Strategy for Operating a Singular Agglomeration Tank Improving Product Size Control and Yield

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Abstract

This paper presents an operating strategy approach for the precipitation circuit at the Maaden Bauxite and Alumina Refinery. The precipitation circuit is crucial for crystallizing aluminium hydroxide, a fundamental step that significantly impacts the yield and quality of alumina production. The circuit was designed with two parallel and identical trains, each comprising fourteen tanks. The first two in each train function as agglomeration tanks, followed by growth tanks. Alumina size variation and difficulties of controlling fines generation lead to trial to reduce agglomeration capacity. Operating the circuit with a single agglomeration tank allowed a better balance of nucleation and agglomeration, hence addressing variations in the size and strength of the alumina product. To enhance efficiency, this project introduced a substantial operating modification: having only one agglomeration tank and repurposing the second tank as an additional growth tank. This change allows for more effective use of the available tank capacity, thereby improving the overall process in both yield by 0.18 g/L and the quality of the alumina product size by 1 % reduction.

Keywords: Alumina quality, Agglomeration tanks, Refinery yield optimization, Precipitation circuit, Alumina size.

1. Introduction

Maaden is among the fastest-growing mining companies in the world and the largest multi-commodity mining and metals company in the Middle East. Since 1997, Maaden has grown into the Middle East's largest mining company and operates through five business units including exploration, base metals and new minerals, phosphate, industrial minerals, and aluminium.

From mining bauxite in Al Ba'itha to smelting and rolling aluminium at state-of-the-art facility in Ras Al Khair, Maaden Bauxite and Alumina Company (MBAC) is a key component of Maaden's aluminium operations, MBAC sources bauxite from the Al Ba'itha Mine, the only bauxite mine in the Middle East. The bauxite from Al Ba'itha mine is transported via railway to Ras Al Khair feeds the refinery producing 1.8 million tonnes of alumina annually, 80 % is fed to smelter producing over 1 million tons per annum of premium-grade aluminium with the reminder exported globally.

The refinery is a high temperature plant utilizing Bayer process technology, processing bauxite contain boehmite and gibbsite bauxite. Two identical digestion units fed by Al Ba'itha bauxite to produce metallurgical grade alumina or smelter grade (SGA).

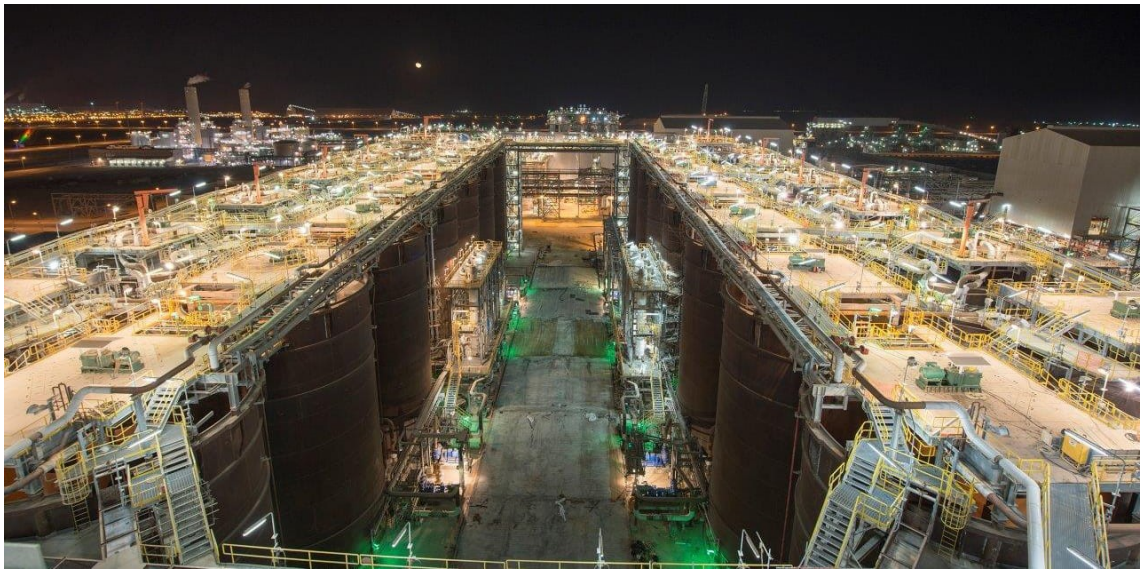

Figure 1. Maaden refinery - precipitation area night top view.

This paper presents an operating strategy approach for the precipitation circuit at the Maaden Bauxite and Alumina Refinery. The precipitation circuit is crucial for crystallizing aluminium hydroxide, a fundamental step that significantly impacts the yield and quality of alumina production.

2. Overview and Operating Strategy of Precipitation Circuit

The circuit is designed with two parallel and identical trains, each comprising fourteen tanks arranged in a zigzag pattern. The first two in each train function as agglomeration tanks, followed by growth tanks. Alumina size variation and difficulties of controlling fines generation lead to trial to reduce agglomeration capacity. Operating the circuit with a single agglomeration tank allowed a better balance of nucleation and agglomeration, hence addressing variations in the size and strength of the alumina product.

The precipitation of hydrate is mostly done using a process where the small hydrate crystals (“fine seed”) are absorbed in single larger particle through precipitation of new hydrate. This process is called agglomeration where fine is “destroyed”. The remaining twelve tanks in each train are growth tanks. In these tanks the feed hydrate crystals (“coarse seed” and the agglomerated fine seed from the Agglomerations tank”) increase in size through the growth process.

Criticality of size control and the importance to sustain the product quality drives the improvement and modification to the existing precipitation circuit with consideration of economic and productive feasibility [1].

The refinery precipitation circuit with two agglomeration tanks, had a control strategy of adjusting the fill temperature set point in addition the agglomeration power. The latter was controlled by varying the seed charge and maintaining the liquor to precipitation optimized.

That control strategy resulted in aggressive size waving caused by unbalanced fine generation and destruction. The two Agglomeration set up made the circuit skewed towards more fine’s destruction (high Agglomeration power). The prolonged low fines situation triggered a sudden fines explosion. It made the circuit sizing follow a wave. This is bad for both sizing stability and particle strength.

That lead to the decision to try singular agglomeration to improve the product size at the same time utilizing the second agglomeration tank as a growth tank that will boost the precipitation yield.

3. Plant Trial and Results Discussion

There has been a full plant trial over four months, operating the Precipitation circuit with one Agglomeration Tank, instead of two. The new arrangement is fully operational now.

The purpose of this trial was to try to stabilize and reduce the variation in size control over the period to improve alumina quality by reducing agglomeration power and increasing productivity by using one more tank as growth.

It was estimated that only 15 % "Agglomeration power" is achieved in second agglomeration tank. Maaden plant always encountered high agglomeration capacity, making it difficult most of the time to get nucleation, essential for fines generation and particle strength. So, sacrificing 15 % of Agglomeration capacity would have the following advantages.

1. Easier to nucleate, better fines balance, improved particle strength and Alumina Quality;
2. The freed-up agglomeration tank could be converted to growth tank, benefiting with higher yield;
3. In addition, the consequent increase in supersaturation in the first agglomeration tank has also increased the Soda (Na_2O) level of product to about 0.33 %, that was also benefited Smelter.

During the time of the trial there were adjustments to the control levers of precipitation process, the intention was to vary one controller and fix others to achieve a better understanding and improve the control strategy of the circuit. Refinery adjusts the agglomeration power based on the last growth sizing where the size count is measured to identify the particle count that is representing 3 µm level which then will grow to have the size of < 45 µm. The trends showed in Figures 2 and 3 confirm the actual size improvement within precipitation and alumina products [2].

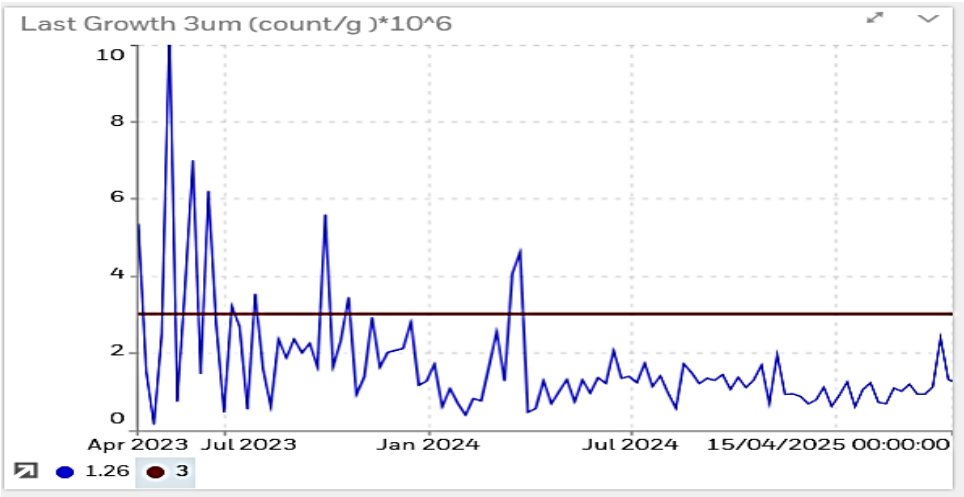

Figure 2. Last growth tank size trend

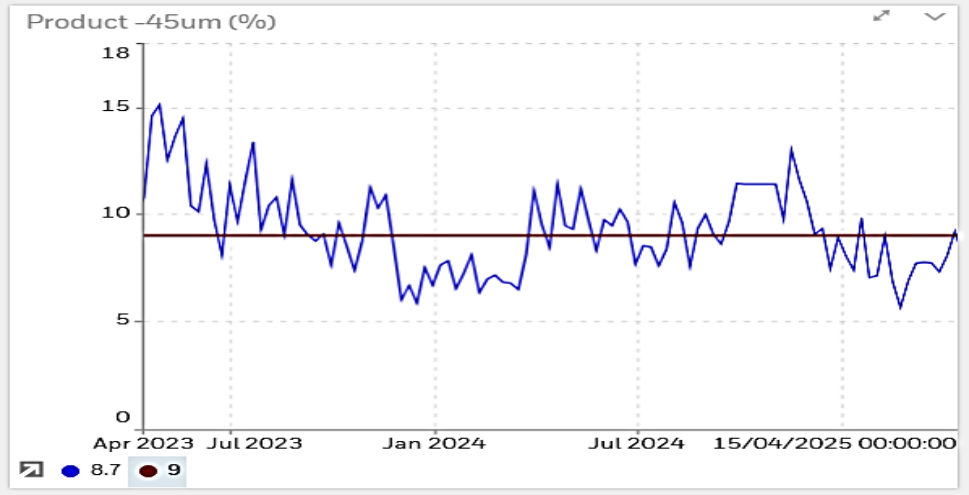

Figure 3. Product size trend

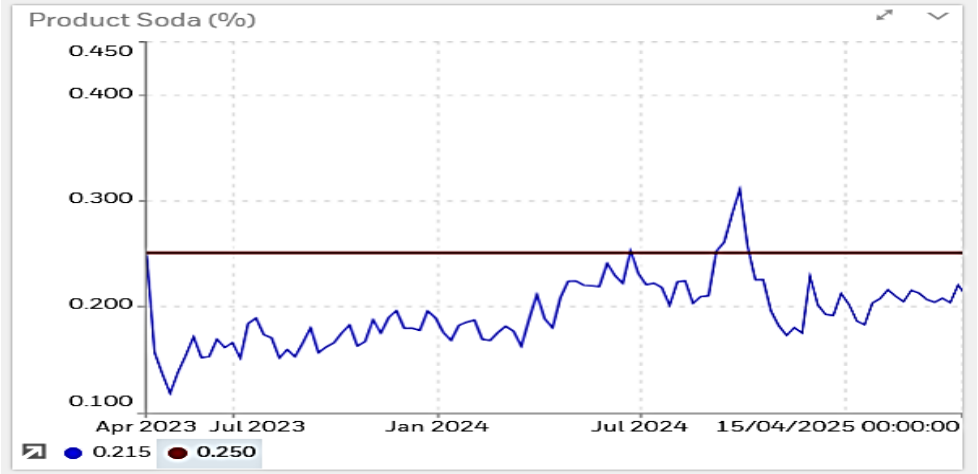

Figure 4. Product soda trend

The variability of the size and the aggressive changes between fining and coarsening periods creating waves in last growth tank (Figure 2). These waves kept the product -45µm level in the upper side of desired limit in the first half of the trends above 9% (Figure 3). After single agglomeration operating strategy started end of Jan 2024, excursions were effectively controlled and maintained the product size lower than 10 % of -45µm (Figures 2 and 3).

The average soda content in the product increased from 180 to 240 ppm following the implementation of the new strategy (Figure 4).

4. Conclusion

The transition to a single agglomeration tank in the Maaden Alumina Refinery's precipitation circuit has demonstrated a significant improvement in operational efficiency and product quality. By reallocating the second agglomeration tank as a growth tank, the process achieved better control over particle size and reduced excessive fines generation. This strategic modification not only optimized the use of existing infrastructure but also contributed to a measurable increase in refinery yield. The results validate the hypothesis that a balanced approach to nucleation and agglomeration can enhance the overall performance of the precipitation circuit. Future work may explore automation and real-time monitoring to further refine this strategy [3].

5. References

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