Technical Solution for Beneficiation Plant Operational Continuity During Tailings Thickener Overhaul

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Abstract

Mineração Paragominas carries out different stages of process, including bauxite extraction on the mine, beneficiation and transfer to the Alunorte alumina refinery through a long-distance pipeline. To meet pipeline and refinery's requirements, there are strict particle size distribution and chemical composition specifications to the beneficiation process. The beneficiation plant consists of two production lines operating in parallel, with SAG and ball mills, for bauxite comminution and particle size adjustment for transport on the pipeline, vibrating screens and hydrocyclones for clay removal, and thickeners for water recovery and slurry density adjustment for next process steps. The present study objective was to develop a process solution to allow beneficiation plant operational continuity without one of the four installed thickeners, due to the need for complex maintenance for approximately 20 days. Potential solutions were raised and evaluated conceptually, then simulated using Nageswararao model for hydrocyclones to bring a quantitative understating on their effect over plant productivity, water balance and product particle size distribution. Prioritized solutions for the temporary condition included bottlenecks evaluation and process flows redirection, replacing water by low density bauxite slurry for cyclone feed density control and changes on cyclone geometry to meet product specification. As a result, product specification and water balance requirements were achieved and production loss during tailings thickener maintenance was reduced from 40 %, expected without the present work, to 2 %.

Keywords: Bauxite processing, Optimization, Thickener.

1. Introduction

Mineração Paragominas (MPSA), located approximately 70 km from the municipality of Paragominas, in northeastern Pará - Brazil, plays a strategic role in the aluminium production chain in the country. The company is involved in activities such as bauxite extraction, ore pre-processing, tailings disposal and site rehabilitation. Bauxite is transported through a 244 km pipeline, to the city of Barcarena-PA, where it is refined into alumina by Alunorte. To meet the operational requirements of the pipeline and ensure the quality of the product, the beneficiation process follows strict specifications, for particle size distribution and chemical composition [1].

The beneficiation plant consists of two parallel production lines, which include SAG and ball mills for bauxite comminution, vibrating screens, and hydrocyclones used for the removal of clay fractions. These fractions, predominantly composed of kaolinite, are considered contaminants as they react with sodium hydroxide in the Bayer process, increasing caustic soda consumption [2]. The plant also has product and tailings thickeners, that plays a critical role in managing the process water balance by promoting efficient water recovery and adjusting slurry densities to downstream

processes. The continuous operation of this equipment is essential to ensure stable plant performance and a consistent supply of bauxite to the refinery.

Faced with the need to conduct extensive maintenance, lasting approximately 20 days, on one of the plant's four thickeners, the challenge arose of maintaining operational continuity without compromising product quality or causing significant losses in the bauxite and alumina production chain. To address this scenario, the present study proposed the development and evaluation of process alternatives based on modelling and simulation.

The solutions were analysed with using Nageswararao classification model, recognized for its robustness in representing the performance of hydrocyclones under varying operating conditions [3]. This approach made it possible to quantitatively assess the impact of the proposed alternatives on plant productivity, product particle size distribution and the system's water balance, providing a solid technical basis for decision-making during the maintenance period.

2. Material and Methods

2.1 MPSA Beneficiation Plant

Mineração Paragominas' bauxite beneficiation circuit consists of two similar plants working in parallel. It includes three main classification stages to separate the coarser fractions from the finer ones, where most of the contaminants are concentrated. The first stage is responsible for comminution of the ore, including crushing, SAG milling and pebble crushing. The second stage, called the mid-size particles classification circuit, is carried out in 660 mm diameter hydrocyclones, whose underflow, feeds the ball mill. The third stage, called the fine particles classification circuit, is carried out in 254 mm diameter hydrocyclones. A simplified flowchart of the processing plant is shown in Figure 1

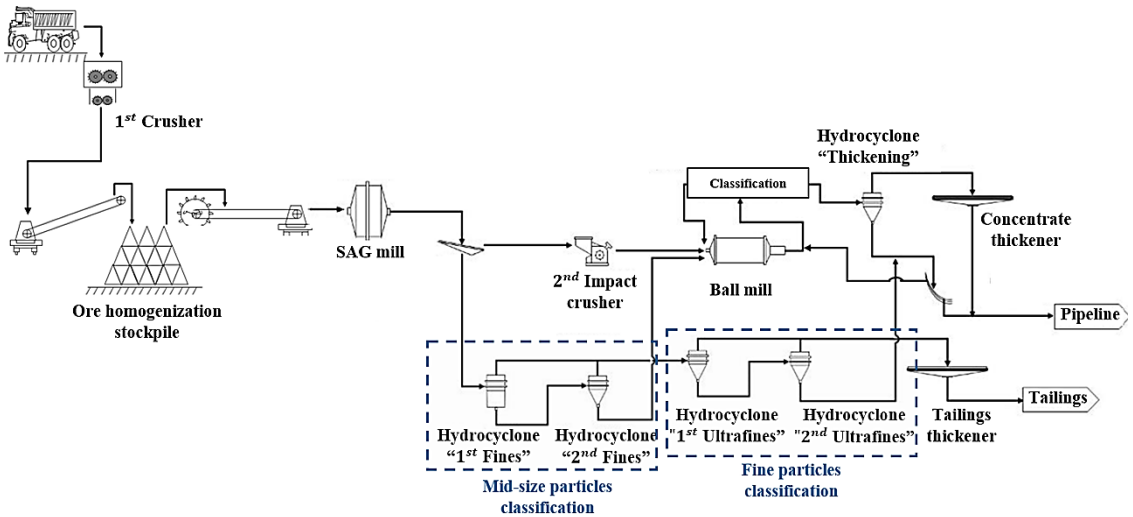

Figure 1. Simplified flowchart of MPSA's processing plant.

Due to the scheduled and extended maintenance required for the tailings thickener at Plant 2, as shown in Figure 2, a projected 40 % reduction in Mineração Paragominas' production capacity was anticipated. This reduction was attributed to the impact on the plant's water balance, which would render the operation of Plant 2 unfeasible during the maintenance period.

Through this methodology, compliance with the product's granulometric specifications and the stability of the plant's water balance, were ensured, ultimately minimizing production impacts during the critical maintenance period.

The main solutions that were implemented - such as redirecting flows, partially replacing water with diluted bauxite slurry, and making changes to the geometry of the cyclones – proved to be effective both in simulation and in real operation. The result was a significant reduction in the estimated production loss, from 40 % to just 2 %, while maintaining product quality within the specification range and operational stability.

This study highlights the relevance of using simulation tools to support decision-making in critical situations. It also emphasizes the value of technical preparation and predictive analysis to anticipate risks, mitigate losses and guarantee the continuity of industrial processes. This ensures the integrity of assets, high levels of productivity and process stability.

5. References

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