

## Optimization of Cyclone Geometry for Bauxite Beneficiation

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### Abstract

Bauxite is the main ore for alumina and then primary aluminium production, consisting mainly of gibbsite, as aluminium source, iron oxides such as goethite and hematite and kaolinite, a clay mineral commonly found in Amazonian bauxites, as the main carrier of reactive silica. In the process, due to the small particle size, kaolinite is usually removed by attrition and washing of coarse material followed by desliming using hydrocyclones. Kaolinite has a special relevance in this context as in the Bayer process, it reacts with sodium hydroxide, thus increasing caustic consumption in the process. Beneficiation process at Hydro Paragominas is based on the separation of coarser fractions with higher gibbsite content from the clay minerals, where kaolinite is more concentrated. The separation takes place in two-stage hydrocyclone circuits, one for mid-size particles classification and another for fine particles classification. Pilot tests and process simulations have been carried out seeking the optimization of cyclone geometry, by testing different apex and vortex diameters. A total of 36 different conditions were evaluated with optimized condition bringing reactive silica reduction potential of 1.3 percentual points.

**Keywords:** Bauxite beneficiation, Clay removal, Silica reduction, Hydrocyclones.

### 1. Introduction

Bauxite is a rock composed by aluminium oxides/hydroxides and is the main ore for production of primary aluminium. Amazonian bauxite, processed by Hydro Paragominas, are mostly composed of gibbsite as the main mineral and gangue composed of kaolinite, iron oxides (hematite and goethite), titanium oxides (rutile and anatase) and quartz [1–5].

Kaolinite, the source mineral for reactive silica, is a clay mineral and due to its fine particle size is usually removed from the process in desliming steps using hydro-cyclones. A special attention is paid to kaolinite in this context as in the Bayer process, it reacts with sodium hydroxide, increasing the caustic consumption in the process by forming desilication products [6–8].

Available alumina concentration and reactive silica removal on bauxite beneficiation through desliming in hydrocyclone steps is based on the chemical profile, shown in Figure 1. The combination of the high costs associated to processing kaolinite at the refinery and bauxite chemical composition on different particle sizes, with high reactive silica and low available alumina grades on the fraction finer than 10 µm is the main motivation to develop the present work, seeking optimized apex and vortex finder diameters to maximize reactive silica removal on Hydro Paragominas beneficiation plant.

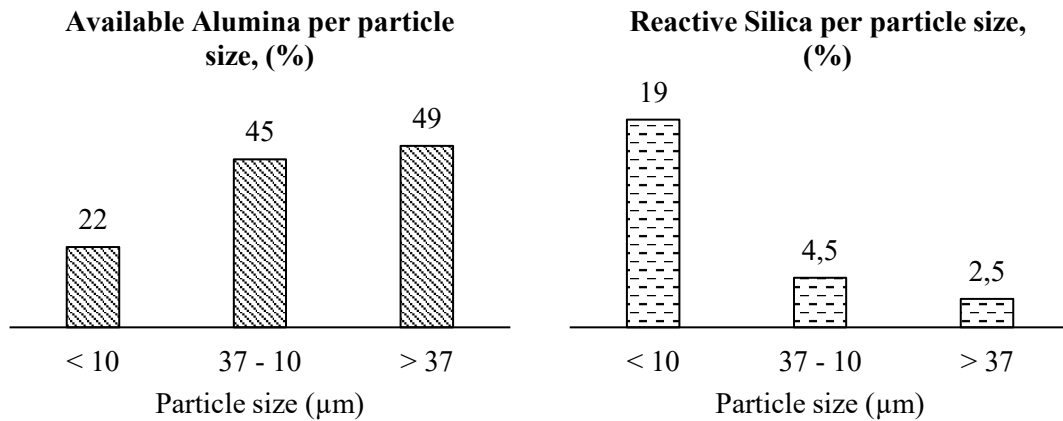


Figure 1. Amazonian bauxite chemical profile on different particle sizes [6]

## 2. Materials and Methods

### 2.1 Hydro Paragominas' Beneficiation Plant

Hydro Paragominas' bauxite processing circuit includes three main classification steps to separate the coarser fraction, with higher gibbsite content, from the finer fraction, where most of the kaolinite is concentrated. The first step is also responsible for separating fine particles from pebbles, which is followed by the re-crushing process, and is carried out on vibrating screens. The second step, called mid-size particles classification circuit, is carried out in 660 mm diameter hydrocyclones and separates clay and finer bauxite particles, from mid-size particles, that feeds the ball mill. The third step, called fine particles classification circuit, is carried out in 254 mm diameter hydrocyclones and is the final step for separation of clay, beneficiation process tailings, to fine bauxite particles, that forms the product. A simplified flowchart of the processing plant is presented in Figure 2.

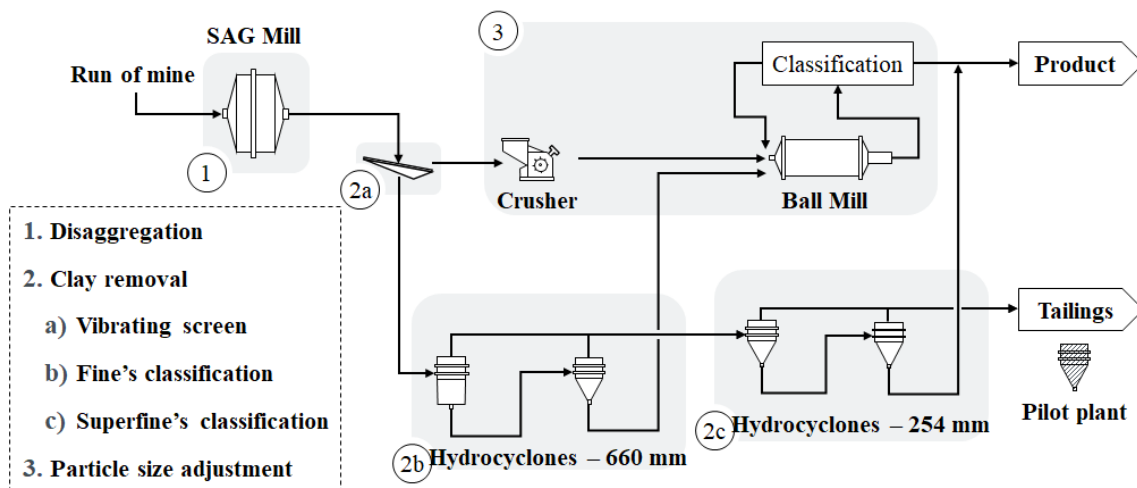


Figure 2. Hydro Paragominas' beneficiation plant simplified flowchart.

### 2.2 Pilot Equipment

A pilot plant was installed at the beneficiation plant to support process evaluations on fines classification circuit. The equipment has been used on pilot tests to evaluate the performance on

and 4.61 %, representing a 1.26 percentage points silica reduction on the fines circuit and a 0.19 percentage point reduction on beneficiation plant product silica grade. This higher silica reduction was associated to a reduction on alumina recovery at the beneficiation plant of 0.8 percentage points, from 82.7 % to 81.9 %.

At the refinery, processing the bauxite with 0.19 percentage points lower reactive silica grade would lead to a reduction on 1.4 kg of caustic per tonne of bauxite.

#### 4. Conclusions

On both primary and secondary steps of classification, higher reactive silica reduction results were found for testing conditions with lower apex / vortex diameter ratio. On the conditions with higher silica reduction, higher alumina losses were observed, due to the presence, even in low concentration, of available alumina on the fine particles below 10 µm removed on the desliming process.

Among the 36 simulated scenarios, reactive silica reductions up to 1.26 percentage points on the fines circuit and 0.19 percentage points on the beneficiation plant product were found through:

- Replacing 89 mm diameter vortex by 102 mm ones on both classification steps;
- Replacing 51 mm diameter apex on primary step by 38 mm;
- Replacing 44 mm diameter apex on secondary step by 38 mm.

Higher silica reduction was associated to a reduction on alumina recovery at the beneficiation plant of 0.8 percentage points, from 82.7 % to 81.9 %.

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