Adaption of 80 m² Belt Filter from Processing Fine Classified Seed to Coarse Product

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Abstract

By August 2021, Alteo Gardanne was fully engaged to transform the alumina refinery from a bauxite feed to an alumina trihydrate (ATH) feed by January 2022. As part of the transition from bauxite to ATH feed, the 20 year old 80 m² Hassler belt filter, that was being used as an oxalate removal unit by washing the fine classified seed, would become the product deliquoring and washing filter: taking coarse classified hydrate slurry in the spent liquor to obtain, in a single filtration stage, the finished product hydrate with low leachable soda and moisture content. In less than 3 months, the modifications required to ensure the target operation condition of this new filtration mode were implemented, knowing that no back-up would be available from now on. This paper describes how Alteo together with Sahl Regen modified the belt filter in two steps to achieve target quality in the product hydrate while minimising specific water consumption. The modified 80 m² belt filter has since achieved product specifications without any issues.

Keywords: Product filtration; Belt filter; Deliquoring filtration; Dewatering filtration.

1. Introduction

When Alteo Gardanne was preparing the transition from bauxite feed to alumina trihydrate (ATH) feed, Sahl Regen was engaged in August 2021 to assist in this transition during the trying times of the COVID-19 pandemic targeting a January 2022 completion date. It was recognised by then that the change of duty of the Hassler 80 m² belt filter (known within Alteo as belt filter F18) from deliquoring and washing a fine alumina hydrate seed containing solid phase sodium oxalate to deliquoring and washing a coarser alumina hydrate product sufficiently to achieve a product quality acceptable to the downstream calcination section would require some modifications to the filter. It is well known that increased product hydrate moisture is detrimental to the operating cost of the downstream calcination process [1–2]. A too high soluble soda content in the product hydrate would also not be acceptable.

2. Change in Duty of Filter F18

Prior to the transition of the Alteo alumina refinery from a bauxite feed to an ATH feed the duty of belt filter F18 was mainly to deliquor and wash in order to remove solid phase sodium oxalate from fine hydrate seed recycled back to the Series 2 precipitators. As such, optimising the cake moisture and leachable soda content were not core objectives, as the filter was designed for the removal of the solid phase oxalate in the fine hydrate seed. Table 1 shows the change in particle size distribution that the belt filter F18 would have to deal with, from the original Series 2 precipitation train fine seed to the coarse product hydrate from Series 3 precipitation train.

Alteo's product hydrate prior to the transition had been deliquored and washed on a series of 2 successive drum filters with the wash water from the last drum filter step being used as part of the Series 2 fine seed wash on belt filter F18. Table 2 summarises the change in duty and objectives of the Belt Filter F18. After the transition from bauxite feed to ATH feed there would no longer be a requirement to remove sodium oxalate from the process as there would no longer be any sodium oxalate input to the refinery. We took the opportunity to replace the two old drum filters in series to deliquor and wash the Series 3 coarse classified product hydrate with the newer 80 m² belt filter.

Table 1. Transition of feed to Filter F18.

Feed to filter F18	% -32 µm	% -45 µm	% -63 µm	% -90 µm	% -150 µm	d_{50}
Series 2 seed wash	11.8	23.5	45.0	74.2	97.5	67.2 µm
Series 3 product hydrate	2.3	4.0	12.1	34.5	79.0	107.5 µm

Table 2. Old and new objectives of Belt Filter F18.

Feed to filter F18	Objective of Filter F18
Series 2 seed wash	Efficiently remove solid phase oxalate from fine Series 2 seed
Series 3 product hydrate	Produce coarse product hydrate from a slurry in spent liquor with < 7 wt-% moisture and < 80 ppm leachable soda (Na_2O)

3. Description of Belt Filter F18

The belt filter F18 was installed in Alteo Gardanne's hydrate filtration building in 2002 as a means of removing sodium oxalate from the refinery. There were two types of precipitated hydrate: the coarse classified hydrate from Series 3 precipitation train and the fine classified hydrate seed from Series 2 precipitation train. The Series 3 precipitation train was kept coarse and free of solid phase sodium oxalate and the Series 2 precipitation train was kept fine and allowed to have solid phase sodium oxalate. The belt filter F18 was installed to manage the inventory of solid phase oxalate by washing it out of the Series 2 seed.

Figure 1 (drawn to scale) shows the original arrangement of belt filter F18 when it was used to remove solid phase oxalate from the Series 2 seed. In the schematic the following points should be noted:

- Stretched between the two end drums is the belt moving from right to left; the returning belt is not drawn.
- The green rectangular blocks on top of the belt represent the location of the weirs which prevent the wash water or feed slurry from spreading too far on the belt; "Hydrate Slurry" denotes the fine seed in the spent liquor slurry feed to the filter.
- The green arrows below the belt indicate the filtrate collected in the vacuum box below the rubber belt being conducted to the vacuum header.
- The flanges on the vacuum header are also indicated where the flanges shown in red had a blind installed in the flange. Thus, all the spent liquor filtrate from the feed would end up in the first collector vessel on the right side (labelled BA103).
- "Calcination Filtrate" denotes the wash filtrate from the last stage of the product drum filters used in the Calcination section to wash the product hydrate. The filtrate from that section of the F18 belt filter would end up in the centre vacuum collection vessel (BA104) due to the blind flange (indicted in red).
- "Recycled Filtrate" is recycled filtrate from the vacuum collection vessel (BA105).

- "Recycled Digestion Condensate" is Digestion condensate that has been used to wash the belt, cloth and drive drum of hydrate solids and collected in the trough below the filter leading to pump PC105.

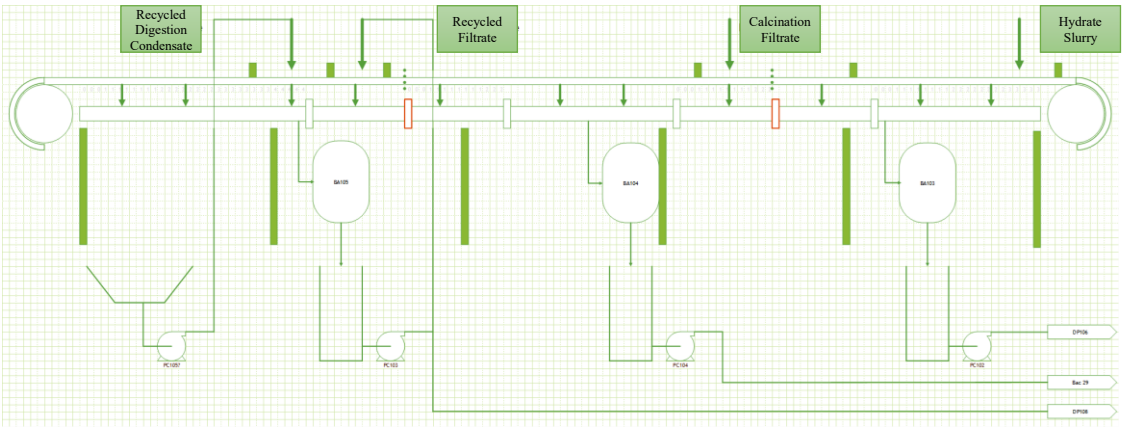

Figure 1. Original arrangement of belt filter F18 prior to transition from Series 2 seed to Series 3 product hydrate.

Figure 2 is a picture taken looking towards the feed end of belt filter F18 with one of the weirs with a plastic skirt in the foreground and the wash water flexible hosing coming down to the different wash water distribution points above.

Figure 2. Belt filter F18 showing one of the weirs that limits the spread of wash water in the foreground.

4. Modifications to the Vacuum Header to Belt Filter F18

Since the new product hydrate is considerably coarser, than the previously processed fine seed from Series 2, it is therefore also more porous to air flow. Therefore, in order to maintain a reasonable pressure drop across the filter cake to deliquor, dewater and the dry the cake the vacuum pumps supplying vacuum to belt filter F18 would need to be doubled or even trebled. Originally there was only one dedicated vacuum pump for F18, with the possibility of a neighbouring vacuum pump to act as a spare. To mitigate this, it was decided to install a new

larger diameter manifold in parallel to the existing vacuum line. Figure 3 shows a sketch for the new vacuum supply header, and Figure 4 Left depicts how the arrangement was expected to look, and Figure 4 Right the actual installation.

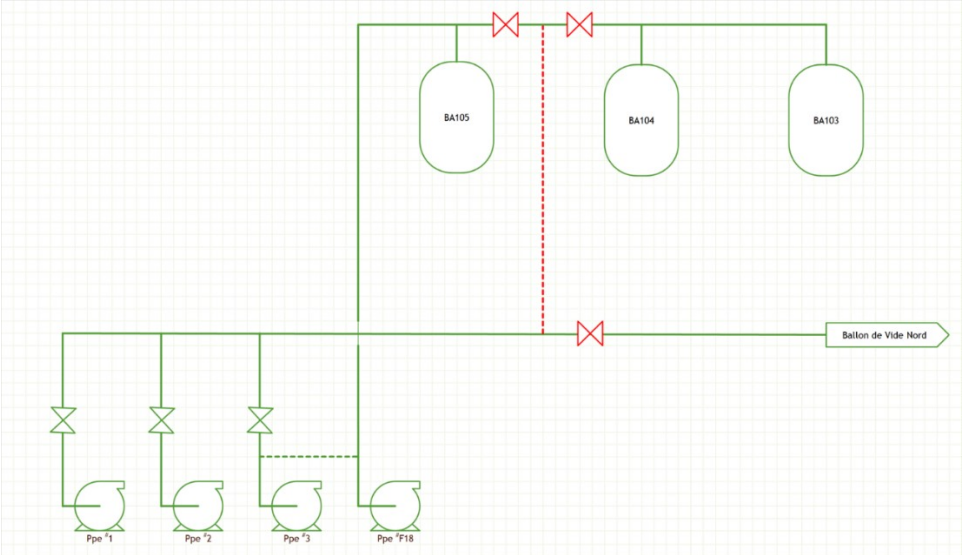

Figure 3. Sketch of the additional vacuum supplier header.

Figure 4. Left: how the new vacuum header would arrive between BA105 and BA104; Right: New Vacuum Supply header as installed with BA104 with new flange for additional liquid level indicator.

On January 27th 2022, prior to committing to install the new vacuum header to F18 (as described above) some tests were conducted on the F18 belt filter using Series 3 product hydrate and 2 vacuum pumps on line on the original vacuum header, i.e. operating both the dedicated and standby vacuum pumps at the same time. The results were as expected not very encouraging, as a moisture between 13 and 16 wt-% when operating one vacuum pump and between 9 and 14 wt.%. when operating 2 vacuum pumps were measured – far above the design objective of < 7 wt.%. Based on these results it was decided to proceed to install the additional new vacuum header (Figure 3 and Figure 4).

5. Modifications to Belt Filter F18

Figure 5 (drawn to scale) shows the modifications that were made to belt filter F18. A key change is that 2 to 3 vacuum pumps are connected to the 2 vacuum headers from the vacuum pumps (Figure 3). As a result, much less deliquoring and dewatering area on the filter is required. Also note that there is no longer any "Calcination Filtrate" as belt filter F18 would be the only product hydrate filter. The weirs and blinds in the vacuum header were moved in order to reduce the deliquoring and dewatering area on the filter. This involved rotating BA104 and making a new tie-in point on the vacuum header. Figure 6 shows the rotated BA104, and the new tie-in point to the F18 vacuum header with the blinded flange just to the left of the tie-in point. Furthermore, one additional spray bar was included after the addition of Recycled Digestion Condensate with a small portion (≈ 10 %) of the Digestion condensate diverted from washing belt, cloth and drive drum. Figure 7 when compared with Figure 2 illustrates the significantly reduced deliquoring and dewatering areas and the significantly increased drying area.

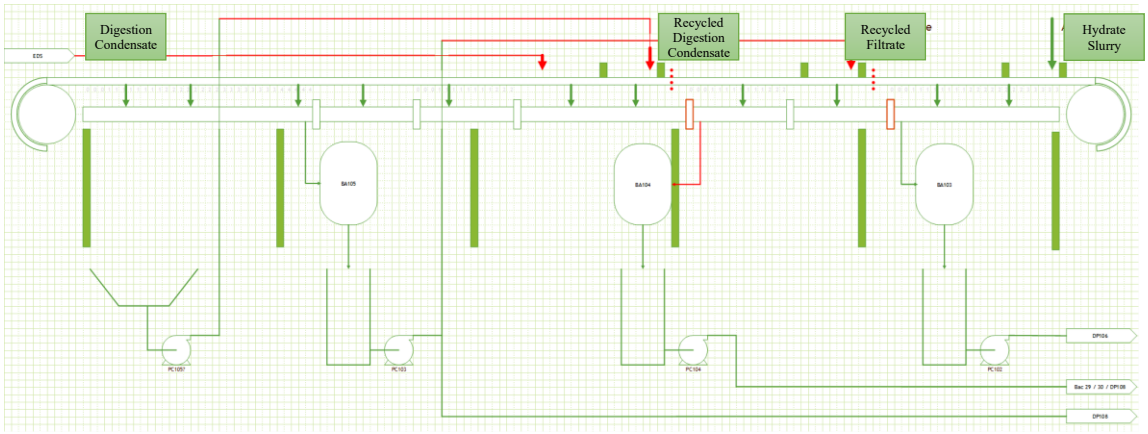

Figure 5. Modifications made to belt filter F18.

Figure 6. Rotated BA104 with the new F18 vacuum header tie-in point and a new flange with an instrument to detect high liquid levels (on left); new additional vacuum header just behind BA104.

6. Results

6.1 Preliminary Test Results

With all the new vacuum pump header installed and all modifications completed on belt filter F18 more operational tests were conducted in April and May 2022. The results are summarised in Table 3.

Table 3. Summary of results obtained after all planned modifications had been implemented.

Date	Vacuum (mbar)	Speed (m/min)	Tonnage (t/h)	Moisture (%)	Soluble soda (ppm)	Digestion condensate (m^3/h)
07 to 26/04/2022	250–380	3.5–7.0		4.6–7.0	20–670	
05 to 09/05/2022	300–390	4.0	38-51	4.9–6.0	14–25	13–20

Figure 7. Belt Filter F18 showing the significantly reduced deliquoring and dewatering areas and the significantly increased drying area.

6.2 Industrial performance

The data in Figure 8 shows that during the month of February 2024, the Belt Filter F18 operated between 45 and 62 t/h of moist alumina hydrate with Digestion Condensate between 15 and 20 m^3/h, which gives a specific water consumption of around 0.33 m^3/t moist $Al(OH)_3$. Figure 9 shows that during the same period the product hydrate had 5.3 to 6.6 % moisture and 5 to 20 ppm Na_2O soluble soda. A key performance indicator is the vacuum that should be maintained to belt filter F18 between 350 and 400 mbar. Another benefit observed is an increased filter cloth life.

Previously, the belt filter F18 filter cloth had to be replaced every 3 months whereas a filter cloth life of up to one year is now reached.

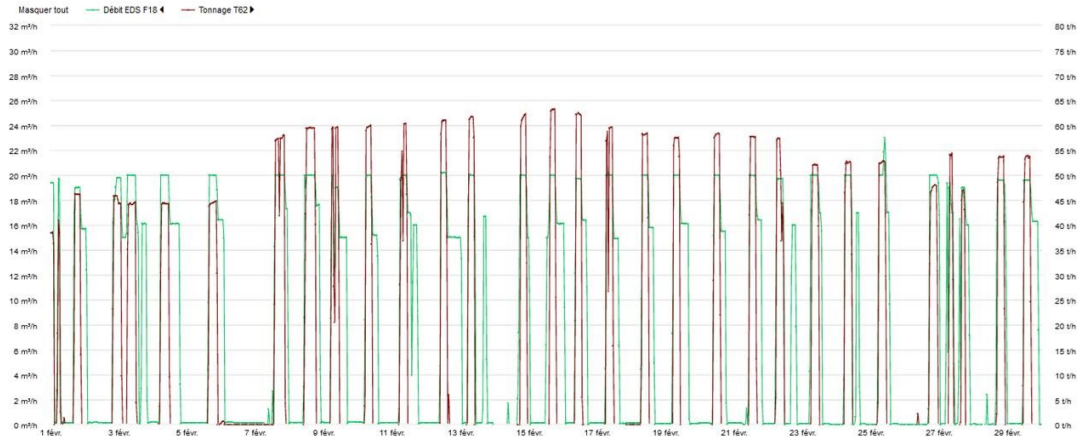

Figure 8. Industrial performance of belt filter F18 during the month of February 2024.

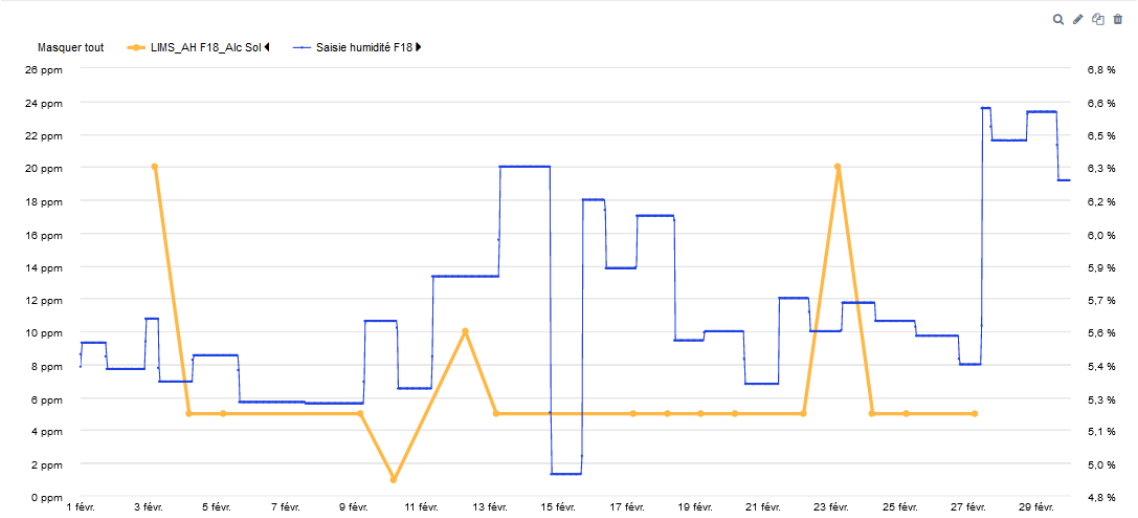

Figure 9. Moisture and soluble soda of product hydrate during the month of February.

7. Further possible improvement

Further improvements can be made to F18 to reduce either the Digestion Condensate usage and/or soluble soda in the product hydrate. In the original design of Belt Filter F18 there was a recycle wash recycling filtrate generated from the use of the recycled Digestion Condensate. This “large” volume of wash water, even though slightly contaminated proved useful to “soak” the cake and displace the remaining soluble soda. As such a further improvement that can be implemented on belt filter F18 is to use this same principle on each of the washing stages; i.e. each wash stage would be preceded by a recycle wash using filtrate from that wash in “large” volumes. Figure 10 shows a sketch of the required modifications to further improve the efficient use of the Digestion condensate.

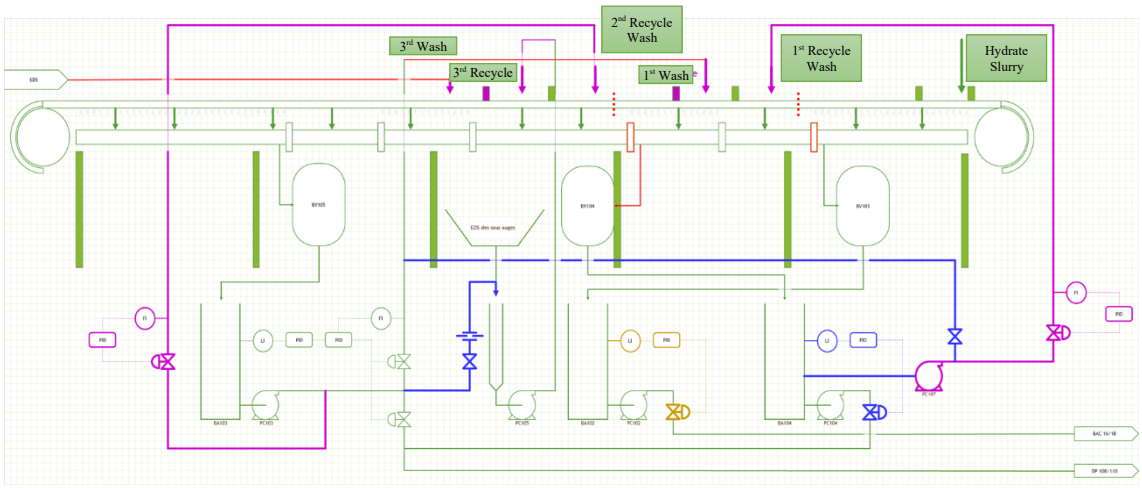

Figure 10. Recycling filtrates to increase wash efficiency.

8. Conclusions

It can be concluded that the objectives of converting Alteo's belt filter F18 from fine seed wash for sodium oxalate removal to product hydrate wash to produce high quality commercial aluminas with low moisture and with a reasonable wash water consumption of around 0.33 m^3/t moist alumina hydrate were achieved. In addition, some further modifications were identified and which could further improve wash efficiency and/or product quality. The high wash efficiency has been sustained during continuous operation since April 2022 to date (June 2024) and can be considered a world benchmark. This achievement can be sustained with only one or two changes in filter cloth a year.

9. References

1. Theodor Beisheim, Linus Perander and Peter Sturm, The Hydrate Dryer Story – From Lab to Industrial Implementation, *Proceedings of the 38th International ICSOBA Conference, 16 – 18 November 2020*, *TRAVAUX* 49, 225–232.
2. Michael Missalla et al., Energy efficiency in alumina refineries – Combining hydrate filtration with alumina calciner, *Proceedings of the 33rd International ICSOBA Conference*, 29 November to 1 December 2015, Dubai (UAE), *TRAVAUX 44*, 243–247.