Value engineering study for bauxite reject disposal

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Abstract

The Alumina Rondon Industrial complex will have a production capacity of three million tons of alumina per year. For this production, approximately 12 million tons of run of mine will be necessary resulting, after beneficiation, in 8 million tons dry basis of bauxite. This process will dispose circa four million tons dry basis of reject. This reject is a troublesome to dewater clayish material. The goal of this study is to further evaluate different ways of dewatering, handling and disposal of the generated reject. The initial comparison done in other study included several scenarios, varying dewatering and disposal options. The previous study concluded that intense dewatering with press filters prior disposing was the most economical solution when combined with mine back-fill of the material. This study was reassessed and other dewatering equipment was included resulting in both CapEx and Opex reductions without implicating in any major change of the selected disposal method.

Keywords: Bauxite tailings; reject disposal; total cost of ownership.

1. Introduction

To produce aluminium, it is necessary to refine alumina. In the year of 2013 the total smelting grade alumina (SGA) production was 100 million tons. In the last ten years, the SGA production has doubled. Alumina is refined from bauxite, and usual grades range from 35 % to 55 % of Available Alumina (AA). From the approximately 200 million tons of bauxite annually refined at least 20 % are from washed bauxite.

In the Bayer process, the Available Alumina (AA) contained in the bauxite is digested. Along with the AA digestion the Reactive Silica (RS) digestion also occurs. There are two sources of reactive silica (RS) quartz and kaolinite. Depending on the digestion temperature one or both might be digested. At 150 °C only the kaolinite is digested, at 250 °C the digestion of quartz also occurs. After its digestion, the reactive silica precipitates as Desilication Product immobilizing Sodium cations, which will have to be replaced by the addition of NaOH – one of the main costs of Alumina production. Thus, the amount of NaOH makeup is directly related with the amount of reactive silica in the ore. Therefore, for bauxite to be considered viable, the amount of AA must justify the consumption of NaOH by the RS. In a first approach, the ratio AA/SR (or module) must be higher than 10.

Typical grades for Rondon do Pará run of mine (ROM) bauxite range in 33 % for AA and 8.0 % RS. When a chemical analysis is made for discrete size ranges, it may be seen that RS is concentrated in fractions smaller than 37 µm. When this mass is removed, the remaining particles add up to more than 44 % AA and roughly 2.5 % RS. These grades are summarized in Table 1 below. This justifies the beneficiation, i.e. the separation of the minus 37 µm for this specific bauxite. Kaolinite is a clayey mineral and has naturally fine particle size. The beneficiation process goal is to reduce the particles size so the water may access all the clay lumps, to disaggregate and separate it from coarser particles.

Table 1. ROM, Product and Reject grades, mass recovery.

	ROM	+37 µm or Product	+37 µm or Reject
AA	33.9 %	44. %	7.10 %
RS	7.80 %	2.50 %	21.6 %
Mass Recovery	100 %	72.3 %	27.7 %

Due to this fact, the washing reject is composed of fine material. The reject minerals density, its particle size distribution, the particles shapes among other factors make its dewatering a process concern.

1.1. Bauxite beneficiation

Bauxite beneficiation is initiated in the crushers. The ROM is fed to a sizer type crusher where finer particles are able to flow trough and coarser particles are reduced. The crushing station product has 75 mm top size which allows proper washing of the bauxite. The simplified flow process is exposed in image 1.

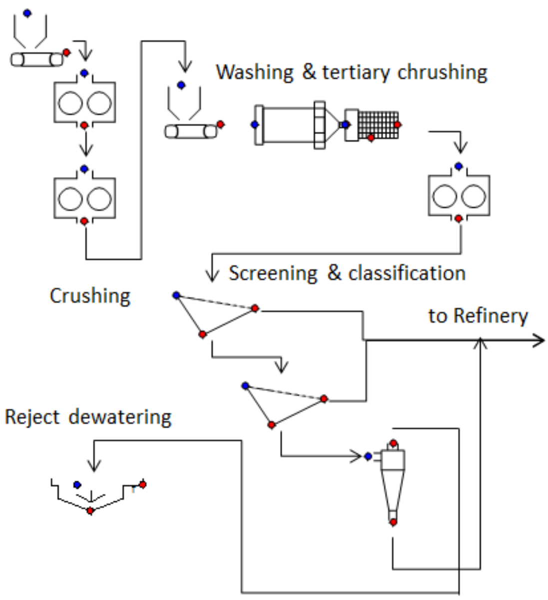

Figure 1. Alumina Rondon simplified beneficiation flowchart.

After being crushed, the bauxite is fed to a drum washer where it is mixed with water and agitated. This energy input disaggregates the clay making the separation possible. After scrubbing, the pulp with 1 to 1 water to solids ratio is discharged in a 40 mm trommel where the coarser particles are directed to a tertiary crushing unit. The product top size is then reduced to 40 mm. Both the crusher product and the finer fraction from the trommel are jointly fed to a set of screens. The oversized fraction is product and the undersize is fed to a hydrocyclone classification unit. There, particles smaller than 850 µm are fed to a rougher – cleaner – recleaner circuit, separating the minus 37 µm. The overflow of this circuit is the reject from bauxite beneficiation.

The reject is pumped to a thickener with nearly 15 % of solids in weight. In this thickener a large amount of process water is recovered for further re-use in the process. The thickener underflow with 35 % solids should be further dewatered for water recovery and proper disposal.

The equipment weights are listed in table 2. It is also relevant to note that the amount of equipment pieces are markedly higher in filter presses, for instance, each filter has more than 180 plates.

Table 2. Equipment weight.

	Weight by unit	Units	Total weight
Filter presses	256 t	10	2 560 t
Decanter centrifuges	10.2 t	19	194 t

The operating expenditures (OpEx) might be approached by the utilities consumption. The press filters themselves have low energy consumption if directly compared with centrifuges. However, when the auxiliary equipment are also considered, the energy for filtering is markedly higher. Specifically for the filters, due to several pumps and smaller engines and, mainly, to air compressors used for pressing or drying the cake. Table 3 list the power needed for each dewatering equipment set.

Table 3. Power draw.

	Power by unit including auxiliary equip.	Units	Total Power
Filter presses	1 320 kW	10	13 200 kW
Decanter centrifuges	230 kW	19	4 370 kW

4. Conclusion

Both technical solutions are suitable for the proposed process. The filters dewater the slurry to 25 % moisture while the centrifuges dewater to 30 % moisture. Since, in this specific case, liquid phase recovery is not critical for the process – differently for the red mud – this gap does not cause any process impairment. The main concern is to have a material that might be handled with a front-end-loader, carried with trucks and disposed in mined stripes. These activities might be efficiently developed if the material to be carried is not too sticky and might be well spread with tractors. This bauxite reject with up to 30 – 35 % moisture meets these characteristics.

The risk of not achieving the specified moisture might be accessed with altering processing parameters in the centrifuges, possibly reducing the solids trough output. If such an unexpected event occurs, other units might be acquired.

From the cost perspective, it is straightforward to assume a significant saving in both CapEx and OpEx, aligned with ease of operation and maintenance. The building needed for centrifuges is also simpler, due to the reduced need of parts handling and weight.

5. References

1. Van Deursen, C. M., Trade-off study for bauxite reject disposal, ICSOBA-2012 19th International Symposium.