Bauxite fines recovery via desliming and concentration

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Abstract

Votorantim is a major producer of primary aluminium and operates an industrial complex in the municipality of Aluminio. This industrial complex comprises an alumina refinery, a smelter and aluminium transformation units. This complex processes bauxite from three different mines. One of these mines is situated in the municipality of Miraí, in Minas Gerais state. This site comprises mining and bauxite washing operations. The washing plant is set to recover the coarse fraction of the bauxite by scrubbing and screening. The fraction finer than 850 µm is rejected to a tailings dam. Several studies concluded that part of this material might be recovered by removing the clay and concentrating the lighter fraction, richer in alumina, by removing the heavy fraction, richer in iron minerals and quartz. The equipment considered for these operations are hydrocyclones and spiral concentrators. This processing route was developed by applied research done in laboratory scale and proven in a pilot application. Recovering this fraction of the bauxite will increase the mass recovery of Miraí plant up to 20%.

Keywords: Bauxite; ore dressing; concentration; fines recovery.

1. Introduction

The Votorantim Group started as a textile factory and was commissioned in 1918 in the municipality of Votorantim, São Paulo state. Since then, Votorantim has been diversifying its activities. Industrial operations now include cement, mining and metallurgy (aluminum, zinc and nickel), steel, pulp, orange juice, and electricity generation.

The aluminium business includes four bauxite mines, a refinery, a smelter and plastic transformation units and a mega project, Alumina Rondon. To produce aluminium, the bauxite is mined and transported by railway to the refinery where up to 1 million tons of alumina can be produced, resulting in nearly 500 thousand tons of metal per year.

From the 230 million tons of bauxite produced every year worldwide, roughly 60 million tons are form beneficiating operations. Bauxite beneficiation is typically done via size separation. The beneficiation of bauxite is done in order to increase the low temperature available alumina grade (THA or total hydrate alumina, the alumina that is recoverable at 150 °C Bayer process), to reduce the reactive silica grade (RS) or both. This type of beneficiation process uses the difference in relative concentration of both materials in different size ranges. Commonly, THA is in coarser fractions and RS, in finer fractions of the run of mine.

This is also the process that is applied in beneficiating the bauxite from Miraí. There, the run of mine bauxite is fed into crushers, disaggregated in a washing drum or scrubber and separated by size in two sets of screens; being the undersize of the first the feed of the second one. Both oversizes are jointly staked as product, and the undersize of the secondary screen is disposed as a pulp in a reject dam.

The mass recovery of each bauxite is a consequence from natural condition of the deposit and the process applied. Since typical operations “wash” bauxite, the material characteristic taken into account is the particle size. If it is coarse enough, it is product and if it is fine, the material is rejected. This approach is justifiable if there is a clear distinction in THA and RS grades along the particle size distribution (PSD). Indeed, if the THA grade is high enough and the RS is low enough up to a certain size, this size should the cut size for the process.

This rationale may be applied in the bauxite found in the municipality of Miraí and implies in a cut size of roughly 850 µm (eventually a little smaller). But, at this cut size, the mass recovery of the operation is just over 40 %. In order to increase this mass recovery, finer particles should be recovered. However, even though the RS grades are low for particles as fine as 40 µm, the THA grades are in the low 30 %, lower than the product at 43 % THA. With the purpose of reaching the same THA values, a concentrating operation must be implemented.

2. Previous work review

Other bauxite mines beneficiate the fine bauxite fraction via classification with hydrocyclones separating the minus 40 µm. This cut is justifiable due to the size of kaolinite particles, mass recovery below 40 µm and size range where hydrocyclones are applicable. Kaolinite reacts with NaOH, being this mineral the RS bearer for the low temperature Bayer process. Kaolinte has 46.6 % of SiO_2 and has $Al_2Si_2O_5(OH)_4$ as chemical formula. This means that if the bauxite has 3.0 % of RS, it actually has 6.4 % of kaolinite. It is relevant to state that not all kaolinite particles are free from gibbsite particles (or available alumina bearing particles) and this lack of liberation limits the amount of separable RS.

Several operations in northern Brazil process their fine bauxite only via hydrocyclones achieving acceptable THA and RS grades and mass recovery. This is also the case of Alumina Rondon, a Votorantim Metais project. The process flow of Alumina Rondon is in image 1. This circuit is in a rougher-cleaner-cleaner configuration, where the underflow of the first cyclone battery is the feed to the second, the underflow of the second feeds the third being its underflow the fine product to be dewatered.

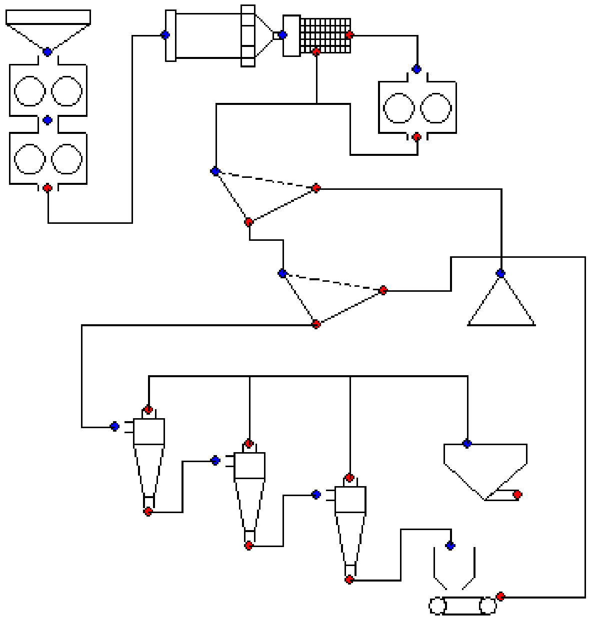

Figure1. Alumina Rondon simplified flow chart.

4. Conclusion

The laboratory tests and the pilot run demonstrated that it is possible to obtain a fine bauxite product similar to the one obtained in the coarse fraction. The coarse fraction characteristics follow in Ttable 6.

Table 6. Miraí bauxite characteristics.

Characteristic	Unit	Value
THA	(%)	44.0
RS	(%)	3.0
Total Alumina	(%)	48.0
Total Silica	(%)	11.0
Alumina bearer	(%)	gibbsite
Total Organic Carbon	(%)	0.2
Iron	(%)	12.5
Settling Rate (HX)	(m/h)	30
WI	(kWh/st)	11
Moisture	(%)	12
PSD	P95 (mm) P05 (mm)	50 1.0