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Development and Testing of the World's Largest Capacity Tailings Filter Press

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ABSTRACT

FLSmidth and Goldcorp partnered to develop the EcoTails® process for mine waste management in 2015. A significant portion of this project was the development of a new, much larger capacity, filter press. A filter press that could filter more tailings at a lower cost and less manpower was needed to make tailings filtration viable for large tonnage open pit mines. The development of this filter press took many years and culminated in a proof of concept filter that operated successfully in the summer of 2019. This paper will examine the need for such a large filter, the drivers for features that are incorporated into the filter, and the results of the successful testing.

INTRODUCTION

In 2015 FLSmidth and Goldcorp partnered as part of the EcoTails® project to develop a new, much larger capacity, filter for dewatering tailings. The goal was to dewater flotation tailings at a scale greater than 120,000 tons per day at an operating cost of less than $1.00 per ton. To minimize the number of operating filters, and operating costs, the filter needed to be able to dewater more than 30,000 tons per day of tailings and produce a cake with a cake moisture of less than 20 wt%.

To achieve these requirements the team needed to solve three main problems that are associated with current filter press technology:

1. Low filter press volume per filter (filter presses are a batch process and low volumes per batch mean low production rates per filter)
2. Slow cycle times (slow cycle times mean fewer batches per hour and lower production rates)
3. Intensive maintenance and low availability (impacting operating costs and requiring high numbers of spare filters to maintain filtration plant availability with plant availability)

Low filter press volume per filter

The solution to low filter press volumes is to increase the plate size and increase the number of filter chambers in the filter press. Larger filter volumes have many benefits:

- Fewer Filters
- Smaller Building Foot print
- Fewer Support Components. ie; Pumps, Valves, Instruments, Controls, Piping
- Fewer Cake Handling Conveyors Under Filters
- Simpler Control Coordination Between Filters
- Fewer Filter Chambers
- Reduced Number of Filter Cloths to Change
- Reduced Number of Filter Plates to Handle

The final design includes a filter plate with dimensions of 5m high by 3m wide and 160 chambers resulting in a filter volume of over 90 m^3 and over 4,000 m^2 of filtration area. The final plate was width was arrived at by a limitation of filter media looms to generally provide a width of no more than 3 meters. The height of the plate, 5 meters, is twice the dimension of the largest operating filter press at that time, which was 2.5 meters.

Figure 1 5mx3m plate

These figures are over 300% more than current typical large filter presses. Figure 1 shows a rendering of the plate while Figure 2 shows a rendering of the 5x3 filter as currently designed.

Figure 2 5mx3m filter

Slow cycle times

Filter cycle times consist of two main components, process time and mechanical time as described in 'High Efficiency Filters for Tailings Applications' (Rahal, 2019). Process times are minimized by:

- Filling the filter at high pressures
- Eliminating the use of membranes for squeezing the cake
- Reducing or eliminating cake air blow
- Optimizing feed pumping control to take full advantage of pump flow and pressure capacities.

Mechanical times are minimized by:

- Opening the complete plate stack all at once
- Maximizing the speed of the opening and closing
- Performing valve openings and closings in a parallel method when possible
- Optimizing cloth washing and cloth shaking times when possible

For most flotation tailings, total cycle times of less than 8 minutes can be achieved if both the process and mechanical times are minimized. There are multiple operating examples of filter presses with cycle times of less than 8 minutes on flotation tailings. Cycle times of 6 minutes are possible using the optimized mechanical times described here.

Intensive maintenance and low availability

Most maintenance on a filter press is associated with the filter cloth and filter plates. Filter cloth has a typical lifetime of around 3,000 cycles on most mineral flotation tailings. This leads to changing the filter cloth on the filter approximately twice per month, depending on how often the filter is operated. A plate design, shown in figure 3, eliminates the failure areas on the filter cloth allowing much longer cloth life.

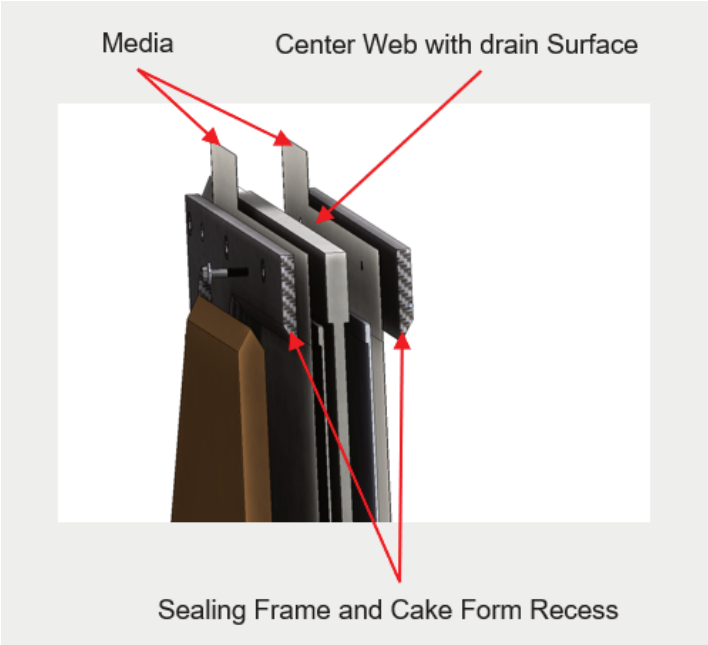

Figure 3 5mx3m plate assembly

As was described in 'Maintaining high availability and low operational costs for filtered tailings facilities' (Wisdom, 2019), high availability can be achieved by performing the cloth and plate maintenance outside of the filter press. Current FLSmidth filter presses can achieve over 90% availability utilizing this method. It is envisioned for the 5x3 filter that plate cassettes of 10 will be removed, as shown in figure 4, and maintained outside of the filter. As soon as the dirty filter plates are put into the maintenance rack, new clean plates are lifted into the filter allowing the filter to operate while the dirty plates are maintained. As the cloth and plate maintenance is performed outside the filter, while the filter is operating, high availability of the filter is maintained. The total downtime to remove a set of plates and reinstall a set of plates has been measured in an operating filter to be 10 minutes.

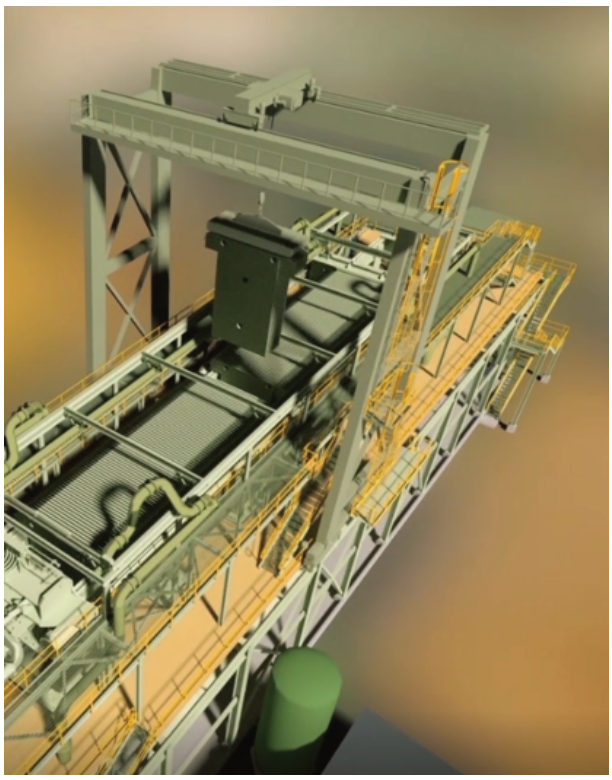

Figure 4 Plate cassette removal (courtesy Ausenco)

In order to proceed with the EcoTails project it was required to build a proof of concept test filter which uses a 5m x 3m plate in which the process performance of the 5x3 filter chamber could be validated.

DISCUSSION

The specifications of the 5x3 Proof of Concept filter are:

- Weight – 40 tonne
- Plate Size – 5m x 3m
- Chamber Volume – 0.6m^3
- Filtration Area – 25.12m2

The proof of concept filter installed and operational is shown in figure 5.

Figure 5 5mx3m proof of concept filter

Like an operating filter the 5x3 proof of concept filter forms a filter cake in a vertical configuration as seen in figure 6.

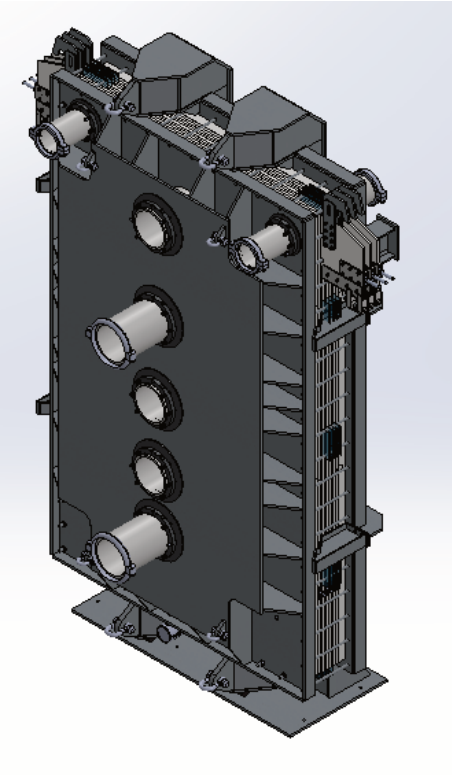

Figure 6 Proof of concept filter vertical position

Unlike an operating filter, the 5x3 proof of concept filter is laid horizontally so that cake samples throughout the filter chamber can be taken. This is accomplished by taking the filter head and corresponding filter plates off in layers using a crane as shown in figure 7.

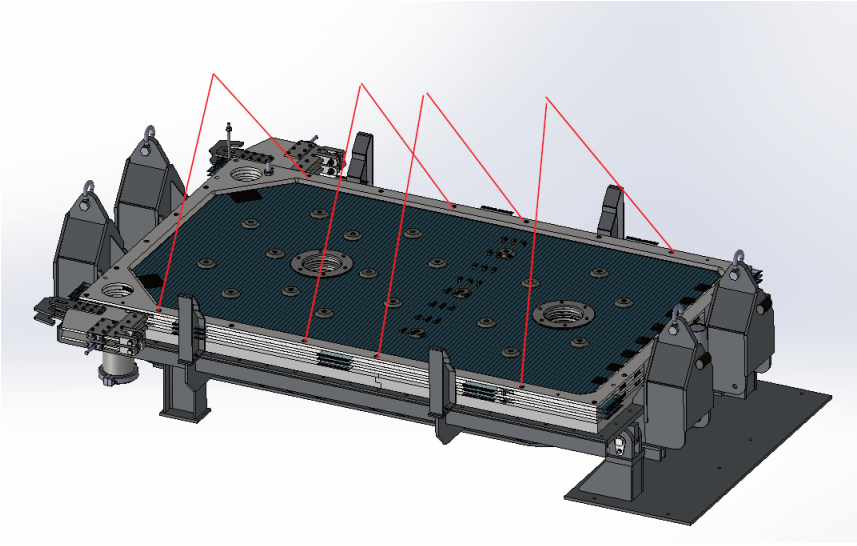

Figure 7 Proof of concept filter horizontal position

Once the cake is exposed samples can be taken as shown in figure 8.

Figure 8 Cake sample

Cake samples were taken in 9 locations, 3 rows of 3 samples, at the top, middle and lower portions of the plate. The cake samples were analysed for PSD, wt% solids, and dry solids density. These results were compared with lab and pilot scale filters using the same feed slurry and the same operating parameters to verify performance.

RESULTS

The tailings material tested had the following characteristics:

- Solids SG: 2.77
- Slurry Density: 1.64 @ 60 wt% solids
- P80: 146 micron
- P10: 2 micron
- Slurry Type: Lead/Zinc Flotation Tailings

A filter cake was formed by pumping the feed slurry under pressure into the test filter. A picture of a 5x3 formed cake is shown in figure 9.

Figure 9 5x3 filter cake

The results from this test showed very little variation between each of the 9 samples. The results of all the samples for this test can be seen in table 1.

Table 1 5x3 Filter Sample Data

Sample Location	Cake Moisture, wt%	Wet Cake Density, kg/m³	Dry Cake Density, kg/m³
Sample cut out #1 - Cake Upper Left	15.6	2213.3	1867.8
Sample cut out #2 - Cake Upper middle	16.4	2245.5	1877.4
Sample cut out #3 - Cake Upper Right	15.6	2241.2	1892.0
Sample cut out #4 - Cake Middle Left	15.7	2157.8	1819.8

Sample cut out #5 - Cake Middle Middle	15.8	2270.5	1912.0
Sample cut out #6 - Cake Middle Right	15.7	2118.1	1786.2
Sample cut out #7 - Cake Lower Right	15.6	2200.4	1856.6
Sample cut out #8 - Cake Lower Middle	15.5	2293.2	1937.4
Sample cut out #9 - Cake Lower Left	15.8	2096.7	1765.1
Average	15.7	2204.1	1857.1
Standard Deviation	0.262	67.65	57.09

When these results are compared to lab and pilot scale filter test results on the same feed slurry and with the same process conditions, the results look outstanding. This comparison between filter performance is shown in table 2.

Table 2 Filter Performance Comparison

Filter Size	**Cake moisture average, wt%**	**Dry cake density average, kg/m³**
Lab Filter	18.0	1.833
Pilot Filter	16.9	1.840
5x3 Filter	15.7	1.857

As can be seen in table 2, the 5x3 filter performed better than the lab and pilot scale filters with respect to cake solids and cake density at the same filtration rates indicating that no scaleup factors are needed when sizing a 5x3 filter from bench or pilot data.

It is also important to ensure that there is no segregation of fine and coarse particles in the filter chamber. The middle of the bottom of the cake and the middle of the top of the cake were analysed

using a Malvern Particle Size Analyzer. The results from the PSD analysis are shown in figure 10 for the top of the plate and figure 11 for the bottom of the plate.

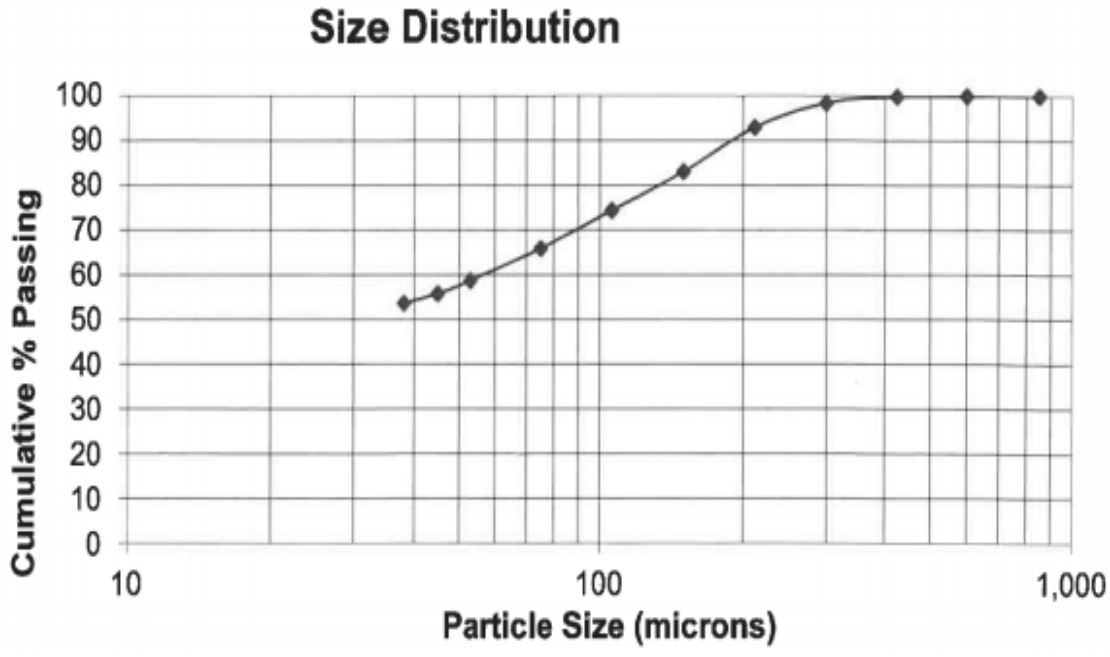

Figure 10 PSD middle top of cake

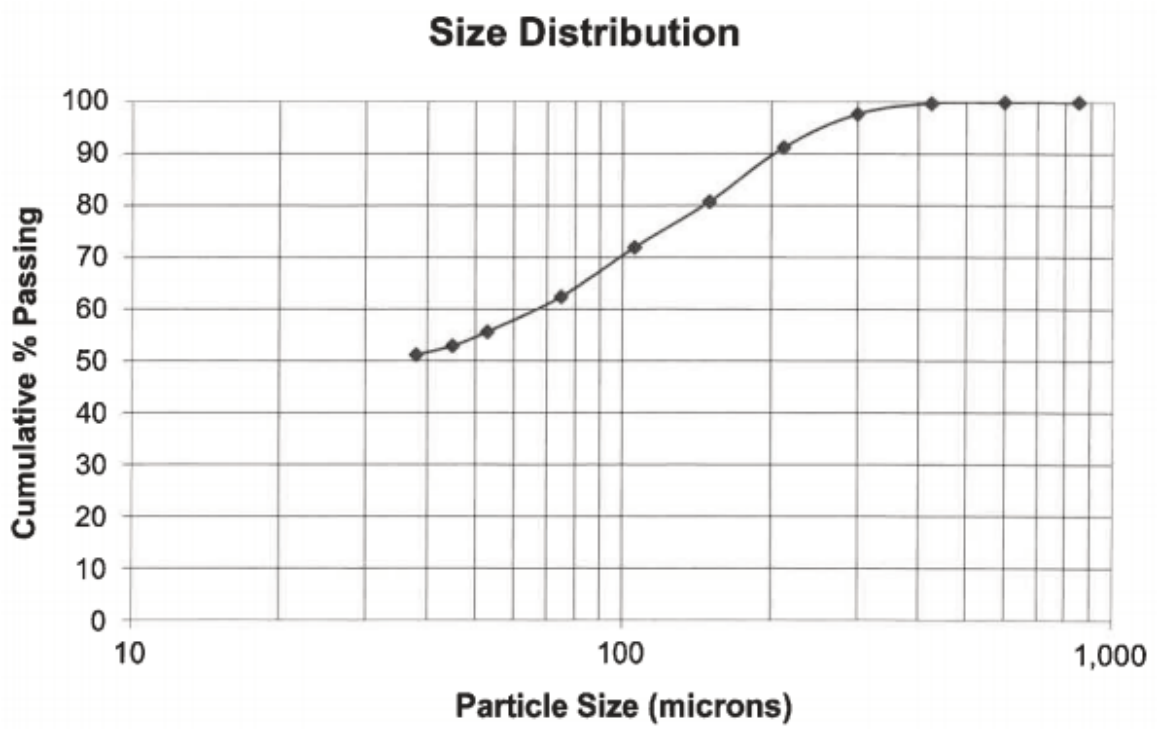

Figure 11 PSD middle bottom of cake

As can be seen from the figures there is no segregation of fine and coarse particles in the 5x3 filter chamber.

CONCLUSION

The EcoTails project required the development of a new, much larger capacity, filter press. This filter press is designed to process 30,000 tons per day of typical mineral flotation tailings at an operating cost of less than $1.00 per ton. The development of this filter press took many years and culminated in a proof of concept filter that operated successfully in the summer of 2019. The results of testing show that a homogeneous filter cake with respect to cake moisture, cake density, and particle size can be achieved in a 5m x 3m chamber.

REFERENCES

Rahal, K. (2019) 'High Efficiency Filters for Tailings Applications' Tailings Conference 2019, Santiago June 2019

Wisdom, T. (2019) 'Maintaining high availability and low operational costs for filtered tailings facilities', Paste Conference 2019, Cape Town South Africa May 2019