

Increasing Mud Throughput Capacity of the Mud Washing Circuit through a Brownfield Project

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Abstract

Mud load management has been one of the largest production opportunity loss contributors for Jamalco due to the unique inverted cone, tangential discharge design of the mud washers as well as the bauxite quality to the refinery. With this washer design, the mud is accumulated in front of the rake at the periphery of the vessel resulting in increased mud residence time, increased rake torque pressures and reduced underflowing capabilities of each vessel. The mud throughput capacity was further limited since 2015 by the deteriorating bauxite feed quality mainly in the increased reactive silica, reduced available alumina and increased goethite content. These challenges have affected the refinery's volume control and liquor to precipitation productivity. With the limitations experienced regarding the mud washing circuit throughput, a need arose to increase the attainable mud throughput from the circuit to stabilize the refinery's total plant flow and by extension its production rates. This paper presents the system modifications undertaken at Jamalco to increase the mud throughput capacity of the washing circuit from 4300 tpd to 5200 tpd of mud using a brownfield project approach. Furthermore, it seeks to highlight the benefits and drawbacks of this approach.

Keywords: Mud washer, Brownfield, Reconfiguration.

1. Introduction

Mud load management at Jamalco has been the highest contributor to production opportunity losses over the past decade. In 2017 and 2018 alone, mud load management contributed to a total of 12 896 tonnes and 26 779 tonnes, respectively, in production opportunity losses for the refinery. At Jamalco, mud management poses a challenge for two major reasons: the inverted cone washer design within the mud washing circuit as well as the deterioration in the quality of the bauxite feed to the refinery.

Since 2015, the bauxite feed quality to the refinery, mainly as it relates to the available alumina content which reduced from 44 % in 2015 to a low of 39.6 in 2018 and the reactive silica content which increased from 1.40 % in 2015 to a peak of 3.87 % in 2018 [3]. These changes led to increased mud generation from the bauxite which pushed the refinery towards its mud capacity limit of 4300 tonnes mud/d with no increase in production rates as shown in Figure 1.

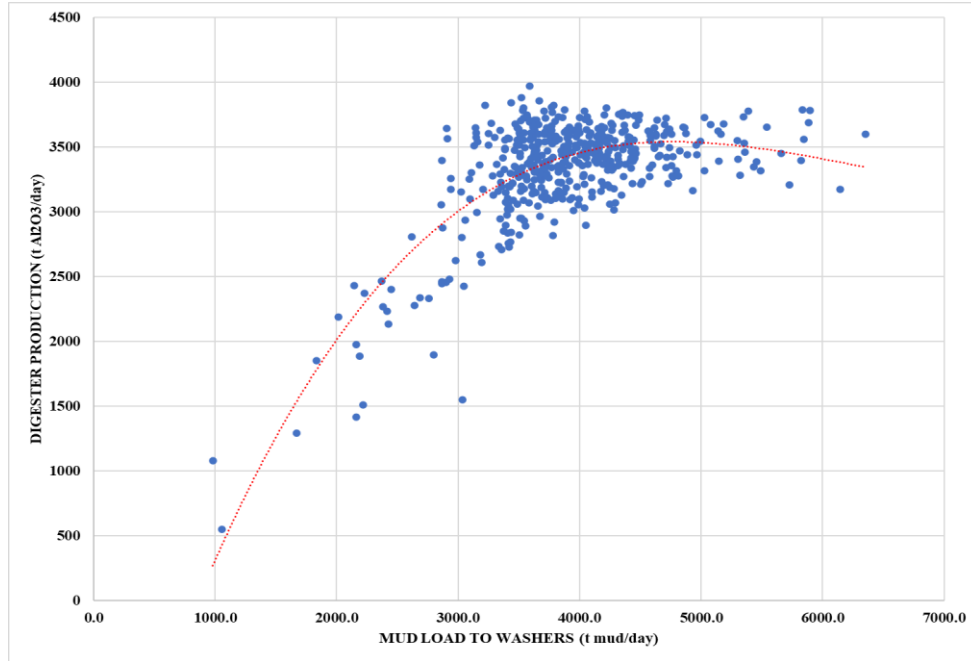


Figure 1. Relationship between the washer mud load and digester production rates [3].

At Jamalco, the unique design of the mud washers, as shown in Figure 2, is also thought to play a critical role in the stability of the mud circuit [3]. The mud washers have an inverted cone design which utilizes two mud discharge outlets (45°) apart, as shown in Figure 2, increasing the difficulty of mud movement.

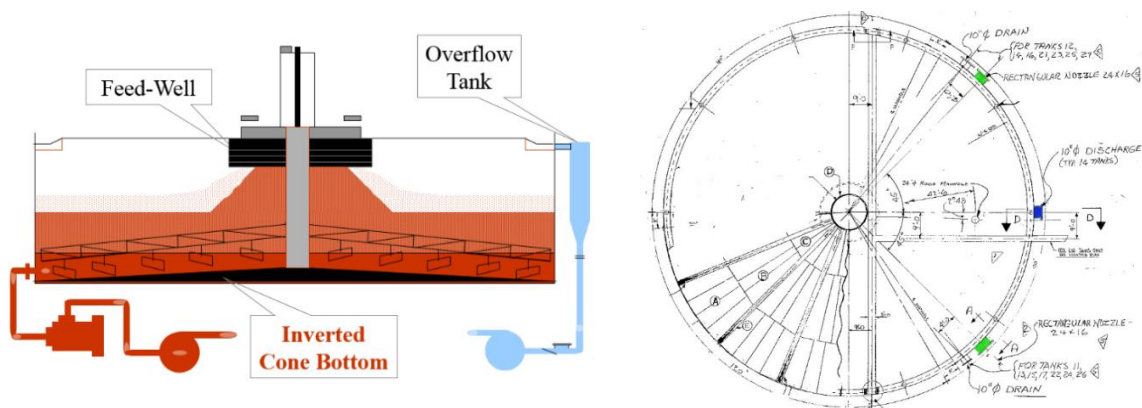


Figure 2. Schematic representation of mud washer design.

The movement of mud to the underflow discharge is solely dependent on the rotation of the rake mechanism. The mud is accumulated in front of the rake arms at the periphery of the vessel and most of the mud mass is moved from the underflow when the rake arms pass in front of the discharge points [3]. This design increases the tendency for mud to accumulate within the vessel which increases the propensity for auto-precipitation [2] and reduces the refinery’s mud throughput capacity. This increase in mud load has increased washer feedwell solids thus reducing the efficacy of the flocculants [1] resulting in higher washer mud levels and lower production rates.

In this paper, the author will provide insight in the methodology used at Jamalco to increase the mud throughput capacity of the washing circuit with a brownfield approach, as well as provide evidence of the increased mud throughput and production benefits.

be closer to its caustic loss targets while increasing the mud throughput capacity of the washing circuit and by extension the plant production rates. To facilitate maintenance activities and reduce the associated caustic losses, one washer, C25, would be deemed the swing last washer for the bank of four washers.

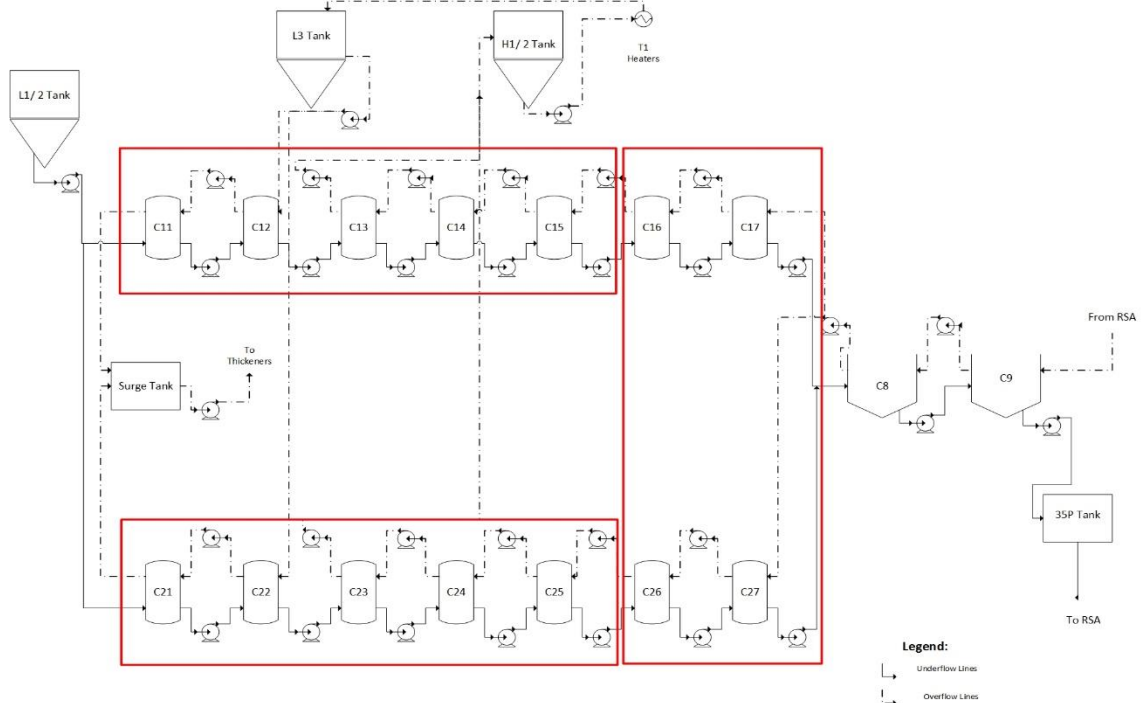


Figure 4. Proposed mud washing circuit split layout.

To facilitate the conversion of bank 1, i.e., C11 to C15 washers, the underflow from the 5th stage washer was rerouted from the feed of the 6th stage washer to the feed header of the 1st deep thickener, C8. The overflow of the 1st deep thickener was rerouted from the 7th stage washer in the bank to the 5th stage washer as shown in Figure 5. To facilitate flexibility for maintenance purposes, bypass systems were implemented to enable the 4th stage washer in the bank to operate as the final washer in that operating bank.

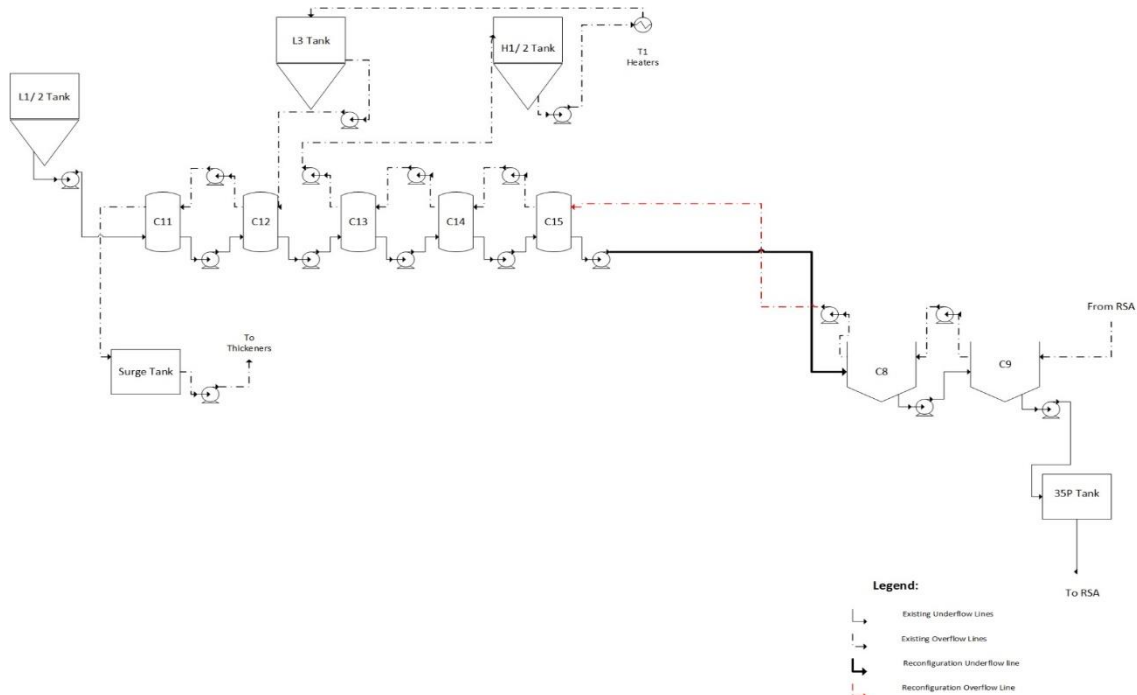


Figure 5. Reconfigured bank 1 process flow diagram.

The layout of bank 2, C21 to C25, was like that of bank 1 highlighted above. The underflow capacity for banks 1 and 2 were designed to facilitate between 340 to 410 m³/h of flow with the existing underflow pumping systems at 200 g/l feed solids, i.e., a minimum of 1635 tonnes mud/d loading per bank (> 75 % of the original washer mud capacity).

Bank 3 was the most difficult aspect of the reconfiguration. Four washers traditionally aligned to banks 1 and 2, i.e., C16, C17, C27 and C26, were reconfigured to become an independent washing train. This reconfiguration was accomplished by executing the following items:

- Installation of a feed line from the decanter underflow surge tank to C16
- Rerouting of overflow from C16 washer to the liquor surge tank
- Rerouting of the underflow of C17 to the feed of C27
- Rerouting the underflow of C27 to the feed of C26
- Installation of an overflow line from the 1st deep thickener to C26
- Installation of an underflow line from C26 to the 1st deep thickener

To minimize auto-precipitation within the 1st and 2nd stages of bank 3, a heater station was designed and installed, using two repurposed and refurbished shell and tube heaters. Like the reconfigured banks 1 and 2, the overflow of the 3rd washer in bank 3 was routed through the heater and the heater discharge routed to the 2nd stage washer in the bank as shown in Figure 6.

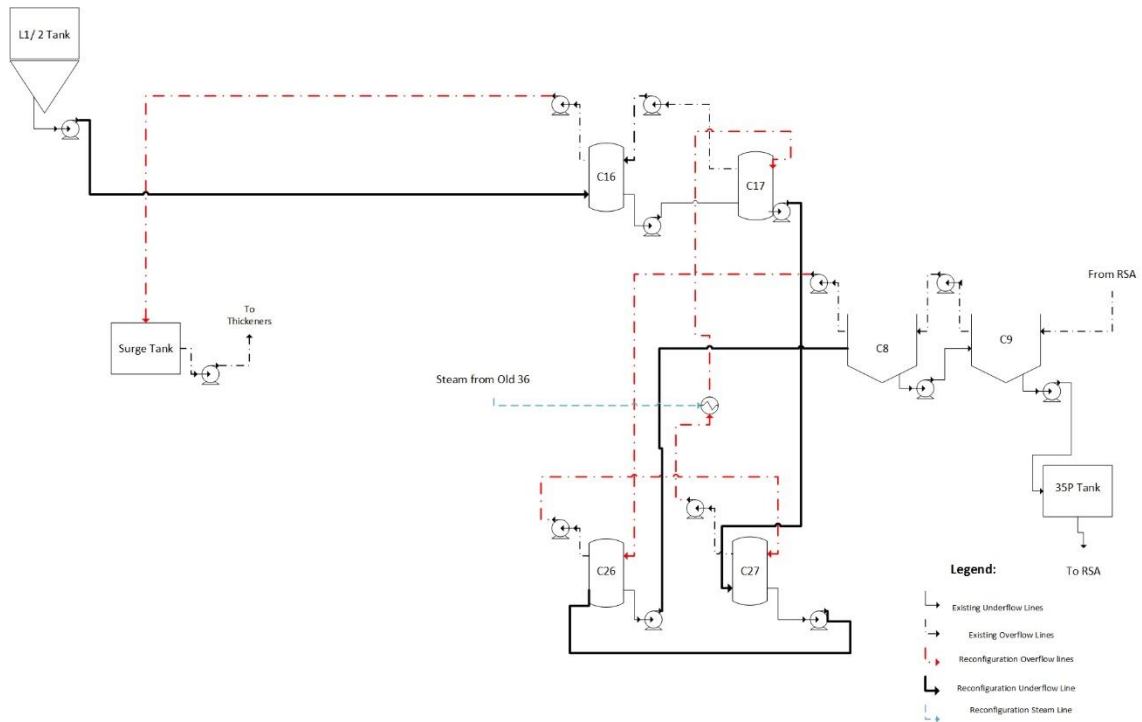


Figure 6. Bank 3 process flow diagram.

Bank 3 was designed for a minimum flow capacity of 410 m³/h, i.e., a minimum of 1962 tonnes mud/d. Thus, increasing the mud throughput capacity from 4300 tonnes mud/d to ~5200 tonnes mud/d solely by piping modifications.

All three banks were fitted within independent instrumentation and control schemes to effectively operate the overflow and mud feed to the washers.

3.1 Swing Final Washer and Its Benefits

The final washer in the reconfigured bank 2, C25, was selected as a swing washer based on the expected concentration profile of the vessel as well as the proximity to the final washer in bank 3. A swing washer is a vessel that can play dual functions within the washing circuit. The piping for C25 was therefore designed in such a way that the vessel can function as the final washer in bank 2 or the final washer in bank 3. The change of the vessel alignment can be done by valve orientation changes and blind swinging for any of the following reasons:

- A vessel in bank 3 is out of service for maintenance or premature failure
- Higher than normal caustic loss from bank 2 or bank 3

The typical alignment of C25 is to bank 2 unless one of the conditions above are met. This swing washer allows for better caustic management of bank 3 by preventing the operation of only three (3) washers during planned vessel outage scenarios.

For robustness of the system, two separate wash water controllers are aligned to the swing washer and will be activated based on the alignment selection manually indicated by the clarification control room technician.

4. Outcomes of the Brownfield Project Implementation

Since the system commissioning in February 2020, the production opportunity loss for the 2020-2021 period associated with mud load management has decreased by 58 % compared to the 2018-2019 period, correlating to a total opportunity gain of 20 411 tonnes. The implementation of the system has also reduced the mud load per washer thus improving the settling ability of the mud within a given washer. This has allowed the refinery the opportunity to generally maintain the average washer mud turbid levels below 80 inches despite higher mud loads to the washers as shown in Figure 7.

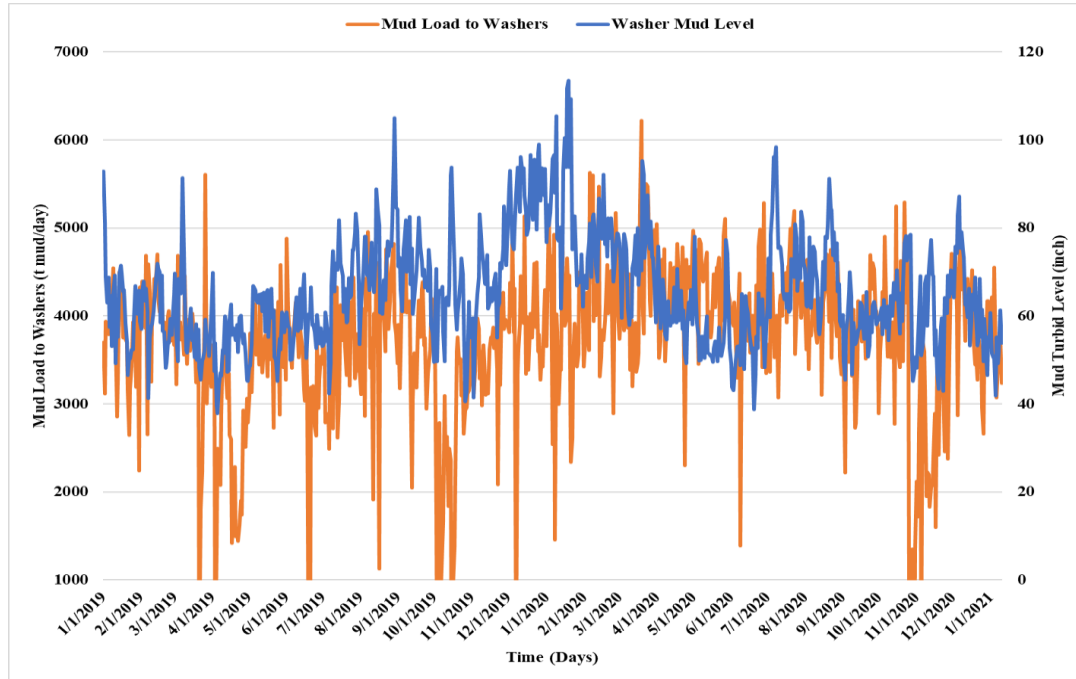


Figure 7. Impact of mud load on the average washer mud turbid level.

Despite the improvement in the production opportunity losses and the general stability of the mud washing circuit, a caustic penalty was incurred due to the reconfiguration of the circuit. Physical caustic inventories showed a 19 kg of caustic per tonne of alumina increase in the soluble caustic associated with bauxite residue in 2020 when compared to that achieved in 2019 and a 13 kg of caustic per tonne of alumina increase when compared to the 2018 performance. This increase in soluble caustic loss was below the predicted model caustic loss increase of ~24 kg of caustic per tonne of alumina. While these increased caustic losses represent an additional cost to the refinery, the reduction in alumina production losses nevertheless brings greater benefits.

Strategies such as the addition of rheology modifiers, implementation of Smartdiver technology and revision of the washer control philosophy are items implemented to minimize the impact of the reconfiguration on the refinery’s caustic losses. It was also found that premature vessel failures contributed to the increased caustic losses over the period. To combat this issue the maintenance strategy around the washers has been adjusted including reductions in the residual life of the individual vessels based on the concentration profile changes.

5. Future Plans

The capital expenditure plan focuses on the alignment of the projects to optimize and maximize the refinery's production and efficiency capabilities. Through this, the implementation of an upgraded flocculant dosing system and installation of additional deep thickeners to improve caustic recovery efforts are two key project enablers to maximize this reconfiguration of the mud washing circuit.

To further optimize the reconfigured washing circuit, initiatives such as the upgrading of the existing pumping systems to maximize the mud throughput capacity are being explored. Additionally, the implementation of systems such as in-line flocculant addition and wash water recycling for feedwell solids reduction as methods to improve the washer efficiencies and reduce the associated caustic losses have already been scoped for execution.

It is expected that these actions, coupled with bauxite exploration and blending, will facilitate the refinery's ability to handle the proposed mining plan each year and its ability to regain its nameplate capacity production.

6. Conclusions

Jamalco's operations and associated costs have been significantly hampered by its ability to handle the mud load to the washing circuit with the deteriorating bauxite feed quality. A brownfield project of reconfiguring the piping layout of the mud washing circuit has successfully aided the refinery in increasing or maintaining its production rates with higher mud generation. Several additional initiatives are underway to improve the stability of the mud washing circuit at the refinery which will bring the location closer to its optimal efficiency and production points. Initiatives such as these are proof that the future of Jamalco as a world class alumina producer is secure.

7. References

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