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High Capacity Dewatering Plants

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ABSTRACT

The mining industry is becoming more and more attracted to dry stacking as a method of mine tailings management.

The development of bigger-sized plates now allows metal producers to utilize pressure filtration technology to process flow rates of up to 200,000 tonnes per day of dry solids, which was undreamed of just a few years ago. The advantages of this technology include very low cake moisture content, significant savings in water usage and the possibility to recover product (when required) without the need of CCD washers.

The filter press technology combined with bigger-sized plates enables filters to be installed in remote sites with high average rainfalls, offering the mining company the possibility of a safer and more sustainable environmental impact, thanks to a stable stack of solid material that requires less room than traditional thickened residue dams.

The aim of this presentation is to show the latest studies where this technology has been applied.

INTRODUCTION

Today, dry stacking can be considered a well-established disposal technique for the management of mine tailings. To be suitable for stacking disposal the final residues should be dewatered considerably below the so-called "liquid limit", i.e. they should behave like a plastic material with high strength (cake), despite their water content (Jewell & Furie, 2015). From this point of view the term "dry stack" can be misleading (a water fraction is always present) but is widely used and accepted in the mining sector.

The moisture target value is defined by geotechnical studies, considering the material geomechanical characteristics, and can be significantly lower than the one related to the liquid limit.

Different filter technologies are used for tailings dewatering, such as filter presses, rotary-drum vacuum filters, travelling-belt vacuum filters and hyperbaric filters.

Filter presses are becoming more and more popular often by offsetting objective disadvantages (e.g. high capex and discontinuous process) due to their significant benefits (e.g. very high dewatering performance, flexibility and high throughput) compared to other types of filters. In the last few years there has been a constant increase in number of filter press installations for different mine commodities (especially gold, alumina, iron ore and coal). As an example, the total installed filtration area for gold tailings increased from one hundred to six hundred thousand m² from 2010 to 2019 (Whittering, Pyle & Lane, 2019).

Typical achievable residual filtered cake moisture (water/solids) by pressure filtration varies from a five to 35 percent, depending on tailings composition and process conditions. In figure 1, the achievable moisture from Diemme Filtration database for different applications is reported.

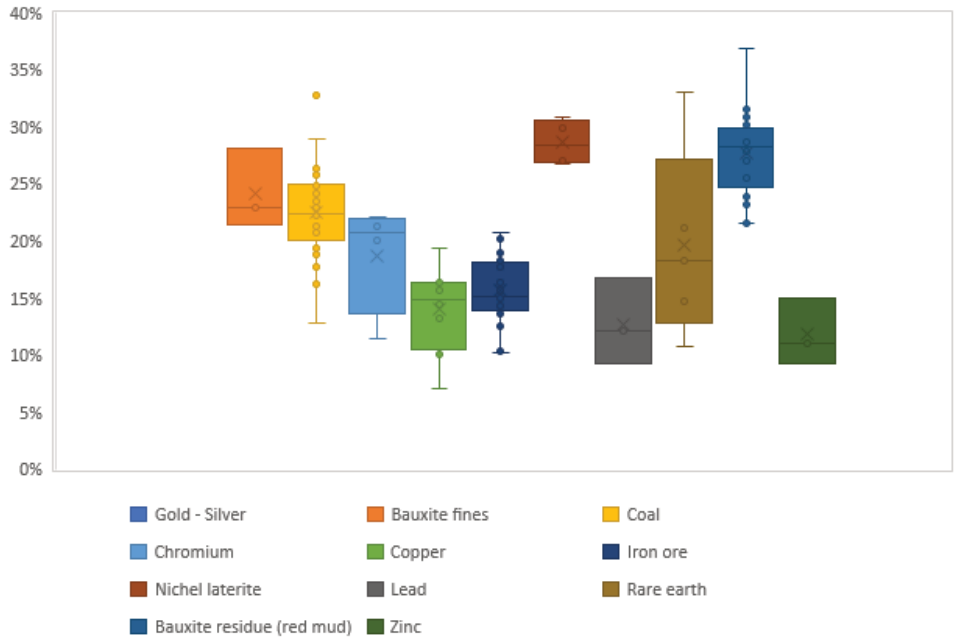

Figure 1 Residual moisture ranges (by mass fraction) by commodities (data from Diemme Filtration database)

Maximum solid throughput depends on many factors (solid specific gravity, particle size and shape, feed density etc) but in general varies from ≈1800 tonnes per day (average filterability slurries, e.g. bauxite residues) up to ≈3000 tonnes per day (high filterability slurries, e.g. copper or iron ore, magnetite, tailings) per single unit, considering a filter equipped with 2500 x 2500 mm plates.

The design of the filter presses design is crucial to get the desired performance while minimizing capex and opex. To achieve this the filtration process should be properly optimized. In the following paragraphs several aspects about this will be discussed.

METHODOLOGY

The filter press design and sizing are not just limited to the definition of the right filtration media and filtration area. Many other parameters (as discussed below) play a key role in determining the performance of the filter (i.e. cake residual moisture, solid throughput, filtrate quality etc.). These parameters include number of plates, chamber thickness, plate design and application of air blowing for cake desaturation. All these options can impact the filter price severely. It is critical that a precise definition of the desired results is understood even before preliminary test work is undertaken.

The following figure summarizes different filter plate pack configurations and possible process steps.

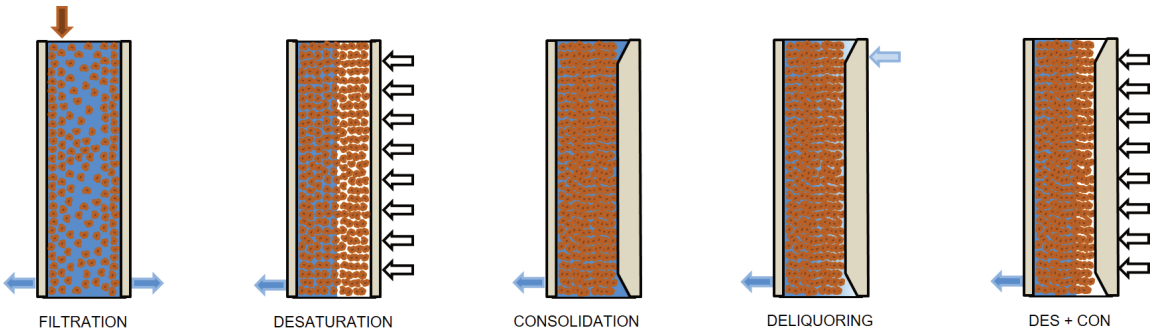

Figure 2 Filter press configurations

The equipment design should define many parameters like:

- Plate pack: recessed plates (i.e. fixed volume chambers) are the simplest solution, and for most applications brings the best cost/benefits compromise (with or without cake blowing). The use of variable volume plates leads to a higher compaction by means of solid rearrangement into the cake (consolidation); the gain in dewatering efficiency is strongly dependent on the cake compressibility (and on the particles' characteristics indeed) and can be very significant (up to ten percent lower moisture), justifying the higher capex (Stickland, Skinner, Cavalida & Scales, 2018)
- Plate number and plate thickness: Diemme GHT filter press can be equipped with up to 191 plates. Considering a plate size of 2500 mm x 2500 mm the total filtration area results in a range of 960 square metres up to 1800 square metres, depending on the plate pack opening system. Chamber thickness for tailings application is usually 40 mm but can be lower (30

mm) or higher (up to 60 mm) to optimize the feeding and compacting time in case the filterability is particularly low or high

- Cake desaturation: cake drying using compressed air is applicable both on recessed and membrane plates. Cake moisture can be drastically lowered and, more important, desaturation is the only viable method to eliminate cake thixotropy, when present (Kaswalder, Collini, Grosso & Finocchiaro, 2015). The efficiency of air drying depends on the cake structure, high cake specific resistances makes the air displacement less effective. Opex related to cake desaturation is due to power demand for compressed air production, while capex is increased by the compressor cost and by the increased filter size (the solid throughput can be up to 35% lower due to increased cycle time)
- Cake deliquoring: liquor displacement by water or other solvents can be applied when the liquid phase contains valuable products (e.g. soda in the Bayer process or cyanide complexes in Merrill-Crowe applications) including water (in fact, water conservation is often an important driver). Filter presses equipped with cake washing can be used as an alternative to CCD washing trains. Diemme filtration filter presses have been successfully applied on gold mines to recover barren liquor from tailings slurries. Multiple-stage countercurrent filtration applied to hydrometallurgical leaching processes (see Figure 3) with a combination of in-situ washing and cake re-slurrying are currently under development, and can represent a viable solution when thickeners can't be used (e.g. process requirement)

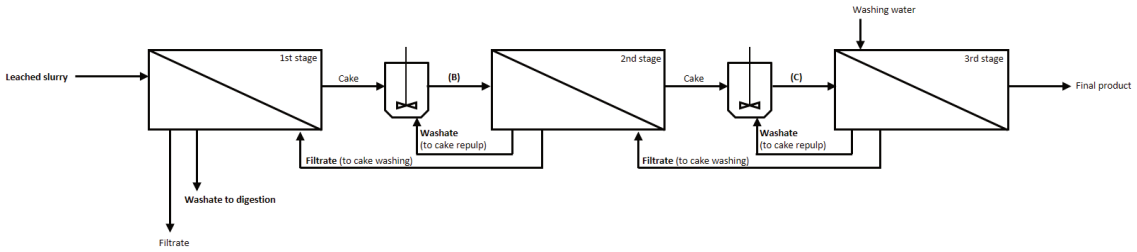

Figure 3 Counter current washing train with pressure filters

RESULTS AND DISCUSSION

Extensive studies have been carried out by the Diemme Filtration R&D department on tailings slurries from different sites. Different process conditions have been simulated for different scales, both laboratory and industrial. The following figures summarize some results.

It's important to point out that these graphs represent only a general picture and that, as previously discussed, many other parameters are involved in determining the dewatering efficiency (i.e. desaturation step air consumption, feeding pump pressure, solid characteristic like particle size distribution and specific gravity).

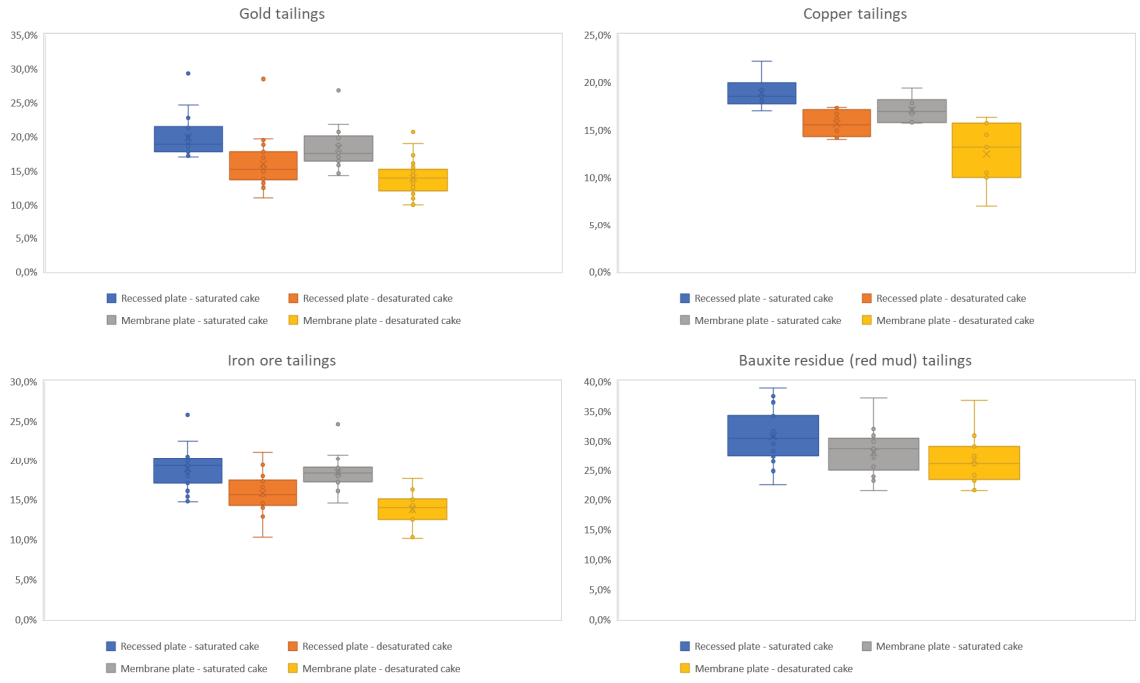

Figure 4 Cake moisture (percent by weight) achievable with different filter configuration

Nevertheless, it looks clear that, as a direct consequence of its versatility, the definition of a standard filter press suitable generically for any case is hard to make: the same configuration, in terms for example of type of plate and process involved (feeding, squeezing, blowing etc.) give different performances while dewatering different products.

The key role for the selection of the optimal process configuration is undoubtedly the definition of the targeted moisture, which is mainly dictated by the stability requirements of the stack. All the results reported in the previous graphs are related to residual cakes that stand below the liquid limit, however with relatively wide range of residual moistures that gives different geotechnical behaviour when stacked. As an example, an iron ore tailings filter cake with 18% moisture can be achieved with relatively low efforts on a filter equipped with recessed plates and no air drying, while to lower it down to 10 percent, membrane plates and air drying is necessary, resulting in significantly different capex and opex.

Figure 5 shows a meaningful example where a real data from the Diemme Filtration operation on a polymetallic tailings in South America are reported (Grosso, 2019); as observable, the cake moisture is strongly dependent on the air drying consumption, and the air compressor power demand is affected by the extreme environmental conditions (the site is located at 4000 m above sea level).

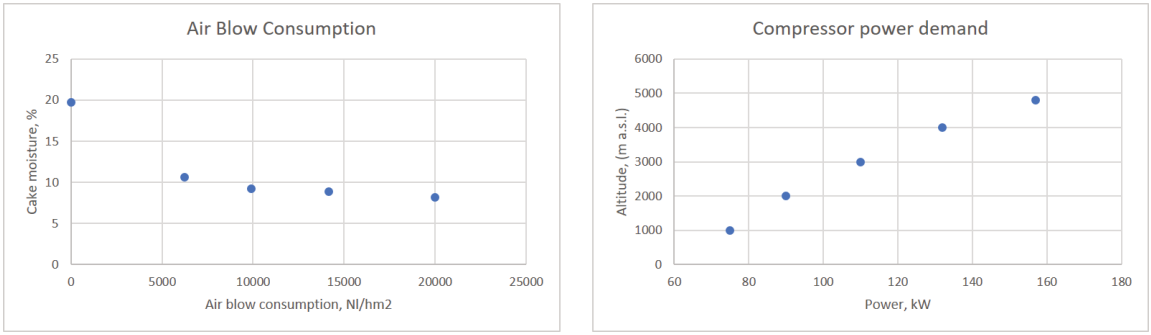

Figure 5 Moisture vs air blow consumption, polymetallic tailings

From this point of view it's increasingly important, during the stack design phase, to make an evaluation of the impact of the moisture requirements.

It should be noted that the current trend is a constant and sharp increase of the throughput demand, higher than 100000 Tonns per day, also related to lower grade deposits that require larger-scale dry stack tailings systems. This needs a constant improvement of the filter press technology, aimed to cost optimization and increased capacity. To fulfil these needs Diemme Filtration developed a new filter press size (GHT 5000, see Figure 6) capable of reaching a filtration area of up to 20 m^2 and a total volume of up to 550 liters per single chamber (plate dimensions are 5000 mm x 4200 mm).

All the features of the smaller filter press have been retained, like membrane filter plates, cake blowing, cake washing, plate and cloth rinse washing, and high pressure cloth washing.

High availability of the filter press, shipping of the components, component handling and assembly are major issues when a big-sized piece of equipment like this is designed.

Also, many efforts have been made to optimize capex and opex, with a particular focus on the installed capacity, by minimizing the power demand of the hydraulic unit as much as possible.

CONCLUSIONS

In the present paper many aspects about filter presses have been discussed. Some of them, listed below, make these devices the best candidates for solid liquid separation of mine tailings.

- Flexibility: filter press can be successfully applied to dewatering of a wide range of different tailings, from high filterability slurries (e.g. copper or iron ore tailings) to clay-bearing fine slurries (e.g. mineral sands, bauxite residues), thanks to a high degree of customisation.
- High dewatering performance: cake moistures achievable are in most cases lower than alternative technologies and furthermore can be tailored according to the geotechnical requirement of the stack.
- High throughput: to fulfil the actual trend and the increasing demand, filter presses have increased in size significantly. Diemme Filtration's GHT 5000 filter press is designed to achieve extreme productivity as requested by many current dry stack projects. As a comparison, 100,000 tonnes per day dry solid throughput for a flotation tailings application

(e.g. copper, zinc, iron ore) can be achieved by 12 GHT 5000 units instead of 33 GHT 2500 (the biggest Diemme filter currently in use).

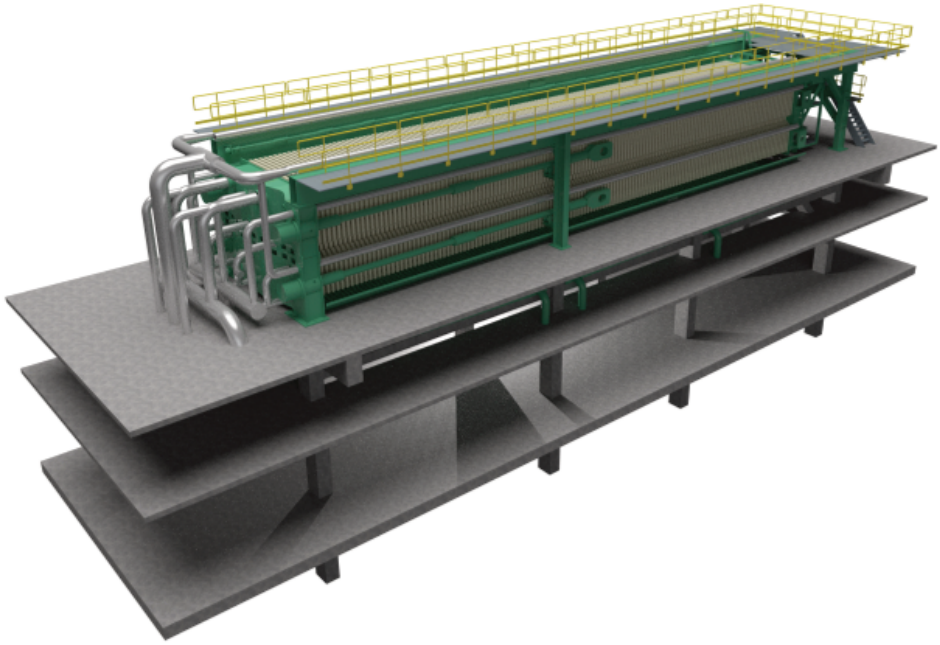

Figure 6 Diemme Filtration GHT5000 Filter press

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