performance, optimize its operation, and ensure that the desired particle size distribution is achieved for subsequent processing or analysis of the sample. This valuable data contributes to better decision-making and process improvement in the context of material handling and processing.

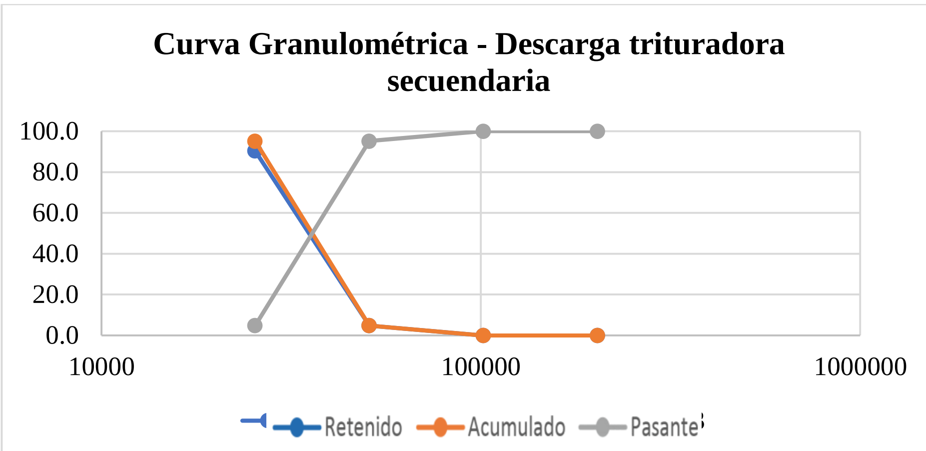


**Figure 4:** Secondary crusher discharge particle size curve

Reviewing graph 4, of the particle size curve with respect to the percentage of passing material, it is observed that the behavior of the figure is more ideal, indicating that the particles are more distributed. This happens, because the data taken were not made with standardized meshes with which a more complete distribution would be taken, but used the handmade ones made *in-situ.*

**Table 9:** Calculation of the P80

| **Q80** | |
|---|---|
| **50800** | 95,2 |
| **21128,1** | 80 |
| **25400** | 4,8 |

As indicated in Table 9, the P80 corresponding to 80% feed to the secondary crusher (80% of outgoing material) corresponds to a particle size of 21128.1 [μm], which indicates that only 4.8% of the ore is not reduced to an optimal size to be deposited in its fine hopper which the reduction ratio indicates that it reduces the size of the ore by almost half. (The calculation of the particle size in which 80% of the mineral passes was made from Table 8 using the Lagrange interpolation method).

*Reduction ratio for the Secondary crusher - C1*

F80= Particle size 80% feed ore.

P80 = Particle size 80% of product ore (outgoing).

$$Rr=\frac{\text{Tamaño de Alimento}}{\text{Tamaño del Producto}}=\frac{F80}{P80}$$

$$R80=\frac{40273{,}1}{21128{,}1}$$

R80= 1.9

Where it is obtained that the reduction ratio is 1.9, that is, the mineral is reduced practically to half the size of feed.

***Particle size sorter***

When performing the following analyses in its crushing stage, we found that, in the system of its particle classification by means of a vibratory sieve, it fulfills an important function when separating the particles, as observed in table 9, the mineral must be greater than or equal to 2 "which is done fulfilling the parameters that the mineral must enter its secondary jaw crusher with a larger size. or equal to a 2" mesh.

Therefore, when seeing the results, the ore that is processed with its secondary jaw crusher only corresponds to 2" mesh material. Thus fulfilling with affectivity the classification only of matter that complies with that particle size.

***Mill 6'x12'***

*Power Mill 6'x12' (MB-C1)*

**Table 10:** Mill feed 6'x12'

| Sieve N° | Aperture (μm) | Sample weight | % Retained | % Accumulated | % Intern |
|---|---|---|---|---|---|
| **8"** | 203200 | 0 | 0 | 0 | 100 |
| **4"** | 101600 | 0 | 0 | 0 | 100 |
| **2"** | 50800 | 0 | 0 | 0 | 100 |
| **1"** | 25400 | 12000 | 42,86 | 42,86 | 57,14 |
| **Intern** | | 16000 | 57,14 | 100 | 0 |
| **Total** | | 28000 | 100 | | |

**Table 11:** F80 Calculation

| **F80** | |
|---|---|
| **50800** | 100 |
| **38947,46** | 80 |
| **25400** | 57,14 |

As indicated in Table 11, the F80 that corresponds to 80% of feed to the mill 6'x12' (80% of incoming material) are optimal particles to enter its grinding which are in a granulometric size of 38947.46 [μm]. Which corresponds that 100% of the mineral complies with this effective granulometry. (The calculation of the particle size in which 80% of the mineral passes was made from Table 10 using the Lagrange interpolation method.) *Mill Unloading 6'x12'*

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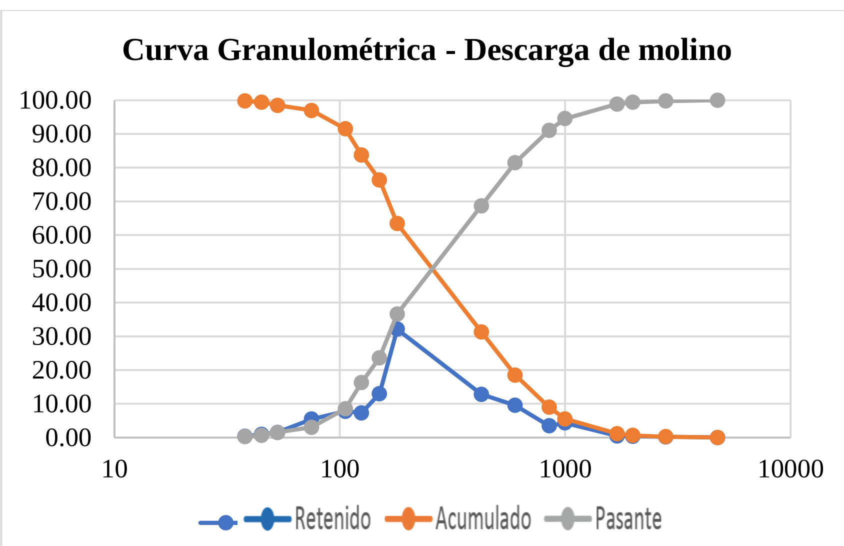
**Table 12:** Particle size distribution, mill discharge 6'x12'

| Sieve N° | Aperture (µm) | Retained weight | % Retained | % Accumulated | % Intern |
|---|---|---|---|---|---|
| **4** | 4750 | 0,2 | 0,03 | 0,03 | 99,97 |
| **7** | 2800 | 1,3 | 0,22 | 0,25 | 99,75 |
| **10** | 2000 | 2,34 | 0,39 | 0,64 | 99,36 |
| **12** | 1700 | 3,05 | 0,51 | 1,14 | 98,86 |
| **18** | 1000 | 26,21 | 4,35 | 5,49 | 94,51 |
| **20** | 850 | 20,91 | 3,47 | 8,96 | 91,04 |
| **30** | 600 | 57,5 | 9,54 | 18,50 | 81,50 |
| **40** | 425 | 77,2 | 12,81 | 31,31 | 68,69 |
| **80** | 180 | 193,45 | 32,09 | 63,40 | 36,60 |
| **100** | 150 | 78,25 | 12,98 | 76,38 | 23,62 |
| **120** | 125 | 44,05 | 7,31 | 83,69 | 16,31 |
| **140** | 106 | 46,92 | 7,78 | 91,48 | 8,52 |
| **200** | 75 | 32,91 | 5,46 | 96,94 | 3,06 |
| **270** | 53 | 9,3 | 1,54 | 98,48 | 1,52 |
| **325** | 45 | 5,48 | 0,91 | 99,39 | 0,61 |
| **400** | 38 | 2,24 | 0,37 | 99,76 | 0,24 |
| **Intern** | | 1,45 | 0,24 | 100,00 | 0,00 |
| **Total** | | **602,76** | **100** | | |

Graph 5 corresponds to the granulometry curve of the distribution of the mineral analyzing its retained, accumulated and passing percentage, describing a curve of the percentage of mineral through well defined indicating that the distribution of its particles was carried out correctly. While, in table 12, it is observed that the feasible ore that is below a mesh No. 100 is 36.60% which is the size of the ore that will be deposited in the leach tank.




**Graph 5:** Granulometry curve of the mill discharge 6x12.

As indicated in table 13, we visualize the P80, which corresponds to 80% of the mill product 6'x12' (80% of outgoing material) are particles that are sent to the classifier (hydrocyclone) which is in a granulometric size of 579.51 [µm]. (The calculation of the particle size in which 80% of the mineral passes,

**Table 13:** Calculation of P80.

| **Q80** | |
|---|---|
| **600** | 81,5 |
| **579,51** | 80 |
| **425** | 68,69 |

was made from table 12 using the interpolation method of *Lagrange*).

*Reduction ratio for Mill 6'x12'*

F80= Particle size 80% feed ore.

P80 = Particle size 80% of product ore (outgoing).

$$Rr = \frac{\text{Tamaño de Alimento}}{\text{Tamaño del Producto}} = \frac{F80}{P80}$$

$$R80 = \frac{38947{,}46}{579{,}51}$$

R80= 67.20

Where it is obtained that the reduction ratio is 67.20 indicating that its reduction is 67 times its size, this significant relationship occurs thanks to the fact that the types of mills are SAG which works with a large feed size, which helps the mineral itself also contribute to the reduction.

## CONCLUSIONS AND RECOMMENDATIONS

The comminution circuit carried out in the processing plant located in the El Tablón sector of the Portovelo canton in the province of El Oro was evaluated, a notable difference was identified between the circuit used in the plant with respect to the one used with the sieves in the Mining Laboratory of the ESPOCH Morona Santiago Headquarters. On the one hand, the analysis carried out in the plant shows that 77% of the ore that reaches the leach hopper is in a -200 mesh (75 microns), while the test carried out in the ESPOCH Mining laboratory indicates that only 57.66% is within the optimal range. Understanding that the 200 mesh target must be above 80%, it is concluded that the ore delivered by the size reduction circuit is not delivering the ideal particle size according to the required feed percentage F80 (for the fine hopper).

Each of the main measurements and/or quantifications carried out in the plant must be reviewed/calibrated, for a constant optimal operation of the beneficiation plants. In them the most outstanding for our study, the granulometric analysis of each of the equipment that make up the comminution circuit. For this, it is essential to start with the realization of an analysis of

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the current comminution process in the processing plant. Generating a flowchart through the Adobe Illustrarion CS6 program, which delivers a FlowSheet of the current system designed in the comminution circuit, which did not allow to identify the oversized equipment or that with little effectiveness contribute to the process of reducing the size of the particles.

The distribution of the meshes in the comminution process is evaluated, showing several novelties in each of the parts of the process. Primary crusher, being the first stage of the comminution process, it is confirmed that the primary crushing shows the most satisfactory results, because it delivers 87.3% of the mineral product in a suitable granulometry to be directly deposited in the hopper of fines.

Classifier, it is concluded that it satisfactorily meets the required parameters. Secondary crusher, it is identified that it works only with the percentage of 12.7% of the ore that the primary crusher failed to reduce to the ideal size, and although it has a similar reduction ratio than the primary crusher, it would currently be oversized in view of the fact that the total feed mass of the secondary crusher is very low.

Grinding, this reduction phase is the most important, since it reduces the ore to a feasible size to be deposited in the cyanidation tank, delivering a mineral size of 579.51 microns that represents a sieve number less than No. 30. Considering that this particle size is required to reduce it much more with the help of the eddy and thus achieve 80% of the mineral in its optimal size.

It is recommended, in each of the ore processing plants, to implement safe points that help data collection, where sampling is allowed for both the crushing circuit and the grinding and thus facilitate a more detailed analysis of its granulometry.

In the same way, in each comminution circuit, perform a more effective monitoring of control both for its crushers and mills, where it was observed that the mineral by having humidity creates jams in the discharges of the hoppers of thick and hopper of fines, so the possibility of implementing equipment of drying the ore to avoid the mentioned problems arises. If this is not possible, manage the constant cleaning of equipment discharges in order to maintain operational homogeneity.

Finally, it is suggested to analyze the feasibility of implementing a secondary crusher of smaller caliber than the primary crusher (lower energy consumption), due to the oversizing that this equipment usually presents in the plants, given that for this specific case it only processes 12.70% of tonnage per day.

In the same way, to carry out an investigation focused on the simulation of an ideal comminution circuit for the entire plant, which proposes optimized dimensioning for each of the sections of the process, in which each of the variables analyzed in this evaluation superimposes.

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